The Dynamics of Energy in Pakistan

Vol : 2

Syed Akhtar Ali

The Dynamics of Energy in Pakistan

Vol II

© Syed Akhtar Ali

Author

ISBN: 9798872328896

Other books published by the author

- Dynamics of Energy in Pakistan Vol I
- Issues in Energy Policy, Pakistan
- Pakistan Energy Issues: Success and Challenges
- Pakistan's Energy Development: The Road Ahead
- Pakistan's Development: Economy, Resources and Technology
- Pakistan's development challenges: Federalism, Security and Governance
- South Asia Nuclear Stalemate or Conflagration
- Political Economy of Pakistan: An Agenda for Reforms
- Nuclear Politics and the Challenges of Governance
- Pakistan's Nuclear Dilemma

Research on Economy & Politics Pakistan

The Dynamics of Energy in Pakistan

Vol II

Syed Akhtar Ali

Research on Economy & Politics Pakistan

About REAPP

This book is based on a study that has been done under the auspices of Research on Politics and Economy of Pakistan (REAPP).Part-I of the study has been published earlier under the title: Pakistan Energy Issues; Success and Challenges. REAPP is a Think Tank which was established in 1984.It has organized many studies in the area of Energy, Governance and Technology.

Other books by the same Author:

1. Pakistan’s Nuclear Dilemma: Energy & Security Dimensions, 1984
2. South Asia: Nuclear Stalemate or Conflagration, 1987
3. Political Economy of Pakistan: An Agenda for Reforms, 1992
4. Nuclear Politics & the Challenges of Governance, 1994
5. Pakistan’s Development Challenges; Federalism, Security and Governance, 2010
6. Pakistan’s Development: Economy, Resources & Technology, 2011
7. Pakistan’s Energy Development; the Road Ahead, 2012
8. Issues in Energy Policy, 2014
9. Pakistan’s Energy Issues; Success & Challenges, 2018
10. The Dynamics of Energy in Pakistan, 2020

Table of Contents

LIST OF TABLES, CHARTS AND FIGURES

List of Figures

PREFACE

Part-I of this book was published in December 2020.This is Part-II comprising of my articles published in the meantime since then. Choice of the format adopted has been based on the independence given to the reader to start reading from anywhere. He does not have to follow a sequence. Also, the chapters have been provided with data tables and figures which could not be published in the articles of the Newspapers. In that sense, this book justifies its existence.

Pakistan is now suffering from a number of problems; slowed down economy, budget deficit and currency depreciation. This has given rise to, among other factors, higher energy tariff. International commodity prices increased to its highest peak in history. Thus both Capacity charges and fuel charges increased. Not only that fuel prices increased, their availability decreased as well. Slow down of the economy has been caused, among others, by high energy prices and vice versa. Power sector Circular debt has been increasing. Even gas sector has come in the cage of circular debt. Rising poverty has limited government's ability to raise energy tariff, although It has been doing so, as much as it found it feasible.

Nobody has a magic wand to solve the problems of this dimension. Many issues are related with past contracts about which nothing can be done. But there are many steps that can be taken. Electricity and Gas theft has been considered as impossible to eliminate. But recent firm actions have indicated that it is not impossible to catch thieves and collect the receivables.

However systems have to be developed which last beyond the exercise of power by the law enforcement agencies. This book deals with a myriad of problems and ventures to offer solutions. Some may be accepted by the stakeholders and some may be not.Nobody can be right all the time on all the issues.

This book has been divided into the following sections.

1.Oil ;2.Gas;3.Coal ;4.Electricity ;5.Renewable Energy; 6.Minerals ;7.Energy Conservation and Efficiency ;8.Environment

Following are the main issues that have been dealt with in this book.

Fossil Fuels & Climate Change Issues

COP 28 has ended with a compromise solution. There was one side, led by the developed countries, and climate activists which emphasized fast track and definite end to fossil fuel. There was another side, led by oil producing countries mostly, which opposed fast track approach and asked for a gradual approach.

The final text of COP28 has for the first time explicitly called for "transition away from fossil fuels –in a just, orderly and equitable manner accelerating action in this critical decade so as to achieve net zero by 2050".It avoided the more explicit and hard language of "phase out or phase down fossil fuels". It has, however, been explicitly against coal calling nations, "to accelerate efforts towards the phase down of unabated coal power". So it was a fight for *Transition away from fossil fuels vs phase down.*

Although, there is a common future in adopting policies which contain temperature increase by or below 1.5 deg C by the turn of the century, for developed countries, all is well; fossil or no fossil. They benefitted from exploiting the fossil and the dirtiest fuels and almost exhausted those. They were producers and exporters of fossil fuels. There are and were some developing countries which were lucky enough to discover and produce fossil fuels. And now that, Alternative energy is approaching near perfection and wider availability in near future, they would be equally on top of it. Infact, they would be better off. Their dependence on fossil fuel, especially, oil would be no more there. They would be independently producing alternate energy like Solar, Wind and Hydrogen etc.

The controversy and heated debate leading to a soft statement has disappointed many policy intellectuals in the West. It may be noted that according to the existing rules, all members of UNFCC have to agree; even if one member disagrees, decisions cannot be made. They are thinking to change the rules to the acceptance by some majority measure like 67-75% of the members.COP process can be wound away. The world policies are shaped by the consensus of the developed countries which are strongly in favor of Net Zero by 2050.Carbon tax may be levied on fossil fuels and imports or exports of the countries using fossil fuels in defiance.

High Energy Prices

The most important issue that has occurred in Pakistan in energy sector is the high energy price. Energy price has doubled or even tripled. Although various blames are laid on the operators and investors, the fact is that it is the state of economy which is largely responsible for high energy prices. Pakistan's energy sector is largely dollar based due to low local content. Exchange rate has gone down from Rs 105-150 to Rs 285 to a U.S, dollar. Similarly, international interest rates have doubled. If one eliminates or adjusts for these two increases, one would arrive at the pre-increase tariff rates. Thus if energy sector has to be improves in terms of prices and supplies, economy has to be improved. And simply speaking, exports have to be increased and imports have to be decreased to maintain a viable exchange rate. However, at this stage, economy and energy are reciprocally inter-dependent.

Competition and Liberalization

There is contentious debate going on regarding competition and liberalization of the energy sector which is currently highly regulated. There are pros and cons of competition vs regulation. Firstly, energy especially electricity are natural monopolies. Western economies have been successful in liberalizing the electricity sector over a period of time.

In Pakistan, there is IPP model which allows for competition and competitive pricing especially in generation sector, which has not been practiced. Only in one case, of Jamshoro coal power plant, there was competition due to ADB requirement. It was, however, not allowed to be implemented in full and remained limited to the implementation of one phase only. The real benefit would have occurred, if and when the second phase was implemented. There are now efforts to revive the phase two, but there are many problems and issues as several years have lapsed.

There is a WAPDA model which involves project component wise bidding; separate biddings for site preparation, civil works, machinery and electrical works. WAPDA projects are government financed though multilateral agencies or G-to-G financing. There cannot be competition in G-to-G projects for obvious reasons as the financer requires to purchase the machinery from its own country. Only in case of financing from Arab countries, it is possible to hold competition to procure items from third countries on competitive basis.

CTBCM (Competitive Trade under Bilateral Competitive Mechanism) has been under development and discussion for several years now. There are many issues and constraints in its implementation which have been discussed in detail in this book in relevant chapters. However, it is stuck currently under Wheel Pricing .DISCOs and PEPCO are demanding what buyers and NEPRA consider to be excessive in the range of Rs 10-15 per unit. Buyers represented by APTMA are offering Rs.5.00 per unit. No mutually acceptable formula could be achieved by now after several rounds of public hearings and follow-up discussions.

In the case of oil sector, deregulation and liberalization has been discussed by many quarter. Government appears to be scared of leaving such a big sector involving imports of 12-15 billion USD in private hands. The performance and integrity of private sector has remained questionable in all liberalized sectors like Sugar, cooking oil, cement etc. It is argued that oil prices are regulated to a degree of less than 50 Rs per Liter, while other parts of the prices are determined by internationally competitive prices. Those who argue for an unregulated market think that overall economy would be expanded if large sectors like Oil are liberalized.

Mineral Sector

Minerals have attracted the attention of the government after the resolution of Rekodek issue. After earning a fine award of 9-10 billion USD, the legal issue has been resolved through bilateral negotiations. After paying off, 900 million USD to the Antafogasta, the Chilean partner, bilateral agreement has been reached successfully and a revised feasibility study is being compiled. It is hoped that both government and other stakeholders including public , lawyers ,judiciary and intellectuals would have learnt lessons from this debacle.

Currently, it appears that resource can be a curse if not handled carefully. Many African countries are suffering under poverty despite having ample resources , especially, mineral resources. There is competition in mineral sector as well. There are more than 20 countries which have e.g. Copper resources and better in quality than Rekodek. No party, investor or resource owner can afford to blackmail each other or take undue advantage of each other. Business has to be done as businessmen and issues should be settled through bilateral business negotiations and not under judicial and legal processes and even that being devoid of the sectoral knowledge.

While, we are entering into the mineral sector under a new zeal, it should be understood that projects are implemented under economic and financial viability. Local processing and downstream industry is not in itself a requirement of success and high development. In mineral sectors, there are a lot of complexities. Prices can go up and down cyclically. Only now, Copper prices have achieved a level of good profitability. Earlier, Pakistan's local copper project at Saindak has been losing money.

Thar Coal

Thar Coal is the only large energy resource in Pakistan. It is the fifth largest resource in the world ranking. Although, it is Lignite, containing 50% moisture and thus having half the Calorific Value, it is still good enough for power production and other industrial uses. Several power plants have been commissioned under CPEC. Thar coal based electricity has proved to be competitive with the imported coal projects. It is unfortunate that under zeal of speed, we went for more imported coal power plants than it was feasible. Recently, there was energy crisis and all energy resources including imported coal became several times more expensive making it totally unviable. It can happen again. Efforts are being made to convert the imported coal power plants to Thar coal. However, imported coal prices have come down which has thrown cold water on these initiatives.

Unfortunately, we have started using Thar coal, when the world has gone through using and exploiting it .It adopted oil and gas and used it extensively. And now they want to go for Renewable energy under Climate issues and pollution. China has announced it won't finance any coal power plant outside its own territory. Both India and China may continue to build and operate coal power plants. Pakistan neither has the money nor the technology to be able to install more coal power plants under international opposition.

Thar coal gasification could produce many products like Methane (gas),Diesel, Methanol, Ammonia, Ammonium Nitrate and Urea fertilizer. China is a major coal gasification producer producing the aforementioned products out of coal. Chinese companies have been visiting Pakistan for installing a project in this respect. However, it is not known if the interest has survived in the context of Climate issue constraints.

Pakistan still imports coal for its industrial use, especially, the cement sector. Import volume is more than 1 billion tons and foreign exchange loss is also more than 1 billion USD. We have provided more detailed and exact data in the relevant chapters. Pakistan has the ability and technology to use Thar coal in the cement and other extractive sectors like Tiles, bricks and glass etc. A Rail Link project to connect Thar with the Rail network has been approved. It is hoped that it would be completed early enough to enable its industrial utilization. We should utilize every opportunity to use this cheaper and economical resource for our industrial and economic development.

Renewable Energy

Pakistan has installed substantial renewable energy capacity; Hydro, Solar and Wind. There are vast hydro resources in Pakistan and so are of Solar and Wind. All resources have their own positives and negatives. Only a mix of resources can provide an economic, balanced and stable electrical system. Hydro slows down in winters, solar is available during the day and Wind blows more in summer than in winter and also its speed varies throughout the day. Fortunately, Pakistani local experts have come to acquire significant expertise to develop least-cost generation models which used to be done earlier by foreign experts. IGCEP (Integrated Generation Capacity Expansion Planning)is being made and revised annually enabling a consistent planning regime. However, lack of coordination with Transmission planning has caused difficulties. However, it has been decided that IGCEP and TSEP (Transmission System Expansion Planning) would be carried out simultaneously and approved accordingly.

COP 28 has called for transitioning of fossil energy sources. It actually means that it would be phased out in next 50 years. There are plans to achieve Net Zero emissions by 2050.They want to limit earth temperature to rise at a maximum of 1.5 deg Centigrade over and above the pre-industrial level. However, earth temperature is rising despite zealous talk in the international conferences.

Electricalization of transport and development of Hydrogen appear to be the two main components of the emerging regime. Transportation sector consumes more than 70% of the Oil resource. Gas is used by the industry and residential sector mostly. Will the developing countries including Pakistan be able to develop a large and stable electrical supply system to convert the transport sector to electricity under a variable renewable energy regime; the capital and technology, both may be lacking to achieve this in the next 50 years. However, if sincere international cooperation is made available, perhaps 50% achievement or more may be possible .

Pakistan should start developing local capabilities and technology in Solar, Wind, Hydro and Hydrogen. There are many common elements. Countries like India, Turkey, Malaysia, Indonesia and even small Morocco have developed significant local capabilities in renewable energy sector.

Bio-Gas

Gas production and reserves in Pakistan are dwindling by the day. Gas reserves may get extinct in less than a decade unless new reserves are found. For several decades, no major gas find larger than 1 TCF has been made. Reliance on imported LNG is increasing. In this context, the importance of other gas resources like Biogas and coal gasification has increased. We have discussed about Coal gasification earlier. Here we will restrict ourselves on Bio-Gas. Pakistan is a country of 20 million people having a cattle population of more than 100 million. It has a large milk production sector. Being an agricultural country, there is production of large biomass as well.

All of these produce waste which can be used in the production of Bio-gas. Bio-gas can be produced at four levels;1. Household; 2.Community;3. Large industrial; and 4.Bio-CNG. There is an estimate of 3-4 billion cubic feet per day of biogas production in Pakistan. At a minimum, one could assume 300-500 mmcfd of Biogas production. Except for small household or community projects, large scale Biogas production has not been pursued. There is a great potential waiting for an adequate government policy.

New Energy Products and Technologies

There are some new subjects that have been added; the most important one being pollution. As these lines are being written in October, Lahore is under smog emergency. This is not a unique thing that has occurred this year. It occurs every year. There are solutions to this problem that have been discussed in several chapters.

Although Pakistan's ranking in GHG production is very low, it is 10^{th} most riskiest country under the impacts of Climate change. We have discussed Carbon market issues and measures on how to fast track implementing carbon and GHG reduction projects.

Seaweeds are an emerging resource which has a potential of providing food, cosmetics, medicine, raw materials such as alternative chemicals and plastics. We have discussed the potential of Seaweed farming in Pakistan.

Pollution and Green House Gases

While developed countries are more concerned about Green house gases like CO2 and Methane emissions, as they have solved their own pollution and environmental issues, the developing countries like Pakistan have the dual problem to face. Pollution containing all kind of pollutants like SO2, NOx, Ozone, CO , particulate matter etc are to be eliminated or atleast minimized. We are facing smog problem in Punjab which has made the social and economic life difficult for citizens. Green House gases and pollution have common dimensions. Pakistan should redouble its efforts towards pollution reduction and green house gas emissions.

I am grateful to the three newspapers, Business Recorder, The News and Express Tribune in which may articles have been published providing the readers timely input and helped avoiding the time delay in which a book like this or even any book is published. I am grateful to several friends and colleagues who have offered comments and inputs which has enriched this book. It would not be possible to name them individually. I am indebted to my wife Dr. Meher Akhtar who has been editing and proofing my books for the last thirty years.

Syed Akhtar Ali

Ist November, 2023

Oil

1.1: Pakistan's Oil Challenge

Pakistan's oil imports are the biggest drain on foreign exchange. Current year's oil import bill has been projected to exceed 23 billion USD as against total exports of 34 billion USD. Oil imports figures may double in USD terms, while in volume terms, oil imports have been around 20 billion tons. Oil prices undulations have been causing the rise in imports mostly.

The mantra of increasing exports as espoused by the international finance institutions has not worked. Import substitution has been discouraged over the last many decades. As a result of which, current account deficit has been widening, which has caused, among other challenges, unbridled inflation. A balance has to be brought about between the two approaches.

There are problems with the availability of other imported fossil fuels as well. Prices of LNG and Coal have increased as well. One could not have predicted the energy price behavior. However, one clear lesson is: "don't depend on imports, reduce it, as much as you can." How can this be done in the case of oil, is our subject of discussion in this space.

Falling oil resources

Pakistan's oil and gas resources have been going down consistently. No major deposits have been found in the last two or three decades. Security-free areas have been exhausted, while political problems have stayed exploration in security-difficult areas. No political breakthrough appears to be in sight. Foreign oil companies have gone away and even national oil companies are trying to find oil resources abroad.

Circular debt has also severely limited the investment capacity and capabilities of the two major local oil companies, OGDC (Oil and Gas Development Company) and PPL (Pakistan Petroleum Limited). Their receivables have reached the level of Rs 1062 billion—OGDC at Rs 654 billion and PPL Rs 408 billion. An associated problem is the receivables of PSO (Pakistan State Oil) of Rs 509 billion. Many renowned experts are pessimistic about the prospects of new finds. Also, it is said that Pakistan plays are more gas-prone than oil-prone.

While one would not like to recommend of closing the oil exploration efforts, one cannot base the whole country's energy future on such a dicey oil situation. What to do? The whole transportation system, including railways', depends on oil. Local oil not there and imports are too expensive, causing economic instability in the form of current account deficit—the dual menace of the circular debt and current account deficit.

Divestment of the shares of PPL and OGDC has been on the cards for a long time now. This may inject some new capital, bring revenues to GoP and cause consequent reduction in circular debt. But more importantly, if sold-off to E&P companies of repute, it may be able to bring in new technologies and management initiatives and remove inertia from these companies. The issue has been lower prevailing share prices. An open question is whether credible E&P companies would be attracted. A possible approach is to attract companies like ADNOC (Abu Dhabi National Oil Company) and Saudi Aramco which have credibility, continuing and sustaining interest in oil and gas sector. More importantly, they have the required capital. They can always attract E&P companies.

Refinery Policy

Out of 20 billion tons consumption, almost 50% is locally processed by refineries while 50% is imported as finished products. 30% of crude oil requirement is produced from local oil fields. Local crude oil production has decreased from 4.3 MTPA to 3.7MTPA. Oil consumption has decreased over long term by the reduction in furnace oil (FO) consumption. FO's consumption has come down from 9.5 MTPA to 3.2 MTPA due to the induction of LNG and other fuels. Local refineries continue to produce 3.2 MTPA of FO as it is a co-product with Gasoline and Diesel.

A new oil refinery (OR) policy has been under deliberations for a few years by now. There are two parts of the oil refinery policy; one pertains to the BMR of existing old refineries while the other pertains to new projects. Most of the existing refineries have outdated technologies and product-mix that does not match with the demand portfolio, i.e., FO is produced, which is more of a liability.

Modernization of the existing refineries is required. It is often debated that the smaller refineries may not be viable and being unable to compete with world class refineries. Environmental remediation component in the oil refineries of the advanced countries add a lot of capex which is saved in developing countries like Pakistan where environmental limits are lax and implementation is weaker. This may be taken as an informal societal subsidy.

The issue is of consumer financed capital input in the oil refineries. What does the consumer get in return-only price increase indefinitely or some limits on it? In power sector, the Neelum-Jehlum fund paid through consumer surcharge returned consumer payments through lower tariff. They also demand tax holidays of 10 to 20 years.

Many people have opposed this. They argue that these are no times for protecting what they call inefficient industries requiring protection or support. As per aforementioned environmental cost saving argument, the rational for tax holiday is further diluted. Others want to support even inefficient refinery projects on strategic grounds.

The argument is that oil sector is a major source of revenues for governments worldwide. Where will the GOP get revenues if such lucrative sectors do not pay corporate income taxes? Trade sector in Pakistan does not want to pay taxes and so are some industrial sectors. The IMF (International Monetary Fund) and other global financial institutions would also oppose it. Exemption of import duties on capital equipment and even other inputs may be defendable.

Furnace Oil

Existing oil refineries are old, producing unwanted FO along with Petrol and Diesel. Power sector does not want FO any more. Nepra (National Electric Power Regulatory Authority) has been reprimanding CPPA-G (Central Power Purchasing Agency-Guaranteed) and NPCC (National Power Construction Corporation) of using expensive FO. It makes electricity expensive to more than Rs 50.0 per kWh.

Table1.1..1: Refinery Energy product Jul-March 2021-22

Unit: M. Tons

PRODUCTS	JULY - JUNE 2016 - 2017	JULY - JUNE 2017 - 2018	JULY - JUNE 2018 - 2019	JULY - JUNE 2019 - 2020	JULY - JUNE 2020 - 2021	JUL - APR 2021 - 2022
JET FUEL						
JP-1	717,285	707,665	581,331	405,083	316,591	393,543
JP-8	160,830	165,635	207,111	157,580	154,392	116,105
KEROSENE	127,008	111,637	110,367	84,984	92,732	82,968
MOTOR SPIRIT						
HOBC (95/97 RON)	14,843	-	59	3,337	33,790	5,533
MS	1,838,190	2,198,996	2,269,713	1,973,444	2,486,476	2,057,690
HIGH SPEED DIESEL	4,574,878	5,257,811	4,740,701	3,790,431	4,697,017	3,872,022
LIGHT DIESEL OIL	25,014	33,341	38,892	23,522	16,165	13,318
FURNACE OIL	3,016,489	3,262,804	2,873,745	2,223,303	2,549,069	1,962,111
GRAND TOTAL:	10,474,537	11,737,889	10,821,919	8,661,684	10,346,232	8,503,290

Oil refineries keep applying pressure on GoP to use their FO; otherwise, they may have to stop Gasoline and HSD which are the co-products. With expensive LNG and that being not available, there may be some scope for a compromise solution. Refineries bring down the FO price to F.O.B. export level prices. Why don't they try to export? It may not be sellable at the asking prices. In an unregulated market, the FO prices would have come down automatically.

Table 1.1.2: Sectoral Consumption of Petroleum Products

Sector	MS + HOBC+ 100 LL	High Speed Diesel	Kerosene	Aviation Fuel	Furnace Oil	Light Diesel Oil	Total Energy	Total Non-Energy	Grand Total
Transport	7.48	6.09	0	0.29	0	-	13.86	0.13	13.99
Power		0.01	-	-	1.51	-	1.53	0	1.53
Industry	0.02	0.38	0.01	-	0.82	0	1.22	0.11	1.34
GOVERNMENT	0.02	0.15	0.04	0.17	0	0	0.37	0.07	0.44
Domestic	-	-	0.05	-	0	-	0.05	0	0.05
Agriculture	-	-	-	-	-	0.01	0.01	-	0.01
Overseas/Export	-	0.01	-	0.24	0.03	-	0.28	-	0.28
Total FY 2019-20	7.51	6.63	0.09	0.7	2.37	0.02	17.32	0.31	17.63
Total FY 2018-19	7.69	7.36	0.1	0.98	3.54	0.03	19.69	0.35	20.03
Growth (%)	2.3	9.89	13.51	28.36	33.03	22.26	12.03	8.92	11.98
Source; OCAC									

Table 1.1..3: Product-wise Sales by OMCs during FT 2019-20

Product	PSO	TPPL	APL	SPL	GO	HASCOL	BPPL	BEE	Others	TOTAL
MS	2.89	0.99	0.67	0.83	0.69	0.54	0.26	0.19	0.4	7.45
HOBC (95/97 RON)	0.02	0.01	0	0.01	0	0	-	-	0	0.06
HSD	3.04	0.68	0.64	0.46	0.57	0.48	0.35	0.18	0.24	6.63
FO	1.09	0.09	0.42	0	-	0.07	0.42	0.04	0.23	2.37
JP-I	0.52	-	0.01	0.02	-	-	-	-	0	0.55
Kerosene	0.06	0.01	0.02	-	-	-	0	-	-	0.09
LDO	0.01	0	0.01	-	-	-	0	-	0	0.02
100 LL	-	-	-	-	-	-	-	-	0	0
TOTAL	7.62	1.78	1.76	1.33	1.26	1.09	1.03	0.41	0.88	17.17
Source: OCAC										

Oil demand management

Unfortunately, no credible demand forecasts of oil and gas are available, although the situation is a bit more explored in the power sector due to support and interventions of IFIs. One may have to rely on finger calculations or back-of-the-envelope exercises at best.

In this energy transition period, the war in Ukraine, oil price uncertainties and floods in Pakistan, and economic and political uncertainties, it is very difficult to develop long-term or even short-term forecasts. Perhaps some scenarios can be built.

At lower prices, oil imports have hovered around 10-12 billion USD. There is Ukraine war and climate change-based energy transition period which have caused uncertainty in oil prices. One is not sure how oil prices would behave in near to mid-term future.

Table 1.1.4: Product-wise Production during FY 2019-20

Product	**RARCO**	**BPPl**	**ARl**	**NRL**	**PRL**	**ENAR**	**Dhodak**	**Total**
AVIATION Fuel	0.25	0.01	0.14	0.08	0.07	0.02	0	0.56
FURNACE OIL	0.53	0.69	0.3	0.3	0.32	0.09	0	2.22
HSD	1.22	0.9	0.48	0.63	0.51	0.05	0	3.79
KEROSENE	0.02	0	0.04	0	0.01	0.01	0	0.08
LDO	0.01	0.01	0.01	0	0	0	0	0.02
LPG	0.09	0.04	0	0.01	0.2	0	0	0.41
MS	0.66	0.4	0.49	0.2	0.22	0	0.26	1.97
NAPHTHA	0	0.07	0.04	0.11	0.06	0.11	0	0.38
TOTAL	2.79	2.1	1.5	1.33	1.2	0.27	0.26	9.45

Source: OCAC

1.2: COP26: The oil and gas predicament

If COP26 could not do much against oil and gas, the recent high prices have done the deserved or undeserved damage to the future of oil and gas. Renewable lobby has always considered low oil and gas prices to be bad news, as it makes renewable uncompetitive and the drive to phase out fossil fuels goes into the back burner.

Renewables like solar and wind power cost have come down independent of oil and gas prices and more improvement is expected in the future. It cannot be undone. Coal will be replaced by solar and wind power, oil by electricity and the advent of EVs (electric vehicles). Natural gas will be replaced by hydrogen and biogas. Hydrogen technology development and reduction in the cost of production is taking place in the same fashion as has happened in the case of solar and wind power. Hydrogen is expected to become competitive with oil and gas by 2030 or even earlier, although infrastructure issues may delay its wider adoption beyond 2030.

If there was a consensus in the COP26 Glasgow Conference, it was against coal. Coal has been saved partly by the last-minute intervention of India and China, as they could manage to push the last date for coal to 2060. Former Dutch minister for climate, energy and utilities Dan Jorgensen declared: “There is no future for oil and gas in a 1.5-degree world.” Coal resources today stand at 300 years of consumption requirement, oil for 50 years and gas for 150 years.

Recent research suggests 89% of coal and 59% of gas reserves need not be developed at all if there is even 50% chance of global temperature rise staying under the crucial limit of 1.5-degree Celsius this century. Beyond Oil and Gas Alliance has been formed to put an end date to the oil and gas production, although major oil and gas producers have stayed away from it. Prominent among members and associates are France, Sweden, Denmark, New Zealand, Italy and California. Although there is no firm commitment to phasing out oil and gas other than wish lists of environmental think tanks, it has been projected that oil demand will go down by 25% due to two factors – increased fuel efficiency of automobiles, and EVs.

Oil demand from the automotive sector is not more than 20-25%. However, EVs may cause an increase in power demand, which may be partly supplied by gas in addition to solar and wind energy. For developing countries, the pace of actual or demanded changes in the context of climate and decarbornisation targets is creating difficulties for the poor countries. The brighter side of technological changes is in favour of advanced countries that have the resources and knowhow, as the technological changes create new market, investment and employment opportunities. Developing countries have none of these.

They are facing the dilemma of “damned if you do and damned if you don’t.” One has to go with the flow. One cannot defy the international power regime, besides there is common interest and destiny in climate change. The most important is the prospects for stranded assets. It takes a lot of investment to build infrastructure and it is not easy to retire these without full utilisation and benefits, otherwise the contribution of infrastructure becomes negative, ie the rich can change cars frequently and with ease, while the poor prefers running his car for much longer.

Fortunately, there is talk about using gas pipeline infrastructure for carrying hydrogen as well, albeit in a mixing mode up to 10-15%. Already, experimentation has become successful in Europe in this respect. In the case of adopting EVs, there are options of converting the existing cars, motorcycles, buses and trucks into EVs. Thus, hybrid solutions may be possible and should be the cornerstone of developmental and infrastructural policies of the developing countries.

Dependence on oil, gas in Pakistan

Pakistan’s gas sector demand stands at 6 billion cubic feet per day (bcfd) and is growing. It meets the residential, commercial, industrial and fertiliser needs.

Oil is mostly supplied for the transport sector. There is a progressive policy for the adoption of renewables and EVs. The dependence on oil and gas would remain for a long time in future. Our problems are manifold, though they are of our own making. When we start developing our resources, the sound bells of NO start ringing. When we started developing Thar coal, the world has started moving away from it and is asking us to do the same. We switched to gas and LNG from furnace oil, but gas has become expensive and has supply problems.

We don’t know what we would be doing with our gasfired combined-cycle power plants. IGCEP predicts that it would not be able to utilise these plants beyond 2025. This has created problems in the way of privatisation of these plants – a case of stranded investment. A big question in our energy sector is that our gas resources are decreasing. Foreign exploration and production (E&P) companies are not showing much interest despite road shows. Our own companies like PPL are going abroad instead of investing locally – a pessimistic indicator for all.

Self-reliance appears to be the only key. It is difficult to expect foreign investment in oil and gas in the wake of domestic political uncertainty and general talk about longterm oil and gas going out of market. They would rather utilise the known high-potential areas than investment in low-potential areas. There is a reasonable oil and gas policy, which grants reasonable incentives. However, it may have to be improved further by reducing upfront costs.

Investments should be made in geological investigations and data acquisitions, which would reduce the upfront time for actual field activities. A review of the wellhead gas pricing formula for new gas finds may be in order as well, after all we are paying much higher prices for LNG imports. Self-reliance is the key in these circumstances, which ironically would also require external inputs. Alternative energy can be a good route to self-reliance, which should be maximised.

While there may be limitations to how much variability can be taken by the grid and when affordable electrical storage would be available, non-grid-based solutions should also be developed. Biogas can meet CNG and rural gas demand amply. Hydrogen is coming up fast. There have been recent developments promising a costcompetitive hydrogen. R&D should be initiated in this respect. Thar coal use should be maximised and other nonelectricity uses should be pursued; the latter is perhaps the easiest solution to date requiring mining and transport infrastructure only. Thar coal gasification should be pursued as long as the little window for it remains available.

1.3: Towards petroleum pricing and subsidies

Petroleum prices have been maintained at status quo, but as it appears that it may not be possible to maintain the prices at the present level for long. How much price increase is possible or feasible is an open question. In this space, we will explore some solutions and strategies. In only recent times, the issue used to be how much to tax the petroleum products. Now the issue is, not to talk of taxation, how much to subsidize. International oil prices have gone so high that petroleum taxation has become impossible. In Pakistan, the problem is the most severe due to the heavy Rupee devaluation.

Maximum taxation rates have been pegged at Rs 30/liter as Petroleum Levy (PL) and 17% GST. Assuming 100 Rs/Liter landed cost, there would have been around Rs 50 per Liter taxation. PL would vary with landed cost; if it were high, lower PL would be charged and if PL being low, higher PL rate up to a maximum of Rs 30 per Liter would be charged. Presently, Gasoline price is charged at Rs 149.98 /L, while it costs Rs.166.95/L, resulting in a subsidy of 29.60 Rs/L. Subsidy on Diesel, similarly, comes out at 73.04 Rs/L, while retail price is 144.07 Rs/L and cost is 208.60 Rs/L.

Current total subsidies on Gasoline and HSD (excluding on Kerosene and LDO, which insignificant) come out to be Rs.73 billion per month or Rs.876 billion per year, if international prices are assumed to remain the same. There is an additional loss of revenue of Rs 900 billion per year in terms of PL and GST. GoP faces a dilemma; petroleum prices have already undergone a big rise in a year in the midst of a general inflation wherein food prices have also suffered due to food prices inflation in international market as well. There are both budgetary deficits and current account deficit.

A compromise solution may have to be done under simultaneous Demand Management and Rationalisation of subsidies. Subsidy is removed altogether from gasoline so as to increase the gasoline price to Rs 166.95-180/L. However, there will have to be two-tier pricing. Gasoline price may have to be frozen at the current level of Rs 149.98/L for low-income group identified as motorcycle users. In effect, this would mean introduction of cross subsidies for the poor, which is widely prevalent in energy sector such as electricity and gas and practiced well.

Subsidy for diesel may have to be halved, reducing it to Rs 36 billion per month. This would increase diesel price to Rs 180/L. Some volume reduction should also help, bringing down the annual total subsidy to less than 400 billion per year. The question is if the resulting price increase would be socially and politically feasible? We have been arguing in this space for the introduction of a separate brand of Gasoline for Motorcycle users in the form of low RoN gasoline. Carburetor vehicles, older cars and motorcycles, can run on low RoN gasoline, while the newer brands owned by higher income groups cannot run well on low RoN, thus a protection against misuse of subsidy by higher income group using newer cars having electronic fuel injection system.

Some circles from the petroleum industry have opposed it to be impractical on account of logistics that management of yet another fuel brand is not feasible or would be difficult. Their second argument is that, there wouldn't be much price advantage. Let us take the first argument of logistics first. There is a very large group of motorcycle users of 4 million which can justify separate arrangements and logistics. Separate and specialized petrol pumps can be established. There is no need of new pumps. Some of the existing ones (one-third or so) can be converted to Motorcycle pumps. However, this should be a voluntary scheme. Motorcycle users (and of older cars) can on their choice use a more expensive normal gasoline. The IMF, reportedly, does not mind subsidies for the poor. The IMF has been objecting to subsidy systems that benefit the rich as well. The other solution is to introduce a petrol card system to motorcycle users under their registration and NICs.

Demand management has to be introduced to curtail consumption. It has been argued that higher prices would curtail demand. This has not, however, happened appreciably. In the recent period, petroleum demand has been on the rise despite heavy price increase. There are two or three reasons; firstly, there are some sectors and segments which are not influenced by price at all; secondly, the poor group is already at a mere subsistence consumption level and; thirdly, economic and population growth causes some increase as well. Rationing is one of the effective tools of demand management. In older times, there used to be Ration Shops for food items such as flour and sugar which worked rather well in non-compute times. Rationing is not liked. But it would have to be resorted to forcibly by the circumstances which may be anarchic. A well-planned rationing system may be prepared at least for implementation when needed. Public sector and large private companies may be advised to introduce fuel control programmes having some targets. 10-20% saving may be possible in this respect. This problem and the proposal should not be dubbed away as `a temporary one. Poverty and non-affordability of the energy items would remain an enduring problem, as we have seen in the case of gas and electricity.

There are other mid-term solutions such as introduction of Bio-CNG which is a cheaper fuel, especially, for public transport system; cleaner and cheaper. In Sindh province, there is a scheme which is running at a slow space. A fast track Bio-CNG scheme may be introduced in all provinces. It may be noted that petroleum prices in Pakistan are lower than in other developing countries which prompts the IMF to pressurize the government to increase petroleum prices. GoP would, however, itself be ultimately constrained to increase the petroleum prices under financial constraints. Even Sri Lanka has higher prices than in Pakistan. In India, petroleum price are about 80% higher. In Bangladesh, 29% higher gasoline prices, although the differences in HSD prices are lesser, a constant feature in Bangladesh policy of lower HSD prices. In Vietnam, the Philippines and Thailand, petroleum prices are similarly higher by 60-70%. However, the specific circumstance of Pakistan of recent high currency devaluation should be considered in this respect arguing for a mid-way compromise approach which may have to be worked out diligently.

Table 1.3..1: Oil Sales and Subsidy-2020-21

	M.S.	**HSD**	**others**	**Total**
Sales-Metric tons	7454021	7E+06		
MT to Liter	1389	1176		
Sales Liters-millions	10353.6352	7800.7		
Sales Price	166.95	208.16		
Subsidy-Rs/L	29.6	73.04		
otal Subsidy-Mn Rs/yr	306468	569762		876230
Tot. Subsidy/m avg-Mn RS	25539	47480		73019
Source: OGRA,PSO,OCAC				

Let us hope that Russia-Ukraine war ends sooner and the energy and other commodity markets come back to normal. Even common people in rich countries are feeling difficulty in paying their energy bills. Poor and developing countries would not be able to sustain so expensive energy for long. IMF and other IFIs will have to think over some form of a voluntary commodity price stabilisation fund for developing countries, in collaboration with oil producers, if the phenomenon lasts for longer.

Table1.3. 2: Comparative Oil Prices in selected countries-1st May 2022

Countries	Prices USD/L	Prices USD/L
Pakistan	0.802	0.771
India	1.476	1.314
Bangladesh	1.033	0.928
Philipines	1.37	1.378
Thailand	1.366	0.877
China	1.359	1.217
Turkey	1.293	1.497
Spain	1.942	1.973
Italy	1.888	1.899
USA	1.193	1.342
Pakistan Rs/L	149.86	144.15
Pakistan Exchange Rate Rs/USD	185.7	
Source: Global Petroleum Prices		

Table1.3..3: Ex-Refinery Price Build Up

	MOTOR GASOLINE RETAIL	H.S.D RETAIL
Ex-refinery	166.95	208.16
PDC	-29.60	-73.04
IFEM	3.93	1.14
	141.28	136.26
OMC margin	3.68	3.68
Dealer margin	4.90	4.13
Petroleum Levy	0.00	0.00
Price before Sales tax	149.86	144.07
Sales Tax - %	0.00%	0.00%
Sales tax	0.00	0.00
Max. ex-depot sale price	149.86	144.07

Table 1.3.4: Ex-Refinery Price Build Up

	MS	HSD
FOB (S'BBL)	122.05	149.71
Premium (S'BBL)	8.02	11.17
C&F ($/Bbl)	130.07	160.87
Ex. Rate	185.95	185.95
C&F (RsLit)	152.13	188.15
Incidentals (Rs'Lit)	0.22	0.30
Custom duty (RsLit)	14.61	18.05
Adjustment (Rs'Lit)	0.00	1.65
Ex. Refinery Price (Rs/Lit	166.95	208.16

1.4: Oil prices and efficient buying

The government has increased petroleum prices by Rs30 per litre. The increase is uniform against all products. There was much talk about some subsidy mechanism for the poor (motorcycles and older cars) and the present finance minister spoke in its favour. This has not yet happened. Possibly it may take some time, or it may be in the second round of the increase since the minister has not negated the possibility of further increase. The increase in petroleum prices has been made uniform. Diesel prices are kept lower universally. That affects economic competitiveness. Diesel is used by public transport and foods transport. Diesel prices should not be increased in the second round, or public transport operators should be compensated in other ways.

The increase evidently is under IMF pressure. No politician would like to increase prices and lose votes and popularity. However, it may be noted that Pakistan's gasoline prices are really low. Before the increase, Pakistan gasoline prices were $0.774 per litre as opposed to $0.621 per litre in Saudi Arabia and $0.966 in the UAE. Even in Afghanistan, gasoline prices are $0.897. In India, it is $1.452, Bangladesh $1.012, Sri-Lanka $1.036. Despite the lowest prices in comparative terms, Pakistan's pricing is unaffordable because of the heavy rupee devaluation. There is double jeopardy: international prices are at their highest in history and we face a severe rupee devaluation.

Unique combinations of circumstances have created a very difficult situation for energy supplies in Pakistan. An extraordinarily hot summer, reduced hydropower due to water problems, commodity (including oil and LNG) price hike due largely to the Russia-Ukraine war and delayed consequences of the pandemic have all created a highly unstable and unsustainable commodity market situation. For developing countries, this has created special problems.

International oil prices have almost doubled from $60/bbl to $112/bbl and gas/LNG prices almost tripled or even quadrupled. Pakistan was already suffering under circular debt of Rs2.3 trillion and now it has to pay subsidies on petroleum. In the past, oil used to be a source of revenue. And now subsidies of more than a trillion rupees have to be paid in order to maintain petroleum prices at a constant level. This is clearly unsustainable. Pakistan is suffering under both current account and fiscal deficits. The rupee is going down and the country is moving towards default. Those who used to oppose IMF intervention are now favouring it for obvious reasons.

Two diametrically opposite impacts are expected due to this oil price increase – increase in inflation and increase in poverty; and a possible decrease in oil demand and thus lower imports and lower current account deficit. Oil imports this year are double than last year, almost $20 billion. A 10 per cent decrease in imports would mean a saving of $2 billion. And IMF assistance may be forthcoming which might stabilize the rupee.

Due to lower international prices earlier, there has been a lackadaisical attitude of successive governments to the issue of oil procuring efficiency. It is claimed that Pakistan oil procurement prices have not been sufficiently efficient. Lower buying cost would have a positive impact on local retail prices and obviate or reduce the need for oil price increase. Although PSO is understood to be doing good in the distribution business, improvements can be done in procuring petroleum at lower prices. To be fair, fragmentation of the procurement under the slogan of privatization and competition is also responsible. Payment of high premiums over international prices is a case in point.

It may be noted that furnace oil local prices are high at $900/t excluding GST (PSO), while international prices for Singapore around the same time periods were $550/t. To add importing expenses of 30 per cent, the landed cost of furnace oil becomes 715 USD/t. There is about a 38-40 per cent margin over landed international prices. It may be noted that furnace oil is not regulated. Everybody imports and declares their own prices. IPPs import for themselves in addition to PSO. It may be argued by the local furnace oil importers and sellers that oil products are not always available at market exchange prices. There is a premium, especially in the shortfall periods.

In the case of diesel, there is a continuing long-term contract with Kuwait Petroleum (KP) for supply of diesel under which a modest premium of $2.5/bbl is charged. Current premium from other spot suppliers is $8.02/bbl for gasoline and $11.17/bbl for diesel. Such premiums destroy the credibility of the international commodity exchange prices. Regulators must look into the bonafides of such high premiums. Long-term contracts on the lines of KP may be considered for gasoline as well. Base-load demand should be under long-term contracts, while variable demand may be under spot arrangements. There may be a variable component in long-term contracts as well. There is a likelihood that this may bring down the gasoline price. Also, the issue of specification variations vs price must be monitored by the regulator. PSO's inefficiency becomes a benchmark for all other companies. Is the tradition of combined buying to get better prices outdated?

If oil prices continue to remain destructively high, some unconventional ways may have to be explored. There are private-sector parties which claim that they can help bring cheaper oil and gas. There are some market peculiarities wherein oil is available under various terms and modes. Iran has been managing to sell despite sanctions. Russian oil is being sold at varied prices through various parties and trading companies. Perhaps private parties can do the magic they claim? One has to be careful about the practices of oil suppliers and trading companies and need not be unduly impressed by the respectability due to the size of their operations. One of the leading trading companies has been fined $160 million on the charges of bribing oil SOEs in South America. Another leading company has been barred from operations by Mexico. Both companies operate here in Pakistan as well. In Pakistan, there would be no dearth of willing partners in this respect. Regulators have to keep their eyes open.

There is a controversy regarding cheaper Russian oil and gas. There are two parts of the controversy: one political and the other technical. India has been benefiting from cheaper oil, although there is great US pressure on India opposing it. China buys oil from Iran at 25 per cent less than international prices under a long-term contract. Whether there was a Russian offer to us or not, the possibility of doing so is there. It might be already happening and oil may be redirected by oil trading companies from questionable sources and the windfall being pocketed by the supplier companies.

Some mechanism may be developed to increase informal imports from Iran by improving road transport, barter and regional markets. Let us try to be a little unconventional. In case of failure with the IMF, this option should definitely be tried. Even otherwise, the US may be flattered through diplomacy into accepting imports from Russia and even Iran. The world is reshaping in the midst of the Ukraine-Russia war. There is international political competition in Pakistan as well which should be utilized more astutely than otherwise.

1.5: Oil prices – what to do?

Petroleum prices have been increased once again. New prices are: petrol Rs209.86 and High Speed Diesel (HSD) Rs204.15/L. It is a 40 percent increase in one month done in two steps of Rs 30 per liter each. Amid heavy load-shedding, power regulator Nepra has increased average electricity prices by Rs7.90 per unit although different consumer classes may have varying effect. Gas companies have asked for a 40 percent increase, which may be announced also. Earlier, there used to be capacity crisis, now there is a fuel crisis. All kinds of problems have been accumulated; hot summers, water shortage that reduces hydro and rising international fuel and commodity prices.

The subsidy of Rs 25 billion per month would still be there as opposed to Rs 120-130 billion before the increase. Full cost has not been passed on to consumers. There is still subsidy of Rs 9.0 per litre on gasoline and of Rs 23.0 on HSD. Would another price increase be insisted by the International Monetary Fund (IMF)? International prices have increased unreasonably. The IMF should demand the local elimination of local deviations. It would be impossible to revert back to Rs 30.0 per litre Petroleum Levy and 17.5 percent GST. It may create political chaos and anarchy which is likely to spread in many developing countries.

It would have been impossible not to increase energy prices irrespective of political or socio-economic consequences. Energy prices have increased by 200-300 percent worldwide; imported coal international price is 375 USD/ton instead of the usual 80-100 USD/t; Brent crude oil is 122USD/barrel; diesel price is disproportionally higher than that of Brent crude oil; LNG prices, too, have increased beyond.

Pakistan's oil pricing system was working fine. With reasonable and affordable prices, GoP was able to even earn revenues as well. Oil prices in Pakistan, generally, used to be lower as compared to those in South Asian countries. India has recently reduced oil prices by reducing excise duty. Petrol price in New Delhi is IRs 96.72 per litre (PkRs. 246.64) and diesel's price is IRs.89.62 (Pk.Rs.228.53). Even then, the increased prices in Pakistan are lower than those in India. In other cities, petroleum prices are even higher. In Pakistan the pain is higher due to general high inflation and the abrupt increase of 40 percent.

Politics and oil price

No political government would want to increase prices and lose votes, especially, when elections are being talked about for sooner or later. Unfortunately, political discourse in Pakistan does not promote realistic perceptions. The current government criticized the outgoing government for high energy prices while the outgoing government is criticizing the present one. The fact is that none of the two governments could have helped the situation. There have been talks about consensus on a charter of economy. People in the advanced and rich countries, too, are extremely concerned at high energy prices.

Even if the IMF would have allowed the subsidies, the budgetary resources would not have allowed it without compromising such important items as defence expenditure. There is circular debt of power sector exceeding 2.5 trillion mark and there is a topping on it of Rs 1 billion circular debt of LNG, and more on oil as full oil price is still not being charged to the consumers.

Cost reduction possibilities

We have recommended elsewhere, that there is a scope for cost reduction in efficient buying. Currently, large margins are being paid over international prices which increase imported oil prices. Local refineries' pricing also include these high margins. Ways and means should be searched for improving buying efficiency. Combined and bulk buying and G2G agreements could help in this respect. Oil refineries are witnessing a windfall profit situation worldwide. Our local refineries should also be benefiting from this rising trend, as their prices are tied to international pricing. Can we ask or request them to share the burden by lowering their margins? It is a difficult issue. Refineries have suffered losses earlier as well. However, profit margins are extraordinary. Margins can be curtailed or brought forward under arrangement with GoP.

Our local crude oil price is equal to international price, although there is a windfall provision which reportedly is not being implemented. An option is that it could be activated. Crude oil pricing may be revised a la local gas pricing providing for floor and ceiling prices, which protects both consumer and producer. There are many options which have small cost and price reduction potential but put together these may total up to a good amount.

Russian oil controversy and potential

What are the options of matching the price rise challenge? Imports of cheaper oil from Russia? There is controversy around it. Russia is the world's third largest petroleum producer and also the world's largest petroleum exporter. Russia exports 5 million bpd of crude oil, 3.32 million bpd of diesel and one million bpd of other petroleum products. India has bought 62.5 million barrels of Russian crude oil since February. The forecast for June is 1.05 million bpd. Reportedly, the import prices are 30-40 USD per barrel lower than the benchmark Brent crude's prices. Indian private sector importers and refiners have earned a profit of USD 30 per barrel. Public sector refiners have been losing money as they did not import the Russian crude.

Table1.5.1: Local and imported petroleum products-2019-20 (million Tons)

Crude Oil	Imports	Production	Consumption
Gasoline	5.54	1.97	7.51
Diesel	2.84	3.79	6.63
Furnace oil	0.15	2.22	2.37
Jet Fuel	0.14	0.56	0.7
Kerosene	0.01	0.08	0.09
Others	1.9	0.83	2.73
Total	10.58	9.45	20.03
Share-%	52.82	47.18	100
Crude Oil	8.22	2.28	10.5
Source: Ogra			

The price gap is so wide that it is worth for India to take the risk of annoying the US and the EU. However, the share of imports from Russia may not be very large. India imported 1.577 billion barrels of crude oil in 2021-22 out of which 62.5 million barrels came from Russia which should be less than 5% of their demand. This would, however, increase as much as to 23% as imports continue. It is highly uncertain that the US and the EU would allow this level of imports from Russia. As far as Pakistan is concerned, we require all the three products: crude, diesel and gasoline. Total petroleum demand is of the order of 17-20 million tons out of which some 50% is produced by local refineries which require crude oil. Crude oil imports are around 8.2 million tons per year (MTPA) and petroleum products' imports total at around 10 million tons; out of which gasoline accounts for 5.5 MTPA and diesel 2.8 MTPA.

Thus unlike India which only imports crude oil, Pakistan imports all the three items: crude, gasoline and diesel. There is a controversy regarding cheaper oil import possibilities from Russia. The IMF deal, FATF and sanctions risk are there apart from other political risks. There are people who contest that Russian crude would not be processable by local oil refineries. However, majority opinion by credible experts is that Russian Crude can be used. Crude oil, however, is imported from the friendly Middles Eastern countries at various known and unknown credit and concessionary terms. The major issue is supply of diesel, which Russia can easily help resolve.

It depends on politics, economics is really clearly beneficial. Russian or Iranian oil may be available via China. China has a long-term supply agreement with Iran at concessional prices of25%. Diplomatic channels and negotiations may enable Pakistan to save some money in importing diesel from Russia. Oil refineries are designed on a particular range of specifications to be able to produce with maximum yield, energy efficiency.

Table 1.5.2: Selected Crude Oil Comparison

Crude Oil	API	Sulfur	Source
Arab Extra Light	40	1.09	Saudi Arabia
Arab Light	33	1.77	Saudi Arabia
Arab Medium	31	2.55	Saudi Arabia
Bakken	42.1	0.18	USA
Basra Light	30	2.92	Iraq
Basra Heavy	23.6	4.2	Iraq
Brent	37.9	0.45	U. K
Dubai	31	2.04	UAE
Iran Heavy	30.7	1.8	Iran
Iran Light	33.7	1.5	Iran
Kuwait	31	2.52	Kuwait
Sakhalain Blend	44.7	0.16	Russia
Siberian Light	34.8	0.57	Russia
Sokol	35.6	0.27	Russia
Urals	30.6	1.48	Russia
Source: Mckinsey Energy Insight			

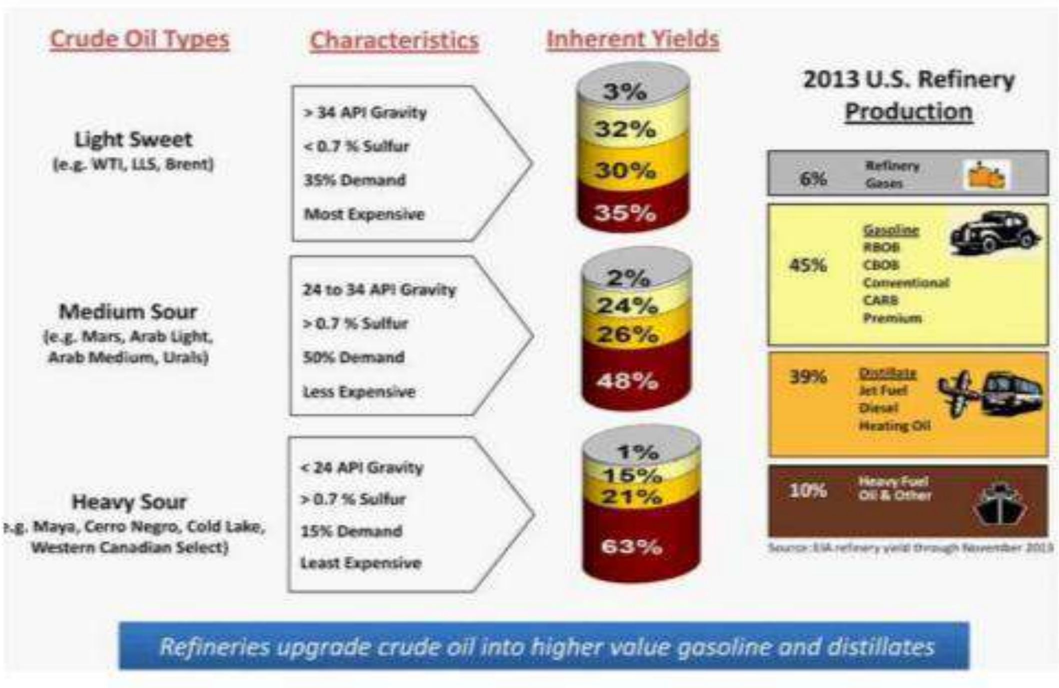
Table 1.5.2: Comparative Oil Prices in selected countries-1st May-1st June 2022

Country	Diesel		Gasoline	
	2-Jun 2022	1st May 2022	2-Jun 2022	1st May 2022
Pakistan	1.033	0.802	1.062	0.771
India	1.205	1.476	1.344	1.314
Sri-Lanka	1.096	1.097	1.233	0.85
Bangladesh	0.899	1.033	1.001	0.928
Vietnam	1.15	1.243	1.389	1.1114
Philippine	1.434	1.37	1.531	1.378
Thailand	0.966	1.366	1.541	0.877
China	1.308	1.359	1.452	1.217
Turkey	1.496	1.293	1.533	1.497
Spain	2.012	1.942	2.147	1.973
Italy	1.972	1.888	2.055	1.899
USA	1.463	1.193	1.265	1.342
Pakistan Rs/L	204.15	149.86	209.86	144.15
Pakistan Exchange Rate Rs/USD	185.7		197.6	
Source: Global Petroleum Prices				

and least cost. Certain crude oil may be feasible to run technically on a particular refinery but may not be economical. It is no use to buy cheaper crude oil but produce at low efficiency. An optimum maximum of profitability is required. It appears that Russian oil is closer to specs with the Saudi crude oil that is usually procured in Pakistan. Some oil refineries have done analysis of the Russian crude and have found it feasible. There are others who are dealing in generalities only.

Classification of crude oil is based on viscosity (lightness or heavy) and sulfur level (sweet and sour/high, medium and low). Based on these two factors, there are six combinations or classifications. There are, however, many other characteristics; some 160 types of crude oil are traded internationally. Light and sweet crude oil are the easiest to process. Let us compare Russian crude oil with Saudi Arabia's. Two out of three Saudi grades are high sulfur carrying from 1.09 to 2.55%. However, sulfur level of Urals is high (1.48%) but is lower than Saudi's. Other three Russian crude grades are low sulfur (0.16-0.57). API viscosity of three Russian crude oil grades — Siberian Light, Sokol and Urals — are 30.6-35.6 which are comparable with Saudi of 31-33 API.

Figure 1.5.1: What's in a barrel of crude oil



Subsidy vs stipend?

The government has not opted for a highly attractive proposal of introducing low Ron petrol. It has opted for a stipend of Rs 2000 per person/family. This stipend may have to be doubled to Rs 4000 in the light of the new increase on 2nd June. The programme does not appear to have been received well. Time would be required for implementation and impact, while the price increase is immediate.

Fuel rationing and conservation

It is difficult to support increase in petroleum prices due to general poverty and high inflation. It is also difficult to oppose due to high international prices, widening current account and budgetary deficits. However, conservation is due. It does not appear from the traffic pattern and shopping bazaars that there is a problem in the country. It is estimated that 10-20% petrol and diesel consumption can be reduced if policy steps are taken. Fuel rationing is feasible in the days of IT and NADRA, BISP and Ehsass. Rationing of wheat flour and sugar worked very well in the 1960s. What is the problem now? Private and public companies and agencies may be asked to set a target for fuel saving. Rationing can save both foreign exchange and subsidies.

Oil prices – what to do? – I

High prices may lead to saving in consumption. To the extent of careful consumption, it is good. If the consumption reduction is too much affecting economic growth, then it is too bad. Petroleum consumption in the month of May has been reported to have gone down by 2%. HSDs has gone down by 7% and gasoline's is up by 3 %. Year on year, increase has been reported in 2021-22 but it may be a compensation for reduction in earlier year. Thus there are mixed signals yet. With this new increase, it is highly likely that the consumption may go down. It is hoped that it does not go down as much to hurt the economy and exports.

Other options and prospects

Finally, economic growth, employment and equity are the solution to enable the people and the economy to absorb and afford the rising energy and commodity costs. Direct and indirect food subsidies are the only possible compensation. However, that requires budgetary resources. International Zakat and welfare funds from rich Muslim countries could also be mobilized for the poor. Time has come to do away or at least reduce the elite capture. Shadow economy is estimated to be 40-50 percent of economy. Tax collection has to be increased. Tax holidays must be eliminated. Sectoral ministries keep bringing policy proposals of 10-20 years tax holiday proposals. The realities of resource gap are not being fully realized.

Table 1.5.3: Comparative Gasoline price range countries, May 2022

Countries	USD/Liter
Venezuela,Libya,Iran	Near zero prices
Syria,kuwait,Nigeria, Malaysia	0.3-0.47
Iraq, Egypt, Nigeria, Russia, Saudi	0.5-0.794
Pakistan,UAE,	0.80-0.986
Bangla, Sri-Lanka, Indonesia,Mexico	1.033-1.156
USA, Australia, Vietnam, Turkey, Japan, China	1.193-1.37
India, Canada, France,Italy,Spain	1.476-1.91
Germany, Singapore, Denmark, Norway, Hong-kong	2.096-2.872
Source: Global Petroleum Prices	

Table 1.5.4: Comparative Diesel price range countries-May 2022

Countries	USD/Liter
Iran,Venezuela, Saudi, Algeria	0.01-0.201
Egypt,Malaysia, Qatar,Oman, Russia	0.364-0.764
Pakistan,Srilanka,Bangladesh, Taiwan	0.771-0.967
Cuba, Kenya,Chile,UAE, Japan	1.05-1.147
Indonesia,China,Nigeria,India,	1.213-1.314
USA,Brazil,Australia,Turkey,South Korea,Canada	1.342-1.596
Italy,Spain, France	1.899-2.009
Netherlands,Denmark,Germany,Norway,Hongkong	2.126-2.574
Source:Global Petroleum Prices	

Market theory of balancing demand and supply appears to have failed. Supply is not catching up with demand. Cartels are powerful. In Europe, there are voices for forming a consumer cartel to face the oil producers' cartel. Unless the Russian-Ukraine war comes to end, the oil pricing and supply issue will not be settled. It is strange that International Monetary Fund (IMF) and International Financial Institutions (IFIs) and other agencies do not recognize these problems. There is no initiative in the world to alleviate these problems of the developing countries. Oil has been released from strategic reserves by some International Energy Agency (IEA) member states, which caused little or no dent on the market. President Biden plans to visit Saudi

Arabia to rebuild the relationship and try to convince Saudis to do something to reduce international oil prices. Will something happen?

1.6: Oil, gas prices: need for stabilization fund

Oil prices go up and down. Now gas prices are also linked with oil prices. While lower oil prices go unnoticed and without affecting the economies of the developing countries in a positive or significant way, higher oil and gas prices cause havoc — socially and economically. Pakistan has been affected much more badly because of an already high current account deficit and falling currency. IEA (International Energy Agency) which coordinates energy issues of the OECD countries requires oil storage of three months consumption by the member countries which is largely abided. Although its purpose is to keep supplies at comfortable level, it also mildly tries to balance the prices. Early in this year (2022), IEA members did try to improve supplies by unloading storages in the market, with little success in affecting prices.

Supplier countries are organised mostly under the OPEC, which has been lately quite effective in maintaining high oil prices by keeping production low. It would be fair to say that oil producers suffered due to extremely low prices during the Covid as economies and demand went into sort of recession. Oil prices went as low as 10-20 USD/bbl. Full economic and social impact of high oil prices including in Pakistan have yet to be noted and felt. In Sri Lanka, for example, semi-anarchic situation has developed and the full assessment of economic losses and destruction has not been done.

Some people in Pakistan and elsewhere in the developing countries have argued for building oil and gas storages. There is some working oil storage capacity in Pakistan covering on the average 14 days of requirement, while the OGRA law requires 20 days of coverage. Although there is a case of expanding storage capacity, it is an expensive business. It requires capital investment for construction and working capital for the commodity. The costs are to be finally borne by the consumer.

It should also be noted that large storages are more common for crude oil. Producer countries store their extra production in consumer countries. A case in point is the UAE-India agreement in this respect. However, IEA storage requirement and maintenance of three months' storage could not affect the prices in the recent days; it may cater to the strategic requirement assuring continued supplies during emergencies. In Pakistan and elsewhere in developing countries, strategic requirements may create demand for storages and some enhanced storage may be built eventually.

Hedging has been argued and tried in Pakistan as well. One of the last special assistants to prime minister (SAPMs) did try hard to install such a system. However, it was not found cost effective and had many risks. Hedging has been practiced by airlines to keep air tickets prices stable over the short term. Oil supply companies also indulge in hedging to be able to meet the contract prices in short-term contracts of less than one year.

Major oil prices' rise and fall have been over a time cycle of 5-7 years, although it is difficult to predict points of inflexions with accuracy. As we have discussed, physical storage is costly and difficult. There is a greater feasibility of financial storage in the form of oil price fund. When oil prices go down, the savings may be deposited in an interest carrying fund. When the prices go up, these savings are utilized to fiancé the excessive prices. Although, the principle is simple, its actual mechanics of working may be complicated. Fund's design can be developed. It can be a national fund or preferably an international fund focused on developing countries. National funds may not be implementable in Pakistan, at least.

Several deductions have been made earlier under various heads like Iqra surcharge on imports, but these end up in common pool, which means the amount so collected is spent on other heads to be not recovered. International agencies like the International Monetary Fund (IMF) and World Bank may not be required to dominate it and the fund should have larger influence and participation by China, Russia, South Korea and

OPEC countries. The IMF and World Bank, however, have the intellectual and organisational resources to carry out this exercise.

Developed countries have a moral and political responsibility to pay some heed to the problem. Wars and conflicts are mostly created by them and the poor countries are mere spectators and suffer needlessly. From Vietnam to Russia-Ukraine conflict, it is all great power game. And additionally, the conflict is spread to economic sphere in the form of sanctions; Iraq, Venezuela, Iran and now Russia. It is good to see that news is pouring in that there may be some mechanism to allow flow of oil from Venezuela and Iran to ease the oil prices. In earlier times, diplomatic pressure on Middle Eastern countries used to be enough to maintain a low price oil regime; no more.

Expanding world economies are in the interest of all. It is not a zero-sum game. Market expansion is going to come from the developing world, while populations are stagnating in the advanced countries. Labour shortages are emerging in non-typical labour markets. Current behaviour of advanced countries is rather callous. There is no initiative and no consideration.

The IMF demanding unreasonable and abrupt increases in local energy prices in countries like Pakistan is a sure indicator. While there could be a case for requiring elimination of petroleum subsidies, it is absolutely ruthless and even destructive to require PLD and GST in an environment of ever-rising oil prices, of which nothing is certain. It may be good in the long run, but what about the short term? In the long run, it is said, we are all dead. It is in the short term that we all live and we have problems. So, it is hoped that some steps would be taken to alleviate the difficulties of the poor countries in meeting the abruptness in oil and gas prices.

As for Pakistan, the choices are limited. Pakistan has taken the bait of neo-liberal economic agenda for several decades; leave import substitution and ride the bandwagon of export development. Imports have climbed up while exports could not be expanded, causing current account deficit and currency devaluation issues which have exacerbated the energy price issue as well among others. Under such policies, reliance has been there on imported energy resources and development of local energy resources has been short shrifted.

Sufficient attention has not been given to the development of local oil and gas. Thar coal remains highly under-utilized, while imported coal power plants may be closed down if coal prices continue to remain high. A railway link project is required to bring Thar coal to the market outside the mines. The project remains to be approved and implemented. Thar coal gasification to convert it into gas and diesel, etc., has been talked about for quite some time now. The international energy crisis has made the campaign against coal a bit milder. It may be the right time window to initiate these projects. Renewable energy can fill some gap at low cost. To be fair and balanced, renewable energy like wind and solar has become competitive only recently. Elsewhere, we have stressed the need of a fast track solar programme.

Hydro resources could have been developed more. Unfortunately, the installed hydro plants are giving lower output due to lack of water, adding to load-shedding. Hydros take inordinately long time to complete. Their water component adds to its critical role. LNG spot prices are very high; it is the term contracts which are somehow able to maintain lower average. Biogas and Bio-CNG have a reasonable potential of providing gas in reasonable quantity and at reasonable prices. Biogas projects can be implemented in less than a year. Scope for improvement and fast tracking is still there, at least in selected areas. Struggle should never end.

1.7: The rising oil prices

In Pakistan, petroleum prices were raised yet again to Rs248.74 per litre for petrol and Rs 276.54 for diesel. This is the fourth time petroleum prices have been raised in a period of 1-1.5 months under IMF guidelines or pressure. Subsidies have been eliminated almost altogether, although there may be some residual subsidies that are to be adjusted. The agreement with the IMF requires full price recovery plus PLD taxation of Rs30-50 per litre and GST of 17 per cent. This means more has yet to come.

While elimination of subsidies may be a rational and reasonable IMF requirement, demanding PLD and GST in such an abrupt manner when international oil prices are extremely high, is rather ruthless and shows a high degree of insensitivity to the poor of this country. While in USD terms, Pakistan prices may not be so high, in local rupee terms, the current prices are more than 100 per cent of the usual prices and have increased rather abruptly. The wages of the poor, however, have not increased at all and cannot increase in tight economic circumstances.

The IMF can very well argue that it is Pakistan which has brought its economy to a level that it had to approach the Fund. And it is not for the first time that Pakistan has gone to the IMF. This is the 16th or 17th time an IMF loan is being sought over the last 30 years or so. Successive governments in Pakistan have been pursuing an elite agenda, not collecting taxes and extending subsidies that benefitted the rich and powerful. The question the IMF must consider: how is any of this the fault of the poor? The poor in Pakistan should have resisted and revolted. The fact is that Pakistan has no choice. It has to accept the IMF conditions or be ready to face default. Default may not be a good idea, although some nihilist but respectable economists have argued in favour of default rather than meeting the IMF conditions.

Let us come back to the petroleum pricing issue. One way of answering the price growth issue is to look at the prices in comparable countries or in the region. In India, the current average/typical gasoline prices are at Pak Rs277 per litre. Indian prices have always been higher than Pakistan, for which there is no apparent reason except higher taxation in India. Otherwise, the Indian petroleum industry is much larger and more efficient than Pakistan's. India exports petroleum and is highly competitive, although not much is known here about India; financing military expenditure and cross-subsidizing exports could be some of the possible reasons. It should be noted that India is getting 30 per cent cheaper crude oil from Russia. However, it may not be more than 10 per cent of their current requirement. It is on the rise though by the day.

The lowest petroleum prices in the region are in Bangladesh. The Bangladesh government has started indicating that subsidies are becoming unsustainable. Some oil price rise is expected there. In most countries, diesel prices have been kept lower than that of gasoline on the simple premise of public use of diesel in passenger transport and goods traffic. In Pakistan, for one reason or the other, this logic has not been accepted. However, the current high diesel prices in Pakistan are due to high diesel prices. We have to put off this discussion for a later date when prices stabilize. It may be noted that in Sri Lanka, despite the widely known economic conditions and default, diesel prices are still lower than Pakistan and elsewhere except in Bangladesh. Both Bangladesh and Srilanka have maintained quite low diesel prices. Export competitiveness appears to be the major driver in their energy pricing policies.

In the US, petroleum prices have been lower than elsewhere in the advanced countries due to a highly competitive oil industry and local abundance of oil production. American benchmark crude oil prices have always been lower than elsewhere. The US retail prices of petroleum products have always been considered as benchmark prices. This time, diesel prices are 10 per cent higher than gasoline in the US. This is due to higher market prices of diesel which are a result of demand, supply and other issues. Usually, diesel and gasoline prices are almost the same in the US as opposed to Europe and other advanced countries.

In such a bleak scenario, there are very few options and prospects for good. However, there is a possibility that the oil price may go down. It may take a year or so to stabilize around $90-95 as indicated by future contracts. The rupee may get strengthened as has happened recently among the good news of the IMF's agreement finalization process. The rupee may improve if all other financial sources follow IMF funding. The government may be able to pass on the savings to the consumers or use it to meet other deficits and subsidies.

There are some cost reduction opportunities as well, however small these may be: efficient buying, reduction of demurrage and other losses, negotiating fair margins by the oil refineries and E&P companies. An unfortunate aspect of Pakistan's local crude oil pricing formula is that the wellhead prices are paid at international prices. There is no price advantage. As foreign oil producers are squeezing us, local ones are doing the same, even when it is public-sector companies. Similarly, oil refineries are making hay while the sun shines. There is an S-curve ceiling and flour pricing formula in case of local gas. Why is this not so for oil? It would protect both the producer and the consumer. Reportedly, there is a windfall profit formula which apparently has not been activated. Every penny is important in the energy business, as it is consumed in millions and billions of units; be it barrels, cubic feet, kWh or MMBtu.

Finally, how to protect the poor from such excruciating prices? We have been proposing for quite a while a low-price gasoline brand for motorcycles and smaller and older vehicles. This is a low–RON gasoline. Apart from being cheaper, it provides direct and targeted subsidies for the needy.IMF supports targeted subsidies but opposes unintended benefits for high income groups. The government of Pakistan has not yet been able to make a decision about this. Instead, it has announced a stipend of Rs2000. This has not yet been implemented or is not visible. This was announced simultaneously with the increase of the first Rs30 increase. There is a need to suitably enhance this amount.

Energy conservation measures have been announced which may reduce consumption, although that does not directly affect prices. However, reduction in consumption would reduce imports, reduce the current account deficit and affect the exchange rate in a positive manner. Reduced exchange rates would also reduce retail oil prices. The price raise itself may reduce demand. On a lighter side, all poisons have antidotes.

Table1.7.1: Petroleum Energy Products consumption by Sector

Unit: Tonnes
TOE

Sector	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	ACGR
Domestic	77,169 *79,607*	66,075 *68,162*	60,557 *62,470*	45,844 *47,292*	29,816 *30,758*	29,522 *30,454*	-17.5%
Industrial *	1,990,398 *1,992,437*	1,784,781 *1,785,880*	1,299,437 *1,307,193*	1,221,474 *1,220,638*	1,472,777 *1,474,086*	1,332,899 *1,337,911*	-7.7%
Agriculture **	12,671 *13,201*	14,527 *15,134*	15,021 *15,649*	11,993 *12,494*	12,134 *12,641*	11,822 *12,316*	-1.4%
Transport	14,582,925 *15,434,433*	16,047,392 *16,988,579*	14,673,564 *15,549,796*	13,861,073 *14,694,099*	15,779,499 *16,729,634*	17,409,035 *18,452,089*	3.6%
Power	8,531,825 *8,328,980*	6,377,388 *6,223,984*	2,759,465 *2,688,911*	1,526,796 *1,487,578*	2,364,586 *2,310,032*	3,683,322 *3,605,543*	-15.5%
Other Government	366,958 *385,300*	387,801 *407,198*	409,132 *429,790*	371,303 *389,781*	306,961 *321,983*	373,489 *392,193*	0.4%
Total:	**25,561,946** ***26,233,957***	**24,677,964** ***25,488,939***	**19,217,176** ***20,053,809***	**17,038,484** ***17,851,882***	**19,965,773** ***20,879,133***	**22,840,089** ***23,830,506***	**-2.2%**
Annual growth rate	9.77%	-3.46%	-22.13%	-11.34%	17.18%	14.40%	

* Include consumption in cement manufacturing industry:

Tonnes	129,925	62,048	62,048	131,123	157,161	108,744	-3.5%
TOE	*130,234*	*63,340*	*63,340*	*130,391*	*156,597*	*110,181*	

** HSD consumption for tractors in agriculture sector is not separately available and is included in the transport sector. Agriculture sector represents LDO only.

Source: OCAC.

Note: See Page No. (iv) for OCAC Disclaimer

Table 1.7.2: Petroleum Energy Products consumption by Fuel

Unit: Tonnes
TOE

Energy Products	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	ACGR
Aviation Fuels	639,545 *662,728*	632,293 *655,576*	555,437 *577,090*	458,593 *476,388*	346,362 *360,487*	428,412 *444,956*	-7.7%
Motor Spirit 87 RON	6,646,965 *7,101,617*	7,386,362 *7,891,589*	7,599,364 *8,119,160*	7,454,021 *7,963,876*	8,351,259 *8,922,485*	9,006,833 *9,622,900*	6.3%
HOBC	90,595 *96,321*	124,918 *132,813*	86,621 *92,095*	56,343 *59,904*	164,000 *174,365*	152,101 *161,714*	10.9%
Kerosene	120,958 *124,780*	114,386 *118,001*	102,830 *106,079*	88,939 *91,749*	70,211 *72,430*	65,691 *67,767*	-11.5%
HSD	8,484,280 *8,919,524*	9,038,298 *9,501,963*	7,354,409 *7,731,690*	6,626,725 *6,966,676*	7,791,066 *8,190,748*	8,915,873 *9,373,257*	1.0%
LDO	19,490 *20,305*	20,986 *21,863*	25,179 *26,231*	19,574 *20,392*	15,147 *15,780*	15,628 *16,281*	-4.3%
Furnace Oil	9,560,113 *9,308,682*	7,360,721 *7,167,134*	3,493,336 *3,401,461*	2,334,289 *2,272,897*	3,227,728 *3,142,839*	4,255,551 *4,143,630*	-14.9%
Energy Products Total:	**25,561,946** ***26,233,957***	**24,677,964** ***25,488,939***	**19,217,176** ***20,053,809***	**17,038,484** ***17,851,882***	**19,965,773** ***20,879,133***	**22,840,089** ***23,830,506***	**-2.2%**
Annual growth rate	9.77%	-3.46%	-22.13%	-11.34%	17.18%	14.40%	

There are two recent and important developments that are worth discussion. Firstly, petrol prices were increased on 1st July once again — the 4th rise in the last 35 days — by a margin of 5-6%. Subsequently on Tuesday (5th July), Brent Crude oil prices drastically went down from 113.50 USD to below 103 USD/bbl. We will first discuss the international crude oil prices sliding down issue and then the local price rises.

Oil brokerage firm Citi projects that Brent crude oil prices could fall to 65USD per barrel by year (2022) end and USD 45 by year (2023) end. The scenario assumes no intervention by OPEC. OPEC supply reduction may alter the forecast. Another assumption being that Russian crude oil exports remain robust. Fears of recession are affecting demand, which is going down. Inventories may go up causing downslide of prices. Earlier, future price of 95 USD was quoted by other agencies. This would indeed be good news for poor countries, including Pakistan, and even richer importing countries.

New gasoline price is 248.74Rs/L (6.35% increase) and High Speed Diesel (HSD) is Rs 276.54/L (5.0245% increase). On gasoline, Petroleum Levy of Rs 10 has been applied and on HSD of Rs 5. An agreement with the IMF requires full price recovery plus PLD taxation of up to Rs 50 per litre (in steps of Rs 5-10 per month) and GST of 17%. This means more has yet to come. While elimination of subsidies may be a rational and reasonable IMF requirement, demanding PLD and GST in such an abrupt manner when international oil prices are extremely high is rather ruthless. In Pakistan, there are two reasons behind growing concerns among people on the petroleum pricing issue: rising international prices and heavy currency depreciation. While in USD terms, prices may not be so high, in local rupee terms, however, current prices are more than 100% of the usual prices and have increased rather abruptly. Wages of the poor have not increased at all and cannot increase in tight economic circumstances.

Let us see how much more the petroleum prices can rise. One way of answering the price growth issue is to look at what are the prices in comparable countries or in the region. In India, the current average/typical gasoline prices are at 1.317 USD/L (8% higher than Pakistan's 1.219 USD/L), which are the highest in the region. Gasoline prices in India were 18% higher than in Pakistan only three weeks ago. The current increase in Pakistan has narrowed down the difference to 8% only. However, diesel prices in Pakistan are now 14.7% higher than in India. In the past, prices in India always higher than in Pakistan, for which there is no apparent reason except higher taxation in India. There used to be political controversy in India as to why petroleum prices were lower in Pakistan.

In India, as late as April 2022, the share of taxation in gasoline prices was 43.65% and a year earlier it was 63.22%. In the case of diesel, the share of taxation in April was 38.04% and a year earlier it was 56.77%. The current price comparison between India and Pakistan is rather perplexing. There may be buying inefficiency issue in Pakistan. It should be noted that India will continue to buy 'cheap oil' from Russia. However, it may not be more than 10% of its current requirement.

In the region, Bangladesh has the lowest petroleum prices. In most countries, prices of diesel have been kept lower on the simple premise of public use of Diesel in passenger transport and goods traffic. In Pakistan, for one reason or the other, this logic has not been accepted. However, the current high diesel prices in Pakistan are due to high diesel prices. We have to put off this discussion for a later date when prices stabilise. In the US, petroleum prices have been lower than elsewhere among the advanced countries due to a highly competitive oil industry and local abundance of oil production. WTI, American benchmark crude oil prices have always been lower than elsewhere. The gasoline and diesel prices in the US are 1.371 USD/L and 1.511 USD/L, respectively.

The US retail prices of petroleum products have always been considered as benchmark prices. This time, diesel prices in the US are 10% higher than those of gasoline. It is due to higher market prices of diesel due to demand and supply and other issues. Usually, diesel and gasoline prices in the US used to be almost the same while in Europe diesel prices are kept lower for economic and social reasons.

In the current bleak scenario, when all energy and commodity prices have increased many times, there may be very little options and prospects for something good to happen in the near future. However, there is a possibility that oil price may go down. Prices had crossed 120 USD. And late went down from 116 USD to 108 USD and went up to 112 USD; still a 4 USD decrease. Rupee may get strengthened as has happened recently. Rupee may improve if all other financial sources follow the IMF funding. GoP may be able to pass on the savings to consumers or use these to meet its other deficits and subsidies.

There are some cost reduction opportunities as well, however small these may be: efficient buying, reduction of demurrage and other losses, negotiating fair margins by the oil refineries and E&P companies. An unfortunate aspect of Pakistan's local crude oil pricing formula is that the wellhead prices are paid at international rates. There is no price advantage. As foreign oil producers are squeezing us, the local ones are doing the same.

Similarly, oil refineries are making hay while the sun shines. There is an S-curve ceiling and floor pricing formula in case of local gas. Why it is not the same for oil. It would protect both, producer and the consumer. Reportedly, there is a Windfall Profit Levy (WPL) formula, which apparently has not been activated. India has introduced or activated Windfall profit provision recently (293.80 USD/tonne, i.e., 39.38 USD/bbl). There are exclusions, however. Small crude producers are exempted from (WPL). Also, extra production from the last year is also exempt from WPL.

The latter being a clever provision for encouraging increased production. This kind of incentive may also be tried by Pakistan policymakers for both oil and gas. Every penny is important in energy business as it is consumed in millions and billions of units; be it barrels, cubic feet, kWh or mmbtu. Another question: can WPL be diverted to oil pricing formula and help reduce oil prices for the poor? Will IMF accept it? Would WPL proceeds be significant enough?

Finally, how to protect the poor and low income group from such excruciating prices. We have been proposing for quite a while a low price gasoline brand for motorcycles and smaller and older vehicles used by the low income group. This is a low –RON gasoline. Apart from being cheaper, it provides a vehicle to channelize the direct and targeted subsidies for the needy.

The IMF supports targeted subsidies but opposes unintended benefit for the high income group. GoP has not been yet able to decide about it. Instead, it has announced a stipend of Rs 2000. It has not yet been implemented or is not visible. This was announced simultaneously with the increase of the first Rs 30 increase. There is a need to suitably enhance this amount. Energy conservation measures have been announced which may reduce consumption, although it does not directly affect prices. However, a reduction in consumption would reduce imports, would reduce current account deficit and would affect the exchange rate in a positive manner. Reduced exchange rates would also reduce retail oil prices. Price raise itself may reduce demand. On a lighter side, all poisons have antidotes.

Table 1.7.3: Comparative Oil Prices in selected countries-1st July 2022

Country	Gasoline	Diesel
Pakistan	1.219	1.356
India	1.317	1.182
SriLanka	1.528	1.278
Bangladesh	0.953	0.856
Vietnam	1.44	1.303
Philipines	1.565	1.624
Thailand	1.517	0.993
China	1.45	1.307
Turkey	2.216	1.654
Spain	2.184	2.148
Italy	1.371	2.188
USA	1.643	1.511
Pakistan Rs/L	248.74	276.54
Pakistan Exchange Rate Rs/USD	204	204
% increase Pakistan	6.349	5.0245
Source: Global Petroleum Prices, Shell		

Table 1.7.4: India Petroleum Price Structure-IRs/L-22 May 2022

	Gasoline	Diesel
Crude Oil Price -Average-IRs/L	50	50
OMC Processing Cost	7.35	8.15
Central Excise Duty+Road Tax	19.9	15.8
Petrol Pump Commission	3.8	2.6
VAT (Delhi	15.67	13.07
VAT (Mumbai	30	20
Retail Price _Mumbai	111.35	97.28
Source:https://www.mycarhelpline.com/index.		

1.8: Will low oil prices sustain?

New price of gasoline is 230.24 Rs/liter (7.44% decrease) and diesel's is 236 Rs/L (14.66% decrease). Gasoline's price has been reduced by 18.5 Rs/L and HSD's by 40.54 Rs/L. Pakistan oil pricing is complicated under falling exchange rate and the International Monetary Fund (IMF) dictates and requirements of heavy taxation on oil and government of Pakistan (GoP). Prices in Pakistan are now lower than those of India; gasoline's 16.5% lower and diesel's 4.5% lower. What could be the future like? Will Pakistan oil prices be maintained or will go up or come down in future? Will international oil prices go down further in the coming days? Will exchange rate of Pakistan improve? Can the IMF conditions be implemented without damaging socio-political conditions? We will discuss the issues and possibilities in the following paragraphs.

No GST has been charged and a nominal petroleum levy of Rs 10/L has been imposed on gasoline and of Rs 5/L on diesel. The price reduction has been made in the background of a 20% reduction in Brent Crude oil prices. The question is: will Brent go down any further and how much? It is a million dollar question. The Russia-Ukraine war may bring it down further. Recession is being projected worldwide which may push the prices down. It is a double-edged sword. Recession may cause loss of exports and remittances.

Table 1.8.1: Comparative Oil Prices in selected countries-June 27-July 11-15 2022

Countries	Gasoline	Diesel	Gasoline	Diesel
	June 27 th 2022		July11-15th2022	
Pakistan	1.219	1.356	1.096	1.124
SriLanka	1.317	1.182	1.311	1.176
Bangladesh	1.528	1.278	1.525	1.276
India	0.953	0.856	0.95	0.854
Vietnam	1.44	1.303	1.298	1.15
Philipines	1.565	1.624	1.54	1.565
Thailand	1.517	0.993	1.323	0.963
China	1.45	1.307	1.405	1.261
Spain	1.643	1.654	1.456	1.54
Turkey	2.216	2.188	2.045	1.984
Italy	2.184	2.148	2.037	1.994
USA	1.371	1.511	1.298	1.471
Pakistan Rs/L	248.74	276.54	230.24	236
% delta	6.349	5.0245	-7.44	14.66
Pakistan Exchange Rate Rs/USD	204	204		
Pakistan Exc.Rate-15th july	210			
Source: Global Petroleum Prices, Shell				

The most important question for Pakistan is how to meet the IMF conditions vis-à-vis oil prices. This time a combination of lee-ways has brought good news and possible political advantages to the reigning government. What will happen next? The IMF has prescribed full GST of 17.0% and Petroleum Levy of up to Rs 50/L and the change to be implemented gradually in the current budgetary year. To explore some of the aforementioned issues, we have played with two scenarios. Scenario-I: with prevailing prices and exchange rate and IMF requirements of 17.0% GST and Rs.30.0 PLD and 2. Scenario-II: At reduced Brent crude oil price of 80-85

USD/bbl, Rs 185 exchange eate, Rs 30 PLD/L and GST of Rs 30.67/L. Scenario-I gives a gasoline price of Rs 293.8/L and HSD price of Rs 320.6/L; these would be almost impossible and unaffordable prices.

Table 1.8.1: Petroleum Products Cost Structure-15th July

	Gasoline	HSD	Kerosene
Ex-Refinery Price Build up			
FOB (USD/bbl)	120.78	149.19	136.38
Premium (USD/bbl)	16.12	8.5	5.09
C&F (USD/bbl)	136.9	157.69	141.47
Exch.Rate Rs/USD	209.75	209.75	206.91
Liters/bbl	159	159	159
C&F Rs/L	180.6	208.0	184.1
Incidental-Rs/L	0.3	0.32	0
Custom Duty-Rs/L	20.44	23.51	0
Adjustments-Rs/L	4.77	-2.24	0
Ex-Refinery Price-Rs/L	206.1	229.6	184.1
Distribution Cost	5.39	-6.85	5.64
IFEM	211.5	222.8	189.7
OMC Margin	3.68	3.68	1.58
Dealer Margin	4.9	4.13	
Petroleum Levy	10	5	0
Price before Sales Tax	230.1	235.6	191.3
Sales Tax-%	0	0	0
Sales Tax-Rs/L	0.00	0.00	0.00
Max Depot Sales Price	230.1	235.6	191.3
Refinery Margin	20	20	
Projected Brent Crude Prices	100.78	129.19	
Source: OGRA, Oil Refineries, others			

However, under better international price environment under Scenario-II, gasoline price would come out to be Rs 206/L and HSD's would be Rs 209/L. These are Rs 30/L lower than the existing new prices. It would be possible, if exchange rate is brought down to Rs 185, and more realistic import prices of gasoline and HSD of USD 100/bbl emerge. This would be an all positive scenario; a low exchange rate and lower import prices. However, this may make the full GST and PLD application possible. If the economy and exports improve, exchange rate will improve. This may be the only leverage, Pakistan policymakers have.

Apart from a cost-plus formula, one may ask an innovative question: what is the legitimate oil price that can be charged to consumers? We could define the word 'legitimate' to be the comparative prices elsewhere-India and Bangladesh and a maxima of the US prices. US prices are the most efficient and moderate among the advanced countries. The adjoining table gives price data on most relevant possible countries. Pakistan oil prices in USD terms are: gasoline 1.096 USD/L and HSD 1.124USD/L. Bangladesh prices are the lowest in the region: Gasoline 0.95 USD/L and HSD 0.854 USD/L; India has the highest prices in the region: gasoline 1.311 USD/L and HSD 1.176 USD/L. It may be noted that gasoline prices in Pakistan still are 16.4% lower than those in India while HSD prices are 4.4% lower. The US prices of gasoline and HSD are, 1.298 USD/L and 1.471 USD/L, respectively. We have examined elsewhere, as to why HSD prices are internationally very high these days.

Looking at these, 1.00-1.2 USD per liter appears to be the right price; in between India and Bangladesh. This actually is in the range of current Pakistan prices (1.096 USD/L for gasoline and 1.124 USD/L for HSD). But it is without GST and some PLD. It is clear that IMF dictates will be partly feasible only if international prices go

Table 1.8.2: Petroleum Products Cost Structure-15th July

Low Crude+ST+PLD Scenario			
	Gasoline	**HSD**	**Kerosene**
Ex-Refinery Price Build up			
FOB (USD/bbl)	100	110	100
Premium (USD/bbl)	8.5	5.5	5.09
C&F (USD/bbl)	108.5	115.5	105.09
Exch.Rate Rs/USD	185	185	185
Liters/bbl	159	159	159
C&F Rs/L	126.2	134.4	122.3
Incidental-Rs/L	0.3	0.32	0
Custom Duty-Rs/L	0	0	0
Adjustments-Rs/L	4.77	0	0
Ex-Refinery Price-Rs/L	131.3	134.7	122.3
Distribution Cost			
IFEM	5.39	5.39	5.64
	136.7	140.1	127.9
OMC Margin	3.68	3.68	1.58
Dealer Margin	4.9	4.13	0
Petroleum Levy	30	30	0
Price before Sales Tax	175.3	177.9	129.5
Sales Tax-%	17.5	17.5	0
Sales Tax-Rs/L	30.67	31.13	0.00
Max Depot Sales Price	206.0	209.0	129.5
Refinery Margin	20	25	
Projected Brent Crude Prices	80	85	
Source:OGRA,Oil Refineries,others			

down further and if the exchange rates come down to under Rs 185. Will the IMF allow petroleum price subsidy to keep the prices low while still charging GST and Petroleum Levy? This would be too clever by half. Taking with one hand and giving with the other. This did not work with the previous government and the IMF programme had to be put off. However, the IMF may allow targeted subsidies for the poor. Direct transfer to poor consumers' accounts or special petrol versions for motorcycles, for example. Local oil prices can be tinkered with, here and there, reducing local crude prices formula, more efficient buying of imported crude and finished products, reducing or removing custom duties on imported crude and fuel.

Table 1.8.3: Petroleum Products Cost Structure-15th July

IMF Scenario at prevailing price and exchange rates			
	Gasoline	**HSD**	**Kerosene**
Ex-Refinery Price Build up			
FOB (USD/bbl)	120.78	149.19	136.38
Premium (USD/bbl)	16.12	8.5	5.09
C&F (USD/bbl)	136.9	157.69	141.47
Exch.Rate Rs/USD	209.75	209.75	206.91
Liters/bbl	159	159	159
C&F Rs/L	180.6	208.0	184.1
Incidental-Rs/L	0.3	0.32	0
Custom Duty-Rs/L	20.44	23.51	0
Adjustments-Rs/L	4.77	-2.24	0
Ex-Refinery Price-Rs/L	206.1	229.6	184.1
Distribution Cost			
IFEM	5.39	5.39	5.64
	211.5	235.0	189.7
OMC Margin	3.68	3.68	1.58
Dealer Margin	4.9	4.13	
Petroleum Levy	30	30	0
Price before Sales Tax	250.1	272.8	191.3
Sales Tax-%	17.5	17.5	0
Sales Tax-Rs/L	43.76	47.74	0.00
Max Depot Sales Price	293.8	320.6	191.3
Refinery Margin	20	20	
Projected Brent Crude Prices	100.78	129.19	
Source: OGRA, Oil Refineries,others			

1.9: Comparative Prices of POL products

New petroleum prices have been announced; there is no big increase in prices of Petrol and HSD. However, the International Monetary Fund (IMF) agreement requires a Rs 10 increase in Petroleum Levy (PL) every month so as to take it up to Rs.50 per litre. The government has increased PL by more than the IMF requirement; PL is now Rs 37.50/litre a Rs.20.0 increase, which means that Rs 17.50/litre has been added as PL which is Rs.7.5 more than the IMF requirement. Had the IMF requirement been followed petrol's price could have been reduced by about Rs.5.00. However, PL on diesel has been reduced by Rs.2.50 per litre. This may be balancing the increase in PL of gasoline insofar as revenue requirement is concerned.

One couldn't understand the reason for reducing the PL on HSD by Rs.2.5 and increasing it on petrol by Rs.7.5/litre. If it is an attempt to reduce the diesel's price, it should be welcome. Diesel is used in public and goods transport and affects inflation more than petrol does. In our region and elsewhere in the developing countries, this is the trend. Let us compare prices in Pakistan with the regional prices. Pakistan exchange rate has been quite mercurial in this period, which makes comparison a bit difficult and rather dicey. However, a rather rough comparison can be made. We will make comparison over a period of the last one month. In India, prices change every day and are different in every town or city due to transport cost differential. The lowest prices are in New Delhi, the India's capital, which is rather perplexing. (may be there is a nearby oil refinery). The highest prices are in India's south, which are IRs.10 per litre higher than New Delhi (it is almost 10% higher). Same may happen here if much criticized IFEM is done away with.

In USD terms, prices of petrol and diesel in Pakistan increased by 7.9%. Petrol's prices in India and the US decreased by -1.44% and -8.22%, respectively. In Bangladesh, petrol prices remained almost constant. Diesel's prices in Bangladesh and India decreased by 4.26% and 1.35%. In the US diesel prices remained almost constant. In Pakistan, prices of petrol and diesel are almost identical with a small difference. This is not the case in other countries of the region and this has been the trend over a long time. Diesel's prices in three countries - Pakistan, Bangladesh and India - are comparable; 1.13, 1.147, 1.168 USD per litre respectively. Petrol prices, however are 25.46% higher in India and 36.8% higher in Bangladesh. High Petroleum prices are a new trend in Bangladesh, otherwise, prices have been lower there. Traditionally, there have been high taxation in India - almost 50% of the price. In Pakistan, taxation on petrol is 11.65% of the selling price. GST is not being charged. If GST is charged, taxation share may rise to 28%. With Rs50 Rs/litre PL and 17% GST, taxation share in Pakistan may approach Rs85/litre on an average price of Rs.200 per litre. This would take taxation share to 42%. At high international oil prices, this kind of taxation would not be socially, politically and economically feasible at all. They may have to continue not charging GST. Why don't they charge GST? GST is shared by provinces, while PL goes to the federal government. The IMF is occupied with balancing the budget of the federal government only.

In Pakistan prices of petrol are almost comparable with those in the US. For some reasons, diesel's prices in the US are these days very high - 27% higher than those in Pakistan and 15% higher than those in India. Russian diesel supply issues may have done this. Russia's diesel export share in the European market has been high. Traditionally, petrol and diesel prices used to be the same in the US due to identical taxation on petrol and diesel. Pakistan has been following almost the same policy as opposed to most developing countries which have maintained lower prices of diesel and low taxation on it.

There are two factors in oil sector which have made life difficult in Pakistan: increase in international oil prices and depreciation of rupee (PKR) vis-à-vis USD. While the increase in international oil prices applies to all the countries, currency deprecation is peculiar to Pakistan alone. It is hoped that rupee will recover to its original recent value of Rs.185 which would enable Pakistan to maintain affordable prices. One is not sure of how international oil prices would behave in the short to medium term. Counter forecasts are being made by various agencies. A decrease in oil prices may decrease Pakistan's annual import bill. Moreover, the current account deficit would go down and resultantly exchange rate will improve. Local retail prices of petroleum products, in that case, would acquire a comfortable and affordable level. If this does not happen, we will have a hard time.

Table 1.9.1: Petrol Price sensitivity

Assumption PL@Rs60/ltr GST: Nil		USD/PKR						
		260	280	300	320	340	360	380
Arab Gulf USD/bbl	70	232	243	255	267	279	291	303
	80	254	267	281	294	308	322	335
	90	277	291	306	322	337	352	367
	100	298	315	332	349	366	383	400
	110	320	339	357	376	395	413	432

Table 1.9.2: Comparative Petroleum Prices :Pakistan, India and Bangladesh-USD/L :Ist-15th Aug-22

	Aug. 1st 2022	1st. Sept 2022		1st Sept Pakistan=100		Increase %		
	Gasoline	**HSD**	**Gasoline**	**HSD**	**Gasoline**	**HSD**	**Gasoline**	**HSD**
Pakistan-global Petroleum Pakistan-national price	0.961	0.985	1.037	1.063	100	100	7.91	9.92
Bangladesh-New	1.366	1.198	1.368	1.147	131.92	107.9	0.15	-4.26
India	1.32	1.184	1.301	1.168	125.46	109.88	-1.44	-1.35
U.S.A	1.18	1.357	1.083	1.351	104.44	127.09	-8.22	-0.44
Pakistan Local Price-Rs/L	227.19	244.9	235.9	247.43				
Pakistan Exchange Rate-USD/Rs	225.09				218.37			
India-Delhi-IRs/L			96.72	89.66				
India-Hyderabad-IRs/L			109.6	97.88				
India-Mumbai-IRs/L			106.2	94.25				
Source: OGRA, Global Petroleum Prices								

1.10: Cheaper petrol for the poor

Petroleum product prices have been reduced by the government despite rising international prices, which first crossed $100 per barrel mark and have now approached $130. The issue has been compounded by the Ukraine conflict. In Pakistan, petroleum prices have been and are the lowest in the region. Petroleum product prices have been reduced by Rs10 per litre. Gasoline and diesel prices, after the recent reduction, are at Rs150 per litre and Rs144 per litre.

The lower petroleum prices have been possible by reducing the petroleum levy to almost the negligible level (Rs1.81 on gasoline and Rs3 on diesel), while GST has already been reduced to zero earlier. In US dollar terms, the comparative gasoline prices per litre are: Pakistan 0.855, Sri Lanka 1.025, Bangladesh 1.035, India 1.366 and the benchmark US price is 1.044. Corresponding diesel prices are: Pakistan 0.823, Sri Lanka 0.599, Bangladesh 0.930, India 1.192 and the US 1.061. Except for abnormally low diesel prices in Sri Lanka, Pakistan prices are significantly lower.

Price reduction has generally been appreciated by the people, especially the poor, while critics have termed it unsustainable. The government may have provided up to a certain level of oil prices but it cannot possibly afford to absorb them indefinitely and so the people as well. There are three reform proposals that the government may have to design and implement in the petroleum sector – cross-subsidies for the poor, petroleum rationing for high price periods, and lower diesel prices than gasoline via cross-subsidies vis-à-vis gasoline.

We have discussed the rationing issue earlier in this space. However, it may be worth reminding it here as well. Even if the government absorbs high prices in its budgetary resources, what can it do to handle the foreign exchange drain? Imports by value can increase by 30% or more. Hence, a contingency plan for rationing may be required. Voluntary rationing followed by mandatory one may have to be introduced. Initially, public and private sector companies may be obliged to rationing. In the days of computers and NADRA, it should not be difficult to administer rationing.

Just in passing, lower diesel prices than gasoline is a universal practice to support public and goods transportation, bringing in both welfare and economy-wide competitiveness. However, this can be implemented only when there is some level of taxation, which is not there now. Let us now discuss the proposal of cheaper petrol for the poor. In this price reduction, the rich are free riders. This cannot continue for long. The reduction is essentially meant for the non-affording consumers and not for those who drive expensive vehicles costing Rs1.4 million to Rs5 million or even more.

In Pakistan, there has been quite a considerate pro-poor tariff policy in the energy sector, as is indicated by the very low tariff slabs for the small consumers, who happen to be poor. At least part of the rise in circular debt both in the electricity and gas sectors has been due to this subsidised tariff. The petroleum sector, for a variety of good reasons, could not introduce a pro-poor differentiated pricing. The most important has been the lack of a suitable product differentiation. In case of electricity and gas, the lower income groups are identified as per consumption quantity slabs. The assumption is that the poor and low-income groups consume less, and thus lower price slabs are identified accordingly. In case of gasoline, no such consumption-based pricing system is possible.

Subsidy for bike users

Reportedly, the government is considering some kind of subsidy for the motorcycle users, which are mostly poor or fall in the low-income group. There are around 30 million motorcycle users consuming some 40-50% of the total gasoline consumed in the country. Thus, there appears to be an identifiable population, which can be given the benefit of subsidies. There are two possible approaches – one is to transfer the subsidy amount through the Ehsaas programme. Ehsaas intervention may be rather difficult for 30 million users and their motorcycle registrations.

Our proposal is to provide subsidy by introducing a separate brand of gasoline under a low-octane system. Currently, RON-95 and higher octane are available in Pakistan. This change has been made only recently. Earlier, up to 2020, it was RON-92, and up to 2017, it was RON-87. Higher octane (RON) fuels are required by new and modern vehicles having the electronic ignition system. Older vehicles and motorcycles having the carburetor system can do at lower octane levels.

Our proposal is to introduce a low octane fuel of RON-87 for the poor motorcycle and old car users. It would be easier and cheaper to market such a fuel product. Our existing refineries produce RON-87 gasoline as a standard product. They add environmentally injurious additives like manganese compounds to enhance the octane rating to 92 or higher, which costs more money and consumes vitally needed foreign exchange.

All we are saying is not to add this injurious additive; the latter may be necessary for cars but is not required for motorcycles. Nothing extra has to be done. In fact, an environmentally more benign product will be there. What is so wrong about that? A Rs10-20 per litre cheaper petrol product can be targeted for motorcycles. Additives cost of Rs5 per litre or more can be done away with – and also lesser taxation in the form of no or lesser petroleum levy and possibly reduced GST. The deemed duty of 7.5% on diesel can also be shifted to the conventional gasoline of RON-95 and upwards, creating space for the proposed low octane gasoline.

This shifting of deemed duty would create a balance that is heavily tilted against diesel, which is consumed by goods transport and public transport used by the poor. Some leading and renowned Pakistani experts are supporters of these proposals. As usual, locals' proposals are not appreciated or valued much. So let me quote from a leading international petroleum advisory group.

"Lower octane grades, with octane number lower than RON-90 or AKI 85, are still available for use in motorcycles, very old vehicles or off-road applications such as fishing boats, agricultural machinery or small spark-ignition engines of non-road mobile machinery (NRMM). They are continued to be used primarily in the developing regions of Africa, Latin America, Russia & CIS and parts of Asia-Pacific and the Middle East. For example, in Indonesia, RON-88 is used primarily by motorcycles. Low octane gasoline grades fully dominate the gasoline pools of Bolivia and Yemen, while they account for the majority of gasoline pools in Colombia, Ecuador, Egypt, Iran and Indonesia."

As for the remaining richer or affording gasoline (hi-octane) users, it appears that there is a scope for higher taxation and pricing, keeping in view the difference between gasoline prices in India and Pakistan – India PKR 243 per litre, Pakistan PKR 150. This is the class which buys cars in the range of Rs1.4-4 million or even higher. It can certainly pay more. The surplus from this category can finance the petrol price subsidy for the poor motorcycle users and the diesel. However, so long as the Ukraine conflict and the associated international issues continue, there is very little any government in the world can do about petroleum prices, except for controlling consumption and rationing.

New debate on cheaper bike petrol

Published on December 12, 2022

Last week, Planning Commission held a meeting for discussion on introducing a special fuel for motorcycles, which should fit the pockets of motorcycle users, who are typically low-income, lower middle class persons. The issue has been on the table of policymakers for several years now. With the increase in petrol prices, subsequent to the rupee depreciation, the issue has acquired more urgency and importance.

As is the general opinion about Pakistan being an elitist state, petrol supply chain is also geared for higher income car owning people, even though almost 40-50% of petrol is consumed by motorcycles. It is true that petrol market worldwide is geared towards cars as in almost all advanced countries, cars are the major consumer category. In developing countries including Pakistan, motorcycles are a major category. This is not to suggest that petrol market should ignore cars, however, motorcycle users' needs and pockets should be kept in view. If it is an unregulated free market, hopefully, the issue would have been cared for already. If the oil industry is not sensitive to the needs of 50% of the petrol market, politicians would be in these days of high political competition.

The issue has two parts; technical and economic. It is argued by experts that motorcycles do not need high octane (more than RON 90), which is more than enough for normal motorcycle engines. Higher RON 92 and 95 are overkill. It costs more to produce higher RON petrol, especially in Pakistan where older refineries are not geared (do not have catalytic reformers) to producing the higher grade petrol. They have to import and add manganese-based additives, which cost additional money.

It may be a requirement for cars but is not needed for motorcycles. Thus is the need for introducing low RON cheaper petrol, which is a product of our low-tech refineries. The other argument is socio-economic; subsidising the poor. Motorcycle users are a low-income group. It is unfair to tax the high-income car users and low-income motorcycle users equally. Easiest way is to introduce special (low octane) petrol, which may attract lower tax rate than the normal higher octane petrol. IMF would also go along with it. The lender has been stressing targeted subsidy which goes to the needy and not to a system where all benefit from the booty in the form of lower taxation.

While the best solution is introduction of low-priced, low octane petrol, there are direct ways as well. In India, some states have lowered taxation on petrol used by motorcycles. Lower priced petrol of Rs30 per litre is being offered. Maximum buying limit has been kept at 10 litres to prevent misuse. Admittedly, not all states have done this, but it is expected to grow. Aam Admi party is causing great competition in India. In New Delhi and elsewhere, where Aam Admi party has its government, even free electricity is being offered to the poor.

Iran is another example where small users including cars are offered a lower rate in a ration card system. Incidentally, for the knowledge of the younger crowd, there used to be a ration card and ration shop system in 1960s and 70s. One would go to a ration shop to purchase flour with a ration card on which purchases were recorded. To be fair and balanced, let us now examine the arguments of opponents of the scheme. First, there would be difficulties in the supply chain management of special grade petrol. The answer is as follows. It is no small market segment; it is 40-50% of the market. An altogether dedicated system can be introduced including specialised petrol pumps. When special facilities can be arranged for a very small segment (2-3% market) of high octane (RON 97), what is the problem in caring for 40-50% market?

Second opposition comes from the motorcycle producers, mostly high-grade, high-priced Japanese motorcycle producers who have a small market share and are expected to go down with falling market share. They argue that their customers require high pick-up motorcycles, which require higher octane. The answer is that their consumers can continue to buy higher octane fuel. Nobody would force them to buy special grade. Policy should not be dictated by smaller and powerful minority groups. General welfare has to be maximised.

Third, refineries may object suspecting that some or all of them may get stuck with the old technology of skimming and their target of shifting to the new technology of catalytic reformers would be compromised. This is a difficult question. Some answer may have to be found for them. All petrol is not locally produced. Imported petrol may be of special grade, which may be procured. There may be competition issues. It may take five or more years for all refineries to convert. May be some may not choose to convert or may not be able to convert without subsidies from consumers or government.

Special petrol for motorcycles offers environmental advantages and lower cost, which can be passed on to the consumers. Besides, it creates fiscal space for government to reduce indirect taxation on low-income groups, which in this case are motorcycle users. A lesser taxation of Rs20 may be offered to this group. This tax reduction can be balanced, partly or fully, by higher taxation on normal automotive gasoline including RON 95 and RON 97. Thus, there is a potential of pricing special petrol for motorcycles at Rs30 per litre cheaper than the ordinary petrol sold for cars.

It may be possible that this special low octane fuel may be used by older and small car owners, who also belong to low-income group. Policy designer or maker has to cater for many targets, constraints and priorities. Choices may be limited and options not there at all. Let the stakeholders get together and find out the solution. Low-income groups are suffering and do not have much space left to wait more for inflation relieving reforms. And the march of new technologies must also go on; Hobson's choice. Many people think that deregulation of the petroleum sector is the solution. Market would cater for the needs, they argue. If there is a market segment of 40-50%, the underdogs would come up against the entrenched interests.

1.11: Oil price hike-September 14 2023

Petroleum prices have been increased; petrol is costing Rs 305.34 per Liter and diesel Rs 311.84. It is an increase of 5.17 percent in the price of petrol and 6.48 percent in the price of diesel over the prevailing price in the last fortnight. In percentage terms, it appears to be a small increase but in absolute terms, the increase is significant; an increase of Rs 14.91 in the price of petrol and Rs 18.44 in diesel. In an environment of generally high inflation when everything is getting dearer, such an increase has caused unrest among people.

All governments want not to increase the prices of essential items to maintain popularity, if not a genuine desire to help the people. Let us examine the dynamics of petroleum prices and whether something can be done to control such prices. On the beginning of the year, price of petrol was Rs.214.0/L and of diesel Rs 227. It is a 42.8 percent increase since the beginning of the year in petrol prices and 37.37 percent increase in the price of diesel. In the same period, USD became 34 percent expensive. It appears that the oil prices went up 17 percent higher than the depreciation rate in currency. This should be the share of international oil price increase.

Brent crude oil prices stood at 88.16 USD per bbl on first of September. Brent peaked recently in April at 88.16 USD and started going down to73.69 in May. From July (72.74USD), it started going up and reached first of September price of 88.16 USD. It becomes obvious that the main cause is the heavy currency depreciation and international oil price increase combined. USD has reached up to Rs 305 and more depreciation cannot be ruled out in the short run, although with improvement in the economic and trade conditions, one may hope that the USD-Rs parity would improve in our favour.

It may, however, be noted that the petroleum prices in Pakistan despite such trying conditions are the lowest in the region. In India, petrol prices are 32 percent higher and diesel 17 percent. In Bangladesh, petrol prices are 22 percent higher and diesel 3 percent. In Sri Lanka, Petrol is 22 percent higher and diesel is priced almost the same as in Pakistan. Earlier, in Sri Lanka, diesel used to be priced abnormally low which probably contributed to default. In ASEAN, in Thailand, petrol price is 44 percent higher and diesel is priced 5 percent lower than in Pakistan. Only in Vietnam, petroleum prices are almost the same as in Pakistan. It is strange to observe higher petroleum prices prevailing in Pakistan. Often this creates heated debate in Indian parliament and political circles. The obvious answer is higher taxation. Otherwise, India has a very large and efficient oil refinery sector. India is petroleum exporter as well.

Brent Price Movement

Figure 1.11.1: Brent Price Movement

In Europe, petroleum prices are more than 200 percent higher than in Pakistan; however, that comparison is irrelevant for obvious reasons. Petroleum prices in the U.S. are benchmark prices which differentiate high price countries from the low price countriesPakistan petroleum prices have traditionally almost hovered around the U.S. prices. Presently, In the U.S. petrol prices are 14% higher than Pakistan's and Diesel prices 22%.

The US has been taxing petroleum much lesser than the European countries. It may be noted that these figures have been taken from international published sources and may suffer from some inadequacies due to currency exchange rate data and other variations. However, the difference or variations would not be large enough to make the comparison of no value.

