



Pakistan Energy Vision 2035



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KASB

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EXECUTIVE SUMMARY

Pakistan is undergoing an unprecedented energy crisis. There is a demand and supply shortfall of 8000MW in the country, resulting severe repercussions for the economy as a whole. In order to address the mammoth of this power shortage, government needs to formulate a definite strategy for the future. An overview of the energy sector reveals the predicaments that have resulted in severe power cuts backs.

Furthermore, the analysis underscores the need for immediate reforms in the sector to bring about a relief in the future. This report aims to define the contours of a viable energy policy for Pakistan.

Other highlights of this report include a revolutionary solution to T&D losses through the introduction of Micro Grid and Smart Grid. These will effectively help Pakistan meet its challenge of reducing line losses, and this report also gives maps showing the distribution of line losses in the country.

Lastly, the long-term goal would be to fully utilize the potential of Pakistan's Shale Gas reserves (105 TCF) and Shale Oil reserves (9.1 billion barrels). The report gives short-term, medium-term and long-term strategies regarding Shale Gas.

Overall, the country will have to move towards high efficiency and lower emissions (HELE), which underscores the importance of natural gas for the country. Towards this goal, the retrofitting of thermal power plants to improve the efficiency of existing gas-fired power plants and a fuel audit will have to be conducted. This audit will determine a merit order for gas allocation to thermal power plants.

Moreover, when it comes to diversifying the energy mix, coal is an option that Pakistan is exploring, and this report recommends that ultra-super critical plants be installed in the country to achieve greater units of power generated, in relation to fuel consumed, again underscoring the principle of efficiency which forms the umbrella of Pakistan's Energy Vision 2035.

Some other recommendations that have been suggested in this report, after an in-depth study of the aforementioned sector include:

In the short-term, the domestic sector will have to make the following improvements in:

1. Natural Gas

Increase the tariff for slabs consuming gas greater than 3.55 million cubic feet per month, in order to discourage the excessive and misuse of gas

- Promote the use of Solar water heaters and solar geysers
- In the power sector, energy conservation and good practices will have to manage demand-side issues.

2. Industry

Gas

The industry should be prioritized for the availability of gas.

In case of cement industry, the use of waste to energy should be promoted further in order to spare the gas for other manufacturing industries.

Electricity

The priority should be given to the industries producing export quality products. While the other industries which are not involved in export or producing substandard products should be confined to single shift only thus conserving the electricity for prioritized industries.

3. Agriculture

In short term, the transport sector is prioritized for use of fuel oil and discourages the use of gas.

Gas

The gas relieved from cement industry and inefficient thermal power plants should be allocated to fertilizer. Hence the order of priority in allocating gas is as follows:

1. Industry
2. Power(Efficient thermal Power Plants)
3. Agriculture
4. Domestic(cooking only)
5. Commercial

4. Transport

Gas

Promote the use of public transport for optimizing the use of fuel in transport sector.

Oil

In addition to this, the hybrid cars should be introduced on gradual basis in this sector to reduce the expensive oil consumption and relieve the burden on national exchequer.

5. Power

Gas

Allocation of gas to the most efficient thermal power plants on immediate basis to optimize the utilization of this resource and spare the gas for industrial use.

Re-negotiate the price of LNG with Qatar as the current price of imported gas is estimated around \$19/mmbtu (incl. CIF, shipping costs etc.). Moreover, Pakistan will have to look into import options with other natural-gas rich countries, to have a better bargaining position. In light of the Shale Gas revolution's impact on natural gas pricing, the trend is of lower prices in LNG deals. For example, Cheniere made a deal with Gail India from 10.5/mmbtu. There is also the phenomenon of the divorce or delinking of oil and gas prices, and countries will have to rethink linking LNG prices to oil-indices.

1. Energy Renovation and Modernization of thermal power plants to enhance the fuel efficiency and optimize the gas usage.
2. Gradual shift of power generation from thermal to hydro resources

Oil

1. Real time monitoring of quality and quantity of imported fuel oil through web based procurement system

Inclusion of contract performance clauses addressing the specification i.e. sulphur content, basic sediment and water and specific gravity, of procured fuel oils in sales/purchase agreement. These clauses, if present in contract would help to monitor the quality and quantity of procured fuel oil. As any deviation in the aforementioned specification would be subjected to the price variation accordingly.

The real time monitoring and presence of these performance based clauses if included would optimize the cost of generation thus having direct impact on end user tariff. Moreover, this step would also provide a relief to the circular debt as import bill is one of prime components of this debt.

Electricity

Generation of electricity through renewable resources especially hydropower with a gradual cut back on thermal based plants.

Installation of solar panels on rooftops of villages not connected to the grid to ensure maximum penetration of electricity in the country.

Increase in efficiency of Coal based plants in order to curtail environmental footprint and ensure maximum utilization of fuel. The recommendation is to move towards higher efficiency and lower emissions (HELE), and ultra-super critical power plants would be the way forward.

6. Commercial

Electricity

The practice of closing the business activities by 8:00 pm needs to be replicated again in order to cut down the electricity usage and spare it for domestic and industrial usage

Street Lights

It is common practice that most of the street lights are kept on even during day time, therefore, they needs to be managed appropriately.

Long Term Strategies

Gas

1. A strategic and concrete Natural gas policy addressing the demands of all sectors should be formulated after due collaboration of relevant stakeholders.
2. Shale gas needs to be explored keeping in view the current gas shortfall and increasing gas dependent needs.

Oil

1. Promotion of Biogas buses in order to reduce the dependence of oil in transport sector. It is estimated Pakistan is the 13th largest country in cattle production can produce biogas with

high concentration of methane required in biogas buses. Thus, this increased amount of waste shouldn't be wasted and utilize to reduce the dependence on oil.

2. In addition to this, the usage of petroleum products in transport can be reduced through modernization of railway system and shift both passenger and cargo trains from diesel to electricity, as practiced in India. It is estimated that around 1000MW of electricity would be required in modernizing the whole railway track which if implemented would play a pivotal role in reducing the burden of import component in circular debt.
3. In case of power, concerted efforts should be done to enhance the electricity generation through other low cost sources with hydropower as prime priority,(others include solar, wind, biomass, bagasse cogeneration, power generation through low Btu, nuclear and coal) thus reducing the dependence on oil and shifting to cost effective options.

Electricity

In long term in order to manage the demand side issues in electricity following measures should be taken:

1. The houses should be designed in a way to minimize the usage of electricity at-least during day time.
2. The industries should also be designed in a way to maximize the usage of day light and reduce the electricity consumption at-least during day time. In addition to this there should be annual energy audits of all industries to avoid the wastage of electricity.
3. The street lights in long term should be converted to LEDs to minimize the electricity consumption.

Coal

1. In long term, there is a need to explore the coal resources in Baluchistan, Punjab, KPK and AJK having heating value around 9000 Btu/LB -15000Btu/LB which is greater than the heating value of Thar coal resources i.e. 5000-13000Btu/LB.(See Annex A)
2. In addition to this, new options should be explored for power generation using coal. In this regard, Coal Water Slurry (CWS) is quite cost effective option and its retrofitting cost in case of coal conversion of thermal power plants is comparatively less than other technologies. Moreover, it is also suitable for using low quality Thar coal having greater moisture content (16%) as compared to other coal resources in Pakistan. Therefore, this new technology needs to scrutinized with due diligence.

PREAMBLE

1.1 Scope of Study

The main theme of this report is to give broader picture of current state of energy within the country and its impact on country's economy. The report intends to highlight the key issues and underlying factors behind this unprecedented energy crisis and propose doable and practical strategies on short, medium and long-term basis. Furthermore the report would also identify the gaps in current policies and propose concrete policy recommendations to be endorsed as soon as possible.

The current energy crisis, being a product of flawed policies and inept decisions, can only be addressed with commitment and dedication on part of government. Additionally, the collaboration of all stakeholders in the identified areas should be encouraged in purview of broader national interest.

1.2 State of Energy Sector in Country (Gas and Oil Sector)

The electricity sector during 2013 did not show any signs of recovery. Apart from certain isolated and secluded efforts for improvement, it stooped in the three sub-sectors. In the generation sector, capacity added in the system during last two years could not be operated fully owing to constraints in fuel availability and timely payments. The gap between supply and demand in the PEPCO's system went over 6,000 MW¹ mark, it remained around 4,000 to 5,000 MW for most part of the year, The gap representing about one third of the total demand in PEPCO's system, forced one third of the electricity consumers to remain without electricity over a twenty-hour period. Further reduction in supply due to constraints in the transmission and distribution networks led to load shedding of up to 12 hours in urban areas, whereas the rural areas experienced load shedding for 18 to 20 hours a day. According to Planning Commission of Pakistan, as a result of the losses from power and gas shortages, the GDP

¹ State of Industry Report 2013, NEPRA,
<http://www.nepra.org.pk/Publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202013.pdf>

shrunk by 3% to 4%² in the year 2012-13. The Figure 1 shows daily peak demand in ex PEPCO system during summer and winter and also the pattern of demand on typical days of the seasons³.