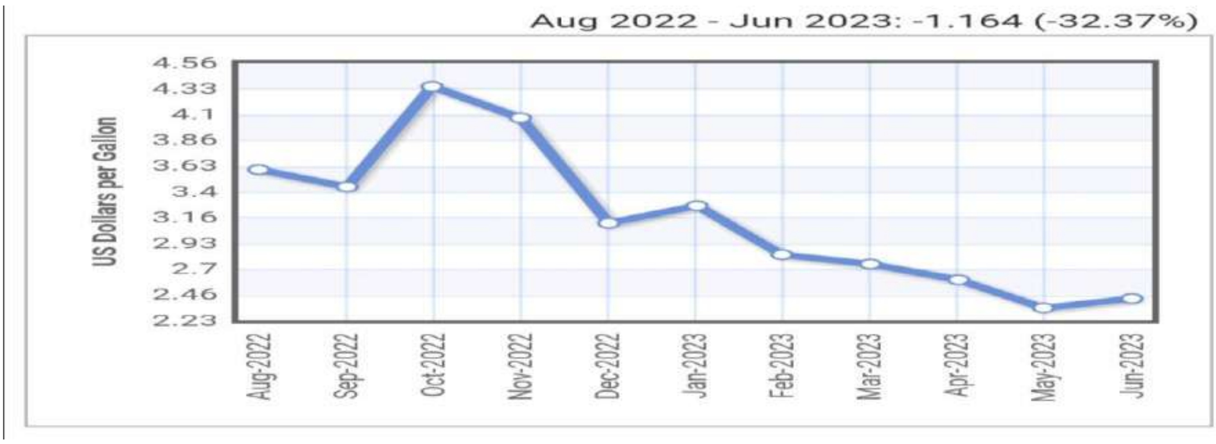
This price comparison wherein Pakistan petroleum prices appear to be the lowest among the relevant countries should not mean that everything is all right and that nothing should be done to improve or control the situation. Earning power in Pakistan is the lowest in the region as well and has gone down recently. One of the solutions appears to be to increase the salaries and wages as and when possible, by 50%. This may cause inflation. But sometimes, inflation is to be fought with inflation.

Let us now examine the issues in price structure of Petroleum products in Pakistan.

GST issue

1- From Feb 15th 2022, GST on petroleum was done away with. Earlier, GST had been varying around 10%. On September 2018, GST on petrol was reduced from 10.54% to 6.84% and on diesel from 11.64% to 10.32%. Presently, there is no scope for levying GST, nor can PLD be reduced. Only when oil prices come down and in near future there appears to be no chance for international oil prices to come down, there is no space in this respect.

Figure 1.11.2: New York Harbor Ultra-low Sulfur 2 Diesel spot



Higher taxation on HOBC

2- There is a proposal to levy GST on HOBC at 17%. Revenue of Rs 9.0 billion has been estimated on this account. HOBC is consumed by new and luxurious cars driven by the rich. PLD is levied on HOBC; it would further enhance government revenue. There is a scope for increasing both PLD and GST on HOBC .This may fetch more than 25 billion Rupees in revenues. This may be added to the pool to adjust other products marginally lower. Perhaps, there is no other space available at the moment.

3- The IMF (International Monetary Fund) demanded the government levy GST on all petroleum products at standard rate of 17%. It has been estimated that an additional income of Rs.30 billion per month (Rs 360 billion pm). The revenue from PLD in 2022-23 was Rs 579.9 billion. If GST is levied at 10% rate, the government revenue from GST would have been Rs 549 billion, almost as much as PLD.

Lower taxation on diesel

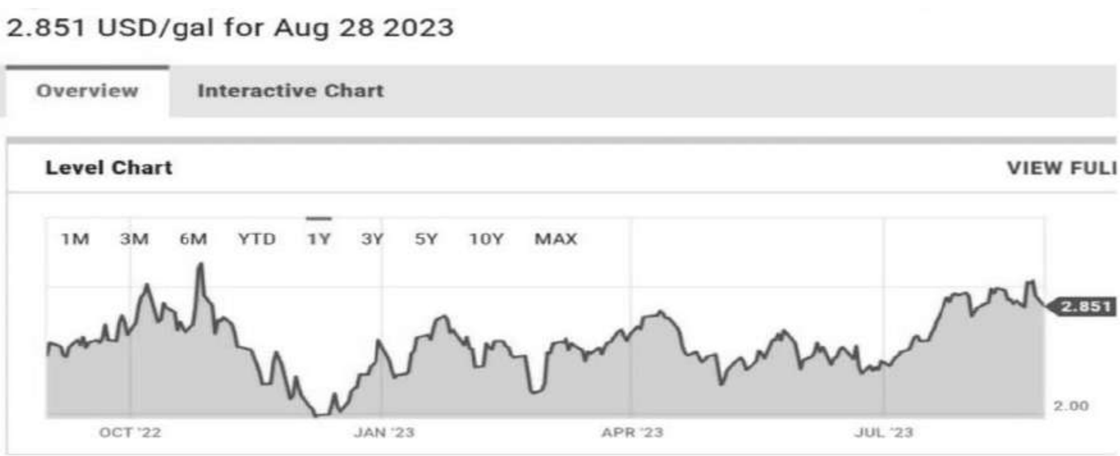
4- The only other improvement that may be possible is to decrease taxation on HSD as HSD is used in public transport of goods and people.

Introducing a cheaper brand for motor-cycles

5- There has been a proposal to introduce a low octane petrol for motor cycles and possibly older cars having carburetor mechanism. This new brand may be taxed lesser to bring down prices and through a cross- subsidy mechanism, higher grade RON 92-95 petrol may be taxed higher.

This proposal has been on the table for quite some time now. With increase in prices and if more is yet to come, this proposal should be considered seriously. There is some pessimism in the oil sector which opposes and discourages all innovations. The case in point is their opposition to the introduction of Euro-5 Petroleum and Russian oil; also most recently, the introduction of bonded warehouse oil storages. Political leadership may have to take firm actions.

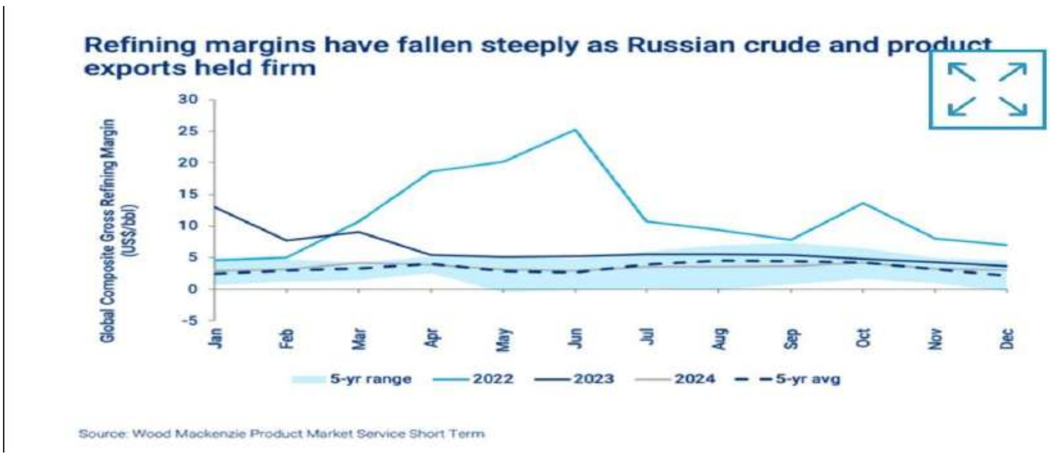
Figure 1.11.3: US Gulf Coast Conventional Gasoline Regular Spot Price



Conclusion

There are only a limited number of options at the moment, which may help bringing down the petroleum prices as we have indicated in the above. These should be examined by the relevant agencies. Additionally, improvement in procurement and logistics efficiency can help bring down the cost and prices. Involvement of Chinese OMCs (oil marketing companies), who have access to cheaper petroleum in the world supply chain, can also be of value in this respect. Multi-agencies' involvement in the oil sector may have to be done away with and the role of regulator may be strengthened.

Figure 1.11.4: Global Composite Gross Refining margin Rate



Finally, improvement in the economy and trade balance should control currency depreciation. Taxing the untaxed sectors and tax collection efficiency should increase the resources to be able to finance the subsidies that may be required.

Also, there are transparency issues. There is no website in the country, whether of Ogra (Oil and Gas Regulatory Authority), OCAC (Oil Companies Advisory Council) or the Petroleum Division, which provides the cost structure of the petroleum products.

Data is distributed to OMCs only and hidden from the people. Journalists somehow manage to eke out the relevant data from their contacts in `the bureaucracy and OMCs. Earlier, such data used to be published with clarity and detail. There are issues of overlap between OCAC, OGRA and the ministry which complicates the issues as well. It is hoped that the situation is corrected by the relevant agencies and the officials.

Figure 1.11.5: Petrol Price Breakup

Table 1.11.1: Petroleum Products Prices Ist September

	Ex Refinery	Retail Ist Sep	Re 15th aug	Increase
Petrol	228.59	305.36	290.45	14.91
HSD	249.56	311.84	293.4	18.44
LDO ?	223.96	210.13	199.79	10.34
SKO	223.17	233.52	192.38	41.14
JPI	223.96	264.3	214.01	50.29
Source: PSO, PRL, BYCO				

Table 1.11.2: Monthly Price Trend Petroleum Products-2023

	Sep	Aug	July	June	May	April	March	Feb	Jan
Petrol	305.36	272.95	262	262	282	272	267	249.	214.
Diesel	311.84	273.4	260	253	288	293	280	262.	227.
LDO	210.13		154.	147.	164.	174.	184.6	187	169
SKO	233.52	192.38	171.0	164.0	176.0	180.2	187.7	189.8	171.
JPI	264.3		214.0	207.6	216.2	230.8	203.8	213.8	189.
USD/PkRs	305	287.45	287.4	286.5	285.2	283.8	278.8		
Source: PSO									

Table 1.11.3: Comparative Petroleum Product Prices Selected Countries-28st Aug 2023

28th Aug 2023						
	Petrol	**Diesel**	**Petrol**	**Diesel**	**Petrol**	**Diesel**
	USD/L	**USD/L**	**Pk.Rs./L**	**Pk.Rs./L**	**Times %**	**Times %**
Pakistan	0.955	0.965	286.5	289.5	0	0
India	1.26	1.13	378	339	1.32	1.17
Bangladesh	1.188	0.996	356.4	298.8	1.24	1.03
Srilanka	1.167	0.952	350.1	285.6	1.22	0.99
Thailand	1.378	0.915	413.4	274.5	1.44	0.95
Vietnam	1.036	0.933	310.8	279.9	1.08	0.97
Turkey	1.422	1.427	426.6	428.1	1.49	1.48
U.S.A.	1.09	1.182	327	354.6	1.14	1.22
Germany	2.038	1.994	611.4	598.2	2.13	2.07
France	2.086	1.985	625.8	595.5	2.18	2.06
Italy	2.118	2.01	635.4	603	2.22	2.08
Japan	1.259	1.118	377.7	335.4	1.32	1.16
China	1.191	1.062	357.3	318.6	1.25	1.10
USD/PkRS	300					
Source: Global Petroleum Prices						

Table 1.11.4: Petroleum sales 2022-23 and GST Estimate Thereof

	M.T.	**Liter/ton**	**Liters(1000)**	**Price Rs/L**	**Sale(billion Rs)**	**GST billion Rs**
petrol	7477152	1386	10363333	305	3161	316
diesel	6363390	1175	7476983	311.84	2332	233
All Petroleum	16789462		17840316		5492	549
Source: OCAC data; Rev calc by the Author						

1.12: Deregulating the Oil Sector

There has often been talk of deregulating the petroleum sector. There are pros and cons which have been hotly debated. In policy circles, the same debate or even preparations are reportedly undergoing. We will examine the pros and cons of regulated versus open markets in this space.

In Pakistan, petroleum sector is largely regulated — from crude oil production through refining and marketing. Some products are unregulated such as kerosene, jet fuel, furnace oil and lubricants. Essentially, regulation means price control and some quantity controls. Other regulatory requirements of quality and safety are common in regulated and unregulated sectors.

Competition v/s regulation?

It is said that competition brings benefits and value to the consumers by reducing the price and improving quality, access, service and availability. It also benefits business by enhancing efficiency, productivity, innovation and expansion. In competitive markets, there are no barriers to entry and a large number of producers and consumers so that no one has constraining influence on price. At societal level competition reduces the role of government and promotes freedom and democracy, if required by the society.

However, there are risks of collusion and monopoly. It may increase consumer prices, degrade quality and create supply instability. The statements made in the foregoing may be disputed by some and considered rather idealistic and almost never achieved in full. Where it is achieved in full, it is called pure competition. Pure competition is probably among the labor in poor and developing countries where excess supply often brings their wages down to unsustainable level. It is seldom that there are a large number of suppliers and collusion or cooperation among producers is not rare.

Oil market types

There are four types of markets; **1.** Unorganized free markets; **2.** Organized free markets; **3.** Price cap markets; **4.** Fixed price markets. Unorganized free markets are a free-for-all due to lack of governance and institutional infrastructure. There are no price controls; rather no controls at all even on safety, quality and licensing issues. This type of market is there in small and underdeveloped countries. Organized free markets are those where there is no price control but there are other regulatory controls including on safety, quality and completion assurance, etc. The USA, Canada, Japan, South Korea and most developed countries of Europe have this kind of market.

Price cap markets have free market but there are price cap controls. Amazingly, some advanced countries such as China, Luxemburg, Belgium, Brazil, Mexico and Vietnam have this type of market. This may also be called a hybrid market. Fixed price markets are those which have complete price control. This type of market exists in most developing countries, especially the large and medium ones (Algeria, Indonesia, Malaysia, Bangladesh, Egypt, South Africa and Zambia). Quite some big names these are. Brazil, India and China have a special system apparently open with diffused and subtle controls and markets managed by large public sector companies controlling 80-90% of the market.

Regulation

However, if competitive markets are not feasible or possible, the government brings in some rules and controls to organize a market in a safe manner; this is called regulation. Regulation, it is said, brings stability, reasonable quality and improves the average conditions. On the other hand, regulation rewards the lazy and the inefficient by awarding prices and setting quality and other standards suitable to the least efficient.

Many people are deeply skeptical about the purported competitive and fair practices expected in a deregulated oil sector. There are all kinds of mafias operating in open and unregulated markets of which sugar scandal has been an indicator. In an economy where black money abounds and businessmen maintain two or three books of accounts, evade taxes and launder money, over-invoice and under-invoice and indulge in many other vices, such skepticism appears to be well-placed.

People talk of real or perceived oil mafia already. Will this mafia be strengthened in a deregulated environment? On the other hand, mafia may be diluted by competition—if real competitive conditions are created — a big if, it is said. In almost all global indicators of fairness and transparency, Pakistan comes down among the lowest positions. Can ethos and practices of advanced countries be transplanted in such a situation?

Deregulation will eliminate IFEM under which transportation costs up to storage points are grossed and averaged and on the average Rs 3-4/litre are added to the petroleum retail price. There are many complaints about illegal and nontransparent practices in IFEM. IFEM promotes uneconomic and unnecessary

transportation as well. Real transportation cost may come down due to the elimination of IFEM.

However, the advantage of IFEM is that uniform petroleum prices are maintained throughout Pakistan. In northern areas, petroleum prices may be higher and in the south, especially in Karachi, prices would be lower. There may be a difference of Rs 10 per liter. This may cause discontent in the areas affected by the price differential. This can, however, be handled by imposing a provincial tax on petroleum which provincial governments may apply flexibly to balance the prices.

Petroleum is a probably the largest sector of the economy and petroleum being the vital input for the economic and social life in the country. Oil refineries are considered as strategic assets (almost all are in the private sector). One should tinker with it with a lot of care.

Business circles in the oil sector have been lobbying for deregulating the oil sector, arguing that it would be more efficient and would bring down prices. Generally and broadly speaking, deregulation and privatization are required to spur economic efficiency and growth. The claim has been contested by user groups who are skeptical about the claimed prospects of price reduction. Fixing price ceiling in the manner of a number of jurisdictions may be an antidote to price manipulation.

Performance and price behavior in other unregulated sectors do not provide supporting evidence in support of the oil businessmen’s claim. Maintaining a sustained oil supply system in a highly fragmented market brought about by deregulation may be a nightmare. Supply irregularities may create market manipulation. It is a large market of 12-20 billion USD. When most reputed international oil companies have gone out or are on the verge of going out, it would be highly risky to entrust such a large and strategic sector to a group of small and inexperienced companies.

On the other hand, most oil refineries are entering into distribution and marketing. These are no small companies and have large stakes in the sector. They have a 50% market share. It is argued that with PSO (Pakistan State Oil) around along with a number of refineries may be able to sustain a viable oil supply system. However, one of the major constraints in deregulating the oil sector is the uniform price regime being practiced in the country. Deregulation may make oil prices in southern parts cheaper and in northern areas petroleum products may become dearer by Rs 10.0 at least. With so many political and economic challenges, governments may be averse to add new ones. A classic example is India where such regional price differences exist. The reader is referred to an earlier article on the subject in this very newspaper.

Petroleum Products Pricing

Pakistan has a large poor population which cannot afford high petroleum prices. Ways and means are to be found to subsidize oil prices for the poor and the lower-middle classes. There are two methods: direct and indirect subsidies. Direct targeted and cash subsidies may be feasible for food products. In the energy sector, cross-subsidies may work better. In the case of petroleum, product differentiation can enable to funnel these subsidies.

Even in the advanced and rich countries, there is a price differentiation between diesel and gasoline prices through heavier taxation on gasoline and lower taxation on diesel. In Pakistan also, this used to be the case, but later due to the opposition of environmental lobby led by IFIs (International Financial Institutions), almost uniform taxation has been adopted by Pakistan's policymakers. Amazingly, differential taxation and pricing continue to be the case in Europe, Japan and Australia. Desulfurization campaign of both diesel and gasoline has reduced the environmental rationale. However, the public goods argument for lower diesel prices continues to be relevant. Diesel is used in goods and public transportation; buses, trucks, trains and other larger vehicles.

Two steps are required in bringing change in petroleum pricing policy; lesser taxation on diesel; and 2. product and price differentiation within gasoline. Apart from promoting social welfare, diesel price support would encourage public transportation causing reduction in oil consumption. It is simpler to implement once a modicum of price and economic stability is obtained.

The second option of price differentiation within gasoline can be brought by introducing low-octane gasoline for the motor-cycles and even older and smaller used cars of carburetor design. These are used by the lower-middle classes and even the poor. Such fuels are cheaper to blend and enable the application of lower taxation. This proposal has been lobbied by many experts but somehow there has been hesitation among policy circles on it.

To conclude, oil is a sunset industry being phased out around 2050, although not completely. However, its dominance will certainly go away. Looking for alternative resources in the meantime and managing the transition would be difficult, more so for the developing countries like Pakistan. It may be vital to start working in that direction than being caught in a situation for which we may not be prepared for.

Pakistan's economy and social conditions are facing many challenges. The reasons are policy inertia, pessimism, and fear of the new avenues and solutions, etc. This has opposed innovation and productivity increase. Let us break this closed cycle. There is a tendency in policy circles in Pakistan to reject small solutions and looking for large immediate Goliath solutions. There aren't any. Small solutions add up to a big whole. Even bigger ones take time to implement and get market acceptance.

The two biggest risks are demand-supply manipulation, creating shortages and manipulating prices. Shortages can be countrywide by importing or procuring less or in inner locations. In OECD countries, there is a requirement of three months of storage, which is diligently maintained. Storage costs money both in terms of capex and operating and financial costs of maintaining inventories. All of this is passed on to the consumer and is reflected in prices. An optimum inventory requirement at various levels may have to be worked out and enforced; easier said than done. Competitive pricing pressures may resist storage costs.

International Oil Companies: Multinational oil companies like Shell, BP, Chevron, Exxon, and others are withdrawing from low-margin business of petroleum retail. One of the main reasons for winding up from Pakistan is, among others, this larger policy of withdrawal. One is not sure if, after deregulation, the purported argument of attracting foreign investment and companies would work. Good riddance — there is enough experience locally in the sector. Foreign investment is not free; it causes foreign exchange drain.

PSO (Pakistan State Oil): PSO, a government company, having a market share of almost 50-60%, is a major instrument of the writ of the government, all good and bad may be partially ascribed to this largest and listed company. Fortunately, being a listed company, there are many safeguards that are legally implemented. It is argued that due to the presence of PSO, price manipulation can be resisted, unless GOP becomes totally careless about it and its functionaries and government become beneficiaries of profiteering and loot. One has to be optimistic but the risk is always there. Besides, PSO privatization has been often talked about.

It is said that Oil Refineries (ORs) are leading the demand for deregulating the oil sector. Oil refineries are outdated and lack scale economies, which require a minimum capacity of 200,000 bbl/day. Under various pretexts, ORs have been extracting concessions such as deemed duty. In the new proposed oil policy also, they insisted on tax holidays and deemed duty. In all fairness, ORs had to be protected like other industries by a reasonable margin; otherwise, ORs cannot survive in the long run. It is a separate matter that under the recent market situation, they made hay while the sun shines. Gross margins crossed 40% as opposed to a normal of 15-20%.

Under deregulation, it is said that they expect higher margins and profits and have thus done away with erstwhile concession demands. Thus those who are dreaming of lower prices may be disappointed when reality arrives finally. On the other hand, this may not go uncontrolled. PSO may be a stabilizing market price leader. So long it is not privatized, it may continue to provide this function. In India, there is deregulation but the market is controlled by three large public-sector companies. There is almost no difference in prices among the three public-sector companies, indicating some guidance or consensus-seeking process violating the spirit of true competition. The same may happen here with more frequency and intensity.

Is competition delivering in advanced countries — yes and no? Will Petroleum prices come down under deregulation in Pakistan? What is the evidence from countries having open markets? Are prices being really determined there by real competition? Broadly and to a large extent; yes. There is considerable evidence of consensual and not a really competitive pricing. There may be price leaders which signal the sector if not outright conspiracy-based price setting. Petrol pumps are charging more than they should. Let us quote from a recent U.K. publication:

"Only one in 10 petrol stations are charging a fair price for fuel and small local forecourts are giving drivers a better deal than the big boys, new findings have shown. Recent falls in the oil price should mean that price at the pumps should be at least 10p-a-litre cheaper, around 174p-a-litre for petrol, and much lower than the country’s average 188p-a-litre."

Independent petrol pumps: There are a number of business models governing the petrol distribution and selling business. Normal business models are: 1. COCO — oil Company Owned and Company Operated; CODO — Company Owned and Dealer Operated and DODO — Dealers Owned ad Dealers Operated. First and second kind of business models has a low prevalence due to the investment amount and risks. Mostly, the DODO business model is practiced throughout the world. Under DODO, dealers are bound to buy from the OMCs (Oil Marketing Companies) and observe quality and safety practices as well. Dealers benefit from the reputation of OMCs and their infrastructure and stability of supply.

Independent petrol pumps (IPPs) are a new innovation in the petroleum sector. IPPs are independent of any Oil Marketing Company (OMC), as the name implies; they can buy petroleum from any source. They have low overheads. In Europe, there is a 20% market share of IPPs. In Nuevo capitalist countries like Bulgaria, IPPs market is even higher at 64%; it is 56% in Czech Republic. The market share and acceptability of IPPs is on the rise, as they invariably sell at a lower price than OMC-related petrol pumps. OMCs in the free markets charge a lot of overheads in the form of QA, safety, and royalty, etc., but not in Pakistan. In Pakistan, OMCs’ and dealers’ margins are fixed by the regulator. It would be useful to quote from a recent article from a UK publication on the subject:

"Independently owned fuel stations are more likely to offer fairer pricing than major retailers, according to the RAC just 10% (407) of a sample of more than 4,500 UK forecourts are charging a ‘fair’ price for petrol and diesel, with the vast majority of these being independently owned sites rather than major fuel retailers……Weekly wholesale petrol prices have fallen by a massive 17p a litre, from a weekly average of around 152p at the start of June to just 135p this week. Yet average pump prices have reduced by a paltry 4p."

In a lighter vein, our IPPs in Pakistan are the illegal petrol pumps. Reportedly, these have been closed down — difficult to believe? There were (are) 1,556 illegal petrol pumps (legal ones 8,000 +) which have all the business model characteristics of IPPs except that these are illegal and engage in many unhealthy practices. Can these be organized under an IPP scheme under special Ogra (Oil & Gas Regulatory Authority) rules? IPPs need not be restricted to these illegal pumps and bring a bad name to the concept of IPPs which is expanding almost everywhere. IPPs are sometimes organized under a voluntary business association or group bringing and promoting quality and image. Existing or a new petrol pump may be given the freedom and flexibility to become IPP or come out of it under rules and safeguard. Special Petrol Pumps for Motorcycles, which may have a price-sensitive, may also be organized under IPPs. Options may be many.

Conclusion: There are varying opinions and positions of stakeholders on the subject of deregulating the oil sector. Some people are skeptical of deregulation. Businessmen and professionals associated with the oil sector generally lament that the sector could not expand due to deregulation. They admit that prices and profits may increase in the short-run but in the long run, the supply side will improve and industrial development will take place. Governments have been confused and even scared as the choices are put before them.

Open markets are the way to go forward in the world. However, petroleum is too risky and too large a sector. An open market is not a jungle world. There are rules that have to be made and abided by the sector. We have a Competition Commission of Pakistan (CCP). Unfortunately, however, its role has been marred by a parallel judicial process which undoes or delays the determinations and orders of this regulator. CCP has organizational problems as well. OGRA may have to be remodeled as well. In any case, there is considerable overlap and confusing roles issues. OGRA has been empowered under recent regulations.

As a World Bank report says, that while deregulating, new regulations have to be made. A considerable policy framework may have to be done before opening the floodgates of the open market. It may cause anarchy and market instability. Under the current circumstances, when there are so many challenges, especially, in the petroleum and energy sector, more risks and challenges cannot be added. However, there are those who say that the time window is always small in Pakistan usually.

1.13: Transparency in oil and gas sector

Transparency may have many definitions. Its basic meaning is visibility. In applied sense related to governance, it means visibility of operations and decision-making in qualitative and quantitative terms. Transparency means availability of data and information to all stakeholders. Transparency requirements of the government, public sector and regulators are usually much more and stringent as opposed to the private sector.

Private sector is also required to publish data of financial conditions, sales and inventories in case of large and listed companies. Right to Information (RtI) has become a law in many countries around the world including Pakistan. In Pakistan, regulatory agencies have played a major and positive role in promoting and expanding transparency in their respective domain. Our focus here is on transparency issues in the oil and gas sector. Let us start with some praise and appreciation where adequate transparency and dissemination is provided by the Oil and Gas Regulatory Authority (Ogra).In the case of distribution companies' tariff and LNG tariff, highly accurate and detailed data is published through a meticulous process.

Ogra also publishes an annual report, which disseminates useful information. Here, we will draw the attention of stakeholders to some lacunae in the transparency aspects. There are the following areas which need attention: Price build-up of petroleum products, well-head prices, and oil vs gas wellhead pricing.

Gasoline and HSD cost

In earlier times, Ogra used to publish all components of the price structure of most petroleum products in a readily available form. Only, final prices of some cost elements such as OMC and dealer margins, IFEM (transportation), etc are published. Nowhere can one get a table which transparently describes the cost/ price structure. It is done with quite an elaboration only in the case of E-10 petrol, which is no longer sold. Some intelligent and dedicated researchers may be able to extract data about gasoline, which is not actually intended by Ogra.

Similar is the case of high-speed diesel (HSD). All kind of plausible and implausible explanations and reasons can be given like duplication or overlap of authority with the Petroleum Division on the subject; or a semblance of open market wherein dealer and petrol pump-wise prices are published, in my view, without any meaningful rationale. Gasoline, HSD and other products like kerosene and jet petroleum (whether imported or locally produced) are priced as per the landed price based on the international benchmark prices. This can, however, be deceptively credible. There are unknowns of extra margins that are charged by the importers/ suppliers, demurrages, high port and handling charges and other inefficiencies. Such data is not disclosed. If it is, it is given to OMCs but not published.

As a result, any possible inefficiencies and inadequacies do not become apparent. Smaller buying packages results possibly in higher margins over the benchmark prices. We have discussed elsewhere the possibilities of collaborative buying. When demurrages are not disclosed in cost structures, obviously, the reasons of demurrages would not come under focus. Dredging issues, lack of port handling capacity, etc are the related issues.

Oil and gas wellhead pricing

Ogra determines wellhead prices of oil and gas based on government-approved policies. Policies are of various years and have varying terms. Thus, every field or wellhead may have a different price. There might be special cost features that may be in the purview of the parties. There are royalty issues as well. All calculation details should be published in order to eliminate doubts about transparent activities. As a rule, a regulator should publish all the bases of its decisions. In this respect, we find Nepra to be very diligent in publishing decisions or determinations, the like of which we do not find in case of Ogra as is evident in this instant case. We have other examples as well.

Windfall profits

There is an issue of windfall profits and its taxation. In the case of gas, there is a S-curve formula, which defines floor and ceilings of wellhead gas, which is connected numerically as a percentage of crude oil price. This is a good formula, which protects both the buyer and seller. Unfortunately, in the case of oil, local wellhead prices are kept at par with international (Brent) landed prices. As a result, in these difficult times, we pay as much price as of imported oil. One may legitimately ask as to what is the advantage of local production. International prices are based on supply and demand, which are affected by a variety of factors, all of which do not necessarily apply.

Here, local oil producers and refineries interest collide. If oil producer gulps all the margins in computing the oil price, the oil refiners would not have much fun and vice versa. However, local oil refineries are also benefiting from high prices (cracks difference between crude oil prices and final product prices). The result is the suffering of the consumer, especially of the poor, and all other negative fallouts for the economy.

Why is not there a S-curve formula in case of locally produced oil. If it is good for gas, why should it be bad for oil. Reportedly, there is a provision of windfall profit taxation, which reportedly is not applied rigorously. Public dissemination of this data would have prevented irregularities and inadequacies or misunderstanding. Is that the reason, details are not published. So either windfall provision should be applied to the local oil production or the local oil pricing formula should be changed ala gas pricing S-curve. Also, in such a hard time, there is a case for taxing oil refineries’ extra profits or reducing the selling price of their gasoline and HSD. Oil refineries have suffered earlier during the low oil price days, thus an equitable approach may have to be developed to have a fair deal. Royalties on oil and gas are among politically critical issues. Propagandists often exploit the issue. Clear calculations and adequate publishing by Ogra may go a long way towards clearing the mist around the issue. There are right and wrong perceptions among people about the oil mafia. Information would clarify this and may help to correct the situation. Regulators should publish all their decisions and justification or bases for their decisions. Public eye can make a difference. Today’s public is tomorrow’s government and ministers. Thus, informing the public produces more knowledgeable ministers, who do not have to be fed with info but are ready and laden with data and info to crack on the issues.

1.14: What to do with furnace oil?

Furnace oil used to be the backbone of both power and oil industry until only a few years ago. There were no LNG or coal power plants. Almost all thermal electricity used to be made out of Furnace Oil (FO). Major power stations, including Hub Power of 900MW capacity, were installed. Furnace Oil consumption used to be 9-10 million tons per annum in 2015-16 which kept coming down since. And now, its consumption is around 3 million tons, which is mostly produced by local oil refineries.

In the meantime, LNG, coal and nuclear power plants have been built with a total of 10,000 MW in the 2014-2019 period. This replaced the demand of Furnace Oil which is mostly consumed by the power sector. FO has become expensive as well with the Brent jumping from 50-60 USD to near 100 USD per barrel. Cheap LNG came in with long-term contracts with Qatar. However, LNG Spot has become expensive in the meantime. It came to be as high as USD 30 per barrel or even double of it. It is now not available at all, largely due to the Russia-Ukraine war. Qatar LT contract LNG prices have, however, remained under 14-15 USD per MMBtu.

Pakistan oil refineries are what is called skimming oil refineries which produce Gasoline, Diesel Furnace Oil in addition to some Kerosene and Jet fuel. FO is an essential part of the product mix. If FO is reduced, other products are reduced proportionally. Thus FO is produced even though its demand has gone down. Modernization of existing older refineries has been on the table for quite some time. Under this programed, FO component would be converted to lighter products like Gasoline and Diesel.

What to do in the transition period which may take another 5 years to implement oil refineries' modernization. Although, 10,000 MW of power capacity has been added to the system, there is a uniquely difficult situation that has emerged in the aftermath of the Russia-Ukraine war. Coal, Oil and LNG have become expensive. LNG is not available at any price as Europe and Japan have been amassing all LNG that is available in the market.

FO is available but at a price of Rs 120,000 per ton, translating into 12.18 USD per MMBtu. It is cheaper than Spot LNG which is priced at USD 30 per MMBtu, although Qatar LT LNG is available at 14-15 USD/MMBtu. The problem with FO is that it is used by low efficiency 38-40% power plants in a single cycle mode.LNG/Gas is used in high efficiency (60%) combined-cycle power plants. Thus even if FO may be comparably priced, the low efficiency effect reduces its competitiveness.

Nepra (National Electric Power Regulatory Authority) has been constantly reprimanding the power sector not to utilize FO power plants being older and producing expensive electricity. FO electricity fuel component of electricity cost comes out to be Rs.25.15 per kWh. If spot LNG is used in these power plants, fuel cost can be as high as Rs.58.86 per kWh. In the last summer, FO was used to produce electricity at this exorbitant price. Sometimes, it is cheaper to undergo load-shedding than to produce such expensive electricity. Fortunately, the share of such electricity is not high and the average cost still remains lower. The lesson is that FO-fuelled power plants should never be run on expensive spot LNG. There may be a case for using FO, however, in such power plants. Oil refineries are making this case and trying to convince Power Division to buy and use FO.

The refinery sector's argument is, as we stated earlier, that Gasoline and Diesel production supplies will go down if FO is not utilized. There are several negative impacts of such a possible situation; capacity loss cost and foreign exchange loss due to imports. Nepra and power sector would not be bothered and increase their cost of generation to solve the oil refineries' problems. However, at the larger level of the country's economy, these costs matter. Money lost in whatever sector is the economy's loss. This is an optimization (Operations Research) problem. How to reduce the combined loss. Do we have the requisite tools, databases and models? Not really. One may have to do simple back-of-the-envelope exercise.

Why don't oil refineries export the excess FO. There may be extra logistics cost and the export prices may be low. It may be profitable to offload the excess FO onto the local power sector by using GoP muscle and scaring of it of the consequences that have been mentioned earlier. They may have to reduce their asking price. It may be noted that FO is not regulated. Oil refineries are free to set prices. Singapore FO price is 386 USD. Local FO prices is 521 USD. There appears to be a scope for price reduction and reach a settlement for local sales at a discount. We have estimated that if the refineries reduce their FO price by 20%, it may compete with Qatar LNG cost of electricity generation. It is not such a loss when the alternatives may even be costlier

Table1.14.1: Comparative unit fuel cost-USc per kWh of Furnace Oil vs LNG

	F.O.	LNG Spot-S cycle	LNG Spot CC	LNG Qatar S-Cycle	LNG Qatar CC
Price Rs/t	120000				
USD/t	521.74				
CV	40.7				
USD/MMBtu	12.819	30	30	15	15
Thermal Efficiency-%	40	40	60	40	60
Heat Rate-Btu/kWh	8530	8530	5687	8530	5687
USc/kWh	10.93	25.59	17.06	12.795	8.5305
Rs/kWh	25.15	58.86	39.24	29.43	19.62
Rs/USD	230				
Source: SAA					

Table 1.14.2: F.O Imports,Sales and Production

	Imports	Production	Sales
Total	2259609	2408345	2368005
Industry			961028
Power			2266206
exports			48985
govt			101006
others			
Total F.O. imports	2259609		
HSFO	1620312		
LSFO	639297		
Source:OCAC			

The FO 'imbroglio'

LNG has become expensive exceeding USD 15.0/mmBtu and price scenario remains uncertain for the coming winter. Furnace Oil (FO), which was almost replaced by LNG, has become cheaper and seems to be emerging once again. Will LNG-FO price ratio remain to the disadvantage of LNG for a long time? There is confusion now whether FO-based power plants should be shut down or not as opposed to a consensus earlier for its closure? What are the other fuel alternatives? What is the future of combined cycle power plants?

LNG was introduced in Pakistan for two reasons: (i) Local gas fields are depleting and local chapter gas production has been going down; and (ii) HSFO has been expensive (by 20% on the average) than LNG and HSFO power plants were much less efficient than combined cycle power plants running on gas/RLNG. Highest efficiency of new oil-fired power plants has been quoted at 40%.Older oil-fired power plants such as GENCOs and KE are even less efficient (28-30%). A decision has been made by Power Division and power regulator Nepra to close down such plants. However, this could not happen initially for demand reasons and later due to transmission constraints. Nepra has been reprimanding NTDC, CPPA-G and PCC for repeating the usage of oil plants but they have continued it. Hubco has been on the agenda for a long time now about which we will discuss later in this space.

HSFO is a co-product of a number of oil refineries in Pakistan, although most of the oil refineries are switching to deep conversion which eliminates/converts production of HSFO. HSFO was used to be imported as well due to a high share (40%). Import of HSFO is no more. However, HSFO continues to be produced some of which continues to be used in continued running of oil power plants. There has been an installed capacity of 7500 MW of oil plants out of which 1500 GW has been used irregularly on the need basis.

It appeared earlier that finally the time of these plants is over. However, recent price increase of LNG has made oil plants and HSFO relevant again. SPOT LNG prices have been quite low for the last three years going down even to 2 -3 USD/mmBtu level, albeit briefly. Average RLNG prices including about 2 USD overheads remained at 8-10 USD. In winters, however, LNG prices did touch the 15 USD/mmBtu mark. This time, LNG prices crossed the 15 USD mark even in summer. It is being projected that winter prices may even be higher.

All commodity prices are at high prices these days. This is the classical capitalist cycle. Low demand pushes the prices lower than even cost which discourage investments in capacity which when demand increases pushes the prices due to lower capacity and supply. This is a 5-7 years cycle usually, unless there is change in technology as has happened in the case of Shale gas in the US.

Recently, the price of HSFO remained at 10 USD/mmBtu while LNG price crossed the 15 USD/mmBtu mark. The price difference has come down but still HSFO remains cheaper.

In winters, residential sector's demand increases to 2.5 times the summer demand in the SNGPL region. Thus it appears that in the coming winter, oil power plants could emerge as viable and needed ones.

The PPA contract of Hubco oil-fired plant (1200MW) is expiring in 2027. Due to higher oil prices, Hubco hardly runs at more than 1%. CPPA-G will pay an estimated Rs 260 billion in terms of fixed capacity charges. The present value of these future payments comes out to be Rs 65 billion. The government is said to have been proposed to buy out this plant. There has been a proposal made by Hubco to convert the oil-fired power plant to Thar coal which also involves some valuation of the present value of the future series of payments. The problem has many dimensions. Firstly, the government is not flush with cash so as to retire future liabilities earlier. Secondly, there is an excess capacity. Thirdly, even newly-built combined cycle power plants are projected to be almost redundant due to high LNG prices and due to the induction of relatively cheaper base load power plants like coal and nuclear. Fourthly, there are Genco FO power plants which are of low efficiency and are on 'Take or Pay'. Shouldn't such GENCO plants be the candidates for buy-out by government as also emphasized by Nepra? Fifthly, there are ten other oil-fired power plants which are producing electricity regularly, although at a lower load factor. What is wrong with Hubco? Why isn't it working like others? If it has some problems, why should the government bail it out through public funds? Why to have a specific treatment for one power plant?

It may be noted that it was only recently that Nepra had to extend PPAs of two oil power plants-Gul Ahmad and Tapal-with a combined generation capacity of about 300MW, while the PPAs of the two plants were expired. Now KE will be importing LNG (probably more expensive than HSFO) for a new LNG power plant of 550MW. Capacity payment of Rs 240 billion will have to be made by the government for an under-utilized Hubco! Separation of generation, transmission and distribution has been on the cards for a very long time.

In passing, it must be mentioned here that Thar coal's fate has been compromised by those who manipulated its tariff to a very high level. Its production cost elsewhere is 20-25 USD/t at the comparable mine characteristics. It has not required elsewhere scale economy argument to be able to mine and sell at a reasonable price. Small mines in Eastern Europe are producing at afore-mentioned cost, while Thar coal's cost is more than double. Fortunately, Thar coal board has become alive to this and has taken steps to reduce these costs. There are other investigations that are purportedly going on in this respect. International opinion against coal is building fast. Only a reasonable Thar coal price may compensate the externalities that may come to be imposed. Furthermore, Railway link for transporting Thar coal has been put into jeopardy by ambitious businessmen who are asking a subsidy in CAPEX for installing this link. The simpler solution would have been to give it to Pakistan Railways under a normal tariff system and financed under the Public Sector Development Plan (PSDP).

For high demand and price reason of gas/LNG in winters, alternate solutions may have to be found out. Combined cycle power plants can be run on Naphtha and as well as condensate. These are currently being exported. There are logistical problems in its exports as well. If these two fuels are stored for winter period, LNG problem can be partly resolved for winter season. We have earlier written a full length article (RLNG: no panacea) in this regard. The reader is referred to it in case of interest. Biogas, bio-CNG and coal gasification can improve gas supplies and stabilize prices, reducing the impact of uncertain LNG prices.

1.15: Oil bonded warehouse policy's impact on economy

Recently, an oil bonded warehouse policy has been announced. This is one of the best and useful policies that one would have seen in recent years.

Figure 1.15.1: Reuters

Pakistan has made no meaningful discovery of crude oil and gas in more than two decades, increasing its reliance on expensive imported fuels to meet consumer needs.

Petroleum Division is the author of this policy along with input from relevant agencies like the Federal Board of Revenue (FBR), Customs and commerce ministry, who deserve accolades. The policy had been under discussion for the past few months and now it stands as an approved gazette policy. Bonded warehouse policies have been around for a long time, which were applicable to many sectors. However, for the petroleum sector, it is a new development.

Under this policy, an eligible importer or manufacturer can import the product or material without paying customs duty and sales tax and store it in a bonded warehouse, which is under the supervision of Customs authorities.

When the owner needs it for sale or use, he will pay the taxes and duties and get his items released, partly or wholly. For the oil sector, it is a new and happy development. We will discuss here its salient characteristics and impact on the sector and the economy. It is known that Pakistan is suffering from multifarious problems related to economy, finances and energy prices and supply. Energy is an important input under all circumstances, good or bad. It costs a lot of money both for the country and companies to import and for users to buy.

Energy supply chain has to function smoothly and any discontinuity is usually costly and disrupting, resulting in all kinds of implications. Energy and especially oil storage form an important part of energy security policy in almost all countries, developing or developed. It is a separate issue that developed and rich countries keep large storages. IEA recommends or requires its member countries to keep oil storage for three months. It is obvious that poor developing countries cannot have that much storage.

In Pakistan, the regulatory requirement for petroleum products storage is 20 days. In financially hard days, like these days, it may not be easy to maintain even this volume of storage. Even if foreign exchange is available, one would like to spend it in other areas as well. In this context, the oil bonded warehouse policy is a welcome step. Large international trading companies and countries keep storages of crude oil as well as petroleum products like petrol, diesel, kerosene and jet petroleum. When supplies are more than demand or prices are low, they store these products.

To reduce risks, these companies would like to diversify storage locations, especially, in areas where there is a large market and which are close to transport hubs. If a country allows, encourages and facilitates oil storage, they are likely to utilise the facility. They may also sell out of storage locally or even export it. Thus, their capital is not tied up and is usefully utilised.

Host country gets the benefit of storage availability without involving huge finances. A company can build its own storages or hire the available ones. It would bear storage costs and charges it to customers. One can readily see how such a facility and activity can boost energy security and economic activity. Storage building activity boosts the engineering industry and employment. It also develops the wholesale oil market.

It can boost investment in oil refining and trade and buying local companies or having JVs with them. Consequences are numerous and multifarious. Pakistan consumes 17-22 million tons of petroleum products and crude oil per year. It has varied from $12 to $20 billion in the past depending on prices and quantity. One month of storage would involve $1 to $2 billion.

Foreign oil companies are going out of Pakistan for a variety of reasons. However, it is from retail operations. Wholesale market operations will remain attractive. In India, the retail oil market is occupied by three public sector companies. Foreign companies do not come in there. However, Adnoc and Saudi companies have built storages there, although of crude oil.

India is self-sufficient in finished petroleum products. However, it imports most of its crude oil requirements, hence the international and regional interest in storage. Admittedly, as oil is a regulated sector in Pakistan, there are complexities of sales and pricing. There are issues of financial and physical outflows. This requires a comprehensive policy. Such a policy has been prepared recently. It appears that most of the issues have been taken care of. Nothing is perfect. There may be some dangling issues, which may be taken care of in consultation with stakeholders.

However, there are some stakeholders which are more of a vested interest, who would like to block market expansion and entry of newcomers. They have been lobbying against it. In the oil sector, people have been talking of mafias, rightly or wrongly. But if they belong to public sector companies, it should be a matter of concern for the government. But unfortunately that those very circles, which are lobbying for deregulating and opening up of the oil sector, are the ones who are opposing the introduction of this policy.

In the long run, if market expands, most players benefit and share the fruits of expansion. In the short run, there may be a need for adjustments. That is what market is. The policy should be able to attract Middle Eastern and other oil companies. It is an ideal project for SIFC. It is hoped SIFC would be able to consider it in its portfolio.

1.16: Towards Alternate Fuels

Petrol, Diesel, Gas and LPG are widely known and used Fuels. But there are other alternate fuels as well which can be used independently or can be mixed with the afore-mentioned fuels in various proportions. Motivations for the alternate fuels can be varied depending on individual circumstances. These are; environmentally cleaner, local resource endowment, lower cost and foreign exchange savings. We will discuss here the already developed fuels like Bio-Ethanol and Methanol. We may in passing discuss Biogas as well, as its resource base is there but not being used as widely as it could have been. We will not discuss Hydrogen as we have already been discussing it in this space and also because it is not commercially viable in current circumstance.

Bio-Ethanol

The main alternate fuels are Ethanol (Bio-Ethanol) and Methanol.PSO had introduced E5(5% mixture of Ethanol and 95% Gasoline) more than a decade ago. For unknown reasons or market skepticism , the E5 grade as dropped. However, amazingly, OGRA continues to issue tariff for this product probably leaving options for those OMC which may have some new thoughts about it and may like to enter into this segment. Ethanol is being locally produced by our sugar industry and is exported. Competition with export possibilities may be another constraint. Economics of exports vs equivalent amount of Petrol should be reexamined.

Technically, there should be no skepticism as E5 and even E10 (10% mixture of Ethanol and Gasoline), as these are being very widely used in most countries including the U.S.,E.U. and ASEAN and other regions. Even higher % of Ethanol is being envisaged. India is already doing it in case of E5 and E10.It had a goal of introducing even E20 (20% Ethanol) by 2030. However, recently, India has advanced its target to 2025.The motivation is cleaner fuel Environment has become a major issue in South Asia, as we are seeing the Smog issue on both sides of the border.

The second motivation is resource base. Bio-Ethanol can now be produced out of crop waste and even MSW (Municipal Solid Waste).On both sides of the border, crop waste like Rice stubble is being burnt and contributing to smog and pollution. There are other crop wastes also. Similarly, there is a lot of MSW burning in both the countries. Under the new circumstances when environmental issues have become so serious, E5 and E10 issue should be taken up afresh and appropriate programme and policy be introduced.

Methanol

Now Coming to Methanol (CH3OH). Methanol is a versatile chemical. It is used both as a starting chemical for producing many chemicals and petrochemicals. It is used as energy compound as well. It is mixed with Gasoline and Diesel as Ethanol is. In small percentages mixtures, it can be used without any change in engines. In larger percentages, however, some small adjustments are required in I.C. Engines. Methanol is a clean burning fuel which can replace all fuels, partly or wholly; gasoline, Diesel, LPG and Kerosene etc. Methanol burns efficiently in all Internal Combustion Engines without producing any particulate matters, soot, NOx or Sox etc.

Methanol is also mixed with LPG for use in cooking stoves. In Africa, many countries have adopted it. Methanol is being widely used in China, in ordinary vehicles and specialized vehicles. A wide grade of Methanol blend are used in China from M5 (5% Methanol) to M100(100% Methanol) It is also being used in industries in boilers and power applications. In the West, however, it its use in pure Methanol form is limited .only3% mixture is allowed. Methanol is also used in Fuel Cells which have many applications including automotives. Methanol is choice of fuel for world marine fleet wherein Bunker Oil is being replaced fast.

India has developed plans for installing several Methanol and DME plants with an output of 20-30 Million tons per year. This would save it 10% of crude oil imports from abroad. NITI AYOG India has planned 15% Methanol fuel standard for future.

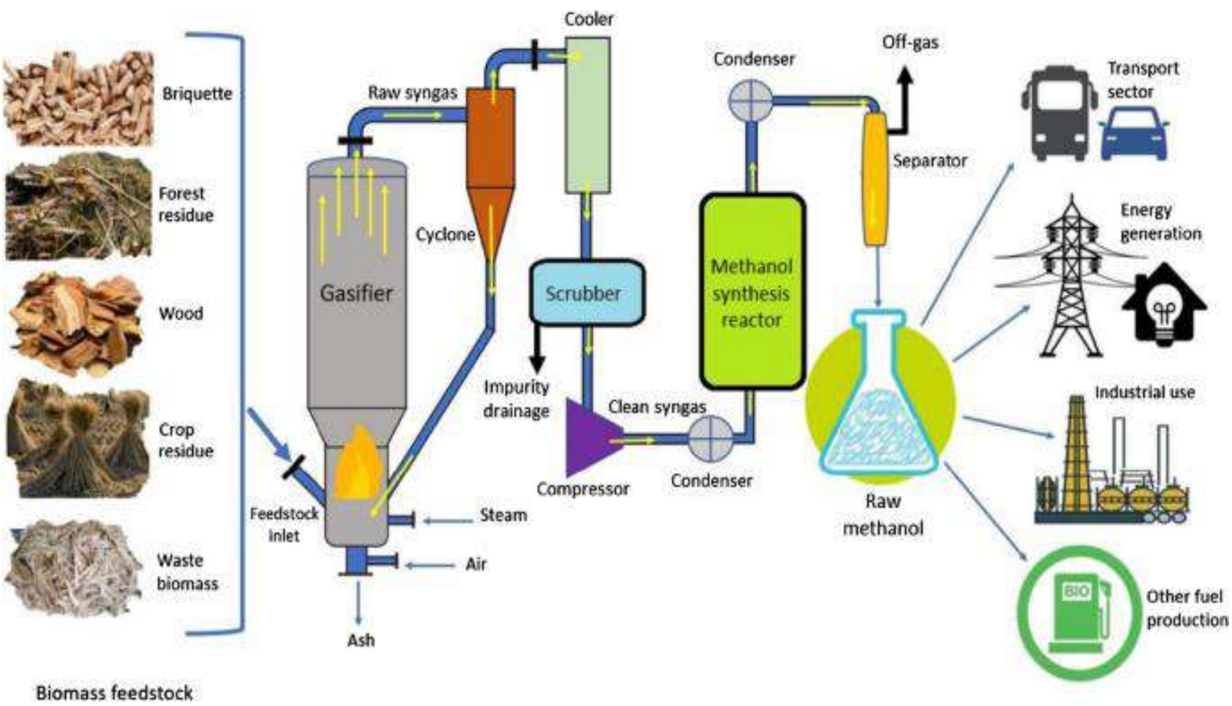
There are two types of Methanol; Fossil and Green. Green Methanol is produced mostly out of green matter like biomass. Fossil Methanol is produced from Gas and Coal. In China, all Methanol is produced from Coal via coal gasification route. These days, CO2 coming out of industrial or power plant exhaust is being converted to Methanol as well.

Why Methanol is important for us. We have Thar coal which can be used to produce Methanol and Methane through syngas route. Methanol is nothing new. There are more than 90 Methanol plants in the world producing 120 million tons of Methanol per year. China is betting big on it. China consumes 9% of its total fuel consumption in the form of Methanol. It produces 65% of the worlds Methanol production.

A large and credible Chinese company had shown interest in a Methanol project in Pakistan. Reportedly, Methanol is 30% cheaper than Gasoline and Diesel. Methanol being liquid is much easier than gas which requires gas grid for transportation. Most of all, Methanol would add to self sufficiency and would save foreign exchange. Any foreign exchange used in its financing would be given back by import saving.

Resource based industrialization is, perhaps, one of the most viable way of development. Also, local and international market issues and trends are important. One is not sure if Thar coal gasification involving Methanol and Methane production would be acceptable to international agencies. China is using this route which may take interest in it. A carbon balance has to be prepared to examine the environmental and GHG acceptability of the Thar coal gasification (Methanol and Methane and other Chemicals). Displacement of Diesel is a positive aspect of the project. A biomass mix can make this project more attractive.

Figure 1.16.1: Methanol fuel production and utilization



BioGas

The readiest opportunity is of exploiting the Biogas resource. It can be used in four forms; 1.small household plants ; 2. Community Plants ; 3.Large gas grid-connected plants; and 4.Bio-CNG plants. There is a large resource base in the form of dung, food waste, crop-waste and Municipal Solid waste (the organic component). Biogas also has fertilizer as a byproduct. There are other products such as CO2 which is used in refrigeration and cold chain. As compared to the process plants like that of Methanol, Ethanol and Oil Refineries, even very large Biogas plants do not require a lot of capital exceeding 20 million USD. It can be handled by local investors. However, GoP has to organize a programme and policy. There are multiple issues of investments, financing, tariff, land, fuel supply agreements, local bodies' integrations etc. Biogas is very dear to European environmentalists. Some grant or concessional funding may be available through bilateral and multilateral sources including Carbon market.

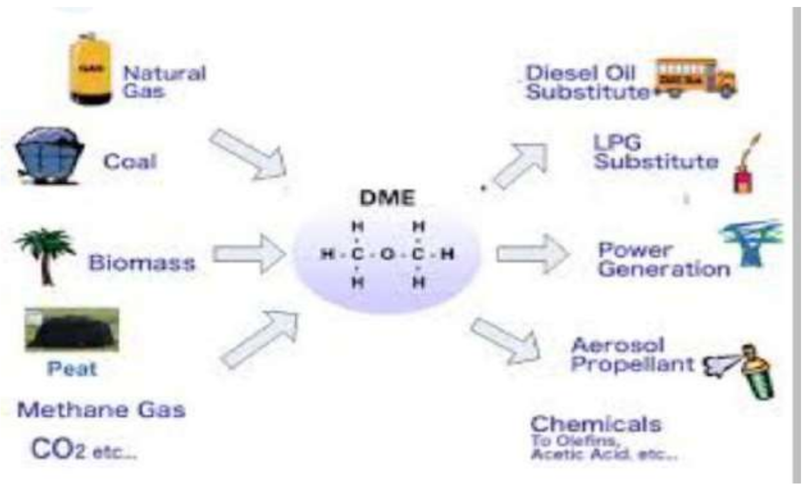
Nothing is a panacea. All energy sources have strength and weaknesses. An energy mix is optimized which may maximize revenues or output and minimize input and cost. Local resource availability may be a strong criterion. Exports, external politics and availability of financial resources are all important factors that have to be considered. Detailed studies would be required in selection and choice of products, processes and Technology. Additionally, it is a highly risky transition time. So many competing options are emerging. It is not known which will succeed? For a poor developing country, the consequences may be more**.**

Ethanol Benifits

- Every major automobile manufacturer in the world approves and warrenties the use of E-10.
- E-85 is safe to use in a variety of automobiles. Please consult your owner's manual to determine if you are driving a flexible fuel vehicle.
- E-10 is compatible with any engine manufactured since the 1970s.
- Ethanol adds two to three points of octane to ordinary unleaded gasoline, so it boosts the performance of your engine.
- Because of its high oxygen content, ethanol burns more completely than ordinary unleaded gasoline and reduces harmful tailpipe emissions.
- Ethanol prevents gas line freeze-up. It suspends moisture in your fuel system, so you don't need to add expensive anti-freeze in cold weather.
- Ethanol burns cooler than gasoline, so it prevents engine valve burnout.
- Ethanol keeps fuel injectors clean which improve the efficiency of your fuel system and reduces deposits that can seriously interfere with engine performance.
- Ethanol is compatible with all fuel system components that have been manufactured in the past 15 years.
- Ethanol is even more water-tolerant than ordinary gasoline. It does not affect the mixture of gasoline and two-stroke engine oil unless there is over 0.5 percent water in the fuel, compared to ordinary gasoline which can only hold 0.02 percent water.
- Ethanol is approved for use by major motorcycle manufacturers including Harley-Davidson, Honda, Kawasaki, Suzuki and Yamaha.
- Off-road vehicles such as ATVs and snowmobiles do not have pollution control devices as do passengers cars and trucks. Ethanol-blended gasoline help reduce exhaust pollution from these types of vehicles

Source: North Dakota Department of Commerce

Figure 1.16.2: Dimethyl Ether Production



1.17: Reducing Smog through Bio-Diesel

Smog has been causing major problems in country's social and economic life. There is no need to describe the extent of losses and suffering that is being caused. Unfortunately, Smog is a regular yearly feature in winter season, especially, in Central Punjab. Emergency measures are taken but not much in the way of some permanent solutions. Admittedly, pollution and smog are difficult issues. With industrial development, urbanization and agricultural activities, pollution increases. Smog is nothing but pollution riding on water drops, simply speaking. Diesel is normally used by Trucks and Buses. Fossil Diesel mixed with a small(5-10 or 20%) Bio-component, it is called bio-diesel.

Vehicular emissions are one of the major issues in causing pollution. Quality of vehicles, their maintenance and the fuel quality are major determinants of the level of vehicular emissions. Fortunately, Pakistan has adopted highest quality fuel called Euro-V which has the least sulfur. However, only imported fuel is of Euro-V standard. Locally produced automotive fuels (Gasoline and Diesel) do not conform to that standard. There is a new Oil Refinery Policy which aims at converting the existing old technology oil refineries to new processes and technology enabling them to produce high quality low sulfur fuel. We have proposed elsewhere that efforts should be made to distribute only imported Euro-V fuel in smog prone areas.

Coming to Biodiesel, it is a renewable fuel with reduced environmental footprint as compared to conventional diesel. It has low sulphur content and produces lesser CO. It has higher lubricity and is biodegradable. Its main advantage is (20 % or more) reduction in particulate matter which plays a major role in reducing smog. It is said that Rudolf Diesel, the inventor of diesel engines, ran his first diesel engine on vegetable cooking oil, which can be called Bio-Diesel.

There are six possible raw material routes for making biodiesel. These are vegetable sources – palm oil, rapeseed, sunflower, cottonseed, canola, jojoba, Jatropha and others; waste vegetable oil or used cooking oil as it is called; animal fats like tallow, lard, yellow grease and chicken fat; algae; sewage sludge; and saline agricultural plants. The most important feature of Bio-Diesel is that it can be made out of waste of various kind, especially, the Used Cooking Oil(UCO).

There is shortage of vegetable oil raw material in Pakistan. Oilseeds and palm oil are imported. Hence, diversion of such sources to non-food energy sources would not be desirable.. Algae, sewage sludge and saline agriculture appear to be feasible as well. Jatropha has been tried ,even in Pakistan, but for a variety of reasons did not make a success almost anywhere. Thus, the only potential source of biodiesel appears to be used cooking oil and food waste.

Food waste - both industrial and post-consumer, slaughter house and poultry fat and waste offer a multi-pronged benefit stream into biodiesel production; income and employment in the agriculture sector and general improvement of environment. Newer waste processing avenues are coming up, the latest one is chicken fat out of feathers, which hitherto had been a major pollution load.

Biodiesel blending

Biodiesel is blended with conventional diesel in various proportions. Five per cent blend of biodiesel, which is mostly marketed, is named as B5, 10% as B10 and 20% as B20.It is reported that up to 20% biodiesel blends, no change in engines is required. However, most vehicle manufacturers allow 5% blend without annulling warranty claims. In most European Union countries, 5% target has been achieved reportedly. The European parliament has issued RED-II (Renewable Energy Directive) according to which 12% renewable fuels are to be used by the year 2030.India has a target of 5% Bio-diesel by 2030.They have installed several plants by now.

Biodiesel production:

It is relatively simple to make biodiesel, especially from used cooking oil. It is so simple that it is produced at home by the enthusiasts in the US. Used cooking oil is filtered to remove physical impurities, heated to 60-degree Celsius and is mixed and stirred with methanol or ethanol (15%) in the presence of a catalyst (NaOH). A byproduct glycerol is produced which settles at the bottom. Water and excess methanol are removed. Ethanol is widely available in Pakistan as a sugar industry byproduct. Glycerol can be used by the soap industry as what used cooking oil is diverted from it in the first place for making biodiesel returns back to the industry.

Pakistan's biodiesel potential

Pakistan's cooking oil market is estimated at 4 million tonnes per year. If 10% of the consumption is assumed to be collectable used oil, 400,000 tonnes per annum of used cooking oil can be used for biodiesel production. By comparison, diesel consumption in Pakistan is 7 million tonnes. Thus, some 5% biodiesel (B5) can be produced in Pakistan.

In India, public-sector oil companies have been recently assigned the task of introducing biodiesel based on used cooking oil. Also, in India, McDonald's and other similar companies have launched their own recycling programmes to turn used cooking oil into biodiesel to run their refrigerated trucks. Start companies are being opened in India for collecting UCO and making Bio-Diesel.

Regulation of used cooking oil

High-level restaurants use cooking/frying oil only twice and discard it after that. Used cooking oil is collected from high-level restaurants and is resold to low-level and street restaurants without any processing or cleaning. Legally, used cooking oil cannot be used again in cooking. It is not known as to how much of it is diverted for non-cooking purposes such as soap-making.

Used cooking oil should be a regulated product. Its sale, collection and resale should all be a licensed activity. The Punjab Food Authority has taken some action in this regard.

Biodiesel industry may provide an alternative outlet for used cooking oil, reducing the opportunity for its diversion to illegal cooking uses in the commercial market.

Time to launch a biodiesel programme

Biofuel initiative was taken in Pakistan in 2007 with a lot of enthusiasm. Biodiesel blending target was B5 by 2015 and B10 by 2025. PSO and all relevant public-sector organizations took a lot of interest. The programme was almost totally based on Jatropha. However, as mentioned earlier, Jatropha plantation efforts and yield did not come up to expectations in almost all parts of the world. It would be advisable that PSO rediscover its earlier programme based on used cooking oil. It is a pleasure to see that Total/PARCO is taking interest in Bio-Diesel. They are cooperating with Punjab food department to establish a viable Used Cooking Oil (UCO) collection programme. Once a collection system is developed, there isn't much in Bio-Diesel manufacturing. For PARCO, it should be a left hand job. Other companies may also try to enter into it.

Thus, we see that Bio-Diesel is useful in a number of respects; removal of used cooking oil from food market, reduction in crude oil imports, saving s in foreign exchange, reduction in pollution and smog and preventing clogging of the sewerage system. Let us revive a Bio-Diesel programme to achieve these objectives.

Households and commercial food centers should be encouraged to participate in a UCO collection programme. Making or Blending Bio-Diesel out of it is a rather simpler job comparatively.

Figure 1.17.1: Bio-fuel Chain

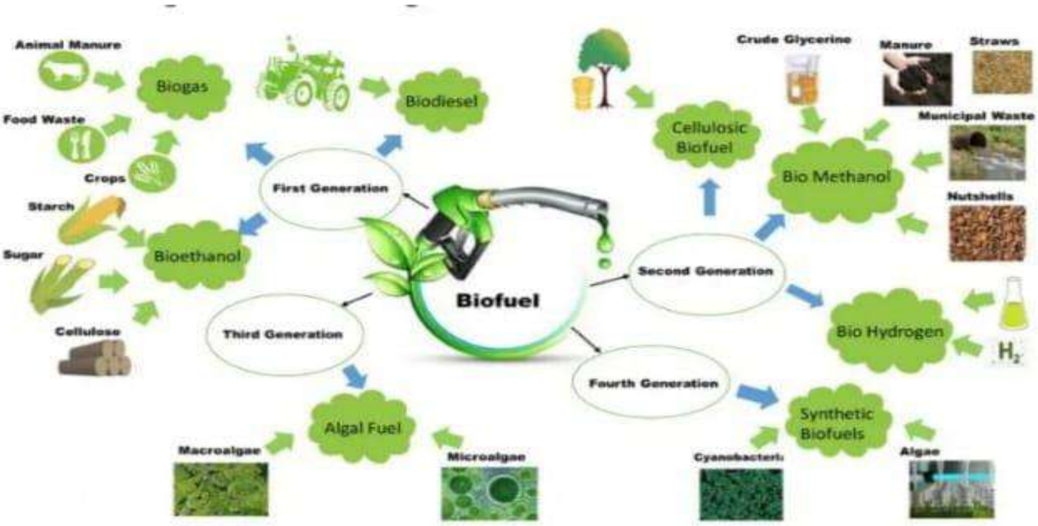
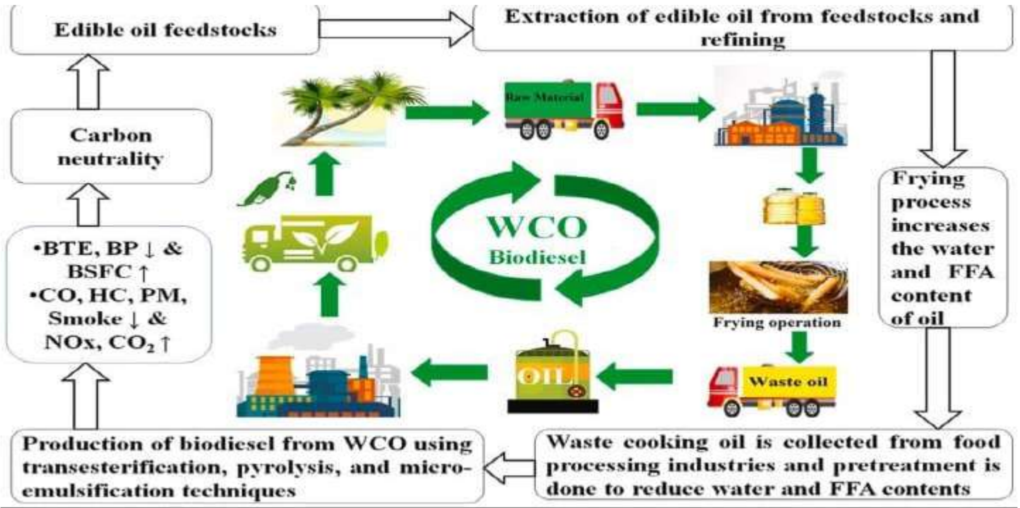


Figure 1.17.2: A Comprehensive review of bio diesel production



India Bio-fuel Policy:

- Looking to the future, Baxi shared ambitious expansion plans for Bio-fuel-circle, aiming to reach a million farmers and extends operations to all Indian states by 2028.The company expects a substantial growth in transactions and revenue, with a fundraising round in the pipeline to finance these initiatives.
- On the environmental front, Baxi emphasized the importance of providing farmers with dependale alternatives to stubble burning, a significant source of pollution, and the role of technology in creating trust in the biomass collection system.
- Bio-fuel-circle, which orchestrates the collection and sale of agricultural waste for bio-fuel production, has enabled approximately ₹200 crore in transactions on its platform, directly benefiting farmers with 10% of these revenues.
- The company's innovative supply chain approach leverages agricultural residues from crops such as rice and cotton, among others, procured post-harvest form over 20,000 farmers in states like Maharshtra, Gujrat, Uttar Pardesh, Punjab and tamil Nadu. With Gujrat as its largest base.

Gas

2.1: Gas Shortages in Winters

There is usually a high gas demand in Winters but gas shortages in the winter have become a norm in Pakistan. Local gas supplies decrease by 10 per cent every year. In the last few years, liquefied natural gas (LNG) would fill up the gaps created by supply shortages, and used to be quite affordable. At present, there is an energy and gas crisis across the world. International suppliers are not responding to our tenders for gas purchases due to an already weak supply situation. LNG is also not available at the right prices. As against the typical price of $10-12/MMBtu, LNG is now being sold at three times these prices. These prices have started to come down a little only recently and that too due to an increase in gas storage in Europe, which is a large well-paying market. Fortunately, there are long-term LNG contracts through which we will continue to get enough gas to use one of our RLNG terminals.

In Pakistan, the market share of LPG in the domestic sector is 41 per cent, commercial 43 per cent and industry 16 per cent. LPG appears to have some potential to fill the supply gap. LPG demand in Pakistan is around 1.3 million tonnes per year (mtpy); almost half of it is supplied by local suppliers and the other half is imported. There is a pricing problem between imported LPG and the local one. The price of local LPG is based on Saudi contract prices (SCP). Imported LPG has always been more expensive. An LPG terminal was wound up earlier due to pricing and other issues. Imported LNG dealers complain about this problem all the time. LPG, LNG and oil are commodities. Their prices also depend on volume and consumers' credibility. Indices like Brent or JKM or TTF indicate average prices. There are discounts for good and large customers and premiums for small and less-reliable customers. And there is no way to find this out. Here lies the declared and undeclared profit. Due to this reason, commodities are imported in many countries under long-term GtoG contracts, which may be indexed. Demand from the private and public sectors are aggregated for interim and variable requirements under spot tenders by organizations like the Trading Corporation of Pakistan (TCP).

There appears to be a need for doing both, long-term GtoG contracts ala Qatar LNG and spot tenders by the TCP. Reportedly, the government recently managed to sign a contract with Qatar for the supplies of one million tonnes of gas per year. GtoG contracts need not be handled by government-owned companies. The government can allocate and nominate private-sector buyers and resellers to the Qatar LPG supplier company. Bulk LPG contracts under GtoG arrangement will hopefully fetch lower prices, and thus the perennial issue of disparity between imported and local LPG prices will be resolved.

There is a third option as well. Some arrangements can be explored to open trade with Iran. We can start with the border trade agreement which has been on the table for a long time. Turkey used to import pipeline gas, and perhaps LPG, from Iran despite sanctions. Our foreign diplomats may be able to do something in this respect. LPG storage infrastructure may play a role in stabilizing prices, especially, in the winter. There are informal LG storage units. Under a policy regime, more overt storage units may enter the market.

Local LPG used to be under a quota regime where the powerful used to get quotas allocated mostly as a political bribe. So, what is the allocation process now that there is no quota system? It is a difficult issue when the price is fixed. Consumer prices increase if producers ask for a premium. Demand may contract. The international average prices for LNG in the month of October were around $0.71 per litre. The average can be deceptive. The actual retail prices varied from $0.324 per litre in Russia and $0.541 In Turkey to $1.022 in Spain. The difference is due to taxes. In Pakistan, LPG retail prices for the same period were Rs201 per kg ($0.768 per litre). LPG prices in the region (India) were almost the same. Petroleum prices in India are usually higher than in Pakistan due to higher taxes and some possible camouflaging and diversion.

The Oil and Gas Regulatory Authority (Ogra) has increased LPG prices for November by Rs2.94/kg. The prices may rise in the coming months as well. There is a case for reducing, or completely doing away with, taxes on LPG, at least for the winter and the crisis period. At present, around Rs34 per kg is charged as GST and petroleum levy. By doing this, a 17 per cent reduction will bring down LPG prices from Rs202/kg to Rs168/kg. Perhaps, there is no commitment with the IMF on it although the institution does not like any tax cuts.

There is a price disparity problem as well. The LPG cylinder price of Rs202 per kg translates into Rs4,333 per MMBtu while the lowest slab of pipeline gas (PNG) is Rs122 per MMBtu. The highest domestic slab is Rs1,400 per MMBtu, Power sector 857, industry 1057. The LNG import price is Rs2800-3000, and the price of domestically produced gas is around Rs1,200. Consumer gas tariffs have not been revised for the last two years. In October, Saudi contract prices (SCP) came down to $590/tonne ($0.3/litre). In April and September 2022, the SCP hovered between $800 and $940/tonne. In January to September 2021, the prices were around $550-650/tonne, and between December and February 2020, the prices were as low as $350/tonne. In Pakistan, the producer price, as set by Ogra, was Rs132,303 per tonne ($601.377/tonne or $0.305/litre) for October. There may be some price variation issues due to propane and butane ratio in LPG. We have considered only propane prices; the difference may be negligible.

Pipeline gas (methane) is limited to network areas which cannot possibly cover the entire population. Gas coverage in Pakistan is around 20-25 per cent. While there are problems in Pakistan due to a heavy share of the low-paying domestic sector, creating circular debt issues even in the gas sector, in India there are big plans to increase gas coverage to 70 per cent of the population.

A winter without gas?

Gas and electricity prices have become politically sensitive issues. The IMF compares prices in dollars, which shows that energy price hikes are negligible. However, in rupees these hikes prove to be quite steep.In Pakistan, elections are approaching as well. Although the government has increased electricity prices, it will be difficult to increase gas prices, especially for the poor and the middle class.

There appears to be some scope for increasing tariffs for large gas consumers who are mainly from the elite class. New connections are being given at LNG prices, which are almost double the prices in the highest domestic slab. Either the supplies to posh areas may be reduced to incentivize them to shift to LPG or gas tariffs may be increased to be comparable with LPG. To be fair, LPG supplies to posh areas should be ample. This sector wastes a lot of gas while using inefficient appliances. They may be encouraged to switch to LPG. Technical assistance for conversion could be provided by gas companies.

LPG has not been subsidized so far, except for LPG air-mix plants. Enough subsidies are being given to the pipeline gas sector. However, in India, subsidized LPG cylinders are available for poor households. Experts believe that Pakistan should introduce a scheme for subsidized LPG for the poor, especially those in northern Pakistan where trees are cut for fuel, especially in the winter. This causes landslides and soil erosion. However, subsidized LPG can only be handled by public-sector companies, not by the private sector. The Utility Stores Corporation can also play its role in LPG retail. The government will have to arrange ample LPG supplies. Biogas and solar geysers could be promoted and incentivized. Keeping aside the long-term biogas development programmes and issues, biogas can still be facilitated for rural-urban mixed areas. Cheap plastic-made biogas generators can be made available which can supply biogas readily by converting organic vegetable and animal waste into gas. Such generators will cost Rs10,000-15,000 per unit. Also, biomass cookers can be promoted.

There are other solutions as well. Expensive charcoal is used in the commercial and rural domestic sectors. A good alternative is Thar coal briquettes that are much cheaper. In central Europe, coal is used consistently. And it seems that with the ever-evolving gas crisis, lignite may be used even more. Coal-biomass briquettes are another possible product. All these options are indigenous and do not cause foreign exchange losses. One-size-fit-all solutions may not work, or be enough, to meet the challenge. LPG is heavier than natural gas and settles near ground while natural gas goes up. As a result, LPG is slightly hazardous. There are many LPG incidents and accidents every year due to this phenomenon. The use of unlicensed LPG cylinders which use inadequate and poor-quality materials is another reason for cylinder explosions. Ogra and the provincial governments should cooperate to control this. I am not sure if LPG marketing companies exercise due diligence in eliminating unlicensed bad-quality LPG cylinders.

LPG is produced by oil refineries and is also extracted from oil and gas fields. LPG is thus locally produced from Karachi to Khyber Pakhtunkhwa (KP) at various locations. It has to be cleaned in gas processing plants and is later transported to LPG marketing companies' cylinder-filling plants. The central LPG market is in Lahore. There is a case for installing a LPG pipeline from Karachi to a point in the northern areas. The Inter State Gas Systems (ISGS) has prepared a proposal in this respect.

It is regrettable that the Jamshoro Joint Venture Limited (JJVL), a large local LPG separation and processing plant, has been shut since July 2020 due to legal complications of royalties and ownership between the JJVL and the SSGC. It is hoped that the issue will be resolved soon, resuming the production of 10,000 tonnes of LPG per month. This will save precious foreign exchange. Under the new NAB laws, negotiating agreements with private parties have become less risky. The case for forming a gas tribunal has been under consideration for a long time now. In addition to the JJVL case, there are thousands of other gas-sector legal cases which are at various stages of litigation. An early implementation of the tribunal proposal may be helpful in resolving these matters in less time and money.

There is market fragmentation which has led to economic inefficiency in the LPG sector. There are more than 200 LPG marketing companies. The consolidation of this market has been discussed quite a few times. But it may not be easy. Taxation, pricing and licensing conditions may be used to incentivize mergers and acquisition among marketing companies. There are pessimistic trends in the production of local gas and imported LNG, while demand is increasing, adding to the demand-supply gas. LPG can play some role, at least in catering to domestic needs like cooking food. There are many loose ends in the LPG sector. Many new developments are, and will be, taking place.

LPG has price links with other competing fuels. In the domestic and commercial sectors, it competes with natural gas. In the transport sector, it competes with petrol, CNG and even diesel. Its pricing and taxation policies have to take these links into account. Stakeholders are demanding an integrated new LPG policy. The government usually involves stakeholders in making such policies. It is hoped that with good policies and an adequate implementation framework, progress can be made in this important energy sector.

2.2: Fertiliser exports

Some fertiliser manufacturers in the country have requested for permission to export their surplus stock so that they can compete in the international market on their own. They have also made some interesting comments on land distribution and made some suggestions – that are mostly in their favour – with respect to targeted fertiliser subsidies for small farmers.

The proposal is based on these manufacturers' excess supply capacity. The current market need is some 300,000 tonnes. Also, there is the issue of gas shortage, which nullifies the purported excess capacity. The government has recently imported fertiliser as the commodity was short in supply in the domestic market. Fertiliser companies have their own distribution network. They are supposed to control their distributors and retailers instead of passing the blame onto the government.

If there is excess, it should be reflected in market prices which should have gone down – this has not happened so far. It is a strange coincidence that the company prices of urea are uniform. Is it price collusion in the face of excess capacity? Previously, urea prices had been deregulated on the premise that there would be competition and prices would come down.

The government has given subsidies to fertiliser manufacturers in the form of extremely low-priced gas which is the main raw material of urea manufacturing. In principle, in face of such high subsidies, fertiliser prices should have been regulated, which could have brought down the prices to a lower and more competitive level. Currently, fertiliser companies are making excessive profits.

At present, Pakistan is short of natural gas. The country's urea making capacity is also determined by natural gas supplies in addition to plant capacity. A better way to utilise the excess plant capacity is to reduce prices so that demand and utilisation increase.

The current prices of urea are Rs 1,717 per 50 kg sack ($195/tonne) as opposed to $690 per tonne in the international market. In April, international prices were $350 per tonne. The prices increased due to increasing natural gas spot prices of $34 per MMBtu as against a normal of $8 per MMBtu. Fortunately, natural gas prices are still low in Pakistan. Local gas prices are at around $6 per MMBtu and long-term contract prices are at around $10 per MMBtu. Very small amounts of LNG have been bought at the current high prices. The average cost – the weighted average cost of gas (WACOG) – should be under $8 per MMBtu. The 'clever' proposal of fertiliser companies is to get the gas at the WACOG of $8 to be able to sell at $690 plus per tonne. On the other hand, the current high urea prices are determined by the current high spot prices of gas at $34.

The government of Pakistan is not composed of simpletons. The consequence of ill-thought-out sugar exports has been suffered by the entire nation. It is almost certain that the government will not take this bait of the fertiliser exports proposal – buying gas at $34 per MMBtu on spot and selling it to the fertiliser sector at $8-10 per MMBtu. Export proponents would not agree to buying gas at the current spot prices. We would still emphasise that such proposals be rejected with the disdain that it deserves.

Excess capacity is a relative term, and it is usually a must for competition. Demand is price elastic. The demand-supply equilibrium is achieved at right competitive prices. Urea prices must come down to bring down the excessive profits to a reasonable level and to wipe out excess capacity.

High profits in the fertiliser sector are indicated by earnings per share (EPS) of major companies, which have risen to Rs13. Cheap gas, uncontrolled prices, and taxation loopholes and changes provided such high-profit opportunities. Let us have a comparison of cost in various jurisdictions utilising the 2019 data. In India, gas is supplied to the fertiliser sector at $6.5 per mmBtu at a consumption norm of 22 units per tonne of urea, resulting in a regulated price varying between $245 and $310 per tonne of urea. The share of gas cost in the final fertiliser price comes out to be $143 per tonne or 46-58 percent.

Another cost estimate is from Yara, a major and credible international fertiliser company with the global market share of 20 percent. It provides urea production cost at $146 per tonne based on the gas price of $4 per unit. By comparison, Pakistan's urea price at half the gas price of Rs300 ($1.93) per unit is $217 per tonne. To be fair, the taxation effect has not been included in it, which may make the difference a bit less glaring. In Pakistan, gas cost in urea comes out to be $42.46 per tonne. Thus, the overhead cost/margin in India is $100 per tonne vs $174.54 per tonne in Pakistan.

There is no denying that Pakistan is short of gas. Its local gas resources are dwindling fast. No major gas discovery has been noted so far. Also, the international gas market is getting unstable. Since gas is the main raw material of fertiliser production, exporting fertiliser will tantamount to exporting gas which we don't have. It would be quite an achievement if we manage to maintain consistent supplies to the fertiliser sector.

Many experts argue that the fertiliser sector is meant for cheap and abundant gas producers and exporters. In Pakistan, the sector has been built around food security consideration. The authorities must consider bringing fertiliser prices under regulation. Under free market pricing, concessional gas prices to the fertiliser sector may have to be done away with and replaced by direct subsidies or taxation in case international fertiliser prices increase or decrease as compared to local benchmark prices. On the other hand, fertiliser companies may import LNG on their own.

Exporting fertiliser should be a non-starter in any case, as it would not only improve the already bloated balance sheet of fertilizer companies at the cost of people and farmers but also put upward pressure on domestic fertiliser prices. The case for fertiliser exports is even weaker than that of sugar exports, for sugar production is seasonal while fertiliser production is almost constant and consistent. Fertiliser companies should not consider exporting the surplus amount. Such a decision is not financially viable for the country.

2.3: Gas crisis and industry

Winter has come and gas crisis has started. Earlier, households used to do hue and cry. But now, industry is doing the same. Everybody knows, and more so, the industrialists should know better, that the local gas production has been going down and LNG is not available. No supplier is bidding even at higher prices.

Even laymen predicted that there would be gas shortages. Government or anybody else does not have a magic wand to solve such problems in immediate terms. All that can be done is rationing in which people's cooking requirements obviously get priority. Industry, however important, gets lesser priority. It is here in Pakistan that government has taken unto itself to supply gas and electricity. In most countries, it is the private sector which manages these supply systems. Large industries do their own thinking acquiring various sources and alternatives.

A number of gas alternatives are available to the industries if they do some advanced thinking and go into action. But the usual tactics are to make hue and cry at the eleventh hour and somehow force the government to augment supplies. This time, it may not succeed as the supply problem is much deeper and graver. Fortunately, there is no electricity crisis yet, although as winter deepens, almost 10,000MW of hydropower may be reduced to several thousand initially and in January it may be reduced to even less than one thousand.

Fortunately, electricity demand is much lower in winters due to the shutoff of ACs and fans. Instead, heating is turned on, which predominantly consumes gas, hence, the gas crisis. There are all kinds of controversial positions taken by opinion leaders and stakeholders. Some say gas should be for exclusive use by the industry. It is too precious to be burnt at homes. Little do they know or appreciate, that throughout the world gas is used in houses for heating and cooking. LPG is used where there is no gas network. Gas networks are usually much less widely spread than electrical networks are due to a variety of reasons.

Some say, mostly out of the energy professional class and mono-dimensional experts, that gas tariff should be kept so high that poor cannot afford it. They recommend LPG for the poor and other domestic users. The rich urban class may be able to afford LPG. But for the bulk of the masses, it would be like Marie Antoinette's famous wisdom; why don't they eat cake? Successive governments have rejected this minority point of view and continue to prefer gas supplies to the domestic sector.

Although it is true that gas prices are too low for the poor and lower consumption slabs, perhaps not much can be done about it. If the labour is paid Rs15,000 per month, how can one legitimately expect them to pay high price for gas or electricity. In any case, most of the rural population is not using gas. It relies on biomass, charcoal, kerosene and to some extent LPG.

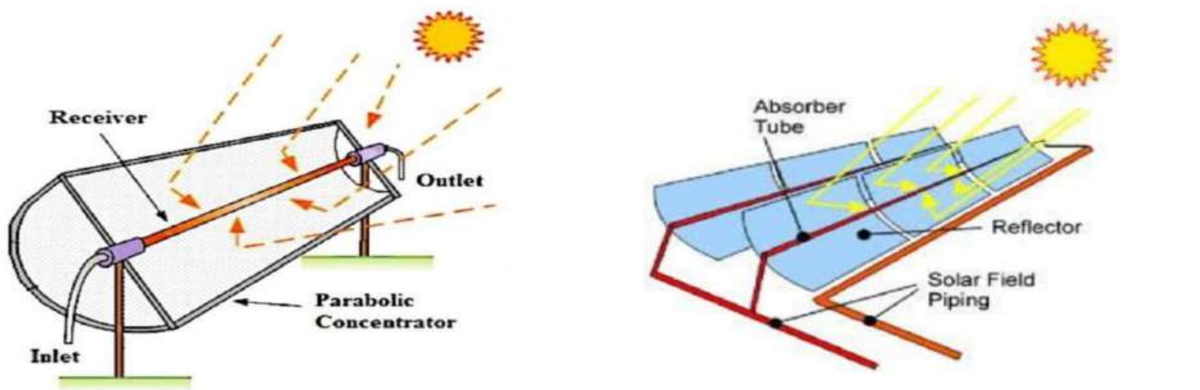
Alternatives for industries

Current or usual industrial energy problem is of thermal energy, firing their furnaces and boilers. Next door in India, the industry uses a variety of energy resources, varying from black and brown coal (lignite) biomass, oil and electricity, in firing their boilers. Refineries are crying hoarse that their storages are full of furnace oil and that if the oil is not lifted, they may have to shut down or reduce their production level. Industries should consider shifting to oil. Normally, boilers are dual-fuel capable or can be converted easily. In Gujarat, the centre of textile industries in India, lignite is used heavily. We have lignite now. Why can't our industry start shifting to lignite, although major conversion efforts may be required or altogether new boilers may have to be installed. It would be cheaper and available throughout, if supply chain arrangements are made. There is shortage of lignite in India, we could even consider exporting it to India.

Cement industry has long shifted from gas to coal. Similarly, all other extractive industries should have converted themselves. However, they have been using imported coal. Price hike of imported coal is forcing them to use local coal. There are logistics issues. Once these are resolved, Thar lignite would be available throughout Pakistan. Thar rail link project is reportedly moving fast and is expected to be completed within a year. Also, there are other local coal sources in Balochistan, Punjab and K-P. Coal is being imported from Afghanistan as well. Moreover, South African coal prices have started coming down.

Textile industry (processing part) requires low temperature heat varying from 60 to 120-degree Celsius. Electrical boilers can provide this kind of temperature. Electrical boilers are cleaner, safer and even cheaper. Solar PV can be used to fire the electrical boilers. If companies have rooftops, they may be able to have their own cheaper solar electricity at a cost of Rs10-12 per unit. If space is not there, they can get together in a cooperative style or otherwise install their own solar. Nepra has made wheeling available. Transmit it through the existing DISCO system and run electric boilers. Biogas can be produced similarly and transmitted through the existing gas network. Gas companies are reportedly encouraging biogas, which is much cheaper than LNG. There are some novel solutions also, which will eventually solve the problem in some cases, like the solar parabolic collectors. Simply speaking, one can call it solar boiler, ie heating and boiling water through solar rays.

Figure 2.3.1: Partabolic Reflector Systems



Power stations have been made on this concept in several countries. There are discussions and explorations in the industrial sectors to utilise this as a cheap source of thermal energy. Gas future is almost uncertain and more so of cheaper gas. Government cannot indefinitely provide gas at $9 while buying at $30. We have recounted many alternatives above. Renewable energy opportunities have emerged in the meantime. For renewable energy options, multilateral and bilateral assistance may be available. On lignite use development,

Table 2.3.2: Solar Reflector Temperature & Cost

Motion	Collector type	Absorber type	Indicative range of output temperature[°C]	CAPEX [€/kW]
Stationary	Flat plate collector (FPC)	Flat	30 - 100	250 – 700
	Evacuated tube collector (ETC)	Flat	50 - 120	800 – 1,100
	Ultra High Vacuum FPC (UHV-FPC)	Flat	50 - 200	1,200*
	Compound Parabolic Collector (CPC)	Tubular	60 – 150	600 - 1300
Single-axis tracking	Linear Fresnel reflector (LFR)	Tubular	60 - 400	800 – 1,800
	Parabolic trough collector (PTC)	Tubular	60 - 300	600 – 2,000
Two-axis tracking	Parabolic dish reflector (PDR)	Point	100 - 500	600 – 1,800
	Heliostat field collector (HFC)	Point	150 - 2000	ND**

* Based on TVP information

** Non-interesting for agro-food application stakeholders in Pakistan may have to help themselves. Fortunately, lignite is available, has been dug out and brought to the surface by two companies. Industrial sector would require much lesser lignite than the power sector. Separate mining activity may not be required. Industrial sector has to organise itself and develop these options. Evidently, the government would be interested in supporting viable schemes. Will the industry really take the initiative? Perhaps, the government may have to take the first steps.

2.4: Alternative Gas Options

Electricity supply issues among rising local energy costs – both at producers and consumers' ends – combined with power plant defects, high fuel cost, supply issues, and low water-reducing hydro have wreaked havoc across the country.

The challenges are not over almost all over the world. For poor governments and their people, the suffering has been much more. For Pakistan, the currency exchange issues and the ballooning current account deficit have created special problems.

There may be a few months of partial respite when the summer's intensity goes down and morphs into a cold winter. Rich and other high-income groups may suffer more than the poor who usually do not get hot water and heating or get quite little. The poor are used to suffering. The rich are not and may not be able to buy energy even when there is no dearth of money for them.

Pakistan's energy crisis does not seem to be ending anytime soon. The country has not received a single offer against its LNG purchase tender. This has happened in the summer when LNG demand is usually less. In the winter, the demand and prices are high. Those that have a larger share of long-term contracts are somewhat saved, while those that depend on spot supplies will suffer more. In the coming winter, due to lower supply and higher gas prices, there may be more load on electricity heaters and more gas demand.

A new gas tariff has been announced, and gas prices have increased – there is a circular debt of Rs1.5 trillion in the gas sector in addition to the circular debt of Rs2.5 trillion for the power sector. Reportedly, the recent gas price increase is more likely to prevent further build-up of circular debt in the gas sector. The higher income group will have to pay more as its consumes more. For some, however, no high price is high enough. The government may have to take some administrative measures to induce this class of consumers to consume less gas. This article is for those who may feel the pinch and may be on the lookout of some alternatives.

As per the new tariff, those previously paying Rs738 per MMBtu will now pay Rs1,856 – a 151 per cent increase. And those paying Rs1,107 per MMBtu will pay Rs3,712 – a 235 per cent increase. For small consumers, the increase has not been as high as compared to others and the cost of gas. This class may be better off with LPG, which has a price of around Rs4,000 per unit. But LPG may also be in short supply, and one may have to have a mix of various resources including renewable energy like solar and biomass.

Fortunately, the government has announced its intention for a fast-track solar programme, and its policy is expected by August 1. It is hoped that both consumer-level and producer/supplier-level solar infrastructure will be encouraged in the policy. There is already a provision of 6000MW in the IGCEP power plan, which may be expanded. However, fast-tracking is needed. It can take less than a year to implement a large-scale solar PV project.

With special attention, 1000MW can be added in the next 12 months; some capacity may come even earlier. Solar costs less than Rs8-10 per kWh. The average cost of supply will go down and the marginal cost will be further reduced.

The biggest alternative is conservation, but that may not take us very far. Conservation practices may have an immediate effect, but technical measures will cost time and money. Renewable energy is getting cheaper, and it requires initial capital investment but has no fuel cost. It is environmentally clean and can play a pivotal role in saving the planet.

Heat can also be produced by electricity. But it will be expensive and create electricity supply issues. Gas heaters and geysers are commonly used in our country. This practice was right when gas was cheaper and abundant. But the situation is not ideal any more. Fortunately, there is a solution in the form of solar geysers – although its use is much less here. It should be noted that even in the winter, there is sunshine in most parts of Pakistan.

On average, there are only 15 days when the sky remains mostly cloudy without sunshine. Thus solar PV or geyser is likely to be available without interruptions. Solar geysers have electrical heaters built in as well, and solar PV and geyser may work in tandem as well. China and Turkey are big users of solar geysers. In Pakistan, solar geysers are imported from China.

Biomass and coal supplies can also play a role in resolving the energy crisis. The rich living in one-kanal (600 sq yard) houses and above may use biomass. Last winter, DHA residents had reportedly burnt their old furniture. Biomass is better in such cases. The urban middle class and poor may not be able to use biomass, although they may buy efficient gasifier stoves.

Special heaters are required for this, which are already being made by small industries. Instead of raw biomass and coal, billets can be used as it is a cleaner and convenient alternative. The government will have to come up with ways and means to expand supplies in this respect. I am based in rural-urban Islamabad and have successfully implemented these technologies, and am not speaking out of theory only.

While there is considerable installation know-how in solar PV, there are inadequacies among local traders and installers, especially in providing insulation in piping, corrosion protection, water filters, etc. It is hoped that with an increase in market size, these inadequacies would be removed.

Solar geysers, except for glass tubes, are an elementary steel fabrication technology although even glass and insulation foam manufacture is also widely spread. If there is encouragement, these large companies may meet the challenge. Unfortunately, we are always in a hurry and in crisis and the causes of local manufacturing have to be compromised to face the challenge and crisis.

There is no denying that these solutions will not be sufficient, but they can provide some respite, helping both consumers and suppliers. Scepticism and hesitation on the part of consumers and policymakers has prevented induction of these technologies. Fortunately, solar PV enjoys consumer confidence. The same can happen in other areas as well.

The government is heavily involved in the gas sector. Its public-sector companies have a large footprint and organizational structure. These companies should play an active role in mitigating the gas crisis. Cheap credit can be passed on through these companies as well. Earlier, some initiatives were taken by these companies, but the subsequent managements have not continued with the initial spirit. There are still some months left for planning, preparation and launching the initiative to meet the winter challenge. It is hoped that the government will include this aspect in its plans and actions.

Diversifying gas use

The gas crisis has been caused by continuously depleting local gas resources, and rising LNG prices. Cheaper local gas supplies will continue to decrease due to the lack of any major success in finding new gas over the last several decades. Small discoveries have been made. It would be advisable to reduce dependence on gas and diversify into the equivalents and substitutes. In this space, we will explore what can be done in this respect.

There are three classes of energy users: urban high income (UHI); low and middle-income urban and semi-urban residents; and low-income rural. The first group lives in posh areas with plot sizes of 500 sq yds or more. In some areas, the plot size has come down to 250 sq yds. There are high-rise posh apartment complexes as well. They can probably pay high or very high prices for energy which they are already doing under the present tariff system. The first group has many options. It can switch to electricity and LPG. It can install air-conditioners which provide both heating and cooling. It can install roof top solar and water heaters. It can switch to electrical water heating. The current problem for this group is that they are significantly hooked on piped gas for cooking, heating and water heating. Geysers are gas guzzlers. During this crisis, many have shifted to other options. The issue is one of improving the availability of other options, logistics, supply chain systems and information. Both prices and non-price instruments (such as continued low supply and pressure) can be used to discourage this segment away from gas.

The real sufferers are those from the low-income urban and semi-urban areas. This group’s typical income may be under Rs50,000-100,000. It lives in small houses and apartments in formal or katchi-abadis. A very large portion lives in semi-urban and rural areas expanding at a fast rate. It is a large and politically active population segment. They are mostly office workers, industrial workers and small traders. They practically have no option except for cheap electricity and gas, and can't buy or afford LPG which is priced several times higher than their gas bill rates.

Most of the gas subsidy goes to this class and will continue to be so. Expansion is taking place in this group and new gas demand will also come from this sector – although there is a case for gradual enhancement of its low gas tariff, especially in the expensive LNG regime whose share is increasing by the day. This group may use biomass efficient and clean stove where living conditions permit. It can be a viable substitute for piped gas for this class as we shall discuss later. They (those earning Rs50,000 and above and living in small single or double-storey houses and portions) may also install one or two solar panels as well if there are credit schemes.

There are around 33 million households in Pakistan. It may be noted that only 25 percent of the population (around 10 million connections) gets piped gas due to limitations on network expansion. In contrast, there are 30 million domestic gas connections while 90 percent of the population has electricity connections. The rural population almost entirely depends on unorganised biomass in the form of tree trunks, shrubs etc. A small portion uses LPG, charcoal and kerosene. Rural areas do have a higher income class which can install solar facilities and have done so already. They will almost never get system piped gas both due to physical and investment reasons. Biogas and biomass efficient stoves are their solution.

The current choolaah practices are unhygienic, and cause indoor and outdoor pollution. This system breeds chest diseases. And use of uplahs is dirty and their continued handling manually by the rural women in this time and age should be shameful for society at large. Biomass collection on the other hand is time-consuming. Tree cutting causes deforestation as well as having an impact on the environment and on climate change. In India, there is a system of LPG subsidy which is almost 50 percent of the normal price.

Lately, biomass efficient stoves have been developed and deployed in many parts of the world with varying levels of success. These stoves do not produce smoke and are run on biomass pellets. They can also be used for improvised heating due to its non-smoking characteristics. Some market for this has already developed in Pakistan. However, these stoves are expensive – between Rs4000 and Rs7000. Pellets are being sold at a price of Rs36 per kg; one kg per day may be sufficient for an average family. An organised and government-supported programme may be able to bring down prices and improve affordability. A network of 100-200 biomass pellet producing programme may go a long way towards energy supplies for the 70 percent population of this country. A biomass plant costs around Rs2 million. It can generate substantial economic activity and employment in the rural economy, saving time and improving health conditions. Gas companies and traders can be used as delivery vehicles for a large biomass programme. Some portions of the urban poor living in semi areas can also benefit from this. This can go a long way towards solving the energy problems of the poor.

Biogas has tremendous potential. It has been estimated that there is a potential of production of some 600 mmcf of biogas. Pakistan is one of the largest milk producers and consumers in the world. There is a large milk and livestock sector contributing some 20 percent to the agricultural GDP. There are two types of biogas – raw and processed. Raw biogas contains some 50-60 percent methane and is good enough for domestic heating. It can be produced in smaller home plants and medium-sized community plants. Community plants can install small, distributed pipe systems as well. Biogas can also be processed and cleaned to pipeline quality standards. In Germany and elsewhere it is being done already. There was a time when the EU had a target of supplying 20 percent of its gas requirement from biogas. Emergence of solar has diluted this target. In high-priced LNG times biogas can add to energy security and help save foreign exchange. For price reasons, the CNG sector can be ideal for getting involved in this. They will become independent of piped gas and earn both from producing and selling the biogas. A government policy and programme may hasten the development of this market sector. Government-owned companies have launched an initiative in this respect. However, the momentum is lacking.

There is a considerable potential for saving gas consumption in the water heating sector. Current gas geysers are gas guzzlers. Solar Water Heaters (SWH) can easily replace geysers. China and Turkey have installed millions of solar water heaters. Some markets have developed for SWHs which can be greatly expanded through a government policy and credit scheme. Local production can increase economic activity and save foreign exchange. The power sector should gradually reduce gas consumption and rely more on alternatives like Thar coal and alternative energy. Two nuclear power plants, although expensive, have been installed. The already imported coal power plants should be converted wholly or partly on local Thar coal. There is almost a monopoly on Thar coal which should be diversified by induction of other private sectors which would help expand Thar coal to industrial sectors such as cement. The latter imports a large amount of coal exceeding $500 million per year. Coal gasification is another option worth pursuing under the CPEC programme.

The LPG market can be expanded through organised and unorganised imports from Iran and Central Asia. Border markets can be very helpful ,some of which have been discussed lately in the context of helping Balochistan. The aforementioned steps can go a long way in reducing the intensity of the problem.

2.5: Role of LPG in gas crisis

Winters are approaching, in fact are there already. There is usually higher gas demand in winters due to heating and later heating requirements. Local gas supplies have been decreasing 10% per year. In the last few years, LNG filled quite some gap and used to be quite affordable. As is common knowledge, there is energy and especially gas crisis all over the world. Suppliers are not responding to our tenders due to the tight supply situation. Europe is a large well-paying market. LNG is not available at right prices. As against typical 10-12 USD/mmbtu, LNG prices have been thrice of the aforementioned price. Only very recently, LNG prices have started coming down due to filling up of gas storages of Europe. Fortunately, there are long-term LNG contracts under which we have been and will continue to get enough to use one of the RLNG terminals.

LPG market has been growing fast at a rate of 17% per annum mainly due to gas shortages. The share of LPG consumption as a percentage of natural gas consumption is only 3.88%.However,if LPG supplies of 1.3 MTPA is diverted, LPG share as a percentage of domestic sector gas consumption will be about 17%, which is not insignificant, in terms of ability to have an impact with increased supplies. Out of about 1.3 million tons annual consumption, the market share of domestic sector is 41%; commercial's 43% and industry 16%. LPG appears to have some potential to fill the gap, although not much. GoP intends to increase supplies by having G-to-G contracts. With increased supplies, the gas deficit problem of network gas may be alleviated to some degree. Almost half of LPG supplies or more are supplied through imports and the residual by local production. There has been a pricing problem among imported LPG vs. local one. Local LPG is priced on the basis of Saudi Contract Prices (SCP) which index is used in LPG sector as Brent is used for crude oil. Imported LPG has always been more expensive — a perplexing problem. An LPG terminal has been wound up earlier due to this and other problems. Imported LNG dealers complain about it. Why is imported LPG expensive? We will take it up a bit later and what can possibly be done in this respect.

Why is imported LPG expensive? It is under private sector, albeit somewhat regulated. They say if oil sector is liberalized and privatised, petroleum prices would come down. There are several reasons, some logical and some not logical but even may be scandalous. Would LNG be cheaper if allowed in private sector? LNG or LPG may be cheaper, in some cases and situations when imported by private sector. However, the profit is pocketed by the private sector and not shared with the consumer. LPG, LNG and Oil are commodities. Prices among others also depend on the volume and credibility. Indices like Brent or JKM or TTF indicate average prices. There are discounts for good and large customers and premiums to small and less reliable customers. And there is no way to find this out. Here lies the declared and undeclared profit. Due to this reason, commodities are imported in many countries under G-to-G long-term contracts, which may be indexed. Demand from private and public sectors is aggregated for interim and variable requirements under spot tenders by organisations like TCP (Trading Corporation of Pakistan). There appears to be a need of doing the both. Reportedly, GoP has recently managed to have LT contract with Qatar for supplies of one million tons per year or more. G-to-G contracts need not be handled by the public sector government-owned companies. GoP can allocate and nominate private sector buyers and resellers to the Qatar LPG supplier company. Bulk LPG contracts under G-t0-G arrangement would hopefully fetch lower prices and thus the perennial issue of disparity between imported and local LPG prices would be resolved.

There is a third option as well. There is a considerable LPG import in the form of smuggling from Iran. The illegality adds to transport costs and the share of the facilitators. Some arrangement can be explored to bring order into it. How about a border trade agreement which has been on the table for a long time? Turkey is able to import pipeline gas and even perhaps LPG from Iran under sanctions? Our diplomats may be able to do something in this respect. LPG storage infrastructure may be able to stabilize prices, especially in winters. There are informal LPG storages. Under a policy regime, more overt storages may come into the market.

Local LPG had been earlier under quota regime wherein the powerful used to get quotas allocated mostly as a political bribe. Even some very respectable and honorable lawyers benefited from this bounty under the Zia regime. How is the allocation now in the absence of quota? It is a difficult issue when the price is fixed. Consumer prices may increase if producers ask for a premium. Demand may contract.

LPG prices

International average typical prices for LNG October have undulated around USD 0.71 per Liter. The average can be deceptive. Actual retail prices vary from 0.324 USD per litre in Russia, 0.541 USD in Turkey and USD 1.022 in Spain. The difference is due to taxation. Pakistan LPG retail prices for the same period are Rs 201 per kg (0.768 USD/L). LPG prices in the region (India) are also around the same. Usually, petroleum prices in India have been higher than in Pakistan due to higher taxation and some possible camouflaging and diversion. Ogra (Oil and Gas Regulatory Authority) has increased prices of LPG by Rs 2.94/kg for November. LPG prices may rise in future as well. There is a case for reducing or even totally doing away with taxation on LPG, at least, for winters and the crisis period. Presently, about Rs 34 per kg is charged as GST and Petroleum Levy. By doing this, 17% reduction in LPG retail would be there bringing down LPG prices from Rs 202/kg to Rs 168/kg. Perhaps, there is no commitment with the IMF (International Monetary Fund) on it, although any tax cutting is not liked by it.

There is a price disparity problem. LPG cylinder price of Rs 202 per kg translates into Rs 4,333 per MMBtu. While the lowest slab of pipeline gas (PNG) is Rs 122 per MMBtu. The highest domestic slab is Rs 1,400 per MMBtu, power sector Rs 857, industry Rs 1,057. LNG import price is Rs 2,800-3,000 and domestically produced gas price is around Rs 1,200. Please look at this widely varying spectrum. Consumer gas tariff has not been revised for the last two years.

Saudi Contract Prices (SCP) in October came down to 590 USD/tonne (0.3 USD/Liter). In April 2022 and September, SCP hovered between 800-940 USD/t. In January to September 2021, LPG SCP hovered around 550-650 USD/t and Dec-Feb 2020, SCP LPG was at as low as 350 USD/t level. Producer price in Pakistan as set by Ogra for October was Rs 132,303 per tonne (601.377 USD/t or 0.305 USD/L). There may be some price variation issues due to propane and butane ratio in LPG. We have taken propane prices only. However, the difference may be very small. Pipeline gas (methane) is limited to the network areas, which cannot cover possibly all the populations. Gas coverage in Pakistan is around 20-25%.While there is disenchantment in Pakistan due to the heavy share of low paying domestic sector creating circular debt issues even in the gas sector, in India there are big plans to increase gas coverage to 70% of the populace.

Gas tariff and subsidies.

Gas and electricity prices are politically sensitive issues. The IMF compares prices in USD terms in which an energy price hike may not appear to be too high. However, in rupee terms in which Pakistanis earn their income, the energy price increases have been too steep. Elections are approaching as well. While electricity prices have been increased, it would be very difficult to increase gas prices specially for the poor and middle classes. There appears to be further scope for increasing the tariff of large gas consumers of the rich classes. New connections are being given at LNG prices, which are almost double the highest domestic slab. Either the supplies to posh areas may be reduced to incentivize them to shift to LPG or gas tariff may be increased to be comparable with LPG.

To be fair, supplies of LPG to posh areas should be ample. This sector wastes a lot of gas in heating space and water in inefficient appliances. They may be encouraged to switch to LPG. Technical assistance for conversion could be provided by gas companies. They have other options to use electrical appliances as well. Up to now LPG has not been subsidized, except in a small way for LPG-Air mix plants. Enough subsidy has been going to the pipeline gas sector. However, in our region in India, LPG cylinders have been subsidized. There is a case for LPG subsidies for the poor, especially, in the northern Pakistan where trees are cut for fuel needs in winters in particular. This causes landsliding and soil erosion. However, subsidised LPG can only be handled by public sector companies. Utility Stores Corporation can also play a role in LPG retail.

Alternative solutions

Finally, ample LPG supplies may have to be arranged by the government on the lines discussed above. Interestingly, the rural population, particularly the rural poor, will not be affected by the gas crisis. There is a blessing in deprivation.

Rural poor use biomass. Urban populace could diversify its dependence as well. Biogas and solar geysers could be promote and incentivised. Keeping aside the longer term biogas development programmes and issues, for rural-urban mixed areas, biogas can still be facilitated. Cheap Plastic made biogas generators can be made available which can supply biogas readily by filling organic vegetable and animal waste. Such generators could not cost more than Rs 10,000-15,000 per unit. Also, biomass cookers can be promoted.

Role of LPG in gas crisis

There are many other solutions. Expensive charcoal is used in commercial and rural domestic sector. Much cheaper Thar coal briquettes can be used in these areas. In central Europe, coal has been used consistently and with the continuing crisis, Lignite may be used even more. Coal-Biomass briquettes are another possible product. All these options are indigenous and don't cause foreign exchange loss. One-size-fits-all solutions may not work or be enough to meet the challenge.

Other issues and proposals

LPG is heavier than natural gas and settles near ground while natural gas goes up. As a result, LPG is slightly hazardous. There are many LPG incidents and accidents every year due to this phenomenon. The use of unlicenced small industry LPG cylinders which use inadequate materials of poor quality is another reason for LPG cylinder explosions. Ogra (Oil and Gas Regulatory Authority) and provincial governments should cooperate to control this. One is not sure if LPG marketing companies exercise due diligence in eliminating unlicensed bad quality LPG cylinders.

LPG is produced by oil refineries and is also extracted from oil and gas fields. LPG is thus locally produced from Karachi to KPK at various locations. It has to be cleaned in gas processing plants and is later transported to LPG marketing companies' cylinder-filling plants. LPG's central market is in Lahore. There is a case for exploring a project for installing an LPG pipeline from Karachi up to a northern point. ISGS has prepared a proposal in this respect. It is regrettable that JJVL, a large local LPG separation and processing plant, has been shut since July 2020 due to legal complications of royalties and ownership between JJVL and SSGC. It is hoped that the issue is resolved and a production of LPG of 10,000 tons per month is started, saving precious foreign exchange.

Table 2.5.1: LPG Retail Prices (Oct 2022)

Countries	USD/L
Russia	0.324
Taiwan	0.453
Pakistan	0.45
Turkey	0.541
Philipines	0.629
France	0.742
India	0.448
Canada	0.941
Spain	1.022
Germany	1.15
Global Average	0.71
Saudi Contract Price	0.3
Source:Global Petroleum Prices	

Under the new accountability laws, negotiating agreements with private parties should have become less riskier. The case for forming a 'Gas Tribunal' has been under consideration for a long time now. In addition to JJVL case, there are thousands of gas sector legal cases, which are at various stages of litigation. An early implementation of the tribunal proposal may be very helpful in resolving these cases in lesser time and money.

There is market fragmentation which has introduced economic inefficiency in the LPG sector. There are more than 200 LPG marketing companies. Consolidation of this market has been discussed for quite some time. How to go about it? It may not be easy. Taxation, pricing and licensing conditions may be used to incentivize mergers and acquisition among the marketing companies. There are pessimistic trends in the production of local gas and imported LNG, while demand is increasing, adding to the demand-supply gas. LPG can play some role, at least, in catering to the needs of cooking food in homes.

There are many loose ends in the LPG sector. Many new developments are and will be taking place. LPG has price linkages with other competing fuels. In domestic and commercial sectors, it competes with natural gas. In transport sector, it competes with petrol, CNG and even diesel. Pricing and taxation policies have to take these linkages into account.

The stakeholders are demanding an integrated New LPG policy. GoP normally involves stakeholders in making such policies. It is hoped that with good policies and adequate implementation framework, progress can be made in this important energy sector.

Table 2.5.2: Comparative Tariff:NG vs LPG

Natural Gas -NG	Rs/MMBtu	
Domestic	122-1400	excludes GST
CNG	1371	excludes GST
Power Wapda/IPP	857	excludes GST
Industry	1054	excludes GST
Export sector	819	excludes GST
Wellhead Gas price	1320	excludes GST
LNG average local	3080	Includes GST
LNG Spot	6600	excludes GST
LPG	4331	Includes GST
Source;OGRA etal		

Figure 2.5.1: Sectoral Consumption of LPG during FY20

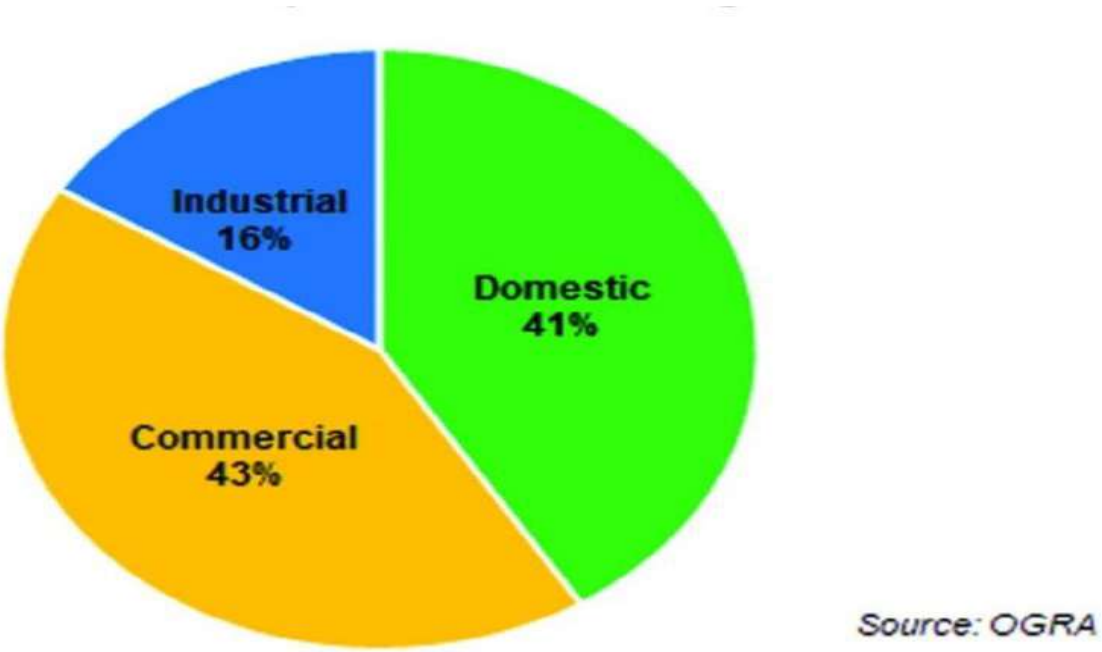


Table2.5.3: LPG Producer and Consumer Prices

	Description	Rs. / MT	Rs./11.8 Kg Cylinder
A	**LPG PRODUCER PRICE**		
(i)	Producers' Price (including excise Duty of Rs.85/M.Ton) (Excluding Petroleum levy) Propane 40% and Butane 60%	132,303.43	1561.18
(ii)	Petroleum levy	4,669.00	55.09
(iii)	(i+ii)	136,972.43	1,616.27
(iv)	17% GST of (iii)	23,285.31	274.77
(v)	**Maximum Producer Price with GST (iii+iv)**	**160,257.74**	**1,891.04**
B	**LPG CONSUMER PRICE**		
(i)	Producer Price with GST	**160,257.74**	**1,891.04**
(ii)	**Breakup of Marketing, Distribution and Transportation Margin:** Marketing Margin: Rs.17,000 /M.Ton Distribution Margin Rs.10,000/M.Ton & Transportation Rs. 8,000 /M.Ton	**35,000**	**413.00**
(iii)	17% GST of (ii)	5,950	70.21
(iv)	**Maximum LPG Consumer price (i+ii+iii)**	**201,207.74**	**2,374.25**

2.6: Gas tariff and circular debt

Finally, much-awaited new gas tariff has been announced by government under negotiations with the International Monetary Fund (IMF). The increase is up to 12-112% in various gas tariff slabs. Earlier, Oil and Gas Regulatory Authority (Ogra) had recommended an increase of 74% in the average selling price of gas by SNGPL, increasing average price from Rs.545.89 per MMBtu to Rs 952.17 per MMBtu; similarly SSGC's average price had been recommended to increase by Rs.469.28/MMBtu increasing from last year price of Rs.692.63/MMBtu to Rs 1161.91/MMBtu.

The Economic Coordination Committee (ECC) of the Cabinet organises the average price into sector-wise and slab-wise tariffs. If this is done to match total revenue from Slabs to the total gas cost, there is no accumulation of arrears called circular debt. If matching of cost and revenue is not done, it continues to add up. There are other complications such as LNG diversion to domestic sector which remain unpaid and remain as part of the circular debt. It may be noted that this gas pricing is based on locally produced gas. LNG accounts are separate. Ogra monthly determines LNG price which is a weighted average of LNG term contract and spot prices. Large consumers such as power sector, industries and fertilizer sector buy its additional requirements from LNG imports.

There are foreign exchange price volatility issues, which often require throwing the cash flow forwards. And finally, the tariff accounts begin from 1st January 2023, while we are in middle of February, which creates the arrear issue. This, among others, should pave the way for finalization of the agreement with the IMF. Gas circular debt (GCD) has increased to an unusually high level of Rs.1.64 trillion. The new gas tariff would stop the further build-up of gas sector circular debt. However, the already built up amount would remain on the books. Earlier, circular debt used to be in power sector only. Power sector Circular debt (PSCD) has reached a level of Rs 2.467 trillion. Thus together, it is a big total of Rs 4.1 trillion. There has been some control of PSCD lately. New addition to PSCD had been largely controlled.

There is monthly fuel adjustment charge that is collected from the electricity consumers. Recently, the government has been preparing a plan to deal with the circular debt under negotiations with the IMF.

We will investigate in the following the change in gas prices and its impact on circular debt. We will also discuss Bangladesh's tariff, which has similar gas profile and circumstances and has undergone similar exercise with the IMF. The issue of gas and electricity tariff adjustments in Pakistan is much more difficult than that of Bangladesh, as Pakistan suffered from an extra ordinarily high CAD (Current Account Deficit) which caused major currency depreciation and high inflation. Gas prices have not increased in Pakistan for the last four years or more. There have been cosmetic changes. Special subsidized gas tariffs had been issued for export sectors such as textiles. Inadequately low gas tariff, cross subsidies and increase in LNG prices have contributed to the accumulation of circular debt. Bangladesh, the star performer until recently, with highest growth rate and per capita income, had to go to the IMF as well. And as usual and typical, one of the conditionalities is upward adjustment of energy prices, most importantly of gas. Bangladesh had to increase gas and electricity tariffs as per the IMF dictates.

There are several plausible reasons to compare Pakistan's gas tariff with Bangladesh's. First, the tariff structure is almost similar to be comparable. Second, Bangladesh is a competitor of Pakistan in textile sector. And, thirdly, Bangladesh has a comparable gas profile with Pakistan's. It produces gas and imports LNG from Qatar. It has two LNG terminals as Pakistan has. Bangladesh's gas demand is 3500 bcft/yr as against gas supply of 2670 Bcft/yr. Bangladesh has increased gas prices from 14 to 178%. In Pak rupee, average prescribed price is around Pk.Rs 1700/MMBtu (1 USD=230 Pk. Rs?). A very remarkable change in Bangladesh's new gas tariff is that there is a near uniform tariff for all sectors of Rs 1850.32/MMBtu except power sector which has a lower tariff of Rs 863.48/MMBtu. Tariffs of Residential, Fertilizer and Tea garden sectors have not been increased.

Pakistan's exchange rate has been quite volatile lately. It has increased from Rs.230 per USD to Rs.275. Hopefully, the IMF agreement may help stabilize the exchange rate to a lower level, which many experts have estimated to be around Rs.250. For a variety of reasons, we have made comparison with Bangladesh at Rs.230 per USD which may not make much difference if the expected exchange rate in Pakistan stabilizes at Rs 250. There are two possible measures that can be adopted to bring down GCD to a manageable level: 1. Suitable increase in gas tariff; 2. Reducing and parking of cross-subsidies to the end-use sector. For example, gas tariff for fertilizer sector is inordinately low. It is meant to keep fertilizer's prices low and resultantly keep food prices low. Although, gas is sold to the fertilizer plants at varying prices, the selling price of fertilizer is the same for all plants. Admittedly, there is a level of undue profiteering in fertilizer sector. Some reform is required in this. Also, the gas prices to fertilizer sector have to be adjusted upwards and the increase is to be charged to agricultural sector wherein the subsidies are more acceptable.

Fertilizer gas tariff of Bangladesh has almost been thrice of Pakistan's — Bangladesh Pk.Rs 992/MMBtu vs Pk.Rs 320/MMBtu. In the new gas tariff, fertilizer gas price has been increased from Pk.Rs 302 to Pk. Rs 510. Engro tariff has been kept untouched due to historical contractual reasons. Pakistan's fertilizer tariff is now 50% of the corresponding tariff in Bangladesh. Fertilizer gas pricing is a complicated issue related with agricultural prices. Fertilizer is being sold at identical prices despite significant differences in their gas prices.

We have raised this question earlier in this space. Such a heavy cross-subsidy may be transferred to subsidy in agriculture sector to increase the viability of gas sector. In future, this issue will become even more serious with the fall in local gas production. Major difference in gas tariffs in the two countries (Pakistan-Bangladesh) has been in power sector. In the old gas tariff, power sector gas rates in Bangladesh were a mere Pk. Rs. 337/MMBtu as opposed to Pk.Rs.1050 in Pakistan. Under new gas tariffs in the two countries, the tariffs are almost comparable; Pakistan's tariff (Rs.1050) vs Bangladesh's of Rs 939, only 12% higher than that of Bangladesh. Although power tariff is not the subject of this piece, it is quite probable that power tariffs in the two countries may have become closer as well. This is expected to positively impact the energy tariff difference in the two countries. In the case of captive power, Bangladesh has almost doubled it over the old tariff, trying to discourage inefficient captive power.

Industrial gas tariff in Bangladesh is now the same as that of industry (Pk. Rs 2011), eliminating the anomaly. Pakistan's captive power tariff is Rs 1200, only 60% of the corresponding gas tariff in Bangladesh. It appears that there is a scope of further adjustments in this respect in Pakistan. The new industrial gas tariff in Pakistan has been enhanced from Rs 1054 to Pk.Rs 1200 — a minor increase of 14%. The corresponding tariff in Bangladesh has been increased by 88% to Pk. Rs 2011. Thus Pakistan's new industrial gas tariff is only 60% of Bangladesh's. Bangladesh had three industrial gas tariffs earlier: large, medium and small. These have been merged into one slab. Apparently, there is no separate slab for export sector in Bangladesh. In Pakistan, there is one for which the tariff has been increased by 34% — from Pk.Rs 819 to Pk.Rs 1100.

The major issue is the gas tariff in the residential sector. For good reasons, the poor class of consumers is charged extremely low gas price. Lowest gas tariff slab in this category is Rs.121 per MMBtu as against the average gas price of Rs 1200. This slab has a share of 40-50% in the total residential gas sectors consumption. There are other low tariff slabs as well of Rs 300 and Rs.553 per MMBtu. Put together, the share of highly subsidized gas for residential sector is more than 90%. How much the highest slab consumers can be squeezed is a question. It cannot possibly absorb the cross-subsidies of the 90% residential consumers. However, upward adjustments would be necessary in the tariff slab of well-to-do people. Where to draw the line would be a complicated issue.

Gas tariff for residential sector in Pakistan is quite complicated and variegated. There are 8 slabs in residential sector and now two categories-protected and unprotected have been added to the new tariff, making the total number of slabs to 12. For lifeline consumers (protected), gas tariff has not been increased and is kept at Rs 121. In the unprotected category, the same slab has been enhanced to Rs 200, an increase of 65%. In the medium (lower middle class) tariff, the increase is modest-8.5-33.3%. In the middle-class consumer category, there are two slabs: Rs 800 and Rs 1100. Increase in these slabs has been of 44.7-49.1%. There are two tariff slabs in the large consumer category. The highest gas tariff for large residential consumers has been increased from Rs.1460 to Rs.3100; an increase of 112%. It may be compared with the alternative of LPG price which is Rs 4400.00 per MMBtu. And in the other slab, there is an 80% increase, from Rs.1107 to Rs 2000. Thus there is a ratio of 26 times between highest and the lowest tariffs. It is amazing that in Bangladesh, there are fixed charges for small residential consumers; single burner Tk 990 (Pk. Rs 2168) and double burner Tk. 1080 (Pk.Rs 2365) per month.

How the IMF will deal with this strange rate is not known. Also what happens to gas wastage when there is a fixed charge is also a big question. A lifeline consumer pays an average of Rs 500 per month. There are 4.3 million residential consumers out of which 0.4 million have prepaid meters. The Bangladesh government has reportedly provided a subsidy of Rs 131.4 billion (1.25 billion USD). In Bangladesh, the poor class consumers have a fixed monthly rate of Pk.Rs.2019 which if compared with the lifeline consumers in Pakistan who pay Rs 500 per month or even less. In that way, Bangladesh's poor pay 3-4 times more than their counterparts in Pakistan.

Metered residential consumers pay Pk. Rs 1117 per MMBtu. In India, residential consumers pay Pk.Rs 4223 per MMBtu. There are no tariff slabs in residential sector in India. LPG is consumed by the poor in Pakistan which has a rate of Rs 4403/MMBtu. These numbers provide an upper limit for highest slab of residential sector.

In India, LPG prices are the same as those of piped natural gas (PNG). There are no tariff slabs for poor consumers. India had a subsidized LPG programme of 1 free cylinder per month which has been changed to a charge of 50%. This was for all-rich and poor. The Indian government is now encouraging the well-to-do not to avail the subsidized LPG facility. Also, efforts are being made for direct subsidy transfer in this respect. There is a subsidy amounting to IRs.5812 Crore (726 Million USD) to the residential LPG sector.

Table 2.6.1: Sector-wise Gas Price Hike Bangladesh-Pk.Rs./MMBtu

	Bangladesh			Pakistan			Pakistan/Bangladesh	
Sectors	**Old**	**New**	**Increase %**	**Old**	**New**	**increase-%**	**old**	**New**
Power	337	939	17	857	1050	23	2.55	1.12
captive power	1073	2011	88	1087	1200	10	1.01	0.60
Large Industry	803	2011	150	1054	1200	14	1.31	0.60
Medium Industry	790	2011	155				0.00	0.00
Small Industry	723	2011	178				0.00	0.00
Cement				1277	1500	17		
Fertilizer	993	993	0	302	510	69	0.30	0.51
Exports				819	1100	34		
Commercial	1786	2011	14	1283	1650	29	0.72	0.82
Residential-single/double burners/month		2190	0	121-553	200-600	65-8		
Residential-medium				553-1107	800-2000	94-80		
RESIDENTIAL Prepaid/large	1117	1117		1460	3100	112	1.31	2.78
CNG	2668	2668	0	1371	1805	32	0.51	0.68
1 USD to Takka	105.64							
1 USD to Pk.Rs	250							
1 Takka to Pk Rs	2.367							
1 M3 to MMBtu	0.0353							
Source:TBS Bangladesh, OGRA								

In Bangladesh, gas sector subsidies amount to 1.2 billion USD. Thus subsidies are common in South Asia to the residential gas sector due to wide- spread poverty. It is hoped that the IMF would understand this. CNG tariff in Pakistan has been increased in the new tariff from 1371 to Pk.Rs 1805, an increase of 32%. CNG tariff in Bangladesh is Pk.Rs 2668. No change has been made in the new CNG tariff. At revised rates, CNG tariff in

Pakistan is not different what is in Bangladesh. It means that this tariff disparity was there in earlier tariff in the two countries. Thus, rooms for upwards adjustment may be there in this respect. Upper limit is set by comparative gasoline price. Usually, a 20-25% margin is maintained.

Had Pakistan gas tariff been increased and adjusted yearly in the last four years, circular debt in gas sector would not have accumulated. A reasonable increase in gas tariff, however, was due under or without IMF pressure. It will further hike inflation and increase difficulties which, however, may be lesser than the consequences that may have to be faced otherwise. Populism in economic policy has to have some limits in order to be sustainable. Consideration should be given to bring wage levels to a reasonable level as opposed to playing with commodity prices.

Table 2.6.2: Residential gas Tariff Pakistan

	Existing	New	increase-%
Protected			
upto 0.25 hm3	121	121	0
upto 0.5 hm3	121	150	24.0
upto 0.6 hm3	300	200	-33.3
upto 0.9 hm3	300	250	-16.7
Unprotected			
upto 0.25 hm3	121	200	65.3
upto 0.6 hm3	300	300	0.0
upto 1 hm3	300	400	33.3
upto 1.5 hm3	553	600	8.5
upto 2 hm3	553	800	44.7
upto 3 hm3	738	1100	49.1
upto 4 hm3	1107	2000	80.7
above 4 hm3	1460	3100	112.3
Source: OGRA			

Table 2.6.3: Computation of Weighted average RLNG price for SNGPL Jan-2023

COMPUTATION OF WEIGHTED AVERAGE RLNG PRICE FOR SNGPL JANUARY 2023 **Annex: A**

Particulars	Unit	(SNGPL JANUARY 2023)				
		Transmission			Distribution	
		PSO	PLL		PSO	PLL
No. of Cargos		9	1		9	1
Quantity Received	MMBTU	28,350,000	1,702,700		28,350,000	1,702,700
Retainage PSO @ 0.816 % and PLL @ 0.49%	MMBTU	231,336	8,343		231,336	8,343
Quantity Delivered at Terminal	MMBTU	28,118,664	1,694,357		28,118,664	1,694,357
Transmission Loss SNGPL @ 0.38%	MMBTU	106,851	6,439			
Distribution Loss: SNGPL @ 7.86%	MMBTU				2,210,127	133,176
Total Loss Including Retainage	MMBTU	338,187	14,782		2,441,463	141,520
%age Losses		1.19%	0.87%		8.61%	8.31%
Quantity availbale for Sale	MMBTU	28,011,813	1,687,918		25,908,537	1,561,180
LNG Price (DES)	US $/MMBTU	10.9679	10.7568		10.9679	10.7568
PSO/ PLL other imports related costs	US $/MMBTU	0.8210	0.7441		0.8210	0.7441
PSO / PLL margin (@ 2.50%)	US $/MMBTU	0.2742	0.2689		0.2742	0.2689
Terminal Charges	US $/MMBTU	0.4740	0.5859		0.4740	0.5859
RLNG Cost	US $/MMBTU	12.5371	12.3557		12.5371	12.3557
Retainge volume adjustment	US $/MMBTU	0.1031	0.0608		0.1031	0.0608
T & D volume adjustment	US $/MMBTU	0.0483	0.0474		1.0783	1.0592
LSA management fee	US $/MMBTU	0.0250	0.0250		0.0250	0.0250
Cost of supply -SNGPL	US $/MMBTU	0.4470	0.4470		0.4470	0.4470
Cost of supply -SSGCL	US $/MMBTU	0.1421	0.1421		0.1421	0.1421
Total RLNG price without GST	US $/MMBTU	13.3026	13.0780		14.3326	14.0898
Quantity available for Sale	MMBTU	28,011,813	1,687,918		25,908,537	1,561,180
Total cost of RLNG	US $	372,629,250	22,074,631		371,336,055	21,996,752
sum of Total RLNG cost (PSO & PLL)	US $	394,703,881			393,332,807	
sum of quantity available for sale (PSO& PLL)	MMBTU	29,699,731			27,469,717	
Weighted Average Sale Price without GST	**US $/MMBTU**	13.2898			14.3188	

Notes:

i.

Calculation of LNG DES Price	PSO		PLL
No. of Cargoes	6	3	1
Quantity (No. MMBTU)	18,900,000	9,450,000	3,200,000
Bricem Oct-22	93.4976	93.4976	93.4976
Bricem-Nov-22	90.9218	90.9218	90.9218
Bricem-Dec22	81.3986	81.3986	81.3986
Brent_m	88.6060	88.6060	88.6060
Slope	13.37%	10.20%	12.14%
CP = Slope x Brent_m	11.8466	9.0378	10.7568
Average DES USD / MMBTU	10.9103		10.7568
Port Charges (in the excess of limit borne by LNG supplier)	0.05760		0.0000
DES Price USD / MMBTU	10.9679		10.7568

i. Average cost of supply has been taken on provisional basis as per RERR-FY 2022-23

ii. The figure of Retainage has been taken provisionally subject to adjustment upon actual figure.

iii. UFG has been incorporated on provisional basis @ 0.38% in respect of transmission and @ 7.86% in respect of Transmission & Distribution as per SNGPL claim in respect of Review of Estimated Revenue Requiremnt FY 2021-22. subject to adjustment upon actual figure.

iv. The above prices have been computed on the basis of data provided by M/s PSO & M/s PLL. The parties (SNGPL, SSGCL, PSO & PLL) shall scrutinize the same on the basis of evidences before making payments as per their mutual agreements.

Table 2.6.4: Computation of Weighted average RLNG price for SNGPL Jan-2023

COMPUTATION OF WEIGHTED AVERAGE RLNG PRICE FOR SSGC: JANUARY 2023 **Annex: B**

Particulars	Unit	(SSGC JANUARY 2023)			
		Transmission		Distribution	
		PSO	PLL	PSO	PLL
No. of Cargos		9	1	9	1
Quantity Received	MMBTU	28,350,000	1,702,700	28,350,000	1,702,700
Retainage PSO @ 0.816 % and PLL @ 0.49%	MMBTU	231,336	8,343	231,336	8,343
Quantity Delivered at Terminal	MMBTU	28,118,664	1,694,357	28,118,664	1,694,357
Transmission Loss SSGCL @ 0.12%	MMBTU	33,742	2,033		
Distribution Loss: SSGCL @ 12.32%	MMBTU		-	3,464,219	208,745
Total Loss including Retainage	MMBTU	265,078	10,376	3,695,555	217,088
%age Losses	MMBTU	0.94%	0.61%	13.04%	12.75%
Quantity availbale for Sale	MMBTU	28,084,922	1,692,324	24,654,445	1,485,612
LNG Price (DES)	US $ /MMBTU	10.9679	10.7568	10.9679	10.7568
PSO/ PLL other imports related costs	US $ /MMBTU	0.8210	0.7441	0.8210	0.7441
PSO / PLL margin (@ 2.50%)	US $ /MMBTU	0.2742	0.2689	0.2742	0.2689
Terminal Charges	US $ /MMBTU	0.4740	0.5859	0.4740	0.5859
RLNG Cost	US $ /MMBTU	12.5371	12.3557	12.5371	12.3557
Retainge volume adjustment	US $ /MMBTU	0.1031	0.0608	0.1031	0.0608
T & D volume adjustment	US $ /MMBTU	0.0152	0.0150	1.7761	1.7447
LSA management fee	US $ /MMBTU	0.0250	0.0250	0.0250	0.0250
Cost of supply -SNGPL	US $ /MMBTU				
Cost of supply -SSGCL	US $ /MMBTU	0.0889	0.0889	0.0889	0.0889
Total RLNG price without GST	US $ /MMBTU	12.7693	12.5454	14.5302	14.2751
Quantity available for Sale	MMBTU	28,084,922	1,692,324	24,654,445	1,485,612
Total cost of RLNG	US $	358,624,548	21,230,881	358,233,799	21,207,265
sum of Total RLNG cost (PSO & PLL)	US $	379,855,429		379,441,064	
sum of quantity available for sale (PSO& PLL)	MMBTU	29,777,245		26,140,057	
Weighted Average Sale Price without GST	US $/ MMBTU	12.7566		14.5157	

Notes:

I.

Calculation of LNG DES Price	PSO		PLL					
No. of Cargoes	6	3	1					
Quantity (No. MMBTU)	18,900,000	9,450,000	3,200,000					
Bricem Oct-22	93.4976	93.4976	93.4976					
Bricem-Nov-22	90.9218	90.9218	90.9218					
Bricem-Dec22	81.3986	81.3986	81.3986					
Brent_m	88.6060	88.6060	88.6060					
Slope	13.37%	10.20%	12.14%					
CP = Slope x Brent_m	11.8466	9.0378	10.7568					
Average DES	10.9103		10.7568					
Port Charges (in the excess of limit borne by LNG supplier)	0.05760		0.0000					
DES Price USD/ MMBTU	10.9679		10.7568					

I Average cost of supply has been taken on provisional basis as per RERR-FY 2022-23

II The figure of Retainage has been taken provisionally subject to adjustment upon actual figure

III. UFG has been incorporated on provisional basis @ 0.12% in respect of transmission and @ 12.32% in respect of Transmission & Distribution as per SSGCL claim in respect of Review of Estimated Revenue Requiremnt FY 2021-22. subject to adjustment upon actual figure.

IV. The above prices have been computed on the basis of data provided by M/s PSO & M/s PLL. The parties (SNGPL, SSGCL, PSO & PLL) shall scrutinize the same on the basis of evidences before making payments as per their mutual agreements.

2.7: Gas tariff and reforms

The government is to announce new gas tariff for the current financial year (1st July 2023-30th June 2024). The announcement will be late by almost three months .Circular debt issues are interconnected with gas tariff on which a plan has already been submitted by the government to the IMF, some details of which have already been shared with the media.

Ogra (oil and gas regulatory authority) determines average yearly gas price of the two gas companies. Based on Ogra determination, the economic coordination committee (ECC) of cabinet determines consumer tariff for one year. Ogra has done its job and now it is the job of economic coordination committee (ECC) of cabinet to devise and approve the consumer tariff.

Both government and consumers should be nervous about the possible rise in the new gas tariffs in the context of already heavy increases in petroleum products and electricity prices. On average, gas price has to be increased by 47% as determined by Ogra. It would not be equal increase among all but as usual there would be different rates of increase. Lower socio-economic groups would most probably be saved or loaded lesser and richer classes would have to bear the brunt. People belonging to middle class, despite a lower burden, suffer due to comparatively lower earning incomes. The art of consumer tariff determination, therefore, is all about devising the consumer tariff of the middle classes.

Review of regional gas tariff

Bangladesh increased gas prices at the beginning of 2023 bringing gas prices in most sectors to Tk 30 per M3 which is equivalent to Pk.Rs.2273 per MMBtu. This includes commercial, industry and captive power. Only residential got Pk.Rs 1364/MMBtu, power (Pk.Rs.1061/-) and fertilizer sector (Pk.Rs 1212/- per MMBtu) got comparatively lesser tariff. Largest increase had been in fertilizer sector in the context of similar pressure that we are facing in Pakistan.

LPG price in Bangladesh is the highest in South Asia. Interestingly, pipeline gas price in India, which covers both residential and industrial sector are Pk.Rs 5060 per MMBtu, is very close to LPG prices. However, India used to provide 12 free LPG cylinders per year, which was reduced to 50% price. Later, Direct Benefit Transfer Scheme has been introduced which continues till date. LPG subsidy stands at IRs 200-400 per cylinder on a price of IRs 900 Rs per cylinder.

This scribe is not aware of some special subsidies that are given to export sectors in India. It can be concluded that Bangladesh's gas tariff is much higher than Pakistan's, although it may increase in a few months as there is always a lag of six to nine months between the timings of change in the two countries. Residential tariff is several times higher than in Pakistan except the large residential consumers' category, which is lower in Bangladesh being only 44% of what it is in Pakistan. Bangladesh's industrial and captive power tariffs are twice Pakistan's; while power sector gas tariff in Bangladesh is 24% higher. However, these are rather rough calculations due to several reasons like currency variations, comparability issues, etc.

There are three prices which can be used as a reference for devising consumer tariff, although traditional approach is to apply a percentage increase. It is difficult to impose schemes that are totally out of sync with historical prices. The three price references are; 1. Locally produced gas at USD 6-7 per MMBtu; 2. LNG at USD 10-12 USD per MMBtu; 3. LPG at 15-18 USD per MMBtu.

Possible scope of increase in gas tariff

Ogra has determined a need for increase in average gas price by 47%. A simple and simplistic solution is to increase gas prices in all categories by the same percentage of 47%. After all, if the last year's tariff was right, passing on increase in the gas prices on the base of it should be right as well. However, everything has not been right in the previous year's tariff. There are opportunities to improve it. For example, there is a case of adjustment in low gas prices for tariff, which has been discussed here in this space.

Looking at the gas price data in our region and elsewhere, it appears that upward increase in gas tariff is required, especially, in residential .In the lower level tariff, even distribution cost is not covered. But is it the right time to make major increase in gas tariff? Similarly, there are issues in trying to take a major move towards reducing circular debt. Gas tariff and circular debt are inter-related issues.

In the context of very high inflation, currency devaluation and increases in electricity and petroleum prices without any increase in wages, it should make both the government and the people nervous to expect any increase in gas tariff. The other side of the issue is that nothing is free. Gas prices are increasing. Local cheaper gas resources are going down. No significant progress has been made or appears to be in pipeline in finding new gas resources. Nor are we trying any conservation-like promoting devices such as solar geysers, neither biogas resources are being explored seriously. Resultantly, reliance on expensive imported gas resources like LNG will increase.

Residential tariff

There is scope for increasing gas tariff in higher slabs, especially, slab 5 and slab 6.LPG prices could be a good reference. When poor people, having no gas connection, consume and pay for expensive LPG, why can't the rich pay the same? LPG-based pricing also results in a general increase rate as recommended by OGRA. It may be noted that gas prices in India are almost LPG based.

However, the number of consumers in this category is not much but consumption is disproportionally higher, especially, in winters. Tariff increase in this category will also induce the consumers in this category to adopt conservation measures such as Solar Geysers, insulation, etc. Minimum payment requirement may also be introduced for the residents of posh areas and large plots areas. There is higher investment requirement to cover these areas. It has been noted that some people in this category get a gas bill of Rs.500-700 only.

However, some increase in small and medium category tariff will have to be, willy-nilly, done to cover the costs. In Bangladesh, minimum monthly charge is PkRs 1380-1500 per MMBtu for smaller single and two burner consumers.

Average gas tariff in this category has been estimated at PkRs. 1364 per MMBtu. Bangladesh prices in the lower tariff category are 455-124% higher. There are social and political limitations in applying high increases in gas tariff of this category.

Gas tariff and reforms—I

However, gas bills amounts for lower consumption categories aren't very high as compared to the electricity bill. A small consumer gets an electricity bill of Rs.5000/-as compared to Rs 500-700 for the gas.

Increase in gas tariff in small category may not be as hurting as it may be in case of electricity. The number of slabs could be reduced to three or four. Minimum tariff in residential sector may be increased to Rs 400.0 per MMBtu. Middle tariff could be around Rs 1000.0 per MMBtu. Upper-middle tariff could be Rs 2000.0 per MMBtu and high-end at Rs 4500.

Fertilizer sector tariff

Fertilizer sector tariff in Pakistan is Rs. 512 per MMBtu. In Bangladesh, fertilizer sector gas tariff is PkRs. 1212 per MMBtu, which is 240 % higher than in Pakistan. Strangely, a top fertilizer manufacturer is charged only 0.7 USD (Rs 200 only per MMBtu). It has a very old plant under a contract but till when can it be extended? In India, fertilizer sector is not subsidized through gas sector; they have a separate fertilizer subsidy system.

There is a case for doubling the existing fertilizer gas tariff. We provide the following details of the implications of this issue and approaches thereof. Apart from life-line consumers and other low income groups' consumer tariff issue, there is a major source of anomaly in gas tariff which arises from very low gas tariff traditionally awarded to the fertilizer plants.

Subsidy to fertilizers is a desirable issue, but the question is from where it should be financed? Should it be financed from the agricultural budget or from gas consumers? Cross-subsidy to fertilizer plants has been causing circular debt and on consume gas tariff.

Gas subsidies are not liked by IFIs and other international bodies, while agricultural subsidies have been common in Europe and are understood. Thus transferring the cross subsidies from the gas sector to agriculture would be a desirable step.

There are anomalies in fertilizer retail prices as well. Fertilizer plants get gas at varying tariff but the effective market price of fertilizer bags to farmers is almost the same. Intermediaries siphon off the price anomalies.

Intermediaries are the same hoarding class which manipulates prices of other commodities like Sugar, Flour, and Cooking Oil, etc. In case of sugar, producers are involved in the booty but in the case of fertilizers, it is not known who the partners in the booty are?

Market price of Urea available to farmers is Rs 3800 per bag as against the prescribed prices of Rs 3210 per bag by FFC/Fatima, Rs 3600.0 by EFFERT, Rs 3411 per bag by RLNG-based fertilizer plants and Rs 3600.0 by FFBL. It has been estimated that intermediaries pocket varying amounts of Rs 200-700 per bag .

There are questions about the price setting by the fertilizer plants under a varying gas price. Reportedly, Ministry of Production exercises some kind of control on fertilizer pricing. The process, however, is not transparent as it is in the case of other regulators like Ogra and Nepra.

In the background of these anomalies, it has been reported that GoP is considering removal of gas price variations among various fertilizer plants and wants to bring it equal to the industrial gas tariff. It would be a welcome step.

This need not increase the fertilizer prices if, as mentioned earlier, the gas price subsidy is passed on to the agricultural sector and fertilizer price is regulated by Ogra. There may be other approaches of adjusting and passing on farmers subsidies under other heads and let the fertilizer price increase suitably.

Industrial and commercial tariff

Industrial growth in Pakistan has been stagnating. Exports are also linked with industrial gas tariff. Bangladesh industrial gas tariff is 189% higher than Pakistan. It appears that an increase of 47% (average Ogra determined increase) in industrial gas tariff should be affordable by the industrial sector as well as commercial sector. There is a scope for a comparable increase in commercial tariff as well.

Power sector

It may be desirable to keep tariff for power sector a bit lower than the uniform rate increase formula. Under uniform increase of 47%, gas tariff for power sector would come out to be Rs.1544 from the existing rate of Rs.1050.

A 10-15% discount may be considered if surplus from other areas are available. Captive power tariff should be 20% higher in order to discourage Captives. It is more of a tax evasion tool than a technical requirement in many cases.

Reforms in gas tariff procedure

There is a need to reform the current procedure for tariff award, which results in consuming time and delays in tariff award and Government acceptance and announcement of the same. WACOG may have to be adopted, although its final legal acceptance appears to be doubtful or in some confusion. With adoption of WACOG, it may be appropriate to adopt power sector approach and methodology.

Instead of DISCOs to be the buyers, an intermediary virtual organisation (IVOG) like CPPA-G may have to be created. IVOG will be virtually buying from gas producers and LNG importers and calculate a monthly WACOG.

OGRA can do this calculation instead of IVOG.OGRA will compute gas tariff a la NEPRA for Yearly, Quarterly and Monthly periods and do the adjustments. More simplification can be done on NEPRA procedures. Distribution cost may be announced yearly as a lump-sum rate. UFG can be added as per case and CAPEX allowances permitted separately.

Conclusion

Solar, Wind and Hydrogen appears to be the future. It appears that increased Thar coal utilisation (gasification) may not be possible in the immediate future as is evident from the minutes of JCC (China-Pakistan) meeting recently reported in the press. Solar and Wind would require balancing support from gas-fired power plants, which are under-utilized currently due to pricing and supplies reasons. We would continue to need gas for various sectors for at-least two or more decades.

Table 2.7.1: Comparative Gas-LPG Prices:India,Bangladesh;Pakistan

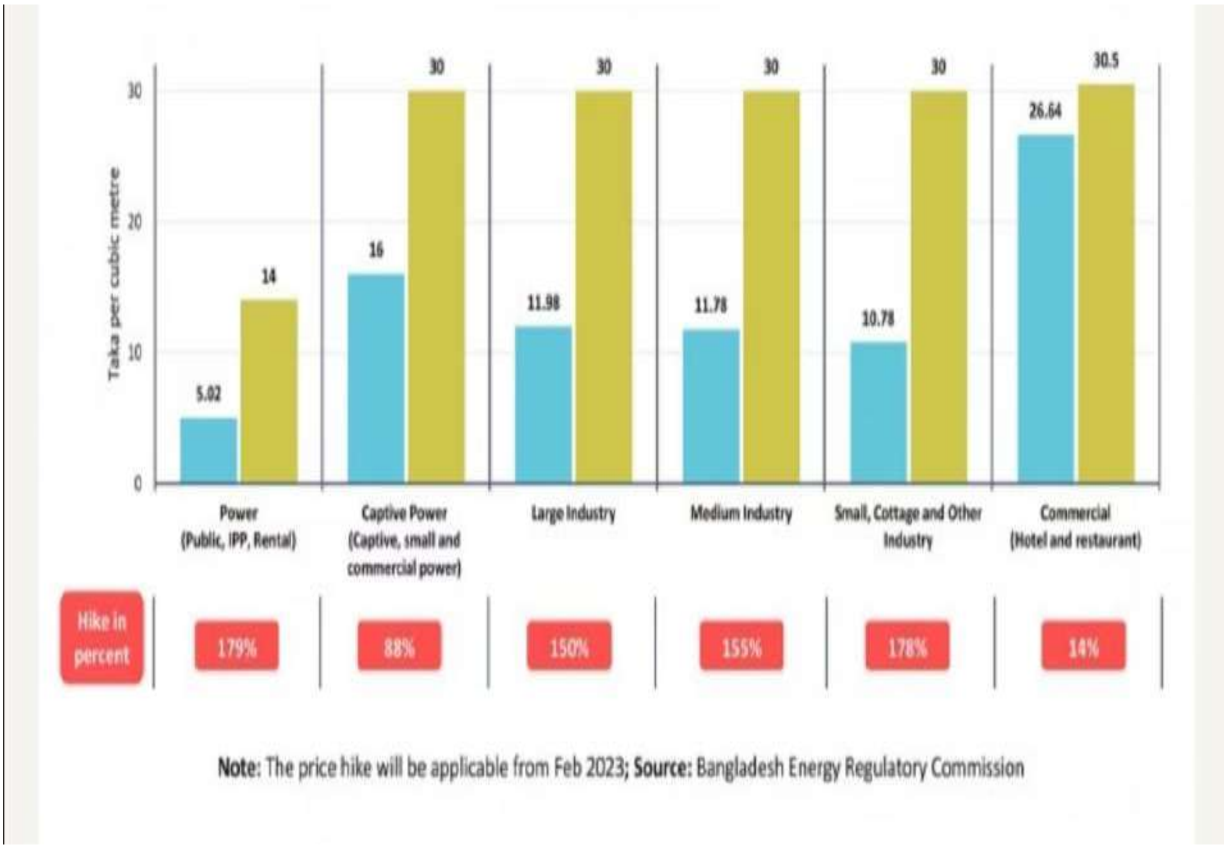
	India	Bangladesh	Pakistan
Gas-Residential	5060	1364	1100-3100
LPG-Residential	5353	6797	5436

Table 2.7.2: Natural Gas Tariff Pakistan 15th Feb 2023 vs Bangladesh-Pk.Rs/MMBtu

	Pakistan	Bangladesh	Bngl/Pakis %
Residential-0.25 hm3	200		
0.6 hm3	300	1364	455
1 hm3	400	1364	341
1.5 hm3	600	1364	227
2 hm3	800	1364	171
3 hm3	1100	1364	124
4 hm3	2000	1364	68
4 hm3+	3100	1364	44
Commercial	1650	2310	140
Gen>industries	1200	2273	189
Captive Power	1200	2273	189
Export Oriented Industrie	1100		
CNG	1805		
Cement	1500		
Fertilizer			
General Off Take	510	1212	238
Dawood Hercules	510		
Pak China	510		
Hazara Phosphate	510		
Engro	210		
Fauji Fertilizer Bin qasim	510		
IPP, WAPDA and Others	1050		1061
Source: Petroleum Division, Business Standard Dacca			

The gas scenario appears to be bleak in the context of little new find of local gas. Political problems in Balochistan have added to this situation. Also, circular debt problem have affected the liquidity of our gas exploration companies like PPL and OGDC. Improvement in existing policies like Tight Gas policies is being done. It is hoped that some improvement comes by. LNG prices are high and spot market prices are unstable. We need gas for industrialisation and exports.

Figure 2.7.1: Sector-wise gas price hike



There are two pipeline projects, IPP (Iran-Pakistan Pipeline) and TAPI (Turkmenistan-Afghanistan-Pakistan-India) pipeline. Pipeline gas should be cheaper than LNG, although no details have been made public in this respect. Prices may have to be renegotiated as per new market conditions. IPP is almost ready on Iranian side. Pakistan is constrained due to international sanctions on Iran. In the context of improving regional middle-eastern environment, it may not be out of place to expect the powers that be to allow IPP project. It is hoped that TAPI also comes on stream in near future.

2.8: North-South pipeline: some proposals

A new gas transmission pipeline to transmit imported RLNG from Port Qasim to Lahore is under active discussion; it is even implementation for the last six months. The project was conceived in 2015 under which Russia was to build this pipeline under a BOOT arrangement. For a variety of reasons, including lack of agreement on transmission tariff probably delayed the project implementation. Lack of immediate gas demand and LNG controversy perhaps contributed to lack of progress in this project.

Original gas pipeline capacity was proposed at 1.2 bcfd with a diameter of 42 inch which is the most popular dia in its category in the world. However, the Russians have proposed to have a higher diameter of 56 inch. This would increase the capacity to 2.54-3.4 bcfd depending upon the design and compression. The issue is whether there would be enough demand of gas over the life time of the project and whether the project would be economical in the new proposed size and other issues of indigenization, self-reliance, project timings, etc.

Gas demand

Long-term future of gas is uncertain worldwide. It is no more an attractive fuel. It used to be a sought-after low CO2 fuel for replacing coal and nuclear. In Pakistan, it has been and continues to be a high demand fuel. However, in power sector, its use has been projected to be going down due to high cost LNG. All combined cycle power plants are projected to be out of merit order due to the induction of base load coal and nuclear power plant which fuel cost is lower than LNG, even before the rise in LNG prices. Only power plants based on gas from dedicated fields such as Uch, Kandhkot and Mari, etc., are and will be in merit order. Only residential and industrial, CNG and fertilizer will be the demand sector. Even in fertilizer sector, bulk of the gas is coming from dedicated fields.779 mmcfd is coming out of dedicated fields and only 196 mmcfd is supplied from the pipeline system.

According to Ogra's Petroleum Industry 2019-20 Report, actual gas demand in FY-20 was 4,616 mmcfd which has been projected to increase to a level of 5,597 mmcfd by FY-2031; an increase of 981 mmcfd or 21.25%, (which may be easily handled by a pipeline of 1.2 bcfd capacity). The demand is slightly exaggerated due to higher projection for power sector which is not consistent with IGCEP (Power Plan). IGCEP predicts LNG-based combined cycle power plants to be going out of the merit order due to induction of coal, nuclear and renewables. 400-600 mmcfd gas demand will be curtailed under this head. Local gas production has been projected to go down from FY-2020 actual of 3,267 mmcfd to only 1,369 mmcfd. The gap is to be filled by 1,297 mmcfd LNG and IP and TAPI 2092 mmcfd. If IP and TAPI do not come by, LNG can be assumed to take its place, making its total going up to 3,389 mmcfd.

Here, it may be pertinent to point out the need for some degree of coordination among power and petroleum division. Nepra and Ogra scarcely meet in an institutional manner and the two regulators operate mostly in silos. IEP (Integrate Energy Plan) has not been in the priority of things. SAPM Tabish Gauhar has proposed formation of a coordination cell in the ministry of energy to effect the required planning and coordination among the two divisions. In most jurisdictions, there is one regulator for both Petroleum and Power, although this may not be an urgent issue.

The low demand LPG scenario, in the medium term, is supported by viewing the prevailing market appetite. PGPL terminal remains under-utilised. LNG terminal investors and other marketing licensees could not find customers and are only in the pursuit of stealing existing large customers of the SSGC and SNGPL which the latter are not prepared to surrender. Rising LNG prices are expected to suppress LNG demand and thus it may militate against the large dia and capacity transmission pipeline.

Supply side

Although, gas/LNG use in power sector is projected to be out of merit order, there are other uses in domestic and industrial sector which will continue. Currently, there is no substitute for gas in the industrial sector. On supply side, biogas, bio-CNG, and coal-based SNG are the options that need to be developed. Yet Hydrogen is another option that is coming up and may be viable by 2030. This would diversify the transmission load away from a central trunk and LNG.

Pipeline capacity controversy

Keeping in view the low demand for expensive LNG and some potential for enhancing the existing network capacity, there does not appear to be much utilization potential of a high capacity transmission 3-3.5 bcfd pipeline of 56 in dia by FY 2031 as proposed by Russians. It is twice or more of the additional capacity required by FY 2031. It appears that a smaller dia pipeline of 42 inch with 1.2 bcfd capacity may do the job adequately. For two LNG terminals that are currently under discussion, a pipeline capacity of 1.2 bcf is sufficient. A third can be accommodated through optimizing existing network. Due to depleting gas fields, segments of existing network are getting redundant or under-utilized. This will continue over the next decade. There is a need to undertake network simulation and optimize the existing network by enhancing segment capacities.

There are knowledgeable people who oppose the increase in diameter and capacity for a variety of reasons. They would like to stick to the 42 inch dia. Their argument is that this is the standard size on which Pakistan's transmission network is based. Pakistani companies have experience and capability in this. Shifting to higher size would make them dependent even more on foreign expertise. Only recently (2015), Pakistani gas companies implemented a similar project of 1.2 bcfd capacity (42 inch dia and 1142 kms) at a highly competitive cost of USD 1 billion which is half of what Russian proposed CAPEX for the same capacity. At current prices, a 33 to 50% increase in project cost is expected of local project. Pakistan has funding available in the form of GIDC of Rs 300 billion which would enable it to finance it out of its own resources, although foreign exchange component may be an issue. They also argue that world market is of 42 inch dia and lower. Pakistan gas companies' portfolio would be enriched by sticking to 42 inch dia and would enable them to participate in the pipeline construction contracts abroad, i.e., in the Middle East and Africa.

It is estimated that due to falling local production, certain transmission segments are falling unutilized or under-utilized. Balancing and expansion of the existing network may also be able to create an additional transmission capacity of 500 mmcfd at a reasonably low cost. This would provide a cushion for the interim period and would make the aggregate additional capacity to 1700 mmcfd (1.7 bcfd).

Due to a variety of risks including the rising price risk of LNG, all investment resources cannot be diverted to one trunk line of LNG from Karachi to Lahore. There are other sources that may come up including Iran-Pakistan pipeline and TAPI. Iran-Pakistan would require Gwadar-Nawabshah link. Coal gasification may become attractive due to high LNG prices and would require a different transmission route.

Transmission tariff

Higher gas demand in the longer run and lower unit cost is the argument in favour of higher capacity/dia of 56 inch. There is purported scale economy in higher diameter. With 50% increase in CAPEX from 2 billion USD to 3 billion USD, gas throughput may be increased by more than 100%.The 3 billion USD figure may be brought down also resulting in a cheaper tariff. Russia has been demanding 81 USc/mmBtu earlier almost twice the existing tariff of the local gas companies.

Pipeline economics

Pipeline economics is a complicated issue. In the West, one-third of Capex goes to material and the remaining to all other cost components; often labour costs are 50% of the total Capex indicating its labour intensive nature. In Pakistan and the region, reverse tends to be the case; a two-thirds being material and a one-third other costs. Local pipeline Capex are therefore more sensitive to steel prices. Chinese steel plate prices in the UAE market these days are 1060 USD per ton. These are due to hot commodity markets in the aftermath of the Covid recession which depressed prices earlier. Today high energy and commodity prices are a rebound from the earlier low level.

For reference purposes, Indian costs can be more realistic and comparable. In Nawabshah-Gwadar pipeline project, Capex was a major issue of controversy in which German consultants had been employed. Their estimates were found unacceptable and the projects could not be approved, although there were possibly other reasons as well for the project's closure. International tariffs are market-based on take and pay basis, while most projects here are on take or pay basis putting all the risks on the buyer and thus of necessity should be lower than international tariff apart from high labour cost issues in the west. These issues can cause considerable delays in a mutually agreeable cost and tariff, unless the Pakistani side surrenders totally.

There has been a trend in Pakistan of allowing liberal tariffs without due diligence either by the regulators or by the government which has resulted in 40% higher power tariff, causing circular debt and many other difficulties. An independent third-party consultant may be able to determine the Capex and tariff. Upfront power tariff policy can be a useful reference based on which recent investments for about 10,000MW have been made. Apparently, Ogra does not have that kind of framework; it has been dealing with operating projects which have a different dimension.

Concluding, it appears that 56-inch-dia high capacity gas pipeline proposal would be capital intensive, uneconomical and beyond the realistic needs of the prevailing and projected gas market in Pakistan. Excessive power capacity at high tariff is a painful reminder of mistakes that have been committed which should not be repeated. Also, it may take too long to negotiate and implement the larger 56-inch project. As it is, the Russians had initially proposed a time period of 4.5 years even for a smaller project.

Admittedly, it is a delicate and sensitive project marking the beginning of relations with a new Russia in changing political environment. However, agreeing to terms which we may not be able to honour later may create even a worse bottleneck. Reportedly, China is patiently tolerating payment delays. Thus a balanced and realistic approach is required. Even in 42-inch-dia project, a significant share of Russian involvement is possible by the way of providing all the imported materials and supplies. There are many other options to accommodate trade with Russia including oil and gas exploration, LNG and oil supplies contracts, oil refinery, steel mill and others.

2.9: Gas storage – why and how?

At the moment, Pakistan gas supply risk is increasing due to depletion of domestic gas resources and increasing reliance on imported liquefied natural gas (LNG). It is expected that reliance on LNG will increase with the continuous depletion of local fields and increasing demand. Several times, reportedly, the line pack pressure has increased beyond safe levels, risking the system. Pakistan has adopted a Floating Storage and Regasification Unit (FSRU) model as opposed to land-based gas terminals – the latter has considerable storage space as opposed to the FSRU. Thus, prima facie, there is a need for gas storage in Pakistan.

There are other reasons for having the gas storage. Normally, winter demand and prices of gas are high and summer demand and prices are low internationally, although this summer LNG prices are unusually high. Normally, it is found that buying excess gas in summer and storing it for winter makes a business sense. For countries, it provides supply and price security as well. With the emergence of gas markets, storages have become even more important. In the gas market context, a large number of suppliers procure gas at various times. Supply and demand cannot often be matched and thus storage becomes vital for the operation of gas market. Gas storages are difficult and expensive due to pressure and flow requirements. There are mainly three types of underground storages – depleted gas fields, salt caverns and aquifers. The most widely used are depleted fields, although salt caverns and LNG tanks are rapidly emerging as storages.

The underground gas storage requires base gas, which is also called cushion gas. This gas is required for maintaining pressure in the field in order to maintain the flow. This base gas remains permanently in the reservoir until the end of the life of storage facility. This component of gas forms a major part of capital expenditure (capex) and a bottleneck in financing. The other component is working gas, which is routinely injected and withdrawn.

Operationally, there are two types of gas storages – base load and peaking. Base load storages are for long-term and seasonal requirements and normally depleted field reservoirs are suited for base load operations. For gas market operations and routine peaking requirements, salt caverns are used as these have faster withdrawal rates. Depleted field storages are normally of larger capacity as opposed to salt caverns and LNG terminals. Cushion gas requirement for such storages is also very high at almost 30-50% of the total storage capacity. Salt caverns have the advantage of lower cushion gas requirement. Salt caverns can be built in a series of several caverns, which are added gradually as demand increases. Typically, the depleted gas storage costs $700-1,000 million, depending on the capacity and gas prices. Cushion gas may have a share of 30-40% in this cost. Salt caverns are cheaper. Recent cost estimates for an ongoing salt cavern storage project in Turkey have been put at $2.5 billion for a storage capacity of 5.4 billion cubic metres. A total of 48 caverns, of 630,000 cubic metres each, are being developed while six are already in place.

Gas storage capacity requirements depend on many factors including the risk situation, fund availability, tariff affordability, local construction costs, storage fields, etc. However, indicative data from industrialised countries may give some idea. Large consumers like Germany, Italy and the Netherlands have one-third storage capacity as compared to their annual demand.Perhaps the largest gas consumer of Europe has only 7% storage. Other countries like Poland and Spain have a 20% ratio. This cannot be used as a formula but does indicate typical figures.

Pakistan's case

Pakistan has both depleted gas fields and salt deposits. Depleted fields are mostly in Sindh and salt deposits are in Khewra in Jhelum. There are implications for establishing gas storages in the south or north. Gas market is in the north and depleted resources are in the south. There would be transmission infrastructure issues for gas storages built in the south. In the north, being closer to demand areas may suit the characteristics of salt caverns.

Currently, a gas storage study is being carried out under the Asian Development Bank (ADB) grant while earlier a study has already been done. However, it is almost a decade old. As half of the capex may go to cushion gas, new gas development and price regime may have pushed the decision-makers to commission another study. The typical summer and winter prices of LNG have a difference of $2 per mmbtu. For the first time in the past seven years, the LNG prices are high in summer these days and have reached $15-plus. What repercussions it would have on winter prices is not known. The recent price experience indicates merit of long-term contracts as opposed to the earlier perception against it due to lower spot prices. Now, it is the opposite.

In Pakistan, there is scepticism among a section of the people regarding high capex on gas projects including the storage, giving rise to add-on costs and prices. Literature survey on the subject indicates that the network is optimised and system cost decreases due to the gas storage. Moreover, if there is a difference between winter and summer prices, it would pay for itself. Also, it is possible to adopt a business model whereby one or more gas producing countries may agree to store their excess gas in Pakistan’s storage facilities. This gas may be their property and they may be allowed to sell in the local market at prevailing market prices. This may halve the capital cost of the project as cushion gas will cost as much as 50% of the project cost. Oil is being stored by the UAE in India under this model.

The use of semi-depleted fields can be considered as well. This will enable the utilisation of most of the installed equipment, reducing the upfront capex. Part of the cushion gas can be financed through installment payments to the field owners equal to the cash stream that they would have received in case of continued operations. Alternatively, in the case of LNG, there are storage opportunities in the form of land terminals and Floating Storage Units (FSUs). FSUs are relatively cheaper. Old LNG ships that are not sea-worthy can be converted to FSUs at a relatively low cost. FSUs are installed with a regasification unit on barge or on land. A number of developing countries have installed FSUs.

Pakistan Petroleum Limited (PPL) and Oil and Gas Development Company (OGDC) are the owners and operators of most of the gas fields in Pakistan. They should be actively involved in gas storage planning, development and even operation of storage projects. Exploration and production companies are well versed with gas extraction. What would be new for them are gas injection operations. Cushion gas purchase investments can be minimised by utilising the existing gas in semi-depleted fields.

2.10: Flaring Gas CNG Controversy

Recently, a controversy arose when some oil-gas producer company sold its to-be-flared gas to some CNG dealers. Pre-Flared gases come out of the oil wells and are a mixture of many compounds, although, it is predominantly (more than 80%) Methane which when compressed is called CNG. It would be a safety hazard if out-of-spec fuel is sold to the general public. It may be a different situation, as we will discuss later, that the case of specialized industrial user may be somewhat different.

Methane from Oil wells is burnt/ flared as a next best solution. Venting Methane would be 28-80 times injurious to climate health than burning Methane gas and producing CO2 and flaring it. Untill recently, this has been the best solution. Burn the waste, if you cannot do anything about it. However, now the thinking is that Waste is a Waste when you think that it is a waste. It has been found that waste contains many useful things. It may contain energy and materials that can be recycled. Bulk of the metals used today come from recycling than from mines.

Around 140 bcm of natural gas is flared annually these days out of 10,000 oil well stacks. This amount of natural gas is more than what Europe imports from Russia, it is said. This is a major source of soot, methane and black carbon injuring human and climate health. Around 70% of the gas is flared on a near-continuous basis. In the Net Zero emission (NZE) target, it has been decided that 95 % of non-emergency flares would be stopped by 2030.This would avoid more than 365 Mt CO2 equivalent of emission.

In Pakistan, there is quite some confusion on the issue. There are apparently four points of view among this confusion; 1. There is no significant flaring going on; excess gas is supplied to industries around; 2. Using flared gas is uneconomic, therefore flaring is unavoidable; 3. Flared gas cannot be used in CNG. No explanation is given that is it the case even after processing; 4. There is flaring done surreptitiously. More than 100 mmcfd is flared which is a lot of resource and money, although the wells are dispersed.

There is a very good but simple idea with respect to the useful utilization of the natural gas which may otherwise be flared. In South America, in a small country, gas is being produced on its eastern side and the population and other users are on the western side. There are probably less than 100 wells which flare gas. Individual gas output is small. What they did was they collected the un-flared gas (which is actually burnt) in pressurized cylinders and transported it to one or more centralized processing facilities to produce CNG and other normal gas. In our recent case, some enterprising entrepreneurs reportedly started distributing unprocessed gas to be sold as CNG. It is reported that some 80% of the wells' gas was collected and distributed in this fashion.

Thus, technical solutions are available, if not many, but are there. The issue is economics. Would it be worthwhile in terms of cost and prices to collect transport, and process the unflared gas to a central processing facility. These days, LNG has set a price level of 12-15 USD per MMBtu. Normal gas price is around USD 6 per mmbtu. It all depends on how extensive processing is required and what would be its selling price. Is it competitive and affordable? This is also a comparative issue. For some consumers, it may not be affordable like low-end domestic consumers, especially, in Pakistan. It may be attractive to CNG pumps and their users whose prices are the highest. Nearer locations may be more attractive than farther ones. Feasibility of individual projects would decide the outcome. Hence, no price regulation may not be advisable. Let the market decide.

CNG has stringent composition requirements for safety reasons, specially, when general users use the CNG. However, there may be some industrial or commercial users in whose case, safety rules and composition may be relaxed. Also, there may be nearby factories which may be using diesel or other dirty fuels. These may be SME industries like Brick Kiln, Ceramic, tiles etc. Such plants may not require processing or extensive processing. No wonder, there has been difference of opinion on the issue within the OGRA hierarchy. Flexibility and innovative thinking may help solve it or lessons could be learnt from others.

Technology has also improved over the years favouring smaller scales and mobile solutions. There are skid-mounted gas cleaning small plants. There are long CNG Cylinders of 40 ft container size with 18-24 inches dia which can carry a lot of CNFG unlike the normal size ones.

Then there are programmes like Carbon market which can make a solution more economic by adding the revenue from the Carbon market. However, it may not be sure that the solution may be accepted by the potential emission buyers.

It is very important to think about the energy and the industry. Germans started firing their coal power plant when there was a gas supply and prices crisis. Everybody is cognizant about the commitment of Germany to the environmental and climate objectives. We have discussed in the afore-mentioned some of the possible solutions. More may be thought of e.g making LNG at the well site, if found feasible.

CNG option appears to be the most viable as CNG stations are dispersed and location matching of the source and users may be possible. On the other hand, there may be possibilities of regional processing plants from where refined gas may be shipped to the users. The profit motives of CNG dealers may be channelized through devising solutions and showing those. Safe use of CNG and profitability may not be contradictory. Gas used and saved from CNG can fire industrial equipment and boilers and furnaces.

Gas price regime has changed significantly. One has to reexamine the issues that may have been rejected in the past. A lot has changed since then, technology, prices and costs. Those in the oil and gas sector, who are opposing it, should have a fresh look. Secondly, the environmental and climate aspect should not be forgotten, especially, when it brings in revenue and resources. I am scared that someday Carbon tax may be levied on non-performing countries. We may be caught unprepared. But here in case of such projects as Flare-CNG and Biogas, we get resources, money and environmental goodwill.

Figure 2.10.1: CNG Transport in Long Cylinders

Table2.1.1: Composition of Bio-Gas

COMPOSITION OF GAS SAMPLE		
Components		Mole%
Oxygen	O_2	0.59
Nitrogen	N_2	6.95
Carbon-Dioxide	CO_2	0.19
Carbon Monoxide	CO	0.00
Methane	CH_4	65.36
Ethane	C_2H_6	13.22
Propane	C_3H_8	8.79
iso-Butane	i-C_4H_{10}	1.61
normal - Butane	n-C_4H_{10}	2.7
iso-Pentane	i-C_5H_{12}	0.35
normal - Pentane	n-C_5H_{12}	0.00
Hexane plus higher	C_6++	0.24
Hydrogen Sulphide	H_2 S	0.00
Sulphur		0.00
		100.00
Water Contents		< 7 Lbs/MMscf

Coal

3.1: Thar Coal prospects

International fuel prices have been increasing consistently for the last few months. The prices of imported coal have increased three times their original prices – from $80 to over $240 per ton. Pakistan has three coal-based power plants which run on imported coal – the Sahiwal, Hubco and Port Qasim plants, each having the capacity to produce 1320MW. The combined coal import bill at present is more than $3 billion. If we convert these plants to Thar coal, we can save billions of dollars that are otherwise being spent to cover cost and foreign exchange expenses.

If coal prices in the international market remain high, it will not be possible to run the existing power plants for long. It is quite strange how these plants are currently managing their operations amid price hikes; their production, however, is going down. Thar coal's variable/fuel cost is only Rs3.9/kWh while the cost of imported coal-based power plants, Sahiwal and China Power Hub, is around Rs30/kWh; the additional cost of Rs10 per kWh is added to this under the fixed cost head, leading the total to Rs40/kWh.

Although in Pakistan the price of Thar coal is around $50-60 per ton which is twice the typical per-ton price of $25-30 partly due to low utilization, we will not touch this controversy at this time. Despite all the pricing and costing issues, imported fuel cost is seven times higher than that of Thar coal. In normal circumstances, Thar coal-based electricity and imported coal-based electricity might have cost the same. This is probably why our decision-makers initially decided to go for three imported coal-based power plants.

Table 3.1.1: Comparative Coal Power Plants Tariff

IMPORTED COAL	Rs./kWh	Sahiwal Plant 1320MW	China Power HUB 1320MW	Port Qasim 1320MW	Lucky 660MW
Tariff Components	**UPFRONT Tariff (2014)**	Current Tariff	Current Tariff	Current Tariff	Current Tariff
Fuel	4.2913	29.2533	23.5905	14.8904	15.3743
Ash Disposal	0.2200	0.2200	0.2200	0.2200	0.2200
Lime Stone	0.0900	0.0900	0.0900	0.0900	0.0900
Var. O/M -F	0.0684	0.2581	0.2581	0.2580	0.2581
Var. O/M -L	0.0456	0.1093	0.1254	0.0630	0.0631
Total Energy Charges	**4.7153**	**29.9307**	**24.284**	**15.5214**	**16.0055**
Fixed O/M-F	0.1435	0.5415	0.5414	0.5413	0.5414
Fixed O/M -L	0.1435	0.3438	0.3493	0.1984	0.1984
Working Capital	0.2276	2.8321	1.5284	1.3852	0.7722
Insurance	0.1021	0.1021	0.1021	0.1021	0.1021
ROE	1.1872	2.6164	3.7285	2.4792	4.1898
Debt	1.6691	5.7072	6.1776	6.2175	4.4283
Fixed CTS Component	0	0	0.5878	0	0
Total Capacity Charges	**3.4730**	**12.1431**	**13.0151**	**10.9237**	**10.2322**
Total Tariff (Rs./kWh)	**8.1883**	**42.0738**	**37.2991**	**26.4451**	**26.2377**

Imported power plants cause two problems; one relates to fuel cost and the other is about foreign exchange. Pakistan currently faces the highest current account deficit, leading to shockingly high levels of currency depreciation which is further destabilizing the economy.

People in the country ask why we cannot use Thar coal. Transitioning to Thar coal is 'easier said than done', but it can be done. There are three issues with Thar coal; it is technically called lignite and its energy content (calorific value or CV) is half of that of imported coal(sub-bituminous); its water content is almost 40-50 per cent – dry coal is required to be burnt in power plants; its sulphur content is higher than imported coal.

Despite these facts, lignite was once used in Europe for almost half a century; it has also been used in India as well. It is a separate matter that the world is now moving away from all kinds of coal for power generation. The current issue is about the conversion of the existing imported coal-based power plants to Thar lignite and regarding the handling of issues like lignite moisture, low CV and high sulphur? It is easier to design power plants based on Thar coal instead of converting the existing power plants whose design is based on a different type of coal.

There are a number of proposals to deal with the issue. Initially, we can start with a 10-20 per cent mix of Thar coal and imported coal. This may be done in six months although there will be some logistics issues. The other proposal is the almost-total conversion to Thar coal, which may require significant technical changes, costing time and money.

Traditionally, CFB boilers have been used in the case of Thar lignite. Also, in the case of normal sub-bituminous (imported) coal, the mineral is pulverized to a talcum powder-like state, which is later fired from the sideways. Such boilers are called pulverized coal or PC boilers. Coal burns like an oil stream in them. They do not require pre-drying as the coal used in it is usually dry. All the three imported coal-based power plants are based on PC boilers.

There have been some technological developments which have let the lignite coal pulverized and dried in one package. If sub-bituminous coal is to be substituted by Thar coal, processes involving coal handling, storage and pulverization will require adjustments. The coal's pre-drying process can be done through solar energy as Thar is full of sunshine. It can be dried at both mines and power plants. Exhaust steam is generally used in a reverse cycle for extra drying. This has already been done in Germany. Lucky Power reportedly uses almost the same approach in burning imported lignite and plans to use the local lignite eventually.

There are several logistics issues. Coal is transported through rails, but unfortunately there is no rail link connecting the Thar coal site to the Pakistan Railways network. Even though a rail-link project has been prepared, it is unlikely to be implemented due to a variety of financial reasons. Even if it is approved, it may take two to three years for construction. However, transportation by truck is possible.

There is great demand for cheap Thar coal by industries, especially cement, ceramics, glass and steel industries. Some amounts of this coal are reportedly being sold to third parties belonging to industries, although in a legal vacuum. Both Engro-Thar and Sino-SSRL are under the cost-plus pricing strategy, where fixed cost is paid for and absorbed in electrical tariffs. Mine owners have to be paid variable cost and incentives; a third-party sales pricing mechanism should have been developed by now. Also, Thar coal should be converted into a ready-energy product by drying and grinding, and possibly briquetting, if we want to promote the industry-wide use of this coal and save foreign exchange in other sectors as well.

The technical changes of the existing power plants have many risks; there may be loss in efficiency and increase in costs – both variable and capex; there may be mistakes and accidents – Thar coal is prone to spontaneous combustion; the shutdown of power plants will be required, which may result in a loss of revenue for the operator and owner companies; all of these costs are not provided in the agreement and have to be absorbed by the government.

These plants consume five million tons of coal each per year. If Thar coal substitution saves $175 per ton, $875 million per plant will be saved annually. If one assumes the project additional capex for the conversion to the tune of $250 million, the payback period would be around 3.42 months. And the total savings for the three imported coal-based power plants would be $2,625 million per year. This saving can also absorb the funding requirements of the rail tracks of a capex of $200 million. There is unutilized mine capacity for which capacity cost is being paid that would be extra saving.

The issues are more financial than technical. Our Chinese partners have great technical prowess in the field of coal-based power plants. Rising coal prices in the international market and foreign exchange issues are great motivators for Pakistan to go with this shift. Assistance from China's government under CPEC may be helpful in this regard. We should be more proactive and flexible in developing a financial solution.

3.2: Looking beyond Thar coal

China has announced in international fora that it won't finance any coal power plant project outside of China anymore. This has sent shockwaves among stakeholders in Pakistan, who were counting on technology and finance from China to utilise the huge Thar coal deposits of 185 billion tons. China has already built a 660-megawatt power plant in Thar and is in the process of building another power plant along with a coalmine with a capacity of 1,320MW.

There are several other Thar coal projects_in the pipeline, all based on technology and finance from China. China has also built three power plants in Pakistan based on imported coal. There are other project ideas and proposals regarding coal gasification to produce diesel, gas, fertiliser and chemicals, on which considerations are at various stages. Hopefully, China would honour its existing commitments to Thar coal, which unfortunately are not much beyond the two projects – one already constructed (SECMC 660MW) and the other under construction (SSRL 1,320MW). Coal is not used in power sector alone in Pakistan, which is a relatively recent phenomenon. Cement sector is using mostly imported coal along with some sub-bituminous coal produced in underground coalmines in Balochistan.

Before the advent of coal-based power plants, Pakistan imported 10.7 million tons in 2017, and almost all of that went to the cement sector. Cement sector's installed production capacity is projected to grow to 100 million tons per annum (mtpa) from the existing 55 mtpa. Thus, cement sector's demand for coal is going to be 20 mtpa in the near to mid-term. Cement sector is vital both for domestic construction industry and for exports. Thus, total imported coal demand for both power and cement sectors, which appears to be touching 25 mtpa, will go up to 35 mtpa. Based on average price of $100 per ton, the total annual import bill for 25 mtpa of coal will be $2.5 billion.

There is no economic fuel for producing cement other than coal. Cheap local gas had been used earlier for producing cement. Rising gas prices and depleting local gas resources have forced cement producers to shift to coal. Unfortunately, now both gas (LNG) and coal are expensive. Coal prices have gone as high as $146 per ton from $70 earlier. LNG prices are exceeding $36 per million British thermal units (mmbtu), which is absolutely uneconomic and unaffordable.

In this context, local coal production appears to be cheaper and viable. Although there has been controversy over Thar coal production costs, there have been recent estimates of $30 per ton, which is equivalent to $60 per ton for imported coal. Thar lignite coal is one half in calorific value than the imported coal. Lignite may not be an ideal fuel for cement production as it contains 40-50% moisture. However, it can be pre-processed to fire in cement kilns. A 20 mtpa demand for imported coal from the cement sector will be tantamount to 40 mtpa of Thar lignite. Add another 10 mtpa for other sectors, it adds up to 50 mtpa of Thar coal demand for other than the power sector.

If this import is replaced, one could save $2 billion. It is, therefore, vital to establish Thar lignite mines of 50 mtpa over the next five years, even if we forget about the use of Thar coal in power sector. It may be plausible that the announcement of China is restricted to coal-based power plants only and there is no bar on the use of coal in other sectors such as cement. Pakistan should also start developing indigenous mine development and operating capacity. There is now some experience already in this respect. Chinese government may be more than willing to transfer technology in this sector, now (by reducing its direct exposure in terms of operations and finance) that it wants to improve its international image among the climate lobby of the world.

Coal power expensive

It should be noted that coal power, whether based on local or imported coal, is expensive at 8.5 US cents per kilowatt-hour (kWh) while renewable energy like solar is available at less than 4 US cents.

International prices have gone down to even 2 cents and lesser. There is forecast for solar power going as low as 1 cent, although storage cost could double it. The issue is how to manage the transition and avoid stranded investment. Chinese decision may ultimately prove to be a blessing in disguise. Thar area of 10,000 square km can generate 400 gigawatts of solar electricity based on 25 square km per GW.

By comparison, the Indicative Generation Capacity Expansion Plan (IGCEP) predicts 55-75GW of generating capacity by 2030. Although all electricity cannot be produced in one location, it may be reasonable to plan 5-10,000MW of solar power in Thar area.

With LNG price uncertainties, depleting local gas resources, and stoppages on coal power, very little options will be left for adding base load power plants. Hydro is a base load power plant but it does not run in winters. Nuclear is expensive and takes a long time to materialise. There is a lot of politics involved in it too. Furnace oil seems to be re-emerging. We may have to adopt go-slow and wait-and-see approach to closing down/conversion of furnace oil production, till the dust settles. We should not repeat the same mistake of total foreign reliance. A local solar equipment production industry plan should be developed, not only for producing solar PV panels but other items such as inverters, etc as well.

Incentives

An incentive programme should be prepared, encouraging the local manufacturing industry. After all, huge incentives in the form of customs tariff have been given to the automotive industry. And now, there are proposals for 10% price protection for the refinery sector.

There is ample scope for incentives when coal-based electricity tariff of 8.5 US cents is compared with less than 4 cents for solar power.As of today, no energy source is a panacea. Solar is available during the day time only while hydro and wind are available in summer. Fossil fuels such as oil and gas are exhaustible and subject to price variations, while coal is dirty and bad for the environment and climate.

The days of energy utopia are not too far ahead into 2040-50. World is moving towards the solar-wind-hydrogen chain. Hydrogen will make energy transportable and tradable across national boundaries. We have to start moving in that direction.

3.3: Shifting to Thar lignite

Pakistan has 180 billion tons of lignite coal deposits, which have the potential of firing 1800 power plants of 1000 MW for 30 years or 500 power plants for 100 years. These deposits are more than the combined oil and gas resources of Iran and Saudi Arabia – although I haven't personally verified this claim.

Unfortunately, the world has turned against coal and even gas and oil. Last year, China announced that it would not finance coal-based power plants abroad anymore, although it would continue to do so within its country. What can we do? We do not have enough money or technology. Insensitive and unrealistic targets regarding the adoption of renewable energy have already created instability in the oil, gas and coal markets, resulting in unaffordable high prices; no end appears in sight. Poor countries and the poor are suffering great enormous difficulties, and even people from rich countries are facing financial inconveniences. We have installed only one or two Thar coal-based small power plants, and a few are in the pipeline, which may not exceed 5000 MW in total. There are three big 1100 MW coal power plants based on imported coal which are draining our foreign exchange reserves even though they are producing relatively cheap electricity. Thar coal had the potential for supplying a significant portion of our energy needs and saving our foreign exchange. Oil and gas resources are also dwindling, and no new resources could have been found in reasonable quantities. Our energy future does not appear to be bright in these circumstances.

But there is some good news as well: identifying the possibilities of making some other high-value products from Thar coal. Besides producing electric power, Thar lignite coal has been producing synthetic natural gas (SNG), fertilisers (urea and others), ammonia and other chemicals. Limitations on coal use will restrict the production of all these products. Products that will be discussed are those that cannot possibly be restrained from production through coal. Another important aspect is that although lignite coal is considered to be inferior – as it has high moisture and low energy content – recent discoveries suggest that this coal is more useful than other types of coal.

Lignite can be used for making graphite. Researchers in North Dakota recently found out that lignite coal is much more amenable to graphitisation than the more expensive Bituminous and Anthracite coal – these coal types do not lend themselves to graphitisation at all. Graphite is a high-value product used in nuclear power as a neutron moderator, electrodes in arc steel making, electrodes in both conventional and EV batteries, graphite lubricant roads, plates, tubes, etc. The selling price of graphite is around $16,000 per tonne and the price of lignite – used as a raw material – is around $30 per tonne.

Also, lignite coal may contain trace elements called rare earth elements (REEs). Lithium is one of such REEs. Li-ion batteries are the most popular EV batteries whose demand is expected to grow exponentially in the future. Battery-grade LiOH has been trading at $46,000-65,000 per tonne, as compared to $7,000-10,000 per tonne of copper.

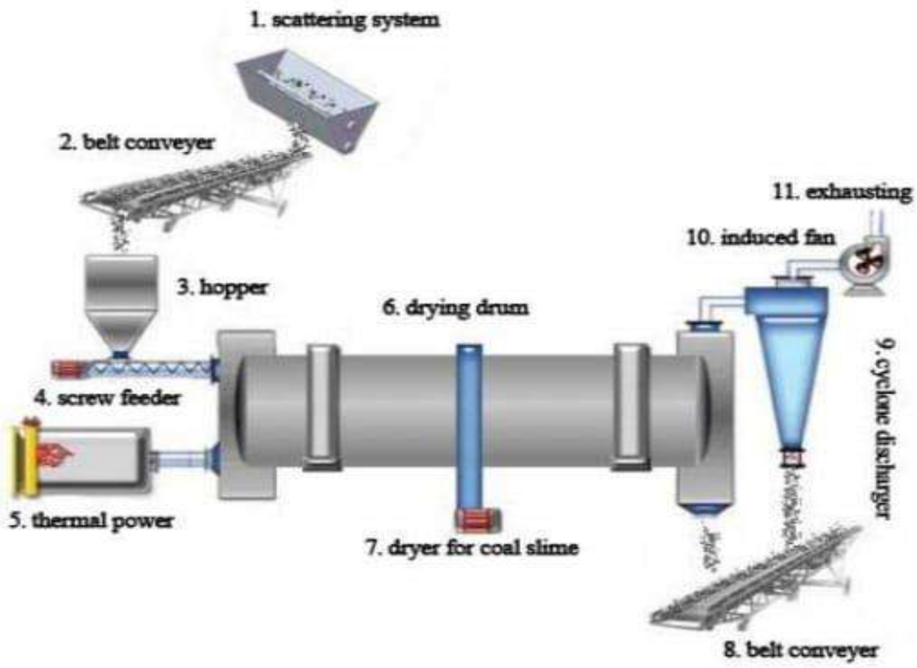
At present, only China is supplying lithium, but its lithium resources are not expected to continue for long – unless new resources are discovered. Other countries are also in their exploration phases for this natural resource. It has been found that North Dakota lignite contains up to 500 ppm of lithium, leading to a total of 3,600 tonnes as against the total global production of 70,000 tonnes per year. Thar lignite may not necessarily contain lithium, but since lignite coal's geographical location does not affect its properties, it may be possible that Thar lignite coal contains lithium.

Serious geological studies should be commissioned, possibly involving the geological agencies of North Dakota, which have experience in such research. There are other foreign agencies, especially in China, which may be helpful. Humic acid and leonardite are well-known. Leonardite is naturally oxidised lignite and rich in humic acid. It is found close to the surface of lignite mines. Humic acid is used as a soil conditioner in agriculture and leonardite is used in oil and gas drilling mud. India is exporting leonardite at $1,400 per tonne. These are final products for markets, and the authorities must pay attention to them.

Pakistan imports 19 million tonnes of coal per year – half of which is likely to be consumed by imported coal power plants – and the other half by cement plants. International coal prices and shipping costs have quadrupled –$400 per tonne as opposed to the previous $80 per tonne. Cheaper imports from Afghanistan and some local production from Balochistan saved Pakistan's cement and construction industries. Afghanistan's coal sector is not integrated with international markets yet and sells its product at much lower prices. It is in the interest of the local cement industry to develop local coal supplies, which would be cheaper and stable.

While converting imported coal power plants to Thar coal-run plants may be a difficult and time-consuming job, Thar lignite can be easily introduced in cement plants. Dewatering technologies are readily available and have been used in Germany. More than a billion dollars of foreign exchange can be saved per year. Many countries are using separated municipal solid waste (MSW) to fire cement kilns. In Pakistan, too, some companies have tried it. There shouldn't be too many problems for cement industries in converting to Thar coal. It would also be difficult for the powers that be to stop or discourage this activity, as it is only converting from one coal type to another.

Figure 3.3.1: Coal drying



Coal gasification and the associated products and chemicals like urea, DAP or even diesel have been indicated to be economical – if compared with LNG – but they may be opposed by even friendly countries due to pressure from international climate forces. Therefore, we should take the step that is possible and does not involve a lot of money or high technology. Our cement companies are highly organised to undertake the challenge. Government policies and facilitation would be required. Near-monopolies in Thar coal mining may have to be removed and new parties should be inducted and awarded mining licences.

Thar lignite coal can be used for the production of both high- and low-value products. High-value coal products are required for the production of electrical vehicles, and they are likely to be accepted by the international climate lobby – which may oppose energy products. Let us try out this low-hanging fruit as the windows of opportunity are closing one by one.

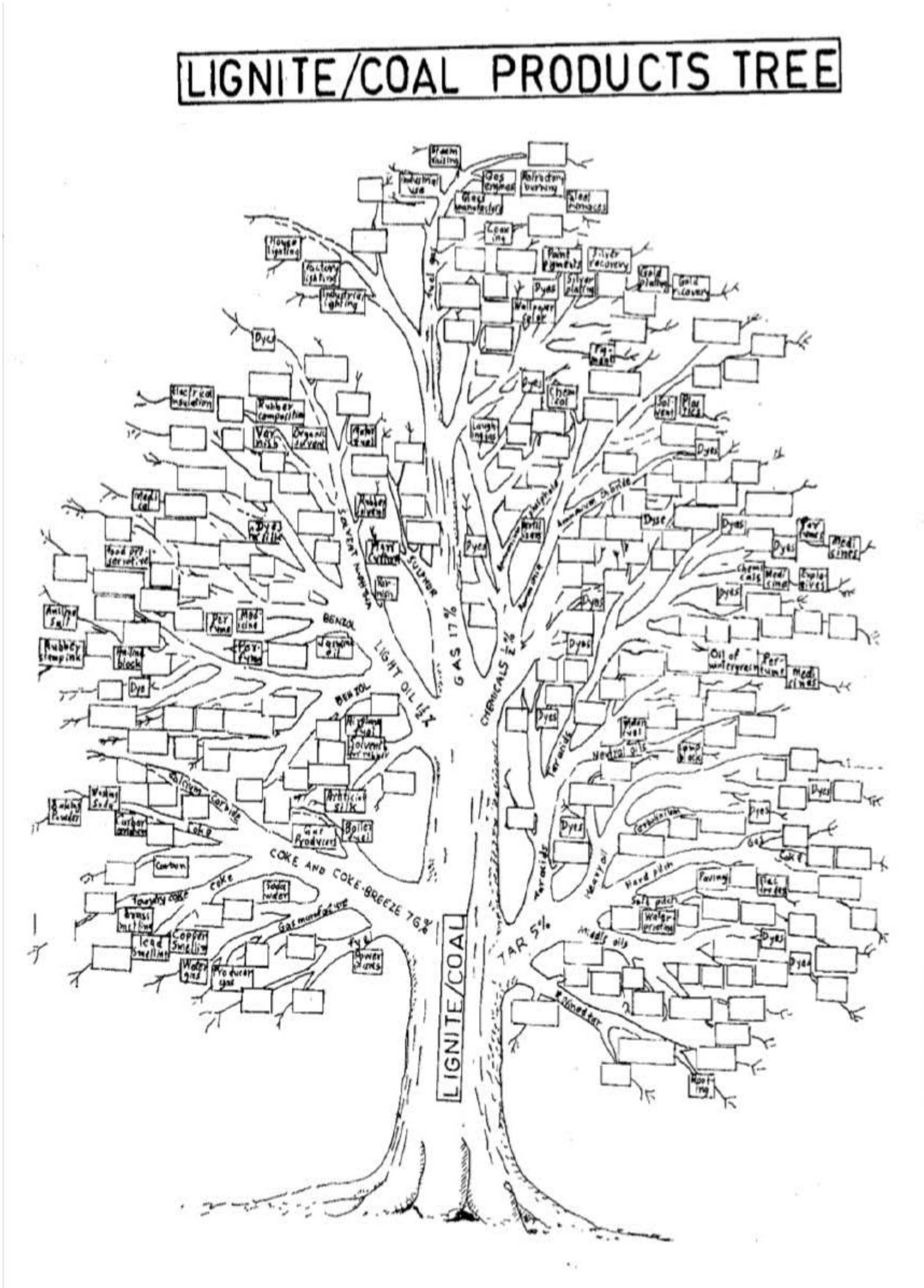


Figure 3.3.2: Ignite/Coal Products Tree

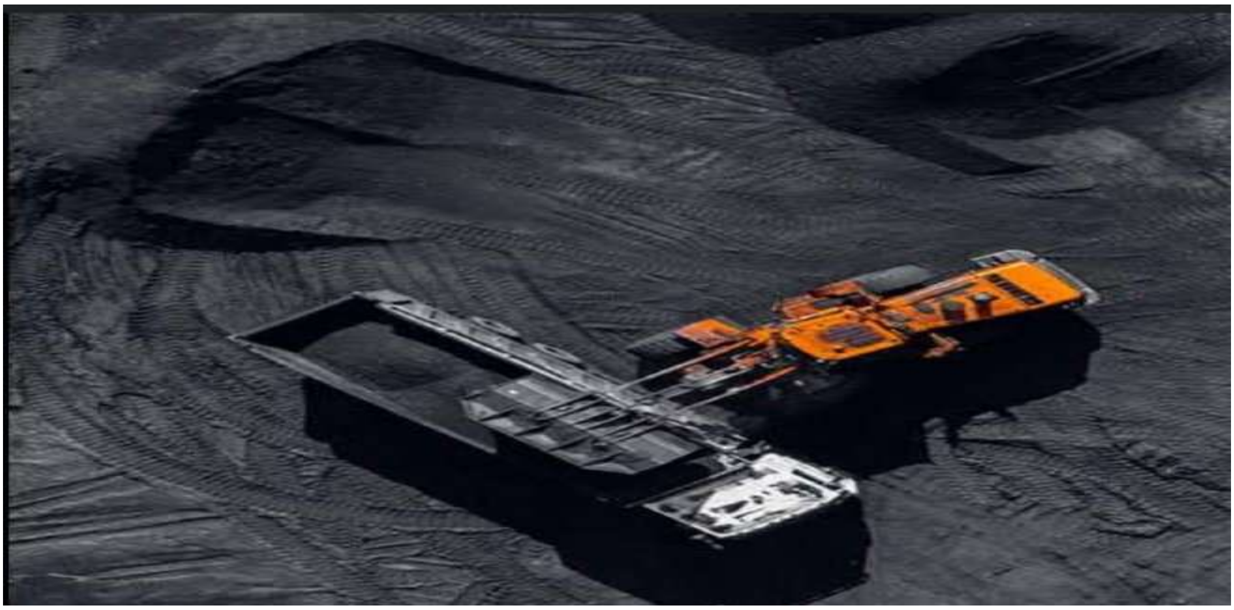
3.4: Making good use of Thar coal

International fuel prices have gone up several times, be it coal or LNG or even petrol and diesel. Imported coal prices have increased three times – from $80 per ton to $240 per ton or even more. We have three coal power plants which run on imported coal – Sahiwal, Hub and Port Qasim – having 1,320MW capacity each with combined coal import bill of more than $3 billion. If we convert these to Thar coal, we can save several billion dollars in cost and foreign exchange.

If the high imported coal prices continue as these are, it will not be possible to run these power plants for long. It is strange as to how it has been possible to continue to run these power plants up to now. Their production has been going down. Thar coal variable/ fuel cost is only Rs3.9 per kWh while imported coal power plants (Sahiwal and China Power Hub) are costing around Rs30 per kWh. Add Rs10 per kWh as fixed cost, you can imagine, where does it take us to – Rs40 per kWh? Although in Pakistan Thar coal price is $50-60 per ton at this stage (twice the typical price of $25-30) due to low utilisation, we will not touch the controversy at this time.

Despite all the pricing and costing issues, the imported fuel cost is more than seven times higher than the Thar coal fuel cost per kWh. In normal circumstances and prices, Thar coal-based electricity and imported coal-based electricity cost the same, which probably led the decision-makers to go for three imported coal power plants. There are two impacts; one of fuel cost and the other of foreign exchange. We are suffering from the highest current account deficit, leading to abnormal currency depreciation and causing destabilisation of the economy. Everyone in the country asks why we can't use Thar coal. Easier said than done but it can be done.

Figure 3.4.1: Thar Coal being loaded at mine



There are three issues with Thar coal. Thar coal is technically called lignite and its energy content (calorific value – CV) is half that of imported (sub-bituminous) coal. Second, its water content is almost 40-50%, while one requires almost dry coal to be burnt in power plants. Third, its sulphur content is higher than imported coals. The issue is how to convert the imported coal power plants to Thar lignite. How to deal with lignite moisture, low CV and high sulphur? It was easier to design the power plants on Thar coal in the first place instead of converting the plants, which have been designed on a different type of coal.

There are a number of proposals. One, start with a 10-20% mix of Thar coal and imported coal, which may not require a lot of changes. This may be achieved in less than six months, although there would be logistics issues. Two, the other possibility is almost total conversion from imported coal to Thar coal, which may require significant technical changes, costing time and money. Classically, CFB boilers have been used in case of Thar lignite (as Engro Thar has installed). In case of normal sub-bituminous (imported) coal, coal is pulverised to a talcum powder like state and the coal powder is fired from sideways.

Such boilers are called pulverised coal-PC boilers. In them, coal burns like oil stream. It does not require pre-drying as the type of coal used in it is dry. All the three imported coal power plants are based on PC boilers. Lately, there have been technological developments, which let the lignite coal pulverised and dried in one package. If sub-bituminous coal is to be substituted by lignite coal, adjustments are required in coal handling, storage and pulverisation. Pre-drying can be done through solar energy as Thar is full of sunshine.

It can be dried both at the mine and power plant site. Additionally, exhaust steam is used in a reverse cycle and used for extra drying. This has been done in Germany earlier. Reportedly, Lucky Power is using almost the same approach in burning imported lignite and plans to use the local lignite eventually. A natural question arises why not convert Lucky first, which we will deal with later. There are logistics issues. The standard transport means for coal is railways. Unfortunately, there is no rail link connecting the Thar coal site to the railways network. A rail link project has been prepared, which could not be implemented due to a variety of financial reasons. But even if it is approved, it may take two to three years for construction.

However, truck transport is available. It may not have been attractive due to the smaller difference between the local and imported coal cost. It is certainly feasible now. There is great demand for cheap Thar coal by industries, especially cement, ceramics, glass and steel. Reportedly, some Thar coal is being sold to third parties belonging to industries, although in a legal vacuum. Engro-Thar and Sino-SSRL both are under cost-plus whose fixed cost is paid for and absorbed in electricity tariff. Mine owners have to be paid variable cost and an incentive. Thus, a third-party sales pricing formula should have been developed by now; better now than never.

Also, Thar coal is to be converted in a ready energy product by drying and grinding and possibly briquetting, if we want to promote industry-wide usage and save foreign exchange in other sectors as well. Technical changes of the power plant has many risks; 1. There may be loss in efficiency and increase in costs – both variable and capex; 2. There may be mistakes and accidents, especially with Thar coal as it is akin to spontaneous combustion; 3. Shutdown of power plant would certainly be required, which would be a loss of revenue for the operator/ owner companies. All of these costs money, which is not provided in the agreement and have to be absorbed by the government of Pakistan. These plants consume 5 million tons of coal each per year.

If Thar coal substitution saves $175 per ton, the annual cost saving per plant would be $875 million. If one assumes the project's additional capex for conversion to the tune of $250 million, the payback period would be 3.42 months. Total saving for the three imported coal power plants would be $2,625 million per year. There would be equivalent savings of the same amount of foreign exchange also.

These savings can also absorb the funding requirement of railways' track with a capex of $200 million. There is unutilised mine capacity, for which capacity cost is being paid that would be extra savings. It appears that the financial issues are tougher than the technical ones. The name of the game is timing. At least, 10-20% substitution may be done without losing much time, while planning and implementation of full conversion is initiated.

3.5: Opening up Thar coal to non-power sectors

Thar coal has come a long way. Two blocks are functional with installed power generation capacity of 2,000 megawatts. Power sector has helped open up Thar coal, which was lying dormant after its discovery in the 1980s. Several attempts were made to make a breakthrough but failed. Solving federal vs provincial control issue took a period of five years.

On the other side of the border, India also has the same continuation of Thar Desert, which the neighbour started exploiting in the 1970s and is about to consume all in less than a few decades more. With SECMC's third phase, Thar coal production would reach 12.2 million tons per annum (mtpa) and fortunately at a viably low cost of $30 per ton as opposed to twice the current price.

Combined with Sino-SSRL production, total Thar coal production would be around 20 mtpa, enough to fire 3,000MW of power capacity. There are two problems, however, with Thar coal; high moisture content (40-50%) and low calorific value (50% of the normal sub-bituminous coal). It has to be dried and may be processed before transportation, both for safety and economic reasons. This adds to cost.

It is conventionally priced lower at $25-30 per ton as opposed to $80-100 per ton for the conventional thermal coal. Current Thar coal costs of $65 per ton might have been another constraint in its wider use. As mentioned elsewhere, these costs/ prices may come down to $27-30 per ton in the near future in one of the blocks. Northern parts of Pakistan may suffer from higher costs due to transportation.

Unfortunately, we installed three coal power plants on imported coal. One can be wise in hindsight. At that time, there was power capacity crisis. And now we have fuel availability and pricing problem. Imported coal prices went up to $300 per ton, almost thrice the normal level, which made operations at these plants unfeasible for some time. Fortunately, international coal prices have come down to $150-200 per ton, which is still high but workable temporarily.

The three coal power plants consume 12 mtpa, costing $1.8 billion per year at $150 per ton. Efforts are being made to switch these plants to Thar coal, initially at 10-20% level. Had Chinese been in the circumstances we are in, they would have done it 100%. But why should they have been? There are technical issues complicated by contractual and legal complexities. Although there is a potential of 100,000MW or more power production from Thar coal, practical limits put an upper ceiling of 8,000MW, say 10,000MW, due to resource constraints such as water constraints. Furthermore, as we are starting with Thar coal, world has turned against it. Coal power plants are the focus of world opposition.

International financing is required for installing power plants, which may become expensive and difficult. No new Thar coal-based power plants are being planned is a good enough indicator. There are other opportunities of converting coal to gas, fertiliser, diesel and even hydrogen. Being capital intensive, there may be same reluctance as it may be in the case of coal power plants. Chinese companies have done preliminary studies in this respect but they could not be developed into firm projects yet.

While there may be sufficient power plants capacity, the industrial sector is suffering from pricing and availability issues of thermal energy in the form of gas or LNG. While local gas production is depleting, spot market LNG prices have gone up and infact not available at any price. Fortunately, we have long-term LNG contracts with Qatar, which have partly saved from a catastrophe. Fortunately, our cement sector had already converted to coal, although to imported coal. This conversion trend was almost worldwide in the cement industry. But other sectors are still gas dependent. In Gujarat and adjoining areas in India, which is a textile hub of India, lignite is being used, making India competitive in that sector, while our textile industry is dependent on energy subsidies. Our industry is converting to expensive furnace oil to fire their boilers.

Cement is a big sector in Pakistan with installed capacity of 70 mtpa, which may go up to 100 mtpa in the next 10 years or earlier. It also earns foreign exchange through exports to regional countries. Cement sector's coal demand itself is very high as much as 7 mtpa, which is equivalent to Thar coal of 14-15 mtpa. But the cement sector depends on imported coal mostly. This alone can be a sizable market for Thar coal. There is steel sector which can also be converted to Thar coal. It is suffering from the lack of energy supplies and high costs. Cement and steel combined are major inputs for the construction sector. The latter can give a fillip to the economy or otherwise slow down the economy and the associated employment creation. The question is why don't these sectors utilise Thar coal. It is local and cheaper and now foreign exchange is not there or is terribly expensive. The answer is that Thar coal has been wedded with the power sector alone. And coal imports were cheaper and easier.

Thar's remoteness and isolation was an issue, which is going to be solved in the near future by laying a railway line connecting Thar to the railway network. There is a policy vacuum relevant to non-captive uses of Thar coal. Existing coal production capacity is constrained from using Thar coal due to legal and financial lacunae, which could have been removed by allowing them to sell at a marginal cost plus a reasonable profit margin.

However, the main issue is opening up of Thar coal to non-power users such as cement, steel, textile and other sectors. Cement sector is a very big and progressive one. It has highly modern and capital-intensive plants. It has organisational and other resources and capability. A coalmine costs the same capex of a few hundred million dollars as one or two cement plants would be. There can be many business models such as competitive mine auction capacity in blocks of 5 mtpa or more.

Cement or steel sector may form a cooperative to reduce risk. Classical IPP model with some changes can be adopted. There can be price control ala pharma industry or unregulated prices. GMDC (Gujarat Mining India) model can be adopted. Possibilities and potential are many. Existing players may also be inducted into this initiative so that invisible resistance and barriers may be reduced. They can participate as mine contactors making good use of their experience. JVs of mine contractors with local parties may be encouraged.

Currently, there is a scope for opening four Thar coalmines of 5 mtpa. It would create a competitive market. This mining activity can be quiet and much less visible and noticeable than coal power plants. These mines may not require international financing as power plants require and can be implemented with ease as other capital-intensive plants like cement ones. Cement, steel and textile sectors put together are a great resource that should be mobilised by the policymakers. Sindh government may also consider establishing an SME industrial estate in Thar area, which may engage in various coal processing industries like coal drying, briquetting, sales, dispatch, etc for miscellaneous customers.

Figure 3.5.1: Pakistan Coal Consumption: Cement from 2001 to 2017

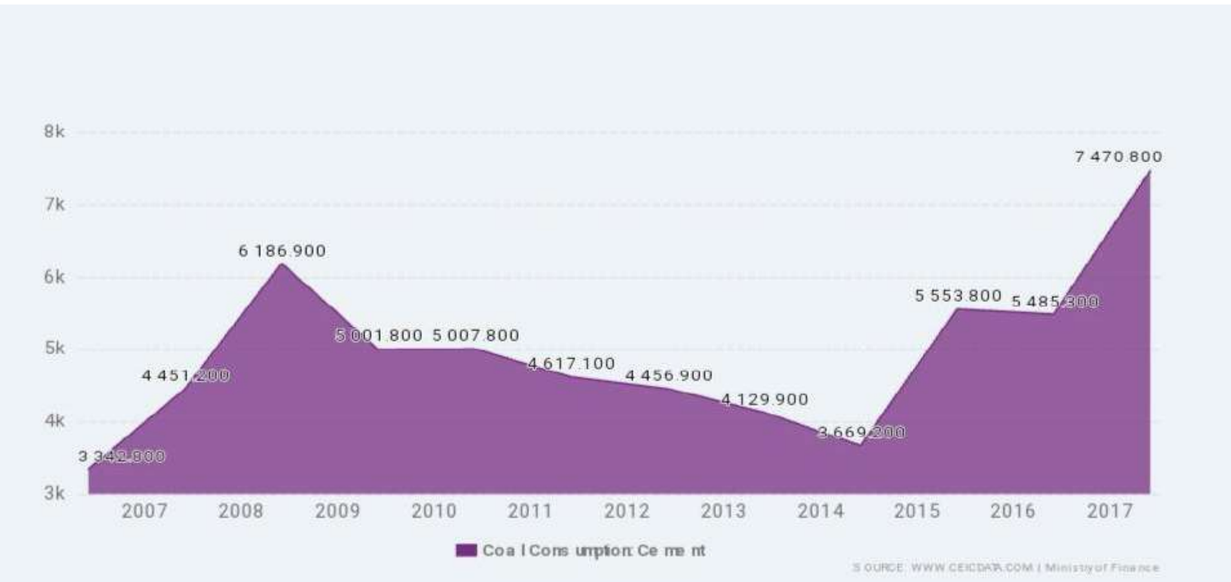


Table 3.5.1: Intalled Production Capacity's Statement

Sr. No.	Name Of Unit	Province	Production Lines	As on June 2020 Operational Capacity	
				Clinker	Cement
1	Askari Cement Limited - Wah	Punjab	1	1,050,000	1,102,500
2	Askari Cement Limited - Nizampur	KPK	2	1,620,000	1,701,500
3	Attock Cement Pakistan - Hub Chowki, Lasbela	Baluchistan	3	2,852,857	2,995,500
4	Bestway Cement Limited - Hattar	KPK	1	1,170,000	1,228,500
5	Bestway Cement Limited - Chakwal	Punjab	2	3,428,571	3,600,000
6	Bestway Cement Limited - Farooqia	KPK	2	2,835,000	2,976,750
7	Bestway Cement Limited - Kalar Kahar	Punjab	1	1,950,000	2,047,500
8	Cherat Cement Company Limited-Nowshera	KPK	3	4,320,000	4,536,000
9	Dandot Cement Limited - Jehlum	Punjab	1	480,000	504,000
10	Dewan Hattar Cement Limited - Hattar	KPK	2	1,080,000	1,134,000
11	Dewan Cement Limited - Dhabeji	Sindh	2	1,680,000	1,764,000
12	D.G.Khan Cement Limited - D.G.Khan	Punjab	2	2,010,000	2,110,500
13	D.G.Khan Cement Limited - Chakwal	Punjab	1	2,010,000	2,110,500
14	D.G.Khan Cement Limited - Hub	Baluchistan	1	2,760,000	2,898,000
15	Fauji Cement Company Limited - Fateh Jang	Punjab	2	3,270,000	3,433,500
16	Fecto Cement Limited - Sangjani	Punjab	1	780,000	819,000
17	Flying Cement Limited - Lilla	Punjab	1	1,140,000	1,197,000
18	Gharibwal Cement Limited - Jehlum	Punjab	1	2,010,000	2,110,500
19	Kohat Cement Company Limited - Kohat	KPK	3	4,778,571	5,017,500
20	Lucky Cement Limited - Pezu	KPK	5	6,485,714	6,810,000
21	Lucky Cement Limited - Indus Highway, Karachi	Sindh	4	4,666,667	4,900,000
22	Maple Leaf Cement Factory Limited - Daudkhel	Punjab	3	5,400,000	5,670,000
23	Pioneer Cement Limited - Khushab	Punjab	3	4,333,571	4,550,250
24	Power Cement Limited - Nooriabad, Dadu	Sindh	2	3,210,000	3,370,500
25	Thatta Cement Limited - Thatta	Sindh	1	549,600	577,080
Total			**50**	**65,870,552**	**69,164,080**

Figure 3.5.2: Products of Coal Gasification

from coal using the coal gasification process. About 35.8 million dekatherms of SNG are produced annually.

Ammonium sulfate is an agricultural fertilizer marketed under the name Dak Sul 45®. Approximately 100,000 tons is recovered yearly from a flue gas desulfurization system.

Anhydrous ammonia is used as fertilizer for farming and as a feedstock for producing various chemicals. Dakota Gasification Company has the ability to produce about 400,000 tons per year.

Carbon dioxide is used for enhanced oil recovery. About 2 million metric tons are shipped to Canada annually.

Crude cresylic acid is used in the manufacture of pesticides and products such as wire enamel solvent, phenolic and epoxy resins, and antioxidants. Annually, 26 million pounds are produced.

Krypton and xenon gases are used for specialty lighting, such as high-intensity lighting and lasers, and for thermopane window insulation. About 3.5 million liters of krypton-xenon are produced annually.

Liquid nitrogen is used for food processing refrigeration, as an oil well additive, and in chemical processes. About 300,000 gallons are produced annually.

Naphtha contains products that can be used as a gasoline blend stock, in making solvents, and in benzene production. About 8.4 million gallons are produced annually.

Phenol is used for the production of resins in plywood manufacturing and in the casting industry. About 28 million pounds of phenol are produced annually.

Tar oil is sold as a fuel and feedstock to the carbon black industry. Up to 40 million gallons can be produced annually.

Urea is used as an agricultural fertilizer produced from ammonia and carbon dioxide. The urea facility is able to convert a portion of the anhydrous ammonia product to make 1,100 tons of urea daily.

Diesel Exhaust Fluid (DEF) is urea liquor, which is required by law for modern diesel engines for emissions control. It is injected into the exhaust stream to react with harmful greenhouse gases. DEF is a non-hazardous solution comprised of a 32.5% or 50% urea concentration. DEF is used in Selective Catalytic Reduction technology to remove harmful NOx emissions from diesel engines. Dakota Gas has the capacity to convert a portion of the urea product to produce 64 million gallons of DEF per year.

Liquefied carbon dioxide produced in the urea production facility is sold for fracking and enhanced oil recovery projects, mostly in North. Dakota, as well as beverage-grade CO_2. The plant has the capability to produce about 70,000 tons of liquefied carbon dioxide annually.

Thar coal mine expansion

SECMC (Sindh Engro Coal Mining Company) has filed a tariff petition for expanding its capacity. This is a third expansion. The mine started its phase-I at 3.8 MTPA (Million Tons per Annum) through phase-II at 7.6 MTPA to the current Phase-III expansion at a cumulative capacity of 11.2 MTPA.

We will make a few comments on improving the proposal and approaches for reducing foreign exchange component. The bulk of the production cost appears to be in foreign exchange, which is a larger problem of Pakistan's local production and even export items. The production cost has been coming down gradually with plant expansion; it has come down to the proposed 30-year tariff of 37.26 USD/ton.

The incremental CAPEX of the Phase-III is 104.97 USD out of which 68.18 USD is EPC (engineering, procurement and construction) cost, all in USD. One would have expected a marginal FE component. However, diesel cost, which is in foreign exchange, is a whopping 18.8 million USD. We will discuss this later in this space. Similarly, one would have expected lower FE component in over-burden removal (OBR), which is costing 22.91 million USD. Localization of mining activities is a much desirable objective which has multiple advantages.

The main issues appear to be the financing cost and the diesel cost. We will first deal with the diesel cost and then take up the financing cost issues. Diesel cost appears to be one of the significant costs at 6.58 USD per ton coming out to be 15-16 percent of the per ton cost of production. In total annual terms, this would amount to 73.7 million USD per year — all in foreign exchange. We are passing through a foreign exchange crisis.

It is almost a perpetual problem; exports being less than half of the imports and rest expected to be filled by remittances and foreign loans. Not much explanation is required in this respect. SECMC itself is suffering from the lack of foreign exchange to pay off the liabilities of its foreign contractor which has served a notice. SECMC has enough cash but cannot convert it into dollars.

What can be done to do away or at least reduce this heavy out-flow of foreign exchange? The answer is electricalization. Electricalization of mining is being done almost everywhere in the world. With the introduction of EV, this has become to use EV trucks and shovels. Cheap local Thar electricity is already being produced at site. EV mining trucks of 30 to 400 tons have been developed which work on batteries. Similarly, electrical conveyors may be added as much as possible.

Earlier, one would have spoken about the need of BWE (Bucket Wheel Excavator) but these are diesel operated. One is not aware if electrical BWE has been developed. These may be a bit more expensive. I am not sure. It may add much to operating cost but would save diesel cost in foreign exchange. SECMC and the regulator may like to examine the electricalization issue.

Easier said than done; reportedly, there are tariff and accounting difficulties in using electricity from the partner electricity production project owned by the same share-holders. It is hoped that these issues are reviewed and a reasonable consensus is reached enabling saving of foreign exchange by reducing diesel fuel consumption. Motivations of similar companies abroad are different: pollution and climate change. Although we share the same values but our urgent issue is saving foreign exchange. It is hoped that both the petitioner and as well as the regulator would consider this issue and at least launch a partial Diesel-to-EV conversion programme.

Financing cost, especially, RoE at 18 percent in USD terms, appears to be high. But it is a contractual matter and has relevance to larger issues of IPP (independent power producer) projects. There is a debate on requesting renegotiations of the financial terms of these projects. However, a rate of 4 percent interest on long-term loan on sovereign guarantees, if quoted correctly, has saved our skin.

Today, LIBOR is at 5.5 percent as opposed to 0.5 percent only a few years back when Nepra (national electric power regulatory authority) was merrily awarding high margin at 4.5 percent. Thus LIBOR-based IPP loans' effective interest rates have increased to 10 percent per annum, almost double the earlier rate. All of this has necessitated reviewing the financial terms. We have discussed the options elsewhere.

For the phase-III project under consideration in this petition, the debt is being financed in local currency at KIBOR plus 2.5 percent, while KIBOR is being quoted at 21.99 percent. A margin of 2.5 percent is rather high. Usual rates for such established companies are in fraction of a percent. There are extra-ordinary conditions prevailing these days. It is wondered if alternative cheaper financing could be availed. The benefits of Thar coal became more evident when recently international coal prices tripled reaching 300 USD/ton. Rupee depreciation multiplied the problem. Unfortunately, we have installed three large coal power plants working on imported coal. Cheaper Afghan coal was available and also some local sub-bituminous coal from Balochistan was there which helped reduce the calamity.

The imported coal power plants' operational capacity came down to almost half. These may have to be closed down but fortunately imported prices came down to USD 125 per ton; still high. Thar coal energy content is about half that of international (Sub-bituminous) coal. Thus a 40 USD/ton local Thar coal price would mean 80 USD/ton in comparable terms. There is much more potential of Thar coal than is being evident in this particular project. About 20 MTPA of coal is imported for the three imported coal power plants. And industries like cement, glass, tiles and others also use gas or imported coal.

Only cement industry has converted to coal but largely uses imported coal; all of these can be converted to Thar coal. With further improvements and economies and localization, the impact of Thar coal would increase .There is a potential of saving 5 billion USD per year and this potential can be realized in the next 5 years. It is hoped that the regulator will consider our suggestions while examining the tariff petition. The federal government and Sindh government should resolve the issue of implementation of Thar rail link, which has been delayed enough by now. Other steps required are to involve third parties in coal mining beyond captive mining. Facilities and investments are required for processing Thar coal for industrial uses.

3.6: Gwadar coal-based power plant impasse

The Gwadar coal-power plant has reached an impasse. The project is being implemented under CPEC by a Chinese company. It is an important project affecting the progress and economics of projects in Gwadar. The project promoter company has designed and proposed a power plant of 300MW based totally on imported coal. Nepra and other relevant stakeholders rightly require the use of local coal in the backdrop of government's decision not to install any power plant on imported fuel due to the current account deficit crisis.

Nepra has asked the promoters to come up with a solution in three weeks to enable the regulator to award a tariff. We will examine the issues, difficulties and possible solution to the impasse. The project has been delayed by several years on account of many reasons. The Gwadar power plant is being discussed since 2015. Various concepts have been discussed and evaluated.

Originally, IC engines working on diesel were considered which appear to be still working. However, it is expensive and cannot possibly meet the requirements of such an ambitious project area. Later, a combined cycle power plant on RLNG was conceived. The idea was to ultimately connect it to the IP pipeline. The concept was dropped due to the mounting difficulties and sanctions on Iran.

Ultimately, the coal-power plant was selected as an option. In the meantime and very recently, a 150MW solar power plant has also been proposed. Indeed, solar option would have been the best. However, it had to be in hybrid form – solar-wind-storage, some IC engine coupled with electricity from Iran. This would have been the cheapest and the most secure and reliable option.

There is a good solar and wind resource around the Gwadar region. The project could have been implemented phase-wise matching the demand and saving the undue capacity payments of the initial period when demand would be much lesser. From the promoter's point of view, it would have been difficult to accept as they argue that they have already invested a lot of time and money in the current concept based on imported coal.

Candidly speaking, for project promoters, the imported coal projects are much simpler to implement and have many possible revenue streams. Gwadar is a port town which would be easily supplied from the Indonesian and South African ports. Often there is more income from buying coal under long-term contracts or even booking the whole mines for 30 years. It is very difficult for a promoter to eschew the imported coal option.

For Pakistan, imported coal is a bad recipe, especially under the current account deficit and the recent experience of a huge price rise for imported coal going up to $400 per ton or even more. The existing imported coal-power plants had to be run under-capacity and even had to be closed down.

Another imported coal-power plant in Jamshoro is already close to commissioning and cannot be switched to local coal readily and would need major changes in design. The concept of Gwadar project can be changed without any c-cost or loss except for the additional work in redesigning the plant. However, the major issue is where is the local coal? It is argued that Thar coal is being used at the mine mouth. It could not yet be transported outside Thar.

From Thar to Gwadar, it would be the longest distance among all imported coal-power plants. Even the Lucky Coal-Power Plant, which has been licensed on Thar lignite, is relying on imported lignite. There are logistics issues. Truck transport from Thar to the Lucky plant is feasible but is expensive and may damage the road system, it has been argued. There is a rail-link project that has been found feasible but is being delayed due to a tussle with Pakistan Railways, which wants to benefit from the revenue generated out of the link project.