Maximum Demand

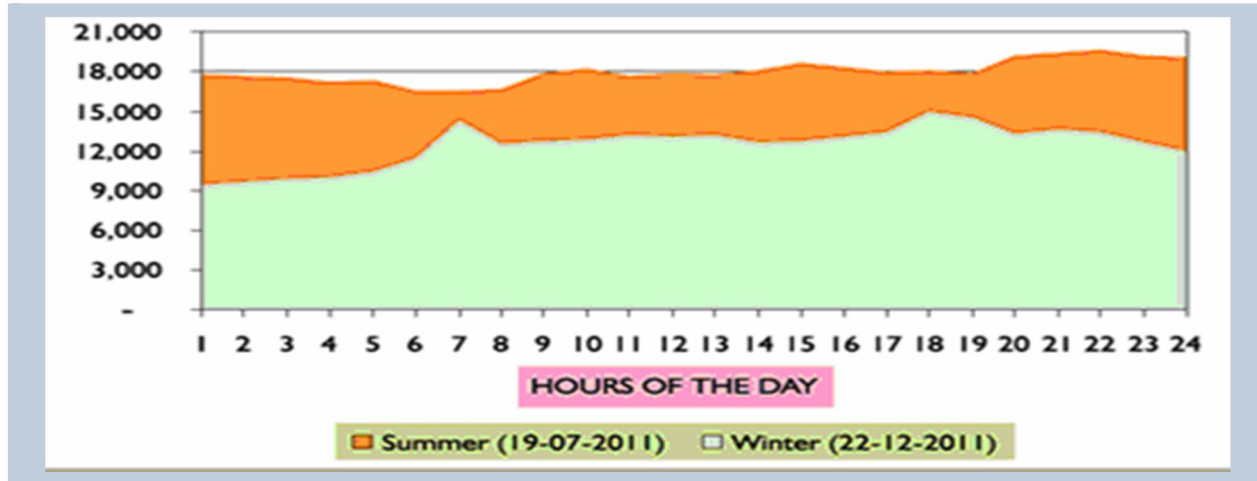


Figure 1 Maximum Demand

The aforementioned deteriorated picture is the clear evidence that power sector at present is lying in total disarray. There are technical and financial issues that need to be resolved in order to address this unprecedented energy crisis. It is pertinent to highlight here that it is not the issue of installed capacity that has led to the crisis, as may be noted from the available statistics. In fact the installed generation capacity of the system is 23,578 MW⁴, whereas the available capacity remained less than 14,000 MW⁵. Mostly the underlying cause was a payment deficit to the generation companies for buying the expensive fuel oil, forcing them to curtail their outputs. Moreover, technical availability and efficiency of generation plants was compromised due to lack of timely maintenance and rehabilitation. Therefore, the real issue isn't the lack of capacity; it is in fact the thermal efficiency and corporate debt issue that has fully engulfed

² Economic Survey of Pakistan 2013-14, Ministry of Finance, http://www.finance.gov.pk/survey/chapters_13/14-Energy.pdf

³ State of Industry Report 2011-2012, NEPRA, 2012

operations of the sector. Adding to the predicament is the incompetency of DISCOs in improving their recovery ratios and losses. The power situation in KESC is also not very different from that of PEPCO's. It is also experiencing load-shedding but according to the policy of KESC's management, industrial category of consumers is not subjected to power cuts. The load is shed for longer hours i.e. around 4 hours in those areas, which are known to steal or where lower bill recovery ratios persist. Other consumers have been less severely hit as power cuts vary between one hour to two and half hours for them on daily basis.

The issue of circular debt still remains unresolved. Corporate debt has forced the Oil Marketing Companies to limit their supply. Non-payment of dues, coupled with a shortage of gas supply to the sector, has rendered all the efforts by Government to end crisis useless as IPPs operate their plants on day-to-day basis through payment of dues. At the same time, the cost of imported fuel is touching the alarmingly high levels, leading to further widening of the gap between the NEPRA determined and Government notified tariffs (See Table 1). It may be observed that increased dependence on imported fuels has greatly undermined the GOP's efforts to overcome corporate debt issue.

Table 1: Gap between NEPRA's determined Tariff & Government of Pakistan's Notified Average Sale

	FY2010-11	FY 2011-12
NEPRA's determined average sale rate (Rs./kwh)	9.58	11.89
GOP's notified average sale rate* (Rs./kwh)	7.78	8.72
Gap in terms of Rs/Kwh	1.8	3.17

Source: State of Industry Report, 2012-13

On the consumption side, the performance of DISCOs remains unsatisfactory. High losses, low recoveries of the billed amount and technical constraints like overloading of transformers and transmission lines, leads to the limiting of efficient transfer of power to consumers. A look at DISCOs' losses on sub-division level shows that there are high unprofitable. Even those, which are considered to be performing better, have sub-divisions with losses close to 30%⁶. KESC is no exception with sub-divisions having percentage losses close to 50%⁷. Moreover, the same DISCOs also have very low billing recovery ratios, as a result of which only 40 to 45% of the electricity is useful in revenue realization.

⁴ State of Industry Report 2013, NEPRA,

<http://www.nepra.org.pk/Publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202013.pdf>

⁵ Ibid

⁶ State of Industry Report, 2012-13, NEPRA, 2013

⁷ Ibid



CHAPTER 1

**FACTORS OF
ENERGY CRISIS**

1.1 Energy Crisis and its Implications

The present rampant energy crisis in the country is deepening day by day due to lack of strategic and proactive approach, incompetent management of resources and investment in the infrastructure. This dilapidated management has led to unprecedented shortfall in all sub sectors of energy (oil, gas, coal and power), thus crippling not only the routine life but also dragging the nation's economy at devastating stage. This grave energy crisis has led to 2% loss to the GDP per annum and impact on revenue generation is approximated to Rs 52billion. Moreover, the rate of unemployment has also been aggravated to 6%⁸ in 2010-11, thus leaving millions of people unemployed across the country. Hence the factors responsible for endemic energy crisis in all subsectors and its associated issues are tabulated herein below:

1.2 Issues in Power Sector

Pakistan has been facing serious electricity demand shortfall of around 5000-5500 MW since 2007 leading to long hours of load shedding in both rural and urban areas. This escalating shortfall is primarily due to the lack of fuel availability. As the power system with the installed capacity of 23500MW can cater the peak demand of 1950MW. However, the available capacity stands around 1400MW⁹, thus leaving a persistent shortfall. The underlying factors responsible for this electricity shortfall and its associated issues are explained below:

1.2.1 Increased Dependence on Furnace Oil

The fundamental factor responsible for the electricity shortfall is increased dependence on furnace oil and lack of diversification in electricity generation mix. It is estimated that currently

⁸ Economic survey of Pakistan 2013, Ministry of Finance

⁹ National Electric Power Regulatory Authority NEPRA, 2013, State of Industry Report (2012-13)

65% (36% on RFO and 29% on gas) of the electricity is generated through thermal resources while 32% is obtained through hydropower (See Figure2). The increased share of furnace oil in generation mix is attributed to the Power Policy-1994 which attracted investment of private sector in thermal power plants and led to the reversal of energy mix from hydro vs thermal ratio of 50:50. It is significant to highlight here that in purview of lack of gas availability for power generation, the thermal power plants are compelled to run on furnace oil. Thus, this increased dependence on furnace oil is directly translated into increased cost of generation and consequently increased tariff due to expensive fuel component.

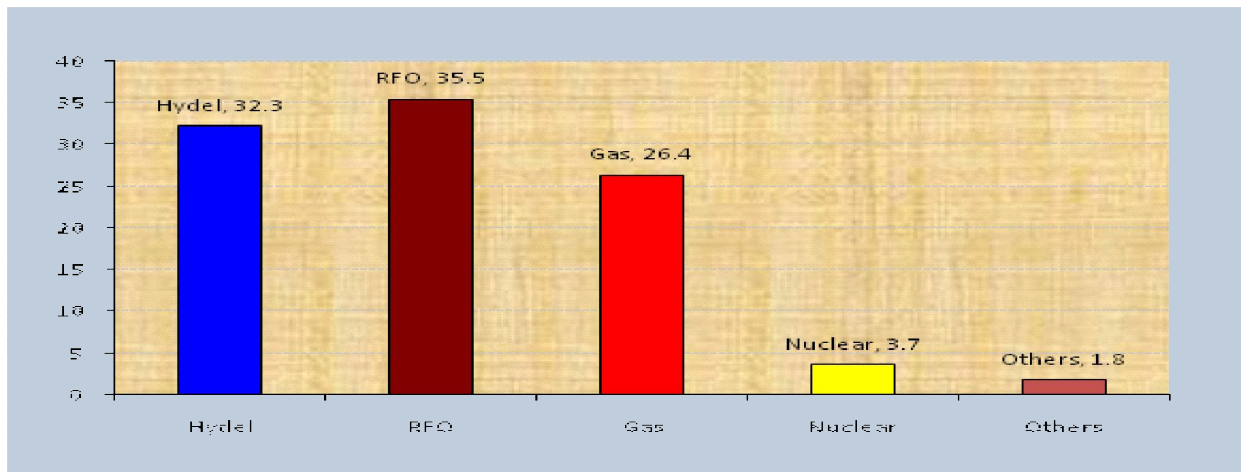


Figure 2: Generation Mix of Pakistan, Source: State of Industry Report, 2012

As discussed above the greater the share of thermal energy resources (Gas & FO), greater would be the cost per GWh. Curtailment of natural gas necessitating the use of RFO and overall decline in the share of hydel generation in total generation has led to the higher cost inputs for DISCOs. The average costs of unit delivered to the DISCOs in 2012-13 is given

Table 2:

Table 2 Average Cost of Unit delivered to DISCOs (2012-13)

	Hydro	Coal	HSD	RFO	Gas	Nuclear	Import	Mixed	Wind
GWh	28,643	66	1,474	30,662	23,431	4,413	296	730	6
% Share	31.93	0.07	1.64	34.18	26.12	4.92	0.33	0.81	0.01
Cost (Mln Rs)	4,660	206	27,848	488,617	99,340	4,978	2,662	9,331	51
Cost (Rs/Kwh)	0.16	3.12	18.89	15.94	4.24	1.13	8.99	12.78	9.12

Source: State of Industry Report, 2011-12

The Table 2 identifies that RFO constituting the largest share in generation mix is costlier than any other source. The figures show that 30,662 GWh are generated at the cost of Rs.488,617million.