The issue should be resolved and the project implemented under public-private partnership. It is quite possible that the rail link would be completed by the time Gwadar coal-power plant is ready for commissioning. However, the promoters are insisting on a design that may make the use of Thar coal impossible; use of API4 coal and boilers designed on that coal.

Fortunately, there is a working model in the form of Lucky power plant, which is currently working on the imported lignite API3. It is a super-critical power plant based on lignite coal but has specialised coal-crushing facilities which dewater the coal simultaneously with crushing and have larger boiler furnace designs required for low CV coal. The Lucky power plant is a good example of how private sector can solve difficult problems and implement projects that are acceptable to all.

The Gwadar coal-power plant can be modeled on Lucky Power. It can be allowed to initially work on imported lignite until Thar coal logistics are completed. Under no circumstances, it can be allowed to proceed with a design that almost completely seals the fate of the local coal. There can be flexibility in the time schedule and the remission of delayed fines and perhaps additional provision of capex for the changes that are required, although the capex is already too high if compared with international projects or similar projects implemented under CPEC.

Thinking long term, which should be done by the Thar Coal Energy Board, logistical arrangements should be studied for the transport of Thar coal to Keti Bandar. It can be a rail link or a water canal. Already, there is talk of bringing water from sea to Thar for expanding the Thar coal capacity utilisation, which has been estimated at an upper maximum of 8,000MW. From Keti Bandar, Thar coal can be transported to Gwadar through small sea vessels. On a more practical scale, Thar coal can be transported from Port Qasim to Gwadar by sea-going vessels. It may be much cheaper both in terms of opex and capex.

Thar is at a higher elevation. Coal slurry pipeline of 150 km can be laid up to Keti Bandar. There are coal pipelines working in the US and China. One may, however, ask why this fuss on a 300MW coal-power plant at Gawadar, which is 10% or less of more than 4,000MW imported coal-power plants? It is a genuine question. Something must be done in this respect as well. However, it is much difficult to make changes in the existing plants and relatively simpler in the new ones.

Figure 3.6.1: Gawadar-Thar Coal Transport Route

By the way, there is a large potential market for Thar coal in the industrial sector, especially cement, tiles and other extractive operations. However, industries would require dewatered and dried coal. Power plants have arrangements for drying but industries generally cannot. Besides, it costs more to transport wet coal. TCEB may like to pay attention to this aspect and open up new mines with drying facilities. Concluding, the plant is to be designed in a flexible model ala Lucky Power. It may initially run on imported lignite and later on the availability of logistics and others may be able to shift it to Thar lignite.

Electricity

4.1: Prospects of National Electricity Plan

The National Electricity Plan (NEP) is being developed by the Power Division as a consequence or supplement to the National Electricity Policy 2021, which has recently been approved by the Council of Common Interests (CCI). Yet another plan, some people are wondering, when for the last almost three years, there have been controversies and gaps in another plan (Indicative Generation Capacity Expansion Plan – IGCEP), which have yet to be settled. Already, there are a number of committed projects, which would take care of most of the next 10 years. Legal issues and disputes may emerge if the committed projects are not included in the NEP.

These are, however, practical issues which, it is argued, can be handled. NEP may even be validating the results of IGCEP, if not differing from it or improving upon it. It is argued that the IGCEP, developed by the National Transmission and Despatch Company (NTDC), is too narrowly based involving only two independent variables – gross domestic product (GDP) growth and electricity price – while the NEP is more broadbased involving six objectives – sustainability; energy equity and financial viability; security of supply; governance and stakeholders' input; research, development and indigenisation; market and risks – and 16 indicators.

A positive aspect of both the policy and the proposed NEP is the inclusion of security of supply and indigenisation. Indigenisation is to be viewed in terms of both fuel and equipment. We have mentioned earlier that Pakistan is lagging behind many developing countries in terms of local content, which increases the dependence, cost and drain of foreign exchange. Similarly, the dependence on imported fuel such as liquefied natural gas (LNG) and imported coal is a negative aspect of the prevailing fuel supply mix, which ought to change – easier said than done.

All energy sources have some negative aspects, dictating the need for a divergent supply mix, which balances out the positives and negatives. Renewable energy sources, such as solar and wind, have become highly competitive and affordable, yet these are variable. Solar is available during day time and wind and hydro are available in summers only. This year, hydro availability has posed a special problem recently. All countries, eg Brazil, which have a high hydro content, have suffered frequently due to water flow issues. In Pakistan, agricultural water conflict also poses a constraint in this respect. Thus, fossil fuels are required to balance the variability of renewable energy.

De-carbonisation

NEP would attempt to handle climate change and carbonisation of energy mix, which are additional issues that will affect Pakistan more than others, although our contribution to climate change is infinitesimal. There is direct and indirect pressure on the government to shape the energy mix in a manner so as to decarbonise it as much as possible. The problem is that there is nothing as a free lunch. Objectives often move in opposite directions.

There are investment and fuel supply issues as well. Indigenisation of fuels would certainly involve the development and utilisation of Thar coal, which is not liked by the international stakeholders. Indigenisation reduces the cost and foreign exchange drain. LNG is becoming expensive by the day, although it may complete its price cycle and may become competitive again. Local gas is cheaper but its resource base is going down and new sources are uncertain. Yet the gas (LNG and conventional) offers the most energy efficient route (60% plus for combined-cycle power plants higher than any other fossil fuel). NEP will attempt to handle demand management issues, although it is not always easy to match demand and supply and is done at a cost penalty.

The irony is that LNG was introduced to eliminate expensive furnace oil (RFO). We are still dependent on it and to top it all, the IGCEP projects that in a few years all the combined-cycle power plants will become redundant, although this is more due to gas and LNG price variations. There are political issues which hamper the adoption of a realistic and representative mixed cost, called WACOG, on which no consensus has been reached yet. Demand management affects cost and tariff. Adequate demand management reduces peak demand and helps utilise the installed capacity to the highest possible level and thus reduce the fixed cost.

Provincial issues

In almost all energy discussions, provinces appear to be unsatisfied and demand more share, benefits and participation. On the other hand, provinces are free riders in many ways. The clearest example is the ever-rising circular debt. Cost side of the equation is borne by the federal government and most of the leakages are of provincial origin. One would like to ask, why not provincialise the whole energy system as is the practice in most federations?

It is a complicated issue and involves many risks most important of which are capacity and capability gaps and optimisation issues. Ultimately, it may have to be done at some point in time but falls beyond the scope of our discussion here in this space. In the intervening period, something can be done to satisfy provinces to a good extent. The problem is that all planning and modelling has been done at the integrated level. For example, in all the models developed earlier, subsectoral demands have been addressed but not the provincial one, the latter in an indirect obtuse manner only. NEP modelers may do well to introduce provincial equations as explicit variables.

The NEP objective mix includes universal access/ rural electrification, which can be a vehicle to achieve this as well. Renewable energy sources such as wind and solar in the form of distributed generation could help achieve some aspects of provincial issues in remote areas, especially Balochistan. Unfortunately, we are still tied to the central grid system and planning in terms of centralised generation and associated transmission.

NEP should bring distributed generation into the fore and if it does so, it can earn its place despite the IGCEP being an established planning approach. Distributed generation, although not necessarily fully, will help solve universal access and provincial issues as well. NEP objectives include financial viability in terms of cost and affordability, the latter two being reciprocal of each other.

The classical least cost planning is intended to achieve this, although an upper limit to cost can include both aspects of cost and affordability. Fuel cost and supply constraints have been a significant issue behind load-shedding and lack of capacity utilisation. The Integrated Energy Plan (IEP) has been discussed in the past and has continued to be on agenda. Planning Commission has tried it a number of times but could not succeed for a variety of reasons. Inter-ministerial rivalry has been partly responsible for this. But the combined Power and Petroleum Divisions may be able to deliver it this time. It is not known whether NEP people plan to include the IEP or fuel supply module with the required level of detail and granularity.

Concluding, intensive stakeholder consultation is being undertaken, however, the proof of pudding is in its eating. We look forward how the exercise of NEP comes out and whether it is able to replace IGCEP or serves as a base for detailed planning and improvement of the existing framework.

4.2: Power distribution sector's performance

Circular debt and privatisation of power distribution companies are under active discussion these days in the background of International Monetary Fund's (IMF's) demands. Apart from the IMF, the issue is important enough, warranting consideration at domestic level as well. Unsustainable electricity tariff is considered as one of the woes, and cross subsidies being one of the culprits. From a social point of view, this is the oddest time to consider reforms when the largest victims of the economic downturn are the poor and the poorest of the country.

How to minimize impact on the poor is the biggest question in any sectoral reforms that are to be on the policy discussion table. In this context, performance review and improvement of DISCOs is to be possibly on the top of the list. We will take up a few indicators and try to draw up some conclusions in this space. For reviewing the status of the power distribution sector, the most revealing is the negative equity of all DISCOs. It may be startling to note that all DISCOs have a negative equity due to continued accumulated losses. We have 2020 data courtesy a USAID study.

Total DISCOs' equity is minus Rs 1.013 trillion. PESCO (Peshawar Electric Supply Company) tops the list with minus Rs 282 Billion, followed by QESCO (Quetta Electric Supply Company) Rs 196 billion, LESCO (Lahore Electric Supply Company) Rs 170 billion, HESCO (Hyderabad Electric Supply Company) Rs 121 billion and SEPCO (Sukkur Electric Supply Company) Rs 122 billion being among star losers. PESCO's negative equity of a magnitude of Rs 282 billion has a context of being the highest T&D loss (38.69%) company. One would have expected QESCO to be the highest loss share company, but it isn't.

T&D losses

Disco T&D losses have come down from 21.7% in 2017 to 17.5 % in 2021 as against Nepra's (National Electric Power Regulatory Authority's) target of 13.41%, while KE (K-Electric) losses have come down to 15%. KE losses are still more than better performing companies like IESCO (Islamabad Electric Supply Company), FESCO (Faisalabad Electric Supply Company) and GEPCO (Gujranwala Electric Power Company). Apparently, there is no reason that KE losses should not be comparable. However, this is a separate issue.

T&D losses are indeed one of the worst aspects of DISCO performance and source of losses. These should not exceed a level of 5% and a maximum of 10. As expected, PESCO T&D losses were the highest of all at 38.69%; followed by SEPCO 36.27%; HESCO 28.82%; QESCO 26.68%.

Again, it is surprising that HESCO and QESCO losses are comparable, contrary to general expectation that QESCO would have the largest losses as a % of sales. Among better performers are IESCO, GEPCO and FESCO having losses fewer than 10%. Typical T&D losses in OECD countries are at around 5%. In lesser countries, T&D losses are at 10-15%.

Recoveries and receivables

Total Disco receivables in 2021 were of Rs.1.266 trillion. Receivables in public sector companies balance sheets are often doubtful. If these receivables are discounted, the negative equity would jump to Rs.2.26 trillion. However, before discounting receivables totally and finally, let us have a look at its break-down. Out of the total receivables, Rs 683 billion, almost half belong to private consumers. How much of it will be actually realized is an open question.

Similarly, Rs.354 billion is due on account of Balochistan agricultural consumers. Will GoP or provincial government pay on their behalf? In any case, it would be a loss. The only realizable receivable is probably Rs.189 billion from the government, which is on account of unpaid bills by the government department.

There is some problem in 2021-22 recovery rates as negative losses have been shown meaning that more money was received than billed. Perhaps, it is due to recovery of some long over-dues, one is not sure. Average bill recovery rate of all DISCOs comes out to be 90.51% in 2021-22. Billing was at Rs 2,423 billion while recovery stood at Rs 2,193 billion, reflecting an unrecovered amount of Rs.230 billion.

The lowest collection is of SEPCO at 56.6% as compared to HESCO's 70.1% and QESCO's 80.6%. Among bad performers, Mepco's (Multan Electric Power Company's) recovery of 94.21% is surprising, while of PESCO's 87.7%. It is surprising that IESCO recovery is the lowest among good formers at 90.3%. Perhaps, there is some mistake in this data. If unrecovered amount is reduced by 50%, there is a saving/revenue potential increase of Rs 115 billion.

It appears that T&D losses could be brought down to 10% or less than 10 % as is the case with the better performing companies like IESCO, FESCO and GEPCO. It is said that half the T&D percentages are technical losses and half are theft; this may be true in the case of IESCO, FESCO and GEPCO where the losses are less.

In case of companies with higher losses, PESCO, HESCO and HESCO, this is not the case. Only 5-7% may be technical loses, and the rest 25-30% may be sheer theft. Poor law and order conditions and elite participation in it are the widely acknowledged reasons.

Situation in the region

Disco is called DISCOM in India; both mean distribution companies. There is a mixed situation in most developing countries. For example, in India AT&C losses even exceeded recently from 20.73% in 2019-20 to 22.32% in 2021-22. India has targeted it at 15% which has yet to be achieved. Amazingly, these losses were at 40% in the year. In problem areas, the losses are of this order. In Delhi, Kerala and Punjab, the losses are around 10%.

DISCOM losses in India may even further deteriorate in coming years due to economic factors. DISCOM losses after receiving a subsidy of IRs.986 billion were IRs 61 billion with accumulated losses on the books at IRs 4.886 trillion (In Pakistan parlance, this may be taken as near equivalent of circular debt). The gap between unit revenue and cost increased from IRs 0.30 per kWh earlier to IRs 0.90 per kWh in FY 21. This gap should increase due to higher fuel costs in international market, although India is not heavily dependent on imported coal as Pakistan is.

The ills in India are the same as in Pakistan: poverty, theft, corruption and elitism. Ironically, the solutions cited in the Indian literature are identical with what is normally discussed in Pakistan: big targets lesser achievements.

For example, India has plans to install smart meters for almost a decade. It has achieved an implementation by now of 2-4% in this respect. Fortunately, Pakistan has adopted a programme of smart meters on Distribution Meters, which India has too. It may cost under 500 million USD. Otherwise, complete smart metering on all consumers in Pakistan would have cost 5-7 billion USD. This kind of money would not be available here. There are other priorities and approaches to improve DISCO performance.

Bangladesh reduced its T&D losses from 36.19% in 1988 to 15.42% in 1998, in a period of only 10 years. Is it poverty reduction or increase in GDP growth that has caused it? Bangladesh also had to go to the IMF recently under similar reasons of higher energy imports. Both Bangladesh and Pakistan are greatly dependent on LNG and furnace oil imports.

T&D losses have been valued at Rs 520 billion. If losses are reduced to Nepra's (National Electric Power Regulatory Authority's) target level, there would be a saving of Rs 122 billion. If T&D losses are brought to a level of 10%, there would be an annual saving of Rs 215 billion. Combined with improved recovery potential saving of Rs 115 billion, total saving potential comes out to be Rs 330 billion.

We would like to correct a tendency in popular circuits of estimating total loss value and calling it saving potential. As discussed, there is a limit to loss reduction. We are not discounting here NTDC (National Transmission and Dispatch Company) transmission losses, as its scope and impact of savings is not significant.

No serious effort appears to have been made towards reduction of the T&D losses. There was a USAID project of DISCO improvements in 2007-2014, which did a lot of effort and made some key recommendations. The project installed demonstration/pilot projects involving Smart Meters in PESCO, MEPCO and HESCO. Later on in 2014, ADB (Asian Development Bank) developed an ill-designed Smart Meters (SM) project for better performing DISCOs like IESCO and LESCO. One could not understand the logic behind selection of these companies; while ignoring the worst-performing companies where pilot projects had already been launched earlier by USAID project, professional jealousy or what?

Power distribution sector's performance

Another problem with smart meter project's design is the proposal of installing SM at consumer premises. There are 35 million consumers, which would cost 5-7 billion USD and 7-10 years to install. An alternative project design could be SM installation at Distribution Transformers (DTs), which would have cost lesser time and money around 500 million USD. The issue continued to be debated between lender and the borrower. Fortunately, an agreement has been reached on an optimal and prioritized project design.

It is hoped that SM project would be completed in three years or less. Governance issues may still remain as SM project can be resisted and destroyed by the chieftains and Mafias. If DTs can be stolen and installed at locations of choice, what can possibly be done? The technique is of isolating high theft areas through DT and Transformer input and output (sales/bills) analysis. One can then apply increased vigilance and inspections to identify real culprits. Smart meters can then be selectively installed in such cases. KE has worked on such a scheme and has achieved success.

The kunda culture

Table 4.2.1: Disco's Transmisson & Distribution (T&D) losses

COMPARISION OF DATA FOR FY2019-20 WITH LAST FOUR YEARS (2016-17, 2017-18, 2018-19, & 2019-20):

3.1 Transmission and Distribution (T&D) Losses (%):

Name of DISCO	2016-17	2017-18	2018-19	2019-20	2020-21
PESCO	32.6	38.1	36.6	38.9	38.20
IESCO	9.02	9.13	8.86	8.69	8.55
GEPCO	10.24	10.1	9.87	9.51	9.23
FESCO	10.6	10.5	9.8	9.6	9.30
LESCO	13.8	13.8	13.2	12.4	11.96
MEPCO	16.9	16.6	15.8	15.2	14.97
QESCO	23.1	22.4	23.6	26.7	27.96
SEPCO	37.8	36.47	37	36.3	35.30
HESCO	30.8	29.8	29.5	28.9	28.20
K-Electric	21.71	20.4	19.1	19.73	17.54

Unauthorized connections and theft have been done classically through kundas and tampering with meters. There has been much talk about installing cables, which are technically called ABC (Aerated Bundled Cables). PESCO and MEPCO had announced programmes for installation of these cables. ABCs help fight kunda connections due to covering as opposed to bare conductors employed normally. These are a bit expensive but have been quite successful. An added advantage is safety preventing electrocution and other incidents.

KE has reported some success in installing ABCs in problem areas. How much implementation has been done in DISCOs is not known. KE invested 50 million USD through a loan programme. High-loss DISCOs such as PESCO, MEPCO, HESCO, SEPCO and QESCO certainly need this kind of installation. There are other requirements such as conductor sizing and distribution transformer improvement that may help in reducing technical and non-technical losses.

Readers may think that I am justifying the ills and inefficiency of power sector in Pakistan. India is much better than us on several accounts in this area; its generation cost is less; it has much high local content both in equipment, materials and fuel. General technology level is higher. While we will take up some technical issues later, we would like to make a recommendation that may work in both countries; increase minimum wages significantly, doubling in less than three years and continuing the trend into the future. This would enable the poor to buy some energy at international prices. Before, achieving the afore-mentioned, reducing cross subsidies and leakage are not possible. In the aftermath of Covid, floods, war in Europe, international energy crisis and high prices, recession and, particularly, heavy currency devaluation in Pakistan are the factors that must be appreciated by the IMF (International Monetary Fund) and other institutions. It does not mean that the federal government cannot do an thing; it can collect taxes from the powerful of one sort or the other. It may be argued that an increase in minimum wages may take time, but then so should the energy tariff increase agenda. This requires growth and employment and collection of revenues.

Table 4.2.2: Recovery (%)

Name of DISCO	2016-17	2017-18	2018-19	2019-20	2020-21
PESCO	89.1	89.5	88.6	87.7	102.5
IESCO	99.64	99.1	90	90.3	116.87
GEPCO	98	97	98	94.36	106
FESCO	97.21	97.93	91.03	94.18	102
LESCO	100.45	97.8	97.67	94.6	98.72
MEPCO	96.21	99.68	99.8	94.21	103.61
QESCO	43.5	46.1	24.4	80.6	39.8
SEPCO	110.8	60.1	63.9	56.6	64.7
HESCO	95.2	76.7	74.5	70.1	76.7
K-Electric	90.04	91.04	92.6	92.14	94.8

Many DIPs (dual in-line packages) have been launched in the past with technical and financial assistance of ADB and USAID. How successful these have been? The glass is half full and half empty. Aid programmes have their own problems and peculiarities with large overheads and project design issues. Success depends on recipients as well. Nepra could do well to launch a DIP focusing on T&D loss reduction and tariff incentives thereof and specifying activities and improvements.

Table 4.2.3: Key FY20 Financial figures, PKR billion

Particulars	IESCO	LESCO*	GEPCO	FESCO	MEPCO	HESCO*	SEPCO*	QESCO*	PESCO	TESCO	TOTAL
Assets:											
Non-Current Assets	102	93	55	127	118	41	29	90	75	11	741
Current Assets	170	217	110	130	174	160	174	154	256	99	1,644
Total Assets	**272**	**310**	**165**	**257**	**292**	**201**	**203**	**244**	**331**	**111**	**2,385**
Liabilities:											
Non-Current Liabilities	84	224	116	144	184	51	47	48	195	24	1,116
Current Liabilities	195	256	57	123	193	272	268	392	418	108	2,281
Total Liabilities	**279**	**480**	**173**	**268**	**377**	**322**	**314**	**440**	**612**	**133**	**3,398**
Total Equity	**(7)**	**(170)**	**(7)**	**(11)**	**(85)**	**(121)**	**(112)**	**(196)**	**(282)**	**(22)**	**(1,013)**
Total Equity and Liabilities	**272**	**310**	**165**	**257**	**292**	**201**	**203**	**244**	**331**	**111**	**2,385**
Working Capital	(25)	(39)	53	7	(19)	(112)	(94)	(237)	(162)	(9)	(637)
Revenue:											
Electricity Sales-net	134	269	125	168	199	50	34	54	128	27	1,186
Subsidy from GoP	23	63	28	59	80	36	21	32	73	4	420
Total Revenue	**157**	**332**	**153**	**226**	**279**	**86**	**55**	**86**	**201**	**30**	**1,607**
Gross Profit/ (Loss)	10	33	10	31	31	4	(3)	(3)	1	7	122
Net Profit/ (Loss)	(12)	(2)	(12)	6	0	(11)	(17)	(65)	(20)	3	(130)

Note: *Un-audited financial statements

Nepra currently feels contented with giving targets of loss reduction and recovery. It is not enough. Ogra (Oil and Gas Regulatory Authority) has launched a similar programme which has had a reasonable success in at least one of the Gas DISCOs.

Organisational issues

There is a role for ministry in policymaking issues of the sector and inter-sectoral and inter-ministerial coordination and dealing with international financial bodies and other international agencies. It is in itself a large agenda. Boards have been formed and their role has been emphasized and these have been encouraged to do more than fiduciary responsibilities.

Table 4.2.4: DISCOs Operational Performance during FY20

DISCO	T&D Losses - Reported, %	T&D Losses Allowed, %	Loss due to breach of T&D Loss target, PKR billion	Collection Rate, %	Loss due to non-collection, PKR billion	Combined AT&C Losses, PKR billion	Overloaded 11kV feeders	Overloaded power transformers	No. of trippings of 132kV	Consumers, million	Units Sold, TWh
In Red	>10%			<90%			> avg	> avg			
IESCO	8.69%	8.60%	0.2	90.3%	19.6	19.7	6%	3%	204	3.1	10.4
LESCO	12.40%	10.88%	5.9	94.5%	20.9	26.8	24%	16%	3,442	5.2	20.6
GEPCO	9.51%	10.03%	Nil	94.4%	9.5	9.5	7%	9%	91	3.7	9.9
FESCO	9.62%	10.10%	Nil	94.2%	13.3	13.3	5%	11%	314	4.4	13.1
MEPCO	**15.23%**	**15.00%**	**0.7**	**92.9%**	13.9	14.6	**15%**	**12%**	**1,889**	**6.9**	**16.4**
HESCO	**28.82%**	**22.59%**	**7.9**	**73.2%**	19.5	27.5	**12%**	**21%**	**418**	**1.1**	**3.9**
SEPCO	36.27%	29.75%	6.0	56.5%	20.8	26.8	19%	12%	828	0.8	2.7
QESCO	26.68%	17.50%	10.9	49.3%	55.6	66.6	100%	29%	436	0.6	4.8
PESCO	**38.69%**	**31.95%**	**22.5**	**87.7%**	19.8	42.3	**31%**	**36%**	**614**	**3.7**	**9.0**
TESCO	16.19%	12.47%	0.0	68.2%	9.0	9.0	79%	29%	80	0.4	1.8
Total	**17.82%**	**15.53%**	**54.0**	**88.8%**	**202.0**	**256.0**	**23%**	**17%**	**8316**	**30.0**	**92.8**

Source: State of Industry Report, DISCO Performance Evaluation Report, DISCO Performance Statistics

Note: IESCO: Islamabad Electric Supply Company; LESCO: Lahore Electric Supply Company; GEPCO: Gujranwala Electric Power Company; MEPCO: Multan Electric Power Company; HESCO: Hyderabad Electric Supply Company; SEPCO: Sukkur Electric Power Company; QESCO: Quetta Electric Supply Company; PESCO: Peshawar Electric Supply Company; TESCO: Tribal Areas Electric Supply Company

Neither do boards have improved their performance, nor do ministries let the boards operate independently with deeper involvement in company policy and performance issues. It is often argued that boards are not selected on merit. Engineering and sectoral experts argue that it is only they who are entitled to be on the boards. They seem to discount other professionals' inputs such as those belong to finance, law and management.

Table 4.2.5: Snapshot of Discoms' Financial Performance

	Unit	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Discom Loss on subsidy received basis	Rs Crore	71,621	68,257	56,939	48,619	38,745	33,594	61,360
Subsidy received	Rs Crore	36,100	36,758	45,584	74,515	78,938	88,919	98,653
Gap (ACS-ARR) on subsidy received basis	Rs/kWh	0.84	0.78	0.58	0.48	0.37	0.30	0.52
Accumulated Losses as per Balance Sheet	Rs Crore	253,700	306,317	358,581	413,933	411,753	440,826	488,686
Total Outstanding Debt	Rs Crore	304,228	365,066	403,816	421,978	416,957	454,773	478,452
AT&C losses	%	25.48	22.62	25.72	23.96	23.50	22.33	22.01
Outstanding dues by Discoms (As on last month of FY)	Rs Crore	NA	NA	NA	NA	31,704	42,063	66,652

Table 4.2.6: Investment allowed and made by DISCOS during last five years

(Rs. in million)

DISCOs	Description	2016-17	2017-18	2018-19	2019-20	2020-21
PESCO	Allowed	8,366	9,610	7,029	8,450	9,982
	Actual	8,366	11,347	7,029	5,725	13,938
TESCO	Allowed	971	770	2,150	2,500	4,053
	Actual	971	744	2,150	2,500	n.p.
IESCO	Allowed	10,090	6,719	11,918	10,090	6,719
	Actual	5,313	7,451	10,259	7,413	8,625
GEPCO	Allowed	2,775	3,200	5,295	5,500	5,554
	Actual	2,775	1,617	5,295	6,749	5,942
LESCO	Allowed	19,781	21,459	10,826	19,781	21,459
	Actual	9,758	12,081	10,527	10,238	n.p
FESCO	Allowed	7,140	7,857	11,084	8,803	7,857
	Actual	8,033	3,502	6,244	7,640	10,268
MEPCO	Allowed	11,416	13,000	13,439	14,000	8,369
	Actual	11,416	12,924	13,439	13,887	10,927
HESCO	Allowed	4,729	5,500	3,072	4,597	2,227
	Actual	4,729	4,804	3,072	1,971	n.p
SEPCO	Allowed	977	3,400	3,467	4,000	3,981
	Actual	977	3,062	3,467	2,137	n.p
QESCO	Allowed	3,080	8,000	4,308	3,763	4,243
	Actual	3,080	4,748	4,308	2,619	3,765
TOTAL	**Allowed**	**69,325**	**79,515**	**72,588**	**81,484**	**74,444**
	Actual	**55,418**	**62,280**	**65,790**	**58,379**	**53,465**

Source: DISCOs

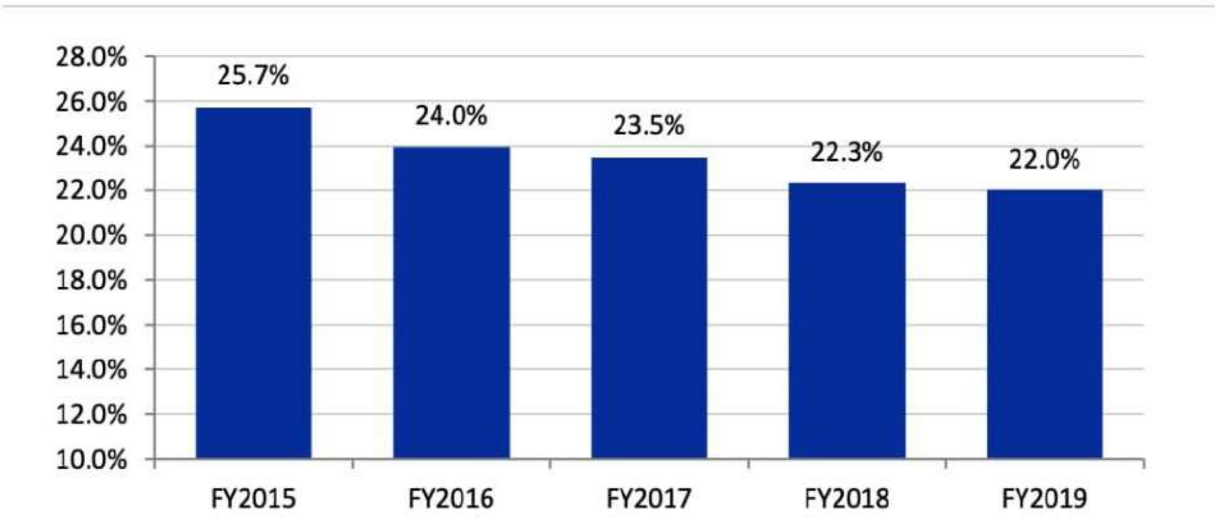
Figure 4.2.1: Accumulation of Circular Debt

Table 4.2.7: Circular debt flow

Item	June 2020 (PRs billions)	December 2020 (PRs billions)	Projected June 2021 (PRs billions)
Section A: Break-up of Circular Debt Balance			
Payable to IPPs	1,038	1,225	1,510
Fuel payables	105	100	100
PHPL payables	1,007	977	977
Total	**2,150**	**2,303**	**2,587**
	July 2019 to June 2020	**July 2020 to Dec 2020**	**Projected July 2020 to June 2021**
Net increase in circular debt flow	**538**	**152**	**436**
	July 2019 to June 2020	**July 2020 to Dec 2020**	**Projected July 2020 to June 2021**
Section B: Break-up of Circular Debt Flow			
DISCOs under-recovery	199	(37)	58
Unbudgeted subsidies	135	41	197
Pending generation cost adjustments	270	121	151
DISCOs inefficiencies	42	8	59
IPP interest charges, delayed payments	55	42	92
PHPL mark-up	70	33	68
Nonpayment by K-electric	77	40	97
Unpaid subsidies	-	38	-
Subtotal	**848**	**286**	**722**
Less: Prior-year recoveries	(310)	(134)	(286)
Net increase in circular debt flow	**538**	**152**	**436**

( ) = negative, DISCO = distribution company, IPP = independent power producer, PHPL = Power Holding Private Limited, PRs = Pakistan rupees.
Source: Asian Development Bank.

Figure 4.2.2: trends in AT&C losses at all India level



PEPCO was disbanded and boards were brought into the picture expecting that this would work. It hasn't. One may argue that the 'glass is half or full' syndrome may be there. It is alleged that PEPCO became just another bureaucratic layer without much value-addition. After board's lack of success, it was thought that reviving PEPCO in an improved form and agenda could be a good idea. However, a confused organization has been founded, which could not start functioning after two years of the founding decision. In India, there is a highly competent body like CEA (Central Electric Authority) that provides all technical input and guidance to the electrical power sector. In Pakistan, we need to have a similar body.

4.3: Improving power DISCOs' performance

Inefficiencies of distribution companies have been considered as one of the main power sector problems, although this is not the sole issue and performance improvement alone may not allow to get rid of the problems and difficulties of the sector. Losses may at best be halved and brought to the level of 8-10%. Technical improvements such as smart meters alone may not be a panacea but organisational changes would be required as well. We will discuss some of these issues and strategies in this space.

One of the DISCO performance metrics is T&D losses, which include technical and commercial losses. The latter includes theft and there is no dearth of it in the system. In Pakistan, aggregate T&D losses have amounted to 17%, a slight improvement over immediate years. Interestingly, the situation in India is more or less the same. There, these losses are 21%, which have come down from 33% in 2003. There should be no complacency, however, in India the financial condition of DISCOs is almost equally bad, requiring billions of dollars of bailouts by the central government. There is so-called circular debt too, which as per latest data was INR 1.39 trillion – our corresponding figure is PKR 2.3 trillion, roughly equal taking into account the exchange rate difference.

It should be noted that the Indian economy and population is 8-10 times larger than that of Pakistan with installed generating capacity of 373,436 megawatts, of which 89,636MW is renewable and 45,699MW is hydro. Reasons are almost identical between the two countries – poverty and low paying capacity of consumers, theft and leakages, corruption and inefficiency.

Average may, however, be a deceptive metric. It can hide good and bad performers. Pakistan's average of 17% hides worst performers Pesco, Mepco and Hesco with T&D losses of 38.8%, 14.93% and 38.55% respectively and good performer Iesco at 8.54%.

Organisational issues

One thing that appears to be common among high T&D loss entities is their size and geographical areas – Qesco, Pesco, Hesco and Mepco have geographical areas of 334,616 square km, 77,474 square km, 81,087 square km and 105,505 square km. By comparison, K-Electric's jurisdiction is 500 square km, which has a peculiar urban domain. Qesco is a supplier to the largest province, which is sparsely populated.

Large areas mean larger distances between control centres and field offices and facilities. Distance breeds remoteness, lack of control and oversight, and field officers' fiefdoms. It is said that the farthest point from the head office should not be more than 100 km to enable senior managers to travel to field offices and facilities.

Small and cogent DISCOs have been discussed over the years. Pesco's division into two or three companies is on the cards. Hesco has been divided already into two parts. There is indeed a strong case for dividing large geographical domains of DISCOs into two or three parts. It may also be noted that with the implementation of Competitive Trading Bilateral Contract Market (CTBCM), electricity selling business is slated to be taken away from DISCOs and given to independent licensed companies as has been done in most advanced countries.

Thus, one-third of the turnover may be privatised. If geographical division is implemented as well, the DISCOs size would be reduced to 20-30% of the existing parameters. The size reduction along with wire-only status may enable the DISCOs to improve their efficiency as money and market aspect may be taken away from them and they would be restricted to asset management.

In the reduced size, the risk of managing DISCOs may come down and competition among takers may increase. Lesser companies may delve into buying and running DISCOs. In the current situation of large assets and turnover, only foreign companies and their joint ventures may venture, which may result in foreign exchange drain.

Privatisation has been opposed by trade unions and they have managed to discourage it, although it is the government which did not have clear plans and strategy in this respect. This may continue to be the case.

Companies can, however, be divided without going into privatisation. In fact, the prospects of privatisation may improve. Only accounting and billing has to be separated along with a few other manageable organisational adjustments. Smaller companies may require cheaper management and smaller boards as well. T&D losses and other pilferages may be controlled due to closer control and oversight. This is the step one that could have been taken by any hesitant government. High-loss DISCOs may be initially taken up for this task.

Technical interventions

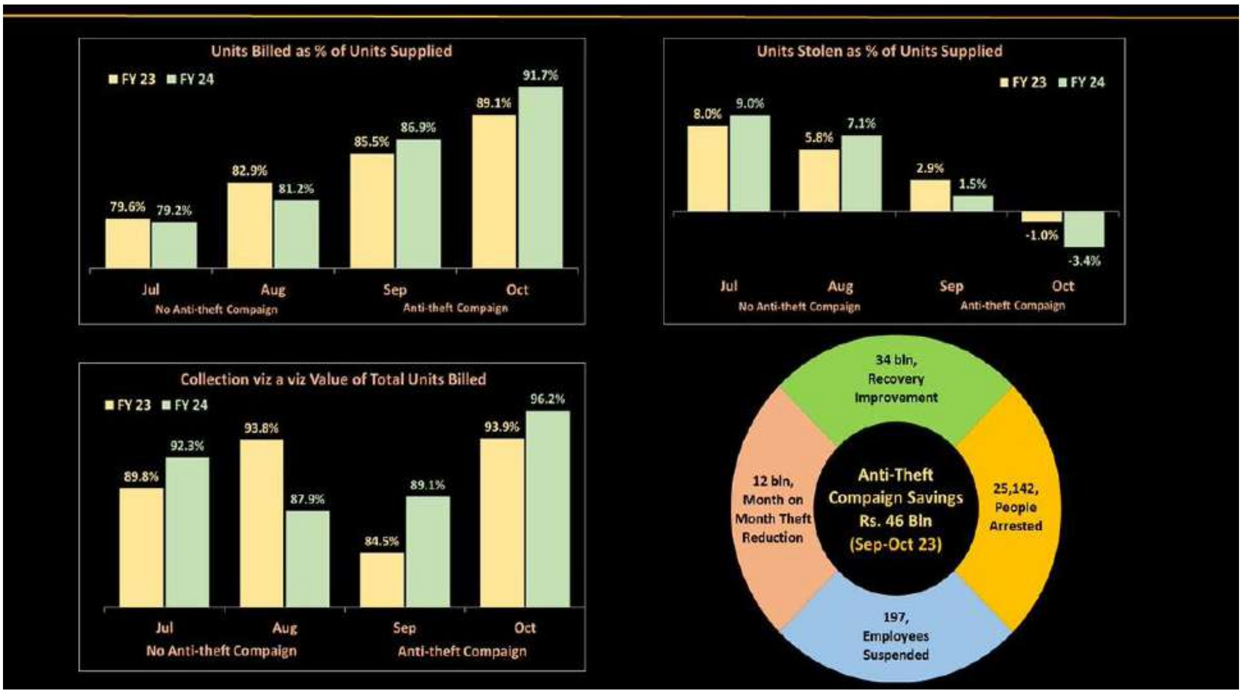
Interesting developments have taken place for the reduction in T&D loss (theft, leakages, billing frauds, etc). A Canadian company has developed a smart and mobile sensor, which can be installed (clipped with ease) on transmission or distribution wires and major electrical parameters can be measured. It has an inbuilt wireless communication module, which instantaneously transmits data to an analytical software platform.

Anomalies in the energy flow can be diagnosed with the help of database. The sensor at $100 a piece is not a bad deal. It is not required to be fixed at one place but is mobile. Hence, a few teams per district can have sets of these sensors to keep monitoring possible anomalies and theft.

Fifty sensor sets per district can enable formation of a viable anti-theft squad. For 100 districts, it would be 5,000 sensors. In $1.5 million, a whole country-wide project can be launched. However, there is a catch in it. It requires the support of a software platform, which can be costing more than the hardware and the consultant's fee. The company offers a performance-based payment. It brings its own software and hardware and takes a share in the savings from loss reduction.

Remarkable progress has been made in the area of data mining and analytics and forensic software. Billing analysis can reveal cases of fraud and collusion in meter reading, bills compilation and payments received. There can be internal or external issues. It would be advisable that our DISCOs (both electrical and gas) employ these software or employ specialised consulting services in this respect.

Figure 4.3.1: Anti-Theft compaign Statistics (7 Sep-31 Oct 2023)



Smart meters

We would emphasise the redesign and revival of smart meter programme, which has the potential of reducing theft. The current programme is purposeless and not feasible. If implemented, throughout Pakistan, it would cost more than seven years and almost 10 years.

A redesigned programme focused on distribution transformers would be cost effective and can be fast-tracked to two years. Priority should be given to high-loss DISCOs where the initial ground already exists through the earlier US-aided pilot projects.

4.4: Privatisation of power distribution companies

DISCOs (distribution companies) in the power sector have been a constant source of worries for successive governments in Pakistan. Losses, leakages, receivables, supply quality and discontinuities, and now the rising circular debt for which DISCOs are only partly responsible.

Many options have been examined and pursued, of which two are the most common and widely debated; privatisation and provincialisation. Provincialisation and privatisation need not be mutually exclusive as we will discuss later. And there is electricity market (CTBCM), which may result in partial privatisation by way of taking away electricity marketing and selling. We will examine the issues and prospects involved in each option.

In the electricity sector, power DISCOs are the remaining entities, which are the subject of policy discussion for some kind of offloading from the federal government. There is a circular debt of around Rs3 trillion, which belongs to the power sector and mostly lodged in the accounts of DISCOs.

High generation cost and unpaid subsidies may not be exactly ascribed to DISCOs. High fuel cost has been a recent phenomenon wherein gas and coal prices tripled, causing uncollected receivables, close-outs and increased theft; and then macroeconomic problems like current account deficit (CAD), currency depreciation and general inflation. Finally, Covid followed by floods. This is coupled with IMF and other IFIs dementia, which fail to recognise these issues and insist on increase in tariff, a subject that merits discussion some time later.

Privatisation background

There has been a long experience of privatisation. Public sector industries have been mostly privatised; some are running successfully and some have closed down for a variety of reasons.

Financing the annual losses and deficits has been a major issue of the SOE, which was largely reduced. Some still remain like PIA and Pakistan Steel, which have to be financed from government kitty almost yearly with no end in sight. In energy sector, privatisation has not happened, although government shares have been reduced in some companies. The problem with energy sector is that these are mostly monopolies or near-monopolies and are typically large companies.

Some companies have been and continue to be profitable and have been financing energy sector deficit like circular debt. OGDCL, PPL and PSO are successful examples. Although OGDCL and PPL are profitable, there are performance issues and their falling oil and gas resources have made their prospects of survival questionable. Gas DISCOs have almost the same problems as power DISCOs have.

Component of private sector has become significant due to the introduction of IPPs. Hydro and nuclear remain in public sector, while most of the other power generation is under private sector IPPs. There are some power generation companies in public sector (GENCOs), which are slated to close down eventually, one after the other. Private sector (IPPs) has an installed base of 18,750MW.

Privatisation issues

Why hasn’t privatisation succeeded or even implemented in the power sector? There are many possible reasons for it. Firstly, DISCOs are a monopoly involving complex financial transactions. Electricity prices are not determined by the market. Prices have to be subsidised for the low-income group and even for export subsidies.

Accounting for these subsidies and losses in transferring and continuing with these is indeed complicated and makes both government (the seller) and private sector (the buyer) unsure of the viability and the risks involved. KE was privatised in a highly fluid framework, when almost nobody was prepared to take it over. IFIs pushed the privatisation process. Secondly, DISCOs are large companies, financially and geographically. There aren't many parties in Pakistan which have the financial and organisational capacity and capability to buy and run these organisations.

If there are a few, one would be diverting them from doing much useful work in other sectors. Look at PTCL. It was taken over by UAE government-owned Etisalat. Some of the large banks have been taken over by NGOs or foundations. Thirdly, there are risks in selling DISCOs to foreign enterprises due to special problems involved in DISCO business. There is widespread theft in which rich and powerful are involved.

A foreign company in loss may resort to international courts due to these issues. What has happened in the case of Karkey and Reko Diq. Local partners may also indulge in some questionable and unacceptable practices, which are not unthinkable for the private sector in this country. Money laundering and double book-keeping is rampant, which can create complications of international dimensions. Many internationally reputed companies are not interested to come to Pakistan. Thus, there are risks on both sides.

Fourthly, stability and sustainability of government policy is yet another risk and unknown. Pakistan is a poor and developing country where political and ideological issues haven't yet been sorted out with a broad consensus. This creates differences and disagreement in business transactions. Chinese have recently demanded withdrawal of Mohammad Ali Report; the latter report pointed out some accounting inadequacies in CPEC power projects. Power generation is much simpler business than DISCOs. The opportunities of contract disputes are many as indicated earlier. This may cause cracks with major international friends.

Fifthly, a new policy issue and complication has emerged, that is of CTBCM. DISCOs are to be reduced to wire-only business. Under CTBCM, there is an open access wheeling policy under which the current DISCO management argues cost allocation has not been done properly. They have gone to court.

CTBCM is in limbo but has to be implemented under Nepra law.

Sixthly, public is not satisfied with the privatisation of KE, which is the only example of DISCO privatisation. This is not the place here to go into the controversial issue of KE performance. Excessive load-shedding in Karachi has annoyed both residential and industrial customers. Would new parties into the DISCO privatisation process be any different? They may have the same or even more management, capital and ownership issues. This makes provincial governments rather unsure of supporting DISCO privatisation.

Seventhly, there are financial issues of payables and receivables and accumulated losses. Valuation issues are not simple; there are risks and uncertainties of all kind. Some propose selling DISCOs in one rupee.

Eighthly, there is a labour union issue. Pakistan's private sector employers do not have very good standing with labour and employees. Their scepticism is not misplaced either.

Unions oppose privatisation. No practical formula has yet been available to deal with the labour union's opposition.

Many federations in the world have energy sectors, especially power distribution, under provincial administration, although the entities are mostly privately owned in advanced countries like the US, Australia and Canada. In Germany, even local government manages power distribution. In India, DISCOs (distribution companies) are provincially managed where these are in the public sector as well.

In Pakistan, both provinces and the federal government have played with the idea of provincialisation of DISCOs. In Sindh, there has been a particular interest in this respect. PPP-led provincial governments are ideologically pro-public sector and labour classes.

They have been interested in taking control of other important enterprises like Pakistan Steel. However, the devil is in detail. The deal does not go through due to financial complications as have been described earlier in the case of privatisation, although such complications may be lesser in case of governments dealing with each other. To the extent of subsidies, it may be fair to expect that provincial governments may accept the existing and future liabilities. Sustaining people is provincial responsibility and sustaining state is federal, it may be argued.

There may be a formula to share other accumulated losses. The question is why should a provincial government accept the financial liabilities? There may be political and ideological reasons in Sindh, but other provinces may not be interested. A particular issue and difficulty is the political and economic requirement of uniform pricing. It affects welfare, employment and development. Provincialisation or privatisation may disturb this uniform pricing system. Many other possible initiatives are affected by this requirement. A fundamental decision may have to be done in this respect where provinces may compete with each other in terms of resource allocation, pricing and investments.

Would smaller provinces like that? Certainly not! K-P may? Some circles in K-P have been demanding pricing autonomy in energy sector but are not willing to pay costs elsewhere. Uniform pricing policy may have to be removed or kept simultaneously in all provinces. Benazir Bhutto government announced a special electricity tariff for Swabi, which could not be sustained for long? The question is why provincialisation; from fire into frying pan? If government is bad, it is so, both in federation or province. It may, in fact, be worse.

The influence of chieftains, elite and vested interests is much more in provinces. Provinces are not able to collect taxes. Will they be able to collect electricity bills, directly or indirectly? Are provinces able to manage public services like water, sewerage and solid waste, which are under their domain? It may happen that DISCOs may have to be reverted back to centre after being worsened by provincial administrations.

Segmentation and restructuring

Perhaps, the first priority should be restructuring and segmentation. Most DISCOs are spread over a large area. For example, Pesco starts from DI Khan through Kohat, Peshawar, Nowshera to Mansehra. It is an area of 12,000 square km, too remote and widespread for management to effectively control. Regional managers have their fiefdoms with all kinds of vices, problems and issues.

Similarly, other DISCOs like Mepco have the same issues. Both are among top loss-making enterprises. Smaller companies may make these financially slim to attract local private sector. This does not require any prerequisite. It can be done without loss of time and much complication.

Right sequencing?

In the aforementioned perspective, what to do first: privatise or provincialise, restructuring/segmentation or implement CTBCM. We have argued elsewhere that electricity market may take precedence over all other initiatives. A big if is the successful business model of electricity market.

CTBCM is facing a number of issues and bottlenecks. Now at the end of 2022, IGCEP is being implemented without reference to CTBCM. Reverse auction is waiting for implementation for many years now. Privatisation can only proceed ahead when market framework is known and is stabilised.

As discussed elsewhere, a DISCO becomes wire-only business and becomes much simpler and less risky in electricity market titled CTBCM in Pakistan. Role of government would be reduced or may become indirect. In that case, the debate of federalisation or provincialisation becomes less important.

Common problems

It is often argued that in most developing countries, electricity sector is in public sector. Poverty and subsidy issues are also widespread in developing countries, which necessitate government involvement. Privatisation may require some kind of electricity market where price is determined by market forces of supply and demand. Cross-subsidies are to be replaced by direct subsidies to the recipients by the government through taxes.

IMF and IFIs have been demanding such policy frameworks. It has not happened in most developing countries, although reform processes are there at various stages, as it is in Pakistan. When chips are down, politicians and governments are reluctant to implement the proposed systems. Risks of change are great. There are poverty and macroeconomic problems.

IFIs are callous and insensitive to these issues and insist on their frameworks developed through grants, technical assistance and loan packages. DISCOs' privatisation is complicated by their monopolistic nature of structure and business. It may be argued that privatisation may take second place to electricity market.

Conclusion

Has Privatisation Commission been working in silo, without understanding and knowing the problems and issues of DISCOs and what is going on in the sector in terms of electricity market framework?

In a recent meeting at Privatisation Commission, as reported in newspapers, this has been acknowledged in one way or the other. They have decided to involve power sector and Ministry of Energy in their deliberations. If so much is dependent on the outcome of electricity market process called CTBCM, it is vital that various echelons of government acquire understanding of it. There are problems and issues in CTBCM, some of which have been recognised and acknowledged by Nepra. However, some vital issues still deserve discussion and evaluation.

CTBCM will affect Pakistan's economy in a major way. Nepra and CPPA duo cannot be left on their own and allowed to ignore considerations of vital issues that have been pointed out by the stakeholders. Government should organise a third-party independent review of CTBCM and introduce adjustments where required. If nothing else, an independent evaluation will give confidence to government in supporting the implementation of CTBCM framework and ultimately privatization.

Table 4.4.1: Salient DISCO data

	Consumers	Sales (MWh)	T&D losses %
KE	3405332	16068	17.54
PESCO	4038313	9608	38.18
IESCO	3485617	10943	8.55
LESCO	5887248	22352	11.96
MEPCO	1172990	17466	14.93
FESCO	4869142	14501	9.28
GEPCO	4159712	10922	9.23
HESCO	1196494	4014	27.99
SEPCO	662168	2776	35.31
QESCO	679391	4775	27.82
Total CPPAG	33189794	99370	17.35
Source:NEPRA			

Table 4.4.1: Power Generation (GWh) Nov-2020

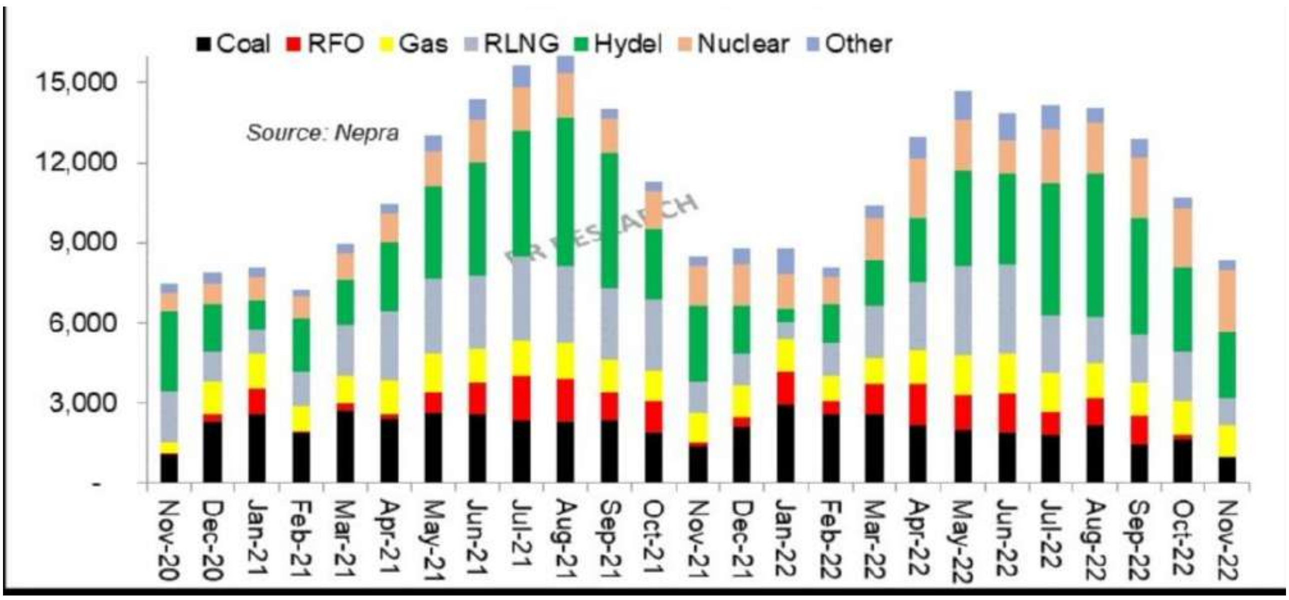


Table 4.4.2: Annual Growth rate of Electricity Consumption 2017-2022

		2017-18	2018-19	2019-20	2020-21	2021-22
CPPA-G Area						
Domestic	GWh	46,163.80	45,590.34	47,643.43	49,814.54	52,404.73
	%	11.46	-1.24	4.50	4.56	5.20
Commercial	GWh	6,753.33	6,601.50	6,259.48	6,687.97	7,386.99
	%	10.45	-2.25	-5.18	6.85	10.45
Industrial	GWh	23,274.17	24,284.57	21,489.04	24,664.95	28,115.20
	%	15.98	4.34	-11.51	14.78	13.99
Agricultural	GWh	9,983.68	9,675.51	9,642.17	10,115.32	10,921.90
	%	10.16	-3.09	-0.34	4.91	7.97
Public Lighting	GWh	318.95	289.38	272.58	491.85	344.76
	%	6.92	-9.27	-5.81	80.44	-29.90
Bulk Supply	GWh	5,014.14	3,711.75	3,289.83	3,158.77	3,611.05
	%	45.51	-25.97	-11.37	-3.98	14.32
Others	GWh	394.12	3,734.30	4,194.24	4,439.15	5,081.06
	%	-65.75	847.50	12.32	5.84	14.46
Supplied to KE	GWh	5,128.20	4,956.71	5,426.14	6,118.04	9,036.54
	%	1.01	-3.34	9.47	12.75	47.70
Total	**GWh**	**97,030.39**	**98,844.06**	**98,216.89**	**105,490.59**	**116,902.24**
Percentage change	**%**	12.00	1.87	-0.63	7.41	10.82

Table 4.40.3: Transmission and Distribution losses of Discos's for FY 2020-21 and FY 2021-22

DISCO	FY 2021-22 (Units in GWh)			Target Losses (%)	Actual Losses (%)		Amount of Actual Units Lost (Rs. in billion)
	Purchase	Sold	Lost	2021-22	2020-21	2021-22	2021-22
PESCO	16560	10355	6205	20.73	38.18	37.47	153.80
TESCO	2284	2071	213	9.31	9.58	9.33	3.70
IESCO	13027	11961	1066	8.15	8.54	8.18	21.90
GEPCO	12678	11528	1150	9.2	9.23	9.07	24.70
LESCO	28334	25070	3264	9.08	11.96	11.52	72.70
FESCO	17512	15918	1594	9.34	9.28	9.10	33.40
MEPCO	22548	19202	3346	12.79	14.93	14.84	75.10
HESCO	6010	4034	1976	19.07	38.55	32.88	45.00
SEPCO	4489	2890	1599	17.41	35.27	35.62	43.70
QESCO	6716	4831	1885	14.49	27.92	28.07	46.30
Overall Average	**130158**	**107860**	**22298**	**13.41**	**17.95**	**17.13**	**520.30**

Source: DISCOs

Table 4.4.4: Recovery Percentage of Disco's over last 2 Years

Description	PESCO	TESCO	IESCO	GEPCO	LESCO	FESCO	MEPCO	HESCO	SEPCO	QESCO	Overall DISCOs
Amount Billed (Mln. Rs.)	233591	43386	289977	252986	587306	366707	400711	88892	63209	96523	2423292
Amount Realized (Mln. Rs.)	214419	28728	277284	248407	567887	347777	368972	65530	40314	34053	2193375
Recovery 2021-22 (%)	91.79	66.22	95.62	98.19	96.69	94.84	92.08	73.72	63.78	35.28	**90.51**
Recovery 2020-21 (%)	101.87	83.27	116.87	105.1	98.72	97.2	102.15	75.63	64.48	39.8	**97.30**
Inc./(Dec.)	**-10.08**	**-17.05**	**-21.25**	**-6.91**	**-2.03**	**-2.36**	**-10.07**	**-1.91**	**-0.7**	**-4.52**	**-6.79**

Source: DISCOs

Table 4.4.5: Distribution Transformers and Percentage of Over-loaded Distribution Transformers of Discos (2021-22)

DISCO	Total No. of Dist. Transformers		Total No. of Over-Loaded Dist. Transformers		Percentage of Total Over-Loaded Dist. Transformers	
Up to June	2021	2022	2021	2022	2021	2022
PESCO	79,437	81,149	2,441	2,442	3.07	3.01
TESCO	18,827	19,194	751	3,502	3.99	18.25
IESCO	51,988	53,616	950	1,503	1.83	2.80
GEPCO	76,125	80,085	1,883	1,972	2.47	2.46
LESCO	122,124	126,758	20,447	20,140	16.74	15.89
FESCO	120,446	124,801	1,198	1,383	0.99	1.11
MEPCO	187,791	223,922	4,157	6,732	2.16	3.01
HESCO	43,873	44,317	1,114	1,133	2.54	2.56
SEPCO	39,076	39,437	2,677	2,436	6.85	6.18
QESCO	64,119	66,119	5,343	5,026	8.33	7.60
Total	**803,806**	**859,398**	**46,341**	**46,269**	**5.77**	**5.38**

Source: DISCOs

Table 4.4.6: Power Transformers and Percentage of Total Over-loaded Power Transformers of Discos (2021-22)

DISCO	Total No. of Power Transformers		Total No. of Over-Loaded Power Transformers		Percentage of Total Over-Loaded Power Transformers	
Up to June	2021	2022	2021	2022	2021	2022
PESCO	252	259	95	95	37.70	36.68
TESCO	55	57	14	8	25.45	14.04
IESCO	267	273	9	23	3.37	8.42
GEPCO	174	181	34	51	19.54	28.18
LESCO	428	441	74	70	17.29	15.87
FESCO	240	249	45	45	18.75	18.07
MEPCO	312	317	30	46	9.62	14.51
HESCO	122	128	14	25	11.48	19.53
SEPCO	133	134	20	32	15.04	23.88
QESCO	179	180	49	47	27.37	26.11
Total	**2,162**	**2,219**	**384**	**442**	**17.76**	**19.92**

Source: DISCOs

Table 4.4.7: 11 kv feeders of Disco

DISCO	Total No. of 11 kV Feeders		Total No. of Over-Loaded 11 kV Feeders		Percentage of Total Over-Loaded 11 kV Feeders	
Up to June	2021	2022	2021	2022	2021	2022
PESCO	1,138	1,193	435	386	38.22	32.36
TESCO	266	302	144	141	54.14	46.69
IESCO	1,211	1,293	26	49	2.15	3.79
GEPCO	910	949	106	156	11.65	16.44
LESCO	2,011	2,058	285	451	14.17	21.91
FESCO	1,185	1,265	75	129	6.33	10.20
MEPCO	1,652	1,726	323	318	19.55	18.42
HESCO	570	583	77	93	13.51	15.95
SEPCO	548	562	83	93	15.15	16.55
QESCO	688	735	688	302	100.00	41.09
Total	**10,179**	**10,666**	**2,208**	**2,118**	**21.69**	**19.86**

Source: DISCOs

Table 4.4.8: Investment allowed and made by DISCOs during last 5 Years

(Rs. in million)

DISCOs	Description	2016-17	2017-18	2018-19	2019-20	2020-21
PESCO	Allowed	8,366	9,610	7,029	8,450	9,982
	Actual	8,366	11,347	7,029	5,725	13,938
TESCO	Allowed	971	770	2,150	2,500	4,053
	Actual	971	744	2,150	2,500	n.p.
IESCO	Allowed	10,090	6,719	11,918	10,090	6,719
	Actual	5,313	7,451	10,259	7,413	8,625
GEPCO	Allowed	2,775	3,200	5,295	5,500	5,554
	Actual	2,775	1,617	5,295	6,749	5,942
LESCO	Allowed	19,781	21,459	10,826	19,781	21,459
	Actual	9,758	12,081	10,527	10,238	n.p
FESCO	Allowed	7,140	7,857	11,084	8,803	7,857
	Actual	8,033	3,502	6,244	7,640	10,268
MEPCO	Allowed	11,416	13,000	13,439	14,000	8,369
	Actual	11,416	12,924	13,439	13,887	10,927
HESCO	Allowed	4,729	5,500	3,072	4,597	2,227
	Actual	4,729	4,804	3,072	1,971	n.p
SEPCO	Allowed	977	3,400	3,467	4,000	3,981
	Actual	977	3,062	3,467	2,137	n.p
QESCO	Allowed	3,080	8,000	4,308	3,763	4,243
	Actual	3,080	4,748	4,308	2,619	3,765
TOTAL	**Allowed**	**69,325**	**79,515**	**72,588**	**81,484**	**74,444**
	Actual	**55,418**	**62,280**	**65,790**	**58,379**	**53,465**

Source: DISCOs

Table 4.4.9: Transmission & Distribution Assets

DISCO	FY	T/Lines 132 kV (km)	G/ Station 132 kV (Nos.)	Power Transformer		11 kV Feeders		Distribution Transformer		No. of Consumers
				No.	MVA	No.	km	No.	MVA	
PESCO	2020-21	2967	95	252	6925	1138	37177	79437	6264	3848951
	2021-22	2999	97	259	7365	1193	37695	81149	6424	4038313
TESCO	2020-21	441	11	55	974	266	10567	18827	1378	443180
	2021-22	441	13	57	1243	302	10543	19194	1440	444146
IESCO	2020-21	3482	111	267	6679	1211	26237	51988	4279	3276164
	2021-22	3512	114	273	6939	1293	26932	53616	4395	3485617
GEPCO	2020-21	2611	59	174	5110	910	24659	76125	4745	3933086
	2021-22	2682	59	181	5255	949	24996	80085	4798	4159712
LESCO	2020-21	3051	167	428	12953	2011	30055	122124	9245	5527854
	2021-22	3110	172	441	13443	2058	31562	126758	9479	5887248
FESCO	2020-21	2337	102	240	6039	1185	45690	120446	7628	4641802
	2021-22	2322	108	249	6261	1265	46281	124801	7934	4869142
MEPCO	2020-21	4072	134	312	8720	1652	79837	187791	9102	7217677
	2021-22	4110	135	317	8990	1726	80962	223922	12960	7614953
HESCO	2020-21	2771	70	122	2791	570	28471	43873	2680	1172990
	2021-22	2778	72	128	2934	583	28502	44317	2720	1196494
SEPCO	2020-21	2262	60	133	3010	548	24722	39076	2178	805717
	2021-22	2308	62	134	3101	562	24824	39437	2253	814778
QESCO	2020-21	5500	73	179	3465	688	40822	64119	3339	662168
	2021-22	6258	75	180	3636	735	41606	66119	3466	679391
Total CPPA-G	**2020-21**	**29495**	**882**	**2162**	**56670**	**10179**	**348237**	**803806**	**50839**	**31529589**
	2021-22	**30520**	**907**	**2219**	**59169**	**10666**	**353903**	**859398**	**55871**	**33189794**
KE	2020-21	833	69	172	6536	1937	10283	29702	8153	3185332
	2021-22	838	69	179	6803	2001	10520	30771	8685	3405332

Source: DISCOs/KE

Table 4.4.10: Distribution losses (DISCOs)

DISCO	Losses of	2017-18		2018-19		2019-20		2020-21		2021-22	
		GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
PESCO	132 kV system (including 66 & 33 kV)	393.00	2.80	221.80	1.60	273.70	1.90	235.60	1.50	322.67	1.90
	11 kV and below system	5031.80	36.40	5006.40	35.60	5433.50	37.50	5697.60	37.20	5882.36	35.52
	Overall system	5424.77	38.15	5228.24	36.56	5707.25	38.69	5933.36	38.18	6205.03	37.47
TESCO	132 kV system (including 66 & 33 kV)	45.00	2.66	40.79	2.24	87.76	4.08	39.85	1.79	-	1.20
	11 kV and below system	166.03	10.07	177.21	9.96	260.24	12.61	173.50	7.94	-	7.97
	Overall system	210.97	12.46	217.94	11.97	348.24	16.19	213.35	9.58	212.00	9.32
IESCO	132 kV system (including 66 & 33 kV)	215.00	1.84	212.00	1.79	199.00	1.74	137.00	1.15	128	0.99
	11 kV and below system	850.00	7.42	837.00	7.20	795.00	7.07	885.00	7.48	937	7.26
	Overall system	1067.03	9.14	1048.74	8.86	993.49	8.69	1022.00	8.54	1065	8.18
GEPCO	132 kV system (including 66 & 33 kV)	142.10	1.29	138.17	1.24	120.87	1.10	115.16	0.96	115.00	0.90
	11 kV and below system	957.50	8.83	957.50	8.73	924.71	8.51	995.21	8.35	1033.75	8.23
	Overall system	1099.61	10.01	1095.62	9.87	1045.56	9.51	1110.38	9.23	1149.00	9.07
LESCO	132 kV system (including 66 & 33 kV)	236.66	1.00	228.67	0.90	114.91	0.50	74.91	0.30	138.54	0.5
	11 kV and below system	3046.04	13.00	2977.77	12.40	2802.65	12.00	2960.83	11.70	3125.06	11.1
	Overall system	3282.74	13.83	3206.45	13.17	2918.33	12.40	3035.72	11.96	3263.6	11.5
FESCO	132 kV system (including 66 & 33 kV)	285.83	1.98	254.47	1.70	218.42	1.50	225.36	1.40	247.83	1.40
	11 kV and below system	1235.87	8.73	1214.76	8.26	1168.66	8.20	1257.81	8.00	1345.91	7.80
	Overall system	1521.84	10.53	1469.07	9.81	1387.09	9.56	1483.28	9.28	1593.74	9.10
MEPCO	132 kV system (including 66 & 33 kV)	443.91	2.30	352.88	1.80	292.07	1.51	321.38	1.57	383.87	1.69
	11 kV and below system	2708.85	14.60	2704.17	14.20	2650.66	13.90	2744.74	13.60	2962.42	13.25
	Overall system	3152.75	16.59	3057.04	15.79	2942.75	15.23	3066.11	14.93	3346.28	14.72
HESCO	132 kV system (including 66 & 33 kV)	213.00	3.71	212.90	3.83	157.64	2.88	145.60	2.61	102.20	1.84
	11 kV and below system	1502.90	27.18	1425.90	25.67	1423.22	26.04	1414.70	26.06	1874.38	31.18
	Overall system	1716.06	29.88	1638.47	29.49	2921.64	42.89	2518.40	38.55	1976.58	35.55
SEPCO	132 kV system (including 66 & 33 kV)	115.21	2.46	104.89	2.38	76.03	1.79	75.32	1.76	87.49	1.95
	11 kV and below system	1518.95	35.27	1485.99	34.83	1423.40	34.44	1412.9	33.73	1454.27	33.73
	Overall system	1715.92	36.67	1631.02	36.97	1542.38	36.27	1513.33	35.27	1599.59	36.63
QESCO	132 kV system (including 66 & 33 kV)	117.09	1.85	99.54	1.60	127.10	1.90	114.91	1.70	126.71	1.90
	11 kV and below system	1301.21	20.90	1373.18	22.30	1634.91	25.20	1734.4	26.60	1758.01	26.70
	Overall system	1422.43	22.44	1472.64	23.56	1762.00	26.68	1849.56	27.92	1884.7	28.10
Total Distribution Losses in CPPA-G System		**20614.12**	**18.32**	**20065.23**	**17.61**	**21568.72**	**18.86**	**21745.49**	**17.95**	**22295.54**	**17.13**
KE	220 kV & 132 kV system (including 66 kV)	159.48	0.92	214.93	1.21	198.16	1.11	208.00	1.07	164.00	0.83
	11 kV and below system	3398.88	19.69	3163.78	18.10	3311.38	18.83	3210.00	16.65	2875.00	14.64
	Overall system	4305.75	23.70	4195.31	22.66	4250.54	22.94	4169.22	20.60	3645.09	17.86

Note: Gross generation of KE own power plants considered
Source: Distribution Companies / KE

Table 4.4.11: WAPDA Hydroelectric Tarrif (2021-22)

S. No.	Power Stations	Province	Capacity (MW)	NEO (GWh)	Variable Rate (Rs./kWh)	Fixed Charges (Rs./kW/M)			Hydel Levies			
						Fixed Rate	Revenue Gap	Interest on Loans for NHP	NHP Regular (Rs./kWh)	WUC (Rs./kWh)	NHP Arrears (Rs./kW/M)	IRSA (Rs./kWh)
1	Tarbela	KPK	3,478	4933.47	0.0430	421.9400	(425.917)	63.8370	1.1000		-	0.005
2	Warsak	KPK	243	305.50	0.1070	748.1980	64.3320	63.8370	1.1000		-	0.005
3	Duber Khwar	KPK	130	173.98	0.2150	1,768.2840	369.3290	63.8370	1.1000		-	0.005
4	Allai Khwar	KPK	121	125.05	0.2150	1,508.8710	523.7890	63.8370	1.1000		-	0.005
5	Khan Khwar	KPK	72	31.78	0.2110	1,592.3050	213.2540	63.8370	1.1000		-	0.005
6	Jabban	KPK	22	38.94	0.2750	2,881.4670	3,505.1650	63.8370	1.1000		-	0.005
7	Dargai	KPK	20	28.10	0.0880	826.7720	(587.876)	63.8370	1.1000		-	0.005
8	Kuram Garhi	KPK	4	4.59	0.2550	1,924.9610	343.3300	63.8370	1.1000		-	0.005
9	Chitral	KPK	1	0.53	0.3430	2,164.9410	(4,020.787)	63.8370	1.1000		-	0.005
10	Tarbela 4th Ext.	KPK	1,410	2259.96	0.1340	781.9920	876.992	0.0000	1.1000		-	0.005
11	Golen Gol	KPK	108	50.65	0.3440	2,446.5390	3225.457	0.0000	1.1000		-	0.005
12	Gomal Zam	KPK	17	17.03	0.6340	3,092.3000	(470.671)	0.0000	1.1000		454.646	0.005
13	Ghazi Barotha	Pujnab	1,450	2105.09	0.0790	777.8990	434.0900	366.4990	1.1000		-	0.005
14	Chashma	Punjab	184	216.29	0.191	1,524.435	1,403.294	366.4990	1.1000		-	0.005
15	Jinnah HPP	Punjab	96	63.34	0.2670	1,521.2800	1,113.6030	366.4990	1.1000		-	0.005
16	Rasul	Punjab	22	18.04	0.1570	895.5500	(34.025)	366.4990	1.1000		-	0.005
17	Nandipur	Punjab	14	11.57	0.1320	833.8580	(1,222.819)	366.4990	1.1000		-	0.005
18	Shadiwal	Punjab	14	7.93	0.1780	833.8300	(790.848)	366.4900	1.1000		-	0.005
19	Chichoki	Punjab	13	9.11	0.1760	866.5510	(870.662)	366.4990	1.1000		-	0.005
20	Renala Khurd	Punjab	1	0.53	0.3420	1,831.9180	(3,455.565)	366.4990	1.1000		-	0.005
21	Mangla	AJK	1,000	1,342.19	0.0670	715.0900	41.6110	0.0000	-	0.150	-	0.005

Source: NEPRA

4.5: The National Electricity Plan

Complying with the recently introduced requirements of the Nepra Act, the power division has prepared the first draft of the National Electricity Plan (NEP). This plan is one of the new instruments in the country's energy regime and appears to be a good effort. It may not be a conventional plan – providing projections and numbers – but is better than that, although there may be semantic issues.

The NEP puts together almost all that has to be done in the power sector under a cogent framework. Not only it lists activities to be done, but also assigns responsibilities and sets deadlines. Previously, it was rarely found in government documents. It appears that this time the power division means business. Having said that, it is important to see how and when the plan will be implemented. Also, regardless of the fact that the government has take a commendable step, it is essential to point out the flaws and inadequacies in the plan and suggest the possible improvements.

There are a few challenges: a major market initiative called the Competitive Trading Bilateral Contract Market (CTBCM) is under development which has an overlap with the NEP. It has tried to create harmony and sync with the CTBCM, but it will be quite tricky. The pace of the CTBCM may create conflicts and challenges.

The main achievement and milestone that has been partly implemented is the establishment of the Power Planning and Management Company (PPMC) which will serve as a technical organ of the power division. This step indirectly accepts that conventional bureaucracy cannot handle complicated technical issues. The NEP is almost a job description of the PPMC which is the main organisation that will organise and monitor the implementation of the NEP.

In all countries, there are similar organisations that support technical ministerial work. In India, there is the Central Electric Authority (CEA) which has a similar role. Perhaps, with time, some additional roles and functions would be added. It is likely to be a real challenge to build up this organisation, selecting the right personnel. Preferably, at least 50 percent of the professionals should be seconded from the existing DISCOs, GENCOs, NTDC and other power division institutions to this organisation. There are quite qualified and skilled people in these organisations. If the sector as a whole suffers from issues and problems, it does not mean that all employees are unprofessional.

The NEP has five dimensions and 13 objectives. High transmission and distribution losses and the consequent circular debt are the major issues in Pakistan's power sector which are casually mentioned in the plan. 'Decarbonisation', on the other hand, has been given a prominent title and placement under the 13 objectives; 'hydrogen' has been added as well. In foreign-funded studies and initiatives, this is a common problem. Decarbonisation is an important aspect, but is it as important or more important than the issues like transmission and distribution losses?

Also, there is no guidance with respect to how this particular issue should be handled and solved while on other issues there is significant helpful material. Privatisation and smart metres are being touted as the only solution, but it has not happened for the last two decades or more. While pending privatisation is a looming issue, not much has been said about the smart metres issue as well. How will the investment of $7 billion be financed among other pressing needs? Are there other solutions? It is hoped that the developers of the NEP would deal with these issues efficiently and come up with reasonable strategies and proposed actions.

The merger of Nepra and the Oil and Gas Regulatory Authority (Ogra) has been proposed, and the National Energy Efficiency and Conservation Authority (NEECA) has been added for a trilateral merger. In most market economies, the power and gas sectors have one regulator. As far as tariff determination is concerned, the methodology and skills required are the same for cost-plus cases.

In technical aspects, there are differences. Not much technical content has been seen in Nepra and Ogra's past work except the formulation of standards by Ogra in its initial days. There is a lot of interdependence among fuel and power, which explains the logic of the merger of the two. However, the merger has not shown much interaction among the merged entities. The classic case is that of the Ministry of Energy; the petroleum and power divisions were merged, assuming that this would bring about much-needed coordination. This did not happen.

The incumbent leadership and senior executives, however, should not get nervous, as this activity is scheduled for mid-2024, long after the incumbent ministers would have completed their term. Another aspect is that of the unnecessary inclusion of NEECA. Let us keep it more as a development body rather than one with a regulatory function. Energy conservation and efficiency have already suffered under the three decades of a company which, even after receiving millions of dollars in USAID funding, did not deliver satisfactorily.

Acquiring power is a cherished objective of bureaucracy. Unless it has powers to control somebody, it doesn't think it exists at all. NEECA bureaucracy has managed to acquire regulatory function in its formative days. The Alternative Energy Development Board (AEDB) made the same mistake and shunned its development objectives, opting for acquiring the role and power of approving projects. Today, it has a problem justifying its existence. It is in doldrums under the merger with the Private Power and Infrastructure Board (PPIB), and it is feared that NEECA would see the same fate. It is essential that it be saved from this and excluded from the proposed merger.

It should be mentioned that tribunals are good and desirable institutions. Unfortunately, the affected institutions oppose or drag their feet when it comes to the establishment of tribunals. The electricity sector tribunal has been in the pipeline for a long time now but has not become functional yet. It may be desirable to extend it to all sectors of energy. It is an unfortunate situation that even public- sector companies of the energy sector resort to going to London for the adjudication of their issues, spending a lot of much-needed and already scarce foreign exchange reserves. A cost-plus regime has also made energy companies insensitive to cost and expenditure. This must end as early as possible. The energy tribunal can save a lot of precious time and money.

The target has been taken as a 75 percent share of renewable energy. And the committed projects are mostly public sector projects of organisations like Wapda and the Pakistan Atomic Energy Commission (PAEC). And they have to be taken into the IGCEP-generation plan irrespective of good or bad economics or whether the least-cost principles are violated. In the recent Indicative Generation Capacity Expansion Plan (IGCEP), bulks of the projects are committed. Not many projects, except solar and wind ones, are non-committed. As a result, there are problems in the open market regime.

Uncommitted supplies or competitors would not be available and hence no competition. So where does the so-called market go? There would be a bilateral contract among wholesale buyers and suppliers in the absence of a benchmark such as one created by a market exchange. In this land of the pure, such liberties given to buyers and suppliers to fix prices are a dangerous proposition. Market enthusiasts should think about it.

It seems that the government of Pakistan is sceptical about talks of an open market regime in the power sector. In the meanwhile, it is letting market players play. The government and other stakeholders may be sceptical due to what has happened in the sugar, oil, flour and other markets.

The government's ambivalence is shown by its permission to DISCOs to go to courts against Nepra's decision on wheeling charges. Wheeling is the first step towards an open market regime. Admittedly, Nepra, in its enthusiasm, decided on unreasonably low wheeling charges of Rs1.5 which was a recipe of destroying the already troubled DISCOs. This also created the prospects of bringing the most inefficient plants into the market due to unduly low wheeling rates – Rs1.5 vs Rs5-6 per kWh, the normal rate of DISCOs.

Nepra ignored the legitimate inclusion of cross subsidies and stranded asset charges. The NEP has taken notice of this and has come out with a reasonable framework. The question is: will Nepra accept it? After a bad experience, it may accept unless it wants to block the whole initiative of an open market under the title of the CTBCM.

The NEP has almost ignored the issue of electricity storage. It should have included a significant number of clauses on the issue. Renewable energy share of 60-70 percent is being talked about. Most countries with solar and wind power ambitions and targets are considering setting up electricity storage facilities. For example, the Philippines with only 26000 MW installed capacity is planning to install one GW of storage and is already implementing a phased programme in this respect.

Solar and wind remain quite competitive until these do not cross a certain threshold. After this threshold, the stability and capacity requirements call for addition of storage which almost doubles the current tariff of 3-4 USc of solar and wind, bringing it at par with that of fossils like coal. Perhaps even then, solar and wind should be a preferable option as there is stiff opposition to coal worldwide.

There are signs that even Thar coal may not be allowed to go beyond the projects in the pipeline. Chinese announcements in international forums about not financing coal projects abroad are an example. In this context, renewable energy along with storage acquires extraordinary importance. The NEP should therefore fill this gas and come out with more than what it has provided in its report.

NEP planners may have overstepped their domain. They are talking about the integrated energy plan (IEP). Energy is not just electricity. There are other sectors such as transport, industry and agriculture which use various types of energy and not just electricity which does require gas and oil and perhaps that is the driver to push them into the integrated energy plan.

A multidisciplinary body like the Planning Commission (PC) can handle this assignment of the IEP. The PC has not been successful in delivering in this respect which has driven them into the proposal of the IEP. There is no guarantee that the Power Planning and Monitoring Company (PPMC) would succeed despite institutional lack of context. It has proposed to move the IEP cell to the PPMC – although it doesn't seem that this will be allowed.

The power division or the PPMC has much to integrate within the domain of the power sector – generation, transmission and distribution. The transmission issue has often been missed as we notice the lack of matching transmission capacity. Distribution has always remained a lone separate activity.

Universal access and rural electrification have been on the agenda for a long time. It was difficult and uneconomical to spread the grid far and wide to include less populated rural areas. Fortunately, solar, wind and small hydro and other renewables have opened up many possibilities. The NEP has touched on this subject. Presently, in many rural areas, people are using these resources under cooperative self-help in an unorganised way.

Electrical cooperatives are quite successful in the US. Under cooperative schemes, at least operations and maintenance and bill collection can be organised even if provincial governments or utilities do the initial installations. Bills can be collected by the locals under a legal cooperative framework with part of it deposited into the investor's account. The lack of framework has prevented access of rural areas to many facilities. The government may also consider spreading the cooperative movement in other sectors as well.

A laudable aspect of the NEP is the provision for indigenisation of fuel. It has provided for the conversion of imported coal power plants to the local Thar coal. It may be a difficult yet totally possible task. Feasibility studies should be undertaken in this respect. Three plants on imported coal was initially a mistake; one or two would have been enough to meet the deficit in the light of installing gas plants.

There is dangerous talkson the closure of these plants under a compensation scheme. In this background, the conversion to Thar coal is a good idea. We are facing a massive current account deficit problem. Increasing exports is a long-term issue. Immediate options are available in reducing energy imports through indigenisation. Thar coal development has almost been entrusted to one company. More players should come into coal mining. Pakistan has hardly any other energy resource, and its gas supply is already dwindling.

It should be emphasised on international forums that Pakistan has a low carbon front and does not have many choices. India has managed to delay coal elimination targets to beyond the year 2050.What harm would a capacity of say 25,000 MW on Thar coal do in the background of more than 200,000 MW coal power plant capacities in our neighbourhood?

Talk of hydrogen is premature for a plan whose timeline is the year 2024. Besides, it is a petroleum division issue, if at all. I am a huge supporter of hydrogen as a long-term option. At this stage, research and development may be initiated in this respect. One wishes the NEP would have provided for the local manufacturing of solar equipment as well.

The NEP is a welcome initiative. It will integrate the much-needed activities which keep dangling as mere suggestions, provide a useful document to stakeholders, and generate a common purpose around which efforts can be organised. It is hoped that it does not stay as a wrapped document.

The plan can be improved and adjusted; the issues raised in the article can be looked into as well. The elimination of circular debt, inefficiencies and leakages and undertaking modernisation and innovation, and expansion to supply the required demand leading into higher consumer utility and satisfaction and reducing cost of supplies are the call of the hour. It can be done. The NEP can be a great tool in achieving these worthy objectives. It should be circulated widely to get the input of stakeholders.

Planning for power

At a time when the country is facing severe power shortages, talk about expanding electricity generation should attract people's attention. The current power crisis is not fuelled by a lack of generation capacity but by fuel shortages. This problem can be avoided through adequate planning, which encourages the country's reliance on local resources, not on imported ones.

The Indicative Generation Capacity Expansion Plan (IGCEP) provides guidance regarding investments in the power-generation sub-sector for planning and approving projects and allocating resources. It is a 10-year rolling plan, which means that every year it is to be updated and one year added to it. Many things have changed and occurred, which affects the energy sector, since the first version of the IGCEP was made. There has been some deviation from the plan, both well-intentioned and contentious.

The new annual version has not been finalized yet and is passing through an internal evaluation process. The National Transmission and Despatch Company (NTDC) prepares the plan. The power division, in collaboration with the relevant agencies, evaluates, and Nepra approves it; the power authority often invites public comments.

The IGCEP provides for the existing capacity of 40,376MW in March 2022. By 2031, the installed capacity is likely to reach 63,503W; while 8,165MW will be retired. Over 12,500MW of additional hydro capacity will be added to reach the total hydro capacity of 22,419MW in 2031. The solar power capacity under the NTDC system has been reduced to 4,000MW (the additional 1050MW of solar is for K-Electric), ignoring the emerging realities and being oblivious to discussions in policy-making circles. It should be, and will be, doubled, and be brought forward. Perhaps the non-implementation of or delays in some hydro projects may provide the leeway.

The additional capacity of 32,987MW can be achieved through the investment of $50 billion. This includes funds worth $14 billion for the 4,500MW of the Bhasha Dam. Fortunately, the dam, which otherwise had many issues, has been included in CPEC projects. Previously, international financial institutions (IFIs) would have to get an NOC from India as the dam's location is said to be in the disputed territory. The dam is required more for water storage than for power.

Energy prices have almost doubled; coal, LNG and oil are currently being used in power generation. Earlier, we suffered due to low power-generation capacity, and now after expanding our generation capacity, we have to suffer power outages due to high fuel prices and low fuel supply; our country couldn't get one LNG proposal against the $1 billion LNG tenders floated by it. This has happened in the past months, but the situation was not this bad. Given the current high prices, many wonder if not getting a single offer was a bane or boon.

Ordinary people often question why Pakistan does not store excess energy. Electricity cannot be stored although new technologies have emerged to meet peak demand. Oil and gas can be stored, but their storage cost is quite high. However, something can possibly be done in this regard in the medium to long term.

The Pakistani economy is in the doldrums, with varying growth rates, current account deficit, rupee depreciation and mounting external debt. All of this may affect power demand and supply and resource allocation capacity. The IGCEP does not seem to have taken account of these factors. Will the demand remain the same? If not, how will it vary? Will there be enough investment resources to cater to the plan? The IGCEP will require around $50 billion, excluding transmission and distribution.

It is also a legitimate question why transmission has been excluded. Earlier, its exclusion was possibly justified under time and resource constraints. Can something be done about it? It is perhaps too much to expect the NTDC to answer the resource issue? It could have asked and involved other relevant institutions. Will the lower demand lower the resource requirement? Will demand be lower?

No effort seems to have been done, except for the repetition of the last data. What was in its possible domain to examine if cheaper renewable resources could be enhanced with or without storage? Is there any scope or possibility of retaining some power plants somewhat longer and thus affecting the resource requirement? We already see many independent power producers (IPPs) wanting to get extensions. The current plan anticipates the writing off of 10,000MW of capacity. It is uncertain if this would be feasible. However, the subject is worth exploring.

Many proposals are under discussion in policy circles; the two most important ones relate to solar power and Thar coal. A fast-track solar PV programme is under discussion to add cheaper power capacity to meet the challenge of high oil and gas prices. The plan has taken no notice of it and kept solar in the fourth year, same as earlier. A 1000MW addition per year could have been a more feasible and timely approach. KE, for a change, has proposed a better solution, which is more in line with the fast-track implementation.

There is also a threat of the shutdown of imported coal-based power plants due to a hike in imported coal prices if the coal pricing issue continues. The country is arranging to procure slightly cheaper Afghan coal for some temporary relief in the power sector. But the real solution is the conversion of imported coal-based power plants to Thar coal. This is feasible and is also under discussion.

The Lucky (Cement) power plant is using imported lignite in a pulverized coal power plant, which is the same technology as that of imported coal-based power plant projects in Sahiwal, Port Qasim and Hub. This conversion may not require the replacement of boilers; small changes in preheating and drying Thar lignite will be required. Germany has already employed similar approaches successfully.

Also, there is no mention of electric storage, which will be required if the solar and wind power share in the national power grid goes beyond a certain level. Power storage has become cheaper and technically available. Battery solutions do not require much time, which is required in the classic hydro pumped storage. This is also being discussed in IFI-financed and Pakistan-based technical-support projects. The IGCEP should have utilized the available reports.

The plan should have talked about electric vehicles (EVs). The country has an efficient EV policy. Due to a rise in oil and gas prices and the planned elimination of fossil fuels, there has been a significant shift to EVs which may become more affordable under a solar PV-based generation and battery-charging regime. EV inclusion will certainly affect the demand schedule; there should at least be a scenario-based analysis and inclusion in the plan; something on the lines of assessing the impact of conservation and labelling programmes of NEECA.

Risk analysis, which is missing from the document, is part of most strategic plans. We suggest that such analysis is added to the document. This will help identify the combination of circumstances and certain probabilities that affect the power sector. For instance, these days, we are going through some unfortunate circumstances that lead to loadshedding. These include the loss of hydro due to lack of rain and water shortages, the price and supply issues of oil, gas and coal, high prices, the unexpected failures of power plants, coal and fuelling issues of nuclear, etc.

Our climate pattern is changing, which may affect hydro supplies. As the share of hydro increases, the risk will increase too. How to mitigate such a risk and what strategies should be used are serious issues. Risk analysis should have been included in power planning.

4.6: Comparative electrical scene in South Asia

Worldwide the energy scene is bad; there are both supply and high price issues. Poor countries' hardship is obviously more. Governments do not have foreign exchange and money to subsidise while people cannot pay the high prices.

Many people in Pakistan are wondering as to what is the situation in the region in terms of energy supplies and prices. We will try to provide a rough comparative sketch of the energy scene in South Asia involving Pakistan, India and Bangladesh. India is comparatively rich in terms of energy resources – coal, hydro and solar. These three resources based electricity is the cheapest in India where coal produces 204,080 megawatts, hydro 46,850MW and renewables 11,065MW, totalling 399,496MW.

It has been mostly self-sufficient in these resources. However, lately there are local coal supply issues as compared to demand and it has to import coal from abroad. Imported coal is being mixed with local coal with a cost penalty of 30% in the cost of generation.

India imports gas in the form of liquefied natural gas (LNG), which is expensive these days, however, there is hardly any electricity generation based on gas. Inefficiency and transmission and distribution (T&D) losses in India are comparable with Pakistan or even more, which affects cost of supplies. There are huge DISCOM losses, which have accumulated almost comparable with Pakistan. In Pakistan, these losses show up in the form of a unique term called circular debt.

By 2014, in Indian rural areas, load-shedding used to be of 10-12 hours. Average power shortage was 17-20%.These days there is power surplus with an installed capacity of 400 gigawatts (with a renewable share of 158GW) against demand for 210 GW. There shouldn't be any load-shedding in India due to both enough supply and having local fuel. However, in April, peak demand in India was 207.1GW and the supply was short by 10GW, which means about 5% load-shedding or 1.25 hours of average load-shedding per day.

Average AT&C losses in India are 22%. There is a large variation in this among states – least loss states are Delhi, Kerala and Punjab, where losses are around 10%. Bihar has 30% losses, UP 33% and occupied Kashmir 50%. Bangladesh and Pakistan seem to have an identical syndrome – high installed capacity and low fuel availability due to higher prices. It had to approach the IMF as well due to the current account deficit created by heavy and expensive energy imports.

Installed electricity capacity in Bangladesh is 25,566MW against peak demand for 14,782MW. Some 7.89% of electricity is generated from coal, 50.84% from gas including LNG, 28% from furnace oil and 6% from diesel. T&D losses in Bangladesh DISCOs have been reduced to 10-12% (from 36.19% in 1988 and 15.42% in 1998), as opposed to 17% in Pakistan. Perhaps, poverty reduction accompanied by the highest per capita income and growth in the region has played a role in the T&D loss reduction. In Bangladesh, load-shedding is much lesser than in Pakistan. Dhaka Electricity Board has announced load-shedding twice a day for two hours each.

Various electricity conservation measures have been enforced. It has almost the same problems as in Pakistan. Excess capacity and high capacity charges, dependence on expensive imported gas and furnace oil.

Tariff variances

Although averages may be deceptive, the Indian average tariff for large customers is Pakistani Rs23.38 per kWh and for small consumers the average is Pakistani Rs10.70 per kWh. It appears comparable with Bangladesh's corresponding figures – maximum Pak Rs25.33 per kWh and minimum Pak Rs12.64 per kWh. Pakistan's maximum tariff is 40% higher than the Indian average.

Median/ typical maximum tariff for residential consumers in India is Pak Rs25 per kWh, which is in Mumbai, Andhra Pradesh and West Bangal. Compared with the corresponding Pakistani tariff of Rs32.77 per kWh, Pakistan's tariff is 31% higher than that of India. The lowest maximum tariff in India is in Delhi and UP at Pak Rs17-18.68 per kWh. Thus, there is a rather wide range between the maximum and minimum – Pak Rs17.10-34.75 in the large consumer slab and Pak Rs5-16 in the small consumer slab.

Similarly, the minimum tariff in UP, West Bengal and Bihar is in the range of Pak Rs14.44-16.05 per kWh. In Mumbai, the minimum tariff is Pak Rs8.37-11.89 per kWh. The lowest minimum tariff in India is in Andhra Pradesh and Haryana at Pak Rs5-5.25 per kWh. Residential electric tariff of Maharashtra and Pakistan are identical – Maharashtra's highest tariff for (700 units plus) is Rs34.75 per kWh vs Pakistan's Rs32.77 per kWh.

Similarly, the minimum tariff (200 units and lower) for Maharashtra is Pak Rs12.39 per kWh vs Pakistan's tariff of Pak Rs13.41 per kWh. However, this slab is for the load greater than 5kW, which is rare. More relevant rate is for the load lesser than 5kW, which is Pak Rs3.45 per kWh. India's complexity is mind boggling. Delhi is supplied from gas-fired (LNG) power plants whose peak-time charges are Indian Rs20 per kWh (Pak Rs52.62).

However, they are able to supply free electricity to small consumers up to 200 units. It is anybody's guess how they finance such subsidy. The provincial Punjab government in Pakistan tried something similar but could not do so. However, the government of Pakistan has announced a remission in fuel adjustment charges for small consumers up to 200 units.

Bangladesh's maximum residential tariff for large consumers is Pak Rs25.33 per kWh vs corresponding tariff in Pakistan of Rs29.33-32.77 per kWh. Thus, Pakistan's maximum tariff is 16-29% higher than the corresponding Bangladesh tariff. Minimum tariff of the two countries is almost identical – Pak Rs12.64 per kWh for Bangladesh vs Pak Rs13.45 per kWh for Pakistan. We don't have lower side (less than 5kW) data on Bangladesh. It is obvious that Bangladesh government is subsidising electricity.

Concluding, India is the least cost country due to mostly local coal-based electricity and hydro. There is subsidy and accumulated DISCOM losses, which has enabled India to keep a low tariff. India has practically not much of a problem with electrical tariff as compared to Pakistan and Bangladesh.

Bangladesh's power infrastructure is similar to that of Pakistan and suffers from the identical difficulties of expensive imported fuel. Lower T&D losses and subsidies enable it to maintain lower tariff than Pakistan.

Pakistan's circular debt is a form of unpaid subsidy and may continue to be there on books, in one form or the other, for a long time to come. Floods have further complicated the problems. Induction of cheaper renewables and local Thar coal and higher capacity utilisation appear to be the near-term solutions towards alleviation of high tariff difficulty. Pakistan's electricity tariff problems are getting increasingly intractable, now with the floods in particular and the political instability.

Power TARIFF: Learning from Southeast Asia

Pakistan is suffering from circular debt, mostly due to high capacity charges, which have been further aggravated due to excess capacity and its underutilisation. One of the solutions that have been discussed and even partly implemented is tariff reforms. A logical argument is that electricity utilisation will increase if tariff is brought down.

The risk, however, is that the utilisation may not increase and thus the companies may suffer on two counts – reduced tariff and reduced sales. Hence, there has been reluctance to introduce tariff incentives on a wider scale. There is an added advantage of reducing industrial or even commercial tariff because of its multiplier effect which includes economic growth, employment and even export competitiveness.

The government did introduce special tariff for export industries and a tariff scheme for consumers who show an increase in their consumption. Reportedly, there has been a positive impact of the tariff reforms. The government is considering further incentive schemes. We will discuss some of the other tariff incentives that may have a salutary effect on consumption, profitability of producers and economic growth.

There are two parts of electricity tariff/cost – capacity/fixed cost and variable cost, which is mostly fuel cost. Fuel cost has been on the rise recently and possibly no reduction is possible on that count. However, there is a kind of magic in reducing the fixed part of the tariff. Ideally, the seller should be able to recoup all costs including the fixed cost in order to be sustainable in the long run.

However, what to do when the market does not allow full capacity utilisation either due to economic conditions or consumer behaviour.

The magic of reducing the fixed part is that it may increase consumption and thus the capacity utilisation. Although capacity/fixed charge is reduced on a unit/rate basis, the total annual income in the fixed category will increase due to the volume effect. This is the theory behind most tariff incentives.

Tariff incentives may be categorised in the following forms: First is small user tariff, which is essentially a subsidised social instrument. One does not expect any commercial benefit from it. However, it has other economic and social benefits. Second is industrial tariff. One earns from lower industrial tariff on a volume basis. In most advanced countries, the industrial tariff is much lower than the residential tariff for industrial competitiveness reasons. In poor countries, usually the residential tariff is lower except in the high-consumption, high-income group consuming more than 700-1,000 kilowatt-hours (kWh).

Third is Time of Use (TOU) tariff - peak and off-peak tariff, which can be further divided into peak hours, off-peak day hours, night time, weekend and holidays. At present, Pakistan has only TOU tariff. This has been done away with for the industrial sector. For the residential sector, however, it still continues. There is logic in charging more for peak hours. It usually costs more to provide electricity in peak hours as more expensive fuel consuming plants (oil, diesel, etc) are used. On the other hand, non-peak hours are supplied by cheaper base load plants like coal, nuclear, etc.

We have detailed data available from Taiwan, which is relevant for several reasons. It lies in a hot climatic region and is a highly competitive country competing with Thailand, the Philippines, Malaysia and South Korea. The tariff example of Taiwan is not unique. It is common in other countries of the East and the West. In Pakistan, electricity consumption is very low in winters and it is being considered as to how to increase it to reasonable levels. It may be noted that cheaper hydropower and other renewables are also either not available in winter or their production is reduced very significantly.

Thus, there is an upper limit on how much we can profitably increase consumption in winters. There is a difference of 13% to 27% between summer and winter tariffs in Taiwan and similar is the case in other countries of Southeast Asia. There are six residential tariff categories in Taiwan starting from 120 kWh to more than 1,000 kWh and tariff starting from 5.868 US cents for the smallest category of 120 kWh to 23.076 US cents for the 1,000 kWh-plus category. There is a difference of 3.93 times between the highest and lowest tariff.

Similarly, it is amazing to note the concessionary residential categories in the case of relatively richer South Korea. The International Monetary Fund (IMF) and international financial institutions' (IFIs) pressure on Pakistan to restrict and remove residential tariff subsidies appears to be misplaced and such policies should be reconsidered by them. There is an average difference of 2.34 times between peak and off-peak tariff. Night-time tariff is the lowest. There is usually very little utilisation between 00 hours to 0700 hours except for three-shift industries or the IT industry. And the scope of increasing the capacity utilisation may be the highest.

In Pakistan, the construction and steel industry may be able to benefit significantly from a special night-time tariff. Steel bar cost in Pakistan is the highest in the region possibly due to both high gas and electricity tariff. Night-time tariff can also benefit the emerging electric vehicle (EV) sector wherein night-time EV charging at home may get popular. The Cabinet Committee on Energy (CCOE) has approved a fixed rate of Rs12.66 per unit as winter tariff (Nov 1, 2021 to Feb 28, 2022) for all domestic and commercial consumers.

The reference for determining the increase would be the consumption in the same month of previous year. The flat rate on incremental consumption will be applicable to those consuming over 300 units per month. They are currently charged Rs20-23 per unit excluding taxes. Similar incentives have been made available to the industrial sector as well. Lower winter tariff on increased consumption was initiated last year and reportedly resulted in 16% growth in electricity consumption.

It is risk free for the seller as it is applied to increased consumption, ensuring an increase in the recovery of fixed/capacity charge. This year, the scheme will encourage the shifting of gas consumption to electricity in space heating, as LNG is getting expensive and may not be available in required quantities at reasonable rates.

It is unlikely that consumers would shift to electricity in cooking uses due to culture, habits and equipment constraints. The loss of revenue in supporting the subsidy in residential tariff can be partly balanced by bringing changes to the net metering solar tariff system. Solar equipment prices have come down sharply. Solar PV is feasible on its own and does not require any support of subsidy. Net metering is either being shunned or amended in many jurisdictions. Net metering did a good job of promoting rooftop solar panels. There is a need to review net metering by installing two meters and two tariff systems or some alternative tariff amendment.

Gas geysers consume a lot of gas. Water heating geysers can be replaced by solar water heaters. Perhaps, it is time to facilitate the introduction of solar water heaters by introducing some subsidies or credit and installment schemes. Biogas promotion and subsidies appear to be in order as well due to rising LNG prices and the lack of availability in this respect. Perhaps, gas companies and the Petroleum Division may be able to take interest in this respect.

Concluding, the government may consider introducing other electricity tariff incentives in addition to the incentives announced already. This will help increase capacity utilisation and electricity revenue, resulting in a reduction in the circular debt.

4.7: Competitive power market

Nepra (National Electric Power Regulatory Authority) has introduced a Competitive Electricity Market framework, which has been christened as CTBCM-Competitive Trading in Bilateral Contract Market. The objective is to reduce cost and prices of electricity supply while continuing to attract capacity investments.

An oft-repeated lamentation has been that IPPs (independent power producers) indulged in excessive profiteering under Nepra's nose. To be fair, it is more of a systemic problem. Perhaps Nepra is now doing its bid to compensate by launching this initiative. In the following, we will discuss a few issues that may add to the usefulness of the CTBCM framework.

Pakistan seems to be lurching from one crisis to another. Currently, we have fuel price and supply problem (although this problem is not unique to Pakistan; growing reliance on imported fuel made it worse) while we had almost recovered from the capacity problem earlier.

Pakistan has come a long way since the Wapda monolith days. A lot has been done to change the structure closer to market liberalisation. Institutions have been created. CTBCM had to redefine their roles without creating new entities. Efforts are now being made to introduce a competitive element to the power sector. CTBCM is a step in that direction.

Elements of Competitive Electricity Market

Competitive Electricity Market (CEM) has two parts: 1. Wholesale market wherein generators and other electricity suppliers sell electricity to Retailers including Discos; 2. Retail Market (RM) connects retailers with consumers. Wholesale market is of two types: (a) bilateral and; (b) pool/exchange. Pool/exchange type market is a traditional stock exchange-like institution that brings electricity buyers and sellers come together to make electricity trade transactions.

Market Clearing Price (MCP) is determined through price-demands and price-supply curves. Spot price of day-ahead, hour ahead and Real Time (RTM) is determined by the exchange. There are usually 24 hours market time segments for which prices are announced. Spot prices can be used as a reference for negotiating OTC and bilateral contracts. Purchases can be made through spot exchanges as well. There are cost-based supply curves called 'single-sides' wherein demand projections are made by the system operator.

There is centralized dispatch based on economic dispatch order. Practically, in this system buyer does not have any influence on the price. Buyer is a price taker. However, there is a scientific calculation of MCP.

All buyers get the same price and all sellers get the same price. CTBCM has adopted this approach. There is double-side bidding as well in which buyer specifies price and demand for every hour and similarly seller specifies price –supply requirements. Matching buyer's and seller's input, MCP is worked out for every hour.

The pool system can be mandatory or voluntary. In order to accommodate bilateral contracts, usually, spot/pools are kept voluntary. There are many exchanges/pools in the world. In Europe, Nord-Pool, EEX, EPX, and EEPX are prominent.

In the US, PJM, California ISO, NYISO, ERCOT (Texas) are more prominent. There are similar exchanges in Australia, Japan and South Korea. India and the Philippines have voluntary exchanges as well. However, trade in IEX and others is limited to only 5-6% of market share. The Indian government has decided to take policy measures to increase this share to 25%.

The opening of Bilateral Market

Bilateral contracting has come of age. 'Bilateral' is now more general and can include pool features. Under bilateral contracts, generator and consumer are the parties. There is a master contract and a running contract. It can be for a few months to 15 or even more years.

Bilateral contracts prescribe price and demand curves. These are usually confidential but their main features are registered with the system operator. Regulators normally prescribe capacity contracts of 115% of the peak demand of the contracts total of a market supplier.

Perhaps the most practical and useful aspect of CTBCM is opening up of the bilateral market. Large industrial consumers (consuming 1MW or more) would be allowed to have direct bilateral contacts with the power generators (IPPs and Gencos, etc.,) paying transmission and distribution charges to NTDC (National Transmission and Despatch Company) and Discos.

It can attract new capacity investments in many ways and encourage better utilization of existing power investments. Industrialists may install larger capacity power plants to meet the demand of their widely dispersed industrial units. Currently, they have to install smaller uneconomic and less efficient power plants. In KPK, KP Hydro would like to sell its cheaper electricity to the nearby industries in KPK.

Emergence of Power Marketers

What is totally new under CTBCM are the emergence and role of power marketers (PMs). PMs would be the intermediaries between generators and consumers; would buy electricity from generators and sell it to the consumers, taking away the energy trading function of DISCOs. Such companies would have to be very large companies having adequate cash and liquidity. Selling 150,000 GWh of electricity, say by 6-10 PMs, is a major business.

These new institutions in private sector would be the riskiest part of CTBCM. It may create mafias and price manipulation causing supply and price bottlenecks. One cannot regulate them; otherwise, the whole idea of competitive market goes away. What to do? Risk has to be taken along with adequate safeguards. Competition Commission of Pakistan (CCP) may have to be energized and special regulations be developed in this respect. Initially, upper roof prices may have to be introduced.

Wheeling-the first step

Wheeling of electricity on transmission and distribution network is the first step towards market liberalization. It would enable direct deal between generator and larger consumer. Disco is paid a suitably calculated service charge for handing the distribution contracting with NTDC for transmission. Thus Discos would be off the trading and supply, although, it may take a long time that Disco is totally removed from electricity trading.

Unfortunately, Nepra underestimated the wheeling charge and issued an unreasonable determination allowing about Rs 1.50 per kWh. Discos opposed it and went to Court for adjudication. The issue is probably under litigation. DISCOs are demanding compensation for cross subsidy, stranded costs, losses and NTDC charges. This comes out to be under their calculations to be Rs 7.0-8.0 under older costs.

The low wheeling charge determined by Nepra would have brought all the inefficient captive power plants to the market. The argument is who will finance the expenses incurred by Discos. All the cost elements cannot be denied on the charge of inefficiency. Has the KE under private sector been able to reduce the power losses to 5%? Low wheeling charges would reward inefficiency. Fortunately, better sense has prevailed. There is a rapprochement on the issue.

Nepra (National Electric Power Regulatory Authority) plans to revisit its determination and a reasonable mid-way solution can be found. There is a USAID study carried out by independent consultants, which can be made a basis for determining the wheeling charges.

Discos' role: the confusion

It has been proposed to do away with the electricity trade and supply function of Discos. Discos would be 'wires only', maintaining and expanding the distribution network. Independent private sector power suppliers would be marketing and retailing electricity to residential sector and perhaps also to industrial sector. On the other hands, it is planned under CTBCM (Competitive Trading Bilateral Contract Market) to transfer power supply contracts from CPPA-G to Discos. Doesn't it contradict and counteract? Perhaps, another contract transfer would take place later? Why not maintain CPPA-G single buyer system till new market suppliers emerge as a viable entities and in good numbers.

Retail market

Retail Markets (RMs) means direct sales by marketing companies to consumers by marketing companies instead of Discos. However, Discos may remain as last resort suppliers. Initially, Discos' monopoly is being removed under CTBCM. It would happen gradually. The European experience in this respect is still not very encouraging. 90 million consumers are still reluctant to switch to new companies. There is fear of the unknown and growing scepticism. Under CTBCM, RM is initially restricted to large consumers of 1 million or more. Eventually, it would be extended to all types of consumers, including residential and commercial ones. RM can be a good tool for creating price pressure on wholesale markets. In Pakistan, residential sector has a large market share of 40%. Without its involvement, market share of CTBCM may not be able to reach a reasonable level. In advanced countries, industrial sector has a larger share, approaching 40% and there is comparatively smaller share of residential sector.

Capacity expansion and contracting

Pakistan could not attract power capacity investments in the period 2007-2013 despite a high demand growth rate.

Later on, CPEC (China Pakistan Economic Corridor) solved the problem along with public sector investments in LNG combined cycle power plants which now GoP wants to offload to clear its liabilities. Thus G-to-G agreements may remain to be a major stumbling block in the development of electricity markets. Due to recent current account deficits, budgetary issues and flood calamity, the attractiveness of Pakistan from traditional western investments may go down further. There is circular debt issue and payables to IPPs (Independent Power Producers).

Competitive power market – I

There is capacity excess or deficit problem that is always there, but it is usually lesser in regulated markets. In competitive markets the problem is more pronounced. There have been capacity shortfalls in the US despite the existence of electricity markets. Capacity shortfall is not new. It still continues in California. California grid operator has recently predicted that there would be a shortfall of 1800MW in 2025. Electricity cannot be stored generally, although electricity storage is fast coming of age; it will take time to make an effective imprint on the market. Thus electric power capacity has been either in excess or in shortage. New England's reserve margin has been recently projected between 27 and 40%, New York's 2-30% and PJM's 34-70%. Optimal economic reserve margins have been estimated to be 10-20% in the various regions.

In CTBCM, adequate care has been maintained by retaining the existing systems offered by: 1. PPIB (Private Power & Infrastructure Board) in power generation and transmission acquisition and; the role of NTDC (National Transmission & Dispatch Company) in preparing long-term generation capacity plans-IGCEP (Indicative Generation Capacity Expansion Plan). PPIB will act as capacity auctioneer by making procurement plans and inviting competitive bids. Provision of competitive bidding was already there in existing power policies under solicited projects. However, it could never be implemented for one reason or the other.

Lack of free un-contracted capacity

A major objection that has been raised by many is that all IPP capacity is under contract. There are firm fixed price contracts for 30 years. How can their supply be brought to open market with changing prices? Advanced countries have gone through this problem by adopting appropriate contract conversion mechanisms. A suitable formula can be developed for contract conversion of those plants which may have retired their debts. Debt period is often 10-12 years, but in this period overpayment has been made under cash-flow based tariff model. A workable formula can be developed for plants having passed 20 years and the ones `which are close to retirement. They can be offered an incentive of continuing beyond 25-30 years, whichever applies. Gencos and Wapda plants with or without power plants can be inducted into the CTBCM system. After all, Russia and China are following electricity market principles despite dominant public ownership.

More contracted capacity under IGCEP

The problem is that new tied up contracted capacity is coming up under IGCEP. New contracts can be designed under merchant plant principles of Take and Pay (TaP). There may a mix – part of the capacity under Take or Pay (ToP) and part on TaP. New solar capacity appears to be coming under G-to-G under CPEC. Some via media can be worked out and should be done on a fast track basis. If it is not done, more capacity would come under Take or Pay contracts and one would not be able to induct them into CTBCM system for the next 30 years.

Cost-based system – a saviour?

Is cost-based system a savior? Perhaps cost-based system has been introduced to deal with the IPP contracted capacity issue. What to do if our proposal regarding IPP contracts conversion doesn't work out? Cost-based system is an extension of regulatory cost-plus system which is a major objection against it. Cost-based system is an old system mostly adopted by South American countries. Almost all developed countries have adopted price based system in which either one party-buyer or seller is allowed to place their price bid. Or there is two-sided bidding which allows both sides place their price bids. Price bidding system has been adopted by all new entrants into the market system like the Philippines, Vietnam, Turkey and India.

Separate spot market

There is a criticism that while a small share of market would be initially (till 2030) under competition, all contracted APPs and Gencos have been included in the system. A separate wholesale market could have been designed a la India, wherein competitive and regulated transactions are separate. There are pros and cons in this regard. An integrated system provides foundations for the eventual whole system. It may not require modifications later. A separate spot market may not reflect the energy products mix's characteristics. On the other hand, separate spot market may not unnecessarily overload the start-up system. India could start a separate voluntary spot market exchange easily more than a decade earlier without much preparations or complications.

Issue of KE

Arguably, Karachi has been suffering under KE. A separate vertically integrated utility in earlier days played a good role having better supplies and running efficiency than the rest of the country under Wapda. Over time, KE has come down and the rest of the country has improved, at-least, in relation to supplies. Fortunately, KE's monopoly will end next year. CTBCM has included in centralized dispatch. Earlier, KE used to operate its inefficient plants under its own merit order. However, CTBCM may remain ineffective until linking transmission infrastructure with NTDC system is installed. In Karachi and Lahore, there would be a strong case of implementing the wheeling scheme for supplies to industrial sector. Independent companies may be formed for this purpose. Another question is whether and when new retailers and generators would be allowed? Will PPIB as auctioneer function as elsewhere in bringing new generation? A lot remains still unclear. It is hoped that all other requirements and possible legal issues are sorted out.

Technology vs market fruits?

That the open market in Europe and the US has caused reduction in electricity prices is a debatable question. Market enthusiasts take the credit for it. There is another technology point of view: induction of high efficiency combined cycle power plants in Europe; and additionally, cheaper shale gas has caused reduction in electricity prices in the US. Also, in the US, 30% of the market is still under vertically integrated utilities a la KE in Pakistan. Most developing countries, including India, have not adopted an all-inclusive electricity market system. It is an open question if the sophisticated systems would work in developing countries lacking good governance. The risk of collusion and price manipulation is very much there. A risk analysis must be conducted before introducing any system of this nature.

Risk management

There is a so-called missing money problem. Often in such complex business models, cash-flows do not match. There may be many sources of error and glitches. Also, an enterprise of such nature and scope having potentially a large imprint on economy deserves a second opinion or review by a third party – call it risk review to make it more acceptable. There are considerable opportunities for improvement, some of which we have discussed in the afore-mentioned.

CTBCM seems to have evolved over time and appears to be not representing the full scope of the market design it seems to offer. Initial thought was to convert the single buyer contracts to bilateral contracts among Gencos – IPPs and Discos. All contracts are bilateral. However, bilateral markets have acquired a much extended meaning and implication. As per recent communication by Chairman Nepra, CTBCM is approaching closer to the Turkish model; the latter is almost a full scope electricity trade model.

The good news is that with the advent of CTBCM, there would be a beginning of the era of open and free electricity market which will eventually lead to cheaper electricity and sufficient power generation capacity. The role of government and politicians will be reduced while the say of consumers and businessmen and market players will increase. That is how the developed countries have grown and prospered.

The bad news is that CTBCM would take a lot of time to be effective and have a meaningful imprint on the market. The most optimist projection (made by CPPA and Nepra experts) is a 15% market share of CTBCM by the year 2030.Is that good enough? Will that bring prices down and more capacity in? Market share can be increased if the relevant recommendations mentioned earlier, are heeded.

4.8: The new IGCEP (2022-31)

The National Transmission and Despatch Company (NTDC) has released a new version of the Indicative Generation Capacity Expansion Plan (IGCEP). As the name implies, it is a power-generation capacity expansion plan for the next 10 years. It is kind of a rolling plan and is revised and redone yearly.

The broad trends are emphasis on renewable energy (RE), confusion and uncertainties on hydro, and the immediate exclusion of residual fuel oil (RFO) and the gradual exclusion of RLNG – by 2027. This time a scenario-based plan has been prepared; this article will discuss the plan along with other issues.

The 2022-31 IGCEP takes the existing demand of FY2022-23 as 28,425MW as opposed to the installed capacity of 43,259 MW and the generation volume of 156,379GWh. There are 36.6 million consumers out of which only 391,442 are industrial consumers. The industrial sector's energy consumption is 27 per cent of the total power consumption as opposed to the 49 per cent share of residential consumers.

There are several issues regarding the assumptions and output of the IGCEP. The plan is based on the GDP growth assumption of 3.4 per cent (low) to 5.45 per cent (high). In the post-floods circumstances, it is difficult to have a degree of certainty. However, the difference between proposed generation capacity and actual production is nominal – 13 per cent or 6000MW. There is no certainty of fuel price fluctuations, especially the price of LNG. Oil prices have started to increase once again. The plan also mentions an investment of $50-55 billion.

There will be serious financial issues in the wake of the recent floods. Other possible constraints could be high interest rates, inflation, falling exchange rates and import restrictions due to a shortage of dollars in the next few years. Those responsible for drafting the IGCEP do not have any way of including these factors in their plan; they have a standard model. Pakistan will have to divert substantial financial input towards post-flood reconstruction. There will be severe limitations on the PSDP. Wapda hydro projects will come under severe pressure and consequent reduction in actual terms. Although non-Wapda projects may also face pressure, they will be relatively better as they are financed under commercial finances, FDI and annual energy payments spread over a larger time span.

The plan has made three demand projections for the year 2030-31 and intervening years at the growth rates of 4.12 per cent (low demand), 4.87 per cent (normal) and 5.78 percent (high demand); the respective demand projections are 38,744MW, 41,338MW and 44,668 MW.

The plan also mentions raising the power generation capacity to 69,372MW by 2031. How this will be done is explained with the following details: the existing capacity is 33,082MW; committed projects are going to generate 14,159 MW; the other 17,812MW will be added through candidate projects, and the remaining 4,320MW will come through net-metering. Committed projects are the approved projects and candidate projects are those which are at various planning stages.

The proposed installed capacity under the three demand scenarios of low, base (normal) and high is 65,262MW, 69,372MW and 73,623MW respectively. Readers may be surprised to see the proposed installed capacities and peak demand; the country's peak demand is 41,338MW as compared to the corresponding base capacity of 69,372MW. There is a large share of RE and hydro in the IGCEP, which typically have low capacity utilization (factor) – solar 20 per cent, wind 35 per cent and hydro 45 per cent. Coal and nuclear have the capacity factor exceeding 85 per cent, leading to an average capacity factor of about 60 per cent in the proposed plant mix. The base installed capacity addition in 10 years is projected to be 30,851MW; the 7,339MW of existing capacity will be retired.

The plan has used a new term, optimized generation capacity (OGC), which one might have difficulty comprehending. In my view, all plans are understood to be 'optimized'. OGC provides the capacity addition of 17,000-18,000MW as opposed to conventional of around 30,000MW. In OGC, there is no addition to coal power except a KE plant based on the local Thar coal of 990MW by 2027. It further contains a low hydro addition of 3,461MW – and 13,278MW from other renewable sources; solar 8,350MW and wind 4,928 MW.

The IGCEP has developed four scenarios. There are four lobbies in the country; nuclear pushing C-5 nuclear power plant; hydro enthusiasts; solar and wind proponents, and Thar coal enthusiasts. There has been quite some support for hydro power in the country, especially the Bhasha dam which will provide water storage and 4,000MW of electricity. There are provincial issues as well. Bhasha has remained on the agenda of successive governments and has been inaugurated several times. Substantial advance work has been done on it, including the purchase of land costing more than $1 billion.

Bhasha has political problems as well due to which IFIs are not financing it. Its capital cost was estimated to be $14 billion in 2013. High financial requirements and a long lead time of 10 or more years have raised many questions on its viability. There are similar problems in other hydro projects as well. Climate change issues, which cause irregularities in water supply through precipitation and glacier melting, have come to the fore. It is not possible for any political government to drop the Bhasha dam project. Hence, the plan uses the term 'scenario' for the dam project. Also, in the report's assumptions section, a reference has been given to an official meeting that says that work on Bhasha has been delayed. It is almost clear from the IGCEP that it is highly unlikely for the Bhasha project to be completed this year.

High LNG prices and imported coal cost have compelled planners and decision-makers to look for cheaper and fast-track options. They have found solar and wind power to be good alternatives. The earlier IGCEP versions had calculated wind and solar power to be around over 10,000MW. However, this plan was spread over a longer period and was subjected to a late start. The present decision-makers want to have a fast track solar power plan. The new IGCEP version provides for 12,375MW solar energy and 7,512MW wind energy; the combined total of 19,887MW which is almost as much as energy generated through hydro. Perhaps this scenario assumes that 6,000MW of hydro capacity may not be realized, and thus a balancing quantity from other sources has been provided in this scenario. Since solar and wind power is relatively cheap, there is an attempt to neutralize the impact of high-priced fossil fuel.

It is important to have a few words on the solar proposal, which has the following four components: utility solar of 4,005MW; solar feeder 2,000MW; KE solar 1,050MW; and net metering 4,300MW. Solar feeder and net metering may have some overlap in these numbers. There is some criticism of the solar net-metering export tariff. Solar rooftop PV is feasible, irrespective of the net metering tariff being more or less. It has many advantages of autonomy and self-sufficiency. Rooftop solar, even with the reduced net-metering component, is expected to achieve the targeted capacity.

The plans to achieve the power generation capacity of 15,000MW through RE (solar 10,000MW and wind 5,000 MW) by 2025 appear to be highly ambitious, even impractical. High targets have political advantages, but highly attractive low prices can only be obtained if the quantity is large. There is criticism around its feasibility, high financial requirements and inability of the transmission system to deal with a variable and intermittent supply. So, although there are demand-side attractions, there are supply-side constraints. The realistic target could have been 5,000 MW by 2025. It will be more feasible and another 5,000-7,000 MW in the remaining years of the plan period.

CPEC does offer a fast track implementation of a good amount of solar and wind power capacity. It need not be in the public sector, as we have seen that imported coal power plants except for the Sahiwal plant have been built in the private sector under the CPEC framework.

The new Indicative Generation Capacity Expansion Plan (IGCEP) mentions nuclear energy. The nuclear option is limited to the addition of one plant of 1,000-1,300MW, which appears to be feasible. The Chinese are eager to both finance and supply nuclear plants as there are no major buyers available at the moment.

Nuclear energy enthusiasts argue that since nuclear has a high capacity factor of 85 per cent and negligible fuel cost, its high capital expenditure (Capex) enables it to compete with hydro. These days, nuclear is carrying us through as imported coal power plants are barely producing more than 50 per cent of the total capacity due to high imported coal prices. But there are several safety issues, especially in our society where nuclear regulation is not independent and things are not in the public domain.

There are 'siting' risks as well, which relate to the impact nuclear power generation has on the surrounding environment, especially on water supplies which needs to be properly evaluated. This is a major reason for scepticism among a lot of knowledgeable people. If those who are in favour of nuclear power want to expand, they will have to be more open about major safety issues.

There are three imported coal power plants, and one is being planned to be installed in Gwadar. Except for this project, no additional coal power plant is planned in the future. Our heavy reliance on imported fuel has already taught us enough lessons. Thar coal has emerged as a cheap and reliable source. Its life cycle cost is only 8.5 US cents. Its current tariff, after accounting for inflation, is less than Rs12 per unit as compared to twice this figure of imported coal plants.

Thar coal cost is projected to come down as production volume goes up. There are proposals to convert, wholly or partly, the existing imported coal plants to Thar coal. These projects will take Thar coal power to 4,590MW as opposed to the total 4,680MW of imported coal power capacity – a level which will be achieved by 2031. However, under the Thar coal scenario, with the addition of two 1,320MW plants, a total of 7,230MW of Thar coal power capacity will be achieved. While it is true that more can be done, there are risks and international pressures which may limit utilization of Thar coal. The conversion of imported coal power plants appears to have a better chance politically, if lesser in terms of technical constraints.

The capacity of the existing RLNG power plants is 9,789MW which will be reduced to 8,710MW by the retirement of a number of steam power plants. More important is the case of four state-owned RLNG combined cycle power plants (Trimmu, Haveli, Bhikki and Balloki) with a combined capacity of 4,400MW. These power plants are under privatization. The IGCEP does not project any utilization of these power plants, unsure of its fate in terms of ownership. There were programmes earlier for the assured 30 per cent utilization and higher probabilistic utilization. K-Electric (KE) will add RNG power plants with an additional capacity of 1,320MW. Many people wonder why arrangements couldn't have been made with KE to utilize these power plants either through physical transfer or electricity transmission. From where will KE bring RLNG?

The Kot Addu Power Company (Kapco) is requesting for the extension of its RLNG combined cycle power plants. Kapco should have the thermal efficiency of 50 per cent as its turbines are of lower vintage as opposed to 60-62 per cent of RLNG-based combined cycle newer power plants like Trimmu, Haveli, Bhikki and Balloki. The future of these new state-owned LNG-based power plants is uncertain; the IGCEP has shown nil to 10 per cent production of these plants.

Out of the 7,339MW retiring capacity, 3,156MW will be based on residual fuel oil (RFO), forming 43 per cent. RFO plants will soon be retiring. The most significant one will be the Hub Power Company Power (Hubco) – around 1,292MW retiring in 2027. Kapco power plants, which are RLNG-combined cycle power plants, with a combined capacity of 1,600MW will also be retiring; Kapco-3 is retiring in 2023 and Kapco 1 and 2 are to retire in 2026. Kapco management has been lobbying for the extension of the power purchase agreements (PPAs) of these power plants, arguing that these plants are in good working condition and can work for another 10 years.

Hubco has also tried extension by converting to coal, which did not prove to be feasible, especially in the current scenario of high imported coal prices. The Uch power plant has a capacity of 586 MW and is running on local low-BTU gas; it will retire in 2031. The 620MW Guddu 5-10 power plant which runs on pipeline gas will retire in 2023. Reportedly, there are safety and maintenance issues with this plant. If gas is available, the Uch-1 power plant may deserve a longer life, if feasible.

Old power plants have an advantage that they have cheap real-estate assets and installed infrastructure like gas and oil pipelines and storage. Their availability may be lower and thermal efficiency may have gone down. Older plants may also find opportunities for finding new partners under the Competitive Trading Bilateral Contract Market (CTBCM) bilateral contract and wheeling.

The general rule should be that all steam power plants running on RFO, RLNG and pipeline gas must go – this is because RFO and RLNG have become too expensive and pipeline gas has a high opportunity cost despite low prices. If oil and RLNG prices go down, maybe there will still be a chance for these power plants to remain useful.

The generation plan has to be accompanied by a transmission plan; both are mutually interdependent. While it was earlier announced that a transmission plan will soon be released, it has not been done. Transmission can add significantly to the generation cost and may influence project selection and generation of the last-cost generation plan. It is hoped that planners will expand their scope of work and expertise in this respect. The National Transmission & Despatch Company (NTDC) is a transmission company.

The IGCEP makes important and useful recommendations with respect to variable renewable energy (VRE). The IGCEP recommends the hybridization of solar and wind power, which will increase the time span of the availability of the two. Hybridization along with suitable storage can provide grid support, frequency control, reactive power, voltage regulation and reserve power. The IGCEP could have presented storage requirements in the plan which we had recommended earlier as well. Enough work and studies have been organized by IFIs on this and are readily available.

I would like to appreciate the work of the IGCEP team which has developed indigenous capabilities to develop such plans. It is revised every year to accommodate changes in the relevant aspects of the sector. Earlier, it used to be at a frequency of five years and done by expensive foreign consultants. The National Electric Power Regulatory Authority (Nepra) will now review the IGCEP, which may consider this article’s suggestions. This will decide what numbers to select and approve in a plethora of options and scenarios.

4.9: Future of hydroelectric power

COP27 has ended in Sharm El-Sheikh, Egypt. It has reaffirmed its commitment to a maximum of 1.5-degree Celsius rise in temperature over pre-industrial global average. Some support to natural gas as a transition fuel has survived. The most important and new feature of COP27 is the loss and damage fund. Not much is known as to what would be the source of fund and how would it be allocated to the loss and damage victims. Will it be governments or individuals?

Initial indications are also not very encouraging. EU has offered 60 million euros to Pakistan as against the estimated damage and loss of $30 billion. COP27 seems to have ignored hydroelectric power as a reliable renewable energy source worth promotion. However, they have spoken volumes about solar, wind, hydrogen and electric vehicles. Reason for ignoring hydro appears to be a lack of mountains in many parts of the world providing water head.

Hydropower has been one of the most pursued sources of energy and the only available renewable energy source before the era of wind and solar power began recently. Solar is the new hero of today and tomorrow. Solar PV would generate 38-50% of the world's electric power (10,000-14,000 gigawatts). Hydropower belonged to yesterday. It may never go beyond 1,500GW.

Hydropower has many advantageous features – it can start instantaneously providing black start functions in case of grid failure and restart, provides energy storage by pumped storage and provides base load power in its availability period.

It requires no fuel except water, which is its defect too; drought causes loss of production and decreased reliability. Continuous and successive droughts can be extremely dangerous for energy supply and the economy. Existing installed hydropower capacity is 1,360GW (17% of the total global capacity), out of which China has 391GW, Brazil 109.4GW, Canada 82.3GW and USA 101.9GW.

However, new additions to hydro capacity in most countries remained below 1GW, while China added more than 20GW. In Norway, Brazil and Canada, hydropower accounts for 93.4%, 63.5% and 58.8% of electricity generation respectively. In Pakistan, installed hydropower generation capacity is around 10,000 megawatts, accounting for 15% of total hydro potential of 60,000MW. It has been a much sought-after source of electricity in our region including India, Pakistan and Nepal due to Himalayas.

IGCEP (power plan) provides for adding 12,000MW of hydro capacity by 2030. In Pakistan, Kalabagh Dam and Bhasha Dam attracted quite some political debate; Kalabagh appears to be buried in the debris of history and inter-provincial political opposition; Bhasha has been inaugurated several times and recently, its implementation dates have been advanced into future. K-P earns significant royalty from hydro and would like to get even more than the present allocation. In the province, the recent oil and gas discoveries may dilute dependence on hydropower royalties.

Will hydropower remain as attractive and sought after in future? Probably not! The emergence of cheaper and widely available sources like solar and wind has diluted the attractiveness of hydropower. Hydropower's capital intensity in an atmosphere of high interest rates has also become a negative factor. Current capital cost is $2.5 million per MW and generation cost is 8-10 US cents per kilowatt-hour (kWh), as opposed to $0.60 million per MW and 2-4 US cents per kWh of solar PV plants.

To deal with the intermittency problem of solar and wind and to provide for grid stability, a new role of hydropower is emerging. Hydro pump storage has been there for a long time now but its share has not been as high as can be expected in future laden by solar and wind power. A classic example of this new role is the installation of hydro pump storage in the UAE. There is no hydro pump storage installed yet in Pakistan.

With the planning and implementation of a large component of 10,000MW solar energy, IGCEP may have to add a significant amount of hydro pump storage. K-P govt may well be advised to lobby for such a capacity. Pakistan has consistently ranked over the last 10 years among the 10 highest risk vulnerable countries due to climate change. After having been hit by scorching heat in April, the country had to face massive floods; 33 million people have been impacted, 325,000 homes destroyed, 735,000 livestock lost and 2 million acres of crop damaged.

Water dams have been swept away in Balochistan. Floods have destroyed 105 mini-hydropower plants in Malakand and Hazara. There were controversies about hydropower even in its heydays, the salient of which are land use, displacement of communities, biodiversity loss, dam failure risks, etc. GHG emissions from hydro are a new amazing discovery challenging its attractiveness. Of these, entire climate change poses the maximum risk, which will be our subject of discussion in this space.

New controversies have come to light. Latest data and studies indicate flood risks due to dams themselves. Dams release GHG as well by anaerobic processes of the vegetation under water. Dams' safety risk may increase with increased climate risks. The need for continuous monitoring of dams, adaptation and improvements has never been more than has come to surface now. Around 61% of world dams are under risk of drought or floods or both by 2050. In 2021, California's hydropower production went down 48% from the 10-year average.

France suffered a loss of 30% in hydro generation. In Spain, the fall in hydropower production due to droughts has been 44%. In Europe, overall production loss has been 20%. National hydropower production in the US is expected to drop 14% from 2021 to 2022. South Africa has suffered from frequent droughts reducing water reservoirs capacity to 11%. India and Pakistan suffered major drought at least once every three years in the past four decades. In 2001 drought, hydro production dropped by 35% due to lack of water. More frequent droughts and successive ones that are expected in the wake of climate change effects, are destabilising hydropower plants' operations. We are observing Neelum-Jhelum issue related with water flow.

In Ukraine, a recent World Bank project has bundled solar PV and BESS (battery storage) to deal with the issue. Also, it is obvious that hydropower cost would go up by the corresponding percentages diluting its comparative economics. Should we have more hydropower? Should we review our plans? What changes are required in hydropower sector planning? Certainly, storing water is a necessity. However, there may be other alternatives, eg charging aquifers rather than building rock or concrete dams or doing both? More rethinking, research and debate are probably required on the issue.

Hydropower has replacements and competitors. It may reduce the classical commitment to hydropower. However, hydropower has its own strength and features which are not available with solar or wind power.

Table 4.9.1: Scenario-wise installed Capacity (MW) by 2030-31

Category	Base	Low Demand	High Demand	Diamer Bhasha HPP in 2029	Chashma Nuclear (C-5) for Energy Security	Local Coal inclusion in 2027 & 2030	Un-constrained VRE
Imported Coal	4,680	4,680	5,340	4,680	4,680	4,680	4,680
Local Coal	4,590	4,590	5,580	4,590	4,590	7,230	4,590
RLNG	8,710	8,710	8,710	8,710	8,710	8,710	8,710
Gas	1,933	1,933	1,933	1,933	1,933	1,933	1,933
Nuclear	3,620	3,620	3,620	3,620	4,820	3,620	3,620
Bagasse	394	394	394	394	394	394	394
Solar PV*	13,670	10,921	13,840	12,103	12,889	12,367	12,375
HPP	22,560	22,262	22,900	26,731	22,262	22,262	22,560
Cross Border	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Wind	6,868	5,805	8,959	5,890	7,046	5,751	7,512
RFO	1,347	1,347	1,347	1,347	1,347	1,347	1,347
Total (MW)	**69,372**	**65,262**	**73,623**	**70,998**	**69,671**	**69,294**	**68,721**

**Solar values are in MW_p*

Figure 4.9.1: NTDC System Installed Capacity (MW)

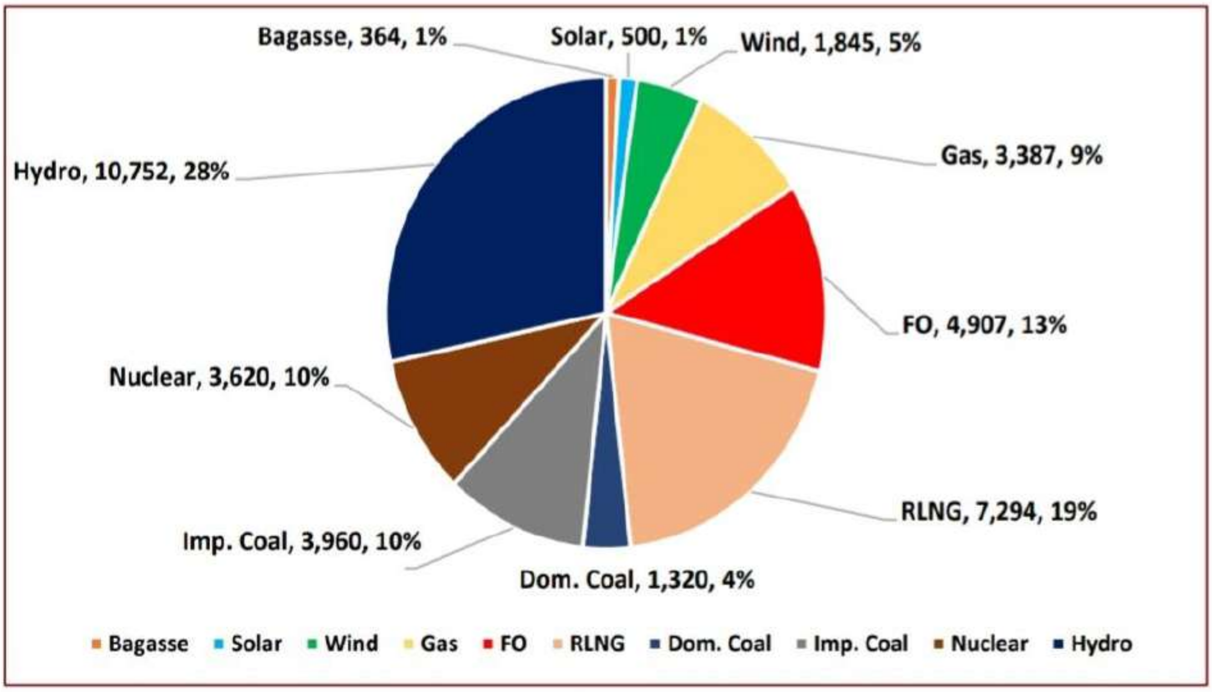


Chart 2-2: NTDC System Installed Capacity (MW)

Figure 4.9.2: NTDC System Annual Energy Genration (GWh) as of 2021- 22

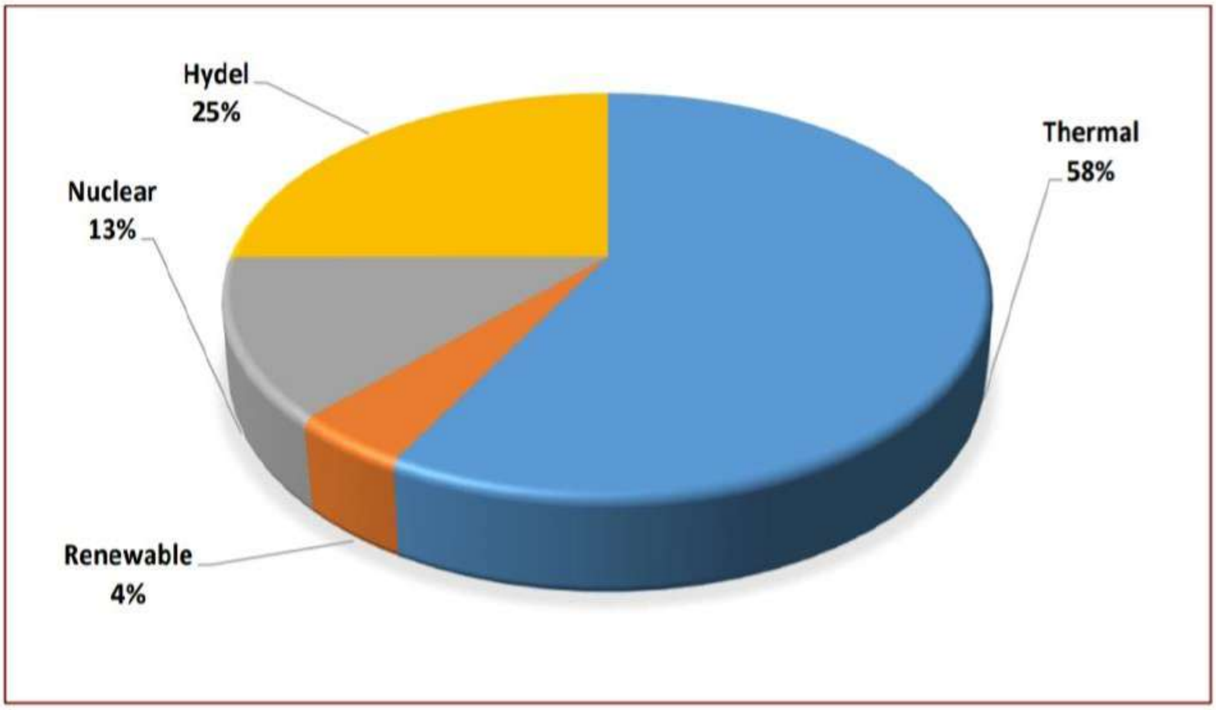


Chart 2-3: NTDC System Annual Energy Generation (GWh) as of 2021-22

Figure 4.9.3: Hydropower installed capacity in 2021

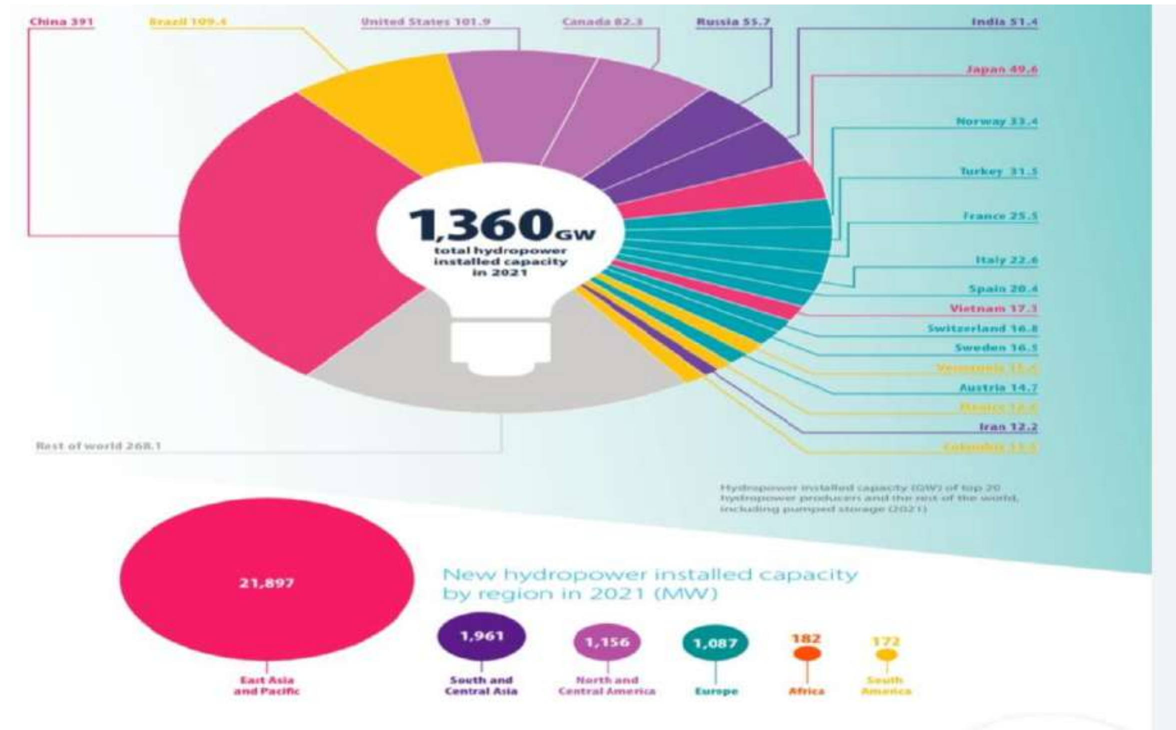


Figure 4.9.4: Global pumped storage installed capacity (GW)

4.10: KE's petition: case for integration

KE (K-Electric) has submitted a petition to Nepra (National Electric Power Regulatory Authority) for getting a separate generation tariff. NEPRA recently did its public hearing on the subject. NEPRA will evaluate the petition and announce its judgment in due course. Although, there isn't much time left as the current tariff system expires on the coming 30th June.

Presently, KE works under an integrated MYT (Multi-year Tariff) system that covers generation, transmission and distribution, all in one number and is awarded for 7-10 years. MYT was awarded in the context of privatisation in 2002-2005. The system was an anomaly having created an isolated island different from elsewhere in the country, which created many problems.

Why did the IFIs which led the privatisation support this kind of system? Probably, they thought that Karachi being an industrial city and it was in a better electricity supply situation, they thought that a privatised company under an integrated system may produce better results.

KE has had a mixed story of achievements. It makes a claim that it reduced T&D losses from 40 percent to 15 percent. The opponents claim that 40 percent losses were due to a peculiar political situation and extraordinary losses level reduction is at least partly due to improvement in political situation in Karachi.

Secondly, the current loss level of KE is higher than of many companies in NTDC (National Transmission and Dispatch Company) system, i.e., IESCO, FESCO, GEPCO, etc. However, it would be unfair to negate many efficiency improvements in the distribution system undertaken by KE; details of which may not be discussed due to the paucity of space. KE might have done still better had it not been beset with the ownership issues.

Perhaps a larger issue is the problems of electricity shortage in Karachi due to low and delayed investments. Current KE management and ownership issues have caused further pessimism in this respect. There have been voices of undoing privatization that may have caused more legal issues. Selling of shares to wealthy buyers has also been stuck to many issues.

Fortunately, KE has itself realized that a change in system is due. Many of us have been arguing for this for a long time now. KE cannot, in the circumstances of risk and CTBCM (competitive trading bilateral contract market) uncertainties, finance the required investments. Under the current system, Karachi and KE do not benefit from the national investments in power generation system, although the NTDC system has been supplying KE with 500-1500MW.

Secondly, KE is forced to operate its lesser efficient and expensive to operate plants due to its isolated or independent system, while more efficient plants in the national NTDC remain unutilised.

In these circumstances, of more practical solution is to undo the MYT system and replace it with the system that prevails countrywide in which generation is under independent IPPs (Independent Power Producers) with an established tariff system, transmission under NTDC system which has a separate tariff system and distribution as Discos operate.

KE has submitted generation tariff for all its operating plants individually and has proposed capacity charges and Operating charges. While, operating charges would not cause any difficulty, as it is being done already. However, fixing generation charges may be an issue that may have to be done by Nepra. In this situation, power plants would become IPPs as other IPPs.

KE can continue to make generation investments as any other IPP. There would be freedom for other investors to enter into KE area. KE monopoly has already gone away under the privatization agreement. Some arrangement may have to be made for selling KE transmission assets to NTDC. KE's proposal does not deal with the issue. But certainly, regulator will have to sort it out.

KE's petition does not talk about what happens to distribution tariff. Apparently, KE intends to amalgamate transmission and distribution. Disco tariff methodology is simple and well established. However, the issue cannot be dealt with in isolation. Both generation and distribution tariff should be decided in one package. Nepra should ask for a petition in this respect as well.

There has to be an agreement with KE to register its generating facilities as an independent IPP. Perhaps, some time schedule may have to be agreed. And also a broader agreement that KE will function as a DISCO and eventually under CTBCM it will operate as a wire only under the framework that has already been established. We would like to add that creating more distribution companies in Karachi, as proposed or demanded by some, would be causing confusion only.

The opponents of the proposal may oppose due to the take-or-pay clause as proposed by KE. All generation facilities are working under take-or-pay. The existing multi-year tariff system includes take-or pay implicitly. The KE plants are depreciated and capacity charges as proposed are not high, e.g., in the range of Rs 4-5 per kWh.

This piece may not be taken as some kind of a cooperative support to KE position as this scribe has been arguing for this for a long time and has written in this space and elsewhere. Finally, due to circumstances that KE is in, it has understood the logic and benefit of joining the countrywide integrated system. It would benefit all; consumers, KE and GoP.

Concluding, KE proposal is in effect a proposal for integration with the country-wide system. It would solve many problems and add several benefits. It would attract IPP investment in Karachi, let Karachi benefit from power investments made elsewhere in Pakistan, reduce power tariff and help reduce some of the Sindh's grievances which have recently emerged in the form of SEPRA (Sindh Electric Power Regulatory Authority) — a separate power regulating agency .

4.11: Mapping the economics of imported coal-fired power plants

Nepra (National Electric Power Regulatory Authority) has rejected the power generation tariff petition of Jamshoro Power Company Limited (JPCL), terming it too high and unaffordable by the consumers. Is NEPRA playing to the gallery or it has some recipe to offer some solution for tariff reduction? The plant (imported coal-based power unit) is cheaper than the other similar plants approved by Nepra. Are there really some solutions?

Coal power plants' economics has been under topsy-turvy and continues to be so. Oil prices have come down to 75 USD/bbl but coal still is at 163 USD/t as opposed to 80-100 USD/t of a normal rate. Local coal-based electricity in India has been trading at under 5 USc per kWh. It went as high as 12-15 USc for imported coal-based electricity. Imported coal IPPs (independent power producers) in India stopped operating their plants or reduced their production. The Indian government has imposed emergency provision to force them to operate their power plants.

It is any body's guess as to when will the normalcy return in the international market. As anywhere, local energy is the best solution, which we will discuss as well in the following. Briefly speaking, higher exchange and interest rates and coal cost are the reasons for high petitioned tariff which is about 45 percent higher than the existing imported coal-based power plants. The petitioned tariff is Rs 32 revised from six months earlier figure of Rs 27.

The main and obvious reason is the depreciation of Rupee which the petition assumed to be Rs 218 in Oct 2022 as opposed to the current exchange rate of 'Rs 284'. Most new IPP tariffs have been at a reference exchange rate of 105. Another major reason is rise in Libor interest rates which earlier used to be 0.5 percent and now stays at 5.5 percent, but the petitioned value is 4.45 percent in Oct 2022. Also, higher imported coal cost is the third reason for high tariff.

How does JPCL tariff differ from the other coal power plant, Thar and imported? JPCL life-cycle unit power tariff is 12.42 USc (Rs 32). The corresponding LCoE (levelised cost of energy) in 2016 of other imported coal power plants was 8.5 USc. So why the generation tariff of JPCL is is higher despite a lower CAPEX cost. It is the higher fuel cost which makes the difference.

International coal prices were 80-100 USD/ton in 2016-18 and the same is 163 USD/t now. The fuel cost component of imported coal power plant China Hub is Rs 35 per kWh. Add fixed cost component CPP of Rs 14.0, the total adds up to Rs 49.0 per kWh. Thar coal (Engro) fuel cost per kWh is Rs 8.86; Rs 14 per kWh of fixed cost (CPP), it adds up to Rs.22.86 per kWh. JPCL is of 660MW which is to produce 4.668 GWh/yr units electricity at a capacity factor of 85 percent. JPCL unit CAPEX is 1247 USD/MW as opposed to that of other imported coal power plant at 1448 USD/MW.

Despite implementation delays and high interest cost during construction, CAPEX of JPCL is 14 percent lower than other similar plants. Its unit CAPEX could have been lower, had its designed capacity been permitted to be at 1320MW. The project was supposed to have two parts of 660MW each. Currently, overhead capex has been built into one part only raising its CAPEX. This was the only power plant which was put into competition and came with the lowest bids as compared to any other similar coal power plant.

One is not sure if the option of implementing the part-II would still be there? ADB (Asian Development Bank) is already being criticized to have funded a coal power plant. It may not be ready to extend support. Also, contractors may not be ready. One of the solutions to reduce cost is to implement its second part. It may be noted that there is a provision of 20 percent share of Thar coal usage and of 80 percent imported coal share in the plant design.

However, as per petition data, there is practically no difference in the calculated tariff of 12.42 USc. It is the same with and without Thar coal? One could not understand the reason. Perhaps, overhead cost of transportation of Thar coal has nullified the difference. The petitioner has not disclosed coal prices, which have been used in calculating tariff. Here, we would draw the attention of the regulator to standardize the formats and not allow such omissions.

There are two types of solution: 1. Financial; 2. Technical. Financial solutions are reduction of interest rates, extension of repayment period. We have discussed these in detail in our last article on the subject in this space. ADB has already implemented this in its loan terms for JPCL project by offering loan repayment period to 20-25 years; otherwise, the asking tariff would have been much higher.

Nepra and IPPs can try this to reduce the payment rate and burden. Second solution is to reduce interest rates by decreasing the loan spread on Libor. It was unnecessarily increased by Nepra from 3 percent to 4.5 percent in the days of low interest/LIBOR rates of 0.5 percent. Now the Libor is at 5.5 percent effectively doubling the borrowing rates from 5 to 10 percent. ADB concessional loans are subject to a mark-up by the ministry of finance. This mark-up increases the interest rates to 15 percent. This loan type has been used in JPCL. Consideration may be given to bring this down. This will help postpone the problem by reducing upfront interest costs.

The technical solution is to convert the plant to Thar coal. The issue has been under discussion for the three existing imported coal-based power plants. It is kind of difficult to do that for existing operating plants where various kinds of risks and cost are involved, complicating a reasonable approach and agreements with the coal IPP. In the case of JPCL, it is different. The plant is owned by the GoP. Technical changes for conversion can be done before commissioning the power plant. Active, serious and immediate consideration may be given by the relevant authorities on this option. Railway track project for Thar coal transportation to north and south is already under consideration. It should be expedited without losing further time.

It is not a question of reducing the high generation and consumer tariff alone. We do not have foreign exchange. Pakistan's economy is suffering from Current Account Deficit. The solution to our economic woes lies in reducing imports and increasing exports. What is needed is conversion of coal power plants to local Thar coal and even many industrial sectors like cement, tiles, ceramics, glass and others. Finally, such currency depreciation and interest rate rise can never lead to reasonable and affordable energy tariff. Although we are not alone in this, our case is extraordinarily difficult. Energy prices and sector are a part of the economy; one cannot be improved neglecting the other. Let us work on both of them simultaneously.

4.12: Power plant retirement policy

There are plans to retire 19 power plants of an aggregate capacity of 7339 MW as per IGCEP (Integrated Generation Capacity Expansion Plan) in the period 2021-2031. Due to the ongoing Current Account Deficit (CAD) crisis, current policy is to use as little imported fuel as possible and make do with local energy sources.

Current load shedding despite having ample capacity is mostly due to the fuel issue. Plants' retirement may not be as simple issue as it may appear to be on the surface. There are a variety of reasons, which force the buyers or sellers to delay the plant retirements.

There is usually confusion or controversy as to who the loser is and who is the gainer? Can there be a power plant retirement policy or a set of criteria in this respect or things have to be decided on a case-to-case basis? We will examine the subject in this space at some detail and make use of some actual cases to elucidate the nature of issues and problems.

While plans provide for plants retirement at the end of useful life of 25-30 years, plant owners often lobby for extension of 5 or more years with the help and support of the user organizations. It has happened earlier and it is happening now.

The case of KAPCO (Kot Addu) power plants extension is under consideration. Earlier, KE successfully sought extension of two oil-fired power plants, despite opposition of other stake-holders. Hubco, which is to retire on 2027, has been trying for some form of extension: conversion to coal or otherwise.

As people retire, power plants retire too. Old power plants have maintenance, efficiency and technology issues. Old power plants have advantages as well having much lesser fixed cost due to debt pay-off and depreciation, but suffer usually from low efficiency and higher O&M cost; while new plants would have higher efficiency and lower fuel cost but suffer from high fixed costs and require full capital budget.

Power plant retirement has to be planned ahead. It is not sufficient to announce retirement date and expiry of generation license. Retiring plants by last day of retirement often provides useful services. It is a part of regional power generation and transmission system. It may have some parts which are still useful and due to lack of replacement planning, may be badly needed.

There are ancillary services such as peak powering, frequency regulation, transmission and black-start management facilities. There may be a tussle or cooperation regarding the continuing use of these services and plant parts. Power producer may want to offer all parts of the plant and earn revenue while buyer/user may want to acquire only the needed services.

Perhaps the most important aspect may be the fuel cost in these days when fuel cost has gone high, although recently, energy prices have come down. New power plants have higher efficiency. Older power plants have typical efficiency of 40% or even less. New power plants such as combined cycle power plants have efficiency of more than 60%.

Fuel types may also influence retirement or renewal considerations. Gas/LNG may have to be imported and RFO may be available locally, facing storage and disposal issue. RFO is a natural byproduct of oil refineries that produce petrol and diesel. Earlier, most of the thermal power used to be produced on RFO.

Refineries insisted to sell locally and earn better price, although some of the refineries have started exporting at 25% lower price. Seasonal supply issues also affect the fuel choice. In winters, power demand is low but supplies also fall down due to low hydro production in winters.

Environmental issues may also be a determinant. KAPCO uses Low Sulfur Furnace Oil (LSFO), while most refineries in Pakistan produce HSFO. The choice of LSFO may be based on the liking for imports or may have genuine environmental policy issues. Foreign investors are usually more sensitive in this regard. Another option is conversion or replacement. In the West, coal plants have been converted to biomass, gas and even solar or wind; that is more due to environmental and climate reasons.

The core parts of the power plants are engines or turbines/generators which may have a cost share of 50-60% and the auxiliary equipment and land and infrastructural cost may be the remaining 40-50%. Also the implementation time for conversion or replacement may be less than half of installing a green field power plant.

Power producer may also want to continue with the comfort of take-or-pay, while the buyer may want to shift to take-and-pay mode, especially when competitive market regime may be around the corner. Regulators not finding enough players for the ensuing competitive market regime may also like to push take-and-pay.

Table 4.12.1: Comparative Tariff Retiring Plants

Fuel	Energy Blocks	Energy Purchase Price	Capacity Purchase Price @30% Load Factor	Total Reference Tariff
		PKR/kWh	PKR/kW/h	PKR/kWh
		Plant 1		
Gas/RLNG	Block I	28.4578	5.2936	33.7514
	Block IIA	30.6851		35.9787
	Block IIB	30.1558		35.4494
LSFO	Block I	23.4265	5.3784	28.8049
	Block IIA	24.9567		30.3351
	Block IIB	24.5277		29.9061
HSD	Block I	64.3231	5.3589	69.6820
	Block IIA	69.3862		74.7451
	Block IIB	68.6640		74.0229
		Plant 2		
Gas/RLNG	Block IIC	30.3166	4.7231	35.0397
	Block III	32.0890		36.8121
LSFO	Block IIC	24.8629	4.6736	29.5365
	Block III	No provision on LSFO		
HSD	Block IIC	68.8500	4.8306	73.6806
	Block III	72.4878		77.3184

ii. The Petitioner has requested Reference Generation Tariff for its 1600 MW (ISO) and Net Dependable Capacity (RSC) of 1345 MW thermal power generation facility for a period for 5 years from October 25, 2022.

iii. The Petitioner submitted the following Net dependable capacity assumed for combined cycle operation on RLNG, LSFO and HSD:

Plants	Capacity in MW			
	Blocks	Gas/RLNG	LSFO	HSD
Plant 1	Block I	347	334	334
	Block IIA	298	289	289
	Block IIB	247	236	236
Plant 2	Block IIC	236	228	228
	Block III	258	not applicable	249

RoE indexation has created problems of affordability these days in the context of CPI approaching 36%. It is a general problem not restricted to retiring power plants. RoE of 17% itself is excessive. Consideration may be given for restricting RoE indexation to 10% per annum.

The case of KAPCO

KAPCO gas/oil/Diesel combined cycle power plant is of 1600 MW. KAPCO plant has some useful ancillary equipment which has enhanced its case of renewal. It has a switchgear plant, a black-start facility, transmission infrastructure and others.

The plant has been working at a load factor of 47% and the petitioner has applied for a load factor of 30% (500 MW out of 1600 MW). Its LSFO power plant component has an advantage for environmental reasons but has a disadvantage from cost and foreign exchange point of view, as local refineries, except ARL, produce HSFO.

Its generation license expired in 2021, which has been renewed by Nepra (National Electric Power Regulatory Authority) recently for three years as against the petitioner's request of 5 years. There has been a controversy about it. Senate of Pakistan has opposed the renewal and has asked for its cancellation. Senate's jurisdiction has, however, been contested.

NTDC (National Transmission and Dispatch Company), NPCC (National Power Construction Corporation) and MEPCO (Multan Electric Power Company) have supported the renewal application for their respective relevance. It is contested if full plant renewal was necessary or ancillaries only could have been renewed. Plant owners would definitely like to get full renewal in order to maximize revenue.

The main problem with the KAPCO plant is its low thermal efficiency of 43% as opposed to 60% plus efficiency of new combined cycle power plants. In the current circumstances of currency depreciation and lack of foreign exchange, the issue has acquired a serious dimension.

The positive aspect is that a green field site would have a fixed unit cost of 4.5 USc as opposed to Rs.5.00per unit asked for by the petitioner. Thus total cost comparison may favour the renewal case and variable cost comparison may oppose the renewal.

KAPCO has offered both take-or-pay and take-and-pay arrangements for the two parts of the plant. The dominant opinion is that the whole 500 MW be on take-and-pay basis. This would help jump-start the competitive market system, CTBCM (Competitive Trading Bilateral Contract Market).

The case for life extension of other power plants may also be strengthened if take-and-pay is adopted as a standard approach. However, its pricing may require a different approach with which Nepra has little experience. Spot market is another easier solution which Nepra has not considered or is confused about.

There appears to be emergent reasons for renewal as alternative arrangements have not been made, as is the case usually in the system. It is hoped that some amicable and equitable solution can be found with mutual and public consultation process. For future, retirement planning, renewal or closure should be done well in advance so as to avoid emergencies and unnecessary pressure on the decision-makers causing controversies of various kind. A combination of policy and case-to-case considerations may be an adequate approach.

Keeping in view the ongoing economic crises, new investment may not be forthcoming or may be expensive. There may be need for other power plants extension/renewal than might have been considered while making IGCEP and other plans. However, under take-or-pay system, there is risk of awarding unwanted and undesirable extensions. Take-and-pay arrangement appears to be mutually useful approach for the renewal of retiring power plants, which should be adopted.

4.13: Reducing rising electricity tariff?

NEPRA (National Electric Power Authority) has increased electricity base tariff by Rs 4.96 per unit from Rs 24.82 per unit to Rs 29.78 per unit. It is a 20% increase .Consumer tariff has yet to be announced, but it would increase substantially, especially, as there is commitment to IMGF on full cost recovery in the energy sector.

Gas sector consumer tariff would also increase as similar base tariff has been recently increased by OGRA as well. As is usual, 20% increase in wholesale tariff may not be proportionately passed on to all consumer category. Poor domestic consumers up to 300 units may get a lower brunt and higher end consumers may get proportionally higher (more than 20%) increase.

Textile sector has asked for a reduced tariff due to its export competitiveness issues. It is a zero-sum game. Concession to one category of consumers is passed on to the other category. Earlier, government used to absorb the deficit in the form of circular debt which has increased to Rs. 3 trillion.

One of the major problems is the rising capacity charges (increase from Rs.11.0 in 2022-23 to Rs.17.1 in 2023-2024) due to lesser utilization of capacity and others. This can be increased with economic recovery resulting in lower capacity charges. Increasing capacity utilization may increase imported fuel consumption which increases foreign exchange requirements. We are stuck in foreign exchange area also. So easier said than done? But something has to be done.

There are some financial restructuring options of the IPPs (Independent Power Producers) that may have to be examined. This is our main objective in this space. The main issue is that most of energy sources in Pakistan are dollar denominated. Even if it is a local resource, its production facility has been created with foreign investment or debt which has to be serviced.

The recent example is of Thar coal, which is local but its production requires fixed and variable costs, which are in foreign currency. Not to talk of imported fuel power plants wherein all costs are in foreign currency; investment or debt servicing and fuel cost and other variable costs, all of it. Most of the power plants were constructed when USD was around 100 Rs and interest rate on foreign currency were at 5-6% and local interest rates were under 10%.Imported fuels were cheaper as well; coal at 80 USD/ton and LNG at 8 USD/MMBtu, Brent crude 120 USD/barrel or lesser, etc.

Oil increases transport cost of fuels. LNG prices until recently went 3-4 times high; coal at 350 USD/ton and LNG at 30-35 USD/MMBtu. Fortunately, these prices have come down to slightly above the earlier averages. Average fuel charge has come down from Rs.10.20 per kWh in 2022-2023 to Rs.7.63 in FY 2023-24. Average fuel cost and unit capacity charge typically used to be 50-50 earlier. Now capacity charge has a share of 66% versus fuel cost of 36%. Hydro having a large share with fuel cost being zero has been contributing to lower average fuel cost and continues to do so. However, the recent reduction appears to emanate from reduction in imported fuel prices.

A recent calamity is of hike in foreign currency interest rates; Libor has increased to 5.5% from 0.5 % level when most of the power plants were contracted. Effective borrowing rates to finance the capex of the power plants has become around 10% (LIBOR + 4.5%). Thus capacity payments have increased from 5% to 10%, almost or precisely doubled. Combine it with currency depreciation, Rs 100-110 to 1 USD having gone to Rs 280-284.2.7 times increase. In some cases, RoE is also Libor based.

Thus capacity payment should have quadrupled or even more. Older solar power plants are selling electricity at Rs 30 per kWh, while new solar tariff was USc 4.0 per kWh, which should have increased to 8 USc due to Libor increase which should translate to Rs.25 per kWh. All of this has increased producer and consumer power tariff. Under IMF conditions, Circular debt has to be reduced, although in such circumstances, circular debt cannot be attempted or decreased from financial tricks or tariff increase. DISCOs' efficiency increase under or without privatization is the solution. Privatization has not happened. It will take 5 years to privatize; more on this later.

Financial restructuring

We have indicated earlier the rising share of capacity charge in the overall electricity cost. We would deal here with some of the possible solutions dealing with the capacity charge; debt restructuring and swap of some type or a mix of the two. Debt restructuring means reduction of interest rates or increase in repayment period. There is a case for some adjustment with respect to interest rates as Libor has increased phenomenally and Nepra awarded Libor margin is rather excessively high. It used to be 3%, which was increased to 4.5% due to lower prevailing Libor.

LIBOR has gone up; thus a case for reduction of this margin suitably. Second solution is increase in the repayment period. In the power sector, debt servicing is cash based and not cost based which brings the servicing load forward. An increase in the repayment period combined with or without leasing type constant total payment can bring down the financial load.

Reducing rising electricity tariff?-I

Currently, project debt is paid in 10-12 years after servicing of which servicing is significantly increased to equity return only. If loan period is extended to 20 years, financial servicing load would be pushed forward. In case of up-front tariff projects, where investor has borrowed the loan, this would translate into equalization of tariff over 20 years. A reduction in financial servicing load would mean a reduction in foreign exchange requirement as well.

Debt/equity swap

Table 4.13.1: Revenue Requirements of DISCOs

Description	FY 2022-23		FY 2023-24		Inc./(Dec.)	
	GWh		GWh		GWh	
Projected sales of XWDISCOs	113,002		110,165		- 2,837	
	Rs. Mln	Rs./kWh	Rs. Mln	Rs./kWh	Rs. Mln	Rs./kW
Energy Charge	1,152,357	10.20	840,462	7.63	- 311,896	- 2.57
Capacity Charge	1,250,959	11.07	1,874,334	17.01	623,375	5.94
Transmission & MOF	114,606	1.01	151,363	1.37	36,758	0.36
Power Purchase Price	2,517,922	22.28	2,866,159	26.02	348,237	3.73
DISCO Margin	244,189	2.16	341,403	3.10	97,214	0.94
PYA	42,409	0.38	73,599	0.67	31,191	0.29
Revenue Req. of XWDISCOs	2,804,520	24.82	3,281,162	29.78	476,641	4.96

The debt which is in the form of energy tariff payables or loan is to be paid in foreign currency, USD mostly. In case of China, there may be possibility of payment in RYB. How do you buy or procure this foreign currency? Debt-Equity swap can be a useful approach. Where, the project is owned by local equity holders or government, the lender can be paid in terms of equivalent share value; the latter though is not easy to determine and can be contentious.

The project may not be the same of which there are pending overdues. It can be a different one. For example, for payables of coal power plant, LNG power plants or Discos can be sold in part or full. There can be other projects or assets which require to be paid in local currency.

There can be many intermediary financing arrangements of debt swap schemes. Bonds may be issued to cover the sales price or value of the privatisation assets. There can be privatization or swap bonds which can be traded in the market.

Table 4.13.2: Electricity Generation Cost (2023-2024)

Source	Generation GWh	Share %	Fuel Cost Rs/KWh	Capacity Charge Rs/KWh	Power P. Price Rs/KWh	Power P. Price Usc/kWh
Hydel	41226	29.7	0.09	6.84	6.93	2.52
Imported Coal	16552	11.9	17.18	23.36	40.54	14.74
Local Coal	22696	16.3	10.55	13.42	23.97	8.72
FO	2630	1.90	23.74	24.82	48.56	17.66
Gas	14312	10.3	8.57	4.45	13.02	4.73
RNG	6639	4.78	23.56	27.86	51.42	18.70
Nuclear	25566	18.4	1.04	17.34	18.38	6.68
Import Iran	66	0.05	24.73		24.73	8.99
Wind Power	5212	3.76		33.64	33.64	12.23
Bagasse	1136	0.82	6.6	8.77	15.37	5.59
Solar	2563	1.85		15.04	15.04	5.47
Total	138759	100	6.52	20.6	27.12	9.86
Rs/USD	275	0.20				
Source:NEPRA						

Debt for export swaps

This is akin to barter trade system or PL-480 of yester years. Foreign currency payments can be tied to exports. Export projects can be designed for such purposes, e.g., agricultural exports to China. Debt to climate change projects swaps. It has been done and is being done.

Pakistan can finance climate change projects in local currency which is paid for in foreign currency by project buyers or donors. This can be applicable to any sector and is not fixed to power sector alone.

Will debtors agree to swaps and debt restructuring?

These are not unknowns in the financing world. There has to be sympathy and long-term economic and political interest. In Chinese and CPEC (China Pakistan Economic Corridor) we have both. We have to, however, come up with feasible solutions and not just sit on the overdue payments asking for extensions incessantly. The CPEC can be used for increasing local production and exports. The proceeds can finance the payment dues of various sectors.

China today is as sophisticated as the IMF and World Bank, and is expanding its activities in financial domains. China would certainly accept reasonable proposals, concessions and adjustments. They may be lacking the kind of spoon-feeding know-how the IFIs like World Bank may be used to. Let us do our home-work adequately.

To conclude, what we have proposed in the foregoing is not extra-ordinary. It has been tried elsewhere in debt related cases. Even a partial success in the foregoing may give results. It is the only short- term solution possible. In the medium term, there are solutions that we have indicated in the beginning; steps should be taken in that direction as well.

In the previous space, we focused on immediate financial restructuring solutions for enabling reduction in electricity tariff. In this space, we will briefly discuss other avenues mainly related to institutional, policy, technical, and management issues.

It should, however, be kept in mind that the recent rise in electricity tariff has been earlier due to increase in fuel cost and recently and now due to heavy rupee depreciation. There have been and continue to be similar problems in erstwhile successful countries like Sri Lanka and Bangladesh and elsewhere. This increases the urgency to eliminate waste and increase efficiency.

We discussed that capacity (fixed charges) have risen from 50% of the total electricity cost to 67-75%. One of the solutions, as discussed, is financial restructuring. The other solution is to increase utilization of electricity. Industrial sector offers such an opportunity.

Reducing rising electricity tariff?

While increase in industrial output is a general and larger requirement of increasing employment and growth, it can increase electricity consumption significantly. Tariff reduction is not possible to achieve this due to IMF (International Monetary Fund) reasons, other policy stimulation steps `would be required to achieve this.

Care has to be taken in adding more generation capacity to the system. IGCEP (Indicative Generation Capacity Expansion Plan) is based on high economic growth rates. Most forecasts do not show high growth up to medium term. IGCEP plans have to be toned down. Capacity without demand would exacerbate the high tariff problem.

Sun shines in the day and wind blows mostly in summers. Solar and wind are cheap 4 USc. There are variability and constancy issues. There is an upper limit in the system to absorb these with stability. However, there is scope for adding solar and wind in hybrid mode or otherwise with storage of 4-hrs where feasible. Roof top and distributed solar close to the demand may be an ideal solution.

Low and weak transmission links result in avoidance of economic dispatch order, increasing generation cost. Transmission capacity will have to be improved and enhanced along with improvement in performance of NTDC (National Transmission and Dispatch Company).

RFO is expensive but available locally. It is being exported now. RFO is deregulated causing mismatch and over-pricing problems. Recently, it has been exported at 70 USD per barrel much lower than the price it is sold at in the local power market. Right pricing may help both local producers and the power sector.

Ultimate efficiency comes out of competitive market and private ownership. Privatization has been a cherished goal of successive governments, but it has not happened. For competitive markets, CTBCM (Competitive Trading Bilateral Contract Market) has been launched without any success.

As per NEPRA (National Electric Power Regulatory Authority) chairman himself, a pile of reports 6 feet high has been produced. Even wheeling charge issue could not be resolved. Basic issue remains as to how will the contracted IPPs (independent power producers) will be brought into the system.

Reducing rising electricity tariff?-I

There are possible solutions in this respect, but no attention has been paid to it. All contracts are bilateral but bilateral contracting without a spot market may open the doors of corruption and collusion. Often Turkish model has been cited, which also has a spot market. India has a spot market. CTBCM-based bilateral contracting does not seem to have large entry potential either. There is a need to have a third party review to search new approaches for creating a competitive regime.

DISCOs have T&D losses and receivable issues. Corruption and leakages are additional but main issues cause increase in production cost. PESCO, HESCO, SEPCO and MEPCO are major problem companies. One of the problems is the large organization size and geographical coverage; MEPCO and PESCO are major examples.

Division of these companies into smaller units has been considered earlier but not implemented. PESCO had been divided into two units earlier and a new initiative has been taken recently. Similarly, MEPCO may have to be divided in two units. In the case of LESCO, industrial, commercial and large consumer section may be considered for separation and organization as a company.

Discos in Sindh in general and KP in particular suffer from law and order problems. Transformers are removed and installed by private parties forcibly and DISCO management cannot do anything about, a former M.D. Pesco narrated his horror stories. Law and order agencies are under provincial control. Provincial governments have no stakes in the losses.

They have political interests and compulsion. Powerful people and groups are involved. With rise in tariff, the incentives for theft would increase even more. Provincial governments have to share the losses (may be 50-50), after all the losses are caused by the local populace.

On the other hand, the Sindh government has been expressing interest in provincializing DISCOs in its domain. Skepticism has been shown in the ability of the Sindh government to manage these companies. Provincial governments are more susceptible to local power elites and toughs. A reduction of federal losses will cause reduction in tariff.

There are technical solutions as well. Smart metering at consumer level has been deemed to be costly (7 billion USD) and time taking (5-7years). There would be no money available for this kind of gigantic activity. However, a cheaper solution is installing smart meters and controls at DT Transformer level, which may take lesser time and money (under 500 million USD).

KE has done it and has reportedly achieved improvements. Poor maintenance and overloading of transformers has been cited to be a major source of additional cost and losses. A significant reduction in tariff can be achieved through technical improvement such as this. Insulated distribution cables may also reduce theft chances and cause tariff reduction. KE has achieved major success in this area.

A technical organization had been planned to work on the technical issues and problems of DISCOs and may be GENCOs'. Such organizations exist in most countries, including in our region (CEA India). There are common issues, which need be considered in totality. It is high time that a central technical organization employing qualified staff is established without losing time. Induction can be made from within existing organizations or/and from outside.

Finally, a firm policy and a firm hand are required to deal with the vices prevailing in the electricity system. Without weeding out corruption and inefficiency much cannot be achieved. DISCO management has to deal with corruption from within and the governments, federal and provincial, have to improve the law and order situation in DISCO areas to weed out the influence of local toughs and powerful elite who steal and do not pay.

Doing away with GST on electricity?

It is already happening what was expected. People have come out against rising electricity bills. Protests may convert into anarchy. Does government have some immediate remedy? Although, problems are of long term nature, we have explored here in this space some immediate steps that may partly reduce the misery of the people immediately. There are both supplies and pricing issues. It is also known that heavy currency devaluation and international commodity crisis in the context of Russia-Ukraine conflict has, in large part, contributed to these problems. The problems are becoming unbearable, although the government pricing policies have tried to save the poor people from the brunt of energy price inflation.

In the process, middle classes are suffering 8and falling into the poor category. The tragedy is that more is yet to come. Policy makers and administrators are at a loss as to what to do? There are a number of long-term solutions that have often been discussed, but in this piece, we will try to look for some steps which may help reduce the misery of the people. Government's hands are tied under the IMF agreement. Cost has to be recovered in full from the consumers, although cross-subsidy has been allowed. But there is a limit to how much load can be transferred to the richer consumer categories.

In India, electricity rates are different in different states. Small residential users' (up to 300 units) rates vary from (equivalent to) PKR 16 to PKR 24 per unit. In a few states, it is even higher such as Tamil Nadu PKR 28 per unit. Large Residential consumers' tariff averages around PKR 38.57 per unit. In Pakistan, small corresponding tariff is Rs.30 per unit. And large one goes beyond Rs.60 per unit. It can be concluded that the difference between India's and Pakistan's electricity tariff in small consumer category is much lesser than the difference in large consumer category.

In India, T& D losses are almost the same as in Pakistan. But in India, most power comes from cheap local coal. Coal plants are also locally manufactured saving costs and finances. Also cheaper hydro and now solar and wind power result in lower tariff. India has also not suffered under heavy currency devaluation and nor have interest rates risen in India. Most power financing in India is done through local resources and banks. Tariff is also set in Indian rupee.

On the other hand, it is also true that heavy currency devaluation, international commodity crisis, rise in interest rates both international and national have been partly responsible for a major hike in electricity tariff. Lower capacity utilization has resulted in high capacity charges and circular debt.

Capacity additions are made without considering faltering demand and slow-down in the economic slowdown. Capacity is added without considering availability of local resources; e.g., installation of imported coal power plants and on LNG while going slow on Thar coal. An undue zeal in a fast reduction of circular debt has also given rise to electricity tariff.

Public discourse is misguided as well. Employees' electricity benefits in government sector have become the bane of criticism, although its contribution to the problem is negligible. The consequences of withdrawal of these benefits are being ignored. 'Take or Pay' is being criticised, while it is the most practiced tariff regime in developing parts of the world. In the long run, costs are recovered from the consumer whatever be the system. The solution is in keeping a demand and supply balance.

One of the problems with electricity and gas tariff is that there are a lot of overheads which go up in proportion to the increase in the basic price. Past costs are being recouped in one go. Some overheads such as fuel surcharge are necessary and are a part of the basic tariff, but there are other charges as well, which could be reduced partly or wholly.

GST is charged on electricity and gas tariff at a rate of 17.5%. GST is levied on most items but many sectors are able to evade it and not much is collected from them. It is an indirect tax which has a regressive effect on the economy.

But it has been considered useful for documentation of the economy. We will restrict ourselves here on the GST effect on energy tariff.

GST adds a lot of overheads to the electricity and gas bills. 17.5 % is a large multiplier or adder. In all of the ASEAN region, which includes the most progressive and fast developing economies, general GST rate is 10% or even lower. These countries include Vietnam, Thailand, Malaysia and Indonesia. Even developed countries like South Korea, Australia and Japan have 10% GST rate. China has 13% GST. In India, in many states (Assam, UP, Bihar, Delhi, Odisha, etc.) GST on electricity retail is at a reduced level of 5%, although general GST rate is 15%.

Why should Pakistan ape Western Europe and the U.S. in charging high GST rate of 17.5%. There may be arguments in favor of keeping high GST, most obvious being the collectability and the need to collect taxes and revenue.

Table 4.13.3: Comparative State wise Electricity Tariff Residential India-Pk.Rs/kWh-2023

				Punjab	Bihar	Delhi	Gujarat	Mumbai	Rajasthar	
	low slab	high slab								
	1	30		15.8	21.3	10.5	10.7	15.85	16.66	15.78
	31	75		15.8	21.3	10.5	12.2	15.85	22.79	15.78
	76	125		15.8	21.3	10.5	12.2	15.85	22.79	15.78
	126	225		20.4	24.3	10.5	14.5	22.69	0.00	15.78
	201	250		20.4	24.3	15.7	0.00	0.00	0.00	21.04
	250	300		20.4	24.3	15.7	0.00	0.00	0.00	28.05
	226	400		26.8	28.2	15.7	18.2	22.69	0.00	31.56
	401	800		26.8	28.2	22.7	18.2	28.65	26.83	35.07
	801	1,200		26.8	28.2	24.5	18.2	28.65	27.88	38.57
	1,201	above		26.8	28.23	28.05	18.23	32.51	0.00	38.57
Pk.Rs/Irs	3.51									
Irs/USD	83									
Pk.Rs/USD	290									

Source:Bijli Bachao India

Under the IMF dictates, energy tariff should reflect cost of supplies so that circular debt is controlled. However, the IMF does not bind the government on GST. It does, however, require the government to collect legitimate taxes from those who escape either under rules or outside of the rules. GST can be done away with from the energy sector or at-least reduced. We are passing through emergency. People are crying. High unaffordable tariff will increase theft and will increase receivables as well. There are indications that it has started happening already. Theft is gaining a new legitimacy under the circumstances. There should be a search for a balance and an optimum point.

A GST rate of 5-10% on energy may alleviate some burden from the people, although total GST elimination is more desirable. GST reduction may be on all consumer categories or at-least be applicable on the low income groups. Perhaps, the IMF will be amenable to this proposal. The IMF should be persuaded.

Late payment surcharges are also excessive at 10%. If one delays payment of electricity bill by one day, he is liable to pay 10% of the bill amount. It is not as bad in the gas sector. Why has electricity sellers been provided such a largesse over and above the losses that consumers have to pay.

In the current hard economic circumstances, the issue has become even more painful. NEPRA (National Electric Power Regulatory Authority) in a recent hearing did take a stock of the issue. It is not known what concessions have been worked out. The government should reduce it down consistent with the interest rates which even now are 2% per month or slightly more. The late payment charge may be reduced to 2% for the first month and higher for the later delays.

Finally, my "sympathy" with the federal government which has unnecessarily taken the load of energy sector on itself, partly, in order to expand its powers and domain. All federations have provincialized it. However, it cannot be undone so quickly. Some sharing of losses and subsidies may be possible with the provincial governments.

After all, the beneficiaries of electricity theft and losses reside in the provinces. Some people may not like it. But, provinces have been demanding transfer of electricity and even whole of the energy sector to them for self-governance. Why not start with sharing, especially, in these impossible circumstances. Alternatively, NFC (National Finance Commission) award may have to be revisited.

Concluding, this is a country of 250 million people with majority being poor. It cannot maintain political and social stability without awarding concessions and subsidies to the poor. There are many avenues in the economy to generate resources as has been pointed out by many experts.

The untouchables have to be touched. Immediate solution is required to reduce the misery of the people and prevent unrest and anarchy. The immediate solution, however, is only removal or at the very least reduction of GST from electricity bills at-least of small consumers of up to 300 units. There would be a loss of revenue. The IMF may require alternative taxation. Alternative plans must be prepared and submitted for IMF's approval. It is hoped that the IMF would consider it with empathy, as it must also be observing the unrest.

Figure 4.13.1: Government Electricity price hike(1st July 2023)

	Comparison of Old & New Electricity Tariff (In PKR)				
Tariff Category	Old Tariff	Increase	New Tariff	Other Surcharges & Adjustments*	What 1 unit will cost?**
PROTECTED					
0-50 Units (Lifeline)	3.95	0	3.95	0.00	3.95
51-100 Units (Lifeline)	7.74	0	7.74	0.00	7.74
001-100 Units	7.74	0	7.74	4.47	12.21
101-200 Units	10.06	0	10.06	4.47	14.53
UNPROTECTED					
001-100 Units	13.48	3	16.48	4.37	20.85
101-200 Units	18.95	4	22.95	4.37	27.32
201-300 Units	22.14	5	27.14	4.37	31.51
301-400 Units	25.53	6.5	32.03	6.38	38.41
401-500 Units	27.74	7.5	35.24	6.38	41.62
501-600 Units	29.16	7.5	36.66	6.38	43.04
601-700 Units	30.3	7.5	37.8	6.38	44.18
Above 700 Units	35.22	7.5	42.72	6.38	49.10
TOU (PEAK)	34.39	7.5	41.89	6.38	48.27
TOU (OFF - PEAK)	28.07	7.5	35.57	6.38	41.95

*Includes PHL Surcharge, Uniform Quarterly Adjustment and Fuel Charge Adjustments
**Excludes taxes and other government charges

4.14: Power sector controversy: take-or-pay contracts

Energy prices have increased tremendously which has created controversy and unrest in the country. IPP contracts are under great debate. Many people argue that these are unfair and unjust. Take-or-pay contracts are criticised arguing that IPPs are paid even if no electricity is produced and supplied. Capacity charges (in ordinary language) fixed charges are too high being two third of the total and fuel cost being one-third.

It used to be opposite earlier. Some people have even proposed nationalization of the total electrical system. Discos are already in public sector. Nationalisation would mean nationalisation of the IPPs. Some ex-Wapda experts yearn the Wapda days and criticise the whole idea of power sector restructuring and break-up of Wapda. We will examine in this space as to the validity of these arguments and proposals and investigate if some relief is possible to the consumers.

Apart from IPP charges in the consumer tariff, there are a number of add-ons in the IPP selling price. Bulks of these add-ons are from DISCOs. There are, what people consider unreasonable add-ons from Discos; apart from technical losses which may be reasonably added at 5-10%, there is theft and uncollected receivables which bring these add-ons to more than 20%.

Some Discos have rather excessive and unacceptable add-ons such as Pesco, Hesco and Sepco exceeding 30%. Some DISCOs have quite low add-ons under or around 10%, which may however be reduced also under better circumstances and controls.

There are two types of energy contracts with some variations; take-or-pay and take-and-pay. We have take-or-pay contract system with IPPs. Under these contracts, a fixed percentage of the IPP capacity is to be bought by the power purchaser mandatorily.

Generally, 80-85% of the capacity is specified in case of thermal power plants. If IPP does not and cannot supply this much, it has to pay a penalty, although there are force-majeure conditions which protect both the sides under extraordinary conditions. An unwanted situation under take-or-pay contact system, from the point of view of the buyer or consumer, is that it has to pay even if it does not need the electricity and does not buy it as per contracted capacity.

This results in an increase in the unit cost or selling tariff of electricity. It has to be clarified that only fixed cost are to be paid by the buyer in case of not buying. Fuel and other variable cost are not paid in case of non-supply. Thus part of the cost is paid not all. However, because capacity cost is too high (for the reasons that will be discussed in the following), it is being questioned and criticised. Under take-and-pay contracts, buyer pays for only what he buys and consumes. Apparently, it may be seen as an ideal condition for the buyer; one pays for as much as he needs and consumes. But it may not be so, as they say, nothing is free.

Under take-and-pay contracts, prices are higher whether it is a negotiated or competitive buying. The risks are higher for the sellers and he builds that into the contract. Also, he assumes a minimum assured capacity factor below which the demand may not go down. In advanced countries, there are spot markets where many buyers are available and thus sellers risk are much lesser than in developing countries where electricity markets are not there. Thus it can be concluded that take-or-pay has balanced risks for the two parties and may come out with cheaper cost than the Take and Pay costs. Especially, in developing countries under single buyer model, the risk taking capacity of buyer is more and is priced lesser than individual developer or contractor.

The issue, however, is of competition. If competitive bidding is held for awarding take or-pay contracts, it can be a good acceptable arrangement. However, under G-to-G contracts, wherein competitive bids are not invited, it can be problematic. Under arrangement with large countries having multiple investors and suppliers, it is possible to have competitive bidding from donor or investor country. In the case of no bidding, the buyer has to have a good idea of the contract price, either through involving external consultants or if similar projects have been built recently to give a good idea of cost and prices.

This has not happened in many cases. Nepra which has responsibility in this case indulges in simplistic exercises and public hearings of questionable value. Nor is there any evidence of competitive bidding in many cases or involvement of a neutral external consultant. Most upfront tariff awarded by Nepra suffer from inadequacies and proper due diligence. However, in cases where competitive bidding has taken place, better results and reduced prices did emerge. A classical example is of ADB-funded Jamshoro coal power plant which emerged as the cheapest power plant.

It was an integrated 2x600MW power plant which was reduced to single phase 1x600MW power plant. The issue is still alive and KE has shown interest in Part–II. The second example is of RLNG power plants wherein competitive bids resulted in low prices. The third example is one of 600MW Muzaffargarh Solar Power plant which bidding failed to attract any party. However, current financial problems in Pakistan may have been responsible for the failure.

New bids have been invited with more attractive and less restrictive ToR. Thus it can be concluded that provided due diligence and competitive bidding takes place, Take or Pay is a good contracting approach. Take-and-pay contracts are popular in advanced countries where there are competitive electricity markets wherein electricity price is determined in the spot markets. Contracts are made based on spot prices and associated kerb buying. Demand and supply determines prices. Both buyers and sellers have options of various kind; a mix of various modes to minimise risks.

Current price hike has two major reasons, although there may be some contribution of some undesirable practices in it; 1. heavy Rupee–dollar exchange rate devaluation from Rs 105-140 to Rs 300; doubling of international borrowing rates from 4-5% to 9-10% . LIBOR used to be 0.5% which is now 4.5-5%. As per Nepra-spread formula of x+4.5%, effective borrowing rate almost doubled from 5% to 9.5-10%. This has doubled and tripled the capacity charges and the circular debt, although subsidised tariff for the poor also has contributed.

It should be noted that IPP investor has only 25-30% share in investment and the bulk 70-75% is borrowed from the international banks. Neither IPP nor the buyer has any control on them. They work according to their own system, although reputable IPP borrowers, investing in credible buyers' projects, manage to get better deals which may only have marginal differences from standard market rates.

It has often been argued that Nepra did award higher risk margins which could have been lower and perhaps can be still brought down if there is readiness on both the sides to negotiate. There is other criticism of front-loading of the tariff. Under a possible renegotiation, front loading can be straightened and extended to a longer repayment period. The total effect of such adjustments may go down to 20%. There are example of ADB-funded Jamshoro coal project and recent nuclear power project in this respect. Readers are referred to our earlier writings on the subject (How to reduce electricity tariff) for details.

There may be a scope, under mutual negotiations, to introduce in existing take-and-pay contracts, some share of Take-and-pay conditions, say, up to 10-20%. This may enable the operation of a competitive market in the form of CTBCM or a more viable framework in the form of a spot market exchange. Some incentives may be given in the form of extension of PPA periods and others. Concluding, we are a small party in the world system. World Bank, OECD and international banks determine and shape investment conditions and promote what they think are the most efficient systems, although IMF can be avoided by keeping one's house in order. Even China and Russia follow these.

What has happened in Pakistan in terms of power sector reforms is not unique in Pakistan. It has happened in most developing countries. Neither do we have professional capabilities to conceive altogether different systems. The proposals of reversion to Wapda monolith or nationalisation are too unserious. The contrary is being demanded by a vast majority; more privatization, especially, of Discos and provincialisation of the power sector.

The solution lies in improving the economy; balancing the external and internal account; creating employment and increasing personal incomes of the citizenry. In case of energy, most prices are determined by international market conditions. Prices cannot be brought down, while incomes can by improving the economy. Also for generating resources for subsidising energy in the meantime, tax collection has to be increased. Sole reliance on cross-subsidies may not be feasible for long. It has already affected the industrial tariff and is affecting exports performance.

4.15: Debt Relief and swaps in Power sector

Chinese power plant investors and operators have been giving various kinds of ultimatums to the government of Pakistan for releasing due payments with respect to capacity charges, fuel charges and various operating costs. Earlier, there used to be cash shortage due to low tariff and circular debt difficulties. Now, it is due to lack of foreign exchange. Money is there to pay in local currency but foreign exchange is not there.

The main issue is that most of energy sources in Pakistan are dollar-denominated. Even if it is a local resource, its production facility has been created with foreign investment or debt which has to be serviced. The recent example is of Thar coal which is local but its production requires fixed and variable costs which are in foreign currency. Not to talk of imported fuel power plants wherein all costs are in foreign currency; investment or debt servicing and fuel cost and other variable costs, all of it.

Most of the power plants were constructed when US dollar was around Rs100 and interest rate on foreign currency was at 5-6% and local interest rates were under 10%. Imported fuels were cheaper as well; coal at $80/ton, LNG at $8/mmBtu, Brent crude $120/barrel or lesser, etc. Oil increases transport cost of fuels. LNG prices until recently went three to four times high; coal was at $350/ton and LNG at $30-35/mmBtu. Now, these prices have come down to slightly above earlier averages.

A recent calamity is the hike in foreign currency interest rates; Libor has increased to 5.5% from 0.5% when most of the power plants were contracted. Effective borrowing rates to finance capex of power plants have become around 10% (Libor + 4.5%). Thus, capacity payments have increased from 5% to 10%, almost or precisely double.

Combine it with currency depreciation, Rs100-110 to one US dollar having gone to Rs280-284, an increase of 2.7 times. In some cases, return on equity (RoE) is also Libor-based. Thus, capacity payment should have quadrupled or even more. Older solar power plants are selling electricity at Rs30 per kilowatt-hour (kWh), while new solar tariff was 4 US cents per kWh, which should have increased to 8 cents due to increase in Libor which should translate to Rs25 per kWh.

All of this has increased producer and consumer power tariff. Under IMF conditions, circular debt has to be reduced, although in such circumstances, circular debt cannot be decreased from financial tricks or tariff increase. Increase in DISCOs efficiency with or without privatisation is the solution. Privatisation has not happened. It will take five years to privatise; more on this later.

Reducing intensity of calamity

We would deal with some of the possible solutions; debt restructuring and swap of some type or a mix of the two. Debt restructuring means reduction of interest rates or increase in repayment period. There is a case for some adjustment with respect to interest rates as Libor has increased phenomenally and Nepra-awarded Libor margin is rather excessively high.

It used to be 3% which was increased to 4.5% due to lower prevailing Libor. Libor has gone up, thus a case for reduction of this margin suitably. Second solution is increase in repayment period. In the power sector, debt servicing is cash based and not cost based which brings the servicing load forward. An increase in repayment period combined with or without leasing-type constant total payment can bring down financial load.

Currently, project debt is paid in 10-12 years. If loan period is extended to 20 years, financial servicing load would be pushed forward. In case of upfront tariff projects, where investor has acquired loan, this would translate to equalisation of tariff over 20 years. Reduction in financial servicing load would mean reduction in foreign exchange requirement as well.

Debt-equity swap

The debt which is in the form of energy tariff payables or loan is to be paid in foreign currency, US dollar mostly. In case of China, there may be possibility of payment in renminbi. How do you buy or procure this foreign currency. Debt-equity swap can be a useful approach. Where the project is owned by local equity holders or government, the lender can be paid in terms of equivalent share value; the latter though is not easy to determine and can be contentious.

The project may not be the same of which there are pending dues. It can be a different one. For example, for payables of coal power plant, LNG power plants or DISCOs can be sold in part or full. There can be other projects or assets which require to be paid in local currency. There can be many intermediary financing arrangements of debt swap schemes. Bonds may be issued to cover sales price or value of privatisation assets. There can be privatisation or swap bonds which can be traded in the market.

Debt-export swap

This is akin to barter trade or PL-480 of yester years. Foreign currency payments can be tied to exports. Export projects can be designed for such purposes, eg agricultural exports to China. Debt to climate change projects swap has been done and is being done. Pakistan can finance climate change projects in local currency which is paid for in foreign currency by project buyers or donors. This can be applicable to any sector and is not fixed to power sector only.

Will debtors agree?

These are not unknown in the financing world. There has to be sympathy and long-term economic and political interest. With Chinese and CPEC we have both. We, however, have to come up with feasible solutions and not just sit on overdue payments asking for extensions incessantly. CPEC can be used for increasing local production and exports. Proceeds can finance dues of various sectors.

China today is as sophisticated as the IMF and World Bank and is expanding its activities in financial domain. China would certainly accept reasonable proposals, concessions and adjustments. In energy sector, the lowest hanging fruit would be to use local fuels at least in the power sector. We have installed power plants running on LNG and imported coal despite having Thar coal. The lowest hanging fruit is to use Thar coal both in power generation and in industry.

4.16: Whopping circular debt: why and how

At present, circular debt of the power sector stands at around Rs2.46 trillion. There is now an added element to the circular debt that belongs to the gas sector, which is another Rs1.5 trillion.

Added together, the total circular debt becomes around Rs4 trillion. Gas sector circular debt is a rather new phenomenon created due to higher LNG prices and delays in announcing the new and higher tariff compatible with the gas price increases.

Political governments of all persuasions do not like to increase tariffs in order not to lose popularity. It is now IMF that is forcing the reigning government to increase tariff.

However, this is rather a wrong or hard time as the rupee has depreciated abruptly and disproportionately and all kinds of fuel prices are increasing internationally while we import most of our fuel requirements.

The tariff adjustment under the IMF is bringing extreme hardship to people, especially the poor. Oil sector has been free of circular debt until recently.

In fact, the government used to earn petroleum development levy (PDL) of a maximum of Rs30 per litre and GST of 17% amounting to more than Rs500 billion. Both thanks and curse to the IMF that petroleum product prices have been increased, causing great hardship but blocking circular debt buildup in this sector.

Annually, Rs450-500 billion of circular debt accrues in the power sector. This was earlier. Now, very high fuel prices and dollar exchange rate will be contributing to the circular debt, in addition to the earlier factors, of which capacity (fixed) charges were the most pronounced.

Now, there is double whammy – high capacity charges and high fuel cost among other factors and inefficiencies and losses. We will discuss the components of circular debt a bit later.

The risk is borne by the supplier companies – PSO, IPPs, OGDC, PPL and may be oil refineries as well, although the ultimate liability is sovereign. Sovereign rating has been going down, making it difficult to borrow and at higher interest and conditions.

It would be unfair to load the positives and negatives of power sector of a period on the reigning government. It takes several years to build a plant, which increases production but adds capacity charges.

The way capacity charges are structured (cash flow based), being repaid in 10 to 12 years and highest payments in early years, it sometimes brings more financial calamity than benefit. The plant may remain under-utilised due to lower demand or excess capacity.

Thus, it may be, that today's government may cause circular debt in the coming years and past government may increase the circular debt of the current period/ government.

It may thus be preferable that governments and politicians keep the politics as much away from economics as may be possible. The Charter of Economy has been talked about; and the circumstances would ultimately force them to reach consensus on some broad issues and parameters.

In the current circumstances, it appears highly improbable that the circular debt could be reduced. One should be happy, if the annual increase is maintained at the level of Rs450-500 billion. One may have to wait for normal times to achieve that.

The treatment for the ailment will be visible when we analyse the causes. Fortunately, we have at hand a study done by the ADB, which provides some qualitative and quantitative data in this respect.

The ADB report attributes the circular debt flows to the following: DISCOs' inefficiencies - 31%, delayed tariff adjustments - 35%, financial costs - 16%, and unbudgeted subsidies - 18%.

Unfortunately, the ADB study does not provide much explanation. Neither has government released data on such an important subject.

Reportedly, the Circular Debt Reduction Plan (CDRP) has been prepared with the assistance of IFIs but it remains confidential. The ADB report reveals that the CDRP calls for reduction of the flow of circular debt (new induction in the debt) to Rs75 billion by FY23 from a high level of Rs538 billion in FY19.

Ironically, DISCOs are popularly held responsible for most of the problems, however, the share of DISCOs comes out to be 31%. One would not have given much weight to the delayed tariff adjustments, but its share in the circular debt flows comes out to be 35%.

Fortunately, the government has decided to do away with this phenomenon and has authorised Nepra to announce final tariff, unless the government has reasons to intervene, which will be done in a timely fashion.

High costs

High power generation costs have often been criticised. The previous government has taken the following steps, which we reproduce from the ADB report, (i) reduction in the return on equity (profit) of government-owned GENCOs; (ii) reduction in the return on equity (profit) of IPPs' projects and extension of debt tenors; (iii) elimination of dollar indexation of IPPs' locally-funded equity when valuing project costs in the determination of tariffs of power producers; (iv) reduction in penalties and interest costs associated to late payment of payables, particularly the CPPA-G's; (v) decommissioning of old government-owned GENCOs and privatisation of new government-owned power plants; (vi) non-renewal of matured power purchase agreements (PPAs) with IPPs; and (vii) renegotiation of purchase contracts for imported fuel.

DISCO inefficiencies are often lamented and rightly so. There are T&D losses (mostly theft) and lack of recovery of bills. Nepra compensates for T&D losses up to 15.3% as against aggregate T&D losses of 17% or more. Shortfall of recoveries is not compensated at all.

Consolidated recovery of bills stands at 88.8%. It is impossible to have 100% recovery, as required by the Nepra tariff system. It all adds up to the circular debt. Giving allowances in this respect may encourage the defaulters.

While circular debt flow (annual increase) may be reduced, the debt cannot possibly be wiped away any sooner. There are estimates of circular debt going up to Rs7 trillion, which was before the devaluation and the fuel pricing issue.

Recognising this, there is discussion on converting the circular debt into public debt, which is considered cheaper. However, current economic circumstances have led to an abnormal rise in treasury rates as well.

There are IMF limits on public borrowing from the State Bank. All borrowing is to be from commercial banks.

Pakistan is a poor country; poor government and poor people. Pakistan's energy portfolio is quite risky, as we are noticing these days.

Capital intensity and financial costs of new projects have to be reduced. Local fuel and energy resources should be developed and utilised. Consideration may be given to alter IGCEP towards decentralisation.

Renewable energy such as solar must be fast-tracked. Competition to reduce procurement cost must be adopted. DISCOs governance and efficiency must be improved. T&D losses must be reduced.

4.17: Nepra: Performance Issues

The recently published SOI report highlights the need to introduce tariff reforms, pointing out the front loading and take or pay issues. In the existing generation tariff system, tariffs are calculated on the cash flow model rather than the cost-based one. Debt servicing is front loaded and paid as per servicing requirements. This increases the tariff in the debt servicing period.

If it is cost based (interest plus depreciation), the tariff in the earlier project years is reduced. In heavy capex projects like hydro projects, the problem becomes more severe than in low capex projects such as solar or wind projects. This system has been possibly introduced under lenders' pressure. Many countries including India do not have this kind of system. It is pleasing that the National Electric Power and Regulatory Authority (Nepra) has realised this problem, as indicated by the report. There are other issues such as indexation of various kinds which have been debated at various forums as well. It is hoped that Nepra will take urgent steps in this respect.

Nepra has been constantly pointing out the violation of the economic merit order, especially with regard to the workings of furnace oil power plants. The report has further elaborated on it. The current high LNG prices have changed the comparative prices, and the issue is too important to be ignored. The merit order requires that the least expensive plant be run first in order of its variable cost. There are problems in implementing this clause. There are inefficient plants which may come early in the merit order simply because they get cheap local gas. Efficient power plants (LNGCPP) with higher efficiency of 60 percent may come last in the order because they are run on more expensive RLNG. So much so that some Indicative Generation Capacity Expansion Plan (IGCEP) projects may not be in operation due to merit order issues by the year 2025. And the most frequent expose for violating the merit order has been the lack of transmission or transmission congestion.

These were the technical reasons. But there are some social reasons as well. It is alleged that there is collusion to benefit IPPs which get paid on a take or pay basis irrespective of whether their electricity is utilised. However, they have to keep their plants in hot conditions to be able to deliver when required. IPPs are also compensated for the partial load as there is lower efficiency at lower power dispatch. The buyer has some advantageous provision as well to charge various kinds of penalties on a lack of delivery or partial delivery. If something similar happens in the power sector, consumers suffer due to the loss of compensation cost reduction. On the other hand, IPPs receive undeserved revenue. The report suggests automation and the introduction of innovative technologies to monitor power plant operations and other aspects.

The renewable energy issue should be discussed on a priority basis. First, it is on the international agenda and perhaps the only solution to control the climate change issue. However, there is a cost, tariff and capacity issue which the report has elaborated with courage and sincerity. To point out anything negative about renewable energy is usually discouraged by international institutions on which Pakistan is so heavily dependent. Domestically, hydro power has political and provincial dimensions. There is still a misnomer that hydro power is cheap at one rupee per kWh, although the most recent Nepra tariff of some hydro projects have approached 8-10 USc – not talking about the example of the Neelum-Jhelum project which may not be a fair comparison.

The Sindh government has been protesting against the violation of the least cost generation principle and ignoring its relatively cheap solar project of 400 MW. The positive side of hydro is its water storage capacity which, however, is only available in a few projects. Unreasonable net hydel profits-related (NHP-related) demands have also negatively affected the competitiveness of hydro projects. The report points out the intermittency aspect of renewable energy. Many people, including me, argue that renewable energy has become cheap; solar and wind are at under 4 USc while thermal is at twice this rate – and now even more with rising coal, oil and gas prices. The negative side which is often forgotten is the interruption; solar energy is available during the day and has a peak of only four hours or less; wind blows erratically – but only in the summer (as opposed to in the winter in the northern hemisphere); hydro energy too is limited to the summer season, although hydro has some other good features like fast ramping and more stability.

What happens is that additional (duplicate) capacity is required to compensate for the period where renewable energy power plants are not operating. This affects both capex and tariffs. However, the biggest winning point of renewable energy is autonomy and no fuel prices. A fair comparison, therefore, would be between the total capacity cost (including duplication) and the consequent overcapacity inclusion. A classic example is that a new IGCEP power provides 75,000 MW capacities for a demand of 50,000 MW. NTDC and IGCEP have attracted considerable uniformed criticism in this respect. They could, however, show the alternative thermal power model to highlight positive and negative aspects. There are solutions for reducing and even almost eliminating the intermittency through storage and hybridisation. The report suggests the adoption of these technologies.

It was good to see an excerpt from a USAID-funded study on a strategic plan for the location of renewable energy power plants, in the report. There is a requirement of IGCEP to include location aspects for all power plants. Storage (specially pumped hydro) and hybridisation aspects have become important in the view of intermittency discussed in detail in the report. Some policy discussion in this respect ought to be initiated. The report also recommends two major steps with respect to the market mechanism. First, the discontinuation of the take or pay model, and second, the conversion of existing power purchase agreements (PPAs). Both are problematic areas which have been pointed out several times. Almost all of the IGCEP capacity is under the take or pay basis. There are legal difficulties in the conversion of PPAs. There are possible mechanisms like the delta approach – that has been discussed earlier – and spot market exchange.

The competitive trading bilateral contracts market (CTBCM) avoids this by adopting a cost-based model and bilateral trade among DISCOs. The bilateral trade among DISCOs without a reference price coming out of a transparent spot market is a highly dangerous proposition in Pakistan's objective conditions. Even electricity wheeling has not succeeded. Stakeholders are not adopting the proposed market regime seriously. Without suitable amendments in the CTBCM, the scepticism may continue. The licences of a number of distribution and generation are expiring within this year and the next. There does not appear to be a case for possible extensions in generation licences in the context of surplus capacity. Some mistakes have already been made in this respect. However, the continuation of UCH power which is based on low Btu special resources may be worth examination for continuation, if found in good technical condition.

It appears desirable that licences of distribution companies are renewed consistent with their progress on the CTBCM. Simultaneous actions on a number of fronts may cause confusion and conflict. The separation of electricity trade and wire business is an issue. As an alternative, two licences may be issued: licences for the wire portion of the distribution companies may be issued with definite terms and trade licences may be issued on a conditional basis. Both Nepra and the SOI report have not given any firm opinion on it, although, when it comes to the KE, they have talked about the possibility of combined licences.

For KE, some important stakeholders have been demanding multiple companies in the wake of heavy loadshedding in summer's peak demand. However, it can only be done in the CTBCM framework which provides for competition in retail markets. When it is done, it will be done for all. With respect to imported coal power plants, the report indicates some steps towards introducing a market mechanism in imported coal procurement and pricing. With the recent rise in coal prices, it has become even more important. There is quite some confusion in this respect and a lack of transparency. It would be a welcome step if Nepra takes action with resolve and precision. Some target dates for introducing a Thar coal mix plan appear to be in order, although the report has not indicated any steps in this respect.

There is a flurry of project activities at the provincial levels. Provinces are developing their own projects. Some coordination may be required in this respect to avoid confusion and conflict. It is significant to note the successful electricity wheeling by the Pakhtunkhwa Energy Development Organisation (PEDO) to industrial customers at a rate of Rs5 per unit. This would promote industrialisation in Khyber Pakhtunkhwa. However, there are issues in wheeling. DISCOs have gone to courts against wheeling in its present form and have probably won. Apparently, this was done with the permission of the power division. The issue must be resolved. The SOI report has not discussed this issue.

4.18: Nepra's SOI report 2022

Nepra (National Electric Power Regulatory Authority) has recently released its annual State of Industry (SOI) report 2022. As the name implies, the report gives a comprehensive picture of the power sector, outlining major issues and making useful recommendations. It also provides most relevant power sector data that may not be available elsewhere. It is a must read for all those who want to develop understanding of the sector.

It may be noted that, in the following paragraphs, we would provide a review which includes both statements of the Nepra report and as well as the views and critique of this writer. For clearing any confusion, regarding the ownership of individual views and issues, the readers are referred to the original of the report.

Capacity utilisation

According to the report, during FY 2021-22, a peak demand of 28,253MW was witnessed in the system during June 2022 while in the winter season, the peak demand of the country came down to 15,962MW during December, 2021. On the other hand, the installed capacity of the country is 40,813MW. Higher installed capacity as compared to demand in the system is certainly increasing the consumer end tariff owing to 'Take or Pay' and 'Must Run' compulsions.

Part of the reason is low capacity factor of 40% or less of hydro resources which, however, matches the low demand in winter. The gap between demand and capacity would increase with more induction of renewable resources which have even lower capacity factor. Inclusion of old GENCOs, which are to be decommissioned, is also a reason for this gap.

Here, perhaps Nepra should do some work. Innovations in tariff setting may increase capacity utilization; especially, incentives for large and energy intensive consumers. It is not a subsidy, but an intelligent way of recovering some fixed costs which otherwise may go unrecovered otherwise. Nepra and Power Division have done some work in this respect. It may be worth doing extra effort in this respect.

Merit Order violation

Nepra has been advising power generation companies, NPCC (National Power Control Centre) and NTDC (National Transmission and Dispatch Company) to strictly follow Merit Order rule. But for one reason or the other (usually transmission congestions and constraints), exceptions are made here and there, although, generally the rule is followed.

The cost of such deviations is high and cannot be condoned. An example is use of furnace oil power plants instead of gas-fired combined cycle power plants (NGCCP).There is double jeopardy; furnace oil plants are less efficient (38 %) and furnace oil is more expensive while NGCCP are more efficient (50-62%) and natural gas and RLNG are cheaper than furnace oil. So either efficient power plants are not dispatched or are dispatched partially (PLAC).

Nepra estimates PLAC costs at Rs 41.73 billion. More dangerous is the trends of PLAC costs which have increased from Rs. 5 billion in 2018 to Rs 41.7 billion in 2022. A related issue is operating combined cycle power plants in single cycle mode. Guddu 747 has been under such mode and has caused fuel losses of Rs.55 billion, as per Nepra report.

However, it is not mentioned or investigated as to when these plants were operated in single cycle. It is normal to run gas turbines during peak demand period for a variety of reasons. GTs (gas turbines) have quick ramp up time, i.e., a GT can be brought to peak production faster. Sometimes, in case of unplanned outage, it may be required to replace the shutdown plant. However, if they operated in a single cycle in non-peak times and routinely, it is wrong. And in the first place, an efficient combined cycle plant should not be available, it should be busy being much earlier in the merit order.

NPCC and SCADA

Nepra appears to be placing the blame of inefficient utilization of fuel and capacity on the shoulders of NPCC. The report says that NPCC does not adequately utilize the automation of SCADA (supervisory control and data acquisition) and prefers to use telephone and fax.

Although, it is true that NPCC is responsible for running Merit Order-based dispatching, there may be other reasons such as plant maintenance issues, fuel availability and demand fluctuations, which may also contribute towards deviation from Merit Order. Nepra appears to be specially concerned about it as it is introducing electricity market system under CTBCM (competitive trading bilateral contract market) wherein scheduling requirement and penalties can be severe.

NPCC and SCADA

There is a counter point of view as well. As per info available to this writer, significant progress and renovation has been done with regard to SCADA (Supervisory Control and Data Acquisition) and several aid agencies like JICA and others have helped in this respect.

The situation at NPCC (National Power Construction Corporation) may not be as bad as Nepra's report seems to have characterized it. May be their info is outdated. Nonetheless, Merit Order (MO) is the best tool to minimize fuel cost and the reasons for deviations must be handled by the relevant agencies and stake-holders. A protocol for allowing deviation from merit order may have to be developed.

KE fuel excessive costs

Nepra's report has a similar verdict on KE's operations. Nepra says that most of the KE power plants have completed their economic and technical life but KE insists on their operation.

KE instead of trying to operate in sync with NTDC (National Transmission and Dispatch Company) system, under one pretext or the other, tries to run in solo whereby it operates its fuel inefficient power plants while more efficient power plants in NTDC system remain idle or underutilized. Local gas is misused.

Similarly, KE went ahead with the procurement of new LNG power plants while several LNG power plants in NTDC system were available. These are the virtues of cost-plus system where companies don't care as they would be able to pass costs on to consumers or the government which has to willy-nilly bail them out. This is all what Nepra's report is saying and not this writer.

AT&C Losses

There are three types of losses: Transmission losses, Distribution losses and Commercial losses (dues not received).Distribution losses are of two types: technical and non-technical. Non-technical losses are essentially theft. It is said that both rich and the poor steal electricity. Industries and commercial enterprises also steal electricity. Transmission losses are 2.63% while Distribution losses are 17.13%. Nepra recognizes and reimburses only 13.41% of Discos' losses which are charged to the customers, while the remaining goes towards the losses of Discos.

Total Discos' billing in 2021-22 amounted to Rs.2.3 trillion out of which the recovery losses were 6.91% amounting to Rs. 230 billion and T&D losses were 17.13% amounting to 520.3 billion. Gross losses were thus of Rs.750.3 billion. Nepra recognized only Rs.343 billion losses, bringing the net losses to Rs.573 billion.

Nepra's SOI report 2022

It is not known as to how much is theft and how much are technical losses; 5% could be assumed as technical losses and the rest to be the theft. 17% Disco/distribution losses are an average, while individual Discos' losses may be varied; Pesco (37.47%), Mepco (14.84 %), Hesco (32.88%), Lesco (11.42%) and Iesco (8.18%).Despite purported efforts of Discos' management, theft could not be controlled, although improvements have been achieved in reducing technical losses. High losses Discos suffer from law and order problems, the writ of the government or Discos' is not there in these areas. Preventive measures cannot be taken in these areas. In the short term, it is highly likely that electricity theft or uncollectable receivables may increase due to unaffordably high tariff. While increasing tariff for whatever legitimate reasons, one may have to assess and balance the purported revenue increase vis-à-vis theft losses causing revenue decrease.

Lesser emphasis on ATC loss reduction

While many problems and their solutions have been identified by the report, not much wisdom has been offered in the case of AT&C losses which are perhaps one of the major issues. There is a lot that can be done and is not being done. Although primary responsibility is of DISCOs themselves, NEPRA can be of help. There are technical and non-technical solutions.

KE, despite its other problems, has managed to reduce AT&C losses and has a few solutions example to offer. There is success example in the region which can be borrowed. Nepra can get a loss-reduction plan under expert guidance and stakeholder consultation and enforce the plan in this respect using carrot and stick approach.

In the gas sector, there is a similar issue called UFG losses. Ogra (Oil & Gas Regulation Authority) has been more successful in handling this problem. At least, one of the two gas distribution companies managed to reduce its UFG. Ogra developed and enforced a UFG reduction plan with incentives and monitored it diligently.

Ogra continues to do it. Benefiting from this experience, Nepra can possibly do better. Nepra has to focus on it. Had Nepra applied half the effort as it applied in relation to CTBCM (Competitive Trading Bilateral Control Market), it would have succeeded in ATC loss reduction. There is still time and opportunity to get going on it.

Smart Meters Strategy

Fortunately, some good news has coming in this respect from the Power Division which has issued smart meter installation strategy on Distribution Transformer, scrapping a useless scheme of target-less installation of smart meters in residential areas. The issue has been debated since 2014. Smart meter installation on DTs can be implemented within two years in comparatively smaller budget and enable Discos to identify high loss priority DT areas and take action.

The alternative scheme offered by ADB (Asian Development Bank) would have taken many years and would have required several billion USD which kind of money could have never been available and now in the current circumstances. The DT approach would be able to introduce DT automation and monitoring other parameters. Our bureaucracy has finally stood up against supply-side pressures of powerful IFIs. Perhaps the IFIs themselves also understood the merit of alternative indigenous proposal.

Other Disco Inefficiencies: SOI points out non-commercial attitude of DISCOs ignoring availability of cheaper electricity sources which are available at 11 kV level. Bagasse-fired generation in sugar plants has been cited as an example wherein some cheaper electricity is available at Rs.7.46 per kWh as opposed to its average buying rate of Rs 6-30 per kWh. At least six sugar mills have been trying to sell. This has resulted in a loss of Rs.1.8 billion in two years; and the loss of foreign exchange. Similarly, wind power plants' inaction on the part of Discos has been cited.

Circular Debt

DISCOs can't pay off their debt to IPPs (Independent Power Producers), CPPA-G and to other suppliers and agencies and thus these losses are accumulated and give rise to circular debt. Also, GoP promises to give tariff subsidies, which is passed on to the customer but GoP does not pay it or pays it partially.

As of 30-06-2022, a total amount of Rs. 83,399 million is payable to Discos on account of unpaid tariff differential subsidy. Discos do not have the means to pay and thus they don't pay to the generators and generators do not pay to the fuel suppliers. This is called circular debt. As of 30-06-2022, the circular debt stood at Rs. 2,252,750 million as against Rs. 2,280,149 million during FY 2020-21. Under internationally high fuel costs, circular debt will not come down or start coming down. Most likely, it would increase. Any attempt to reduce circular debt in high inflation circumstances would likely lead to political destabilization and even anarchy.

Power Generation Tariff Issues

The SOI report discusses the high generation tariff which as contributed in high electricity cost and circular debt. Fortunately, the practice of upfront tariff has been dropped, although it saved time. But it promoted background pressures and manipulations. Competitive tariff of solicited projects is being talked about. It was therein almost all policies, but has never been practiced. Even much talked about Reverse Auction Mechanism

(RAM) has not been implemented in case of Renewable Energy (RE). It is an open secret that overstating CAPEX has been pure malice in power sector which should have been controlled by Nepra. One is not able to find any credible capex study in the record which could be made a basis of awarding tariff. Nor is there any credible study on interest rates of foreign loans. Cash flow model has been adopted which maximizes cash flow to investors.

NEPRA has proposed renegotiating project debts to correct this. In a background of late payments of IPP dues, the chances of success do not appear bright. IPPs have already given concessions. Increasing capacity utilization can reduce CPPA and GoP generation losses and reduce electricity prices. The right time and opportunity are through competition in the very beginning. The reader is referred to this writer's recent article on Competitive Power Market in this space.

Privatization and Reorganization of DISCOs

Privatization of DISCOs has been on the cards of successive governments for a long time. As a result, the required efforts and investments have not been done. Reorganization of DISCOs into smaller organizations could have brought about improved control and efficiency along with other changes. IPPs have attracted more attention of the private sector due to lesser problems and rather lucrative returns. Tariff subsidies requirement and debts have also made privatization difficult.

CTBCM may bring a partial privatization by limiting Discos' role to wires, operations and maintenance of the assets and technical operations and services while the electricity sales is to be given to independent private sector companies. And there may be more than one company in Discos' franchised areas. This may be an easier approach supporting both purposes-privatization and as well as bringing in competition. It may also be acceptable to banks and the labour unions.

Pepco had been disbanded, assuming the Disco autonomy could bring results under an improved Board of Directors. It is alleged and perhaps rightly so that bureaucratic controls have increased. Pepco has been revived in a different form to be a technical advisory body. Hopefully, this may give results if right human resources are inducted. Even under privatization regime, there is a need for the role of a technical advisory body. It is hoped that it is brought into operation without further delay.

Need of Indigenization

It is pleasant to find emphasis in the report on developing and using local material and equipment. This is a neglected aspect in the energy sector as a whole. As most projects are externally financed, investors and financers tend to maximize the usage of their own countries' inputs for obvious reasons.

Also, as we are always in a hurry to implement projects as soon as possible and local development and procurement being time consuming, indigenization is sacrificed. There was a time when there was a move to close down Engineering Development Board (EDB) as such. Local products may initially be slightly expensive for a variety of reasons and thus require support of tariff and non-tariff barriers. Nepra may also consider building some localization incentives in the tariff on the style of Turkey and India. Tariff support in these two countries has helped them in building local engineering base in the power sector. In the present circumstances, the issue has acquired added importance.

Closing down the old plants

Generally speaking, old power plants completing their life of 25-30 years are inefficient and outdated and must be closed down. It may be truer for GENCOs than for IPPS as the latter might have maintained their plants better.

However, the location and infrastructure of such plants may be offering a number of advantages. GoP has already decided to close down most of the GENCOs and install solar power plants there, IPPs may pose a problem as under PPAs, these are under BOO.IPPs continue to own the residual assets. Many IPPs have tried to get their PPAs extended. Reportedly, their cases are being reviewed under Take and Pay arrangements. These may be considered to be included under CTBCM.

To conclude, Nepra can play a more active role in removing the ills of the power sector, although publishing of an annual report on the problems and issues is in itself useful and commendable. It has tremendous powers and independence. Nepra has both carrots and sticks to offer. Fortunately, more role and powers have been given to Nepra over time. There are areas such as AT&C losses and others where Nepra can be more active. However, there are constraints in exercise of powers in this problems ridden country of ours. There are, however, ways and means for resolving the power sector problems through initiatives, coordination and leadership. Many lessons have been learnt by the country and task has been made probably easier.