1.2.2 Role of IPPs in Current Energy Crisis

In 1994, the GOP formulated a Power Policy to permit the private sector to invest in the power sector. The basic purpose of privatization was to ensure the delivery of uninterrupted supply of electricity and address the demand-supply shortfall that started triggering in early eighties. This power policy resulted in commissioning of 19 IPP's, fossil fuel based projects having total installed capacity of around 3048 MW and brought over \$3.0billion investment¹⁰. The power policy-1994 allowed full flexibility to IPPs to bring capacity on line as quickly as possible at predetermined power purchase prices. The government guaranteed implementation, fuel supply, and power purchase. Moreover, generous tariffs were offered by GOP to attract the investment of IPPs in power sector and to recover the risks perceived by investors. However, according to AEDB Report-2000, the financial performance of WAPDA and KESC had been ruined due to power policy 1994. The GOP offered to purchase electricity from IPPs at \$ 0.060/Kwh for the first 10 years that was twice the KESC thermal generation and four times WAPDA's average hydrothermal generation. This high front-end tariff determined to meet the cash flow of IPPs resulted in tariffs in initial years as high as \$ 0.083/Kwh. An additional premium of \$0.0025/KWh for the first 10 years was also offered for projects commissioned by 1997. This exacerbation of power purchase from IPPs, also led to underutilization of indigenous capacities within WAPDA and KESC.

¹⁰ Abbasi, A. (2012). Pakistan Power Sector Outlook: Appraisal of KESC in Post Privatization Period, Sustainable Development Policy Institute (SDPI).

Furthermore, a mechanism was provided for indexation of certain tariff components based on the rupee's exchange rate against the US dollar, fuel price variation, and inflation. In addition to the generous private power purchase rates of the IPPs, the agreements stipulated that if the Government bought less or no power due to lower demand, the GOP would still pay the IPPs for 60.0 percent of their plant capacity.

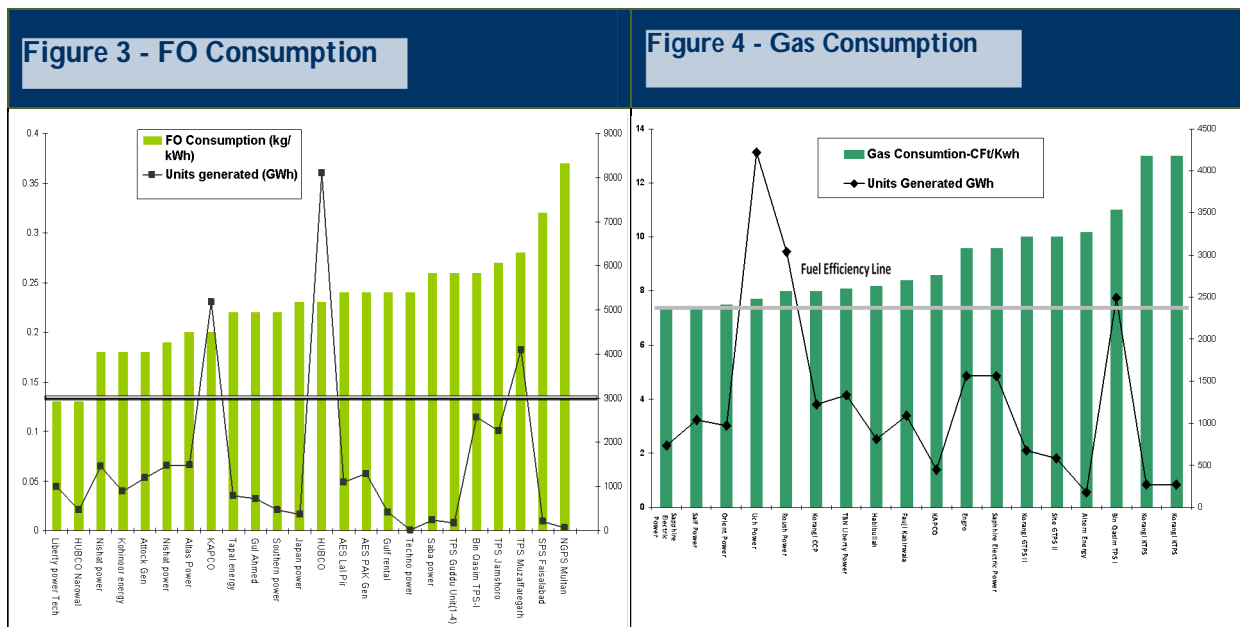
Thus the inclusion of IPP's had seriously affected the power sector due to absence of international bidding procedures, untargeted timings of Plants commissioning and their location and inappropriate choice of FO for IPPs power plant. The location of IPPs being far from load centers and northern areas of Pakistan laid severe strain on country's physical infrastructure, including electricity transmission system. Therefore, the introduction of IPP's was only an addition to already burgeoning problem of power crisis rather than any relief.

1.2.3 Poor Thermal Efficiency

Efficiency ($\eta\%$) is the electric energy output as a fraction of the fuel energy input of a thermal power plant and it is usually expressed in percentage(%). Another parameter used for determining the efficiency is fuel consumption in generating one unit of electricity.

It is unfortunate that though 65%of the electricity is generated through thermal resources and 70% of the thermal power plants are not operating efficiently or in other words consumes excessive fuel (gas & FO) for generating electricity. It is estimated that thermal power plants operating on FO consumes on average 0.22kg-0.35¹¹ Kg to generate one unit of electricity. In

other words 22-35Kg¹² of oil is consumed in generating 100 units of electricity which is very high if compared to Liberty Power Tech, consuming 0.13 kg/unit or 13 kg to generate 100 units of electricity (See Figure 3).



The performance of thermal power plants running on gas is equally presenting a dilapidated condition (See Figure 4).

The graph identifies that most of power plants consumes on average 8-13 cft¹³ of gas to generate one unit of electricity whereas only a few including Sapphire, Saif and Orient consumes 7.3 cft of gas per unit of electricity. This poor fuel efficiency is then translated in to increased cost of generation than the notified cost by GOP, leaving a gap which is then recovered through subsidy. In 2011-12, this gap touched to Rs.3.17kwh from Rs 1.80/Kwh in

¹² Abbasi, A.(2012). Pakistan Power Sector Outlook: Appraisal of KESC in Post Privatization Period, Sustainable Development Policy Institute, 2012, Pakistan

¹² Abbasi, A.(2012). Pakistan Power Sector Outlook: Appraisal of KESC in Post Privatization Period, Sustainable Development Policy Institute, 2012, Pakistan

¹³ Abbasi, A.(2012). Pakistan Power Sector Outlook: Appraisal of KESC in Post Privatization Period, Sustainable Development Policy Institute, 2012, Pakistan

2010-11. This increased cost of generation cannot be fully passed to the consumer which is then recovered through the subsidies granted by GOP, thus again draining the national exchequer. It is estimated that GOP has provided subsidy worth of Rs 170 billion to power sector during first six months (July-December) of the ongoing financial year against the overall allocation of Rs 185 billion for whole year. It is estimated that the subsidy allocated to KESC alone is around **\$ 551 Million** which is greater than GOP budget allocation for Health, Research in Science and Technology.

1.2.4 Poor Governance and Regulation

National Electric Power Regulatory Authority (NEPRA) was formulated under the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL, 1997). In the prevalent worst energy crisis, it is pertinent to analyze the failure of NEPRA in its mission that was envisaged to develop and pursue a Regulatory Framework, which ensures the provision of safe, reliable, efficient and affordable electric power to the electricity consumers. In pursuant to section 45 (J) of NEPRA Act, 1997 clearly gives mandate to NEPRA to advise Ministry of Water and Power(MOWP) on safe and effective ways of meeting electricity demands at affordable cost. NEPRA on the other hand has not only endorsed and issued appreciated policy of rental power projects but also approved tariff of five to eight rental power projects in year 2009-2010. ¹⁴Not only this NEPRA suggested and advice in such way that Rental power projects are only panacea for energy crisis. After clearance from NEPRA MOWP made contract with five IPP to rent 580 MW for five year with total contract cost of 1.24 billion dollars and so far a 36.45million dollars is already paid as down payment to five different IPPs. In another violation of same clause the regulator has now suggested the conversion of existing oil fired power generation plants to coal but forgot

¹⁴ Addition of Generation Capacity through Rental Power Plants-(NEPRA Annual Report-2009-19)

the cost of electricity generation from different sources being disclosed by itself in 2012¹⁵ (Refer Section 1.2.1: Increased Dependence on Furnace Oil).

In addition to this cost of generation of electricity, the cost incurred in terms of retrofitting cost for shifting towards coal and environmental degradation caused by coal is inevitable. It is also significant to mention here that at present when India on advice of CERC, at the end of 12th five-year plan, is planning to decrease the share of thermal especially coal based electricity generation and add 30000 MW of hydroelectricity, our regulator, NEPRA, has suggested to shift towards the coal, thereby ignoring the all costs associated with coal based electricity generation.

In another violation of same clause, the regulator in State of Industry Report, 2012 has recently advised the Ministry of Water and Power (MOWP) to update the physical progress of Rental Power Plants and make the arrangements for interconnecting the 231.87 MW Karkey Rental Power Plant¹⁶. Contrary to this, the regulator never pays heed to issue any advice to MOWP and WAPDA about the timely completion of hydropower projects. NEPRA as regulator never pursued for early or timely commissioning of these hydropower projects with vigor as followed the thermal and rental power projects (RPP). In spite of promoting the completion of hydropower projects within the stipulated time, the regulator has suggested that import of electricity from Iran and India can help in alleviating the electricity shortages in relatively shorter time¹⁷.

¹⁵ State of Industry Report, NEPRA, 2012

¹⁶ State of Industry Report, NEPRA, 2012

¹⁷ State of industry Report, NEPRA, 2012

Similarly in the case of wind energy, NEPRA granted tariff to six different IPPs. These projects were expected to be completed by 2008, adding 450MW of renewable energy in the national grid, but these plans failed to materialize.

Despite of the aforementioned facts, NEPRA is claiming that in the recent past, Pakistan's energy sector has witnessed a gradual shift of focus from nonrenewable energy to renewable and alternate energy. As per last year, authority has accepted tariff petitions and approved tariffs for numerous wind, hydro and biomass base power plants. But, it is important to highlight here that tariff determination is not the fine indicator for shifting the trend from conventional to renewable energy resources, provided the progress of hydropower projects which had to commission by 2011 but is still pending.

The regulator has also reported that it has enlarged its monitoring role by creating a Monitoring and Enforcement Division. A number of performance audits and inspections of power generation plants and DISCOs have been carried out over the year and GENCOs were strongly directed to carry their efficiency tests in order to pass the true cost of generation only. However, the results of these performance audits have so far not improved the performance of GENCOs in terms of cost of generation and passing the true cost to the consumers. As the gap between the NEPRA's determined sales rate and GOP notified price has touched the value of 3.17 Rs/Kwh as compared to 1.80 Rs/Kwh in 2011(See Table 3).

Table 3: Difference between the NEPRA's determined rate & GOP notified Rate

	FY 2010-11	FY 2011-12
NEPRA's Determined Average Sale Rate (Rs/Kwh)	9.58	11.89
GOP's Notified Average Sales Rate (Rs/Kwh)	7.78	8.72
Gap in terms of Rs/Kwh	1.8	3.17

Source: State of Industry Report, 2013

Furthermore, as per mandate, NEPRA is supposed to be acting independently and exercising autonomous decisions. It was initially believed that the government would have distance itself from business decision-making, and would have given space to NEPRA to operate freely in a post-privatization era of regulation and control¹⁸. However, the performance of NEPRA over the years has now made it apparent that it is yet another subservient department working under the auspices of the Ministry of Water and Power (MOWP). It is evident from NEPRA's performance that it has not facilitated the government in attaining the realization of power reform success and has failed in providing adequate advice and guidance in the right direction. The role of NEPRA needs to be revisited in this regard. The annual tariff determinations for DISCOs are lengthy, ineffective and lead to revenue shortfalls and cash flow problems. In addition to this, NEPRA also needs to improve its power enforcement over DISCOs with reference to over billings to consumers and other such cases.

1.2.5 Role of AEDB in Developing Alternate Energy Resources:

The Alternative Energy Development Board (AEDB) was formulated as an autonomous body with an aim to promote and facilitate the exploitation of renewable energy resources in Pakistan. It was assigned task to develop projects based on renewable energy, coordinate all associated activities as national facilitating agency for development of renewable energy in country and act as one window facility for processing renewable energy power generation projects. Unfortunately, the progress in tapping the renewable energy resources in Pakistan for electricity has been insignificant and AEDB has utterly failed to implement the mandate assigned to it by GOP in the Medium Term Development Framework 2005, which fixed a

¹⁸Jamal, Nasir."Toothless Regulators." *Dawn.Com*. 14 Sept. 2010. Web. 31 Jan. 2011.
<<http://www.dawn.com/2010/09/14/protectionism-a-barrier-to-easy-market-access.html>>.

target of 900 MW of electricity generation from renewable energy sources to be added in national grid by the end of June 2010.

The AEDB and NEPRA have entirely failed in advocating the importance and timely completion of renewable energy projects. It is estimated that wind power is still not adding any megawatt in national grid and passing through various stages of development. Currently 48 projects with the capacity of 3200 MW are still under process and Government of Sind has leased 26,000 acres of land for 18 projects with cumulative capacity of 906 MW¹⁹. In case of solar, 8 solar powered projects with 226 M W capacity are also under the developmental phase and 3,000 solar home systems have been installed in 49 villages of Tharpakar, Sind and another 51 villages in Sind and 300 villages in Baluchistan have been approved for electrification using solar energy. 750 units of solar water pumping systems have also been imported in the country and these pumping systems are installed for community drinking and agriculture purposes all over Pakistan²⁰. Moreover, the Punjab government recently commissioned a solar park in Cholistan. Though the colossal installation, having a capacity of 1000MW, may sound as a big achievement on AEDB's part, the exponentially high tariff rate of PKR. 21/kWh that has been allotted to per unit of electricity generated by solar panels massively undermines the whole project. This expensive electricity would add to the ongoing crisis rather than provide relief to it. To fully reap the benefits of photovoltaic cells, the policy should have been diverted towards roof top solar panels for far flung areas which are not connected to the grid from ground mounted parks. Hence, this lack of strategic approach and poor performance on part of these institutes is continuously fueling this energy crisis instead of creating any further improvement.

¹⁹State of Industry Report, 2011-12, National Electric Power Regulatory Authority (NEPRA), 2012.

²⁰State of Industry Report, 2011-12, National Electric Power Regulatory Authority (NEPRA), 2012.

1.2.6 Delay in Hydropower Projects

Pakistan, despite being endowed with large indigenous hydropower resources, has been suffering due to the rapid development of expensive thermal power development. The power generation scenario of hydel:thermal which was 60:40 in 1960 has gone to 32:68 in 1997. This major shift in energy mix from hydel to thermal is primarily due to delay in commencement of hydro power projects including Kalabagh and Basha dam and further delay in case of other upcoming hydro power projects. This change in energy mix has directly translated into significant rise in tariff for consumers due to expensive fuel component (Oil & Gas)²¹.

The country though has hydropower potential of over 120,000 MW of which 56,773 is exploitable. However, it has so far been able to tap around 6,703 MW that is 6% of the total potential and 32.8% of energy mix.

It is unfortunate that irrespective of this huge potential, the hydropower potential has not been tapped with the similar pace. It is further estimated that hydropower is the most reliable source of renewable energy amongst the other options. Solar and wind has a capacity factor of 17% and 30%, whereas, in case of hydro the capacity factor lies around 40-45%²². It is pertinent to state that the prevalent energy crisis would not have transformed into a mammoth, if hydropower projects had been completed as per their schedule. The Kalabagh dam, if completed as per operational date would have generated 11,400 KWH of energy by 2010 and completion of this project would have saved Rs 79 billion if replaced gas and Rs128 billion, if replaced oil. Similarly, the progress of 15 run-of-river projects with a capacity of 1,258MW, scheduled to be

²¹ Abbas, G and Asghar, F 1996, Development of Hydro Power to Meet Energy Crisis of the Country, Working Paper no. 222, Hydro Electric Planning Organization, Water and Power Development Authority(WAPDA).

²² Zaib, M 2011, "18 Hydro Power Projects Delayed, Only 1 Completed", retrieved on May 20th, 2013, <http://dawn.com/2011/01/03/18-hydropower-projects-delayed-only-1-completed/>

commissioned by June 2007 is not only negligible but the delay in completion of 1,848 MW Neelum Jehlum, Chakothei-Hattian projects in Azad Kashmir and Kohala project on Jehlum, scheduled to be commissioned in 2010 is the clear evident of lack of interest in pursuing these hydro power projects. Had all these projects been implemented, Pakistan would have had added 4,210MW of cheap hydroelectricity in the national grid.

1.2.7 High Transmission and Distribution (T & D) Losses

The analysis of line losses by region shows variations in the amount of losses experienced in different areas of Pakistan. Bannu district shows the highest losses throughout the country, with 56.9% followed closely by northern Sindh and west side areas of KPK (31-40%). Turbat, Naseerabad (Baluchistan), Hayatabad (Sindh) experience 21-30% losses. Least losses were found in Punjab and Kallat (Baluchistan).

It is clearly evident from the map that divisions within Circles that lie in the north western region of Pakistan are experiencing one of the highest percentages of line loss. Line losses in Bannu Circle are unimaginably high, with the highest line loss of 63.6% in division Bannu-II. Whereas other circles on the east of Pakistan have managed to keep the line losses relatively under control, with mostly below 20% line loss. Towards the south line losses start to rise again.

The impact borne on the economy by line losses would be better comprehended if the monetary cost incurred is calculated. In the year 2012-13, electricity received was 52998.39 M.Kwh units, and a loss of 8197.03 M.Kwh units, making percentage lost to be 15.5%. Had percentage lost remained same for the year 2013-14 as it was in the previous year, the expected line losses would have been 8810.25 M.Kwh units, whereas the actual loss in 2013-14 has come around 8638.40 M.Kwh units. Therefore, from 2012-13 to 2013-14 percentage lost has decreased by 0.3%, which has accounted for 171.85 M.Kwh units (8810.25 minus 8638.40) to be saved. In

other terms, the government has saved Rs. 2.6 billion Rs loss at 15 Rs per unit electricity cost, though small still a relief to the economy. Yet the total loss in 2013-14 amounts to 129.6 billion Rs, a massive figure, and unquestionably it has dire consequences for the economy.