A comparison of recovery percentages of DISCOs over last two years is given below:

Table 4.18.1: Recovery Ratios In DISCOs System

Description	PESCO	TESCO	IESCO	GEPCO	LESCO	FESCO	MEPCO	HESCO	SEPCO	QESCO	Overall
Amount Billed (Min Rs)	233591	43386	289977	252986	587306	366707	400711	88892	63209	96523	2423292
Amount Realized (Min Rs)	214419	28728	277284	248407	567887	347777	368972	65530	40314	34053	2193375
Recovery 2021-22 (%)	91.79	66.22	95.62	98.19	96.69	94.84	92.08	73.72	63.78	35.28	90.51
Recovery 2020-21 (%)	101.87	83.27	116.87	105.1	98.72	97.2	102.15	75.63	64.48	39.8	97.30
Inc-/(Dec)	-10.08	-17.05	-21.25	-6.91	-2.03	-2.36	-10.07	-1.91	-0.7	-4.52	-6.79
Source: DISCOs											

The following table shows a comparison between of T&D losses for the FY 2020-21 and FY 2021-22 in each DISCO:

Table 4.18.2: Transmission And Distribution Losses of DISCOs

DISCO	**FY 2021-22 (Unit in GWh)**			**Target Losses (%)**	**Actual Losses (%)**		**Amount of Actual Unit Lost (Rs. in billion)**
	Purchase	Sold	Lost	2021-22	2020-21	2021-22	2021-22
PESCO	16560	10355	6205	20.73	38.18	37.47	153.80
TESCO	2284	2071	213	9.31	9.58	9.33	3.70
IESCO	13027	11961	1066	8.15	8.54	8.18	21.90
GEPCO	12678	11528	1150	9.2	9.23	9.07	24.70
LESCO	28334	25070	3264	9.08	11.96	11.52	72.70
FESCO	17512	15918	1594	9.34	9.28	9.10	33.40
MEPCO	22548	19202	3346	12.79	14.93	14.84	75.10
HESCO	6010	4034	1976	19.07	38.55	32.88	45.00
SEPCO	4489	2890	1599	17.41	35.27	35.62	43.70
QESCO	6716	4831	1885	14.49	27.92	28.07	46.30
Overall Average	130158	107860	22298	13.41	17.95	17.13	520.30
Source: DISCOs							

Table 4.18.3: The availability factor of gas based power plants around the globe

S. No.	Power Plant	Capacity (MW)	Net Efficiency (%)	Utilization Factor (%)	PLAC (Rs. Million)
1	QATPL	1231	61.62	67.11	8.291
2	HBS	1277	61.47	87.74	8.353
3	Balloki	1276	60.27	81.45	8.306
4	Orient Power	225	51.20	59.37	1.191
5	Saif Power	225	51.20	41.45	1.209
6	Sapphire Electric	235	51.20	43.19	1.256
7	Halmore Power	225	51.18	41.94	1.031
				Total	29.637
Source: CPPA-G/NEPRA					

Table 4.18.4: The EPP of a few RFO power plant and their utilization in July. 2021 and June. 2022

Month	Description	Jamshoro Power	Hub Power	Saba Power	LaLpir Power	Pakgen Power
July. 2021	EPP Rs./kWh	23.56	16.87	19.56	19.46	19.73
	Utilization Factor (%)	15	23	33	53	58
June. 2022	EPP Rs./kWh	44.31	38.99	38.25	39.17	39.21
	Utilization Factor (%)	10	15	31	58	63
Source: CPPA-G/NEPRA						

Month	Description	Balloki	QATPL	HBS	Sapphire Electric	Halmore Power	Orient Power	Saif Power
July. 2021	EPP Rs./kwh	10.31	10.88	10.30	13.95	14.75	15.71	15.31
	Utilization Factor (%)	77	75	72	26	78	64	76
June. 2022	EPP Rs./kWh	26.80	27.53	25.86	31.87	32.14	31.71	31.91
	Utilization Factor (%)	81	78	93	76	79	75	78
Source: CPPA G/NEPRA								

Table 4.18.5: The annual plant utilization factor and CPP of TPS Cuddu Unit 14-16 and Nandipur

Cuddu 747 MW			
Particulars	**FY 2018-19**	**FY 2019-20**	**FY 2020-21**
Installed Capacity (MW)	747	747	747
Efficiency (%)	49.46	55.98	55.55
Generation (GWh)	5.070	4.315	3.124
Utilization Factor (%)	80.29	68.16	48.93
CPP (Rs./kWh)		-	
Nandipur Power Plant			
Installed Capacity (MW)	567	567	567
Efficiency (%)	46.02	46.87	49.01
Generation (GWh)	1.729	1.476	1.482
Utilization Factor (%)	39.10	33.47	33.73
CPP (Rs./kWh)	.	.	-
Source: CENCOs/CPPA C/NEPRA			

Table 4.18.6(A): The annual plant utilization factor and CPP of TPS Cuddu Unit 14-16 and Nandipur

Particulars	**HBS**	**Ballok i**	**QATP L**	**Saif Powe r**	**Sapphir e Electric**	**Halmor e Power**	**Orien t Powe r**
Installed Capacity (MW)	1.277	1.276	1.231	225	235	225	225
Efficiency (%)	61.47	60.27	61.62	51.20	51.20	51.18	51.20
FY 2019-20							
Utilization Factor (%)	70.03	62.10	53.91	26.47	16.62	19.99	27.51
Plant Operation on HSD (GWh)	o		-	0.12	0.22	0.00	0.33
PIAC Amount (R$. in million)	4.388	4.432	3.774	420	339	389	445
FY 2020-21							
Utilization Factor (%)	80.35	75.83	77.27	35.87	31.47	33.54	48.57
Plant Operation on HSD (GWh)	0.12	51.45	0.820 2	33.79	130.05	38.12	57.18
PLAC Amount (Rs.in million)	4.008	3.075	4.172	490	686	442	539
FY 2021-22							
Utilization Factor (%)	87.74	81.45	67.11	41.45	43.19	41.94	59.37
Plant Operation on HSD (GWh)	120.7 9	289.8 5	410.4 0	82.58	80.32	48	62.08
PLAC Amount (Rs. in million)	8.353	8.306	8.291	1.209	1.256	1.031	1.191
Source:CPPA-G							

Table 4.18.6(B): The annual plant utilization factor and CPP of TPS Cuddu Unit 14-16 and Nandipur

Particulars	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Guddu 747 MW				
Installed Capacity (MW)	747	747	747	747
Efficiency (%)	49.46	55.98	55.55	54.43
Generation (GWh)	5.070	4.315	3.124	2.610
Utilization Factor (%)	80.29	68.16	48.93	42.55
CPP (Rs./kwh)		.	5.51	
Nandipur power plant				
Installed Capacity (MW)	567	567	567	567
Efficiency (%)	56.02	46.87	49.01	48.52
Generation (GWh)	1.729	M76	1-582	1.641
Utilization Factor (%)	39.10	33.47	33.73	37.21
CPP (Rs./kwh)				
Source: GENCOs/CPPA-G/NEPRA				

4.19: An electric regulatory authority for Sindh

Sindh cabinet has approved a draft bill for organizing a separate electricity regulatory body for Sindh — Sindh Electric Power Regulatory Authority (Sepra). It is not known whether or not it would be independent or subservient to Nepra (National Electric Power Regulatory Authority) or what kind of relationship it will have with NEPRA and CPPA-G (Central Power Purchasing Authority-Guaranteed).

There is a confused provision for provincial role in electricity in a centrally controlled and managed electricity system in the country. The present government has recently offered to transfer DISCOs to provinces and has requested each one to at least take one Disco's ownership and responsibility. All circular debt is affected and paid at DISCO level where the difference between cost and revenue is finally paid or becomes a liability. Almost all DISCOs have a negative equity and have been running under losses.

The principal grievance of the Sindh province, as espoused by the Sindh energy minister, is energy poverty — an interesting term indeed. Sindh has cheap energy resources like Thar coal, wind and solar, but is still short of energy. Karachi's electricity and gas problems having a national impact have furthered the appeal of energy poverty issue as raised by the Sindh government. The immediate grievance is that IGCEP (indicative generation capacity expansion plan) as approved by NEPRA has ignored solar, wind and Thar coal.

The issue has emerged with the competition among solar, wind and hydro. Hydro used to be the only local resource and used to be cheaper among all; it's no more the case. Old plants cost around Rs 4-5 per unit and a new hydro plant costs almost twice as much. While solar is available in day only but available throughout the year and hydro is available more in summer and less in winter but is available round-the-clock in the period when it is available.

In a way, it is a good combination if treated properly. No energy source is a panacea; all have merits and demerits. One has to make an ideal least cost mix and that is what IGCEP is supposed to do.

However, IGCEP's methodology and software are not used strictly on least-cost principles. Almost half of the energy generation proposed in the IGCEP is given, externally imposed. It is hydro and nuclear. Competition is not allowed to work, it is argued. Nepra may not be held solely responsible for it; there are other powerful forces which cause external impositions in the choice of projects. And the emergence of competition among solar, wind and hydro is a new issue and a generic one, partly beyond Nepra's powers exclusively.

This is the reason Sindh has decided to make its own regulatory body. Sindh had grievances earlier also and it threatened to make its own regulatory body when provincial transmission and generation projects were opposed by NEPRA. However, Nepra and other federal bodies gave in and Sindh opted not to go for its own regulatory body. The intensity of the problem could have been reduced if power generation monopoly had been taken from KE. KE could have been allowed to competitively have its power generation plants as IPPs (independent power producers). And the generation sharing could be made on a country-wide basis as part of NTDC (National Transmission and Dispatch Company) and CPPA-G system.

KE would have been allowed to work as a Disco only. There is a provision in the rules and the KE agreement to do this. KE does not lose anything. It gets automatic access to country-wide generation resources. However, this is only part of the problem. Provincial control and management is not new in federal systems. In the US, Australia and India, electricity is totally under provincial domain. However, there are power markets which reduce the role of governments to a considerable degree. In India, the power system is under public sector and is provincialised that includes generation, transmission and distribution and financing the power investments and subsidies and the regulation.

The question is will Sindh be able to achieve its objectives of increasing its power supplies by having SEPRA? Energy buyer is CPPA-G. To have an effective autonomy in power sector, all provinces have to be under an identical system. It may cause confusion in the financial system in which Sindh may be a loser or gainer.

Punjab has a large energy market but almost no energy sources except solar while other smaller provinces have potential and actual energy supplies. It is in the interest of the energy producer provinces to be able to sell energy to Punjab which may be easy to handle within a larger Pakistan market. Also, the producer provinces have to make their resources competitive. One is already seeing solar/wind versus hydro conflict raised by Sindh. There are people in both or all smaller provinces that have anti-market political ideologies which would hurt their provinces' and people's economic interest in the long run. A larger integrated market is in energy producers' interest. Isolation would hurt. SEPRA in Sindh would be a step in that direction.

Fragmentation has started with the formation of provincial transmission companies; Sindh and KPK started with it and now Punjab is following in their footsteps. There are two possible motivations for it; 1.Taking electricity to far-flung areas where NTDC may not be taking interest; 2. To install generation projects independent of NEPRA and CPPA-G and avoid overheads like losses, cross-subsidy etc. Not much has been done or achieved. It may be causing unnecessary overheads expenditure sustaining companies having not much load or business. NTDC may be asked to change its policies and practices in order to reduce the incentives of the provinces to seek independent solutions.

It doesn't stop at transmission. It goes to regulation as Sindh is trying to do. Things may then be better off if the whole power sector is devolved to provinces. Pros and cons of various options may have to be studied. The government should be happy to get rid of an increasing circular debt. The World Bank has come up with a proposal to reduce federal expenditure. Sepra's formation may be used as a bargaining weapon to get IGCEP system right and get due share. One is not sure if IGCEP has provision for dealing with provincial demands and supplies or it considers meeting total Pakistan demand only. The incumbent government is convinced of the advantages of solar. In short run at least, solar is the cheapest in energy and capacity terms. To the extent of meeting day time demand in offices, schools, government departments, etc, solar has no competitor. Thar coal has been ignored by IGCEP.

It could be due to international pressure and dependence on IFIs (international financial institutions). The world is still producing 40% of its electricity on coal. India and China have been opposing harsh and fast- track closure of coal use in power sector. China has indicated that it won't finance coal power outside its own territory. Without China, there is no possibility of adding more power plants. However, the existing power plants based on imported coal can be converted to Thar coal. And even more market for Thar coal is there in non-power sector like cement, tiles, ceramics, glass and other mining and extractive industries. India's textile industry in Gujarat and Rajasthan uses lignite.

The Sindh government would do well to launch initiatives in this respect on fast track. NEPRA should take leadership in solving the intra-provincial issues, although the issue belongs to inter-provincial coordination ministry where provinces themselves can play an effective role for getting their due share. Technical solutions have, however, to come from Nepra.

4.20: Towards electrical storage systems

The electricity storage system is not something new, although not widespread either. However, with the advent of intermittent solar and wind power systems, the electrical storage is being seen in a new context. Pumped hydro has been a classical system. Battery storage is a new addition. Open-cycle gas turbines and diesel engines, being expensive and inefficient, are being replaced by storage systems.

In this space, we will explain the use of two systems and their economics and policy issues. The main driver of storage systems is the emergence of solar and wind power as a mainstream power source. There are projections of 50-100% market share of renewable energy by 2050 or beyond. Most recent storages have been installed near solar or wind power plants to handle intermittency.

Pumped storage hydro

Pumped storage hydro (PSH) is an old technology used for load balancing. Water is pumped up either through reversible turbines or independent water pumps to a higher site reservoir or a dam. When needed, the stored water is allowed to flow through the hydro turbine to produce electricity.

PSH is not a new energy producer. It provides energy when needed, especially, during peak hours when energy is priced higher, balancing the energy loss. There is a renewed interest in PSH due to the advent of intermittent and variable solar and wind energy, although there are other competing technologies like battery storages.

The disadvantage of PSH is that it can only be installed in usually remote hilly or mountainous areas, while battery storage can be installed anywhere and in all capacities in the modular and containerised form.

There are a number of pumped storage technologies that have been developed in the meantime. Smaller-capacity pumped storage plants of 5-100 megawatts are being built as opposed to very large plants of 500-2,000MW that were built earlier. Where hilly areas are near sea, hill-sea pumped storage plants are built wherein sea is used as an open lower reservoir. Seawater is pumped to the upper reservoir made on the hill and passed through turbines to produce electricity.

Patented pumped storage applications have been developed, which utilise a special fluid (R-19), which is 2-2.5 times denser. This reduces the height requirement for the same capacity. This will enable the installation of hundreds of such plants in mid-country to the south. Another application combines desalination with pumped storage.

PSH accounts for over 95% of all storage installations worldwide, with a total installed nameplate capacity of over 184 gigawatts (GW). It is expected to be doubled as renewable energy penetration increases. High PSH users are only a few countries. In Austria 18.7%, Switzerland 32.6%, Portugal 17.8% and Japan 8.8% of hydro capacity is installed and utilised.

In other countries, PSH installations are 2-5% of the installed hydro capacity. India has several large pumped storage plants and a number of new ones are also being built. A 250MW pumped storage is under construction in the UAE. Hatta Dam is being used as a lower reservoir and an upper reservoir is being built at a higher altitude of 150 metres.

The plant will provide storage for 7.5 hours and 1,500MWh. Capital expenditure (capex) on the plant is estimated at $387 million. The UAE is in need of electricity storage due to large installations of solar power plants.

Battery storage

One is familiar with lead acid batteries used in automotives for starting purposes. These are, however, of less than 1 kilowatt-hour (kWh) and are of 12-24 volts.

Electric vehicle (EV) batteries have come up, which replace fuel and are of 100-300kWh capacities. Batteries are lead acid and now Li-Ion. New technologies are creeping in fast. Costs are high but are fast reducing – from $1,000 per kWh in 2010 to $230 in 2016 and expected to drop to $100 shortly. Half of the price of EVs today constitutes battery costs. EV batteries have a requirement of low weight and volume, which is not there in grid storage.

Utility grid storage battery

Li-Ion batteries have been used and are in current use as well, typically, in smaller capacity applications. I-Ion and Redox batteries are competitors. Unit costs may ultimately decide the fate of competition. Costs of both are coming down fast with no surety as to who will win ultimately. Li-Ion will remain a winner in EVs and Redox may win in grid-scale applications.

However, Flow batteries are increasingly becoming more popular for a variety of reasons including the cost and characteristics. I-Ion batteries degrade in frequent charge and discharge situations and are less cost efficient in four-hour plus storage times.

Battery Electrical Storage (BES) is expensive comparatively and destined to become cheaper on the style of solar panels. BES and pumped storage have already become competitive as is indicated by the results of a recent tender in India.

The main advantage of BES is that it is not location or site-specific. It can be installed anywhere where grid is available and thus would be a great tool for distributed generation, while pumped storage requires a hilly or mountainous area.

Storage and hybrid policy

The Indicative Generation Capacity Expansion Plan (IGCEP 2030) has been approved recently. Yet, it provides for open-cycle gas-powered plants for peaking and load balancing purposes. More than 30,000MW of renewable capacities (including hydro) are being projected by 2030. It will definitely require battery storage and also pumped storage.

A policy is also required for hybrid solar and wind energy, which has relevance with storage. Balochistan is in great need of a distributed energy system, which may require hybridisation and storage as well. It has both solar and wind resources widely dispersed throughout western regions of the province. There is already wind power curtailing in Sindh.

With the increase in solar and wind capacity, grid stability issues will emerge. It will be appropriate if Nepra, CPPA-G, PPIB and AEDB put their acts together and do planning for adequate storage systems and capacity. Some proposal or project should have been included for storage and battery alternatives – pumped storage and the evolving BES technology, especially Li-Ion – in the IGCEP.

In the absence of such innovative technologies, there is a risk of high grid instability and even unnecessarily higher capital expenses.

Renewable Energy

5.1: Renewable energy potential and constraints

Many people ask if renewable energy is so cheap – 1-2 US cents or at most 4 US cents as opposed to 8-10 US cents for fossil energy along with pollution, why the world does not shift to renewables faster and sooner. The global share of renewable electricity (RE) is 27% and in Pakistan it is less than 5%. Firstly, RE has become cheaper only recently. Secondly, there is huge investment that has already been made in fossil-based power plants, which cannot possibly be written off and replaced with RE instantly.

And finally, the main issue is intermittency – solar is in the day and varies during the day, fast enough wind is not found everywhere, it blows in summer in our area and in winter in the northern sphere. Consumers, whether residential or industrial, want electricity instantly and of quality and quantity as required. Fossil fuel does it very well as the technology has been developed over the last 100 years and more. At present, the renewables ride on the piggyback of fossil. There are technologies which help to manage the intermittency issue to some extent.

One, hybridisation wherein mixing solar, wind and hydro provides a smoother mix; two, storage, until recently, electricity storage was not available except in mountainous hydro areas. Now battery technology is evolving fast and becoming economic; three, availability of grid of ample capacity at a suitable distance; four, certain technologies like hydrogen are under development, which will fill the technology gap that exists towards fuller utilisation of RE; five, there is a question of stranded costs – what to do with the existing facilities and how to bring about new ones; six, demand management can also influence the induction of RE. Thus, RE penetration is going to be gradual, both here in Pakistan and elsewhere. The question is at what rate the shift is possible and economic.

Power Division and Nepra have commissioned and even approved the Indicative Generation Capacity Expansion Plan (IGCEP) and simultaneously commissioned another study called VRELS (Variable Renewable Energy Location Study), which suggests as to how much RE, where and at what cost could be inducted up to 2030. VRELS has found that 20% of target share of VRE by 2025 and 30% of target share by 2030 would be feasible. Key questions are what are the possible regional locations, how much can be installed without grid improvement and how much capital expenditure (capex) will be required for grid improvement. As it is, there are issues in transmission and installed capacity cannot be fully transmitted, causing load-shedding and anomalies in merit order dispatch.

Solar-wind hybrid in Balochistan

In Balochistan, there is issue of grid unavailability. Otherwise, if one examines the PV and wind resource map, there is more wind resource in Balochistan than it is in Sindh. Chagai has the best and largest wind power potential with capacity factor of 60%, which is slightly less than twice that of Sindh. In Sindh, however, there is a grid market and relative peace. Between Gwadar and Chagai, it is almost all windy area along with rich solar potential as well. A high-voltage, direct-current (HVDC) grid connecting Gwadar and Chagai is called for.

There was a proposal for laying a copper pipeline in Reko Diq for transporting unprocessed copper from Chagai to Gwadar for onward sea transportation. A China oil pipeline has also been proposed along the same corridor. Thus, there is a great potential for this corridor. For practical reasons, areas near and north of Gwadar should receive priority and a suitable location should be identified that may energise desalination plants as well. In Gwadar, an expensive coal power plant is being built for the lack of an alternative. Had this VRELS been available earlier, a solar project could have been an ideal choice, providing cheaper, cleaner and constant power.

Special tariff

It should be noted that wind is only in Sindh or Balochistan. In Khyber-Pakhtunkhwa, some wind resources are in Chitral only. Balochistan has law and order and payment problems. People do not pay or pay low agricultural tariff under which air conditioners are also operated. There is a case for special innovative tariff for Balochistan, if and where solar-wind hybrid is utilised. These days, solar-wind tariff is under 4 US cents.

While considering the concession for Balochistan, one should keep in view the small population and the consumption thereof, which have a very small impact on the total.

Solar-hydro/pumped storage hybrid in K-P

It appears that the potential for VRE in K-P has been under-estimated. One of the reasons probably is that hydro has been ignored. Under new Council of Common Interests (CCI) rulings, hydro is to be part of VRE. Also, hydro generation cost (8-10 US cents) is rather high as compared to other VRE like solar and wind. However, hydro offers the cheapest possible storage technology option. Many advances have been made in pumped hydro storage. There are floating solar power plants in dams. One such project is already being developed at Tarbela.

There are open and closed cycle storages. Two storages are built – one higher and the other lower at a height difference of 300-1,000 metres. At the lower level, a pump and turbine house is built. In low demand periods, water is pumped from the lower reservoir to the higher reservoir through solar or other electricity. In high demand period, electricity is generated by water flow from the higher to the lower reservoir passing through turbine. Solar-hydro hybrid/pumped storage can be an ideal solution for K-P and even beyond. Had this option been included, K-P's share in VRE could have been higher.

With the emergence of a new scenario wherein limitations are being put on coal, the importance of VRE will increase even further, which may force planners to increase scope of the study and the IGCEP. Many people are sceptical of all such projections. There is surplus capacity and circular debt issue and non-payment to independent power producers (IPPs). Smaller 50-100MW power plants appear to be more feasible. Solar and wind projects should be invested in by local investors to prevent foreign exchange outflow.

Also, indigenisation and local participation should be promoted to ensure a multiplier effect and generate employment. Some incentives for local manufacture can be introduced. There is a State Bank scheme, which may be improved upon. It is, however, a model study showing the way to plan a sector and the constituting projects. A similar study or a combined one may also be done to include fossil plant

5.2: Solar-wind hybrid Projects

By 2030, Pakistan will have around 60 percent market share of renewable energy sources about half of which will come out of solar and wind. This would bring a good change to the country's overall energy scene, helping in solving the existing environment and climate issues and reducing energy imports.

However, there will be some problems as well. Almost all renewable sources, especially solar and wind, are intermittent – available either on a variable-hour basis or in higher frequency. Previously, during fossil fuel-dependent days, the persistent issue was demand variation while supply used to be mostly maintained at a constant level. Now with such a large share of varying renewable energy sources, maintaining grid stability would be a difficult job.

Transmission and an even distribution system will have to be improved. On the supply side, storage and hybridisation will have to be undertaken. Solar and wind energy resources can be installed on the same plot of land, increasing final output and utilising common ancillary and transmission facilities. Solar-wind is a highly localised combination and may have varying output and capacity factors. A solar hybrid plant may be almost like a thermal power source but with some consistency and much less variability.

It would be the best of both worlds. Even solar and hydro can be combined; one form of which is floating hydro power plants on dams which reduces water loss through evaporation. There are examples of solar power plants floating on canals as well. Solar energy is available in abundance throughout Pakistan. However, wind energy is mostly limited in Sindh and Balochistan. While there are other renewable energy sources in Sindh, Balochistan has limited options and merits the installation of solar and hybrid power plants.

An important and probably most important finding of the World Bank (WB) study is that there are seven sites with solar-wind hybrid characteristics and which are interconnection ready zones. In total, these solar and wind hybrid sites can have a capacity of 1500 MW. These sites are at Qila Saifullah, Panjgur, Khuzdar, Much and Muslimbagh, all falling within the domain of the Quetta Electric Supply Company (Qesco). Only one solar-wind hybrid is in the Multan Electric Power Company (Mepco) region, in Rojhan.

From both demand and supply sides, Sindh is the most opportune province for installing solar-wind hybrid capacity. In Khyber Pakhtunkhwa (KP), only solar and hydro hybridisation is possible. In KP, wind resources have not been identified except in Chitral and D I Khan. In Chitral, solar, wind and hydro can be hybridised – a two- or three-source system.

The Asian Development Bank (ADB) has funded and set up a solar-wind hybrid plant in Khushab, Punjab, which is operating successfully. The plant derives 30 kW from solar and the remaining 20 kW from two wind turbines of 10 kW each. The hybrid pant provides around 50 kW to over 500 people in 80 households. This was the first and only plant installed in 2017.

Some recent reports suggest that a 400-MW solar-wind hybrid plant will be set up in Spain, by 2025. In one of the projects, a 40.9 MW of solar plant will be added to the 49.5 MW wind farm; another 14.5 MW wind farm will see the addition of 13.2 MW solar.

As reported recently, Engro has announced an MoU with the Sindh government for the installation of a 400-MW solar-wind hybrid power plant in Jhimpir to power industries located in the area of Dhabeji and Port Qasim industrial zones; expected commissioning is in 2024. Earlier, the company had decided to install a similar project in Balochistan. However, there hasn't been any update in this regard.

The wind power capacity factor is 35-40 percent, and for solar, it is 20 percent. Their total sum, however, may be less than 55-60 percent for a variety of reasons. Storage may be able to add another 20 percent capacity factor. Recently, in India, a solar-hybrid tariff has been approved at INR 3.86 per kWh with a capacity factor of 80-85 percent. It is a two-part tariff providing separate rates for peak and 0ff-peak power. Normal solar-hybrid power plants implemented in India have a capacity factor of 40-50 percent. One would not be sure if wind power capacity factor numbers are lower in India.

The lowest solar-wind hybrid tariff offered in a recent auction (September 2021) in India has been INR2.34 per unit for project capacities of up to 150-450 MW. Earlier, hybrid tariff auctions were reported at INR2.41-2.69 per unit. By comparison, the lowest solar power tariff in December 2020 was INR1.99 per unit. Thus, it appears that hybrid may not be cheap despite purported advantages of savings in physical facilities. But are market and technology risks or is a loss of capacity utilisation in hybridisation the main reason for this high cost? We have noted above that even higher storage tariffs of INR3.85 – 5.21 US cents – per unit are higher.

It is strange that solar-wind hybrid plants have not been picked up much, not only in Pakistan, but elsewhere too. With the development of battery storage technologies, the potential has improved – perhaps only recently. In Pakistan, a policy vacuum has also contributed to a lack of progress in this regard. One may counter that even the capacity of individual solar- and wind-powered plants remained underdeveloped. However, the National Electronic Power Regulatory Authority (Nepra) has, in its report, emphasised the need of launching hybrid projects.

This leads to an important question: do we need a separate hybrid policy, or will policy provisions be enough? If competitive bidding is implemented, perhaps no other criterion other than the minimum producer tariff would be required. If it is not, it might be necessary to define some parameters and loose issues. Issues such as capacity factor, location and co-location, relative shares of solar and wind may require definition and clarification.

A lack of clarification may later introduce complications and cause delays in project approvals. Is the existing wind power plant eligible for hybridisation as it may perhaps be the easiest and cheapest way of expansion? Or is a new site eligible for a new hybrid project? Can we use the same plot for additional projects, or do we need separate plots that are at some distance? Location priorities are often specified in plans like the Indicative Generation Capacity Expansion Plan (IGCEP). However, the latter has not specified any such thing.

There may be special legal and financial issues in the existing projects requiring expansion. So, without concrete policies or additional provisions, the resultant confusion will delay projects, increase risks or perceptions, and affect the overall economics. The need of the hour is to have a coherent policy which is drafted in a way that it doesn’t delay the policymaking process. But who should make this policy is another complicated issue; should it be Nepra or the power division.

5.3: Local, global solar market trends

There has always been a problem in Pakistan's energy sector. Earlier, there were load-shedding issues due to generation capacity limitations. Now, there is capacity surplus causing circular debt. There is also higher fuel prices issue and lower transmission capacity and its discontinuities. Alternative projects were delayed due to high capacity payment liabilities. Now, high fuel costs and lack of foreign exchange have compelled us to go solar in a big way.

In this space, we will take a view of the national and international solar market in terms of supply conditions and other details. Solar PV prices have been coming down continuously. Some prices are too low to be taken as benchmark prices, while others are more reasonable representing average conditions. MENA region, primarily containing the UAE and Saudi Arabia, has had solar PV utility from 1.5 to 3.0 US cents per kilowatt-hour (kWh) over the years between 2017 and 2019. Main reasons are high insolation exceeding 2,200 kWh/m2/yr and low cost of capital varying between 3% and 6%.

In Chile, in September 2022, Canadian Solar won solar PV bids at 3.738 US cents per kWh for a 253-megawatt project and 1 gigawatt-hour (GWh) storage. Earlier in August 2021, Canadian Solar also won its lowest bid at 1.332 US cents per kWh, among other offers which were in the range of 2.1 to 2.8 US cents. The most recent bidding results that are available in public domain and are relevant to Pakistan's conditions are from India and Uzbekistan.

In Uzbekistan, the lowest bid of French firm Voltalia has been accepted for 100MW at 2.888 US cents per kWh. Masdar, a Saudi firm, won a bid of 3.044 cents per kWh for a 250MW solar PV plant. And Power China won a 150MW solar project at 4.828 cents/kWh. There is a wide variation among project bids. Perhaps locations and specs were responsible for such variations. One notable point is that a French company quoted the lowest bid and won against Chinese, negating a common perception about countries' competitiveness.

Perhaps the most relevant and competitive solar market is India. We have access to public data on 12 successful tenders of 2022 and 2023 with capacities ranging from 250MW to 1,200MW. Three types of projects are there – solar PV only, solar PV and wind hybrid, and solar PV, wind hybrid plus storage. Four types of soar PV utility projects are in vogue these days. These are solar PV only, solar PV with battery storage of one to four hours, solar PV-wind hybrid without storage, and solar PV-wind hybrid with battery storage of one to four hours.

Most popular have been solar alone for covering the day-time load providing the cheapest power. However, solar PV-wind hybrid with storage is emerging to provide 24-hour power supply. Battery prices are still high, although they are coming down fast. With lower battery prices, type 4 will get more popular eventually offering a complete individual power supply solution. Solar rooftop projects have been popular at hose rooftops, both in Pakistan and elsewhere. Commercial and social buildings requiring daytime electricity mostly have found solar PV installations providing electricity at cheaper rates with and without net-metering provisions.

Solar PV project size has started going up, which started with 30-50MW a decade ago. Recently, India has gone for 1,000-1,200MW hybrid projects, although 500-600MW projects are more common. Next popular size is 250-300MW. In Pakistan, solar projects of 50MW have been popular. Solar capital expenditure (capex) was reported to be the lowest in India in 2019 at $619 per kW. Lowest labour cost in installation and low transportation cost due to local manufacturing are probably responsible for the lowest cost figures in India.

For China, unit capex cost of $795/kW has been quoted, although this figure appears to be higher than actual. There are problems in obtaining price data in public domain in China. In the same year, Russia and Japan had the highest unit capex at $2,000/kW plus. In Europe, the same has been at $900-1,000/kW. In Pakistan, Nepra has earlier approved projects at 4 US cents per kWh. For Muzaffargarh project of 600MW, Nepra has approved a benchmark tariff at 3.4108 US cents/kWh.

European sources have, however, expressed pessimism about competition, calling the benchmark tariff too low due to a higher risk in Pakistan's market.

On average, Pakistan's electricity prices have been higher by 40-50% due to higher risk, interest rates, rent-seeking and monopolistic trends in the supply market. Internationally, interest rates have increased as measured by Libor, which is quoted at 5.5% at present. Nepra's earlier tariff of 4 cents was based on lower interest rates of 0.5% Libor and a margin of 4.5%. Local interest cost is even higher at treasury rates of 20-21% and the IMF has demanded a further increase in rates. It appears that Nepra's benchmark tariff of 3.4108 cents/kWh for Muzaffargarh project is based on earlier lower interest rates. However, one is not sure, if and when interest rates would go down, depending on the early recovery of world economy.

Figure 5.3.1: Graph of long-term interest rate Development

Energy projects have a long cycle of 30 years. Nepra may like to seek international input from experts with respect to interest rates trend in the long run, although such forecasts can be dicey. Bidders may be in a better position to project and calculate. It is said that bidders and the market are better than regulators at predicting prices. Ironically, local investors have not welcomed the Muzaffargarh project as it has delayed the implementation of their approved projects which are generally of lower capacity of 50MW. For Pakistan's market, many argue that this is a better project size.

However, other reasons such as existence of load and transmission infrastructure have led to the Muzaffargarh site at 600MW. It is yet to be seen from bid results whether one gets better prices and competition at 600MW or would have got at smaller capacities of 50-100MW. It is a debatable question as to the right size of solar projects. As mentioned earlier, load locations, capacity requirement and transmission infrastructure determine the size. However, from the point of view of local investors and industry, smaller capacities in the range of 50-100MW may be desirable.

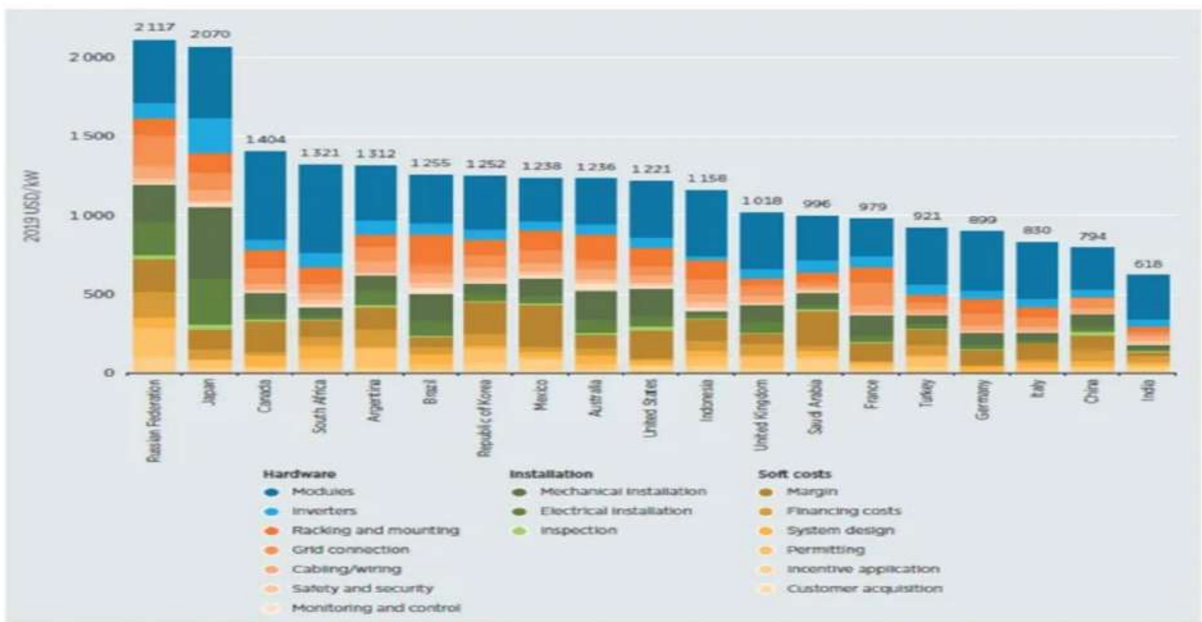
Solar has great future. Fossil fuels may be substantially reduced if not totally vanish beyond 2050. Even hydrogen would require solar and wind. Thus, it is important to develop local industry to create employment, business and trade. There is no better way to do this than capturing the local market. However, due to the recent economic crisis and heavy currency devaluation, energy demand may go down and earlier growth assumptions may not apply.

Actual risks and market risk perception about Pakistan are high. We have earlier indicated scepticism of European circles. It is feared that higher bid prices may be obtained and in that case Pakistan would be better off postponing the project. However, nothing is known in advance about bid results. Market has its own surprises and suppliers have their own reasons and strategies. Chinese companies have better understanding of Pakistan's market and risks with a sympathetic government and CPEC presence. International production capacities in solar are projected to increase leading to higher competition and higher prices. Chinese PV module prices have been projected to fall by 15% in 2023. Let us hope for the best.

Table 5.3.1: Solar PV Utility Cost Selected Countries-2019-USD/kW

		Germany	Saudi	Turkey	China	India	Average	%
	Total	899	996	921	795	618	1192	100
	Module	375	282	359	267	278	358	30
Total Module,Inverter	inverter	54	73	63	42	44	73	6
Sub.total								36
	Mechanical	77	76	50	75	31	119	10
	Electrical	26	29	32	35	15	69	6
Installation	Inspection	4	12	6	4	12	12	1
Sub.total								17
	Racking	85	56	47	9	31	93	8
	Grid Connections	82	37	45	62	29	79	7
	Cabling,wiring	30	21	27	33	29	47	4
	Monitoring	3	9	6	2	1	14	1
BOS hardware	Safety,security	13	10	9	6	21	19	2
Sub.total								22
	Margin	99	217	99	91	26	133	11
	Financing	6	38	62	73	41	52	4
	Permitting	4	16	60	12	14	47	4
	System Design				30	20	35	3
	Regulatory				19	22	32	3
Soft Cost	Customer	4	15	5	14	12	10	1
Sub.total								26

Figure 5.3.2: Detailed breakdown of utility-scale solar PV total installed costs by Country, 2019



Source: IRENA Renewable Cost Database.

5.4: Role of Solar water heaters and Biogas

Gas crisis is already there. It may become worse in winters, although gas shortages in winters would not be for the first time. An added new factor is the high liquefied natural gas (LNG) prices. LNG prices have never been that high in its history. The government has announced an electricity tariff incentive system, which will divert gas users to electricity.

More people will be using their inverter ACs to heat their homes that were earlier used to gas heaters while gas was cheap. People living in semi-urban and rural areas, having access to biomass, may like to light their fancy hearths, which might have been shut for years. Solar water heaters, biomass cookers and biogas can also partly fill the gap. Solar water heaters offer an immediate solution while biogas may take time for implementation in a sizeable way.

Water heating is not uncommon in Pakistan even in summers, while in winters it is very common, especially, in upper income groups which have installed gas geysers. Solar water heaters are not uncommon in Pakistan. However, their market share is very limited. It is mostly imported from China. In China, there are several hundred small enterprises, which manufacture and export solar water heaters to many countries, although a few large companies have also emerged and have a vertically integrated structure.

Biogas and solar plant

China itself is a large consumer of this and 75% of world's installed capacity of solar water heaters is in China.According to some estimates, 63% of solar water heaters are used in residential housing units and 28% in hotels and hospitals. It has a small share in swimming pool water heating and space heating. A government policy is required to facilitate and promote the solar water heater market. Reduction in taxes and duties, credit schemes and advertisements can go a long way towards expanding the installation base. The retail price of a small solar water heater is around Rs40,000 and of a large one is Rs80,000. The price can be brought down through the aforementioned steps.

Some subsidy may be offered through low interest financing. Gas companies may be given a target to sell and install solar water heaters, although in the past these companies have shown some interest in it on their own. Solar water heaters can be manufactured locally also by initially making steel items and importing glass tubes. Great progress has been made by small and medium enterprises (SMEs) in Pakistan in the area of household items.

SMEs are, however, scared of competition with China and their low prices. Large Pakistani companies can form joint ventures with Chinese companies in the Special Economic Zones (SEZs) being built under CPEC. Government signal can play an important role in it. Solar water heaters, unlike solar PV systems, do not require a lot of space. Normally, one unit is sufficient for a small family, although reportedly, there are large homes where one unit has been installed for one bathroom.

One unit requires a space of four to six feet so a small area house (five marla and multi-storey) roof can accommodate several units. There are quality issues in solar water heater supplies and after-sales service. Small items such as Mg rod for corrosion protection are often missing or some retailers do not have any knowledge about it, which results in a shorter life of storage drum. There are installation issues as well. Seldom are hot water pipes insulated, which waste a lot of energy.

All of these problems can be solved if the organised sector comes into this field and more people would be inclined to buy solar water heaters. Most of the aforementioned solutions are, however, focused on high-income groups. There are some solutions for the poor as well. Biomass cookers have been developed in Pakistan which, however, are relatively expensive costing Rs4,000 to Rs5,000 per unit. These cookers can be very useful for the urban poor, who do not have gas connection. Government's policy measures can make it cheaper and make it widely available. Rural poor may not need such devices due to having open kitchen and almost free biomass. Biogas may be a solution worth examining. Instead of forcing gas companies to extend their networks and supply gas at highly subsidised rates, biogas facilities could be subsidised under low-interest credit schemes.

It may be interesting to note that Pakistan has been able to install only 5,000 biogas units as opposed to India which has managed to install 5 million units under comparable socio-economic conditions. Biogas can be produced from all kinds of biomass including cow dung, agri-waste, solid waste, food waste and even waste water. Rice paddy stubble, which is burnt by farmers causing dangerous smoke every winter, can also be diverted to biogas production.

At the larger level, bio-CNG may be economically produced. It is being done in India already with several hundred bio-CNG stations and there are plans to install 5,000 such stations. Bio-CNG in India is costing 50% of the liquid fuel prices. They have also developed bio-CNG based agricultural tractors, which can make rural life self-sufficient. It has been estimated that 200-600 mmcfd of gas can be produced under this arrangement. Bio-CNG has an energy security dimension as well that can support transport system through distributed gas supply to vehicles in case of fuel supply bottlenecks.

Punjab has the largest biogas potential, while it has no other energy resource except solar. A government policy is required to promote bio-CNG by establishing demonstration facilities in semi-urban and rural areas that can be financed by gas companies and PSO. It may be interesting to note that after years of delay, the Landhi Cattle Colony biogas project has been revived and is at an advanced stage of implementation. It will produce and supply bio-CNG to Green Line buses.

Solar geysers

Figure 5.4.1: Solar Heater Field System

After the electricity tariff, the gas tariff is poised to be enhanced as well. The average tariff will likely increase by 50 per cent. There is a point of view that rich consumers living in posh areas should not be given pipeline gas, whatever the tariff may be, and should be supplied LPG or LPG equivalent gas tariff. Not only is the gas tariff going to be high, there will also most probably be gas supply issues, as happens in the winter usually.

There are three main uses of domestic gas: cooking; water heating; space heating. The most sacrosanct use is cooking which a majority of people demand should be given priority in gas supply allocations. This allocation is actually done by the gas companies, regulators and the government. The other two uses do not have such moral sanctity. In fact, per some people, the other two uses are wastage and the gas used in those should rather be diverted to industrial uses which would aid the economy.

For heating, the affluent classes have a choice of using inverter ACs. Most people have started using those, especially those with solar PV on their roof. Heating through inverter ACs – and thereby via electricity – has two advantages: it would increase electricity utilization in the winter when it goes down to very low levels increasing the capacity charges of electricity; and it would reduce gas consumption by reducing usage of gas geysers. Gas companies have also introduced a gas-saving device for increasing the thermal efficiency of gas geysers.

It has been several years now that solar geysers have been introduced in the Pakistan market. However, their use is still limited for a variety of reasons. It used to cost under Rs50, 000 per unit but its cost has doubled recently due to the depreciation of the rupee. Unfortunately, solar geysers are imported, almost totally. A solar geyser essentially consists of two parts – an insulated water storage tank and evacuated water double-walled tube of borosilicate glass. Additionally, there are optional electronic controls and a small water pump.

If solar geysers are installed in at least 50 per cent household roofs, a lot of gas can be saved. Such a step would help the country overall as well as individual consumers. The main problem here is the lack of supply chain and branding. If a customer wants to buy a solar geyser, s/he doesn't know where to go and get a reliable product at the right price. After-sales support is another issue. It is believed that local manufacturing would be able to handle these issues. Earlier, gas companies used to take interest in such initiatives and were quite successful as well. With a change in management, these activities have almost been dropped.

Solar geysers can also be utilized to meet hot water requirements in many industries. The food, beverages and dairy industries have washing and cleaning requirements. Pakistan has a large textile industry that has dyeing and processing components. The textile processing industry has to usually install captive power units to utilize the exhaust heat for water heating purposes. Instead, such plants can install solar water heating panels the way our solar PV panels are installed. Space is a general limitation in Pakistan's textile industry. New sites and locations should take care of this problem.

The global market of solar geysers exceeds $3 billion and is increasing at a rate of CAGR 5.0 per cent. China, India, Turkey, Mexico, South Africa, Morocco and several other countries are a major market. Solar geyser manufacturing is concentrated in China, India and South Africa but now even Morocco has started manufacturing solar geysers.

In China, 35 million households have installed solar geysers, although still a little than 10 per cent out of a total household number of 350 million. There are more than 1000 solar geyser manufacturers exporting 1-2 million units per year. Ninety per cent of the patents on solar geysers related subjects are owned by China. However, low quality and variability is a major issue in some of these products. Out of so many companies, one can find only 10-15 high quality and reliable companies, or so it is generally believed by trade circles. Pakistan being a highly price sensitive market, the combination of the two creates major quality and supply chain issues. In India, there are more than 100 manufacturers of solar geysers.

As mentioned above, small countries such as Morocco have established solar geyser manufacturing facilities. Recently, a plant has been installed in Morocco to manufacture 40,000 SWH which is to go up to 90,000 units per year. It will be a 100 per cent locally manufactured product. There are plans to export it as well.

Egypt, under the assistance of the United Nations Industrial Development Organization (UNIDO), launched a programme called SHIP – Solar Heating in Processing Industry – to popularize solar water heating in the process industry. Manufacturers have been readied to manufacture and supply solar water heating systems to three chosen sectors: textiles, chemicals and food. A concessionary financing scheme has also been introduced. It is being extended to other regional countries and is a good model to be adopted by Pakistan as well.

In local manufacturing, China is a problem and China is a solution as well. No one can compete with China due to their cheap labour, efficiency and subsidized pricing. However, with cooperation and JVs with Chinese companies, local manufacturing and exports can be developed. Pakistan has almost all the manufacturing know-how that is involved – steel fabrication, foaming, and glass industry. Companies making gas geysers or washing machines can go into this besides many other SMEs.

There can be two approaches to locally manufacture SWH in Pakistan. The first is to start with small plants of a capacity of 10-20,000 units .There is a scope for several parties to get into this. The second is that, under CPEC, a major project is launched to transfer Chinese plants and make a manufacturing hub for meeting local demand and exports as well. SMEDA can also fast track the process of popularizing the local manufacturing activities in this respect. It is a separate issue that SMEDA also needs institutional strengthening and modernization.

Local gas production is going down with no signs of new discoveries. LPG and LNG are expensive. In such a scenario, diversification is required. Besides that, some sensitivity should also be shown to the global targets of climate change. Solar geysers and biogas are two major ways to contribute to these objectives besides meeting the ever increasing demand of gas for cooking and non-cooking purposes.

A new line of manufacturing and exports can also thus be created at a time when we need it so badly. A government initiative would be required to create a credit line. There are many green credit lines available internationally that could be explored.

Table 5.4.1: Temperature Requirements for Various Processes

Sector	Process	Temperature Range (°C)
Chemicals	Biochemical reaction	20–60
	Distillation	100–200
	Compression	105–165
	Cooking	80–100
	Thickening	110–130
Foods & beverages	Blanching	60–100
	Scalding	45–90
	Evaporating	40–130
	Cooking	70–120
	Pasteurization	60–145
	Smoking	20–85
	Cleaning	60–90
	Sterilization	100–140
	Tempering	40–80
	Drying	40–200
	Washing	30–80
Paper	Bleaching	40–150
	De-inking	50–70
	Cooking	110–180
	Drying	95–200
Fabricated Metal	Pickling	40–150
	Chromaiing	20–75
	Degreasing	20–100
	Electroplating	30–95
	Phosphating	35–95
	Purging	40–70
	Drying	60–200
Rubber & Plastic	Drying	50–150
	Preheating	50–70
Machinery & Equipment	Surface treatment	20–120
	Cleaning	40–90
Textiles	Bleaching	40–100
	Coloring	40–130
	Drying	60–90
	Washing	50–100
	Fixing	160–180
	Pressing	80–100
Wood	Steaming	70–90
	Pickling	40–70
	Compression	120–170
	Cooking	80–90

1

Table 5.4.2: Industries working with Soolar water heating process

	India	Sharma n shawls	Dyeing, bleaching & washing Garments	Flat plate collector	-100
Mining	Germany	Schiffer GMbh & Co KG	Galvanic Bath	Evacuated tube collector	40-70
		Steinba chund Vallimann	Galvanic baths	Evacuated tube collector	60-80
Chemical	India	L'Oreal Punne	Cleaning process	Flat plate collector	-55
Agriculture	Spain	Acuinova Andalucia S.A.	Heating Water	Flat plate collector	23-26
	China	Hongxin Aquacul ture	Water Heating	Evacuated tube collector	
	Germany	Woltow	Water Heating	Parallel trough collector	
Leather	Austria	Gerberei Kolblinger	The wet process of leather retannig	Flat plate collector	
Fabricated Metal	India	SKF Technologies M sore	Circulation	Parallel trough collector	-95

Table5.4.3: 706 kW Sol ar thermal plant in dairy industry in Greece

Industry	Country	Name	Industrial Operation	Solar Collector	Temperature(0 C)
Breweries	Austria	Gangl Fruit Juices	Pasteurization	Flat plate collector	95-105
	Austria Mexico	Metbrauer ei Newwirth	Pasteurization, sterilization	Flat plate collector	50-95
		Dairy Plant Ladonita	Pasteurization	Parallel trough collector	60-95
Food	Mexico India	Nestle Dairy Plant	Pasteurization	Parallel trough collector	80-95
		Nestle Dairy plant- Lagos ds morenno	Pasteurization	Parallel trough collector	80-95
		B. G. Chitale	Pasteurization of milks	Other or various collectors	-150
	India Austria	Indian institute of Horticulture	Pasteurization of straw	Other or various collectors	80-100
		Mahananda Dairy	Pasteurization of milks	Other or various collectors	-120
		Milma Dairy	Pasteurization of milks	Flat plate collector	
		Krispl Fruit Juice	Pasteur crates washing space climate	Flat plate collector	-80

5.5: Promoting solar equipment manufacturing

Solar photovoltaic (PV) panels have come of age. Global installed capacity of solar PV stands at 728 gigawatts in 2021, which is expected to grow at a fast rate of 13.78% to reach 1,645GW. In monetary terms, the 2026 market is valued at more than $200 billion. Both roof-mounted and utility-scale capacity is growing. Its cost of generation has come down to 2 US cents per kilowatt-hour (kWh) and even lower in some countries. In Pakistan, its cost is a bit higher at Rs4-6 per kWh, but still it is less than half that of fossil power plants.

Addition of solar capacity would bring down the average cost significantly. Current market of fossil fuels is rather destructively high. This has, however, created incentives and sensitivities in importing countries to go for renewable sources including solar.

Solar demand and market

The Indicative Generation Capacity Expansion Plan (IGCEP) has provided for a capacity of 7,932 megawatts for solar energy and 5,005MW for wind power by the year 2030. Solar has an advantage as it is available throughout Pakistan. Solar intensity in Pakistan is twice that in Europe. Wind power can be generated in a part of Sindh only.

Solar panels can be installed in a distributed fashion near almost every district. This would not require large transmission networks. Even if 50 districts are covered with 100MW solar capacities, it would amount to 5,000MW.

Then there is demand for off-grid rural electrification. There is also roof-top solar market of urban areas. If 10,000 rural settlements are electrified by solar energy, it would amount to several thousand megawatts of off-grid energy. Consideration may be given to organising electrical or energy cooperatives to include solar, biomass and biogas. There are a large number of electrical cooperatives in the US.

Some pilot cooperatives may be tried initially. This may have significant impact on agricultural productivity, education and healthcare sector outreach. Solar panel market in Pakistan is of 1,000MW. In monetary terms, it has been estimated at Rs60 billion for panels and Rs10 billion per year for all ancillary equipment like inverters. This is mostly private purchase for roof-top solar.

Recently, there has been no major solar utility project. A number of solar projects are in the pipeline but there are some tariff issues. Temporary excess power capacity, circular debt and current financial problems have also had an impact on the lack of solar project installations. Provincial governments are, however, quite keen on launching their own projects. Some formalisation and apportionment of solar capacities in this respect is required.

Provincial interest and action can go a long way in expanding solar capacity, especially in education and health sectors, and rural electrification. This, however, has to be under a consultative arrangement so as not to cause excess capacity problems.

Solar PV manufacturing

Several developing countries have installed local solar panel manufacturing plants. These include India, Turkey, Chile, Thailand, Malaysia, Hong Kong, Singapore and Vietnam and may be other developing countries. Turkey, Malaysia and Vietnam appear to have emerged as leading solar PV manufacturers.

Turkey entered into solar PV business in 2011 and in a decade's time has built a thriving sector consisting of more than 20 solar PV assemblies and manufacturing plants with aggregate capacity of 5,610MW. Recently, a Chinese company has installed a 500MW integrated solar PV manufacturing facility with an investment of $400 million.

Malaysia has a solar PV manufacturing sector of several thousand megawatt capacities despite a small installed 1,500MW of solar energy production capacity. It means that bulk of the production goes to exports.

China plans to invest $10 billion in integrated solar PV manufacturing in Malaysia. Recently, there has been an agreement between a leading Chinese company for installing an ingot and wafer manufacturing plant in Vietnam of a large capacity of 7GW.

In Saudi Arabia, a relatively large 1.2MW solar cell and assembly plant has been commissioned with an investment of $186.9 million, which does not appear to be an extraordinary large investment figure. Even the UAE has four solar PV manufacturing plants despite high labour costs and availability issues. In India and Turkey, there are incentives and subsidies on local manufacturing.

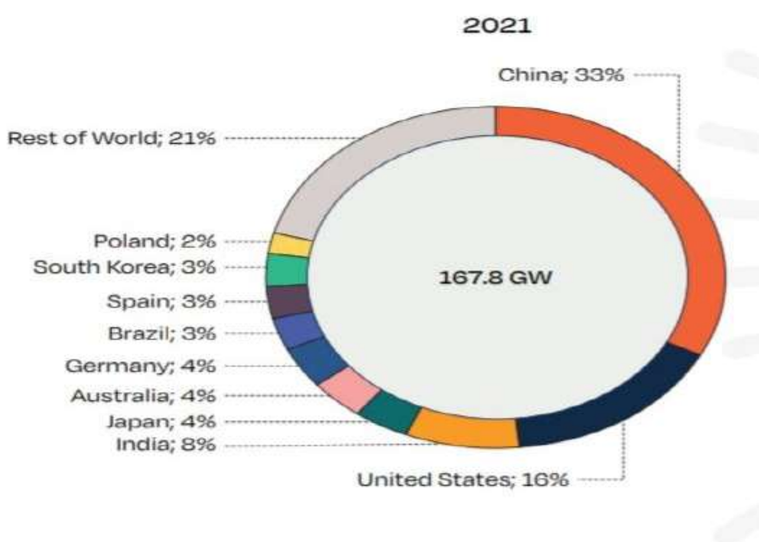
Chinese companies are leading suppliers of solar panels and other associated equipment and are also active in installing manufacturing facilities abroad. We have Special Economic Zone (SEZ) programme with China under CPEC. Some efforts should be made for launching projects for local manufacturing of solar equipment. Pakistan's trade gap is increasing with rising imports. Export of textiles and some agricultural commodities is not enough to close the trade gap.

Local manufacturing has to be expanded in the engineering sector, IT and other pioneering fields. Solar is an ideal field that has a large and growing potential. Some parts of solar industry are also labour-intensive like solar panels, inverters and other ancillary equipment.

Apart from saving foreign exchange, local manufacturing would increase employment and promote technologies and skills. Pakistan's solar market today is dominated by small traders and informal sector, triggering quality and even safety issues.

Local manufacturing would organise the market, reduce cost and improve quality. Although our subject is focused on solar PV, it may not be out of place to emphasise local manufacturing of solar water heaters and biomass cookers to reduce the demand for gas.

Figure 5.5.1: Top-10 Countries Solar share 2021



Remarkably, Pakistan installed a pilot plant for making solar ingots and wafers as early as in the 1970s. The plant is still there and working. Panel assembly facilities were added later.

It was a good nucleus for expanding knowhow. Unfortunately, the initiative couldn't be sustained. However, solar PV economics and competitiveness has emerged only recently.

Although there is a substantial user market, solar PV projects would be required to attract foreign direct investment (FDI) in the manufacturing sector. There are some manufacturers of ancillary equipment like inverters, which are mostly limited to assembly operations. It may also be encouraged and expanded. It may be noted that solar manufacturing capacities in the developing countries are far greater than the installed solar energy production capacity, meaning that all of these are export-oriented besides local consumption.

One wonders, what is wrong with Pakistan? Forward and positive thinking is required, shunning pessimism? Pakistan's user market is estimated at 1,000MW. There is potential for installing some 20 solar PV manufacturing plants of 50MW each. Local investors have that much capital to install one plant each. Joint ventures are also possible for knowhow, brand and export possibilities. Local investors are usually shy without government initiatives and policies, especially in new areas. The government, Board of Investment and Power Division should consider initiating consultations and policy dialogue in this respect

Taxation and Incentives

The government has imposed a 17 percent sales tax on the import of solar PV equipment. Solar traders have protested against it and consider it an anti-green approach. Reportedly, the finance minister had promised to not withdraw the previous tax exemptions on solar panels, but this has not been implemented yet. The government wants to generate much-needed revenue through taxes, while the traders think that such a move would discourage the evolving solar market. Had the government levied taxes under a developmental objective, it would have acquired some legitimacy and support.

It has been estimated that the imports of solar panels and equipment stood at 2380 MW in 2021. In 2016, the total was 700 MW. A good quantity of 5,000 MW of panels has been imported over the last five years. The demand has been growing at a rate of 50 percent. The 530 MW capacity of grid-connected PV systems is surprisingly only a small fraction of the total solar installed capacity, as indicated by the imports data. The capacity of rooftop solar panels (net metering) stands at 282 MW. There should be sizable rooftop capacity which is not under net metering on which data is not available. The demand emanates from the many solarisation programmes of the provinces involving schools, university, and mosques solarisation. Solar water pumping is also a major sector.

Even if we assume solar panels imports to grow at 20 percent in the next five years, the demand/imports may go up as high as 5000-7000MW per year. And the installed capacity by 2025 may be more than 12000 MW. These numbers should be considered by Indicative Generation Capacity Expansion Plan (IGCEP) planners while estimating their demand projections. However, our focus in this space is the need for indigenous solar panel/equipment manufacturing capacity.

The IGCEP has provided for a capacity of 7932 MW of solar and 5005 MW of wind power by the year 2030. Until recently, there has been no major solar utility project. Several solar projects were in the pipeline, but there were some tariff issues. Temporary excess power capacity, circular debt and the current financial problems have also had an impact on the lack of solar projects installations. The provincial governments are, however, quite keen on launching their projects. Some formalisation and apportionment of solar capacities is required in this respect. Provincial interest and action can go a long way in expanding solar capacity, especially in the education and health sectors and rural electrification. This, however, has to be under a consultative arrangement so as not to cause excess capacity problems.

Several countries – India, Turkey, Chile, Hong Kong, Thailand, Malaysia, Singapore, and Vietnam – have emerged as leading solar PV manufacturers after installing local solar panel manufacturing plants. Turkey entered into solar PV business in 2011, and has built a thriving sector consisting of more than 20 solar PV assemblies and manufacturing plants with an aggregate capacity of 5610 MW in a decade. Recently, a Chinese company installed a 500 MW-integrated solar PV manufacturing facility with an investment of $400 million. India has an installed capacity of more than 10000 MW of solar panel assembly and 4000 MW of integrated cell and panel manufacturing capacity. India plans to add another 15000 MW manufacturing capacity.

Malaysia has a solar PV manufacturing sector of several thousand MW capacities despite a small installed capacity of 1500 MW of solar energy production. It means that the bulk of the production goes to exports. The Chinese plan to invest $10 billion in integrated solar PV manufacturing in Malaysia. Recently, there has been an agreement by a leading Chinese company for installing an ingot and wafer manufacturing plant with a large capacity of seven GW in Vietnam. Interestingly, the US, a large importer of solar panels, imports 27 MW of solar panels, and its local production is limited to some 5000 MW. In the US market, Malaysia, Vietnam and

Thailand have a respective share of 31 percent, 28.8 percent and 26.2 percent. In these three countries, exports are made from Chinese-owned and installed plants.

In Saudi Arabia, a relatively large 1.2 MW solar cell and assembly plant has been commissioned with an investment of $186.9 which does not appear to be an extraordinarily large investment figure. Even the UAE has four solar PV manufacturing plants despite high labour cost and availability issues. In India and Turkey, there are incentives and subsidies on local manufacturing. Local manufacturing, apart from saving the fast depleting foreign exchange reserves, is likely to increase the employment rate and promote technologies and skills. Pakistan's solar market is dominated by small traders and the informal sector, creating quality and even safety issues. Local manufacturing will organise the market, reduce cost and improve quality. The same can be said about the local manufacturing of solar water heaters and biomass cookers to reduce gas demand.

Pakistan installed a pilot plant of making solar ingots and wafers as early as in the 1970s. Called the Pakistan Council of Renewable Energy Technologies (PCRET), the plant is still working. Panel assembly facilities were added later. Unfortunately, the initiative couldn't be sustained. However, solar PV economics and competitiveness has emerged only recently. Although there is a substantial market, solar PV projects would be required to attract foreign direct investment (FDI) in the manufacturing sector. There are some manufacturers of ancillary equipment who are mostly limited to assembly operations. Such nuclei may also be encouraged and expanded. It may be noted that solar manufacturing capacities in developing countries are far greater than their installed solar energy production capacity.

This implies that all of them are export-oriented besides local consumption. One wonders: why is Pakistan far behind? The country needs to adopt forward and positive thinking and shun pessimism. Chinese companies are leading suppliers of solar panels and other associated equipment and are also active in installing manufacturing facilities abroad. We have SEZ programmes with China under CPEC. Some efforts should be made for launching local manufacturing projects of solar equipment.

Normally some incentives are required to compete with low-cost-entrenched market players importing the product. India, Turkey and others have done it. India has a subsidy programme and is now considering introducing 40 percent tariff protection for local manufacturers. Subsidies may not be feasible under the current budgetary circumstances. Some degree of tariff protection may be required. The recently imposed GST on the imports of solar equipment has been rightly opposed by market players. Although GST on imports may affect the solar market – burdening end users, it may serve as an incentive for the entrants to local manufacturing, if the latter is exempted.

Another approach for incentivising indigenisation would be to award higher tariffs – say a 50 USc tariff – to solar IPP projects. It would be important to announce such protection much in advance of the solar-IPP approval process. Reverse auction has been talked about. There is provision for solicited projects in the power policy as well. Local investors are usually shy without government initiatives and policies especially in new areas. The Ministry of Industries and Production, the Board of Investment (BOI) and the power division should consider initiating consultations and policy dialogue in this respect.

5.6: Agro-voltaic: farming and power production together

Although it is said that there is ample land on earth to accommodate all solar power that we want, there are land availability issues when one starts looking for land for installing solar power plants – land is not available, is expensive or there are better or more vital uses such as growing food on it. Unencumbered and cheaper land is available far from the point of use, increasing transmission and distribution cost. Solar panels occupy space and stop solar rays reaching the soil and plants. They have found a way – do farming and solar energy production together. We will discuss in the following, the prospects and potential of this proposition in Pakistan.

One solution is to install solar panels at such a height (say around 3 metres) so that the panels do not block the land except the columns which may create some hindrance only. The other is to install bi-facial solar panels which have made their debut recently. There are multiple advantages and synergies – used water from solar panel washing can be used on crops. Solar planners prefer to use farmland over arid land. Farmlands have lower temperatures than the arid land and there is moisture as well, which offers some cooling. Thus, the threat of diversion of agricultural land to solar can be avoided or reduced by agro-voltaic.

What is amusing is that in some cases, it is even beneficial for some agricultural crops that there is some solar hindrance partly to save it from excessive heat, which may be injurious to the crop and cause water loss. The issue is what those crops are and what the matches between solar timings and crop requirements are. This means that there is no one-size-fit-all solution.

Impacts may be variable requiring research and consequent rules and public policy thereof. There are three countries that have made major agro-voltaic installations – China, Japan and Korea. Europe has done quite some R&D on it. Japan and Korea have land availability issues, while China has a lot of arid land. Pakistan seems to have the same issues as China in this respect. In China, an agro-voltaic plant has been installed on the periphery of Gobi desert. Berries are grown along with solar panels of 700MW.

In Japan, a 35MW agro-voltaic plant has been installed in 2018. Japanese law requires that the loss of agricultural land should not exceed 20%. In India, Cazri (Central Arid Zone Research Institute) has been researching on the subject. A number of villages have been tried and a policy for land classification in this context has been made. In the US, agro-voltaic installations have reached the level of 2,900MW. A study done by the University of Arizona and Maryland estimated that there is a cooling of 16-degree Fahrenheit, which is created by the agricultural crops under solar panel, thereby increasing solar output by 2%.

It also reduced water consumption by 15% or more. Underneath, some crop output (fruits and vegetables) under solar panels increased by 100-300%. As to the additional cost, only taller columns (3 metres or higher or lower) may cost some. But there is cost reduction in the form of literally no land requirement for solar while agriculture continues without major loss. Farmers can earn extra revenue by renting the air at a height of 3 metres and columnar land space or can install their own projects. Agriculturists and landowners belonging to Jhelum may find it quite attractive in the near term. There are agricultural areas in Balochistan (Khuzdar, Kachhi and upwards to Qila Saifullah), which may be interested readily.

Criticism has been made against the choice of land for large-scale projects such as Quaid-e-Azam Solar Park; diversion of land and water. Solar productivity has been lower due to the dusty environment of the arid area. Also high temperatures were held responsible for lower solar efficiency. It does not mean that there would be insurmountable difficulties in finding suitable locations for solar power. However, with increase in solar power installation, optimal land tracts may get lesser and lesser. Nor would one like to make a case for agro-voltaic everywhere. However, the idea or proposal of agro-voltaic may get increased attention in the coming days.

By 2030, 1,000MW of solar power may be installed every year. As announced, these would be installed under a competitive process (reverse auction), as opposed to the cost-plus regime prevailing hitherto. Competitive pressures would make such cost reduction proposals even more in demand. A solar power land requirement and a broad sighting study would be required to facilitate induction of solar power, which may include examination of agro-voltaic possibilities as well.

There are other ideas like installing floating solar PV on water reservoirs and surfaces in order to save water evaporation losses. Pakistan has a plan to install solar PV on the Tarbela reservoir. India has installed solar PV on water canals. There are varying design concepts of agro-voltaic, varying from simple elevated solar panels to automated and tilting mechanisms. Elevated solar is already practiced in Pakistan in rooftop solar. Agro-voltaic technology is a recent development and is evolving. A variety of projects can be designed in Pakistan involving export projects for fruit and vegetable exports.

Integrated projects involving agro-voltaic, agriculture and refrigeration could be installed to promote an efficient agricultural export economy. I am not ware if requisite formal research has been conducted in Pakistan in this respect. There is land availability problem in central Punjab. Punjab does not have oil or gas resources or hydropower. Punjab does not have wind as well. It will need solar ultimately, more than anywhere else. In southern Punjab, there are large arid areas, similarly in Sindh and Balochistan. All of these areas have large solar potential. The challenge is to find land tracts that may benefit from agro-voltaic and the crop types which may be suitable to reduced or shaded irradiation.

How come Ukraine and Russia have become wheat exporters? I have no knowledge of agricultural issues. Let our agricultural research community find out if the concept is relevant in Pakistan and how?

5.7: Towards a fast track solar programme

A fast track solar programme appears to be the need of the hour for reducing electricity cost. At least 1000MW should be installed in one year from now. It is not impossible. It can be done as it had been done earlier in the case of coal power plants under CPEC.

We have been and continue running from crisis to crisis; at first there was energy capacity crisis up to 2018 which was resolved by induction of mostly imported energy plants; and now since 2021, there is a fuel crisis. There is both fuel price and availability crisis. All fuels have become expensive and sometimes even unavailable internationally. Fuel prices are too high to be affordable either by consumer or government; the former in terms of consumer tariff and latter in terms of subsidies and foreign exchange. What is the lesson that we can learn from the crisis? Do not depend on imported energy as far as possible; develop local sources of energy.

Fuel prices have increased. The cost of generation has increased up to Rs 36.00 per kWh while consumer electricity tariff remains between Rs 5.00 and Rs 25.00. There is load-shedding of 5-7000MW. To top it all, hydro production is only 50% of the usual production at this time due to climate issues and the consequent water inflow problem in the dams.

Renewable Energy (RE) or Alternative Energy is the darling of today's energy paradigm.RE has been there but became affordable only recently. We have installed some expensive RE plants for entry and learning purposes which have an excessive tariff of Rs 20-35 per kWh. But these were older investments. RE costs have significantly come down fast enough over the last 5 years or so. Solar generation costs have come down as much as to USc 2 per kWh and similarly wind power.

Both solar and wind power have intermittency issue; sun shines in the day and at variable speed and wind blows in summers and also at variable speed giving off energy with variability. Even hydro suffers from this disadvantage that it depends on water supply and water is either not available or is reduced significantly in winters. We are suffering these days from this hydro problem as has been mentioned earlier. Fossil fuels are usually available at constant supply round the clock and 365 days a year, which has been the main reason for its attractiveness and adoption by most countries.

Solar can be useful in many other ways in agriculture, irrigation and transportation. Although, EV appears to be a bad idea when there is load-shedding and high electricity tariff, solar can be of help. Cheap rooftop solar can be produced and used in EV motorcycles. Some 40% of the petrol consumption goes to motorcycles. Rising petrol cost can be substituted by solar electricity produced by EV motorcycle users. New EV motorcycles and conversion of the existing ones can be encouraged through credit schemes. At Rs 10 per kWh, an EV bike's cost per km comes out to be Re 0.83 as opposed to Rs 5.25 for petrol bike at new petrol rates of Rs 210/litre. Even if electricity rates for EV users increase to Rs 25.0 per kWh, running cost of EV bikes would still be Rs 2.00 per km.

Commercial and social facilities, government and private offices even industries can benefit from self-generated solar power. Schools are one or two shifts. Most universities do not work at night. Offices work during the day. Government offices in particular can benefit from day time solar. Private sector contractors can be employed under a solarization programme with standardized credit scheme.

Contractors can market the system to customers. Sindh and Punjab governments are already implementing such programmes actively which can be enhanced. Other advantage of solar is that it is available everywhere –in all sizes and capacity, from rooftop to a large desert location. Solar has occupied our attention here due to this reason, among others. This advantage is not available to Wind power plants.

IGCEP (Electricity Generation Plan) has provided for the installation of 6000MW of solar energy capacity. Efforts must be made to increase this number to cover the shortfall created by some other planned capacities. It has the cheapest CAPEX and COGE (Cost of Generation). On the average, 1000MW of installation of solar power capacity may be envisaged. We would like to propose a fast track implementation of 1000-2000 solar PV; at least 50% of which may have storage capacity as well.

Storage technology has come of age and has become competitive which can provide 2-4 hours of extra hours of electricity supply for solar power plants. Solar power plants with 2-4 hours storage are being installed fervently in the US, Europe, Australia, India and elsewhere. Studies have been conducted in this respect in Pakistan as well. IGCEP may have to add storage projects in its next iteration.

Assuming 50% higher cost due to various reasons such as higher interest rates etc., solar without storage should be available at 3-4 USc per kWh and with storage it should be 6-8 USc. There is no fuel cost except some O&M costs. These days LNG-based electricity is costing Rs 25 per kWh while the imported coal-based electricity is costing the same amount. That the foreign exchange issue causing current account deficit is an extra problem.

1000MW of solar capacity without storage should cost less than one billion USD to be financed by Independent Power Producers (IPPs) under the China Pakistan Economic Corridor (CPEC) or/and others. It will produce 2 billion units which would be valued Rs 75 billion in RFO/LNG terms. It would actually cost Rs.15 billion per year. Thus, in one year it would save Rs.60 billion. Solar with storage is twice as expensive as without storage. Thus, it's real cost-saving is without storage. But peak tariff is charged higher also balancing the cost. However, these would be extraordinary savings of an extraordinary time when fuel cost are excessively high. Even under normal circumstances, solar electricity is 50% cheaper than the cheapest fossil electricity. But one cannot have all solar due to its variability and intermittency. There has to be an optimal mix.

There are some real problems as well which need to be resolved. Although, fortunately, it has been decided to undertake Reverse Auction (tendering in ordinary language) and preparations have been made in this respect. The CPEC people have objected to it and would like to avoid it and have an alternative arrangement on the lines of the earlier projects. Almost simultaneously, the International Monetary Fund (IMF) has termed CPEC energy projects "expensive".

According to it, these projects contributed to circular debt. The Fund has demanded a cost audit. Large project financing can possibly only come under CPEC. Also, CPEC is the fastest route to installing 1000MW of solar or more as they implemented coal power plants in record times. How to agree to a competitive tariff has always been a hard and problematic task. GoP has always under pressure to complete deals with friendly powers due to strategic reasons and reportedly cajoles power regulator National Electric Power Regulatory Authority (Nepra) to agree to the asking tariff. Commercial companies want to maximize their profits, be it CPEC or otherwise. In Pakistan, there is too little knowledge of project costs in China under the latter's complicated special system. It would be a good idea to develop a credible system of awarding projects under the CPEC. Perhaps, a genuine competition among Chinese companies may deliver a competitive price.

Table 5.7.1: Comparative EV fuel cost-Motorcycles

	EV	Petrol
Fuel consumption-kms/kWh	12	
Petrol-km/L		40
Electricity Tariff-Rs/kWh	10	
Petrol-Rates-Rs/L		210
Fuel Cost per km	0.83	5.25
at Rs 25/kWh	2.08	
Source: Computed by the Author		

Unfortunately, a lot of time has been lost. Cheaper and cleaner solar could have been installed several years earlier, avoiding some of the cost and hardships of today. But we suffered from excess capacity and high accumulating circular debt caused by unutilized capacity. There are unpaid IPP bills. Unfortunately, the solar indigenization objectives would again suffer in the haste that circumstances have imposed on us. It should, however, be pursued a little later.

It may, however, be noted that the current oil and energy prices' issue is mostly recent one caused by extraordinary oil, LNG and coal prices. Pakistan's petrol and HSD prices were the lowest in the region despite charging a fair amount of taxation of 50% (30% PLD and 17.5% GST).There are cross-subsidies, though, in gas and electricity circuit which have caused circular debt. There might be a case for some adjustment there but abrupt and large increases cannot be made on the subsidised tariff for the poor. Direct and targeted subsidies may cost the same and may be cumbersome. Thus a programmed approach is desirable, giving some relaxation for the current period when fuel prices are extraordinarily high. Future oil prices are projected to go down gradually to 90-95 USD per barrel by June 2023 as opposed to 122 USD presently. This should affect other prices of LNG and coal. The IMF should have a considerate, flexible and programmatic approach in demanding full adjustment of energy costs. In fact, a separate programme may be conceived to deal with this issue.

5.8: Prospects of expanding solar PV capacity

The government has ambitious programmes for installing solar PV capacities. Fossil-based electricity is expensive, has availability issues and requires foreign exchange, which we don't have. Current load-shedding is also due to the lack of foreign exchange to buy fuel than the generation or transmission capacity. So, the idea of expanding solar appears to be reasonable.

Recently, tenders were floated for a 600-megawatt solar PV plant at Muzaffargarh. Unfortunately, not a single bidder responded. Why did this happen and how can we prevent this from happening again, is our subject in the following. A general feeling is that it was due to political instability and fears of default. Now that the IMF has transferred its first tranche, things have improved. While not much can be done about these macro issues, we will examine the technical issues which can improve the attractiveness and reduce risks and uncertainty issues.

On the technical side, following criticism has been made by the stakeholders – fixing a low benchmark of 4 US cents per unit, large project size of 600MW, and exchange rate and interest rate variations and the indexation requirements thereof. Project size is a double-edged sword. It may be attractive due to the prospects of lower overheads and higher earnings by the bidders. However, the larger project size, which enhances capital requirements, increases financial and implementation risks.

Many, otherwise eligible, smaller parties decline to participate. In this case, large or small, none has responded, though.

It may be worthwhile to examine the feasibility of small-sized projects implemented in stages, eg, 100MW projects. Once investor confidence is built, one can enhance the capacity. There are two approaches for bidding – capex bidding under a cost-plus regime, and tariff bidding, fixed or variable. In this case, tariff bidding was required under a partial indexation regime, which caused maximum confusion. These are 20 to 25-year investments during which period a lot may change, especially in smaller economies and jurisdictions. The US and other countries and their large companies may be able to handle and assess the risks involved and the consequent costs thereof.

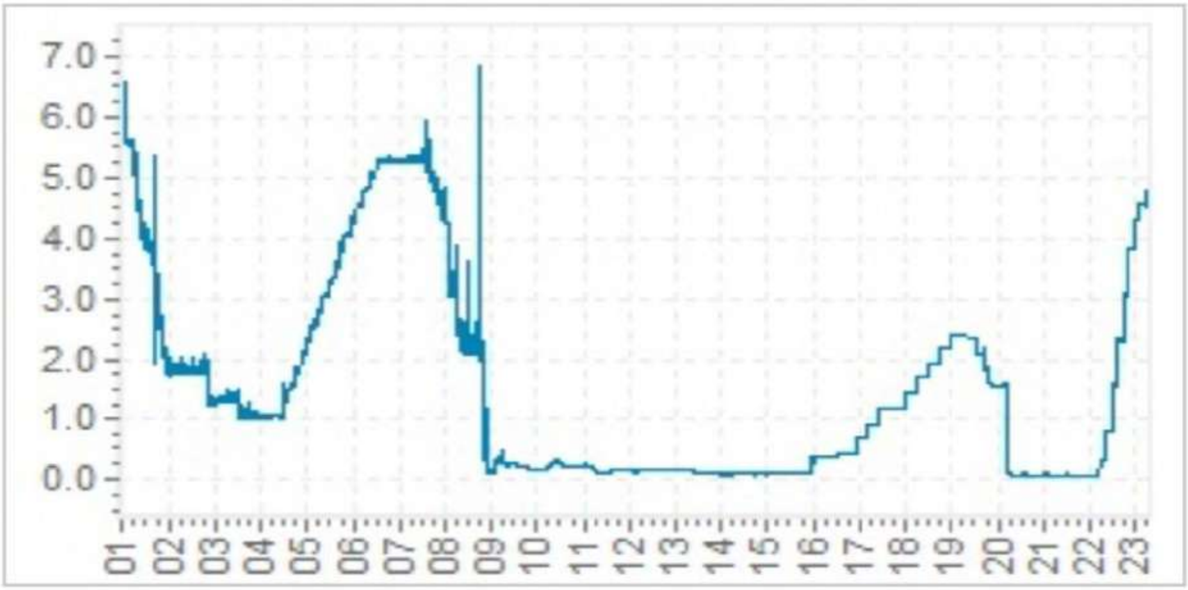
In this project, they have rightly allowed for indexing currency variations in the tariff formula. But have ignored interest rate variations. For a long time, international interest rates under Libor (now SOFR) had remained low and constant over a long time after 2008. Interest rates vary cyclically in the longer run. Libor/ SOFR have increased from 0.5% to 5.5%. It may come down in the medium term. It is difficult to project interest rates and is risky to make assumptions.

The indexation would save sides – the buyer and the seller. One pays for interest rate as it is at the prevailing time. It would be advisable that in the next bidding round, interest rate indexation is allowed. Local interest rates are high and may remain high for a few years at least. It may be desirable to maximise foreign currency component of the project. The question is, if there is so much variability to take into account, why not have bidding for capex? And keep other variables indexed, as is available under the cost-plus framework.

There was allegedly low benchmark tariff of 4 US cents. It is a controversial issue. What is the realistic tariff keeping in view all the fixed and variable factors? The low benchmark tariff gives a signal to the bidder that it is a tight market or it discourages the bidder also, as has happened. Having no benchmark tariff attracts a large number of low and high bidders. It may, therefore, be advisable that the project drops the idea of benchmark tariff altogether. The acceptance or rejection can be done with or without the benchmark.

What is the going rate of solar tariff in various markets? We have data from a very recent (2023) project in India (Punjab). A 100MW project has been awarded at a tariff of 3.2 US cents per kWh. Its capex is $66.3 million. The project will generate 227 MU. Earlier, many projects in India have been awarded at a tariff of 3 US cents. In Pakistan, the tariff granted several years ago was 4 US cents. In the meantime, interest rates have increased. However, capex has come down on solar panels and other ancillary equipment. Commercial sources have indicated a potential tariff figure of 6 cents, which may be on the higher side.

Figure 5.8.1: Graph of long-term interest rate Development



They are possibly assuming a constant and high interest rate at 5.5%. As mentioned earlier, the indexation may bring down the life-cycle tariff. We are short of foreign exchange in our economic formula for weighing the value of foreign exchange vis-a-vis local currency. In earlier times, various yardsticks were available to measure it and build it in project appraisals. Shadow pricing and the classical cost-benefit analysis is unknown these days. We may have to rediscover them again. And our various agencies like IGCEP, Nepra and Ogra may have to be facilitated and trained in these valuable tools. Many people ask, if this is the right time for buying. They also are scared of the upcoming load of capacity cost, which has been causing circular debt.

However, they tend to underestimate the impact of high fuel cost. Latest LNG bids received are at $22 per mmBtu. This is in summer. What will happen in winters when demand is high everywhere. Fortunately, coal prices have come down. IGCEP people can optimise and guide the government on the right combination. But let us get solar prices input from the next round of bidding. Can it be done at the time of elections?

5.9: Solar PV indigenization: strategy and scope

Solar energy is the energy of present and future. Pakistan is importing almost all of the solar equipment from abroad, mostly China. China is the production house of the world and has captured world markets even in developed countries like the U.S. and Europe. In case of Solar PV, China has a world market share of 75-80%. Global installed capacity of solar PV production exceeds 200 GW. Surprisingly, the market share of Europe and the US combined is small, under 10%. Enthusiasm for promoting Solar has prevented protectionist policies in the West.

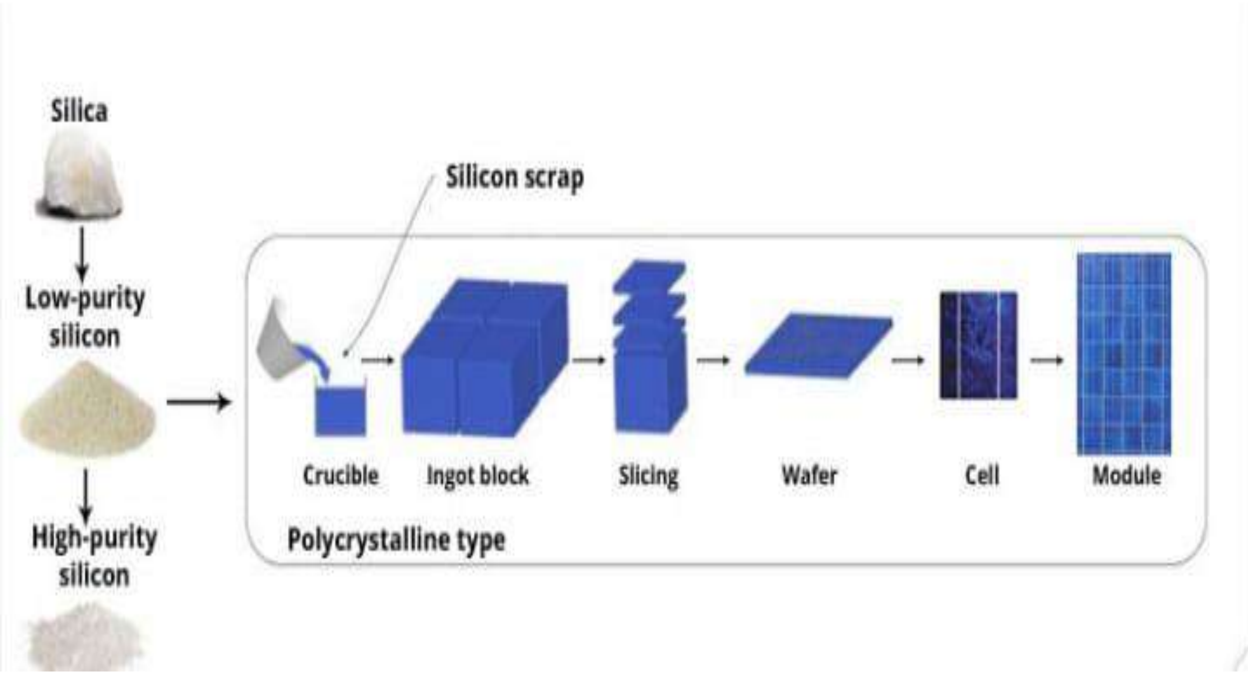
Due to change in political environment, this may now change. The question is should Pakistan start indigenization in the area of solar PV equipment? Would it be economic to produce locally? Would it promote expansion of Solar PV in the country? Same questions also apply to Wind power sectors as well? China Solar PV equipment output is 150 GW (200 billion USD) and exports amount to more than 50 billion USD which means that bulk of the output is locally consumed as is evident by the total installed solar capacity of 306 GW as opposed to only 95 GW of the US. China export markets are primarily the US (26%) and Europe (50%) of total Chinese exports.

There are some 35 countries which have some degree of solar PV equipment production which is limited to solar panel assembly. Only 10-12 have larger capacities exceeding 1 GW, others have under 1GW. Among developing countries, Vietnam, Thailand and Malaysia are the leading producers, which are essentially part of the China supply chain. India, however, has now a gigantic expansion programme to install 38 GW capacity, including integrated plants of 4 GW each. This would bring India to the number 2 rank after China. In Pakistan, reportedly, there are several small plants. It is not known, how much is the local content and how much is their market share, success and quality?

Surprisingly, in Africa under German support (GIZ and Fraunhofer Institute), several countries have initiated installation of solar PV equipment production capacities, led by Egypt, Morocco and Algeria. Even tiny Burkina Faso has recently installed a solar PV assembly plant. High cost of production in the U.S. and Europe has prevented expansion of solar PV equipment industry. In China, Solar panel cost is 20-24 USc, in Asean 26 USc and India 33 USc per watt. As opposed to these numbers, production cost of solar panels is 52-56 USc. Long-term potential in the EU or the US may be created by politics and not the economics.

It appears that a lot of protection may not be required for supporting indigenous solar PV production. Imports and trades have disadvantages also. Recently, a case has been discovered by FBR audit department of over-invoicing and money-laundering of Rs 69 billion in the imports of solar panels. Smaller order size by a large number of traders also results in high import prices.

Figure 5.9.1: Solar Panel Manufacturing Processes



There are five stages of making solar panels. 1. Purification of sand and making poly-silicon which is the most complex part of the process. Most of it is produced by China only, and some by the U.S. and Germany.

It is highly unlikely that even India would be able to reach this level. 2. Ingot blocks casting. 3. Wafers slicing. 4. Cell making, 5. Panel assembly. Most panel assembly plants start from importing cells and assemble panels using other inputs like glass, plastic, wires etc. There are integrated plants as well starting from ingots and ending with Panels.

Pakistan had installed a pilot silicon plant in NIST (National Institute of Skilled Training) in the 1970s. Alas, where Pakistan is now? The plant is still there in PCRET (Pakistan Council of Renew Energy Technologies). Criticism on PCRET is unfair. It cannot be held responsible for lack of progress in the field of R&D sector. Government policies are responsible for it. PCRET is an R&D centre. Such centers are required for a variety of support services in training, quality testing, standards development and a variety of other inputs and advice. Its institutional strengthening is required.

Pakistan's market is relatively small as compared to the population of the country. In 2022, solar panel imports were 2.4 GW. There is potential of growth. One could assume a stable market size of 2 GW per year. This is enough of market size for supporting indigenous production. Average plants capacity varies from 200 to 500 MW. India has an installed capacity of 38 GW for solar PV panels, nearly 50% of which is utilized. India plans to increase this capacity to 100 GW. India will become second largest manufacturer of solar panels in the world after China.

Import duty on solar panels is 40%and on Cell imports is 25%. It means net duty protection on panels production is 15%.The U.S. had also imposed anti-dumping duty of 30%, which has now been reduced to 18. Duties are a double-edged sword. It protects local production but decreases the demand. While Indian market is too big to be a model for Pakistan, Turkey can be adopted as a development model. Turkey has an installed power generation capacity of 100 GW. It has a solar PV panel assembly production capacity of 8 GW with 16 producers. Average plant capacity is 200 MW.

Local content varies from 50-85%. Turkey has one of the largest integrated solar PV plants which started with an initial capacity of 500 MW with a CAPEX of 400 million USD. It has now reached a capacity of more than 1 GW. Pakistan could start both with small as well as large plants. Small plants may be installed by domestic investors. While large plants of 0.5-1 GW may be installed under CPEC (China Pakistan Economic Corridor) JVs, to cater both for domestic and export markets.

It may have a CAPEX of less than 1 billion USD. China's raw material silicon industry is located near Pakistan's border in western China. This plant and many more later can be installed in one of the CPEC SEZs. For larger plants, all would depend on the export strategy of China. There is a large adjoining market in the Middle East and Africa. Turkey is exporting to Europe. Pakistan can do it as well. Pakistan has a considerable industrial capacity both in terms of installations and skills. A considerable capacity is lying underutilized. As we mentioned earlier, Pakistan started with solar and silicon technology in the 1980s.

As we have mentioned, there is some protection in the beginning in many jurisdictions, e.g., India and U.S. There are successful examples of deletion programmes like agricultural tractors which began with a zero-duty regime on raw materials, which are now being exported. Automotives have a mixed story of extra protection but nevertheless an automotive component industry has developed under it. Optimistically speaking, assuming Chinese assistance and cooperation, one can aim at 5 GW installed production capacity by 2030. Pakistan's market can accommodate installing 10 small, medium and large solar panel plants.

Table 5.9.1: Top-10 Most Solar Power Producing Countries

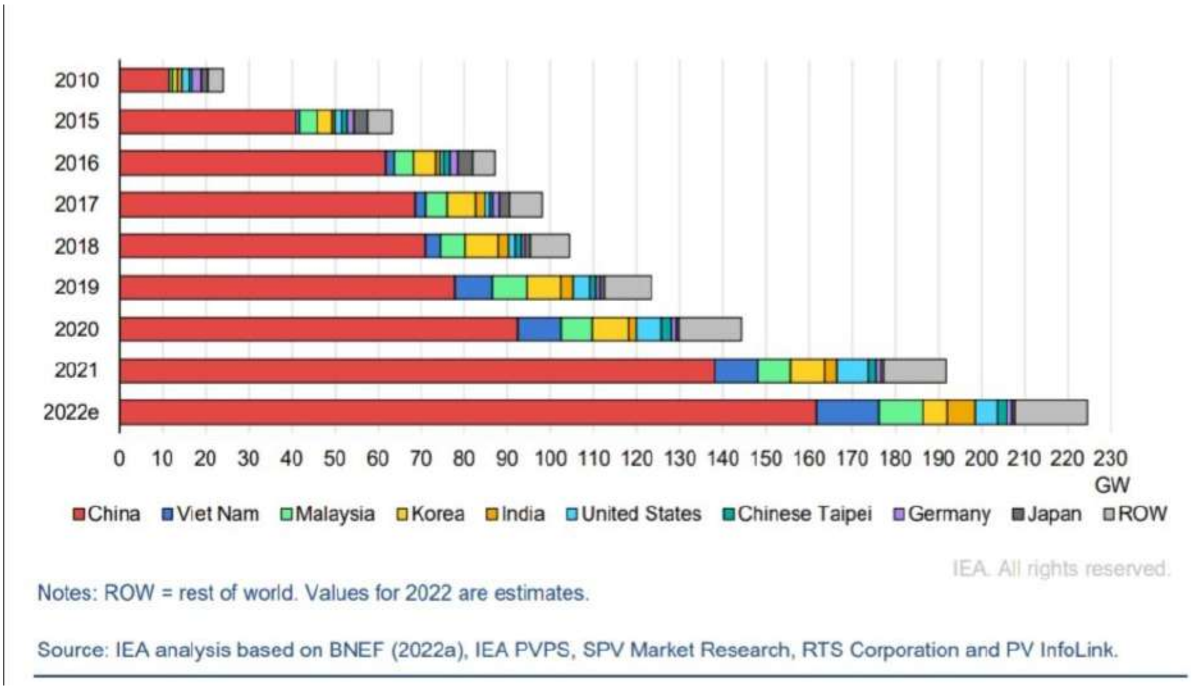
1. China - 306,973
2. United States - 95,209
3. Japan - 74,191
4. Germany - 58,461
5. India - 49,684
6. Italy - 22,698
7. Australia - 19,076
8. South Korea - 18,161
9. Vietnam - 16,660
10. Spain - 15,952

It is not too much; India has 70+ plants and Turkey 16.There are two tracks that are possible; G-to-G supported large plants; and the other smaller plants in private sector. The biggest uncertainty is whether Tier-1 manufacturers would be willing to come and join in with our private sector. They would be interested in 0.2-0.5 GW plant capacities. Due to rising cost of electricity, roof top solar has acquired attractiveness. Presently, most of the solar market is from this sector which can be catered by small to medium private sector. Utility sector will be suffering from demand issues as there is capacity surplus and high capacity cost will be deterring solar expansion in this sector.

We have seen that no bidder came up in case of the Muzaffargarh project of 600 MW. In the meantime, however, government buildings and solar PV pumps would be creating demand. Demand issues can create a time gap to develop large solar PV industry that may participate in the utility industry projects.

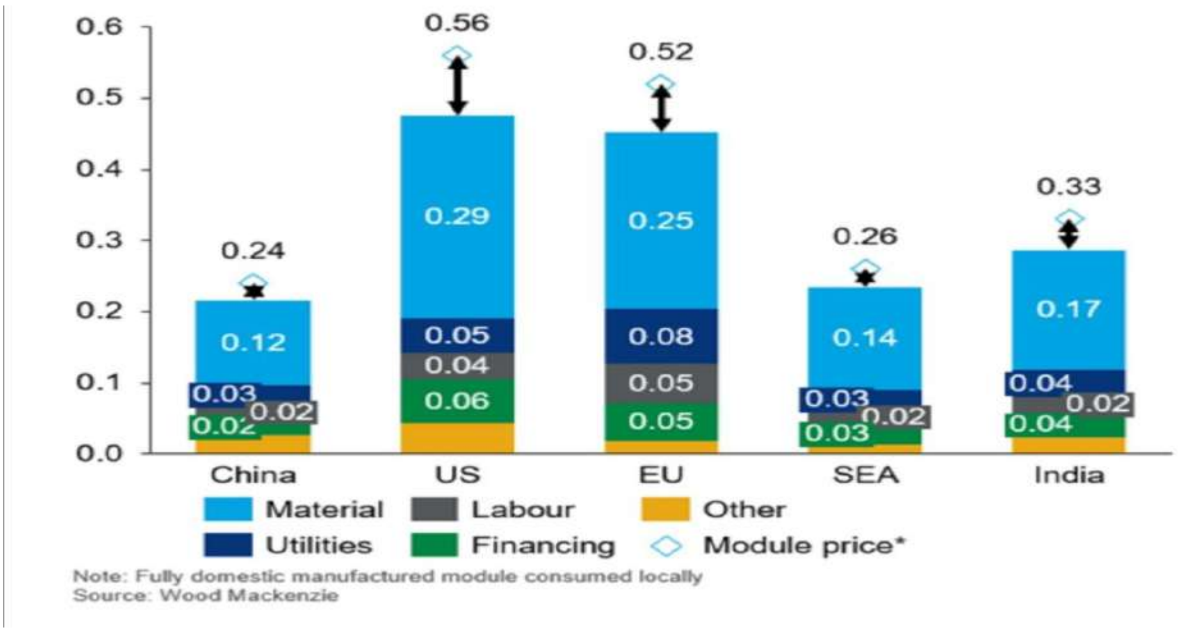
Solar PV is not just solar panels. Panels take only 30-40% of the total cost. There are other components like Inverters and Batteries and other electrical parts. There is a considerable scope of local manufacturing of inverters under JV arrangements.

Figure 5.9.2: Global Solar PV module Production, 2010-22



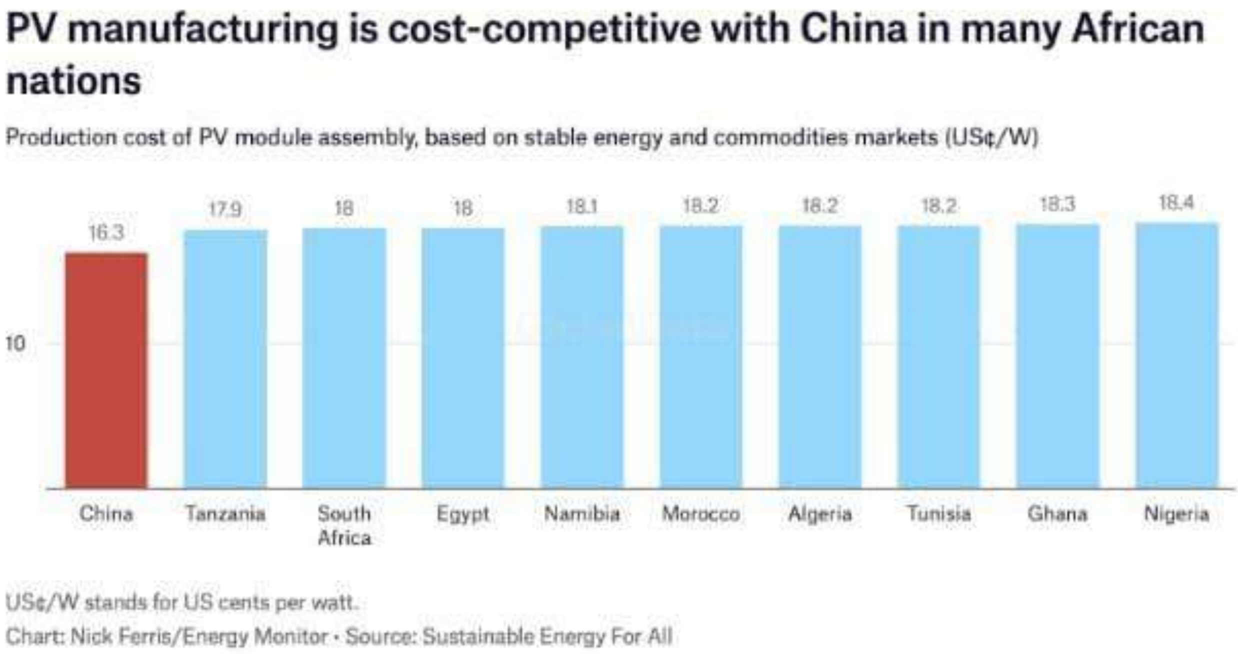
Most inverters in Pakistan are imported from China. Battery manufacturing for automotives have a long history in Pakistan. Solar batteries are, however, large and of different types. Lithium Ion batteries have also emerged in the local market. All of these have significant potential for local manufacture. We will take up these issues in a later piece.

Figure 5.9.3: : Local Module Manufacturingcost by Region, 2022 USD/W



Fossil fuel prices have been increasing and are unstable. Renewable energy are the future. The market will expand. Pakistan's` trade balance has been going from bad to worse. Hence, indigenization, not only of the items discussed, but in all other feasible areas, is an urgent necessity. Planning and implementation of policies and actions are required jointly by private and public sector.

Figure 5.9.4: Solar PV Comparative Manufacturing Cost



5.10: Emerging biogas

The importance of local energy/gas resources should be realised in these days of rising oil and gas prices, which may take the shape of a major crisis if the international political climate remains unchanged. Local oil and gas production is so important for energy security. For a variety of reasons, no significant success could be made over the last two or more decades with regard to oil or gas discovery. It is now time to use some other source. It is estimated that biogas can provide 600-1200 mmcfd of gas and will be in a ready-to-distribute form in most parts of the country, where biomass is available.

Figure 5.10.1: Biogas Plant

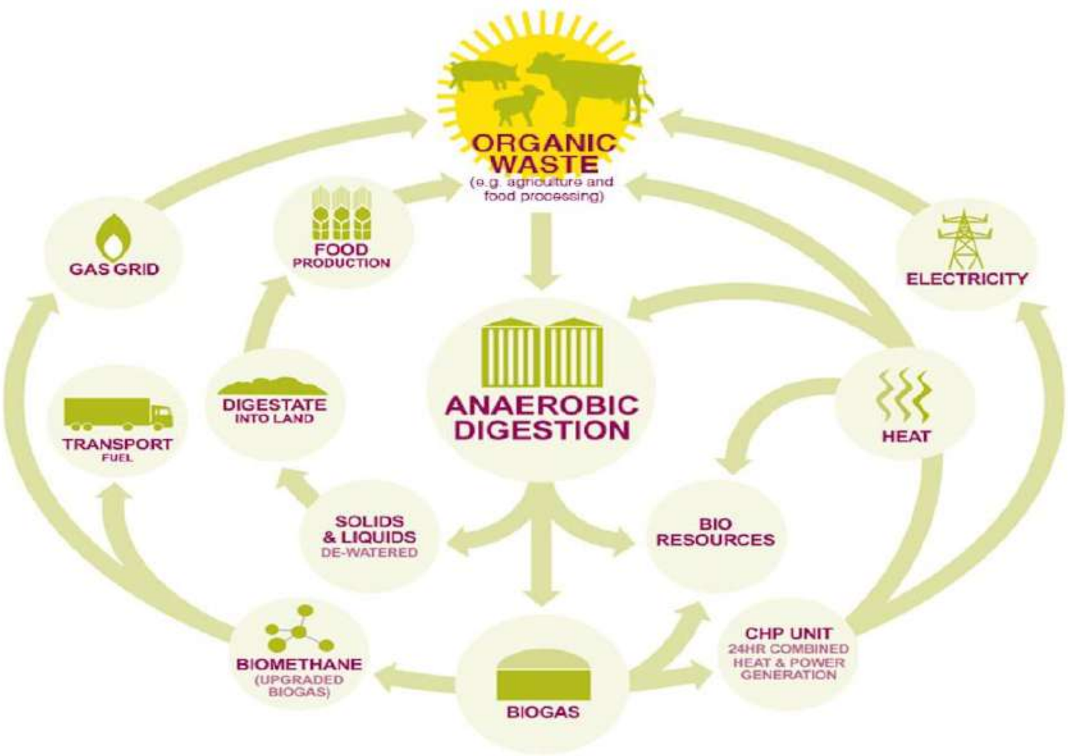
In order to comply with the Paris Agreement, all gas supplies in Europe must be renewable or decarbonised by 2050. In addition, the transport sector has to reduce its greenhouse gas emissions. Biogas has been declared as an important agent for achieving the climate-related 2050 objectives by credible sources. A 2018 study organised by six major gas companies of the EU concludes, “it is possible to scale up renewable gas (bio-methane and renewable hydrogen) production to a quantity of 122 bcm by 2050 in [the] EU. We also conclude that using this gas with existing infrastructure… can lead to Euro 138 billion annual societal cost savings compared to a decarbonisation framework without a role [for] renewable gas.” In Pakistan, biogas has been underestimated, neglected and even dubbed as ‘gobar gas’, limited to providing cooking gas in rural areas. Only a few thousand household plants have been installed as opposed to 931,000 in India and 43 million in China. India also plans to install 5,000 bio-CNG plants in the next five years. Germany has more than 10,000 big biogas plants, and several hundred of them produce biomethane. Global biogas production in 2018 stood at 59.3 billion cubic metres (bcm) per year, about half of which was produced in Europe.

Biogas is not only a source of energy but also part of the circular economy concept, providing many services and functions including environmental management, solid waste disposal, waste water treatment, safe dairy hygiene and practices, natural fertiliser production, smog control and protection of freshwater resources. A circular economy targets zero waste and pollution throughout the full life cycle of materials. The conventional linear economy relies on the take, make, use, and dispose principle. The circular economy, on the other hand, involves a framework of production and consumption that consists of sharing, reusing, repairing, refurbishing and recycling. Waste – sewerage – water remains untreated in most areas of the country, polluting fresh water resources and resulting in the outbreak of several diseases. Biogas plants can use waste water to produce gas and fertilisers, subsidising waste water treatment capital and operating costs. Similarly, municipal solid waste

(MSW) can be disposed of in the biogas plant system by first separating and recycling inorganic materials like paper, textiles, metals, plastics etc, and then digesting organic biomass to produce biogas.

Every year, we deal with the problem of smog, largely due to rice stubble burning by farmers. This rice stubble along with other agro waste can be processed in biogas plants, subsidising the overall rice stubble collection in a smooth and mechanised system. Cow dung is spread in our rural areas, deteriorating air, water and food quality. It can be collected through a scientific method, giving income to cattle owners and farmers. 'Sabzi mandis' – wholesale vegetable and fruit markets – and food streets produce a lot of waste, which can be diverted and processed in biogas plants. In addition to gas production, digestate water is produced, which contains useful nutrients. Farmers can avail this cheap fertiliser and save some cost in buying expensive urea and diammonium phosphate (DAP).

Figure 5.10.2: How biomethane can help turn gas into a renewable energy



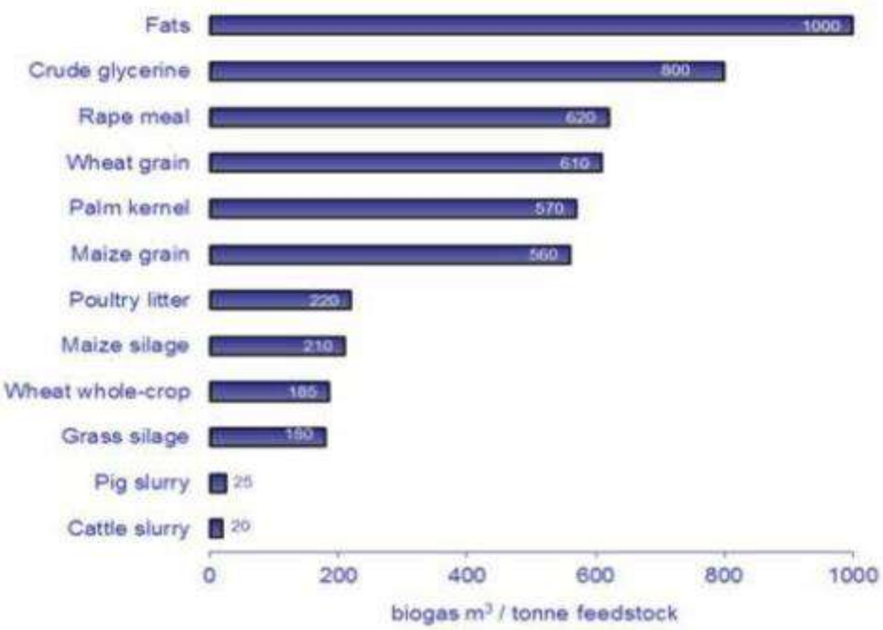
There are all kinds of biogas plants – household drums or a cavern; mid-sized plants for individual industrial and commercial consumers; large plants for producing CNG for vehicles; and even larger plants for producing clean and processed gas for injection into the gas grid. Small household plants can be made underground by sand, mud or cement. These days, plastic drums or rubber containers are also made in factories and supplied to the market for ready installation – although this has not been initiated yet in Pakistan. It can be made available in less than Rs10,000 without any subsidies, and last a decade. Household food waste, human and animal excreta can be used, solving the waste disposal problem and producing gas and fertilisers in small quantities. Community-sized plants can also be made in areas where agro and dung waste is available. Make–do distribution pipes and small compressors can provide for the population clusters of 50-200 people. Dairies with 1,000 cattle in and around can install a reasonably sized plant. In earlier times, electricity production with biogas used to be quite popular, which is being increasingly replaced by solar panels.

Biogas is made in two forms – unprocessed as produced and processed gas. Unprocessed gas contains 50-60 percent methane and the rest is CO_2 and H_2S. For cooking and even electricity production, unprocessed biogas is good enough and is used abundantly. For vehicle use as CNG and for injecting into the standard pipeline system, biogas has to be processed and cleaned of CO_2, H_2S and water vapour, etc. This adds to the cost. Processed biogas may cost between the prices of normal fossil gas and LNG and much cheaper than LPG prices.

Clean cooking fuel is a basic requirement of people. Only 30 percent of the population is getting clean piped gas and 70 percent of the population relies on burning smoke-emitting biomass. Better biomass fuel and stoves can also be provided where biomass resources may not be available in some areas like non-agricultural or urban 'katchi abadis'. Community biogas plants would be much cheaper and affordable than LPG-Air mix plants that have been installed, and the demand from certain quarters, especially Balochistan, continues to be there. In Balochistan, cattle farming is a significant activity where community-based biogas plants can be installed at much reasonable costs.

It should be noted that a power plant project based on solid waste incineration has been approved. It is a highly undesirable project, causing pollution and producing expensive electricity. Fortunately, it has not been installed – possibly due to the later evaluation by stakeholders. Burning solid waste directly is archaic and outdated technology having air pollution risks. If air pollution control equipment is installed, the cost becomes prohibitive. It would be much preferable to separate in organic and organic materials, sell inorganic materials like glass, plastic, paper, etc, and produce biogas for injection into the gas grid or use it in the CNG form to run local government vehicles, including waste collection trucks.

Figure 5.10.3: Typical biogas yields of various feedstock



Several biogas (biomethane and bio-CNG) projects are being studied. In Karachi, a bio-CNG project is being planned in Landhi Cattle Colony, which will supply bio-CNG to the Green Line bus project. The SSGC and SNGPL have invited proposals for build-own-operate (BOO) projects to buy biomethane from the projects for injecting into their grids. A biogas policy is now required to provide a satisfactory framework in this respect. For biomethane injection and bio-CNG stations, Ogra may have to devise some standards and rules. A digestate fertiliser policy specifying standards and a feedstock supply contract on the lines of the fuel supply agreement (FSA) for IPPs may be required as well. Such policies and rules are usually developed interactively with consultations among stakeholders as it happened in the case of IPPs. For community projects, a cooperative framework for owning and managing community plants may be required as well.

5.11Towards Biogas Policy

1.Biogas has acquired a new fillip in the wake of Ukraine conflict in Europe. The latter wants to acquire independence from imported gas from Russia. Climate change targets have also influenced higher biogas targets in Europe and elsewhere. Biogas is not something new; it started from China in 1970s and spread all over the world later, initially for household use in rural areas. Its use is now spread over industrial, commercial and utilities uses.

2. Biogas is produced from biomass of all kind; agricultural waste, urban solid and liquid waste including food and sewerage, animal waste etc. It helps keep cities and rural areas clean, reduces climate injurious emissions of Methane and builds a circular economy. *Manure is produced as a byproduct which acts as a very good fertilizer.* One can guess the potential of biogas in mitigating climate change by the surprising fact that Cows have been found to generate more emissions than cars, on the average? Big companies have joined biogas movement; Shell has acquired biogas companies in Europe and Chevron has launched initiatives in the U.S.

3.China had more than 27.8 million household biogas users and more than 27000 medium and large capacity biogas/bio-methane plants by 2012.India had 4.54 million small household units by the same time .India plans to install 5000 large bio-methane/Bio-CNG plants in the next five years.

4. In Pakistan, Biogas has remained at low key although its initiatives have been launched many decades ago. Technology has improved in the mean time. Gas availability has reduced and prices have been increasing. Industries in rural areas have started making and using biogas. Several large-scale projects are under consideration. Nothing happens in Pakistan without government policy support. We will discuss here the need and scope of the required biogas policy.

5. There are following six biogas use areas that have to be addressed; 1. Biogas for rural homes;2. Community biogas;3.Industrial use;4. Transportation use as CNG;5. Biogas for gas networks;6.Integrated Biogas plants for lage cities. Biogas is of two types; 1. uncleaned and unprocessed gas containing Methane (60%) and CO2 and other extra gases(40%).House and Community use does not require cleaning;2. Biogas cleaned of extra gases is almost pure Methane and is usually referred to as Bio-Methane. We have used a commonly used terms biogas unless differentiation is required.