Line losses experienced by countries during 2009, 2010 and 2011 indicate lowest line losses in most developed countries such as the United States of America, Germany, Japan and the United Kingdom according to World Bank figures²³. Pakistan and India both experience line losses at or around 20%, Pakistan experienced slightly lower line losses than India. Highest line losses were in Congo. Rep (70% in 2009 and declining to 46% in 2011), Iraq (40-35% from 2009-11) and at 34% in Nepal. This suggests a close relation between political security and energy security. It also highlights how a combination of poverty and political security issues can wreak havoc on development and governance. Countries with high levels of economic growth and political stability showed lowest line losses.

In the light of Pakistan’s energy crisis, high line losses are exacerbating the problem, and have a terrible impact on the national exchequer.

It is crucial to identify line losses as a key performance indicator when evaluating PML-N government’s performance on energy sector. A comparison of distribution line losses in various districts of the country between years 2012-13 and 2013-14, can give an insightful understanding of the current situation. The following table shows the absolute changes in line losses from 2012-13 to 2013-14.

Total Electricity (Received and Lost), across all districts	2012-13	2013-14
Electricity Received Units (M.Kwh)	52,998.39	56,963.23
Electricity Lost Units(M.Kwh)	8,197.03	8,638.40

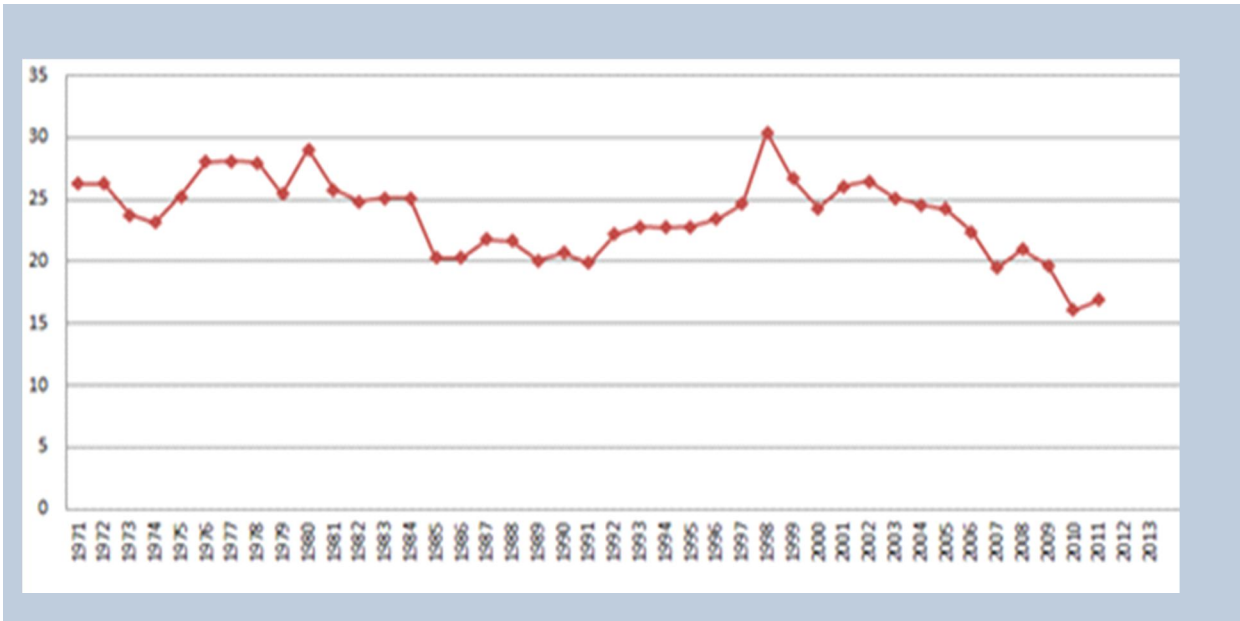
²³<http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS>

But a more in-depth analysis by estimating percentage change in loss to electricity received shows a slight improvement in the overall line losses, over a year's time. From 15.5% losses in 2012-13 to 15.2% losses in 2013-14, it has accounted for an improvement by 0.3%.

Under a district level analysis, it has been observed; around 147 districts have experienced a decrease in percentage change in loss over a year, against only 55 districts that have undergone an increase in percentage change in losses. While there are 8 districts where no change has taken place.

At the time of formation of WAPDA, system losses were 22.79%. These increased with the increase in maximum demand and extension of transmission and distribution system. These system losses touched an all-time peak of 37.58% in 1976/77. The following graph gives a historical view of line losses in Pakistan.

Electric Power transmission and distribution losses (% of output) Line losses by percentage



Source: World Bank Data, 2014

Transmission and Distribution losses refer to the difference between the amount of energy delivered to the distribution system from the transmission system and the amount of energy customers are billed. Two components of line losses are, technical and non-technical or commercial. Technical losses are basically due to heat dissipation from current passing through conductors and magnetic losses from transformers. These losses are part of the process of distribution of electricity, and cannot be completely eradicated. On the other hand, non-technical losses result from theft, metering inaccuracies and unmetered energy.²⁴ This is where effective and efficient administration could bring down numbers.

Realization of the need to correct Pakistan's energy situation was felt with the rising impact of oil prices. Average sale price per unit (kWh) was only 11.51p in 1959-69. This remained static until 1972-73 when it had barely risen to 13.95p. With beginning of the oil crisis, prices rose to 75.6p in 1985-86. There was little need to worry about mundane issues such as electricity pricing as prices remained stable for virtually 12 years. WAPDA pursued its generation and transmission projects resulting in quantum leaps in power supply. As rising oil prices resulted in increased power tariffs, system losses increased tremendously and touched an all-time peak of 37.58% in 1976-77²⁵.

²⁴Hydro one, (2007). *Distribution Line Losses*. Regulatory Affairs. pp.1-13.

²⁵ Beg, D., "Energy Loss Reduction in WAPDA Power Distribution System"

Reasons for high technical losses in Pakistan²⁶ include haphazard expansion of power transmission and distribution systems, large scale use of 11kV and LT lines in rural electrification, inadequate load management, improper reactive compensation, use of poor quality equipment in agricultural pumping in rural areas and air-conditioners and industrial load in urban centers and large transformation stages which result in increases in iron and copper losses.

Theft and pilferage make up a large portion of T&D losses. The KESC (Karachi Electric Supply Corporation) in 2000 reported only 52% of its 1.67 million customers were paying their electricity bills. Non-consumers are consumers not legally registered with an electricity supply company for receiving electricity whereas bonafide consumers are those that willfully pilfer and/or tamper with electricity networks. Electricity theft usually takes place by tampering with meter readings via mechanical jerks, use of magnets and disturbing disc rotation; bypassing meters through the kunda-system; meter-burning; use of remote control to stop electricity supply; changing C.T. ratio and reducing recording; meter reading errors and recording; improper calibration and testing of meters; authorized extension of loads, especially those with H.P tariff²⁷.

The environment and structure of the power industry throughout the world is undergoing dramatic change. The power sector is moving from monopoly to privatization and from integration to disintegration. To keep pace with this change, the Government of Pakistan approved a Strategic Plan in 1994 as a consequence of which the power wing of WAPDA has

²⁶ Khan, M.A., Badshah, S., Haq, I.U., Hussain, F., 2013, "Measures for reducing transmission and distribution losses of Pakistan," International Journal of Scientific & Engineering Research, Vol. 4, Issue 4

been unbundled into 12 Companies for generation, transmission and distribution of electricity²⁸.

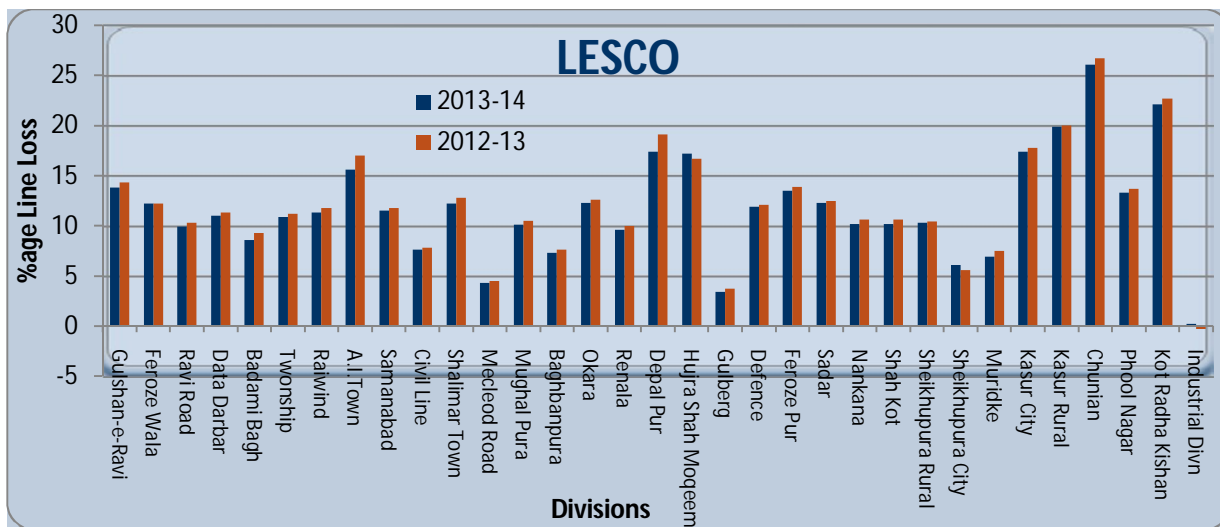
For a detailed understanding of changes in line losses from 2012-13 to 2013-14, the approach adopted is to overview the divisions according to the DISCOs they fall under. Following is the graphical analysis of each DISCO.

The Lahore Electric Supply Company (LESCO) governs electricity distribution and management within the Lahore region and surrounding areas.

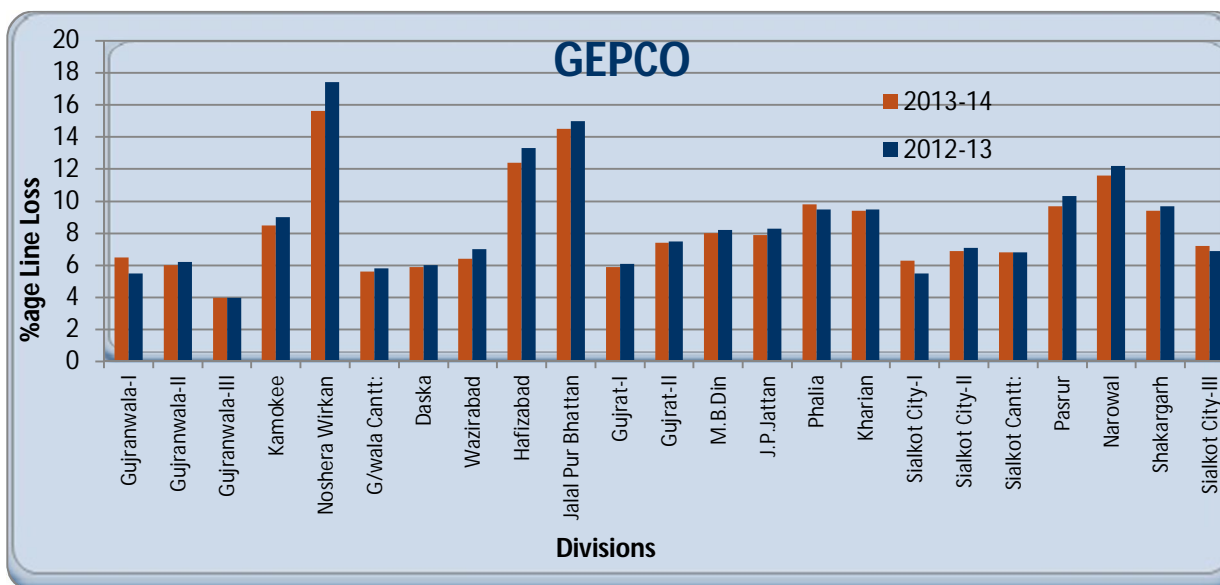
LESCO activity shows an overall relatively high average of line loss in most of its divisions. And for nearly every division in LESCO's domain, there has been a slight decrease in percentage line loss from 2012-13 to 2013-14. But none of the divisions experienced any notable fall in line loss. A highlight of LESCO would be Industrial Division, where line loss is roughly zero, incredibly acknowledgeable considering high line loss in other divisions. But in 2013-14, the percentage line loss for Industrial Division has raised though a very minute rise. It should not go unobserved, since few divisions have a line loss of -0.3% and 0.2%, in 2012-13 and 2013-14 respectively. And there should be every effort directed towards maintaining its level.

²⁷ Khan, M.A., Badshah, S., Haq, I.U., Hussain, F., 2013, "Measures for reducing transmission and distribution losses of Pakistan," International Journal of Scientific & Engineering Research, Vol. 4, Issue 4,

²⁸<http://www.pesco.gov.pk/organization.asp>



The Gujranwala Electric Power Company (GEPCO), setup over area of jurisdiction and network of former Area Electricity Board, was incorporated on 25th April, 1998²⁹. It encompassed the areas of existing Districts of Gujranwala, Hafizabad, Sialkot, Narowal, Gujrat and MandiBahauddin. GEPCO currently has 2,795,221 connections; Average monthly collection for the year 2013-14 is approximately 6261.20 million Rupees.

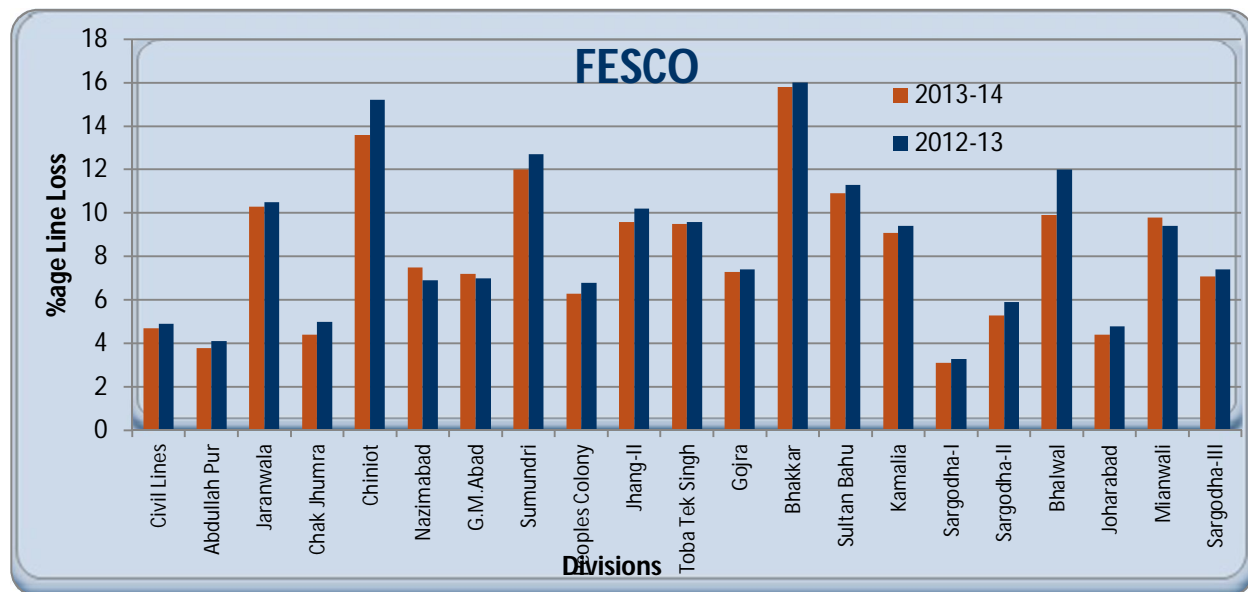


²⁹<http://www.gepco.com.pk/>

Within GEPCO, NosheraWirkan, Hafizabad, and Jalal PurBhattan, have the highest percentage line loss of 15.6%, 12.4%, and 14.5%, respectively in 2013-14. Though in comparison to 2012-13, there is a slight decrease. For other divisions there has not been a remarkable change in line loss over a year. Gujranwala-I, Phalia and Sialkot city – I and III, have higher percentage line loss in 2013-14.

FESCO Distributes and supplies electricity to about 3.23 million customers within its territory. It's population segment consists of a population over 21 million under a Distribution License granted by National Electric Power Regulatory Authority (NEPRA) pursuant to the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997³⁰.

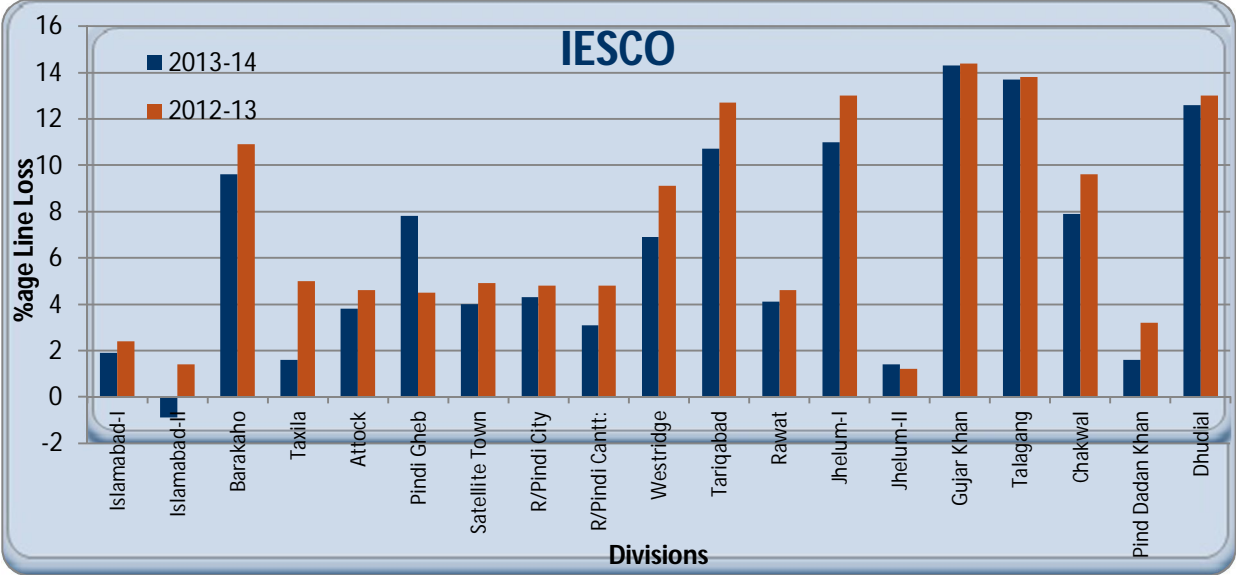
FESCO has some of the highest line loss bearing divisions, where Chiniot and Bhakkar will top the list. While Chiniot and Bhalwal have seen a fall in line loss from 2012-13 to 2013-14 of nearly 2%, for the rest of the divisions any change (rise or fall) in line loss, has been insignificant.



³⁰<http://fesco.com.pk/default.asp>

IESCO was formed in 1998 to take over the assets, functions and responsibilities of Islamabad Area Electricity Board, which was then a division of WAPDA. IESCO's core function is to supply, distribute and sell power (electricity) in the area from Attock to Jhelum, and from the river Indus to River Neelum in Kashmir. It services 2.1 million consumers directly, but touches the lives of more than 25 million people living in the 6 districts it serves.