Biogas for House-holds

6.PCRET is a technology and research centre in Pakistan on Biogas and other RE subjects, while NRSP had been tasked for assistance in building small household Biogas units in rural areas. NRSP is reported to have built 5000 or so units and seems to be inactive now. There is a need to launch new initiatives by provincial and federal government. New technologies have emerged in the mean time. Factory made plastic cylindrical units have been developed, are cheap and have been found to be quite effective. This may decrease lead time and reduce logistics and skills requirement in the older type bricks- made units. A plastic cylinder unit may cost under Rs 15000.00 and brick type may cost around Rs. 50,000. Credit and financial assistance can also help popularize biogas units in the house-hold sector. A target of several million units in a five year plan should be there. This would alleviate pressure in expanding gas system network and also would help alleviate tree-cutting.

Bio-mass cookers

7.Biomass cookers have come up in competition with biogas. Biogas units are usually installed where animal waste is available, while biomass cookers are used where solid agro biomass such as crop residue, tree and plant cuttings and shrubs etc. Dry Biomass material is burnt in biomass cookers .It can be more popular where biomass is available almost free. However, biomass pellets are commercially available as well which can be used by semi-urban or een urban areas. Biomass cookers are available in the market at a price of Rs.2500- 5000.Unfortunately,it requires some electricity to run its mini-blower. Biomass cookers are mobile, can be used in open areas with facility. Users are more at ease when using it. A project of distributing 1 million units would cost Rs. 2 billion. By comparison there are 10 million gas users in Pakistan. A credit and concessional scheme may be able to distribute and benefit several million house-holds. It can be a big vote catcher, speaking politically.

Community Gas

8.LPG-Air mix plants are being built, Biogas which costs less than 50% of LPG ,can replace LPG or be used in consonance. LPG-Air-mix plants have been designed for 1000 households. Much cheaper and for smaller clusters of 100-200 units can be made where there is cattle population. Local bodies may be assigned and encouraged to build community gas plants instead of pressurizing gas companies to expand uneconomic networks. Unhygienic Uplah practice and visibility can be reduced or done away with. A simple community biogas plant can cost around Rs. 1 million or more depending on capacity.

Integrated Plants for Large Cities:

9. Integrated units can be built in large cities combining solid waste and sewerage treatment and management. There are households generating solid and liquid waste, food outlets, vegetable markets, slaughter-houses and Milk-colonies etc which all can provide gas rich raw material that could economize all social cleaning services and provide fuels. City management, local bodies and gas companies may form a consortium. Significant policy work is required to build project models solving cost and benefit sharing, costing, tariff, management and finance. Gas companies may play a major role at the end of biogas production, while City managements may play a major role on collection side.

Bio-CNG

10.A large number of CNG plants are lying unutilized due to lack of gas availability and falling economics.CNG can reduce pollution by substituting petrol and diesel in a significant way. Semi-urban-rural areas which may not have gas but having cattle population should attract investment in Bio-CNG. Bo-CNG pumps may also like to produce biogas nearby (a few Kms away).There may be many ways of cooperation such as consortia forming. There can be father-mother configurations as well. No wonder that in India, Bio-CNG is attracting a lot of attention. It is being sold cheaper or at competitive rates.

Biogas for Industries

11. Rural industries or industries located nearby rural areas can build their own biogas plants. Industries can build far-off plants and transmit their biogas through gas companies' network. There is an open access policy approved by OGRA already.

Biogas –a big business

11. Cleaned biogas (Bio-Methane) is required for non-household uses. For pumping in the gas network also, cleaned biogas (Bio-Methane) is required. Unlike typical small and old type image, Bio-Methane plants are capital intensive. It may cost 6-50 million USD per plant, depending on the plant or cluster capacity. These are indicative European figures. Indigenization can

significantly reduce capital cost. A plant size may be typically of 1-10 mmcfd, as much as a small gas field may be producing or a LNG terminal. Thus it requires a sophisticated business, financing and technical framework. Minimum regulatory framework and hurdles is suggested. Open unregulated pricing is recommended.100-500 Bio-Methane plants can be envisaged for a 200-500 mmcfd market.

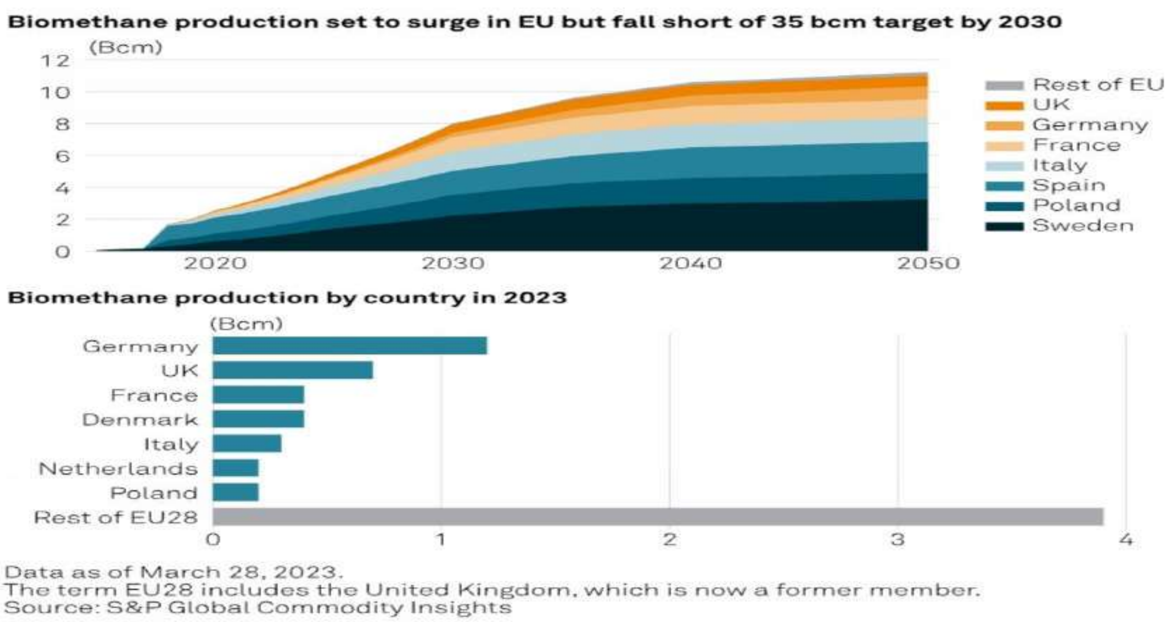
Table 5.9.2:

Estimated Biogas Potential

	Units	MSW	Rice Waste	Cattle Manure	Total
Population-Million	million	yearly data		100	
MSW	Million Tons/yr	130			
Organic Waste	%	50			
Rice Waste	Mn. tons/yr		8		•
Material- yield	kg per head/d	65 Mn tons/yr	400 M3/ton	10	
Total Material	million ton/d	65	3200 Mn M3/a	1	
Gas Yield Rate	M3/ton	400	400	20	
Total Gas Yield	Million M3/d	26000	3200	20	
Total Gas Yield	Million Cft/d	2493	307	700	3500
Total Gas Yield	Billion Cft/d				3.5

Source: Estimated by the Author

Figure 2.10.5: European Biomethane production



5.12: Other biogas uses: fertiliser and cold chain

Biogas is a simple solution. Normally, simple solutions are undervalued and much attention is not paid to them. We have been discussing biogas in the context of energy only, as cooking or transport fuel. There are, however, other benefits of biogas in terms of its byproducts. As we will see in the case of biogas, which itself is a product of various waste streams but contains other subsidiary wastes within it; digestate and CO_2. Biogas, as it comes out of digestion tanks, contains methane, CO_2, H_2S and small fractions of miscellaneous parts. Mainly, methane content is approximately 55% and CO_2 is 45%.

In simple cooking, it is burnt in stoves directly. For other uses such as piped gas, CNG, etc, methane is extracted and other products go waste. However, CO_2 can be extracted and put to good use as we will discuss. It may be noted that biogas is the cheapest and cleanest source of CO_2, as it contains a limited amount of associated products as compared to exhaust gases from power plants, automotives, etc. CO_2 has many uses as a refrigerant such as dry ice in health care. Similarly, the liquid waste is used directly as fertiliser or is converted into packaged dry or liquid bio-fertilisers. Biogas output contains approximately 20% digestate by weight of the biomass fed as initial feedstock. Some hydrogen sulfide is also produced in the ratio of 1-1.25%. All are useful materials as we will see.

In this space, we will take into account the possible use of digestate. Biogas digestate is the residue left from the anaerobic digestion of a variety of wastes including animal dung, food waste, agricultural biomass, municipal solid waste, sewerage, etc. The digestate contains useful nutrients like nitrogen, phosphorous, potassium and calcium. It is a common practice to use biogas digestate as fertiliser, directly or after processing. Processing is required when there is the presence of metals, which are usually found if municipal solid waste and sewerage are there in the feedstock.

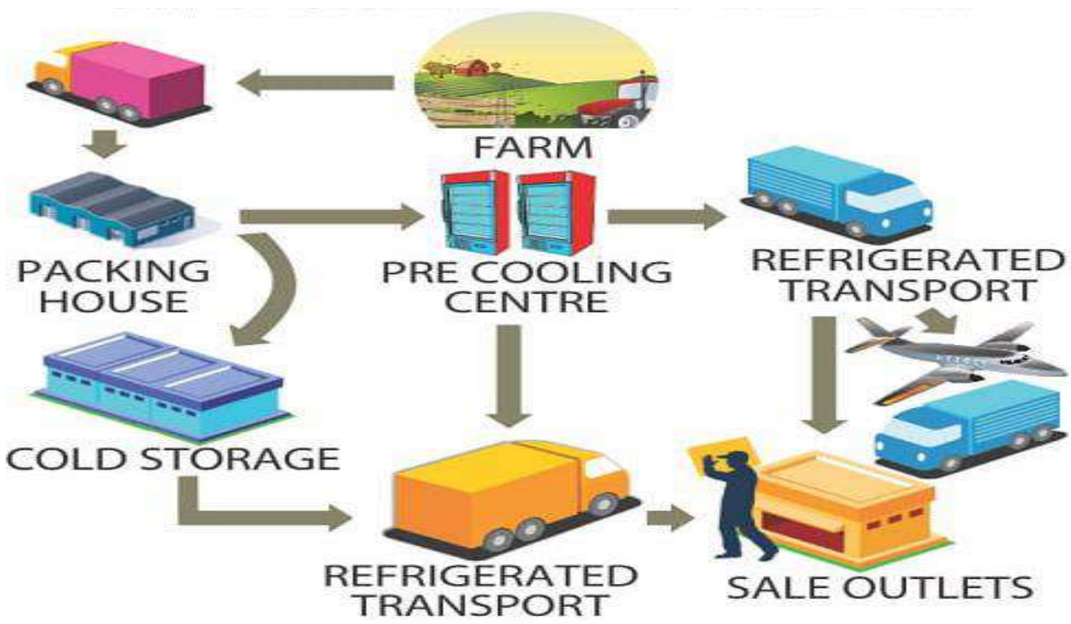
Otherwise, in rural areas, no processing is required and the digestate is applied directly. Digestate is used in the following forms: 1. Solid digestate residue. 2. Liquid digestate. 3. Combined liquid digestate with mineral fertiliser. 4. Combined solid digestate and mineral fertiliser. Mineral fertiliser can include urea, DAP, etc. It has been observed that liquid digestate with mineral fertiliser gives the highest yield and solid digestate gives the minimum yield, comparatively speaking. Already in our rural areas, small self- biogas producers are utilising liquid residue as bio-fertiliser in their fields. In many jurisdictions, packaged bio-fertiliser is also produced on a large scale and marketed over wider geographical domains.

CO2 in cold chain

With the increase in global population, urbanisation and gradual rise in the standard of living, the demand for vegetables, meat, seafood and other related items is increasing by the day. Similarly, international heath sector requirements have given rise to the safe/ cold-temperature transport of vaccines and allied products. As per FAO estimates, 40% of food produced in the world is lost due to it being rotten at various stages of production and marketing. It has been estimated that cold chain availability can reduce this wastage by half. For the last 50 years, no major changes or innovations have been made in the vapour compression cycle-based refrigeration. The refrigerants were earlier Freon-based, which damaged the ozone layer. Now, HFCs (hydro-fluoro-carbons) are being used, which have several thousand times higher global warming potential (GWP) than CO2.

Thus, CO2 has emerged as a refrigerant of choice for the years to come. Following are the main properties and benefits of CO2. 1. CO2 is a natural refrigerant and is cost effective. 2. CO2 is energy efficient. 3. CO2 is not flammable. 4. CO2 is not toxic and it has the lowest GWP at 1. Dry ice has been used in cold chain with great success but other variations of CO2, liquid and gas also provide viable cold chain applications. The applications for CO2 across the food and beverage industry are numerous, particularly because the chemical compound can be used in its three forms - solid, gas or liquid. When it comes to cold chain, the flexible nature of CO2 makes it an ideal application for storage and transportation.

Figure 5.12.1: Cold Chain Management



Biogas gaseous residue conversion to dry ice

Biogas is cleaned and upgraded to become a transport fuel as bio-methane (CH4). Bio-methane can be pumped into the gas network or into a CNG cylinder to be used as a motor fuel. The gaseous residue of bio-methane production is CO2. CO2 share in biogas is 45% plus 1-2% H2S and other materials. CO2 is then cooled to become liquid. Liquid CO2 is throttled through a valve to take a snow form. CO2 snow is pressed to solid CO2 blocks and pellets. This process requires a separate plant, which can be co-located with a biogas plant or other liquid gas production plants like oxygen or ammonia.

Biogas route is cleaner and cheaper. It is much cleaner than other sources of CO2 like exhaust gases from vehicles or power plants, which require much more intensive and costly processing. CO2 is being produced in Pakistan by a number of producers. CO2 market is increasing with the expansion and intensification of healthcare system where it is used in the transport of pharmaceutical products. Also, CO2 is being used in cold chain. With the modernisation of agriculture and export campaigns, the demand for solid CO2 will increase. Biogas production in Pakistan will help in the production of cheaper CO2. Also CO2 itself can be exported.

Solution for smog

Every winter, we have smog in central Punjab and elsewhere. One of the reasons is rice stubble burning. Instead of burning, biogas can be produced from the bio-digestion of rice residue of various forms including stubble. This would provide incentives to farmers to support and facilitate investment directly or indirectly in biogas production. Across the border, similar facilities have already been built under a recent campaign. Concluding, biogas has a widespread geographical potential including and beyond smog areas. Wherever there is bio-waste, there is the scope of producing biogas. And where enough volume is available, byproducts like CO2 refrigerant and bio-fertiliser can be produced and marketed. Provincial governments and local bodies may collaborate with gas companies to develop several projects in this respect. While investment can be done by private parties, the facilitation by governments at various levels is a must. It is hoped that this piece would generate more interest in biogas beyond energy requirements. It can boost both rural and urban economy.

Carbon dioxide uses in industry applications

In addition, plants use CO2 in many specific applications and industrial processes in individual industries.

Carbon dioxide used in Food and Beverage

CO2 has a wide range of applications in this industry.

- The most obvious is the gas used for **carbonating beverages**, in particular beer, soft drinks, and wine. This prevents the growth of bacteria and fungi.
- Carbon dioxide can also be used for **de-caffeinating coffee**.
- Thanks to its aforementioned cooling properties, CO2 **keeps food products cold** while they are being transported. In addition, it can also be used for **quick-freezing** and, in combination with ethylene oxide, for cold sterilizing food.
- Furthermore, CO2 is **a highly effective inert blanket that protects food items during their production**, it can displace air in the canning process, and it can be used to propel or extract food products from their containers.

CO2 USES IN AGRICULTURE

- In the grain treatment process, CO_2 is pumped into silos or other storage facilities in order to **kill insects and protect the products**.
- It also plays an important role in the manufacture of some **fertilizers**.
- Furthermore, the air in greenhouses can be enriched with carbon dioxide to allow the crops there **to optimize their photosynthesis potential**.

CO2 USED IN MANUFACTURING

- In MIG/MAG welding, CO_2 serves as a so-called shield gas, which means that it **protects the weld puddle from oxidation**.
- In addition, in combination with argon, carbon dioxide is used to achieve **an improved welding rate** and to reduce the need for post-welding treatment.

CO2 USED IN CHEMICAL INDUSTRY

Very large quantities of CO_2 are used as a raw material for the **production of methanol and urea**.

CO2 USED IN METALWORKING

Carbon dioxide not only has anti-corrosive features, but it can also be used to **harden the casting molds** used in this industry.

CARBON DIOXIDE USED IN PETROLEUM INDUSTRY

Carbon dioxide can be pumped into oil wells in order to **optimize their yield**. During this process, the CO_2 partially dissolves, which makes the oil less viscous and easier to extract from the bedrock.

CO2 used in Construction

Dry ice pellets consisting of carbon dioxide are used for **removing paint from surfaces**. This process is replacing sandblasting because it lowers the cost of disposal and cleanup.

CARBON DIOXIDE USED IN HEALTH CARE

When added to medical-grade oxygen, CO_2 can help **stimulate respiration.**

CARBON DIOXIDE USED IN ENVIRONMENTAL USES

This one may be most surprising because of the role carbon dioxide plays in climate change. However, when used as **a propellant in aerosol cans**, CO_2 is actually better for the environment than many other alternatives.

Source: Atlas Copco

Table 5.12.1: Biomethane stats of various Countries

Country	Biomethane plants	Raw biogas upgrading capacity [Nm^3/h]	Produced biomethane [GWh]	Plants feeding into grid	Biomethane used in transport	Number of biomethane filling stations	Number of CNG filling stations*
Austria	14	5 160	70	11	n/a	3[p]	180
Denmark	6	8 650	n/a	n/a	n/a	n/a	7
Finland	9	2 731	40	3	43%	24[p]	25
France	8	2 610	41	6	n/a	n/a	310
Germany	178	204 082	9 140	165	3%	165[p] + 143[b]	920
Hungary	2	625	4	1	n/a	1[p]	19
Italy	5	500	n/a	n/a	n/a	n/a	1 040
Luxembourg	3	850	26	n/a	n/a	n/a	7
The Netherlands	21	16 720	683	n/a	n/a	60[p]	141
Spain	1	4 000	n/a	n/a	n/a	n/a	69
Sweden	59	38 858	1 303	13	78%	218[b]	218
Switzerland	24	6 310	166	22	33%	137[b]	137
UK	37	18 957	700	34	n/a	n/a	8
TOTAL	**367**	**310 053**	**12 173**	**255**		**253[p] + 498[b]**	**2041**

** blend*

5.13: Green Hydrogen: A new opportunity

Hydrogen is not something new. It is being used for more than a century. It is Green Hydrogen (GH) that is new. Hydrogen is an energy resource, a clean one and the one which the global community is after for meeting fuel needs without adding to climatic concerns. Hydrogen is not only clean substitute for oil, gas and coal it is also a great storage medium. With increasing influx of intermittent renewable energy, there is and will be need for storage**.**

There is a competitive controversy between hydrogen-operated vehicles versus EVs (electric vehicles). Most probably, battery-operated EVs will succeed. In the case of hydrogen, one may have to replace batteries and add fuel-cell to the EV motors to convert EV to hydrogen, if need be. It depends on the availability issues of battery raw materials, which may ultimately decide the competition issue. It is not the road-transportation sector only, where Hydrogen would be of use. The greatest use of hydrogen may come in electrical storage for the grid, as batteries' requirement of rare and precious metals may be limited, limiting battery storage market. Secondly, in case of high temperature industrial processes, electricity may not be able to compete—technically and economically. Hydrogen uses are almost everywhere where fossil fuels are used, and especially in the following where thermal or chemical uses are there: steel, cement, paper, food, chemical industry, fertilizer, oil refining and petrochemicals, metallurgy, food, glass and other extractive industries. Indeed a long list. Hydrogen has a favorable impact on combustion characteristics of natural gas when mixed into the latter. Hydrogen can be stored in high temperature steel cylinders or cryogenic cylinders at normal pressures.

Existing natural gas pipelines may be repurposed for Hydrogen transport in a mixture form up to 40% without much changes in the pipeline parts including compressor, although there can be a 20% capacity loss. Thus, initially one could start transporting hydrogen in a 20% mixture with in natural gas pipelines. All new gas transmission projects in Pakistan such as North-South gas pipe line project should be designed with this factor in mind.

Hydrogen- natural gas mixture can be used as a mixture or hydrogen can be separated from the mixture. And there are other options of converting hydrogen to methanol or ammonia. For sea transport, ammonia containers may become more popular, eventually making international trade possible in hydrogen. It may be noted that since water and sun may be available at most places, it will be producible at such locations and thus hydrogen may not require extended transmission and distribution system on the pattern of conventional natural gas pipelines. There is a 'Hydrogen 111' programme; under which, the target is to produce 1 kg Hydrogen in 1 USD and in 1 decade. Currently, green hydrogen costs 4-5 Rs/kg, while black or grey hydrogen costs under 1 USD/kg. However, these are the numbers of pre-energy crisis period when fossil fuel prices were low. At present, the prices of LNG green hydrogen may be competitive. By 2030 or even slightly earlier, many jurisdictions will have competitive green hydrogen. Some thirty countries have developed 'hydrogen strategies'. While industrialized and developed countries are moving in the direction of hydrogen gradually including R&D and hydrogen production, even developing countries are moving in this direction as well.

Countries like Chile, Colombia, Costa Rica, Panama, Brazil, Morocco and a few other countries have started initial activities in hydrogen development intended to leading to commercial business. Saudi Arabia plans to replace oil production gradually by hydrogen as oil market goes down gradually. The Saudis have cash. However, even Oman is moving towards developing hydrogen production. India has launched its 'National Hydrogen Mission' under which a target has been set to produce around 1 million tonnes of green hydrogen per year by 2030. Starting late but China became largest and cheapest producer of both wind and solar power. The same thing appears to be happening in the case of hydrogen. China has become highly competitive in manufacturing hydrogen electrolyzers. BNEF, which earlier made projections for solar PV, has reported recently: "Chinese alkaline electrolysis systems generally cost 25% of the price of the same type of project in

Western countries, thanks to cheap labor and upstream supply from the domestic market." This was based on an industry survey of 20 companies.

It put the price of a Chinese alkaline electrolysis system at about$343/kW, compared with $1,200/kW in the West. Can we manage to attract CPEC (China Pakistan Economic Corridor) investment and technology to Pakistan's engineering industry as has been mentioned earlier?

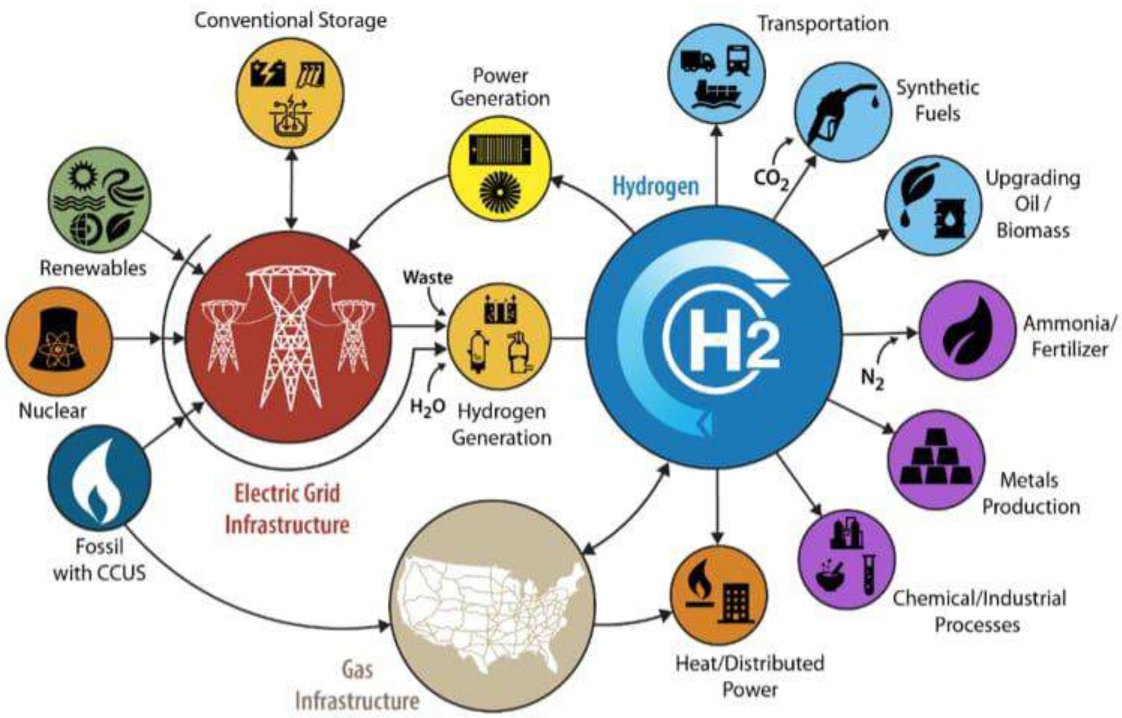
India did not have crude oil but it successfully established a large oil refining industry which not only made it self-sufficient in petroleum products but enabled it to export such products and earn foreign exchange. Pakistan missed the boat. Now there is 'hydrogen opportunity'. India is also vying for export possibilities. Hydrogen is produced by electrolysis of water. Electrolysis requires electricity which is produced by solar or wind and hybrid thereof; excess and unutilized electricity from wind and solar is also used. Electrolysis containers are mostly steel shells and parts made in mechanical engineering industry. We have a good engineering industry base both in public and private sector. Public sector engineering industrial plants are under-utilized where the steel made parts can be manufactured.

Except for Australia and the US, solar intensities and land availability are much less in developed world, including the EU region, Japan and South Korea. For this reason, the EU is supporting hydrogen development in Africa. There were earlier similar initiatives in bringing solar generated electricity from Sahara to Europe. Significant soft investment activities and JVs (joint ventures) opportunities have been made available. Saudi Arabia, the UAE and Oman are also looking at export potential. Pakistan should also look at building export capabilities. It takes time. Fortunately, that time window is there but not for inaction and wasting. We have sunshine and land area and a large coastal line for export infrastructure. We have been digging all over for the unknown oil and gas for the last several decades without any significant find after Sui or Qadirpur. Let us go for the known and visible for which market and resource are there and coming up.

GH will have competitive uses in the country and abroad by 2030.Time goes by fast. Development of R&D and model facilities will enable us to go into hydrogen by 2030. If LNG continues to be unavailable and expensive, fertilizer sector may be the earliest candidate for conversion to green hydrogen. Initially, a part of gas requirements may be procured from on-site green hydrogen production; and similarly in the oil refining sector where it may apply. Thar coal gasification may be the most competitive and ready route for fertilizer sector, however, climate politics may not permit it for a dependent country like Pakistan. To conclude, GH is not a mere hype but a fast emerging reality with a potential to replace oil and gas and even open the doors for exports by those countries which have been hitherto energy importers. However, it is not a panacea. Nothing is a panacea, especially, in the energy sector. A right and affordable energy mix adds to energy security and affordability.

Figure 5.13.1: Hydrogen Production

Conceptual H2@scale (hydrogen at scale) energy system



Source: U.S. Department of Energy, *Hydrogen Program Plan*, Figure 3, November 2020
Note: CCUS is carbon capture, utilization, and storage.

5.14: Hydrogen initiatives

The good news is that two hydrogen initiatives have been announced in Pakistan recently; one by NEECA and the other by petroleum industry. NEECA (National Energy Efficiency and Conservation Authority) had earlier commissioned a preliminary study identifying hydrogen use potential.

Figure 5.14.1: Hydrogen Plant

Recently, it has started discussing implementation issues. It is rather premature, so to speak. Green hydrogen is too expensive today which would stress the already stressed power/energy sector. NEECA's discussion focused on power sector, perhaps, due to organisational politics. They belong to power sector. Due to this reason, there was a proposal to attach NEECA to the Ministry of Science and Technology which has a broader perspective and has R&D organisations like PCSIR (Pakistan Council of Scientific and Industrial Research) under its control. In any case, green hydrogen issue may not be quite within the scope of activities of NEECA, although good initiatives are to be appreciated. It has been reported that hydrogen production is being considered on curtailed power. It would be a folly to design and size a hydrogen production facility based on curtailed power generation from hydro or solar or wind power facilities.

Hydrogen production facilities are very capital intensive--much more than corresponding green power facilities. Dependence on curtailed power would save much less in terms of electricity cost and lose much more in terms of unutilised expensive hydrogen facility. Optimum facilities may be on coastal lines where R.O. facilities may already be there or may be sited. Hydrogen may never be able to replace other green energy sources like wind and solar except in storage. It would be inefficient or even foolish to produce hydrogen from electricity and again convert it to electricity. Hydrogen would be competitive and useful in producing thermal energy in industry and even in household for space and water heating or even cooking, although electricity may be a competitor in households. It would depend on comparative economics.

Hydrogen is being used in Pakistan by cooking oil and ghee industry and in oil refining for desulfurization. It is also used in power generation in cooling down generators and in specialized (stainless steel) welding and fabrication industry as mixture with argon. How much is produced at site and how much is imported is a question to be studied. Also a major consumer of hydrogen is the fertilizer industry wherein hydrogen is produced in making ammonia by cracking methane (natural gas). Cheaper local gas and expensive LNG are used. Local gas is dwindling and fertilizers are required for food security and enhancing agricultural productivity. Fertilizer industry though-out the world is presumed to be the first and leading consumer of hydrogen. New plants would be on hydrogen utilizing a simpler process of combining hydrogen and nitrogen. Oxygen would be available as a by-product.

Hydrogen was derided by eminent personalities like Elon Musk, saying: “Fuel Cell is Fool-Cell”. Hydrogen was considered as rival of EVs, although hydrogen is used in fuel cells to produce electricity which run an EV (electric vehicle). Hydrogen replaces battery storage. Also internal combustion engines that are used currently in existing cars may not be dumped altogether according to recent developments. I.C.E.s are being developed that would directly use hydrogen as petrol and diesel is used in existing automotives. Present consensus is that heavy vehicles, including trains and airplanes, would be using hydrogen. Already, some tracks in Europe are running on hydrogen as demo facilities. Thus potential is great but there are still issues of cost, availability and technological advancements.

This does not mean one should not do anything on hydrogen. It takes ten years in countries like Pakistan to introduce a technology. Hydrogen may take even more. Commercialization in advanced countries will be after 2030, although there is still some market in countries which are experimenting with hydrogen use. Hydrogen would continue to suffer from transport difficulties, pressure and cooling requirements, corrosion of carrying vessels and safety issues. In small amounts as mixture with natural gas, it may replace LNG. There are pilot projects in India, the UK and elsewhere in this respect. Ammonia (NH3) is an alternative solution as well, which is essentially a hydrogen product.

The more important news is that OGDCL (Oil and Gas Development Company Limited), PPL (Pakistan Petroleum Limited), PARCO (Pak-Arab Refinery Limited), MPCL (Mari Petroleum Company Limited) and GHPL (Government Holdings (Private) Limited) have signed an MoU to explore the green hydrogen opportunities. These are very large companies having organizational and financial resources that are required in such initiatives. Currently, they supply oil and gas and will be supplying hydrogen in future, may be initially both and later green hydrogen only.

PPL has been exploring other green options as well, as it has floated consultancy tender for product diversion recently. Another sector that may be ready to initiate such an enterprise would be the fertilizer group, which falls into the user category. This sector is also composed of large companies having organizational and financial resources. It is hoped that they would also launch a similar initiative. Being mostly in the private sector, they `would have some advantages. It may be too much to expect that our local companies in some near or mid-term future would be able to handle complete integrated projects in the area of green hydrogen. Even as simple as installation of large Solar PV facilities, foreign contractors are involved, although partly due to commercial constraints as warranty and guarantees are involved.

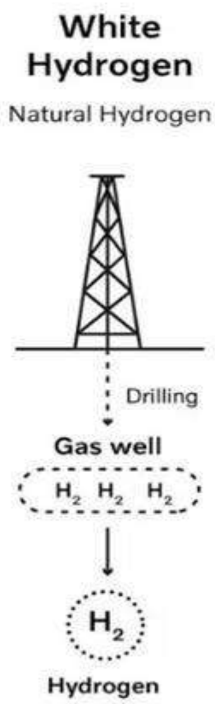
However, capabilities develop through training and familiarization, which help reducing installation cost and external dependence in operations and maintenance. Without this, it may be like the ‘UAE syndrome’. It is therefore vital that we start training and demo facilities in all production, transmission, storage, handling, storage and usage. Some output may be sold to gas companies which import hydrogen, although at a market price that may be significantly lower than the production cost. The loss would not be high due to small production volume. It is about time we startedwith pilot plants for the purpose of training, learning and identifying other practical and implementation issues. Especially when financing bodies like ADB (Asian Development Bank) are involved, it might be easier to get finances for such projects.

One would like to recommend to ADB to support the petroleum group more actively, as these people have a potential to deliver physical and actual output than just papers out of a government office.

5.15: And now Hydrogen from Earth

A new source of Hydrogen has been discovered recently. It has been named Natural/White Hydrogen. It is extracted from earth crust through drilling as Natural Gas is extracted. That is why it is called Natural Hydrogen also a la Natural Gas.

Figure 5.15.1: White Hydrogen

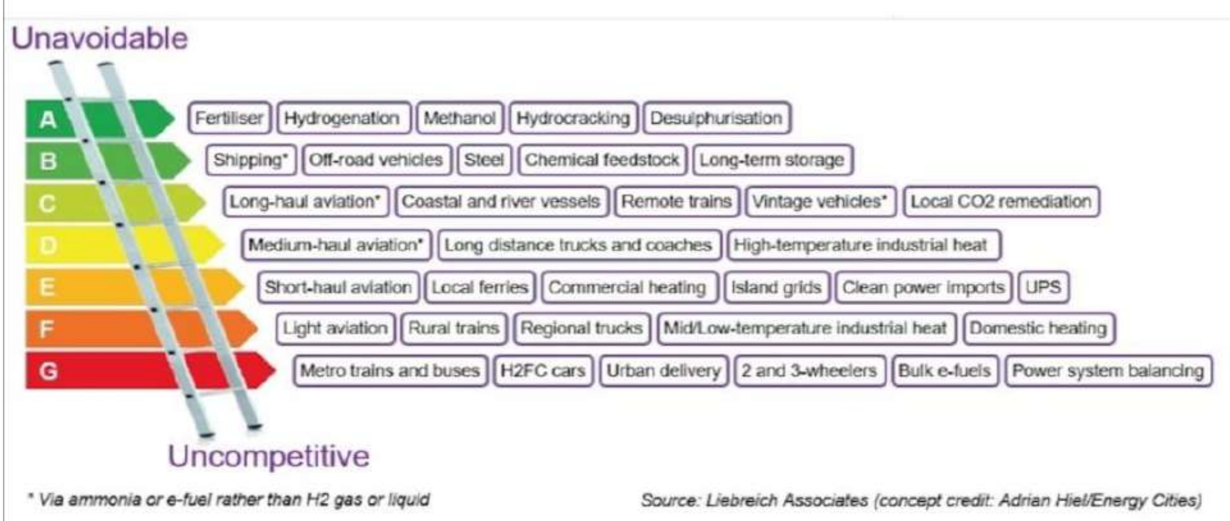


Oil and Gas E&P explorers have now a new task and opportunity to get a find of another type. We will discuss in this space the relevance of White Hydrogen to Pakistan and its E&P companies. White Hydrogen is just the same normal Hydrogen. It is being called by two names; Natural Hydrogen and White Hydrogen to distinguish it from other sources or methods to make Hydrogen. For example, Green Hydrogen is produced by electrolysis of water and electricity produced from such renewable sources as solar, wind or even hydro. White Hydrogen was first discovered accidentally in Mali in 2014 while looking for oil or gas. It turned out to be Hydrogen. Not much attention was paid to it for developing it. However, the pursuit of Green Hydrogen and its targets has provided a new impetus to this one, called White Hydrogen. Also, the Ukraine war has driven the motives to acquire independent gases.

White Hydrogen is produced as a result of chemical reaction of elements and compounds containing Hydrogen. It can be found in many kinds of geological conditions and locations, including those under the ocean. Earth naturally produces Hydrogen continuously where appropriate conditions exist and suitable minerals found. Oxidation of Ferrous minerals has been quoted as to be the most likely source. Besides France and Mali, Hydrogen resources have been identified in Spain, Germany, Russia, Ukraine, Kosovo, Serbia, Kazakhstan, Finland, Sweden and Poland. Recent discovery in France is of a large deposit containing 46 million tones of Hydrogen and able to generate 3 million tones of Hydrogen per annum. White Hydrogen if developed widely can be an additional source to Green Hydrogen releasing pressure on water sources and solar space requirements. As its production technology is extraction through boreholes as is done in case of oil and gas, a lot of lead time may not be required for its wide-scale development and adoption. It should be widely available by 2030.

The main advantage of White Hydrogen is that it will be cheap, under 1 USD per kg as opposed to the current going rate of 4-6 USD/kg of Green Hydrogen. Green Hydrogen is expected to cost 2 USD/kg by 2030 and 1 USD/kg by 2050. There are more optimistic cost projections as well. Hydrogen has usages in many sectors: transportation, domestic cooking and heating, industrial boilers and furnaces, electricity generation and chemicals and petrochemical production. There may be many chemical, geo-chemicals, biological and other routes for Natural Hydrogen generation. However, a lot has been researched about iron ores wherein Hydrogen is produced through ionic reaction with water. Fortunately, there are many Iron deposits totaling 1.42 billion tons in Pakistan at Chiniot, Kalabagh, Nokundi, Haripur and elswhere.

Figure 5.15.2: Hydrogen uses



Reproduced with permission from Liebreich Associates.

There can be multiple benefits. If Hydrogen is found near iron ore sites, there would be no need of coal in iron-making. Green Steel can be produced, which is the most sought-after subject in industrial metallurgy. Otherwise, as we have mentioned elsewhere, there are multiple uses of Hydrogen. Our mining and Oil companies should start exploratory studies on the subject of Natural/White Hydrogen along with the coordination with universities. It may be noted that Fraunhofer Institute has organized an R&D project (HyAfrica) with a consortium of six countries (Morocco, Mali, Mozambique, South Africa, etc.) in Africa with companies. A similar consortium-like effort should begin in Pakistan. There is a great benefit in Natural Hydrogen. Its production can be modeled on oil and gas companies licensing policy. Concessions can be awarded. No national investment would be required while Green Hydrogen would require a lot of investment.

There are a number of national E&P companies which have the geological and drilling know-how. However, there is scant activity at global level in Natural Hydrogen E&P licensing at the moment. An R&D and regulatory base may be able to attract foreign investment. The foregoing is not to suggest that one should start running after Natural/White Hydrogen and drop pursuit of Green Hydrogen.

Green Hydrogen is a reality now and Natural Hydrogen has yet to be proven as to its wider availability beyond the fields that have been identified. For us, perhaps, both are a matter of R&D and a matter that may be relevant and practical around 2030.

There is yet another option that is ready and proven which is of Biogas. Pakistan is a populous and agricultural country having biomass of all kind from agricultural to solid and liquid waste materials that can all be converted to Biogas. There are varying resource estimates of around 400-500 mmcfd, which is a significant amount. No research is required. It is proven and certain. Cost estimates have shown that it is cheaper than LNG and more expensive than system/ground gas. Biogas, after cleaning, can be pumped into the gas pipeline network or compressed into CNG. Both uses are feasible. Biogas is considered renewable as opposed to ground gas. International interest in Biogas has been revived. Chevron has launched several projects in the US. The EU has re-established Biogas targets to 20% of the gas imports from Russia in the wake of the Russia-Ukraine conflict. Fortunately, awareness and sensitivity on the subject has increased over the years. Two gas companies have started preliminary work on Biogas. Sindh government has also initiated a project on Bio-CNG in Cattle Colony, Karachi. There is a need for a Biogas policy that integrates and solves various financial and administrative issues.

5.16: Towards a hydrogen policy

Hydrogen is the most abundant element found in nature. It is a fuel of the future promising carbonless economy. However, it is still being produced and used in chemical industry for producing ammonia, fertilizer and oil refineries. The difference between today and tomorrow of hydrogen is that these days it is being produced from fossil fuels like natural gas and coal and in future it would be produced out of water and renewable energy like Wind and Solar. Water contains hydrogen and oxygen. Hydrogen can be extracted by electrolysis of water, passing an electric current though water and electric current coming out of wind and solar power plants, predominantly. Another difference in future of hydrogen will be in its usage. It would expand into the transportation sector running cars, trucks, trains and even aeroplanes. It will go into steel-making replacing coal, coke and natural gas. It is projected to start commercialization by 2030 and would be a major fuel by 2050, replacing fossil fuels like oil, gas and coal partly or fully.

Hydrogen has emerged a little later in the case of EVs (Electrical Vehicles). There are two types of EVs; BEVs (Battery Electrical Vehicles) and FCEVs (Fuel Cell Electrical Vehicles). FCEVs run on hydrogen. FCEVs have been derided by the famous entrepreneur Ion Musk as "Fool Vehicles". Japanese have shown tenacity in promoting FCEVs. Fuel Cells have had a longer history in Japan, having been used in residential sector CHP applications with efficiency exceeding 90%.

There are three types of hydrogen in terms of source: 1. green hydrogen which is produced from water and renewable energy; 2. grey hydrogen is produced from natural gas; its another variant is black hydrogen which is produced from coal; and 3. blue hydrogen is also derived from natural gas. However, the CO2 produced in the process is captured and stored and probably used in case of need. Green hydrogen depends on the availability of pure water and renewable energy. Water is electrolyzed in electrolyzers. Various technologies have been there in this respect; alkaline and PEM (Proton Exchange Membrane). Cost and prices of electrolyzers are coming down with the expansion of the market. Largest electrolyzer of 20 MW capacity has been inaugurated in Canada in January 2021.

Investments in hydrogen are coming up all over the world. In the last two years, 70GW of electrolyzer capacities have been announced. This is projected to result in reduction of unit capex rates of electrolyzers by 65%. The cost of producing green hydrogen would go down to under 2 USD/kg by the year 2030. Thirty-one countries have announced hydrogen targets. It is being projected that 22% of global energy needs would be met by hydrogen by 2050 with a market value of more than 2 trillion USD.

India launched its National Hydrogen Mission on 15th August 2021. India's target of producing 450 GW of renewable energy (solar and wind) by 2030 is going to help in producing green hydrogen at a lower cost. There is a view that in the interim period, blue hydrogen may be produced and ultimately green hydrogen. Indian Oil Corporation has announced its plan to build India's first green hydrogen plant at its oil refinery in the northern city of Mathura. In the private sector, Reliance has chalked out plans to go into green hydrogen. Saudi and the UAE investment is being attracted to India for producing hydrogen. There are plans to add hydrogen to natural gas supply pipelines and also add hydrogen to CNG. Two hydrogen fuelling stations have been installed at R&D centers.

Thar coal can be a great source of black hydrogen. There are project ideas of producing natural gas or diesel through Thar coal gasification. These projects can be converted to the production of hydrogen. There may be choices or competition between hydrogen and syngas concepts. Fertilizer production can be converted to hydrogen at mine site or Hydrogen can be transported to fertilizer plants located in upper Sindh. There is a steel project lying dormant due to gas supply and cost issues which could be revived. Thar coal hydrogen can be used in this project. Pakistan Steel could use some hydrogen. Oil refineries have a need for hydrogen for desulfurization processes. Thar coal-based hydrogen can be as economic as gasification products, although definitive cost studies may have to be undertaken.

Hydrogen can be a great fuel for exports. If Pakistan manages to install hydrogen production infrastructure in the medium to long-term, it can look forward to exporting hydrogen rather than importing fuel. Saudi Arabia is already implementing a project for producing hydrogen. Hydrogen market may develop faster internationally than it may do at home here in Pakistan.

What should we be doing with respect to hydrogen? It is a typical question for any developing country when new technologies start knocking at the door. Human and financial resources are limited and future not a charted territory. If everybody moves ahead and we do not and stagnate for a variety of social, political and economic constraints, it can endanger our freedom and liberty whatever we have at the moment. Something can always be done. It is not that hopeless. There are options, choices and opportunities. A beginning can be made and a route is charted and whatever resources are available can be marshaled, mobilized and applied.

Pilot projects may be launched for the production of green hydrogen in the wind power regions of Thatta, Jhimpir and Gharo. Excess/unutilized electricity is usually available in these regions. However, one need not restrict to one region due to wind power only. Solar is available almost everywhere in Pakistan. Electrolyzers may be provided to the universities and other R&D centers to produce expertise in green hydrogen production. It is recommended that GoP/Planning Commission may organize a Hydrogen Group of experts drawn from industry, academia and government to develop and recommend a Hydrogen Policy and Plan for the next 10-20 years.

5.17: Electric Vehicles and Alternative Fuels

Electric Vehicles

Immediate solutions are never possible or feasible. There has to be an alternative plan and targets. How about we target a proposal to reduce oil consumption by 25% by 2030? A number of approaches may be feasible: converting oil demand to electricity through the adoption of Electric Vehicles; and electricity generation through solar. While EV proposals and initiatives are originally based on climate requirements; for us, however, it is based on our energy needs and peculiarities.

Major advanced countries have decided to close down petroleum vehicle production by 2030-2035 and to be substituted by EVs. Existing vehicles may, however, remain to be depreciated away or discouraged through taxation laws. EVs have become a reality now in Pakistan as well. In Sindh, EV buses have been imported and should have started operating by now, when the readers are reading these lines. Many local production initiatives for EVs are in the pipeline by the private sector, which includes motorcycles, rickshaws, and even cars and buses.

Motorcycles' petrol consumption accounts for 40-50% of the total gasoline consumption. There are some 20 million motorcycles on the roads while 1.2-1.5 million motorcycles are added every year. Both conversion of the existing and production of new EV motorcycles should be encouraged. What would be the implication of reducing the EV motorcycles population by 50% or so? This has to be worked out, along with the associated demand for electricity that would be generated.

Cars' prices have gone up tremendously. The prices are almost out of purchasing power of the middle classes. Only the rich or perhaps upper middle classes can buy Japanese cars. There is a huge potential for cheaper Chinese EV cars under Rs 800,000/- per vehicle. Similarly, auto-rickshaws at Rs 300,000/- or so. There is potential for conversion of existing buses to EVs. It is being already done in rich and advanced countries. The right time for replacement of Diesel engines from buses may be 5-7 years of operation when Diesel engines have to be replaced. New EV buses can also be produced if an appropriate policy is around.

Figure 5.17.1: EV Converted Bus

An almost 'Industrial Revolution can be caused by promoting local EV manufacturing industry. That would need demand creation. The automotive market is highly price elastic, and it can be seen from the growth of the motorcycle industry. It remained sluggish when it remained dominated by high priced Japanese motor cycles. It grew exponentially when low priced Chinese origin MCs came in.

An appropriate RV Automotive policy is required. Zero taxation and only GST for reasonable local content projects. The market should not be allowed to be segmented, which would harm local content objectives and scale economies.

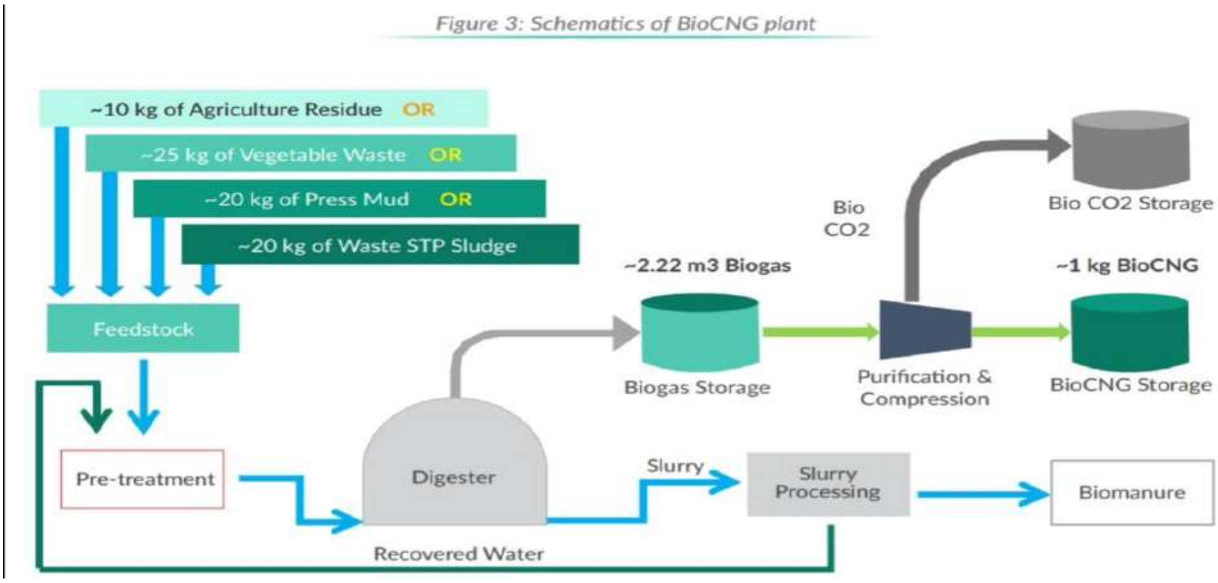
Ethanol Blending in Gasoline

Ethanol blending is being mandated in many jurisdictions of the world for environmental reasons. 10% mixing of Ethanol is the usual target and practice. Additional rationale is indigenization of fuel and price stability. Such a gasoline is called E10.

Bio-CNG

Biogas has a lot of potential in Pakistan. A large human and cattle population creates a lot of waste whose management is becoming an increasing challenge. While Biogas can add to the gas supply system of the country – both on the gas grid and off-grid — Bio-CNG can add to the petroleum supply product portfolio. More than 3000 CNG plants have been installed in Pakistan, many of which have been shut down due to a lack of availability of gas and expensive LNG. In our region, India plans to install 5000 Bio-CNG pumps in the next five years. India already has installed many Bio-CNG plants.

Figure 5.17.2: Schematic of BioCNG Plant



Hydrogen

Ultimately, Hydrogen will be replacing oil and gas. It has already started doing so. Smaller vehicles like cars will be EVs, while heavier vehicles like trucks, construction machinery, off-road vehicles, aeroplanes, and trains will run on Hydrogen. Hydrogen and EVs are also expected to reduce roadside pollution. We have to suffer from smog regularly in winters. Also, Hydrogen is an essential part of climate change control policies. Most of the thermal energy in industrial applications is expected to come from Hydrogen.

Perhaps a more important or equally important aspect is that Hydrogen can be locally produced through solar and wind energy of which we have a lot of potential. Oil and gas are and will be imported as we have discussed in the foregoing. India plans to produce 5 million tons per year of Hydrogen by 2030. India has also started mixing Hydrogen (10-15%) in natural gas pipelines. A number of other developing countries like Egypt, Morocco, Namibia, and Nigeria have made plans to get into Hydrogen. Saudi Arabia is coming up in this sector in a big way.

It takes, on average, around ten years to reach somewhere in acquiring these technologies and reach some degree of proficiency. Hydrogen, in terms of technological complexity, is simpler than other related technologies like solar cell production. It involves steel fabrication and piping, etc., of which we have considerable capabilities. India has ready plans to build Electrolyzers (Electrolyzers are used in the electrolysis of water by which Hydrogen is separated) making capacity of 12000 MW. It is high time that a Hydrogen policy and plan are made by the government. Public sector may have to become active in Hydrogen; initially, by the way of installing pilot plants in various end-use sectors. Private sector will follow eventually once basic know-how and manpower resources are developed to an extent.

Figure 5.17.3: Hydrogen Plant

Hydrogen policy issues have been complicated by organizational confusion as there is no easy answer to the question: where does Hydrogen belong to? National Energy Efficiency & Consideration Authority (Neeca) and National Electric Power Regulatory Authority (Nepra) have been taking some interest in it. The power sector has the least relevance to Hydrogen. It would be unrealistic to suggest using electricity to make hydrogen and then convert it to electricity again. In energy storage or, perhaps peaking, there may be some relevance. Bigger stake-holders are in the oil, gas, fertilizer, and general industrial sectors.

5.18: The future of electric vehicles

Electric vehicles (EV) are thought to be an essential player in reducing oil demand. The former Danish minister for climate, energy and utilities, Dan Jorgensen, declared, “There is no future for oil and gas in a 1.5-degree world.” The International Energy Agency (IEA) Net Zero Emissions Scenario (NZE) predicts that use of fossil fuel should fall by 75 percent by 2050 to achieve net-zero targets.

The transport sector uses the bulk of the global oil. If oil consumption has to fall so drastically to achieve climate objectives, the transport sector should be decarbonised. This calls for a shift of the automotive sector from oil to renewable electricity like wind and solar. Electric vehicles are the best way to achieve this target as they run on renewable electricity.

Global net zero target requires 50 percent EV population by 2050 and the Clean Energy Initiative (CEI) requires a 30 percent market share of EV sales by 2030. In 2021, global EV car sales stood at 6.5 million units per year; China sold three million cars (30 million motorcycles) per year, and the EU and the US sold 2.5 million and under one million units respectively.

Pakistan’s ambitions – if not target – in this respect is the same (to ensure that EV sales are 30 percent of the total sales by 2030), matching with the renewable energy target. One is not sure if the 30 percent target can be achieved in all EVs including four-wheelers, but it is possible that the 30 percent market share or even more may be achieved in the case of two-wheelers. The reason is that there is a large growing market (RoG eight percent) of two-wheelers, in terms of both annual sales (two million units) and vehicle population (20 million). And it is simple technology. Motorcycles consume 40 percent of the annual gasoline requirements of Pakistan.

EVs are relatively quiet and simple to drive and have no gears or clutches. They are also easy to maintain as they don’t require filter or oil change. They have higher pickup and are equipped with electronic controls some of which have anti-collusion and safety features. Drivers won’t need to visit petrol pumps as these vehicles can be charged at home with the help of dedicated home chargers. But they require three to four hours to charge and have a typical range of 100 kms per charge. This may be a disadvantage for those who may have a longer travel activity in a day.

There is a new development in the automotive sector, especially in the area of EVs. Established brands are losing their foothold, and new players are emerging, particularly out of China. Chinese products are cheaper as well. It is expected that these new and cheaper brands will get established in developing countries, something that could not have been thought of earlier. This would create opportunities for countries like Pakistan to achieve indigenisation – the manufacturing of EV motorcycles is more likely in this respect.

In the 1970s, Japan emerged as a leader in the automotive sector, replacing Europeans. It seems that in the case of EVs – if not the total automotive sector – the new leader will be China. A major Chinese automaker, BYD, is exporting EV buses to Europe and the US, and is perhaps the largest manufacturer in this area. China’s market share in supplies of EV parts such as batteries is already 74 percent of the global sales.

Pakistan’s four-wheeler market has been monopolised by two or three leading Japanese manufacturers without any serious efforts to localise the market, although Suzuki did play a major role in indigenisation. This was, to be fair, due to the larger market size and simpler products, compatible with customers’ buying power and attitude. Today, one or two Chinese companies can play a significant role in developing an EV industry and market, provided that government policies do not fragment the market by awarding permissions without disdain. Now, an exciting opportunity is standing outside our door – in the case of two-wheeler EVs, if not four-wheeler EVs. The motorcycle market offers a great opportunity for economic growth, exports and industrialisation due to its market size. Although the EV component has started recently, it has the potential to grow.

A typical problem in small developing economies like that of Pakistan is that annual sales are much smaller, and the park size is much larger. Thus, there is a larger market potential in replacement and conversion. There would be opportunities in the area of conversion of conventional automotive to EVs. Two-wheelers and buses have this potential. Standardisation is likely to help create economies of scale. The main components in EVs are electric motors and battery (with and without regenerative braking).

Thailand is a developing country with a population of 70 million and per capita GDP of $8356 (nominal). It has only 60 percent of the area as that of Pakistan. It is the eleventh largest producer of automotive in the world. Thailand hosts some 35 automotive brands, national and international. In 2020, it produced around three million automotive units out of which more than one million units were exported. Thailand has more than 1,800 vendor companies out of which one-third is tier-1 suppliers and two-thirds are tier-2 and 3 suppliers.

There are other successful examples of Malaysia and Turkey in the automotive sector. Similarly, Iran and Turkey have developed their automotive sectors in an impressive manner, reaching the mark of 1.5 million vehicles per year with a very sizeable level of local content. Under the Regional Cooperation for Development (RCD) – now the Economic Cooperation Organisation (ECO) – there used to be a joint programme of co-production among three countries – Iran, Turkey and Pakistan – under which a ball-bearing company was established in Pakistan.

By comparison, Pakistan could not achieve much despite an early start in the automotive sector in the 1960s. Its smaller market size was quoted to be one of the reasons for its failure. The total automotive market production is limited to 250,000 units per year, even today. However, cheaper Chinese motorcycles have helped expand the demand rather steeply in the last 10 years. Motorcycle demand and production has reached two million units per year which has opened the doors of opportunities in indigenisation and exports, especially in the area of EV bikes.

However, there appears to be more excitement among traders, investors and the environmental lobby than among potential EV buyers. While the EV car potential in developing countries appear to be questionable in the short- to medium-term, there appears to be some optimism for EV motorcycles. But last year's sales of EV motorcycles in Pakistan were 10,000 units only. Let us review the EV status in India which might have some relevance to us. In India, gasoline prices are relatively higher than in Pakistan. There should be a stronger economic incentive in India to switch to EV motorcycles. Last year's sales of EV motorcycles in India were limited to 150,000 or 1.1 percent of the two-wheeler market. The installed capacity of EV motorcycle manufacturing units is already 2.5 million, more than 15 times the demand. The emerging oil market will possibly determine a switchover to EVs.

The EV industry can have a multiplier effect in other areas as well. EVs require li-ion batteries, which are required in other areas of the economy, like electric storage, communication infrastructure, etc. EVs will boost electricity demand, and we already have excess capacity in the power sector, which has partly given rise to the circular debt issue. A lower night-time tariff for EV charging at home will go a long way in boosting the utilisation of the unused capacity and incentivising use of EVs by lower-income groups using motorcycles. This would also reduce expensive oil imports and have a significant downward effect on roadside pollution.

Are electric vehicles (EVs) economical or affordable? Although an EV may not be exactly economical, it is fast approaching the required cost objectives. Rising demand and scale economies would bring the cost down in the short- to mid-term. Actually, the initial capital expenditure – CapEx – or buying cost is higher (150 percent and in some cases 200 percent), fuel/electricity costs are quite low as much as one-third of gasoline cost, depending on the relative cost of petrol/diesel vs electricity.

However, the same is not true in developing countries like Pakistan where gasoline costs are lower than in Europe and the incentives for an EV switchover are much less – for example, EV energy cost in Pakistan is only three-fourth of gasoline prices. Fuel cost advantage in Europe is much higher than it is in Pakistan, especially in the case of cars. In the case of motorcycles, since CapEx contribution in the total cost of ownership (TCO) is less, switchover incentives may be higher.

It also depends on who is buying and what is being bought. Electric motorcycles can be charged at home, and those users who belong to low-income classes may enjoy low electricity tariffs, and this could be a good deal.

Also, EV cars can be charged at home but with much difficulty, as distribution lines in our part of the world do not have much strength and high electric tariffs may dilute the fuel economics of electric cars.

The purchase cost of EVs is almost 150 percent higher. In Pakistan, EV motorcycles are available in the range of $600-1000, while conventional motorcycles are sold at $350-400. For poor societies or people, this upfront cost is a major constraint. If interest or leasing rates are high, they may increase the cost. On the other hand, incentives on custom duties or concessional electricity tariffs may improve the overall economics. Eventually, EV prices would come down with the expansion of the market and the economies of scale.

We have calculated the comparative economics of EV motorcycles and EV buses vs conventional fuels. There can be a lot of variations based on possible variations in assumptions regarding CapEx, fuel cost and exchange rates. Nonetheless, some useful typical comparison is possible. An EV motorcycle's cost per km is around Rs0.5 and that of a gasoline-dependent motorcycle is Rs2.54. The gasoline rates of Rs150 per liter have been assumed as against higher rates in Europe and India.

The electricity rates of Rs10 per kWh have been assumed for EV owners who may be enjoying a low electricity tariff slab. EV car users may not be at this advantageous situation and may have to pay three times the assumed tariff for EV motorcycles. The TCO – without financial cost – of EVs is one-third of that of conventional motorcycles – Rs151,100 as opposed to Rs500,350 of conventional motorcycles.

The payback period of EV buses is 4.08 years which should be quite acceptable as opposed to 3.58 years for diesel buses. Assumptions can make a lot of difference in the results. A diesel bus may give more mileage per year as it is not constrained by electric charging hours. For comparison purposes, we have assumed 35 passengers in both cases – EV- and diesel-run buses. The same revenue per km of Rs4 has been assumed, while the better competitiveness of EV may be able to attract a better ticket price – or diesel may get a lower ticket price. Low diesel prices in Pakistan as compared to that in Europe and India put EV buses in a better competitive situation.

For comparison, we have assumed the electricity rates of Rs30 per kWh, while in reality it may be 25 percent higher if the regulated Nepra price of Rs47 is taken. It is assumed that EV buses would have dedicated charging stations and may not have to pay the high regulatory rates of Rs47 per unit. The diesel price of Rs150 per litre has been assumed, which is higher than normal rates but is still lower than that in India where diesel sells at PKR 250 per litre. Thus EV economics may be looking comparatively better in India than in Pakistan.

The least attractive economics is that of EV cars whose running cost per km is approximately Rs7.078 as opposed to that of gasoline-run cars – Rs9.375 per km. The energy cost advantage is little ie only 32 percent higher gasoline cost, which is low as compared to electric motorcycles. The reason is high electricity charges of charging stations at Rs47 per kWh as opposed to the normal highest electricity tariff slab of Rs25-30. The CapEx per km of ECM is twice that of gasoline-run cars. The TCO of EVCs is Rs6.85 million vs Rs5.06 million of convential cars.

In advanced countries, pricing is unregulated in both electricity and charging sectors. In developing countries, where the power sector is regulated, there is a debate on whether charging tariffs should be regulated as well. Nepra has recently announced a charging tariff of Rs47 (26.8 USc) per unit which is comparable to other countries in Europe and the US, although Indian EV charging tariff is somewhat lower (24.7 USc). Pakistan's exchange rate variations make the exact comparison quite difficult.

An argument can be made in terms of unregulated pricing. First of all, true prices are never known. Second, there would be many variables in the charging-related business. The utilisation level (capacity factor), as known in the case of IPP tariffs, would vary from case to case.

A higher tariff would discourage EV adoption and a lower tariff would discourage the charging-related business. It would be fair if Nepra determines the power tariff for electricity purchases for charging stations and leave the charging tariff for consumers open and unregulated. For home charging, it is advisable that no special electricity tariff is issued. One pays for the tariff slab one belonged to. This way, the low-income group using motorcycles would benefit. Similarly, EV car owners would pay a higher tariff since they belong to the highest tariff slab.

EV economics will become attractive with time, as the EV market and cars' efficiency increase. Pakistan has until 2030 to improve things at home. The EV policy should prioritise the EV motorcycles and buses markets which appear to have better economics. Also, the conversion of existing conventional vehicles to electric may be encouraged as it utilises existing investments and reduces upfront costs, increasing switchover incentives. Our destiny in terms of climate issues is common, and we should participate in such ventures so long as they make sense under our economic and social conditions.

5.19: Giving e-bikes a boost

The government has announced a financing package to promote the sale of e-bikes. These environmentally friendly bikes have the potential to contribute towards achieving environmental objectives, industrial growth and reduction of petrol imports and consumption.

E-bike manufacturing is a volume business, and the Pakistan market has the required potential volume. There are 26 million petrol bikes on the road, and around two million new bikes are sold every year. Also, it is relatively cheap to own and operate an e-bike than a conventional motorcycle. While the upfront purchase cost is higher than that of conventional motorcycles – at least 30-50 per cent, the fuel cost is lower. In this regard, an affordable financing scheme with some interest rate subsidy may be beneficial. It is also a good omen that there is continuity of policy in this respect, irrespective of political changes.

E-bikes have a large market share in the developing and poor countries of Africa, South America and Asia-Pacific. It appears that the EV car market is small and possibly not feasible either for imports or for progressive manufacturing. The story of progressive manufacturing of automobiles is not a successful one. Small volumes have been a major constraint in building a viable automotive industry. There has been some success in small cars where the price and volume factors are dominant. There have been quite a few successes in the area of agricultural tractors, which are being manufactured and even exported. The price and volume factors are visible in this case also although there is an added factor of the peculiarity of the tractor market. Cheap credit financing has also promoted the tractor market and its local manufacturing. The tractor industry has also benefitted from a lack of dominance and oligopolistic market, something that has been seen in the case of cars.

The import promoting policies of the last two-three decades under the WTO regime and the IMF-World Bank ideology and the entry of cheaper Chinese goods has not only slowed down local manufacturing initiatives but also damaged the timely emergence and strengthening of the industrial base. The result and consequence is obvious in the prevailing economic circumstances focusing around current account deficit – imports of $80 billion vs exports of $36 billion. High energy imports are one of the leading causes of this problem.

EV expansion may help alleviate these problems to some degree. EV initiatives ought to be associated with the localization of energy sources as well. The fast-track solar PV programme may help achieve some targets to a great extent. Progress in solar PV has been slow in the last few years partly due to the over-capacity issue, which is a common problem in electricity generation due to the lumpy nature of supplies involving 1000-1300MW capacity power plants in the fossil fuel sector. E-bikes have an especially attractive aspect, and can boost and encourage roof-top solar which would be much more economical for e-bike users. One or two panels without an inverter might be a good package for DC systems. A subsidized electricity tariff for e-bikers in off-peak periods may also be considered.

Another market for EVs are trucks and buses. These vehicles consume high volumes of diesel. These are expensive items, operating in a tough and competitive market. These would also require a well-spread charging network. Recently, the Sindh government bought a fleet of EV buses for Karachi's public transport network. Authorities have installed charging infrastructure in bus garages. For a government, upfront costs which may be as high as $300,000 may not be as big an issue as it may be for the private sector.

International subsidized financing lines can be found for financing EVs. The conversion of diesel buses can be a viable approach since diesel engines are to be replaced every five years. At this replacement juncture, the conversion of diesel buses to the EV system may be a feasible approach. Only institutional operators may be able to own and operate EV buses due to the issue of expensive charging infrastructure.

If one starts with an initial production rate of 175,000 units per year with a growth rate of 10 per cent per annum, one would get the annual sales of 341,000 units. It is much lower than the required sales of 2 million per year by FY 2030 (50 per cent market share of e-bikes). One would have to start with an initial production of 400,000 units per year with an annual production growth of 25 per cent per annum to be able to get the required production rate of 2 million units per year. More aggressive policies may have to be designed in the mid term to achieve these targets.

This shows that it may not be feasible to achieve the 2030 target of a market share of 50 per cent in new e-bike sales. It may be worthwhile to explore other policy options as well, such as conversion of the existing motorcycles to e-bikes; it costs Rs50,000 for one such conversion. These rates may go down if the market expands. Many countries, including Indonesia, have made conversion a part of their policy programme. In India, conversion is being pursued in the bus sector; one conversion costs INR6 million. There are plans in Karnataka to convert 30,000 diesel buses to e-buses by 2030.

India has 200 million plus motorcycles. In FY2022, 231,338 units of e-bikes were sold. In India and Indonesia – two countries with a large e-bike market – there are 10-12 e-bike manufacturers. Contrary to this, in Pakistan, with a much smaller market, licences have been issued to 23 companies for e-bike manufacturing. It would certainly reduce the individual market shares of manufacturers to an uneconomical capacity. While companies may be making profits, the goal of 90-100 per cent local manufacture will remain elusive if this trend continues. Hopefully, some licence holders may not turn up, ultimately reducing the prospects of market segmentation.

The e-bike market provides a rare opportunity for localization. It should not be lost in market fragmentation. The government may like to explore the feasibility of auctioning two or three licenses for a 100 per cent e-bikes production under an incentives package. It should not be a long-drawn deletion programme, and should be attractive enough for large international companies to make significant FDI. There are three major parts of e-bikes: batteries, motor and electronics in addition to the body, wheels and steering etc. These three items may be bought in. Separate licencing may be done for these parts. There may be separate programmes for these components.

There is another perspective as well. The motorcycle and e-bike industries have the same requirements of body-making, which is already well-developed in the country. E-bike manufacturing requires three main components. Does the e-bike policy mean encouragement of the production of these three components? It gives a totally different complexion to the policy design, away from product to components.

Also, motorcycles are one of the top 10 product sectors for exports. It has not happened yet, or very little has happened, but the country has some potential. Africa, Middle East and South America are the potential export destinations. There is a transition period between motorcycles and e-bikes. All production policies in this sector have to be designed keeping export potential in mind.

Figure 5.19.1: Jolta Electric bike

Charging and Range:

Charging times range from 5 to 8 hours, depending on the model. The bikes offer a commendable travel range on a single charge, from 50 KM for the E70 to an impressive 120 KM for the E125. This makes them not only convenient for daily commuting but also suitable for long journeys.

Minerals

6.1: Pakistan mineral outlook

Recently, an important conference, 'Pakistan Mineral Summit', has been organised in Islamabad by the Petroleum Division. Top national and international dignitaries and a large number of professionals participated. The conference brought Pakistan's minerals into a new perspective and possibly marked a new beginning. It also reaffirmed Barrick's commitment to the Reko Diq project as outlined by the CEO of the company in the context of the new Reko Diq agreement. We will discuss in this space Pakistan's mineral outlook today in the context of the new initiatives that are under study.

Pakistan's mineral sector contributes 2.5% to the GDP, which is very miniscule, although there are several large known deposits. Copper, gold, lignite coal, iron, lead-zinc, ferrochrome and marble/granite are the most distinct and visible. Besides, there are a number of non-metals that are there.

Thar coal/lignite is on the top of minerals with 185 billion tons estimated resources, which are already playing a major role in supplying energy to Pakistan. More can be done and should be done to increase its output before the window is closed (within the next 50 years) on this important resource under international climate regime.

Copper

Copper and Lithium are the future oil. Copper is already playing a major role in electrical sector worldwide. No electricity can be conceived without it. However, emergence of Electrical Vehicles (EVs) has created a new market and prospects for it.

Copper prices have been increasing. When Saindak was launched in the 1990s, copper prices were only around 2000 USD per ton, which created difficulties for its financial survival. It is above 8000 USD per ton now and the prospects of it going up to 15000 USD per ton cannot be ruled out.

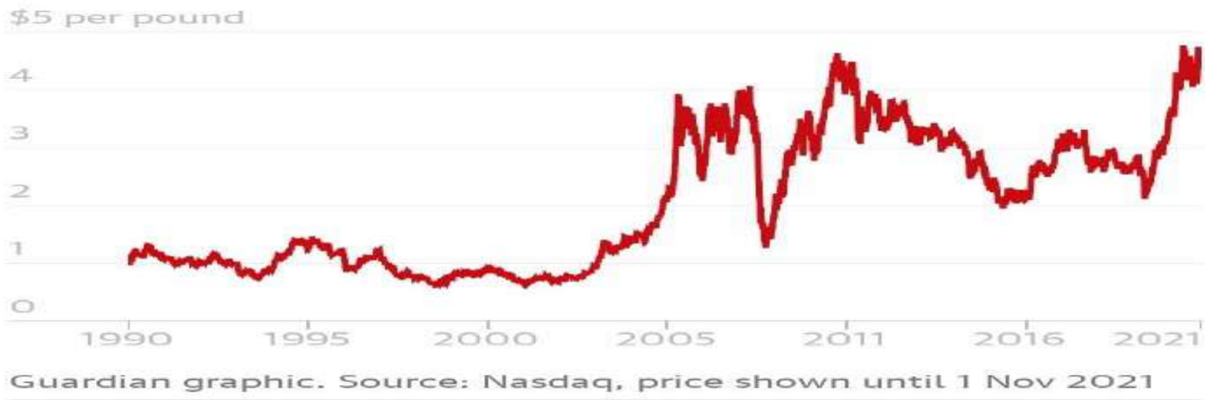
Major copper and gold resources are at Reko Diq, which is now through with the legal problems. Recently, news has come out of a copper deposit in Waziristan which is actually working. Not much has been publicised about it in public domain. This deposit is, however, much smaller than Reko Diq as opposed to wrong information publicised by some journalists.

Table 6.1.1: Minerals Reseves & Grades

Minerals	Reserves (Million Tons)	Grade
Chromite	2.527	Low to Medium
Copper	1352	Low to High
Gold	1,656.00	Low to High
Iron Ore	1,427.20	Low to High
Lead-Zinc	23.72	Low to Medium
Coal	185,000	Low to Medium
Gypsum	6 Billion Tons	Medium to High
Marble & Granite	297 Billion Tons	Medium to High

Copper resources (deposits) have been estimated at 5.9 billion tons (contracted), out of which 2.5 billion tons have been found recoverable, although the latter is variable and depends on the prevailing prices. There is confusion about contracted and non-contracted deposits. Average depth of 15-20 meters has been reported, indicating good mining economics. At current and long-term international prices (LME grade A cathode), the deposit value can be said to be of 100-200 billion USD.

Figure 6.1.1: Graph of Copper price from 1990 to 2021



The resource value at copper finished prices may be misleadingly high. However, in concentrate form in which it is usually exported from mines, its value is lower. As per existing studies by investor Barrick, there are both gold and copper in the Reko Diq deposit (Copper 0.53% and gold 0.3 gms per ton). Whatever be the value, Balochistan will get a proportional royalty at 5% of the ex-mine price. In addition, there would be income from income tax and corporate profits.

Under new terms of agreement, there is 50-50% share of Pakistan and Barrick. The province of Balochistan will have 25% and three federal companies will have a combined share of 25%. Earlier, foreign companies had a share of 75%. Balochistan's share will be 10% without actual equity subscription and 15% would be on payment basis. So Balochistan is having a good deal. Pakistan has been saved of a major financial catastrophe of having to pay fines of about 10 billion USD.

Rival governments have cooperated in the revival of the project along with the Supreme Court which earlier created the problem by declaring the earlier Reko Diq agreement null and void. Let us not repeat such mistakes in the future. World will carefully watch our conduct in the current arrangement As per existing studies, 200,000 tons of copper and 250,000 oz of gold will be produced per year. Reportedly, it is being studied to double the output in second phase. Concentrate (usually containing 20% copper and gold) output would be 80 million tons per year.

Aggregate turnover and exports should exceed 2 billion USD per year, depending on the prices. Earlier feasibility study is being updated. Investment of 8-10 billion USD has been projected. The project will start giving output by 2028. The project should have an economic life of 40 years. Estimated income Flows, (as per private estimates of this scribe): Royalty (@ 5% of sales) should yield 100 million USD per year, all of it going to Balochistan. Additionally, profit share of 25% would accrue.

Three participating national companies will get their profit share as per their equity share. The federal government will get corporate income taxes. It is not known whether corporate income tax exemption has been awarded under SEZ rules. Earlier project feasibility study limited local production to concentrates only containing 25-30% copper. Copper concentrate was to be exported for extra-processing abroad into saleable products. Concentrates' trade is not unknown. Some 30% copper (3.3 Mt out of 11 Mt) is traded in copper-in-concentrate form. It is not known as to what would be the project structure in the new setting.

However, it is not usual for mining companies to install downstream processing units. They cannot be and should not be forced to install downstream industries. A wide variety of business interests invest in the down-stream sector. Industrialization and technology expansion take place under this model. Copper processing is an energy intensive process requiring both gas and electricity. Chaghi area of Balochistan is quite rich in solar and wind resources.

A hybrid solar and wind along with some fossil fuel would be an optimum energy mix. It may, however, be noted that Al-Tuwairqi Steel Mills could not be commissioned. Therefore, energy cost and availability would have to be seriously examined before insisting on smelting and refining components. There are about 20 countries which have active copper mines: Russia, the US, China, Canada and Australia among developed countries and Chile, Peru, Mexico, Brazil, Zambia, Congo, Indonesia, Iran, Kazakhstan and Mongolia among the developing countries. China imports and exports more than 50% of world Copper.

Table 6.1.2: Top-18 Copper producing Countries

2017[2]

Rank	Country/region	Production (thousand tons of)
	World	19,939
1	Chile	5,503
2	Peru	3,462
3	China	1,656
4	United States	1,260
5	Congo, Democratic Republic of the	1,094
6	Australia	859
7	Zambia	797
8	Mexico	742
9	Russia	705
10	Indonesia	622
11	Poland	620
12	Canada	605
13	Kazakhstan	540
14	Brazil	419
15	Mongolia	384
16	Iran	314
17	Spain	204
18	Laos	153

Although most developing countries started with concentrate production and exports, gradually most of them have installed smelters and refineries. They are Zambia, Congo, Iran, India and Chile. Indonesia is mulling banning concentrate exports and is installing the world's largest smelter with a capacity of 1.4 mtpa of concentrate handling. Canada, a developed country, is exporting concentrate only. So it depends on the individual countries' situation and preferences.

It appears that there is sufficient lead time available between now and plant commissioning in 2028. Mining processing equipment is similar to the fabrications work used in the cement sector. Many cement plants have been made by local Pakistani companies. Discussions should be initiated between local companies and the Reko Diq project. Similarly, institutional strengthening is required of the Geological Survey of Pakistan if mineral sector is to be expanded adequately.

Lithium is a highly conductive metal, both for heat and electricity. It is said that it was produced along with the Big Bang which reportedly produced the universe. It has a variety of uses but has emerged as a major electrode material in batteries especially in Electrical Vehicles. It is found both as brine and as solid ore. Largest Lithium deposits are found in South America called Lithium Triangle consisting of Chile, Argentina and Bolivia. Bolivia has reportedly the largest Lithium resources. Australia is the largest supplier.

South Asia, India, Afghanistan and Pakistan have been reported to have lithium. Russians had discovered lithium in Afghanistan during their invasion of this country. There are accounts of discovery of Lithium in occupied Jammu and Kashmir's Reasi district. Deposits have been reported to be of 5.9 million tons per year having a value of 410 billion USD, depending on the prevailing prices. In Rajasthan also, lithium finds have been reported. Recently, prices in China have been quoted at 36000 USD per ton. A lot of preprocessing, including electrolysis, is required to produce marketable lithium.

It has been reported that in Pakistan also lithium has been found in Gilgit-Baltistan, Chitral, parts of KPK and Chaghi in Balochistan. Adequate geological effort should be put and its institutional strengthening would be required for fast-track development of this resource. Cobalt has also been indicated in the same area, which is a pricey mineral more than Lithium probably.

Iron ore

Pakistan has Iron ore resources of around 1.4 billion tons, most of which are of low grade, except the recent discovery of iron ore in Chiniot. Several iron ore deposits have been identified for years, like Kalabagh, Nokundi, Dalbandin, etc. PPL has a JV with provincial government of Balochistan as Bolan Minerals, which provided beneficiated iron ore to Pakistan Steel Mills (PSM). For quality and other reasons, PSM rescinded the contract. Chiniot iron ore is reportedly of higher grade of 60%. Reserves may increase with further exploration. Reserves are of 250 million tons which may increase to 500 million tons.

However, there are bright chances of utilising Chiniot iron ore. PMDC Punjab is developing this project and there have been reported negotiations with Saudi Maaden Company for a JV on it. There may be issues of the supply of energy; coal or gas. While gas is out of question, one of the DRI plants in Karachi has been shut down due to gas supply and pricing issues. On coal side, there is Thar coal, nearby salt range coal, Balochistan coal from Dukki or imports from Afghanistan.

Chiniot project has been designed on DRI (Direct Reduction Iron) — Corex process with an output of one million tons per year. Chiniot ore can also be utilised by adding Corex process line to Karachi located Al Tuwairqi DRI plant (1.28 million tons per year output) that was closed down almost immediately after its opening. There was gas pricing and availability issue. Possibly, Thar coal can be used in the Corex process. Both being probable Saudi projects, there may be good prospects in this respect. The issue is whether to bring iron ore to the coal source or bringil coal to the iron source.

Other ore resources

A lot is known about Thar coal of 185 billion tons, which is today producing cheapest electricity .Presently, 8-10,000MW of Thar coal based electricity is projected in the next ten years. In addition to electricity, many other products can be produced through gasification route. As mentioned earlier, the deposit is very large and every effort should be done to maximize its output on fast-track basis.

Pakistan has 300 billion tons of marble resources spreading over in all the provinces. Marble is mostly utilised in the local construction industry. Only 37 million USD of exports have been reported. It has been claimed and perhaps rightly that this number can and should go up to 370 million USD and even more. However, the sector suffers from highly unsafe labour intensive operations and low technology. There is a waste of 70-80% as opposed to 50% in other countries. This increases cost, reduces quality and competitiveness in the international market. There is a great scope for increasing quality, output, employment and exports. Foreign investment and induction of technology are required.

There are other mineral resources, important among these are zinc-lead and ferrochrome. Cobalt has also been indicated in Gilgit-Baltistan. Besides, there are non-metallic resources as well.

Mining policy and laws

While mineral resources are rightly provided the ownership rights in the constitution of Pakistan, there is a need of developing a unified countrywide mineral policy regime a la oil and gas. The whole country has suffered under policy confusions and subsequent judicial activism in the case of Reko Diq. The federal government had to foot the bill. And in future, the whole country would suffer under a similar debacle. It has to be a balanced investment friendly policy; neither should it be a declaration-of- independence-type political statement nor should it be a sell-off.

There are two issues under which Reko Diq debacle occurred; conversion of exploration license to a production license and installation of down-stream industry by the licensee created a lot of confusion which should be resolved and clearly delineated. Downstream industries ought to be separated from the licensing issue. Two parts can be there in the policy; one provincial domain related with local investments and SMEs; second with large scale mining agreements of international scope to be jointly handled by federal and provincial governments. While there are ample models for dealing with international mining contracts, there isn't much available to promote local SMEs in the mining sectors. SME mineral sector can be a good tool for creating employment throughout the country.

There is rampant corruption and middlemen in the SME mineral sector which increases cost of production and discourages small and efficient parties. e-Auctions or simple manual auctions can be considered for SME mining contracts. e-Auctions can also be useful in local large-scale mining sector. For smaller and weaker mining labour, mineral cooperative system could be introduced as well.

Resource curse

There is a controversy in economic literature led by renowned economist Jeffery Sachs that mineral resources cause various economic, political and social difficulties among developing countries having mineral resources. Focus shifts to earning rents rather than profits through growing and developing. Elite capture and corruption increase. Currency strengthens to higher levels which hinder exports of other products. Evidence of mineral rich African countries such as Congo, Niger, and Guinea, etc., has been cited.

The situation of mineral rich South America is, however, not that bad. Chile and Peru are reportedly doing well but have suffered under imperial and colonial conspiracies and pressures. Mineral curse has already been there in Pakistan to some extent in various forms. We were about to lose 10 billion USD in the fines levied by the World Bank tribunal. Unrealistic projections of mineral abundance have promoted separatism and terrorism.

Fortunately, Pakistan has mineral resources but cannot be called as having abundant resources. Resource abundance is a relative and possibly controversial subject. Pakistan has a large economy and a wider resource base such as agriculture. It won't be a single source economy at all. Thus the prospects of becoming mineral resource dependent, as happened in many countries of Africa, do not seem to be there.

However, Pakistan is suffering from trade imbalance and falling currency. Mineral exports and industries can contribute to the alleviation of these issues. However, we should not commit mistakes of keeping these industries under public sector. Private sector investment under JVs in downstream industries may be promoted. Private sector would naturally ensure that uneconomic projects are not launched. FDI as being negotiated should help Pakistan in ameliorating its current financial problems. For long-term growth, we will have to focus on agriculture and industry.

6.2: Emerging copper market and opportunities

Copper market is emerging once again in the march towards green energy and electric vehicles (EVs). Renewable energy requires four to six times more copper than fossil energy. The International Energy Agency (IEA) has projected that copper demand in the world would double in the coming two decades, ie by 2040. Copper is new oil as the exuberant voices reverberate. Its price and demand will double.

In Pakistan, Reko Diq copper deposits are lying unutilised due to legal issues. There is a tribunal award requiring Pakistan to pay a fine of $5.6 billion. Resource has become a curse. Fortunately, as reported in the press, background negotiations are going on to revive the project. Dissenting voices and concerns have been raised by the stakeholders. In the following, we would like to present the context of the issues involved and the potential that lies ahead.

Current demand for copper lies around 20 million tons and supply is already short by 5-6 million tons, giving rise to higher prices. Already in 2021, copper prices reached their highest level in history at $10,030 per ton. Copper prices had kept going down from 1965 to 2005 and then started increasing to the current level. There is usually cyclical variation in metal prices including copper over a period of 5-10 years. Recently, copper prices had had two dips – one in 2016 at $4,250 per ton and another in 2019 at $4,890 per ton, which were almost half the current price levels.

The current high cycle may continue for the next 10 years due to tremendous demand-pull factors, as has been mentioned earlier. One of the issues in the Reko Diq dispute has been that the investor should also install the intermediate facilities of smelter and refinery to enable local processing by the downstream industry. Value addition and job creation are the cherished objectives of the host government. Concentrates can only be exported out and cannot be used by the local industry. Another doubt among local stakeholders, which has been recently spelled out, is that local refining would enable closer monitoring and regulation of copper and gold percentages which at concentrate stage remains doubtful.

Investor companies have their own objectives, interests, commitments and linkages for concentrate processing. Smelting and refining has traditionally been concentrated in larger and advanced economies like Japan, South Korea, China, India, European states and the US. Also, the smelter's economic size is often larger (350,000-500,000 tons per year), which is bigger than the smaller mine size like Reko Diq of 200,000 tons.

Often investment requirements in the downstream industry are much more than mining investments, which may not be on the mine site and may be done by other parties. Incidentally, Reko Diq mine size is lower than the 20th smallest mine (Sentinel) with a capacity of 260,000 tons. The largest is Escondido with a capacity of 1.4 million tons. Copper was discovered in the 1960s in Pakistan and Resource Development Corporation (RDC) was established to develop the resource in the 1970s. Later, a small project of Saindak was established under Chinese assistance which the government of Pakistan tried to run but had to be closed down due to financial losses. The project was later taken over by Chinese company MCC, which continues to do so while Saindak deposit is closer to exhaustion.

A late comer

China is the largest consumer and producer of finished copper in the world. It is also the largest market of copper. China imported copper ore and products to the tune of $48.5 billion in 2019. China could have been a natural partner for Reko Diq and should have been involved in the project before getting embroiled in a dispute. Perhaps, CPEC was a late comer for Reko Diq, otherwise, it would have been an ideal framework. Now with the tribunal's fine, our hands are tied with the litigant party. Chinese went to Afghanistan to develop Aynak deposits, which could not be developed due to the poor law and order situation.

China, however, got hold of competing copper deposits of 240 million tons nearby, 40 km from Kabul. Its copper grade is much higher at 2.3%, about five times higher than Reko Diq. Jiangxi Copper and MMC prepared a project to produce 330,000 tons per year of copper concentrate and export it to China. Capital investment of $3.3 billion has been envisaged. Project is in limbo due to instability in Afghanistan.

China had got Saindak much earlier. Saindak is a small project, which produced blister copper of 13,222 tons in 2016-17 and exported 12,310 tons with export value of $102 million.

By comparison, Reko Diq is 15-16 times larger project (220,000 tons of copper per year), although its production is limited to concentrate. Extrapolating Saindak data to Reko Diq, the latter's output and export should be worth $1.6 billion at 2016-17 prices.

Iran's copper mine

Iran started developing its copper mine at Sarchashmeh (Kerman province) around the same time as RDC was formed in the 1970s. Iran managed to continue the project. Today, a complete integrated project runs with copper cathode production exceeding 200,000 tons per year. Investment has been recouped several times. Iran's Sarchashmeh deposit is richer than Reko Diq in terms of copper percentage of 0.70% as compared to Reko Diq's 0.41%.

Reko Diq, probably, has arrived at the right time and still continues to be in the right time frame due to the emergence of EVs and renewable energy like solar. Iran's good experience and our bad experience tell us that one should not be overzealous in terms of value-added and downstream industry, jeopardising the project itself.

Ultimately, investment comes in with time when politics and economics of the resource permit. There are three streams of revenue which accrue to the host government in mining projects including copper. Under this scheme of things, the investor and host government takeaway from the copper project almost remains at 50-50%. It is a separate matter that either due to market circumstances or corrupt practices and account manipulation, the host government revenue may be eroded.

This creates political discontentment and disputes, rendering host countries poor as many countries are in Africa. It is time for the parties in Reko Diq to develop a framework for restarting the project. We have earlier discussed the need for improving access to mineral areas and improve the internal climate at local and provincial levels.

On the part of the mining company, the enticement of recouping the fine is great but greater opportunity lies in utilising the copper and gold deposits of Reko Diq for the mutual benefit of the parties involved. Market of copper is expanding and prices rising. Worldwide fast-track utilisation is a priority to maximise the present value of earnings. Project parameters can be changed to increase the throughput and revenue.

Company benefits as well as the host government; the latter can utilise the income and foreign exchange for the betterment of its people and the economy. It is not a zero-sum game. It is value creation.

Table 6.2.1: International Comparison of Royalty Rates

Country (State or Province)	Gold	Copper	Nickel	Zinc	Tin
	Royalties (%)				
Argentina	3.00	3.00	3.00	3.00	3.00
Australia (Queensland)	2.70	2.70	2.00	2.70	2.00
Australia (Western Australia)	1.25	2.50	2.50	2.50	—(2)
Brazil	1.00(1)	2.00(1)	2.00(1)	2.00(1)	2.00(1)
Canada (Ontario)	20.00(3)	20.00(3)	20.00(3)	20.00(3)	20.00(3)
Chile	0	0	0	0	0
Ghana	3.00	#	#	#	#
Indonesia	3.75	4.00	4.00-5.00	3.00	3.00
Mexico	0	0	0	0	0
Papua New Guinea	2.00	2.00	2.00	—(2)	—(2)
Peru	0	0	0	0	0
Philippines	2.00	2.00	2.00	2.00	—(2)
South Africa	0(5)	0(5)	0(5)	0(5)	0(5)
Tanzania	3.00	3.00	3.00	3.00	—(4)

Table 6.2.2: Production and share of Global production by Country and metal (Co, Cu, Mn & Ni) 2018

Country	Cobalt (kt)	Co %	Copper (kt)	Cu %	Manganese ore (Mt)	Mn %	Nickel (kt)	Ni %
Australia	6	3 %	913	6 %	7	14 %	148	7 %
Brazil	0	0 %	381	2 %	3	6 %	74	3 %
Canada	5	3 %	539	3 %	-	0 %	180	8 %
Chile	-	0 %	5 832	35 %	-	0 %	-	0 %
China	9	5 %	1 591	10 %	9	17 %	99	4 %
Democratic Republic of Congo	109	65 %	1 225	7 %	-	0 %	-	0 %
Indonesia	0	0 %	651	4 %	0	0 %	509	23 %
Jamaica	-	0 %	-	0 %	-	0 %	-	0 %
Japan	-	0 %	-	0 %	-	0 %	-	0 %
Papua New Guinea	3	2 %	96	1 %	-	0 %	35	2 %
Peru	-	0 %	2 437	15 %	-	0 %	-	0 %
Philippines	5	3 %	70	0 %	-	0 %	345	15 %
Poland	-	0 %	401	2 %	1	1 %	-	0 %
Russian Federation	5	3 %	785	5 %	-	0 %	218	10 %
South Africa	1	1 %	47	0 %	15	28 %	43	2 %
Total 15 countries	145	86 %	14 969	91 %	35	66 %	1 652	74 %
Total World	168	100 %	16 500	100 %	53	100 %	2 233	100 %

Source: RMG Consulting 2020.

6.3: Minerals Policy: Accommodating local interests

Pakistan has considerable mineral resources which could not be utilised for a variety of reasons, perhaps mostly political. The two main examples are mineral and gas resources. These days, Pakistan is suffering from the gas crisis as the local gas resources are constantly depleting and new resources could not be explored and developed. There are people who are sceptical about the gas resource potential. But there are other knowledgeable people who argue that high security risk areas have not been adequately explored.

A clear example given is of Kohlu where reserves of approximately 22 trillion cubic feet remain underdeveloped due to the local tribal resistance. There may be other reasons as well, but we will restrict to political economy of the subject. In developing countries, mining areas generally have more poverty than other areas, which has caused conflict and strife. In developed countries, due to widespread development and the lack of disparities, these problems do not exist.

And where problems do exist, the developed countries have developed formulae, structures and mechanisms to deal with them. An example is Canada, where tribes in mining areas have been accommodated. Even India has somehow solved the problem through appropriate rules, as a result of which there has been a considerable improvement in the mineral sector associated with peace in the mining regions. In the mining sector including oil and gas, considerable damage occurs to the local communities. Environmental and physical degradation is usual. Local water and land use is affected.

Unfortunately, locals are not compensated adequately under a formal mechanism. Local identities are real such as the tribal ones, while provincial and federal boundaries and identities are political. Under the existing rules, income and corporate tax goes to the federation and royalties' income goes to provinces.

Provincial government is supposed to spend some of the royalty income on the local population in the mining areas but it is always short of revenue to run the administration and is dependent on federal subsidies itself. There is an issue of leakage and corruption, which is more in backward areas than in more developed parts and provinces. The mining sector also suffers from the colonial and imperial practices.

The sector is well integrated with the mainstream in the developed countries. There is generally lesser interest in the developed countries in royalties and more interest in profits and taxes. Thus, royalties have been underpriced traditionally and more so because they belong to the developing world. Creative royalty agreements can also solve some of the royalty income issues such as what the Chinese did with the Aynak Copper agreement in Afghanistan. They had a S-curve formula, giving low royalty rates at low copper prices and higher royalty rates at higher international copper prices.

Metal prices vary a lot. Incidentally, this creative formula did a lot of damage in Pakistan as it was misconceived and compared with the Reko Diq royalty formula, causing opposition and ultimate cancellation of agreement and finally the ICSID tribunal fine of $6 billion on Pakistan. There are various issues mostly of political nature but embedded in income sharing and control – one is of provincial ownership and rights to control and decide on mining contracts and utilisation, which is rather of theoretical concern as the capabilities and technical and management resources are lacking.

What happened to Reko Diq may partly be ascribed to confusion and malpractices in awarding the contract. The second issue is of having a higher share in the income beyond royalties, and the third is the share of locals – tribal vs provincial interests.

Resource ownership is a complicated issue. In developing countries, it is a political issue while in developed countries it is a commercial issue. Resource belongs to the people or the government as long as it is under the surface. When it is brought on to the surface by the application of investment, resources and technology, it becomes property of the developer.

Commercially, companies claim that they decide in terms of maximising profits. The mineral sector could not be developed also due to security and political issues. In the case of Reko Diq, new dissenting voices are emerging against a reported compromise solution with the foreign investor, asserting autonomy and mineral rights. The World Bank tribunal has delivered award against Pakistan involving a fine of $6 billion based on doing a mere feasibility study at an overstated expenditure of $200 million.

While we thought it was our resource and we have the all the rights to it including specifying the installation of a downstream industry like copper refinery. It is a separate matter had Reko Diq project been implemented as per the feasibility study, Pakistan would have got an income of $500 million per year and the accumulated income would have been more than $2 billion by now.

The second issue can be sorted out by developing a formula for sharing revenues other than royalty incomes as has been done elsewhere. The third one of tribal share and ownership has been intractable, although there are ways to resolve it. Tribes have been making claims of land ownership and government circles have been talking about Alaska formula, which recognises and compensates resource ownership based on the land sub-surface rights.

Canadian formula

Resource revenue sharing agreements let tribes share in the economic benefits of forestry and mining operations near their communities. Tribes with resource revenue sharing agreements receive a share of 40% of the annual mining tax and royalties from the operational mines. Tribes can use such revenue for economic development, education, healthcare, community and cultural development.

District Mineral Foundation

In India, they have come up with the institutional concept of DMF under a federal law promulgated in 2015 according to which local governments get 30% of the mineral revenues including royalties. Such income is to be spent by the local authorities. There are issues in its implementation like upward and downward integration. Tribes live in local districts. If local districts get the income, tribes get the impact on their development and welfare. There are other sectors like hydropower, which have recognised local interests and award a share in royalty income in recognition of the required compensation for physical and environmental damage and resource sharing.

In Pakistan, there have been discussions on the subject. However, it is not known if the same has been implemented. The Petroleum Division has come up with a new policy which may give a fillip to the oil and gas exploration activities. However, this deals with the technical and procedural issues which are important itself. However, the main issue is political. They say all politics is local. Local interests have to be recognised for a peaceful and cooperative development.

In Pakistan, where there are diverse ethnic groups and several groups reside in one province, this aspect acquires a special importance. Consultations and negotiations among the stakeholders should be initiated on the issue. There are successful examples as we have discussed in the foregoing. Intellectuals and political parties should help develop consensus on the issue.

6.4: Tuwairqi Steel's revival initiative

Reports have appeared recently in the press on initiatives for the revival of Tuwairqi Steel Mills Limited (TSML), which had been established in 2008 in the vicinity of Pakistan Steel Mills.

It could not be commissioned due to a gas pricing dispute. Finance Adviser Shaukat Tarin has reportedly asked the relevant agencies to look into the case. Many new developments, both positive and negative, have taken place since 2008. Gas in Pakistan has become scarce, gas prices have increased and there is great uncertainty in international prices.

Thus, the prospects of any mutually acceptable and viable solution do not appear to be bright. On the positive side, however, there are two major technological and resource developments, which may help develop a viable solution for TSML's revival. TSML claims an investment of $350 million, which remains stranded due to the gas price dispute. It has knocked the doors of international arbitration. It intends to put another $700 million for the revival. It also wants to use local iron ore.

TSML expected gas supply at a low rate of $1.23 per million British thermal units (mmbtu) – a price that is offered to priority sectors like fertiliser producers. There is no evidence or contract to that effect. Many people even object to the fertiliser industry being given such a low tariff rate, not to talk of the steel sector. As annual gas demand of TSML is 12 billion cubic feet (32.877 million cubic feet per day), it would mean a subsidy of $16.2 million per annum and $162 million for 10 years.

If the opportunity cost of LNG is assumed at $10 per mmbtu, it would mean a subsidy of $48 million per year, the critics may argue. The two developments are global hydrogen initiative and Thar coal development in Pakistan. In 2008, Thar coal was buried under the desert. Only recently, Thar coal has come above the surface. There are two major coal mining and power initiatives – one launched by SECMC and the other by SSRM.

A 10,000-megawatt coal power plant may be built shortly, although green initiatives have thrown some uncertainty in this direction. Initial studies have been done, exploring the possibilities of Thar coal gasification producing both syngas and liquid fuels such as diesel. Thar coal-based syngas can be an ideal, even better, solution for the Midrex-DRI process that TSML has installed. Cost aspect is uncertain but it is projected that it may be cheaper than LNG.

The other development is global hydrogen initiative. Hydrogen can be utilised in reducing iron ore. Iron ore is usually in oxide form. In the conventional blast furnace process as installed at Pakistan Steel, carbon/ coke is utilised for reducing iron ore and adding carbon for carburisation. In the alternative processes, hydrogen is used in various combinations to reduce iron ore and carbon is added in various forms for carburisation. Fortunately, TSML's vertical shaft Midrex process is amenable to conversion to hydrogen.

Types of hydrogen

There are four types of hydrogen according to the source material used – petroleum, gas, coal and water. Out of the four, Pakistan has Thar coal and water along with solar power.

Pakistan does not have gas or oil in those quantities and at lower prices acceptable for the steel-making process. Thus, green hydrogen emerges as a possibility. Green hydrogen is produced by the electrolysis of water – fresh or even seawater. Electrolysis requires electricity, which can be produced through solar energy. We have no dearth of sunshine as we have more than twice of what is there in steel-making countries of Europe.

Electrolysis technology, however, is expensive but is slated to become cheaper on the model of solar PV. By 2030, it may be as cheap as $1 per kg or $8 per mmbtu. If some concessional or grant funding is available, a green hydrogen plant can be installed near TSML by the mill itself or by a third party.

Alternatively, one can use Thar syngas to produce hydrogen, which may be competitive even now. Saudi Arabia has great interest in hydrogen and the developers of TSML are from Saudi Arabia. Thus, Thar coal gasification appears to be a viable and realistic option that should be considered, provided Chinese assistance is obtained under CPEC.

China is also turning green at least on foreign projects. In that case, green hydrogen route may have to be explored.

TSML and Pak Steel technologies

For the non-specialist, let us provide some info on Pakistan Steel Mills and TSML. Pakistan Steel is an integrated steel plant based on blast furnace, which starts with iron ore and coal as raw material and produces finished and semi-finished steel products like billets, structural steel, plates and sheets, etc.

Its production capacity is 2.2 million tons per annum (mtpa) while TSML has half of that capacity. TSML will produce semi-finished iron and steel products. Direct Reduction of Iron (DRI) replaces scrap and its price is assumed to be equal to the scrap price.

TSML has adopted a gas-intensive production process called DRI where gas is used to reduce iron oxides and other ores to produce iron in the form of iron sponge as opposed to the pig iron that is produced in blast furnace where iron ore and coke are burnt together – the like of which has been installed in Pakistan Steel. The DRI vertical shaft process has been adopted by gas-rich countries like Iran, Qatar, Oman, Saudi Arabia and other Middle Eastern nations, some of which have both cheap and abundant gas and iron ore as well.

Most advanced nations having iron ore and coal as well as high steel demand like China, Russia, the United States, and European countries have adopted the blast furnace route. It appears that for small markets like Pakistan, the scrap or DRI-based arc furnace route is good, which obviates the need for large blast furnace projects like that of Pakistan Steel, as we are facing problems these days.

There are proposals of co-production or integration of the two projects – TSML and Pakistan Steel, although both suffer from the unique issues of operating and reviving their main pieces of equipment. There is potential for synergy and cooperation between the two projects. It is hoped TSML will be able to make downstream investments. Its economics and profitability will improve due to the integration and hopefully no further gas price concessions would be required. There is enough land around to expand.

It should, however, be understood that no competitive and profitable industry could be sustained on the crutches of subsidies. Projects should be designed keeping in view the resource endowment and comparative advantage. The government has no money. Money has to come out of corporations and the people earning money.

Table 6.4.1: Coal-based DRI process

Process	Raw material	Product	Largest single module (Mtpa)
ACCAR/grate car	Fines	Solid	0.35
AISI/cyclone	Fines	Molten	0.5
AISI/pellet	Pellets	Molten	0.35
Circofer	Fines	Solid	0.5
COREX	Pellets/lumps	Molten	1.2
DIOS	Fines	Molten	1.0
DRC	Pellets/lumps	Solid	0.15
FASTMET	Fines	Solid	0.45
FINEX	Fines	Solid	0.25
HIsmelt	Fines	Molten	0.50
INMETCO	Fines	Solid	0.3
Romelt	Fines/lumps	Molten	0.4
SL/RN	Pellet/lump/fines	Solid	0.25
Tecnored	Fines	Molten	0.3
Coal gasification + HYL self-reforming (ZR) plant	Pellets/lumps	Molten	-
Coal-based ULCORED	-	Solid	-

Sources: *Duarte (n.d.); Sikstrom (2013)*

Energy Conservation & Efficiencey

7.1: Energy efficiency

The idea that 'energy conserved is better and cheaper than energy produced or purchased' has proven to be true, especially due to rising energy prices, supply uncertainties and climate change effects. In the West, the movement for energy conservation, efficiency, self-reliance and renewable energy started in the backdrop of the 1973 oil crisis. Since then, remarkable changes have occurred in the energy sector. Earlier, energy intensity – energy elasticity of the GDP – used to be more than one which means that to increase the GDP by one percent, an 1-1.5 percent increase in energy supply or consumption was required.

Today, in most countries, this index is 0.5, and, in some economies, it is even negative. This means that the growth rate in energy conservation and efficiency is faster than the growth rate of the economy. But it is not true for developing countries like Pakistan due to a variety of factors, including poverty, low education and technology. The sensitivity of the issue, however, is increasing among government policies and the people.

Energy is used in all parts of human life. A wide variety of sectors, users, producers and traders are involved and directly affected by the energy sector. There are, however, some limited number of areas which consume the bulk of energy, which makes the job of achieving energy conservation and efficiency relatively easier.

Due to market and trade reasons – and not any indigenous effort, many improvements have taken place, especially in imported items. Today's cars are more than four times fuel efficient than those of the 1980s. And with electric vehicles (EVs), efficiency is likely to increase even more. The revolution in the lighting sector came through LEDs. Also, the latest computer and TV screens are many times more efficient than their previous models.

Split ACs are being widely used which are generally more efficient than window ACs as the former is being used for both cooling and heating purposes. Using ACs as heaters is much more efficient than the use of classic resistance heaters. Unfortunately, in this area, only the rich have switched while the poor do not have either the house or the money to benefit from it. Home electrical appliances are more efficient today, but they still have room for improvement.

Unfortunately, the building sector is the most energy inefficient sector, and not much has been done in this respect. Conservation has two sides – energy-efficient appliances and user-side efficiency. There is no use of installing energy-efficient ACs in a poorly built house with poor insulation.

The building sector has a large share of 20 percent in energy consumption. In the US, the housing sector consumes 40 percent of the country's total energy consumption. Due to poverty and shanty houses, we may not have such a high share. There is a stock of 20 million houses, half of which are 'pucca' houses. There are 35 million electric consumers and seven million gas connections. New electricity connections per year average at 1.5 million – these figures give an idea of waste or conservation potential.

However, it may be noted that gas consumption in Pakistan increases in the winter largely due to heating and hot water requirements. And in the summer, electricity requirements peak due to cooling requirements provided by ACs and fans. Water consumption increases in the summer as well, leading to an increase in energy use in water pumping. This brings motor and pump energy efficiency issues to the fore.

There are some voluntary energy conservation labels and schemes like Leadership in Energy and Environment Development (LEED). The application of the LEED criterion has led to some remarkable effects of energy savings in commercial buildings – up to 50 percent savings (more than 275,000 kWh per year). Voluntary participation may be more effective than legal approaches which may eventually come in the long run.

Although for some stubborn customers, a carrot-and-stick approach may also work. Market-based approaches also succeed in such cases.

Space cooling and space and water heating are the most energy-consuming and costly processes, more in terms of operating (energy) cost than in terms of capital expenditure. Both elite and middle classes indulge in wasteful investments in it. Most energy theft used – and even continues – to be due to the use of ACs, gas heaters and water geysers.

Investment in energy conservation is definitely cheaper than the cost of energy consumed otherwise. The culprit in high energy consumption is lack of insulation in our homes and commercial buildings. In the 19th century, in this part of the world, houses used to have energy conservation features like decent heights, ventilation systems and energy-insulating plasters. Roof insulation technology and materials are relatively widely available. A cheaper option – 'white colouring of the roof' – has also found wider acceptance. Roof insulation can be done in existing houses, offering a large potential for further savings. Wider use and the availability of better materials can make a difference.

Wall insulation is a rather difficult issue for existing buildings. However, in new construction, it is neither costly nor difficult to insulate walls. Normally, two walls are built with a cavity of three to four inches. This is required in only outer walls. There are other techniques of insulated plasters or installing insulated panels inside. The installation of insulated panels inside may be feasible in existing houses. In the US, the payback of cavity wall insulation is about three years. In Pakistan, with costly energy and lower construction cost, the payback period may be even less.

The second biggest loss of energy is through glass windows, in both winter and summer. The larger the house, the larger the windows. Glazed windows have become a norm in new buildings and refurbished homes in the West. These windows can be installed in both new and existing houses. Only outer windows have to be glazed. In these glass windows, inert gas like helium is filled to decrease heat transfer. The supply industry has developed this item but is restricted due to a low demand.

In the gas sector, solar water heaters (SWH) offer a great opportunity for energy conservation. They hardly consume any roof space as opposed to a solar PV system. The existing gas heaters and geysers are energy inefficient and are responsible for high gas bills. Gas heaters can be replaced by split ACs which offer both heating and cooling functions. For rural areas, biogas and gasifier stoves are a cheap solution and have plenty of scope.

Electric motors used in water pumps, fans, compressors and all kinds of industrial machinery are another important item. Most of their demand comes from water pumps of up to one kW capacity. There are around four hundred motor manufacturers mostly in the informal sector and are situated in Gujranwala. About 14 million motors are installed in the country, which is expected to increase to 25 million units by 2030. In terms of MW, 70 percent of the motor demand may be coming from large motors of five KW and more. However, even in the industrial sector, motor efficiency averages around 50-55 percent due to a variety of reasons which are not related to only motor quality, but there are operations and maintenance issues as well. Optimum efficiency requirements exceed 75 percent.

New products offer huge potential for boosting energy conservation and efficiency, and both large- and small-scale industries require technical input in this regard. However, in the large motor sector, industrial users need assistance. In the case of small motors, motor manufacturers need assistance. Thus, two different approaches are required to help improve the current situation.

In the first part of the article, we discussed how innovation in products is playing a major role in energy conservation. Innovation and upgrades in home appliances are also playing a key role in energy efficiency. In Pakistan, the market for kitchen equipment like food processors, fridges and freezers has expanded tremendously in recent years – around one to 1.5 million units of refrigerators are sold annually. If local producers work on such upgrades, there would be a tremendous energy conservation and efficiency improvement opportunity.

The involvement of producers is likely to result in a lot of improvements in terms of energy conservation. The National Energy Efficiency and Conservation Authority (NEECA) has recommended adding energy performance labels on products. It is hoped consumers' awareness will create demand for energy-efficient equipment as consumers usually prefer affordable products and are unaware of energy issues.

General industrial practices need a lot of attention and improvements. Energy efficiency can affect both competitiveness and partner and buyer industries. Most Pakistani industrialists are more inclined towards seeking incentives and low energy tariffs but are less sensitive to energy conservation and efficiency issues. Both awareness and technical know-how are required for dealing with this issue. Small and medium enterprises (SMEs) can provide technical assistance to industrialists.

NEECA has released the first draft of an energy conservation policy – the National Energy Efficiency and Conservation Programme (NEECP) – for the review and comments of stakeholders. The subject of energy efficiency and conservation is not new in Pakistan. NEECA's precursor Enercon was formed in 1987 and received technical support and grant financing from USAID. An energy conservation policy was presented in 2006. Some reports were drafted and the required documentation work was done, but the policy couldn't prove to be fruitful. Subsequently, the National Energy Efficiency and Conservation Act was passed in 2016 as a result of which NEECA was established.