The IESCO Strategic Vision 2012-2015³¹ includes commitments to providing leadership in sustainable development and incorporating sustainability principles and identifying alternative and sustainable courses of action to minimize its environmental impact. IESCO is committed to creating and promoting an environmentally sustainable and responsible culture and foster continuous improvement in its performance in terms of its environmental footprint.



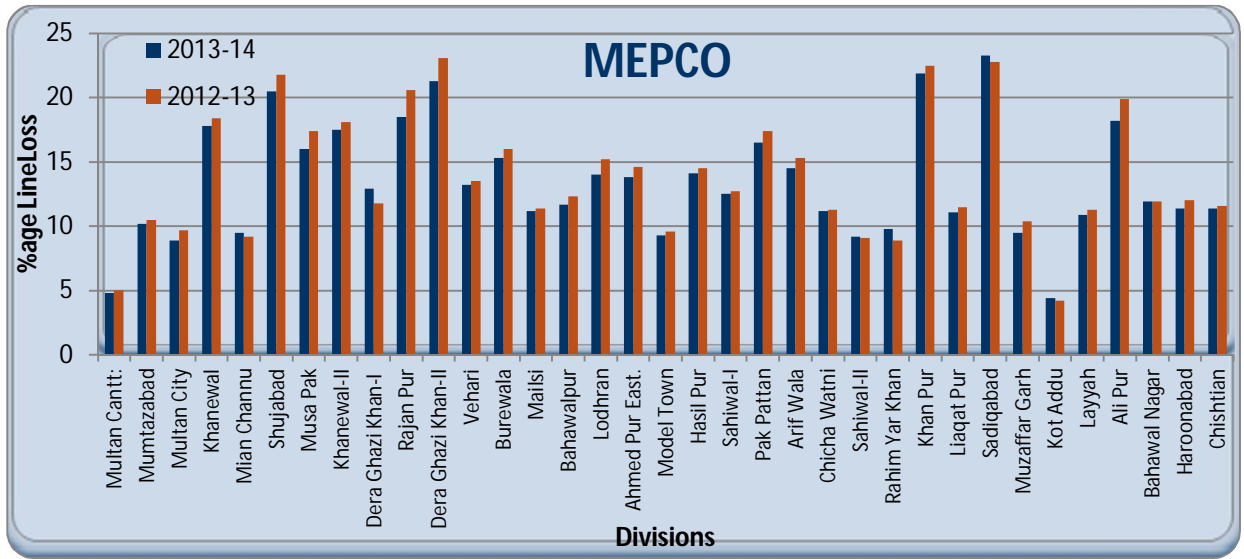
³¹<http://www.iesco.com.pk/>

IESCO gives some interesting insights. It has wide variations across different divisions. On one side there is, Guraj Khan, Talagang and Dhundial with the highest percentage line loss and within a year their change in line losses has been almost stagnant. On the other side, PindiDadan Khan, Chakwal, Jhelum-I, Tariqabad, Westridge and R/PindiCantt had a mentionable fall in line loss from 2012-13 to 2013-14. But nothing can match the exceptional performance of Taxila and Islamabad-II, they have shown a stark fall in line losses. Moreover, what has come as a shocker is PindiGheb, being an urban area it has approximately doubled in line losses in only over a year.

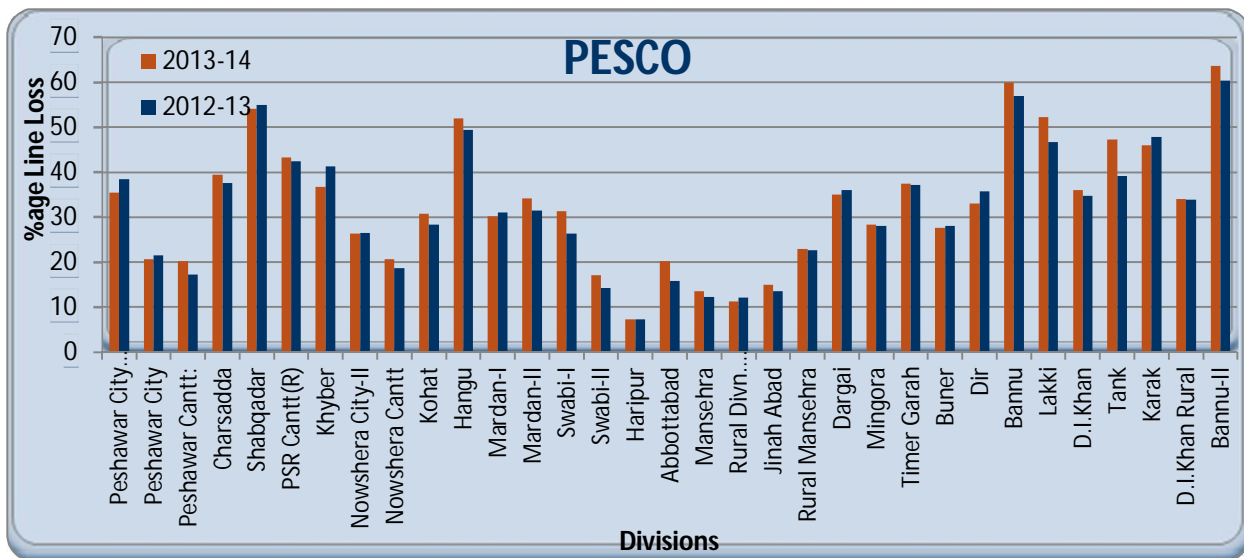
MEPCO, The Multan Electric Power Company is the largest Distribution Company of PEPCO. Its area of operation comprises 13 districts in South Punjab. MEPCO is the only distribution company which touches three provinces and five distribution companies of Pakistan as HESCO(Sindh) at Sadiqabad, PESCO (KPK) at Vahova, QESCO(Balochistan) at Fort Manro, FESCO at Bhakkar and LESCO at Sahiwal. MEPCO also touches the border of India at Minchinabad, Bahawalnager³². The charter of MEPCO is to provide reliable and safe electric power supply to the consumers in its Jurisdiction and is envisaged for the creation of the resources and engineering plans for additions, renovation and augmentation of the distribution system in order to achieve charter.

Any change in line losses from 2012-13 to 2013-14 in the divisions of MEPCO, is of negligible prominence. It is void of any mentionable division in terms of a marked rise or fall.

³²<http://www.mepco.com.pk/htmls/INTRODUCTION.HTM>



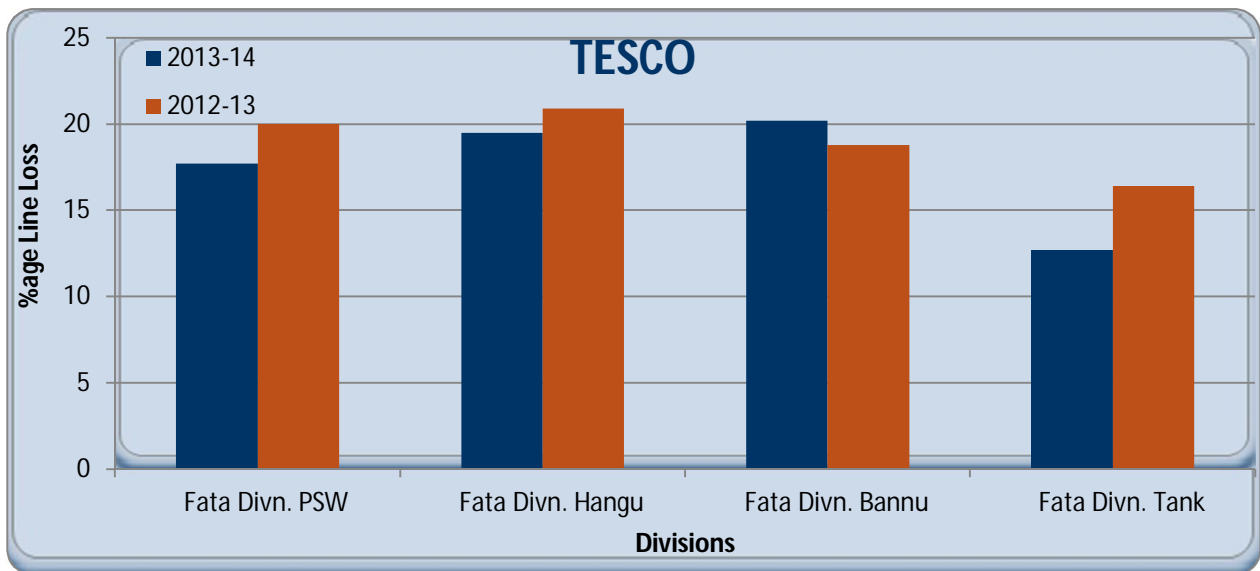
Peshawar Area Electricity Board was reorganized into a corporatized entity under the name of Peshawar Electric Supply Company (PESCO) with effect from 22-03-1998, with the aim of commercialization and eventually privatization³³. Currently PESCO provides service of power distribution to over 2.6 million consumers of all civil districts of Khyber Pukhtunkhwa, Pakistan.



³³<http://www.pesco.gov.pk/organization.asp>

PESCO has failed to account for much change in line losses as most of the divisions show little change in line losses from 2012-13 to 2013-14. But what is worthy of attention here is PESCO has the highest level of percentage line loss in its divisions, with areas such as Bannu having as high as 60% line loss.

Tribal Electric Supply Company (TESCO) was created on 5th August 2004³⁴ as a corporatized entity under PEPCO. TESCO is one of the largest Distribution Companies of WAPDA. TESCO covers energy provision to the entire tribal area of the country and it is the only company providing electricity facility to the customers of this area.