The institution is yet to meet its requirement of the workforce. It has, however, done some foundation work like the preparation of a policy document and the development of some useful standards and a labelling scheme. There seems to be a lot of work in progress that has yet to come under public domain. Lessons should be learnt from past mistakes. NEECA should find out what went wrong in earlier efforts and what should not be repeated.

The NEECP draft seems a good policy. Almost nothing has been left out; this, surprisingly, has invited criticism of some credible experts and institutions. The policy's defenders may argue that a foundation policy document has to be comprehensive, but due to bad experiences of the past, people now want coherent targets.

There is no doubt that the policy seems ambitious as well, but it needs to be prioritised. The first part of this article identified the sectors that needed innovation. The building sector, electric motor and pump manufacturing units, industrial systems, and household electrical equipment manufacturing units are a few areas which are likely to achieve the energy conservation and efficiency targets if the authorities prioritise them. Transport and power systems undertake their development activities and are determined by international suppliers and companies. The power sector is big enough to undertake its conservation and efficiency projects. Electric vehicles are far away, and delving into it from the point of view of energy conservation may not be either a priority or within the capabilities of the local systems.

There is a strategic plan (2020-2023) which is unnecessarily too big for the available period. It may be good enough for 10 years. We are in the mid-period of the plan, and the failures are already evident. Even though funds are available, under climate agendas and emergencies, for the execution of the plan, only money isn't required. The country needs a more concrete and prioritised plan which is accepted by experienced stakeholders.

The recently announced draft has the following items on its agenda: minimum energy performance standards, energy performance labelling schemes, energy information clearing houses, energy audit, technical services and support, and financing policy support. However, the draft hasn't talked about one important item – the development of model and pilot facilities. For example, model energy efficient buildings in all major towns may go a long way in developing the understanding of their benefits and the processes required. These houses can be installed with insulated walls and roofs, glazed windows, solar PV systems, water heaters and other energy efficient devices to demonstrate what a 'model house' is.

The most useful work yet carried out by NEECA is the development of an energy efficiency labelling scheme. Energy efficiency labels give ample guidance to consumers/buyers to compare a product's prices to its energy consumption levels – most household appliances are under NEECA's labelling scheme. Fan manufacturing units are at the advanced stage of the implementation of the policy. It is hoped that this step would create market pressure for energy efficiency. As a result, energy products and producers may end up getting 'market preference' in terms of better prices and market share in the medium- to long-term.

In energy efficiency businesses, consumer awareness is a major issue. Ordinary citizens form to be the main actor. Their decisions and perceptions usually create market pressures. Industrial and business customers and users may have the resources and skills to acquire knowledge and information. Thus, communication and extension activities should form a major part of the institutional conservation efforts. Since the media can play an effective role in this regard, it should receive sufficient budgetary resources.

NEECA will continue to suffer from an institutional mismatch as it is part of the power division. Its conservation agenda seems to be more focused on the electrical side. But since the power division comes under the Ministry of Energy, there will be a few bottlenecks. It is hoped this policy succeeds in achieving its targets as energy- and climate-related challenges are mounting.

7.2: Energy: projects and potential

A rather ugly situation is developing with respect to the IGCEP (Indicative Generation Capacity Expansion Plan). Reportedly, no consensus has been achieved in the CCI on the subject. And, also reportedly, the Sindh minister of energy is mulling over legal channels to get his province's grievances heard. It must be noted that the IGCEP has been under review for a number of years.

The complaint of the Sindh leadership is that the least-cost principle, which is universally accepted as a basic criterion of power planning, is not being implemented in its true spirit. And more expensive and less competitive projects have been pushed in under the name of committed projects. Indeed, in the current situation, there are so many committed projects that making the IGCEP appears to be rather meaningless. Theoretically, all project planning and preparation should follow after the IGCEP has been completed. On the other hand, a portfolio of identified projects is to be there for continuous project development activity. A balance is to be created in this respect.

The cheaper solar and wind power is asserting itself. No solar or wind power project has been implemented for the last many years, despite its cost having come down tremendously – under 2 USc elsewhere and 4 USc in Pakistan. And the proposed IGCEP does not include as much solar and wind power as the proponents want it to be. Sindh has abundance of solar and wind while Khyber Pakhtunkhwa has abundance of hydro and solar power.

Solar and wind power are costing around 4 USc while hydropower costs almost double this figure. There is confusion among people that hydropower is cheaper – costing around Re1.0 per kWh. This indeed used to be the case but applies to older hydro projects like Tarbela and Mangla. All new hydro projects cost much more; Neelum-Jhelum, Suki-Kinari, Azad-Pattan, Karot etc all have tariffs around 8-10 USc. The potential Bhasha power tariff is not known in reliable terms.

All power sources have merits and demerits. Planners, therefore, have adopted least cost as the decision-making criterion for including a project in their portfolio. Unfortunately, a lot of politics and patriotism has gone into the issue. Hydro, nuclear and later Thar have become almost a test of patriotism. Opposing any one of these is taken as unpatriotic. And the new contenders are solar and wind now.

Nonetheless, ignoring solar and wind power generation capacity is acquiring controversial dimensions. It is difficult to justify ignoring or downplaying sources that cost half of the competing sources. Balochistan's requirements of solar projects should have received priority for both cost and non-cost reasons. But this was not done, creating an unnecessary controversy. Similar are the grievances of Sindh.

There is, however, a locational dimension of electricity generation. Generation has to be spread out to minimise transmission cost and losses. As it is inadequate to bring hydropower from KP, it is equally inappropriate to propose bringing hydropower to Karachi and Sindh. The thermal answer is distributed generation which is economic and politically acceptable as well.

There is another complicating factor of the falling energy-to-GDP quotient (elasticity). Almost everywhere in the world, due to the conservation and efficiency effect, less energy is required to produce one unit of GDP. A ready example is LED and energy-efficient air-conditioners and other appliances. There are enthusiasts who wrongly argue that energy consumption grows faster than GDP. Worldwide, the opposite is the case, including in India. In Europe and other advanced countries, the energy and GDP relationship has been dissociated due to ever-rising energy saving technologies. The involvement of eminent economists in energy modeling will alleviate the intensity of controversy that is being generated in this respect.

The fact is that Sindh has vast energy resources including Thar coal, wind and solar – although solar is everywhere – while KP has abundant hydropower resources. However, the problem with the politics in the two provinces is that when the federal government develops resources in these provinces, they often start making unreasonable claims. For example, leaders demanding that gas be diverted to CNG stations in one province while homes in another be deprived of gas for cooking.

Coal has been made expensive through cost manipulations and undue demands of higher equity return. In a matter of a few years now, Thar coal projects are being proposed at almost half the cost. Similarly, there are unreasonable excessive demands in KP with respect to NHP (Net Hydro Profit). What we all have to realise is that energy resource competition is emerging with the advent of solar and wind power. Provinces which are the owners of these resources have to market their resources and be flexible and reasonable. Legal fighting may not be enough.

The issue of committed projects has to be sorted out. Grid code and IGCEP methodology require that generation projects be selected on the basis of least-cost and then projects be committed into a formal project portfolio. The opposite is happening.

One of the reasons is that there are multiple sources of authority who manage to push their projects through informal channels. It costs a lot of time and resources to prepare bankable projects. To be fair, it is also a fact that a portfolio of prepared projects is required in order to develop a realistic and practical plan. Otherwise, one would be able to assign capacities in various sectors only. Perhaps, the Private Power and Infrastructure Board (PPIB) has to come up with reforms in its case processing and introduce some controls.

Another issue is that Take or Pay is a great risk-free system guaranteeing income and profits irrespective of demand or utilisation. Provinces and promoters have a free ride. All they have to do is to get the project approved and let the federal government deal with the problem of circular debt. The market system of Take and Pay seems to be far away. The proposed CTBCM has many issues in the way of a viable implementation.

There is, however, scope of accommodating additional projects as demand may increase more than it has been assumed in the IGCEP. Some projects may not be implemented. There are many doubts on the Bhasha dam (6000 MW) which has been on the agenda for a long time. The Bhasha dam is important from the point of view of water storage and supply. There are political and financial issues. It is a $12-15 billion project. IFIs require that Pakistan obtains an NOC from India – which is obviously considered preposterous by Pakistan.

There are problems with Chinese involvement as well. There are others who think that dams are not necessary, and aquifer charging is a better solution. So, there are opportunities for accommodation and the project proponents should be hopeful that their demands may be accommodated eventually.

It appears that it may just be time soon to start considering the provincialisation of the energy sector as a whole or the power and petroleum sector separately as is a common practice among federations. There are risks involved which have to be evaluated and mitigated in a sector already mired in controversies and difficulties. Politics is making things even more difficult.

How to conserve energy

Oil imports have decreased by 26 per cent in the first five months of the current fiscal year (July-Nov). Crude oil imports have fallen by 16 per cent, diesel imports by 44 per cent, and gasoline by 20 per cent. While there may be some inventory effect as well, this is a clear demand-reduction signal. The reasons appear to be obvious: economic slowdown and pricing and foreign exchange issues.

Whenever there are financial issues in energy supplies, there are immediate calls for closing the markets by 8pm. A research study by 'Business Recorder' concludes that the commercial sector's share in electricity consumption is only 10 per cent and that electricity saving in this area may not be significant. The market closure proposal has not been accepted by the commercial sector and remains largely unimplemented.

Similar attempts were made in the past. However previously the country faced an electricity-capacity crisis; this time there is a fuel-price crisis. On the contrary, tariff incentives have been given to incentivize high electricity consumption so that unit capacity charges could be reduced due to high capacity utilization.

Surprisingly, there is apparently no move to conserve and reduce unnecessary oil consumption although high prices are discouraging oil consumption. Reduction in energy/oil consumption can be a double-edged sword; it can affect economic output. It is wasteful consumption that should be discouraged, while also introducing efficiency measures.

The country's elite who drive posh vehicles consume gasoline irresponsibly. There is a case for increasing gasoline prices only for the rich and the elite. But the problem is that this commodity is consumed by both the rich and the poor. In my previous articles, I presented a mechanism for introducing a low-octane cheaper variety of gasoline for the poor.

It is time to promote public transport across the country – be it transport for goods or passengers. Public transport consumes diesel, and there is a case for reducing diesel prices vis-a-vis gasoline so that public transport can become affordable and attractive. Low diesel prices incentivize economic output as well. It can be done easily by high taxes on gasoline and lower on diesel. Many advanced countries have adopted this practice.

The Covid-19 pandemic has also introduced several fuel-saving options like Zoom meetings or the work-from-home model. Authorities should promote ride-sharing in the country, regularize and expand it. The corporate sector should be asked to introduce fuel-saving programmes and targets.

The oil imports of $20-25 billion as opposed to the $36 billion total exports are clearly unsustainable. This situation will continue for some time unless conservation measures are taken. It is similar to the 1973 oil crisis, which forced several Western countries to promote oil conservation and efficiency. We have a similar situation, and it will continue unless exports increase without incurring high energy costs.

The International Energy Agency (IEA) has advised its OECD member countries to adopt conservation measures. They have developed a ten-point agenda, which may be partly relevant and useful for us. Can Pakistan develop a 10-point agenda of its own?

Pakistan needs to refine and better coordinate its oil import process. The power sector requires furnace oil mostly in winter. There is enough furnace oil production by local refineries. Its import ban was lifted in 2020-21 due to the LNG crisis. As a result, excessive furnace oil imports were made, leading to a surplus, which created a disposal problem.

The demand for furnace oil is high in winter, except for occasional demand in other seasons. Oil refineries should be encouraged to build sufficient storage units for furnace oil. There are other areas where procurement and internal oil logistics can be improved, resulting in oil savings.

Oil is mostly consumed in the transport sector. Some 80 per cent of the total oil consumption is by passengers and freight transport. Conservation and efficiency efforts in this sector may save up to $2 billion of oil imports, depending on the prevailing oil prices. The following three areas can lead to oil savings in transport: driving and maintenance, automotive fuel efficiency, and spare parts availability.

It is important to raise awareness about fuel-efficient driving among vehicle users and drivers. Though people know some techniques to be more fuel-efficient, they are not sensitive about it. Awareness campaigns may help sensitization. Oil marketing companies (OMCs) can play a vital role and use petrol pumps for spreading the message. In Pakistan, one comes across the following tips on the official websites of OMCs: don't be an aggressive driver; observe speed limits; maintain the speed between 50 and 80 km/hr on highways; avoid revving the accelerator to a high RPM; and avoid breaking aggressively.

Other tips include: avoid excessive idling; keep the trunk empty; don't carry unnecessary load; no overload for truckers and CVs; and fill vehicle at the lowest setting, when the pump stops and gives a sound; drive with the AC on instead of opening windows at high speeds; and keep your vehicle exterior clean to reduce air drag. The list goes on: keep tyres inflated at the right pressure; clean, adjust or change spark plugs and air filters regularly; and change engine oil and oil filter as per oil manufacturer's specifications.

Training programmes for automotive technicians should be introduced to implement these requirements adequately. Such trained manpower can also be sent abroad to earn remittances.

The oil crisis of 1973 initiated several energy efficiency and diversification programmes, led by the US. The vehicle fuel efficiency standards (VFES) were introduced which tremendously improved fuel efficiency. Today, vehicle fuel efficiency has doubled or even quadrupled as compared to that in the 1970s-80s.The movement spread to Europe, Japan and Korea. Developing countries recently introduced such schemes and initiatives. India introduced emission standards in 2015, and is now introducing the VFES, which will be enforced by April 2023. Perhaps, time has come to take similar initiatives in Pakistan.

In Pakistan, there are used imported vehicles which are usually more fuel efficient – the fuel consumption of 20km per litre – than the locally produced ones. Import and taxation policies can encourage fuel efficiency through varying tariff rates.

Currently, except for engine capacity, there is no other tariff differentiation. Import policy can place an upper or lower limit on fuel consumption. Imported vehicles should be type-certified in the manufacturing country, specifying fuel consumption rating. Similarly, local producers may be encouraged to increase fuel efficiency of the vehicles they assemble or produce by making adjustments. Tariff incentives may work.

Older vehicles are generally less fuel-efficient either through wear and tear or through fuel efficiency improvement in new vehicles. There are other possible rules and regulations that can be introduced to convince vehicle owners to change to new or less old vehicles. Tax or credit term incentives may work. Since Pakistan is a poor country, it cannot introduce the policy on mandatory retiring of vehicles.

Many countries have extended their energy labelling programmes to the automotive sector as well. Advanced countries introduced this labelling scheme many years back. Now, India, Chile, Vietnam, Thailand, Singapore and Indonesia have adopted the system. Pakistan's National Energy Efficiency and Conservation Authority (NEECA) may consider going into the automotive sector as well.

There should be some initiatives to promote the spare-parts industry to reduce the prices of spare parts. People delay changing parts at the end of its recommended life due to the high prices of these products. Take the case of spark plugs. Its price can vary between Rs1,000 and Rs10,000. This component plays an important role in fuel consumption. There is a huge market for these plugs. Its local manufacturing can be economical. Similarly, other parts like various filters of engines and AC can be produced locally.

There are other approaches as well, such as introducing electric vehicles (EVs). But these plans are mid- to long-term. The combined effect of small changes in several sectors can be quite big. We should not look towards revolutions; history tells us that they do not deliver much.

Figure 7.1.1: : Integrated vehicle Efficiency policy Portfolio

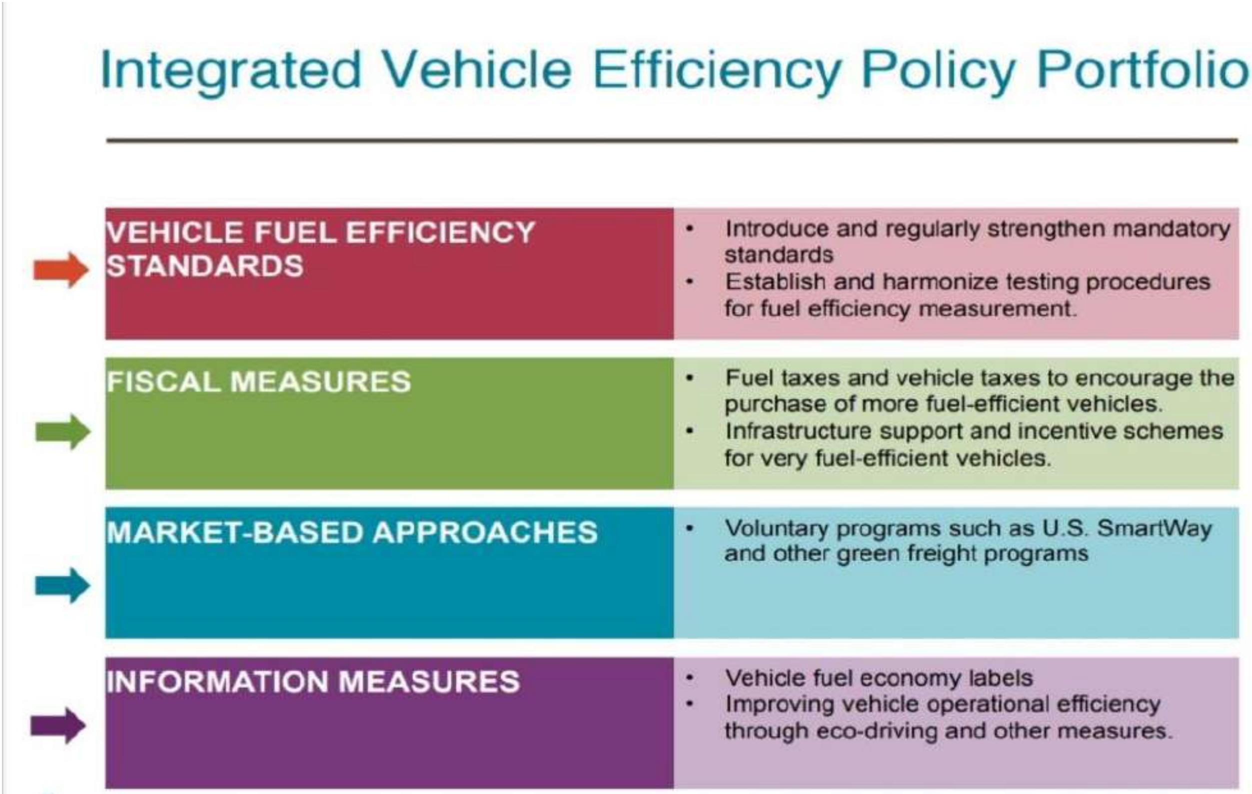
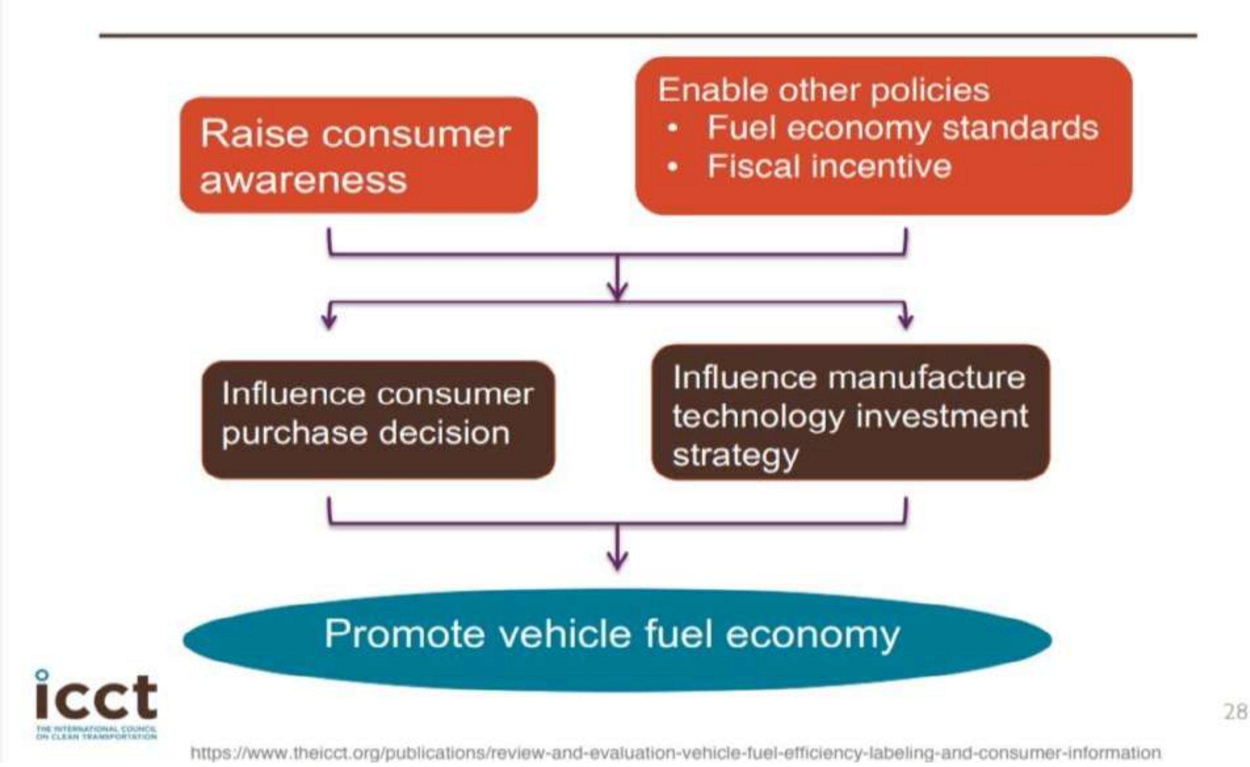


Figure 7.2.2: Vehicle fuel economy labeling (VFEL)



7.3: Energy Efficiency and Conservation Policy

The National Energy Efficiency and Conservation Authority (Neeca) has released a draft of energy efficiency and conservation policy for the review and comments of stakeholders. The subject of energy efficiency and conservation (EE&C) is not new in Pakistan. Neeca's precursor Enercon was formed in 1987, which received a lot of USAID technical support and grant financing.

An EE&C policy came in 2006. Quite some reports and documentation work was done but with little impact except for sensitisation and awareness, and development of a cadre of EE&C professionals. Subsequently, the National Energy Efficiency and Conservation Act was promulgated in 2016, as a result of which Neeca was established, as it exists today. It has yet to mobilise itself fully by inducting the planned human resources. It has, however, done some foundation work like the preparation of policy document and the development of some useful standards and a labeling scheme.

There seems to be a lot of work in process that has yet to come under public domain. Lessons should be learnt from past mistakes. Many people may like to present an even harsher evaluation of Enercon. Neeca should explore and study as to what went wrong in earlier efforts and what should not be repeated. The National Energy Efficiency and Conservation Policy (NEECP) draft report has almost all the features of a good policy. Almost nothing has been left out which, in fact, has invited criticism of some credible experts and institutions – a big agenda.

The defenders may argue that a foundation policy document has to be comprehensive. Due to the bad experience of Enercon, people want concrete output, targets, achievements and impact. The agenda is big, may be out of necessity, but it does require prioritisation. We have identified some priority areas in the first part of this series. Building sector, motors and pumps, industrial systems and household electrical equipment are a few areas which, if prioritised, can lead to some achievement in the conservation and efficiency agenda.

Transport and power systems are separate individual subjects, which undertake their own development activities and are determined by international suppliers and companies. Similarly, the power sector is big enough to undertake its conservation and efficiency projects. Electric vehicles are far away and delving into it from the EE&C point of view may not be a priority or within the capabilities of local systems.

Concrete plan needed

There is a strategic plan (2020-23), which is unnecessarily too big for the time span available. It may be good enough for 10 years. Already through the mid period of the plan, the slippages are evident. Certainly, money may be pouring in under climate agendas and emergencies. But more than money is required. Thus, a more concrete and prioritised plan is badly needed, which is being felt by many knowledgeable institutional stakeholders.

There is enough on agenda as described by the policy itself – Minimum Energy Performance Standards (MEPS), energy labeling schemes, Energy Information Clearing Houses, energy audit, technical services and support, financing policy support, etc. Unless I have missed to read it, there is an important item that has been missed out. Development of model and pilot facilities is badly required.

For example, model energy-efficient buildings in all major towns may go a long way in developing understanding of the benefits and the processes required. Insulated walls and roofs, glazed windows, solar PV and water heaters and other energy-efficient devices could be shown and demonstrated in such model houses. The most useful work yet carried out by Neeca is the development of an energy efficiency labeling scheme. Energy efficiency labels (ECL) give ample guidance to the consumer/ buyer to compare price vs energy consumption aspects of the product.

Most household equipment is under Neeca's ECL scheme. Fans sector is at an advanced stage of implementation. This would create market pressure for energy efficiency. Energy-efficient products and producers would get market preference in terms of better prices and market share in the medium to long term. In the energy efficiency business, consumer awareness is a major issue. Ordinary citizens are the main actors in most items. Their decisions and perceptions create market pressures, although it may work both ways sometimes – supply creates demand and demand creates supply.

Industrial and business customers and users may have the resources and skills to acquire knowledge and information. However, in developing countries like ours, mostly there are SMEs which have to be taught and informed. Thus, communication and extension activities should form a major part of the institutional conservation efforts. Electronic media and advertisement can play a very effective role. Sufficient budgetary resources should be provided in this respect. Neeca will continue to suffer from institutional mismatch as it is part of the Power Division. Neeca's conservation agenda seems to have focused more on electrical side, while it is a much broader agenda.

However, with the Power Division being part of the Ministry of Energy, the bottlenecks may be lesser. Let us hope that we succeed this time around as the energy and climate challenges are mounting.

Energy conservation and efficiency priorities

There is a saying that the energy conserved is better and cheaper than the energy produced or purchased. It is truer today than earlier times due to rising energy prices, supply uncertainties and climate effects. In the West, the movement for energy conservation, efficiency, self-reliance and renewable energy started in the backdrop of the 1973 oil crisis. Since then, remarkable changes have taken place in these areas. Energy intensity (energy elasticity of GDP) used to be more than one, which means that to increase GDP by 1%, it required 1-1.5% increase in energy supply or consumption.

Today, in most countries, this index is 0.5 and, in some economies, it is even negative – that is the growth rate of energy conservation and efficiency is faster than the growth rate of economy. This is not true for developing countries like Pakistan due to a variety of factors such as poverty, low education and technology. The sensitivity, however, both among public and government policies, is increasing. A new energy efficiency and conservation policy has been announced, as we shall discuss in the following. Energy is used in all parts of human life – social and economic. A wide variety of sectors, users, producers and traders are involved.

There are, however, some limited number of areas which consume bulk of the energy, which makes the job of energy conservation and efficiency relatively easier. We will discuss some of the main issues. Due to market and trade reasons, and not due to any indigenous effort, many improvements have taken place mostly in imported items. Today's cars are more than four times fuel efficient than in the 1980s. And with the advent of electric vehicles, it would be even more.

With LEDs, the lighting sector has been revolutionised. Computers and TV screens are many times more efficient than the monitors of yesteryears. Split ACs are being widely used, which are generally more efficient than the window ACs; the former do both cooling and heating. Heating by ACs is much more efficient than the classical resistance heaters. Unfortunately, in this area, only richer classes have switched while the poor do not have the house or the money to benefit from it. Home electrical appliances are more efficient than earlier, but a lot of improvement is required in this sector.

Unfortunately, the building sector is the most energy inefficient and not much has been done in this respect. Conservation has two sides; energy efficient appliances and user-side efficiency. It is no use having energy efficient ACs but wasting the appliance's energy efficiency in a poorly built house lacking insulation. There is a stock of 20 million houses, half of which are concrete houses. There are 35 million electricity consumers and 7 million gas connections. Annual new electricity connections average 1.5 million. This would give an idea of waste or conservation potential. However, it may be noted that gas consumption in Pakistan increases in winters largely due to heating and hot water requirements.

In summers, electricity requirement peaks due to cooling requirements provided by ACs and fans. Water consumption increases in summers as well, boosting the water-pumping energy consumption and bringing to fore motor and pump energy efficiency issues. There are some voluntary energy conservation schemes like LEED (Leadership in Energy and Environment Development). Some remarkable effect of energy savings has been documented in commercial buildings applying the lead criteria, wherein up to 50% savings (more than 275,000 kWh per year) have been obtained.

Voluntary participation may be more effective than legal approaches, which may eventually come in the long run. Although for some recalcitrant and ignorant customers, the carrot and stick approach may work also. Market-based approaches have succeeded. Space heating and cooling and hot water are most energy consuming and costly processes, more in terms of operating (energy) cost than in capex terms. Both rich and middle classes indulge in wasteful investment in it.

Most energy theft used to be or even continues due to ACs, gas heaters and water geysers. Investment in energy conservation in this area is definitely cheaper than the cost of energy consumed. The culprit in high energy consumption is the lack of insulation in our homes and commercial buildings. Houses in the 19th century in this part of the world used to be better in energy conservation features like higher heights, ventilation and energy insulating plasters. Roof insulation technology and materials are relatively widely available. Cheaper white colouring of the roof has also found wider acceptance.

Roof insulation can be done in existing houses and thus offer a large potential for further savings. Both wider use and availability of better materials can make a difference. Wall insulation is a rather difficult issue for existing buildings. However, in new construction, it is neither costly nor difficult to insulate walls. Installation of insulated panels inside cavity may be feasible in existing houses. The second biggest loss of energy is through glass windows, both in winter and summer. The larger the house, the larger are the windows.

Glazed windows, double or even triple, have become a norm in new buildings and refurbished homes in the West. These windows can be installed both in new and existing houses, the latter through replacing windows.

Solar heaters

In the gas sector, solar water heaters (SWH) offer a great opportunity. SWH hardly consume any roof space as opposed to solar PV panels. About one or two-panel space is required to install a SWH. Gas heaters and geysers are energy inefficient and are responsible for high gas bills. Gas heaters can be replaced with split ACs, which do both heating and cooling. For rural areas, biogas and gasifier stoves are cheaper solutions for which there is a large scope and potential.

Another important item is electric motors, which are used in water pumps, fans, compressors and all kinds of industrial machinery. Most of the demand for motors comes from water pumps of up to 1kW capacity. There are a large number of motor manufacturers (400 in number), mostly in the informal sector and are situated in Gujranwala. About 14 million motors are installed in the country, which is expected to increase to 25 million units by 2030. In terms of megawatts, 70% of motor demand may be coming from large motors of 5kW and more. However, even in the industrial sector, motor efficiency averages around 50-55% due to a variety of reasons, which are not related to motor quality only but there are operation and maintenance issues as well.

Optimum efficiency requirements exceed 75%. Thus, there appears to be large potential for boosting energy conservation and efficiency in this area. Both large and small industries require technical input. However, in the large motor sector, industrial users need assistance. In case of small motors, motor manufacturers need assistance. Thus, two different approaches would be required to help improve the situation.

Kitchen goods

Home appliances are yet another major area. This includes kitchen equipment mostly, like food processors, fridges, freezers, etc. The market of these items has increased tremendously in recent years and continues to do so. It is in million pieces per year and are mostly assembled or partly locally manufactured.

For example, 10 million fans, 1 million ACs and 1-1.5 million refrigerators are sold annually. This is a tremendous conservation and efficiency improvement opportunity. We have already discussed the space and water heating and cooling. This was, however, from the demand perspective. Producers' regulation can cause a lot of improvement in terms of energy conservation and efficiency, thus can save energy.

NEECA has initiated work on a product energy efficiency labeling programme in this respect. Consumers' awareness can create demand for energy efficient equipment. Consumers are usually after cheaper products and are unaware of the energy issues. General industrial practices need a lot of attention and improvements. Energy efficiency can affect competitiveness and affect the partner and buyer industries as well.

There are a variety of issues. Pakistani industrialists seem to be more inclined towards seeking incentives and lower energy tariff but are less sensitive to energy conservation and efficiency issues, although things are changing gradually. Both awareness and knowhow are required for which technical assistance would be needed, mostly by SMEs. The foregoing discussion was focused on user/demand side mostly. In a subsequent piece, we will focus on the supply and regulatory side of the issue.

Climate & Environment

8.1: Glasgow agreement and Pakistan

Glasgow Climate Conference has ended with a renewed commitment of 200 nations to climate change goals amid skepticism and criticism by activists of doing too little. The promises of assisting the developing nations with the required climate related financing remain elusive. A major issue that concerns us is that the immediacy on “phasing out” of coal has been softened to “phasing down” coal in the final agreed draft of the agreement, although nearly 40 countries have announced ‘phasing out the coal’. What impact it will have on our coal (Thar) policy and the earlier Chinese announcement that it will not finance coal projects abroad anymore? It may be too early to comment with confidence on the issue, but it appears that the Glasgow agreement does provide indicators on transitional and long-term directions.

Pakistan is among the countries that are likely to be hurt most by climate change and it is in our national interest to contribute and cooperate with the worldwide mitigation and control activities, although our contribution to the problem is less than one percent.

All fossil energy sources like oil, gas and coal generate carbon emissions. Emissions from most of the sectors can be reduced or controlled except agriculture, while bulk of the emissions is from energy generation and consumption. Energy in one form or the other is required in all sectors of human life, namely, agriculture, industry, homes, transportation. World temperature increases due to emission of greenhouse gases, mostly carbon dioxide. The global community wants to reduce carbon emissions to zero by 2050, broadly speaking. The EU and the US have agreed to a target of net-zero carbon emission by 2050, China by 2060 and India 2070.

Non-carbon energy choices are in renewable energy like, solar, wind, hydel (water dams, etc.) and hydrogen. Green hydrogen is a new entrant to the energy scene but has acquired some prominence lately. Grey hydrogen (hydrogen produced from gas and coal) is being already made and used for quite a while, while green hydrogen will be produced out of electrolysis of water by electricity generated from mostly solar and wind power resources. Grey hydrogen is being mostly consumed by oil refining sector and ammonia and fertilizer production. It is mostly produced at site.

While net-zero targets are to be achieved gradually until 2050-2070, a difficult situation has emerged in the meantime; fossil fuels such as oil, gas and coal availability has come down while prices have increased. LNG prices have quadrupled, oil prices increased by 33% and coal’s by more than 100%. The transitional period and process have become very difficult for the poor and under-developed countries. The present has become so hard and difficult that thinking about the future appears to be meaningless. Yet to avoid the repetition of the present conditions, one has to think and plan for the future.

Pakistan has announced not to install coal-based power plants any more other than the ones that are already in the pipeline. However, in an environment conference held in Saudi Arabia lately, the Prime Minister excluded coal gasification from the ‘coal ban’ agenda in his speech. Almost all western countries have announced shunning installation of new coal power plants. The Chinese president has also announced that his country would not finance or install coal- based power plants any more. However, China has not closed the coal option for itself. It is highly improbable that any other country would be available to install coal (Thar)-based power plant in Pakistan. All hopes were tied to China under the China Pakistan Economic Corridor (CPEC) and beyond.

Gas had been touted as a desirable transition fuel by the world community. While the US and Russia are not affected by the gas crisis, most other countries dependent on imported gas are suffering under higher prices. If these conditions continue for long, it would be difficult for poor countries like Pakistan to implement and continue with the coal ban announcements. In fact, it may have to redouble its efforts to indigenize its energy sources irrespective of its carbon impact, at least in the short- to medium-term. The Glasgow agreement has provided an opportunity by softening its stance on coal, although it may be revised next year.

Pakistan's gas needs

Pakistan's economy and social life are greatly dependent on gas. Its local gas resources are dwindling consistently; these are projected to be exhausted within a decade. Its effect is already visible. The prospects of finding new oil and gas resources do not appear to be very bright. There has been no major gas find (of 1 TCF or more) in the last many decades. Foreign oil companies have left Pakistan and there are little chances of attracting any major party in near future. There were some prospects in off-shore play but a recent drilling effort by a global company did not bear fruit. Although one should not lose hope in a sector like oil and gas; it is very risky to base any plan on local oil and gas.

High LNG prices cannot be sustained by Pakistan for long. On the other hand, Pakistan cannot afford to do without gas. The whole country cooks and bathes on gas-fired equipment. There are more than 10 million families depending on gas consumption and more families are waiting for gas connections. Politically, it would be very difficult to deny new gas connections and discontinue or reduce existing gas supplies. Furthermore, there is fertilizer sector on which the whole agriculture depends and there is industrial sector which gives employment and brings foreign exchange through exports. There are some opportunities for partial shifting to electricity of which there is purported surplus. But all gas users cannot shift away.

Coal gasification

Major energy source remains to be Thar coal. Thar coal can be liquefied to produce gas (SNG). It is a tried and tested technology. There are more than 125 coal gasification plants, out of which 75% are in China.

The Chinese have been taking interest in coal gasification proposals and under grave circumstances they may be cajoled to cooperate in building coal (Thar) conversion plants to gas and diesel, etc. One may have to convert the existing imported coal power plants to at least 20% on Thar coal. Cement and other industries also rely on imported coal. One may have to enhance Customs duties on coal imports to make the local substitution attractive.

Coming back to the climate change and net-zero issue, in the mid-term (after 2030) Pakistan could add Carbon Capturing facilities to its coal plants to satisfy the climate expectations and requirements. Coal gasification may be converted to produce the so-called Blue Hydrogen. Blue Hydrogen is the Hydrogen that is produced out of fossil fuels like Gas and Coal but with added carbon capturing. This is the path that many advanced nations like Japan and Australia are taking, albeit partially.

The difficult issue is of timing and probable stranding of energy assets and investments during and after transition. It is highly likely that after achieving some progress towards net-zero by 2030, advanced nations may introduce 'carbon tax' and trade restrictive practices in the form of tariff and non-tariff barriers on the countries which may not achieve imposed targets towards net –zero.

Green hydrogen initiatives in South Asia

Bangladesh Council for Scientific and Industrial Research has installed a pilot hydrogen plant in Bangladesh to produce hydrogen and another is on the way. The plant is based on household waste gasification with an output of 5.8 kg/day which can go up to 29 kgs. It has cost them USD 6.48 Million. India plans to play a major role in hydrogen sector aiming to be the cheapest producer and exporter in the world eventually.

A draft policy requires to meet 10% of the oil refineries' hydrogen requirement by green hydrogen by 2024 and later in next 5 years to 25%. Leading Indian companies have active plans to go into smaller hydrogen facilities initially.

Reliance wants to install an electrolyzer and a fuel cell manufacturing facility as well along with Solar PV panel manufacturing. Indian Oil Corporation (IOC) has announced a green hydrogen plant at its refinery in Mathura (UP). OIC wants to install another facility at Kochin where hydrogen fuelled buses would be plying at the airport. India is also experimenting with mixing hydrogen in natural gas pipelines in one of the districts.

Hydrogen economics

Presently, green hydrogen is very expensive; also, there are supplies and infrastructure issues. Green hydrogen, however, is 4USD/kg (34.8 USD per MMBtu) and above in the US based on the latter's low gas prices. Grey hydrogen (based on cheap natural gas in the US) is, however, available at 1.5 USD per kg (13.05 USD/MMBtu).

There were targets to bring down the green hydrogen price to 2 USD per kg by 2030. These targets have been, however, revised by US's DOE (Department of Energy) to USD 1.0 per kg by 2030. This kind of targeting appears to succeed a la solar PV prices.

In fact, a Norwegian company, NEL, has announced producing green hydrogen at1.5 USD/kg already as early as 2025. These are, however, based on renewable energy input of 2 USc/kWh, something that other countries may not be able to achieve easily.

The Glasgow Conference has softened its stand on coal under Indian and Chinese pressure. Pakistan may also reexamine its earlier announcement of not building coal (Thar) power plants anymore. Coal gasification should be pursued with urgency due to the LNG prices and availability issues which may occur cyclically again.

Coal gasification could be converted to hydrogen production easily when required and 'carbon capture' could be installed as well in the long run avoiding stranded asset possibilities. There is, however, a big if of Chinese readiness in it. Expanding Thar coal output is also required to indigenize the coal requirement of the cement and other industrial sectors which can reduce the import bill by 1 billion USD. Thar coal can be mixed up to 20% in the new imported-coal based power plants.

Green hydrogen is also based on solar and wind. Thus, solar and wind power are the basic technology and resources that we must develop. Electrical vehicles will replace some oil consumption from the transport sector. Solar and wind power equipment's prices have been coming down.

Efforts should be made to bring the local prices to the international prices of 2-3 USc per kWh. There are other options like biogas and solar water heaters, which can fill a significant gap up to 20% probably. Bio-CNG and community biogas plants could be an attractive option.

Initial market for hydrogen is provided by oil refineries, which require hydrogen for desulfurization. Fertilizer plants would be the next candidates for on-site hydrogen production. Karachi-based oil refineries should be the first candidates for such a venture.

Home and industrial sector would require dedicated transmission and distribution infrastructure, although up to 10% hydrogen can be mixed with natural gas in the existing system. Municipal Solid Waste (MSW) could be utilized in hydrogen production improving the economics of both hydrogen and MSW disposal.

It appears that hydrogen may not be market relevant in Pakistan before 2030. However, it would be an essential part of energy security of Pakistan in the mid to long term. All of the aforementioned would require R&D and pilot scale hydrogen facilities to increase the local know-how and local content when hydrogen is inducted into the system. Eventually, international oil companies and others would be handling hydrogen as they do oil now, drawing upon both local production and imported one.

Energy transformation would need a lot of capital which is not being provided by the advanced nations. It is almost half a century up to 2070 and 29 years up to 2050. Taking a dim view, conversion would be forced upon us by the circumstances and we would be importing hydrogen as we import oil and gas today, but electricity cannot be imported. Saudi Arabia has already started making big investments in hydrogen. Long-term infrastructural planning should have an eye on these long-term indicators.

8.2: Chronic air pollution in Punjab

As usual there is again a smog attack in Punjab, especially in and around Lahore, Faisalabad and Gujranwala regions. The problem is so intense that there is a proposal for calling every Wednesday off for the coming few months. Smog causes a variety of respiratory, eyes and skin diseases, making life miserable for the affected and their families.

Smog is caused by a combination of smoke (air pollution) and fog. Air pollution particles ride on fog water and cause double jeopardy. We will discuss in this space the causes and possible solutions. Is there an immediate solution? Let us first discuss it. There is a solution which has been introduced in China where most cities suffer from a similar problem.

The same solution has been tried in countries of Southeast Asia and Delhi in India. This is water sprinkling but not in a random and unorganised manner. Water droplets have to be formed and sprinkled from a height of 50 metres. Fire fighting vehicles can be used for this purpose. Experts' assistance may be procured from China. Some accessories may be brought along by the experts themselves. Admittedly, the solution works and does not work as well depending on the sprinkling techniques used, weather conditions, etc. Pollution comes down in less than an hour as the water droplets absorbing pollutant particles come down.

Also, there is water consumption issue, which although can be recycled. There is no harm trying this immediate solution. At least the most affected areas can be selected for action. Air pollution is caused by industries, construction activity, transport vehicles, waste burning, etc. Transport is considered to be the largest source of air pollution, although in Lahore region, industrial pollution is no less. Transport control actions like holidays and timings can reduce some air pollution. Fuel quality is another solution.

Fortunately, since 2018, a law has been made to import only low sulphur petrol and diesel. However, the problem is that local refineries cannot produce low sulphur petrol and diesel. Until these refineries are upgraded, for which project and policy actions are underway, high sulphur fuel will continue to be used in vehicles. A possible solution is to ban locally produced high sulphur petrol and diesel in pollution-sensitive areas of central Punjab. It should not be difficult.

Rescheduling of fuel deliveries and some commercial adjustments should be possible. If nothing else, winter months can be tried for this. In Delhi, there used to be a similar problem and perhaps partly continues to be there. The Supreme Court of India banned use of diesel buses and ordered their conversion into CNG. They also started a major initiative of producing bio-CNG, which killed two birds with one stone – pollution reduction and increasing energy supplies.

Bio-CNG causes much less pollution than petrol and diesel. Electric vehicles (EVs) are the ultimate solution to the transport sector pollution; easier said than done. Many countries have started introducing EVs, especially buses. EVs are expensive, although their costs are coming down and cheaper versions coming out for low-income groups.

EV policy of Pakistan targets 30% on-road vehicles to be EVs. CDA Islamabad has taken a bold and progressive step of introducing 30 EV buses. Lahore can do it as well including the conversion of BRT buses to EVs. Instead of introducing expensive new EVs, priority may be given for the conversion of fuel vehicles to EVs. For buses, it is a very cost-effective approach. Diesel buses can be converted at one-third of the cost of a new EV. In Pakistan, this knowhow can be developed easily. Buses are assembled here.

Also, 40% of vehicle pollution is from motorcycles. New and converted EV bikes can also help reduce air pollution. Lahore and Faisalabad regions are major industrial centres. Air emission control devices are seldom installed by even large in-dustries, except for cement and fertiliser ones.

Due to the lack of supply and expensive gas, small industries burn all kinds of waste and dirty fuels, causing pollution. It is difficult to order closure of the small industry. However, it should be definitely possible to organise industrial site areas at more distant locations. Also, extension services do help. A new technology has been introduced for less pollution in Bhatta industry. Similarly, other environmental initiatives may be launched with the assistance of international bodies. Again, biogas may be an alternative solution for substituting cheaper dirty fuels. Waste burning, especially agricultural waste burning, is a major issue in the region including India. Rice is grown in the region whose quick stubble removal has been a perpetual problem.

Usually, rice stubble is burnt in open air, causing pollution. Reportedly, some remedial action has been taken but the problem continues. A permanent solution is installing bio-gas plants in these areas for safe disposal of rice stubble and bio-gas production. In fact, bio-CNG may be a better option, which may provide fuel to tractors. Also, large farmers can install bio-CNG production and even filling plants on or near their land, avoiding injection into the gas grid.

Biogas/ bio-CNG has many other advantages like producing fertilisers as a byproduct and CO2 as a cold chain item – both are required for boosting agriculture. Municipal solid waste (MSW) burning is a usual practice in most parts of Pakistan. Food streets and vegetable markets are a special source of MSW. In Pakistan, about 50% of MSW is green waste consisting of vegetables, fruit cuttings, etc coming out of houses and commercial centres.

Some 25% is recyclable inorganic waste like paper, glass, plastics, etc. The green content of MSW can be used in producing biogas and only 10-20% of waste may remain to be land-filled. Rural household cooking is also a source of both indoor and outdoor pollution. Biomass of various kinds is burnt in inefficient make-do stoves consisting of three bricks loosely put together. This not only causes excessive pollution but wastes biomass fuel as well. Indoor pollution causes various diseases in women and children.

New gas stoves burning biomass pallets have been developed, which do not cause excessive pollution and burn fuel efficiently. These stoves cost Rs2,500-5,000 in retail markets. Awareness campaigns, cheaper credit and subsidies may be able to popularise these environmentally beneficent stoves. Gas companies may be tasked to take part in such schemes.

There is a lot of pollution coming out of construction sector. Often open uncovered trucks are used for material transportation. Site activities also raise a lot of dust. Facade covering and on-site water sprinkling can reduce the dust.

Table 8.2.1: WHO GuideLines Air Pollution Parameters(ug/M3)

	annual avg	**24-hr avg**
WHO Standard- PM2.5	5	15
WHO Standard- PM2.5-Lax	10-35	25-75
WHO PM10	15	45
Ozone		100
NO2	10	25
SO2		40
CO		7
Source: WHO		

Even road building activities under government projects cause unnecessary pollution. IFI-supported contracts provide for pollution control activities but local stakeholders do not pay heed to it. Greenery blocks, wherever possible, may be of help and general water sprinkling on sandy areas around urban settlements can cause reduction in air pollution.

Table 8.2.2: AQI Ranking Cities of the World

Most-Polluted	Mid-Polluted	Fair Air	Best Air
Delhi-199	Munich-54	London-32	Minneapolis-0
Lahore-189	Kabul-55	Beijing 33	ChiangMai-4
Dhaka-179	Berlin-57	Bangkok -37	Bishkek-4
Jakarta-164	Milano-59	Tokyo -37	Mebourne-5
Hanoi-162	Karachi-63	Kyiv-37	Canberra-5
Wuhan-158	Istanbul-63	Amsterdam-39	Sydney-9
kolkatta-156	Schenzen-68	Madrid-45	Detroit-9
mumbai-156	Paris-69	Rome 51	Montreal-12
Doha-153	Warsaw-69	Sofia 51	Portland-13
Kuwait-143	Singapore-74	Prague-52	Chicago-13
City Name-Ranking			
Source-IQAir-13th September 2023			

Table 8.2.3: Lahore Air Pollution Data-based on PM2.5

	AQI	days /year	% days
Hazardous	350+	21	4
Very Unhealthy	251-350	58	10
Unhealthy	141-250	127	22
Unhealthy for Sensitives	71-140	185	32
Moderate	36-70	143	25
Satisfactory	16-35	41	7
Good	0-15	2	0
Source: Sectoral Emission Inventory, Lahore: Urban Unit GoPb			

8.3: Transport sector pollution

In the first part of this series, we took a broad view of the air pollution issue, especially in Punjab, where it occupies critical conditions every year. In this space, we will specifically discuss the contribution of vehicles to the air pollution and discuss public policy issues in controlling the pollution.

Interestingly, one can interpret data in two opposite directions; the lenient view would be to say that 32% of the times (186 days per year), air pollution in Lahore has been within satisfactory limits; the other view and a rather harsh one would be that air pollution has been unsatisfactory 68% of the times.

Transport sector's share in air pollution worldwide varies from 20% to 70% depending on countries, locations and social conditions. In Lahore, the transport sector's share has been reported to be 40% of the total; within transport sector, 69% of the air pollution comes from motorcycles. This is rather strange keeping in view the large population of heavier vehicles like cars, buses, trucks and other heavy vehicles.

Table 8.3.1: Lahore Air Pollution Data-based on PM2.5

	AQI	**days /year**	**% days**
Hazardous	350+	21	4
Very Unhealthy	251-350	58	10
Unhealthy	141-250	127	22
Unhealthy for Sensitives	71-140	185	32
Moderate	36-70	143	25
Satisfactory	16-35	41	7
Good	0-15	2	0
Source: Sectoral Emission Inventory, Lahore: Urban Unit GoPb			

Vehicle population in Lahore and generally in Punjab and the whole country has been increasing. In Lahore alone, vehicle population increased from 2.39 million in 2011 to 6.29 million in 2021, of which 4.8 million are motorcycles and the rest are other vehicles like cars, trucks, buses, etc.

According to traffic police and other sources, it has been reported that 40% of the vehicles create smog, which is a very large and alarming percentage. There is no justification for scepticism in these numbers keeping in view the ongoing smog situation.

It may appear on the surface that motorcycles may be producing much less pollution. The large number of motorcycles being a separate issue, the individual motorcycle produces more air pollution than a car, especially the newer cars.

Motorcycles for price and space reasons in the developing countries could not induct new pollution control technologies as motor cars have. As a result, motorcycles cause more emissions than cars.

Specifically speaking, motorcycles emit 13% more CO_2, 36% more NO_x and 335% more hydrocarbons. Numbers may have changed over the years to the detriment of motorcycles due to continuing technology changes and the induction of newer cars.

And the story of two-stroke motorcycle is even much more verse. Two-stroke motorcycle manufacturing has been banned in Pakistan and rightly so.

Pollution control guidelines

Following guidelines are adopted to control transport-based air pollution:

1. Early retiring of older vehicles through laws or incentives
2. Raising awareness of better vehicle maintenance
3. Prescribing and monitoring vehicle emission limits and laws and raising awareness thereof
4. Improving fuel quality (Euro 1-2 to Euro 5-6)
5. Converting to better fuels (CNG, 5-10% ethanol and electric vehicles)
6. Increasing railway traffic, especially freight
7. Promoting public transport and car pooling
8. Green town planning, dispersal of commercial zones and out-city industrial locations to prevent heavy traffic incursion inside the city
9. Establishing low pollution zones

Figure 8.3.1: Emission Testing Motor Cycles

Pakistan has implemented a few guidelines already. Import of Euro-5 petrol and diesel has been made mandatory. Only local refineries produce Euro-2 grade petrol and diesel.

Local refineries produce almost 50% of the total requirements. Old refineries are being upgraded to produce Euro-5 fuel and new clean-fuel refineries have been planned. For pollution-sensitive locations like Lahore and Faisalabad, imported fuel should be distributed only.

Electric vehicles policy

Motorcycles heavily populate Southeast Asia, which forms a major source of air pollution there. Apparently, motorcycles do not appear to be so pollution risky. These provide quick and less-space vehicles for individuals, friends and even families.

Even then, countries like Vietnam and others are planning to get rid of petrol motorcycles and introduce electrical bikes (100%) as early as 2030. Pakistan obviously cannot afford to do so due to poverty and lack of government finance and has adopted more modest targets.

In Pakistan, an EV policy has been introduced under which 30% of the locally produced motorbikes are to be EVs. Already, a number of EV motorbike manufacturing companies have been set up and many are applying for licences to do so.

Conversion of existing petrol bikes to EVs has also been initiated. It would, however, take time to have 100% EV bikes to ply the roads of pollution-sensitive areas. Petrol bikes may be banned gradually and selectively initially from pollution-sensitive areas. Same applies for three wheelers.

Inspection and control (I&C) system

Almost all industrialised countries have introduced and established an I&C system. Even developing countries like India, Malaysia, Indonesia and others have done so.

It appears that Pakistan should also install some kind of I&C, may be initially voluntarily and free. I&C consist of the following steps:

1. Establishing emission limits for various types of vehicles
2. Establishing a legal regime to enforce the law; challans, etc
3. Installing vehicles emission inspection centres with the required hardware and software
4. Establishing emission inspection frequencies, variables and limits
5. Establishing emission database
6. Installing an audit mechanism for measuring performance of I&C centres

I&C equipment measures tail-pipe emissions by inserting a sensor in the exhaust pipe of vehicles and the data is analysed by an electronic analyser. Usually, two parameters are measured; CO2 and hydrocarbons.

Figure 8.3.2: Remote sensing schematic

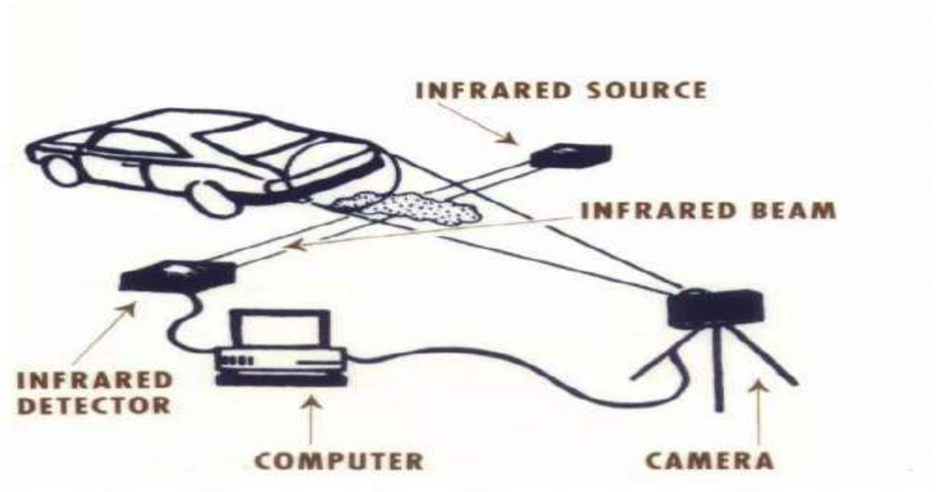


Table 8.3.2: Emission Controlfrom In-Use Vehicles

Pollution Under Control (PUC) Tests:

■ Idle CO HC Emission Test for Gasoline vehicles

PUC Tests – Revised Norms from 1st October 2014

PETROL/CNG/LPG DRIVEN VEHICLES

Vehicle Type	CO (vol%)	HC (ppm)
Two wheelers (2/4 -stroke) (Vehicles manufactured on and before 31st March 2000)	4.5	9000
Two wheelers (2 -stroke) (Vehicles manufactured between 31st March 2000 and 31st March 2010)	3.5	6000
Two wheelers (4 -stroke) (Vehicles manufactured between 31st March 2000 and 31st March 2010)	3.5	4500
Two wheelers (2 -stroke) (Vehicles manufactured after 31st March 2010)	3.0	4000
Two Wheelers (4 - Stroke) (Vehicles manufactured after 31st March, 2010)	3.0	3000
Three Wheelers (2/4 - Stroke) (Vehicles manufactured on and before 31st March, 2000)	4.5	9000
Three Wheelers (2 - Stroke) (Vehicles manufactured after 31st March, 2000)	3.5	6000
Three Wheelers (4 - Stroke) (Vehicles manufactured after 31st March, 2000,	3.5	4500
Four Wheelers manufactured as per pre-Bharat Stage II emission norms	3.0	1500
Four Wheelers manufactured as per Bharat Stage-II or Bharat Stage-III Emission norms	0.5	750

For CNG Vehicles, NMHC = 0.3 x HC; For LPG Vehicles, RHC = 0.5 x HC

I&C centres may be installed at petrol pumps in private and public sectors, operating on free or subsidised service rates. A token system and a database of emission-pass vehicles are to be maintained and also of the failed vehicles, which are given three months to get the vehicles repaired.

Initially, mobile drive-by emission inspection systems may be installed on roadsides with locations changing routinely. Under this system, gross violators may be identified. Also, an initial rapid survey may be conducted through it for designing a policy and the system.

We have noted that transport sector is the predominant source of air pollution out of which motorcycles have the largest share.

Pakistan is a poor country. Motorcycle demand would increase more than that of any other vehicles. It is, therefore, desirable that control policies give priority to motorcycles.

International technical assistance should be sought for installing a viable pollution monitoring regime, both for AQI and vehicle emissions. Monitoring along is not sufficient, corrective repair measures would also have to be introduced through public-private partnership. And finally, EV is the ultimate solution, especially for motorcycles.

8.4: Construction causing Air Pollution and Smog

Construction is perhaps the most important economic and social activity in human life. Construction sectors contribution to Pakistan's GDP stands around 14-15%. In advanced countries, construction sector contributes 23% to air pollution,50% to climate change,40% of drinking water pollution and 50% of landfill waste. However, in these countries the aggregate pollution is much lesser. Construction sites have been reported to be responsible for 14.5% of PM2.5 and 8% of PM10 emissions. In China, it has been reported that construction dust contributes to 27% of the causes of diseases caused by pollution. In Delhi India, it has been reported that 38% of PM10 is due to construction and in Chinnai, it is 23%.

On Pakistan, reliable data is not available on construction sector and site activities regarding pollution. However, one can readily see that dust forms to be a very significant contributor to air pollution. Dust plumes are as visible in Pakistan as one sees industrial smoke plumes. However, it is taken lightly in Pakistan. Industrial and vehicular pollution is given much more attention. Pollution from many sources rides on dust particles and transports the pollution to larger areas.

However, Construction dust control can be the cheapest and easiest of all. Following guidelines are available in this respect.

- Sprinkling water on construction site land, especially, in areas where lose dust appears to be there; as simple as that. Water availability can be a problem. Partly treated waste water can be used also. Where dust seems to be rising and appears to be suspended, water guns are to be employed to settle the dust.
- Site construction plan should be organized and approved keeping pollution causing activities farther from roads and active population centers.
- Tillage also controls wind erosion. Mulching the land soil is the most useful method employed in agriculture which is also quite effective in construction.
- Material loading and unloading can be done carefully keeping the unloading device closer to the land so as to avoid dust rising.
- Under certain conditions, apply polymer and Chloride to the top of the soil and then sprinkle water to create a seal over the loose soil. Speed limit should be observed on vehicles moving on unpaved road on the site. This limits soil erosion. Many people may have seen tucks which raise dust when moving on the site.
- Iron sheet enclosure of 25-35 ft height is to be installed on all sides of construction site. Entire under construction building has to be covered with green tarpaulin or equivalent fabric to stop cement or other material dust coming out. It is a pleasure to see sometimes, these instructions being partly implemented in Pakistan. It is a good beginning.
- Diesel engines should be tuned properly and adequate filters are to be installed, cleaned and replaced regularly.
- Air Quality monitoring equipment is to be installed at site.

If one looks at the above guidelines, it would become learn that these are not such difficult things to implement. It has to be given adequate importance. A simple written policy should be developed in this respect. The problem, however, is implementation of policy. The inspectors who are employed would be normally bribed. One would be at a loss to understand as to what to do with this phenomenon. A classic example is India where all kinds of control policies are drawn, but implementation does not appear to be adequate. As a result, pollution level in most major cities is almost as high as here in Pakistan. On the other hand, the other side of the picture may be that without any policy and control things may be even worse. India is much more densely populated than Pakistan. And there is a lot more industrial and construction activity there.

Fortunately, judiciary has been taking interest in the issue and regular edicts are issued with respect to avoiding pollution. Perhaps, awards may be announced for builders, contractors and developers who manage to implement green environmental practices. The pollution problems will continue to increase and get totally out of hand. As it is, the situation is bad as is widely known. It occurs every year around the same time.

More data collection and studies should be conducted and more air quality monitoring instruments should be installed by the provincial governments. Studies are required to identify nature, volume and share of various factors, so that resource planning and investment decisions can be made. One keep hearing the name of Punjab in this respect. Other provinces should start taking interest. Although, in cities like Karachi, higher wind speeds dilute the intensity of the air pollution problem.

Environmental engineers and managers must be employed who should plan and monitor environmental requirements that have to be implemented. This should be the part of construction permit and even construction contracts.

The problem, however, is that in Pakistan construction sector involves individual house-building controlling which activities may appear to be the most difficult task except creating awareness. However, even larger project construction activities also suffer from careless activities causing pollution. This sector can be forced to comply with good or green management activities. International financing companies do have guidelines but very little attention is paid in actual terms.

8.5: Lahore Smog: creating market for Rice Stubble

Every winter season, starting from October to January, Air Pollution and Smog dawn on Lahore and Central Punjab. Cold temperature and loss of wind velocity plays a role in accentuating the intensity of the problem. Burning of Rice Stubble is one of the major factors, although, all of the problem cannot be ascribed to it. It has been estimated that Rice stubble burning has a 30% share in the total problem of the smog season. Other factors are vehicular traffic, industrial pollution, construction and others.

All crops and crop waste burning have been banned in Punjab. There is Section 144 against it. Violators can be fined and even arrested. However, the problem has a large dimension. It cannot be solved through laws and policing alone. There has to be an affordable solution to the problem.

In order to sow the next crop, farmers have to clean the farm land and remove the straw and stubble as quickly as possible. Many kinds of machines have been introduced which have been adopted by big farmers. There have been subsidies for hiring machines and their services as well. Some effect should have been there of these measures, but the problem persists. There are some smaller but interesting solutions as well. A Harvard/MIT study proposed that only if farmers start burning the stubble two hours earlier, there may be a reduction of 14% in air pollution, saving 10,000 deaths annually in Indian Punjab. They have discovered that Basmati causes much less pollution in stubble burning.

Farmers argue that dew drops on rice stubble make the field too wet for tilling. Burning straw is a low cost and fast solution. It also helps in controlling weeds economizing on the expenditure required on herbs and pesticides. They argue that Machines are too expensive and unaffordable. However, if the stubble is sellable at a price higher than the cost applied in cutting and collecting it, farmers should be agreeable and inclined. Punitive laws may then be effective as well in the face of a viable option.

Rice Stubble has a mass and energy. It is not useless. It should be made a commodity-a sellable commodity. It can be employed in a number of uses in industries, specifically, in producing energy. And there has to be a use and customer for that energy. There are three market areas;1. Biogas and Ethanol Production; 2. Bio-pellets for house-holds, Brick-kilns and other industrial furnaces;3. general market in larger areas.

There are more than 10,000 Brick Kilns in Punjab which burn coal. New technology has been introduced in reducing coal consumption. Bio-mass pallets can be employed to replace 20% of the coal consumption creating a ready market. There is a ready example in India where legislation has been introduced in this respect. There may be some initial problems in introducing and facilitating a chain of SMEs for producing and supplying bio-pellets. But there is a ready market in Brick Kilns. Also, biomass stoves have been introduced which require pellets. Credit and subsidies to promote these stoves will not only help partly solve the air pollution problem by replacing stubble burning in the field. 8.5 million tonnes of rice residue are produced annually. It is a lot of useful material. Coal consumption in brick kilns stands around 3.5 million tons. However, Rice residues CV should be only 40% of that of coal. It appears that brick kilns can consume a significant portion of the rice residue.

The main problem with rice stubble burning is that it is generated and has to be disposed off in a small window of time concentrating air pollution and smog. Its burning in industries over a wider area and in a much larger time slot will reduce the air pollution impact.

Figure 8.5.1: Stubble burning in Pakistan

However, in case of biogas, it is a highly safe and pollution-less approach. Rice stubble is converted into residue, pretreated and then subject to bacterial digestion in airless large vessels, almost as large as that of big oil storage tanks. Biogas can be burnt raw or can be cleaned. Raw biogas contains 45-50% CO_2 and Some H_2S which is removed to produce almost pure Bio-methane. Bio-methane's main usage is as Bio-CNG. It can replace CNG and let its equivalent be used in other industrial, commercial or residential sector. Raw Biogas can promote rural industrialization promoting many kinds of industries. Rice stubbles converted into bales can be marketed over a larger market area. Provincial government can facilitate storage and logistics, if at all it is required. Things should work on their own in the private sector and the markets. Steel furnaces and Boilers can also use this. WE have mentioned earlier of the prospects of rural industrialization.

Figure 8.5.2; Biomass source for making Pellets and Briquettes, and their uses

8.6: Seaweeds Farming in Oceans: A multi-pronged Resource

1. There is a renewed emphasis in Pakistan on Carbon credit market with a view to earn revenue and as well as meet the GHG targets achievements made under NDC. Two conferences have been held recently on the subject. As the humanities problems are mounting, new opportunities, resources and solutions are emerging. Seaweed farming in the oceans is one such development which offers multi-pronged solutions varying from carbon absorption to food, medicine and cosmetics production.

2. Unfortunately, Pakistan has been lacking in Carbon market participation. Carbon market means buying and selling of carbon emission and absorption among parties. It lets companies and countries meet their GHG (Green House Gases) targets and commitments. Reportedly, only 10 projects have been registered with the UNFCC and even lesser projects have started earning. Even Nepal and Bangladesh have done more in this respect with 80 projects between them. And India and China have developed around 1600+ projects.

3. However, there is a great success that must be mentioned here regarding the Mangrove development project in Sindh. Sindh mangrove project has already earned 40 million USD of Carbon Credit. In part II, it is expected to earn another 60 million USD. Over a period of 75 years life of the project, total carbon earnings of this project have been estimated to be 12 billion USD. Besides the environmental benefits, Pakistan will accrue. Similarly, there is tremendous potential in forestry, agriculture and Energy Conservation. Our concern in this space is Biogas and Bio-Methane which we will elaborate in the following.

4. Here we will discuss the potential of developing a related project based on Seaweeds. Seaweeds grow in the salty water of oceans, naturally or through man-made efforts. Seaweeds are a unique natural product requiring no land, no fertilizer or no fresh water of which all the humanity is short of. It offers multi-pronged solution to the climate problem; absorbs atmospheric Carbon, reduces cattle's emissions, provides feedstock for bio-fuels and fertilizers.

5. According to a World Economic Forum (WEF) on the subject, Seaweeds have following properties or distinctions;

- Seaweeds are both nutritious and delicious and can play a major role in world food supply chain
- Some Seaweed grows as fast as 50 cm per day and up to 60 meters in length.
- Some Seaweed can reduce methane emissions from ruminant cattle by up to 90%
- Seaweeds fix carbon at a rate of 1000-3400 gms per meter per year.
- Seaweeds are better absorbent of CO2 than trees of the forest on earth. It can be a great Carbon sink

Just one property of reducing entering fermentation in Cattles stomach can be of tremendous value in Methane mitigation. There are more than 100 million cattle in Pakistan. Pakistan is 3-5th largest milk producer of the world. A single cow emits as much as 250-500 liters of methane per day. Adding 3% of a Seaweed product in the cattle diet by weight can reduce the enteric emission by 80-90%. There are more than one billion cattle in the world which all can be the market of this Seaweed product, even if Pakistan farmer does not use it for the cost reason. It can be exported. Joint Ventures can be formed with companies which produce and market this product. One can earn revenue or Carbon credits, or probably both as a combination of both exports and internal consumption. One is, however, not sure of a commercial product having come out into the market at a reasonable volume or scale.

6. Seaweeds can be digested under a bacterial process and Biogas can be produced out of it, in almost the same manner as biogas is normally produced by digesting various kinds of wastes. Seaweeds have a great potential of producing bio-methane. It has been estimated that if Seaweeds are cultivated on 9% area of the

ocean, all needs of world fossil fuel can be met. One is, however, not sure of the cost. Alongside, it will sequester 53 billion tons of carbon per year. Our gas resources are dwindling. However, for us Bio-gas production may be a ready and fast track priority.

7. Annually, 35 million tons of seaweeds are produced globally. In Dollar terms, market size is 11.4 billion USD. Some 97.5% of Seaweed of the world is produced in Asia, 90% of which is artificially cultivated. China is the largest producer having a share of 56%. Second is Indonesia which cultivates 28.6% of global Seaweed production. Japan and Korea are engaged in high tech seaweed products in food, medicine and cosmetics sector.

8. In India, seaweed farming machinery is being developed and also work is going on there on bio-fuels production from Seeweeds. There are companies busy in developing replacement of carbon intensive products like soy, fertilizers and plastics. And produce their bio-versions based on seaweeds.

9. In Indonesia, one million people are employed in seaweed farming. It can be great source of creating employment and reducing poverty. While, land could not be allotted to the poor, ocean plots can be allotted to the poor for working on their seaweed farms, especially, in Sindh and Balochistan. A study in Philippines gas estimated that in seaweed farming, there is a potential of earning 5-6 times more than that of land farming. In Tanzania, Seaweed farming is third largest foreign exchange earner and a major employing sector, especially, women. There are diverse places where seaweed production is there which include Chile, Ireland and Sweden.

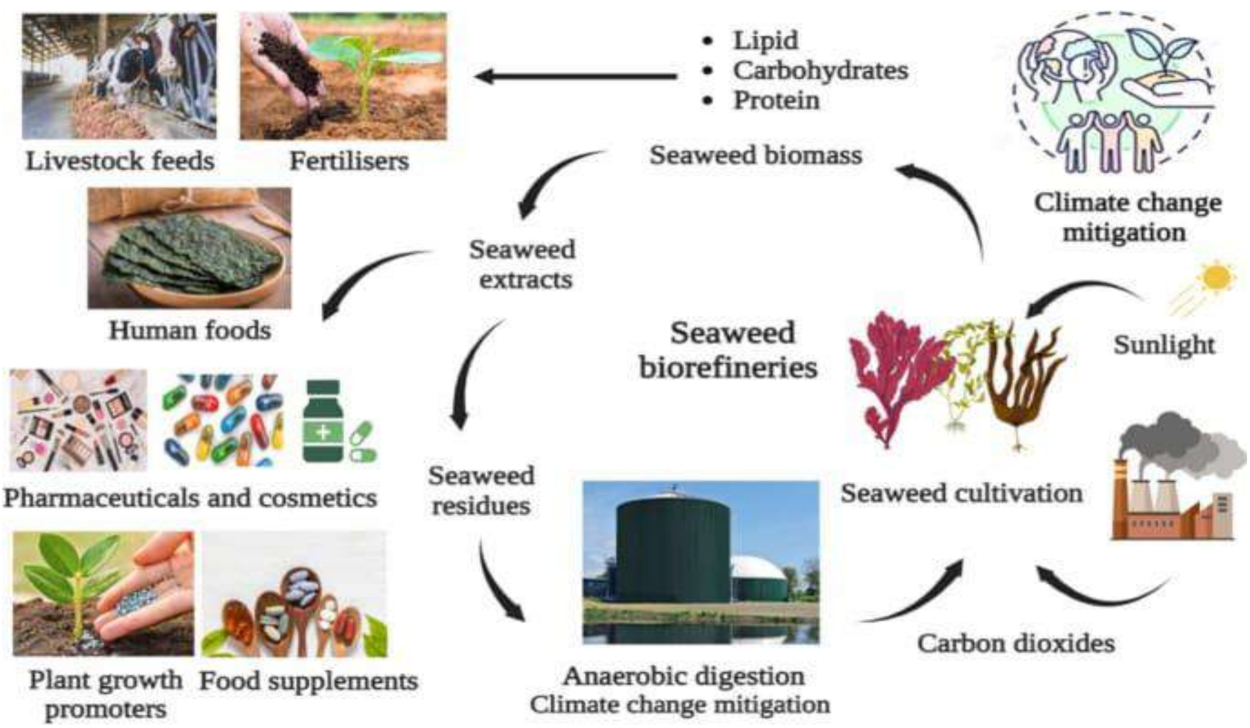
10. Three types of projects can be developed; 1. small subsistence farming; 2. Commercial Farming; 3. Environmental-cum- commercial farming. Small societies can be licensed for subsistence level forming with a nominal registration fee or no fee at all;2. Commercial farming would require licensing and regulation;3 Environmental-cum-Commercial farming would require registration and other features that are usual under UNFCC regulations. This would allow, Carbon trading.

12.It is obvious that feasibility and investment studies would be required to be done to launch larger projects which can be done under JVs. However, for smaller projects, programme studies may be enough done under bilateral or multilateral technical assistance. Time is of essence. Opportunities may be lost if and when competing countries or companies may develop projects earlier. It is regrettable that a serious biogas and Bio-Methane programme under an organized policy framework could not be initiated, even though that all project elements are available.

13. Substantial industrialization and employment can be generated. And a lot of R&D activities in the universities and companies may be initiated. For immediate effect, GHG project may have to be developed under a JV with one of the several large companies which are engaged in Seaweed farming and producing products of various kind**.**

Figure 8.6.1: Seaweed Bioresources

Figure 8.6.2: Seaweed for climate mitigation



8.7: Air Quality Measurements

AQI is an internationally comparable index measuring air pollution levels of geographical locations which are averaged over, counties, Tehsils, districts, provinces and even countries. Only recently, attention has been paid to AQI and measurement instruments have been installed. Earlier, pollution monitoring vans were acquired which are not visible these days. Public interest has increased and a number of private individuals and organizations have installed AQI monitoring instruments. AQI is some kind of average of the following criteria pollution elements;1. Particulate Matter (PM10 and M 2.5; 2. Carbon mono oxide(CO);3.Ozone(O3);4.NO2/NOx;5.Sulfur Di Oxide(SO2/Sox).

UNEP collects AQI data from 645 locations in 117 countries, territories and regions and releases hourly data .37 countries only report data which can be termed healthy air quality. It prioritizes PM2.5 data and applies AI techniques to compute AQI.WHO estimates that about 7 million deaths per year can be attributed to air pollution.

Figure 8.7.1: AQI-Average Quality Index

Air Quality Index (AQI) Values	Levels of Health Concern
0 to 50	Good
51-100	Moderate
101-150	Unhealthy for Sensitive Groups
151-200	Unhealthy
201-300	Very Unhealthy
301 to 500	Hazardous

Particulate Matter (PM)

PM is a mixture of solid particles and liquid droplets found in the air. Some particles like dust, smoke, dirt, soot are large and dark enough to be seen by naked eyes, while others are too small to be seen by the naked eyes.PM are classified as PM10 and PM2.5.

PM10: are particles which are 10 micrometers in diameter or are smaller.PM2.5 are fine particls with diameter of 2.5 Micrometers or even smaller. These are inhalable.

PM are particles come in various size and shapes and may be carrying many chemicals or their products. Usually, in the air PM are formed due to the reactions between Sox and NOx which come out of power plants, industries and automobiles.

PM2.5 pose great risk to the health of citizens through inhalation and getting into the lungs and the blood stream. In many jurisdictions, PM2.5 measurement is taken as a major parameter in computing AQI. Sometimes, it is the sole parameter. In the adjoining table, we provide a table that links PM 2.5 with Air Quality.

AQI Pakistan

Average PM2.5 of Pakistan is 65.81 ug/M3 almost twice the average of China (39.12 ug/M3).Average hides many realities as indicated by the individual city values. Gujranwala and Faisalabad have PM2.5 values of 105.3 ug/M3 and 104.6 ug/M3, placing these among 3rd and forth most polluted cities in terms of these parameters.

It may be noted that WHO standard prescribes 5 ug/M3 for annual average. However, for developing countries, WHO tolerates a lenient number of 25.

Table 8.7.1: WHO Guide Lines Air Pollution Parameters(ug/M3)

	annual avg	24-hr avg
WHO Standard- PM2.5	5	15
WHO Standard- PM2.5-Lax	10-35	25-75
WHO PM10	15	45
Ozone		100
NO2	10	25
SO2		40
CO		7
Source: WHO		

Figure 8.7.2: Report/Sectoral emission inventory of Lahore

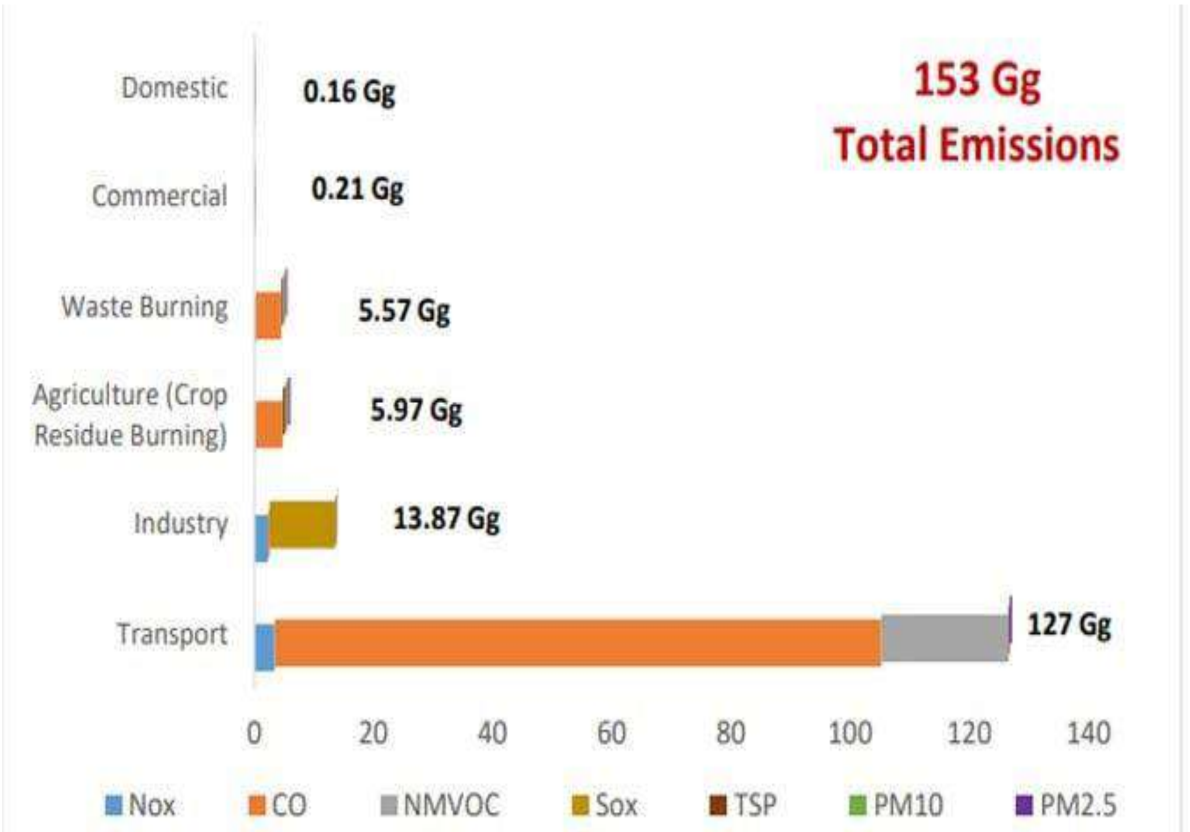


Figure 8.7.3: Contribution of emissions of selected air pollutants (2020)

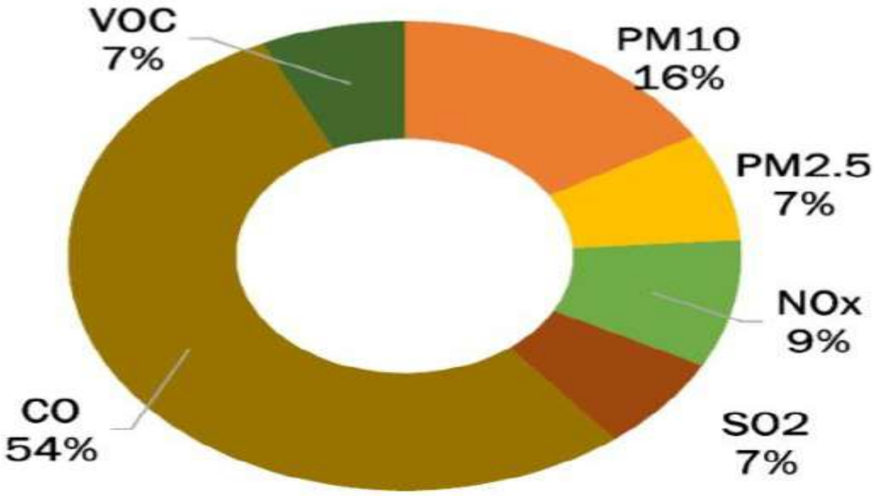


Figure 4.4: Contribution of emissions of selected air pollutants (2020)

Figure 8.7.4: Percentage of Contribution of air emissions by Sectors

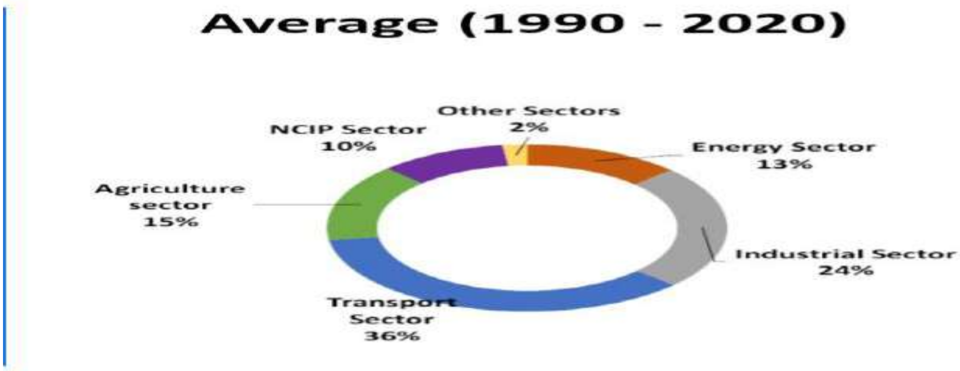


Figure 4.3: Percentage of contribution of air emissions by sectors (1990 – 2020)

Figure 8.7.5: Air monitoring Station in Reno, Nevada

Air monitoring station in Reno, Nevada. Photo: Brewbooks

Table 8.7.2: AQI Ranking Cities of the World

City Name-Ranking	Unhealthy	Moderate	Good
Delhi-199	Munich-54	London-32	Mineapolis-0
Lahore-189	Kabul-55	Beijing 33	ChiangMai-4
Dhaka-179	Berlin-57	Bangkok -37	Bishkek-4
Jakarta-164	Milano-59	Tokyo -37	Mebourne-5
Hanoi-162	Karachi-63	Kyiv-37	Canberra-5
Wuhan-158	Istanbul-63	Amsterda-39	Sydney-9
kolkatta-156	Schnzen-68	Madrid-45	Detroit-9
mumbai-156	Paris-69	Rome 51	Montreal-12
Doha-153	Warsaw-69	Sofia 51	Portland-13
Kuwait-143	Singpore-74	Prague-52	Chicago-13
Source-IQAir-13th September 2023			

Table 8.7.3: Lahore Air Pollution Data-based on PM2.5

	AQI	days /year	% days
Hazardous	350+	21	4
Very Unhealthy	251-350	58	10
Unhealthy	141-250	127	22
Unhealthy for Sensitive’s	71-140	185	32
Moderate	36-70	143	25
Satisfactory	16-35	41	7
sGood	0-15	2	0
Source: Sectoral Emission Inventory, Lahore: Urban Unit GoPb			

8.8: COP 28 Transition: Our Energy Dilemma

COP 28 has ended with a compromise solution. There was one side, led by the developed countries, and climate activists which emphasized fast track and definite end to fossil fuel. There was another side, led by oil producing countries mostly, which opposed fast track approach and asked for a gradual approach.

The final text of COP28 has for the first time explicitly called for "transition away from fossil fuels –in a just, orderly and equitable manner accelerating action in this critical decade so as to achieve net zero by 2050".It avoided the more explicit and hard language of "phase out or phase down fossil fuels". It has, however, been explicitly against coal calling nations, "to accelerate efforts towards the phase down of unabated coal power". So it was a fight for ***Transition away from fossil fuels vs phase down.***

U.N. Secretary General's comment on the outcome of COP28 reflects both optimism and frustration. He said: "to those who opposed a clear reference to phase out of fossil fuels during the COP 28 climate conference, I want to say; whether you like it or not, fossil fuel phase out is inevitable .Let's hope, it doesn't come too late".

One can summarize the main aspects of COP28 agreement as the following;1.transition away from fossil fuel;2. no to coal power;3.net zero by 2050;4;development of low emission technologies such as Renewables, Hydrogen and nuclear;5.carbon capture, storage and utilization;6.Climate finance;7.Loss and Damage Fund.

Los & Damage Fund

The most positive and practical action taken in the conference was regarding Loss and Damage Fund. This fund is meant to help those countries which suffer from the consequences of climate change in the form of floods, droughts, land use damage, food loss etc. The fund was agreed to in COP27 held in Sharam al Sheikh. It has been operationalized. Five countries have pledged 420 USD, although much more is required. It is hoped that more would come along with meaningful approaches and strategies.

Tripling Renewable Energy by 2030

The agreement calls for tripling the installed capacity of renewable by 2030.An associated provision requires doubling the rate of increase in conservation. Both combined should reduce the demand of fossil fuels. It appears to be a clever device which will automatically affect the role of fossil fuels. When demand goes down, supply goes down. The question is if enough supplies of solar and Wind power equipment would be available.

Win-Win for the developed countries

Although, there is a common future in adopting policies which contain temperature increase by or below 1.5 deg C by the turn of the century, for developed countries, all is well; fossil or no fossil. They benefitted from exploiting the fossil and the dirtiest fuels and almost exhausted those. They were producers and exporters of fossil fuels. There are and were some developing countries which were lucky enough to discover and produce fossil fuels. And now that, Alternative energy is approaching near perfection and wider availability in near future, they would be equally on top of it. Infact, they would be better off. Their dependence on fossil fuel, especially, oil would be no more there. They would be independently producing alternate energy like Solar, Wind and Hydrogen etc.

Developing Countries' Energy Predicament

India gets its 70% electricity from coal. Recently, it announced its plans to install an additional power capacity of 80,000 MW based on coal by 2032.India has been arguing to relate emission measurements with countries economy as measured by GDP. It means that emission reduction responsibilities should be proportional i.e. emission per unit GDP. India in COP27along with China fought for coal termination by 2070.

This time, it appears, India played it quiet. Its interests seem to be equally divided between Renewable energy and coal. It is creating Hydrogen production and Electrolyzer manufacturing capacity on a fast track. It would thus benefit both ways, an ideal situation. India has been developing solar and wind power. It plans to install 500GW of Renewable energy capacity by 2030 and 5 million tons per annum of Hydrogen capacity by 2030 also.

OPEC countries opposed the phasing down of fossil fuels and won in getting its substituted by transition. OPEC countries main income is from Oil & Gas .They would suffer from income cuts if oil and gas are cutoff drastically. However, most OPEC countries including UAE and Saudi Arabia are heavily investing in Renewable energy, Solar ,Wind and Hydrogen. In this respect ,they are also part of a win-win situation as developed countries are.

There are other developing countries having large populations(Pakistan, Egypt, Bangladesh etc) and are short of energy resources already. Although developing countries have started developing solar and Wind power, it would be quite hard for them to develop and produce Hydrogen. Their dependence would increase. Fairness demands that the developed countries devise programmes of technology transfer to developing countries. It is obvious that all developing countries would not be able to benefit from it. They would be importing Hydrogen in place of Oil and Gas.

What to do?

China has already announced that it would not install any coal power plant outside its own territory. There is no reason to assume that it does not apply on Pakistan and CPEC.A repetition of firm denunciation of coal power is an additional reason for implementing what can be called a coal power embargo. Thar coal is the only large energy resource that Pakistan has which it has started utilizing lately. Pakistan can increase its Thar coal mining capacity for firing its cement plants. Almost all cement plants are working on imported coal.

Adoption of EVs, especially, motor cycles is already being talked about due to the pollution and smog impact of motor Bikes.COP28 agreement may enhance the incentives of EV motor-cycles. If EV car prices come down to affordability level, this may happen to EV cars as well.

Investment in new refinery project is on the table for more than five year or more. Will COP28 increase the motivations of oil producing countries to spread their oil sector investment or will it dissuade them? All kind of incentives have been provided for the new oil refineries. However, expansion projects of existing oil refineries may be considered a low risk investment.

E&P oil and gas sector has been on the low key for several decades. No major discovery has been made in this period. Foreign companies have been leaving due to low prospects and high risk. OGDC and PPL are already diversifying into the mineral sector. Will new investment ***come*** in this sector?There are good prospects of investment in solar, wind and Biogas sector. Local and foreign Investment can come in this area. Local manufacturing capability may also be enhanced under these investments.

Pakistan has been high on Climate Risk Index among top ten. Pakistan can benefit from loss and damage fund that has been operationalized. Suitable projects should be developed in water sector.

Nuclear power has been supported in COP28 discussions. China may be more inclined to invest in this sector. If fossil fuel are not there or supply reduced, Nuclear power can be the only energy source to stabilize the grid and provide despatchable power. We have discussed this elsewhere in detail.

Concluding, the controversy and heated debate leading to a soft statement has disappointed many policy intellectuals in the West. It may be noted that according to the existing rules, all members of UNFCC have to agree; even if one member disagrees, decisions cannot be made. They are thinking to change the rules to the acceptance by some majority measure like 67-75% of the members.COP process can be wound away. The world policies are shaped by the consensus of the developed countries which are strongly in favour of Net Zero by 2050.Carbon tax may be levied on fossil fuels and imports or exports of the countries using fossil fuels in defiance.

Major COP Outcomes Explained

- **Transition Away From Fossil-Fuel-** Nearly 200 countries agreed to "transition away from fossil fuels in energy systems" at the COP28. The agreement is the first time countries have made this pledge.
- **Global Renewables and Energy Efficiency Pledge-** Signatory countries to work together to triple the world's installed renewable energy generation capacity to at least 11,000 GW by 2030. The countries must collectively double the global average annual rate of energy efficiency improvements from around 2% to over 4% every year until 2030.
- **Loss and Damage Fund-** Operationalization of the Loss and Damage (L&D) fund aimed at compensating countries grappling with climate change impacts. Commitments worth about US$ 800 million had been made to the Fund. The World Bank will be the "interim host" of the fund for four years.
- **Global Goal on Adaptation-** The draft text on the Global Goal on Adaptation (GGA) was introduced at COP 28. It aims to enhance climate change adaptation by increasing awareness and funding towards countries' adaptation needs in the context of the 1.5/2°C goal of the Paris Agreement
- **The Global Cooling Pledge-** 66 national government signatories committed to working together to reduce cooling-related emissions across all sectors by at least 68% globally relative to 2022 levels by 2050.
- **Declaration to Triple Nuclear Energy-** The declaration launched at COP28 aims to triple global nuclear energy capacity by 2050. It was endorsed by 22 National Governments.
- **Coal Transition Accelerator-** France, in collaboration with various countries and organizations, introduced the Coal Transition Accelerator. The initiative aims to leverage best practices and lessons learned for effective coal transition policies.
- **CHAMP Initiative-** Coalition for High Ambition Multilevel Partnership (CHAMP) for Climate Action was launched at COP 28. This initiative aims at efficient planning, financing, implementation, and monitoring of climate strategies
- **Climate Finance-** Under the New Collective Quantified Goal (NCQG) for climate finance, wealthy nations owe developing countries USD 500 billion in 2025.

8.9: COP 28: Climate Finance

COP 28 has ended with so much discussion and debate and has some useful conclusions. But it all requires Finance. Things do not work out by just words. I wish if the financial zeal to allocate and spend money had been as strong as the discussion has been. Unfortunately, this has not been the case. It is hoped that it will be there in future. We will take the stock of the situation in the following.

It would be useful here to first summarize the major conclusions and determinations of the COP 28 conference. These are provided in the adjoining box. Following are brief itemizatios.1.Transition away from the fossil fuels;2.Triple the Renewable energy installation and double the rate of increase of energy efficient improvements;3.Loss and Damage Fund;4.Global Goal on adaptation;5.The global cooling pledge;6.Tripling Nuclear energy installed by 2050;7. Coal Transition Accelarartion;8. CHAMP initiative; 8. Climate Finance.

In 2010, developed countries made a pledge to provide 100 billion USD per year to Climate finance projects. Oxfam has made following comments on Climate finance made upto now."Developed countries report they have provided just $83.3bn of their committed $100bn of annual climate finance. Only $21 to $24.5bn of this could be considered real support. 2. The net financial value of reported climate finance to developing countries – the grant equivalent – may be less than half of what is reported by developed countries. 3. Due to overestimating the climate relevance of reported funds, bilateral climate finance may have been up to 30% lower than reported. 4. Just one-quarter of reported public climate finance is provided as grants. The remainder is mostly loans, the majority of which are not even concessional (they do not represent a better deal than can be obtained on the market). 5. Only 33% of reported public climate finance was for adaptation, while 59% was for mitigation."

Loss and Damage Fund

Perhaps the most important action taken by COP 28 is about Loss and Damage Fund. It was approved in COP 27 held in Sharm-al-Sheikh in Egypt. It has been operationalized now in COP 28.There are unavoidable consequences caused by the climate change like rising sea level, prolonged heat waves, desertification and crop failure etc. It is now known and accepted that emissions cause climate change. Bulk of the emissions (75%) has been caused by the developed countries and the damages are occurring to the developing countries. For example, Pakistan has suffered from flood damages causing losses of 30 billion USD, while Pakistan's emissions are less than 1% of the global emissions. Similar is the case of African continent as a whole.

Thus some compensation should come from developed countries that have caused the damage and should go to the countries which have been damaged and will continue to be damaged unless and until emissions are controlled. The funding actually made available has been upto 5 times lesser than the needs. By the year 2030, 300 billion USD would be required which is one-fifth of the current level of funds flows. How to finance such compensatory funds? Many proposals have been made. Loss and Damage Funds are meant to finance such needs. U.N. Secretary General Antonio Guterres has proposed taxes on Wind fall profits made by the oil companies.

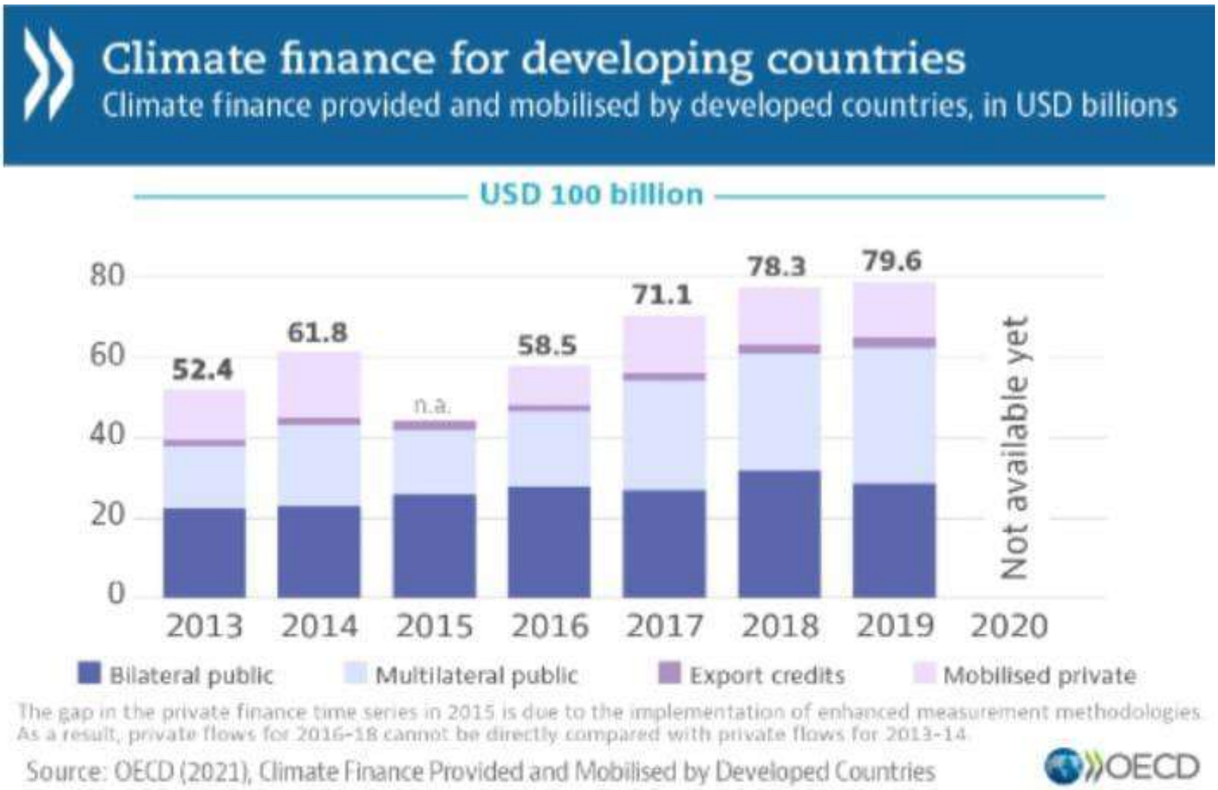
USD 700 million have been agreed towards financing the Loss and Damage Fund (LADF) which has been estimated to be less than 0.2% of the need; USD 100 has been pledged by the U.A.E; the U.S. ,the biggest greenhouse gases emitter has committed only 17.5 USD; Japan 10 Million USD; Denmark, a small country comparatively has offered 50 million USD and Norway 25 million U.S.D. The figures do not add up. There may be other countries which may be there but the data on their grants are not available. It is not certain that even this meager funding may come through. Some existing funding programmes are reworded and the net funding effect becomes zero in such cases. In some cases , financing conditions are made too difficult. It is hoped that the GST committee will be able to make effective rules in this respect.

Fossil fuels are the largest contribution to global climate change accounting for over 75% of global green house emissions. Most of it(80%) comes out of developed world. Thus developed countries have to put their house in order, while pressurizing the developing countries and tending to demand unaffordable actions at a fast track. Although most developing countries would need external finance, it would be more helpful to make them self supporting. Technical assistance and technology transfer to make them would be more effective and feasible. However, technology is available with the companies and not the governments or the inter-governmental bodies. Hence a programme to fund technical assistance may be included in such funding programmes. It would be most effective and would be faster*.*

It has been learnt that World Bank is being given the responsibility of managing the Loss and Damage Fund. Many people at COP 28 have expressed skepticism on the World Bank's ability to successfully manage the fund in the light of its management of Green Funds earlier. They say, World Bank is slow and expensive. Although World Bank has developed ability to understand the developing countries conditions and matching programmes accordingly, it is considered too bureaucratic employing expensive manpower. A 20% service charge rate (of the project cost) is considered too high. It is indeed high. Perhaps a competitive approach among international organization may be considered, it is argued.

Also such a big financing requirement cannot be simply grant funded. Only those programmes which do not bring cash income may be considered for grant income. Other should be interest free or low interest wherein cash income accrue. Also the role of intermediary companies should be reduced. It is alleged that in Carbon Market projects, intermediaries eat up most of the funding. If world has to be changed at such massive scale and so fast in a short time period, traditional working methods would have to be changed

Figure 8.7.6: Climate finance for developng countries



8.10: COP 28 - Tripling Nuclear Power or Tripling Renewable Energy or both

Nuclear power is a zero-carbon source of energy, meaning that during its operations, no carbon is produced or released. In order to achieve climate goal of limiting the environment temperature to 1.5 deg C, energy system has to be made carbon neutral. Hence the efforts of reducing fossil fuel-based energy production and substituting it by Renewable energy and now recently by nuclear energy.

There seems to be some controversy in the initial propositions of the COP 28 conference; a group of countries wanted to triple Nuclear Power capacity and the other wanted tripling the Renewable energy by 2050.The two approaches may not necessarily be contradicting each other. The total demand may be large enough to accommodate both; tripling Nuclear Power and Renewable energy both.

Nuclear power has been under tremendous controversy due to a variety of reasons; nuclear waste, safety, and proliferation and even nuclear war. There were nuclear accidents such as Three Mile Island in the U.S.A., Fukushima in Japan and Chernobyl in the Soviet Union. In the last two or three decades, no nuclear power plant has been installed in the U.S. due to a variety of controversies. It is amazing to see the U.S. now supporting nuclear power tripling its capacity by 2050.Things are not certain really in these initial days. Only today, there have been talks in the U.S. Senate regarding the continuing risk of nuclear power such as nuclear proliferation.

Why is NPP emerging again. Earlier, it was understood that NPP has gone forever due to the reasons and episodes mentioned earlier. The problem lies with Renewable energy. Many people believe that Renewable energy may not be able to provide enough energy in terms of quality and quantity. IN simple terms, Sun shines in the day, Wind blows seasonally, Hydro is also seasonal. High storages are required for balancing renewable supply with energy demand. Fossil fuel can supply stable power but creates climate issues. Also, Fossil fuel runs out eventually.

Pakistan has been installing NPPs rather continuously. Total installed NPP capacity today stands at …….. Two large nuclear power plants of 1014 MW each have been installed and commissioned recently. PAEC has applied for the generation license of another large NPP Chashma Unit C-5 of a capacity of 1200 MW. CAPEX of his plant is 3.48 billion USD. Planned completion is by 2029.Nclear power plants have played a very useful role in recent years when fossil fuel prices increased tremendously. NPPs have hgh CAPEX and low fuel cost. Its economics largely depends on the financing terms. Usually, such capital-intensive plants are financed at interest rates of 1-2% with grace periods of 5-10 years and repayment period of 20-25 years.

Among many resolutions in the proceedings on COPP 28 held in the UAE recently, one important resolution proposed by some 20 countries was regarding Nuclear Power. Triple Nuclear Power by 2050.The proponents included the following; U.S.A., France, Netherlands, Japan, Canada, Zchech Republic, Hungary, Bulgaria, Republic of Korea, Poland, Romania, Slovakia, Slovenia, Sweden, Ukraine and the U.K. Among developing countries are Mongolia, Morocco and Ghana and the U.A.E. It is strange to find Russia, China, major European countries like Germany, India and Pakistan and Saudi Arabia absent from the list. The latter are the countries which have major nuclear installation and have planned a number of nuclear power plants for the future. However, these were initial parts of the proceedings.

By 2022, there were 440 nuclear power plants in some 2 countries with a total capacity of 390 GWe providing 10% of world electricity supply. Tripling the existing capacity would mean adding 780 GWe additional capacities to total 1170 GWe. In 2020, NPP provided 2545TWh units of electricity which a 10% of the total electricity supplies. It means that the total electricity supply in 2020 was 25450 TWh. There may be some variations across various databases.

There are two main NPP characteristics that have made NPP attractive; Gen-IV NPPs;2. Small Modular Reactors (SMR). Most existing NPPs are Gen-II or GEN-III. Gen-IV reactors have the following characteristics;

- Nuclear waste as remains radioactive for a few centuries instead of millennia
- 100-300x more energy yield per unit fuel
- broader range of nuclear fuel can be used
- potential to burn existing nuclear waste (closed fuel cycle)
- improved safety such as automatic passive shutdown, double shield, alternate coolants

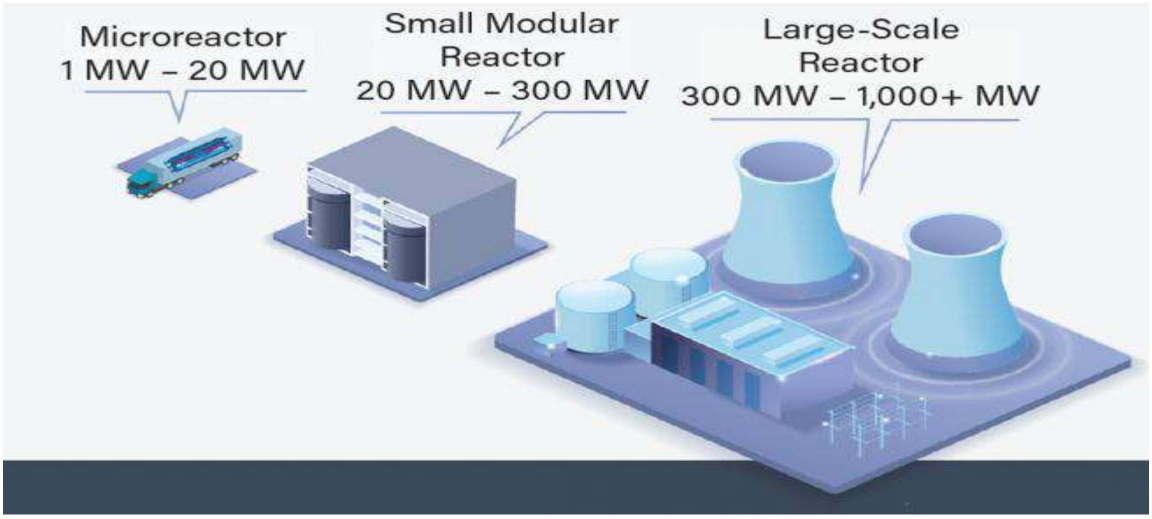
It is not known if the proponents of 10% NPP have included in this aspect to ward off opposition to NPPs. It would be difficult to get acceptance from anti-nuclear lobbies if such provisions as Gen-IV are not adopted. Certainly, Europeans and Japan would insist on Gen-IV. China has already developed and installed Gen-IV reactors in its own territory. This would revive the U.S. dormant nuclear industry. COP28 appears to be a big success for the nuclear industry of the U.S. It may be noted that the U.S. had led the coalition of 20 countries which proposed 10% share of NPPs in world energy supplies.

Advent of Small Modular Reactors (SMR)

In earlier times, the technical wisdom was that larger the reactor, better its economics. Normally,1000 MW or more of NPPs were popular and perhaps may still remain for a variety of other reasons. Large capacity NPPs have a disadvantage that it requires larger grid for safety purposes.SMR have been developed with capacity of 10-300 MW.SMR would be manufactured on factory shop floor with standard design and approval processes taking much lesser time unlike large NPPs which take years in the pre-processes.SMR may be installed even at factory level or on grid stations as a storage device.

Pakistan should also make a beginning in the area of SMR in the form of JV with China. Some parts can be manufactured in China and some in Pakistan. It is wondered whether planning and regulatory bodies in the country are considering these aspects. In the case of large NPPs, Pakistan has acquired quite some local capability with the building of the last two NPPs. In making large NPPs, there is probably no option but to do many things on site.

Figure 8.7.7



Nuclear market is expected to expand with COP 28 resolution. Already UAE is building 4x 1400 MW APR-1400 NPPs, three of which are reportedly operational. Saudi Arabia also plans to install a significant nuclear power capacity as well. It is time to recoup the technology investment back in commercial terms. There can be many areas like training, testing and fabrications where beginning can be made. Nobody offers things on the platter. One may have to follow up with China to be slightly more generous with us in this respect. We need foreign exchange badly. A target of 100 billion USD exports can be only achieved if all eligible sectors take active interest in this pursuit.

Table 8.7.4: Representative sample of SMR under development globally

Design	Net output per module (MWe)	Number of modules (if applicable)	Type	Designer	Country	Status
Single unit LWR-SMRs						
CAREM	30	1	PWR	CNEA	Argentina	Under construction
SMART	100	1	PWR	KAERI	Korea	Certified design
ACP100	125	1	PWR	CNNC	China	Construction began in 2019
SMR-160	160	1	PWR	Holtec International	United States	Conceptual design
BWRX-300	300	1	BWR	GE Hitachi	United States-Japan	First topical reports submitted to the US NRC and to the CNSC as part of the licensing process
CANDU SMR	300	1	PHWR	SNC-Lavalin	Canada	Conceptual design
UK SMR	450	1	PWR	Rolls Royce	United Kingdom	Conceptual design
Multi-module LWR-SMRs						
NuScale	50	12	PWR	NuScale Power	United States	Certified design. US NRC design approval received in August 2020
RITM-200	50	2	PWR	OKBM Afrikantov	Russia	Land-based nuclear power plant – conceptual design
Nuward	170	2 to 4	PWR	CEA/EDF/Naval Group/ TechnicAtome	France	Conceptual design
Mobile SMRs						
ACPR50S	60	1	Floating PWR	CGN	China	Under construction
KLT-40S	35	2	Floating PWR	OKBM Afrikantov	Russia	Commercial operation
Gen IV SMRs						
Xe-100	80	1 to 4	HTGR	X-energy LLC	United States	Conceptual design
ARC-100	100	1	LMFR	Advanced Reactor Concepts LLC	Canada	Conceptual design
KP-FHR	140	1	MSR	Kairos Power	United States	Pre-conceptual design
IMSR	190	1	MSR	Terrestrial Energy	Canada	Basic design
HTR-PM	210	2	HTGR	China Huaneng/CNEC/ Tsinghua University	China	Under construction
EM2	265	1	GMFR	General Atomics	United States	Conceptual design
Stable Salt Reactor	300	1	MSR	Moltex Energy	United Kingdom	Pre-conceptual design
Natrium	345	1	SFR	Terrapower/GE Hitachi	United States	Conceptual design
Westing-house Lead Fast Reactor	450	1	LMFR	Westinghouse	United States	Conceptual design
MMRs						
eVinci	0.2-5	1	Heat pipe reactor	Westinghouse	United States	Basic design
Aurora	2	1	LMFR	Oklo	United States	Licence application submitted to the US NRC
U-Battery	4	1	HTGR	Urenco and partners	United Kingdom	Basic design
MMR	5-10	1	HTGR	USNC	United States	Basic design

Table 8.7.5 status and performance Nuclear Power Plants

Reactor Unit	Type	Net Capacity [MW(e)]	Status	Operator	Reactor Supplier
CHASNUPP-1	PWR	300	Operational	PAEC	CNNC
CHASNUPP-2	PWR	300	Operational	PAEC	CNNC
CHASNUPP-3	PWR	315	Operational	PAEC	CNNC
CHASNUPP-4	PWR	313	Operational	PAEC	CNNC
KANUPP-2	PWR	1014	Operational	PAEC	CZEC
KANUPP-3	PWR	1014	Operational	PAEC	CZEC
KANUPP-1	PHWR	90	Permanent Shutdown	PAEC	CGE

e: IAEA - Power Reactor Information System (PRIS).

is completely generated from PRIS data to reflect the latest available inform