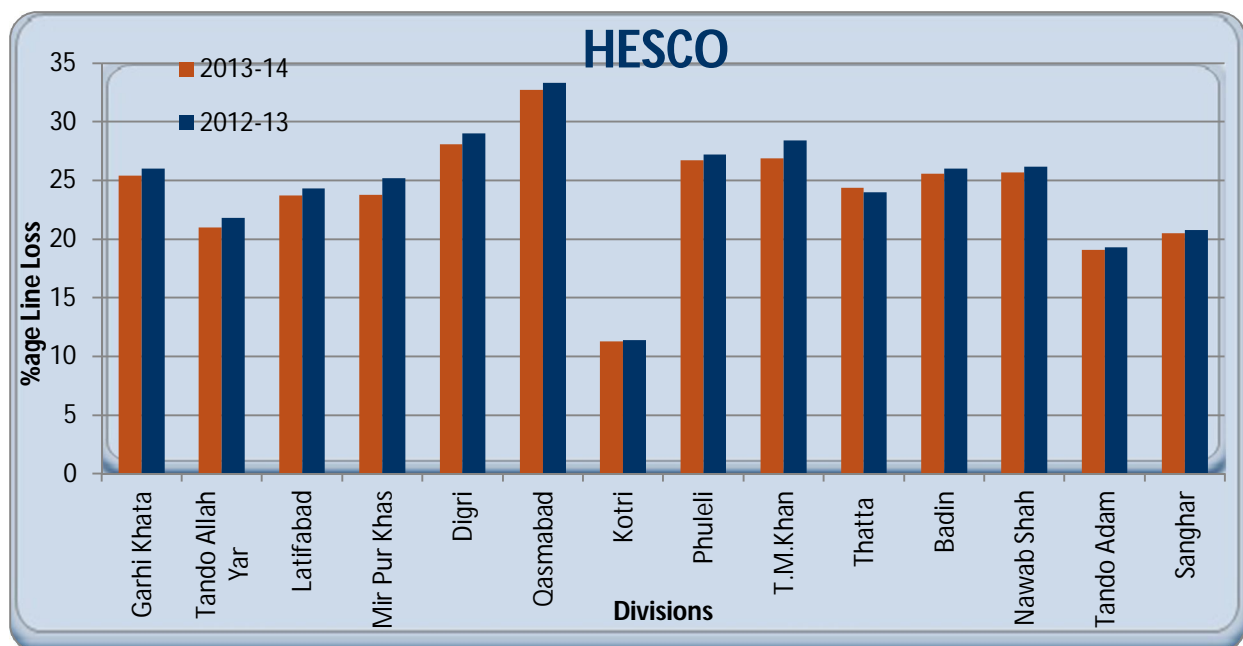
The area of jurisdiction of TESCO reaches about 1200 KM. It consists of seven agencies and FRs that are situated along Afghanistan boundary. The seven agencies are Kurram Agency, Orakzai Agency, Khyber Agency, North Waziristan Agency, South Waziristan Agency Bajur Agency, Mohmand Agency and FRs are FR Peshawar, FR Kohat, FR Bannu, FR Lakki, FR Dera Ismail Khan, FR Tank.

³⁴<http://www.tesco.gov.pk/>

TESCO managed to bring down line losses in three out of four of the divisions, where Fata Divn. Tank had a maximum decrease in line losses. Out of all the districts Fata Division Bannu had a rise instead of a fall in line losses.

Hyderabad Electricity Supply Company Ltd. (HESCO) was incorporated on 23rd April 1998 and certificate for commencement of business was obtained on 1st July 1998 from NEPRA under section 146(2) of Companies Ordinance 1984 as one of the eight AEB's constituted through amendments in WAPDA Act during 1981³⁵.

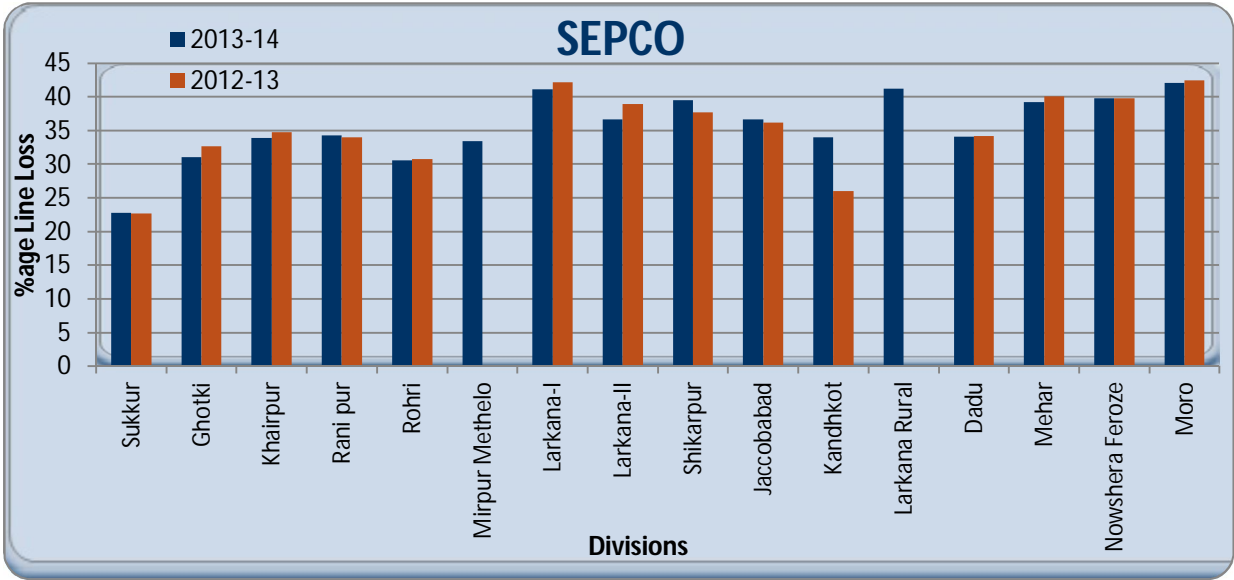
A decrease in line losses has been observed across nearly all of the divisions of HESCO from year 2012-13 to 2013-14. To maintain such consistency across all divisions is a great achievement, even if the decrease is minimal.



³⁵<http://www.hesco.gov.pk/htmls/mainFrame.asp?req=org>

SEPCO (Sukkur Electric Power Company) started functioning with effect from 16.08.2010³⁶. The areas now under the distribution system of SEPCO consist of three operation circles namely Sukkur, Larkana and Dadu.

Larkana Rural, and Mirpur Methelo are newly created divisions, reason why there last year line loss data is unavailable. Mostly divisions across SEPCO have shown minor decrease in line losses from 2012-13 to 2013-14. Sadly, Khandhkot has gravely grown in line losses in a year's time.

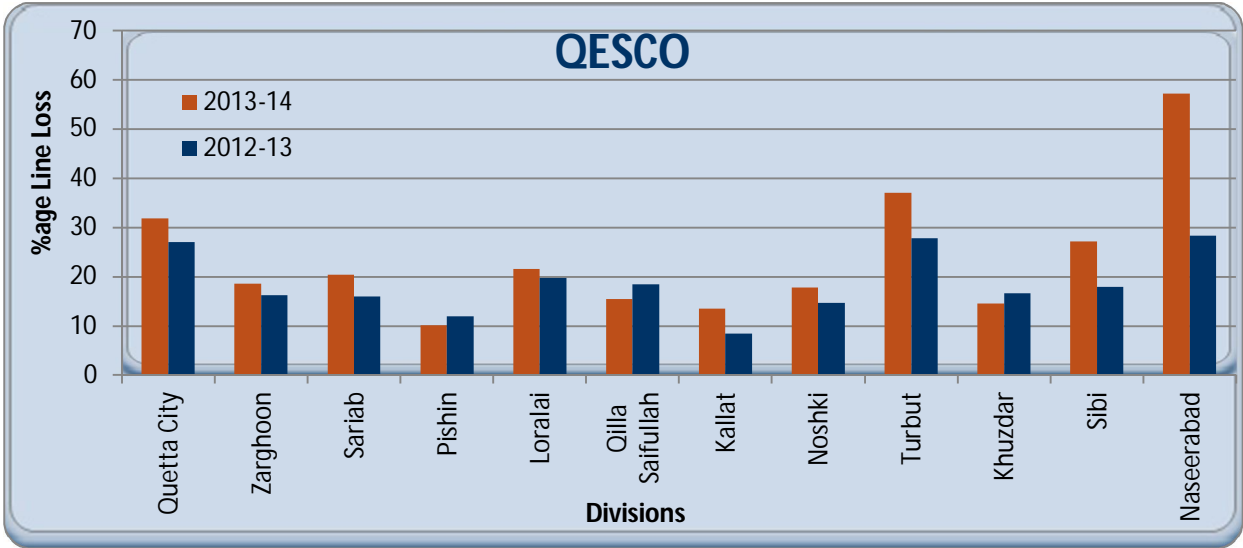


QESCO was one of the Eight AEBs, which were constituted through amendments in WAPDA Act during 1981. QESCO is dealing with Power Supply System in the whole Baluchistan less District Lasbela. It is smallest in terms of consumers but largest as it covers 43 % area of Pakistan. The peak demand at the moment is 1177 MW evaluating measures and anticipated to be 1659 MW by the year 2015 with 8 % uniform annual growth³⁷.

³⁶<http://www.sepco.com.pk/index.php/organization/about-sepco>

³⁷<http://www.qesco.com.pk/Intro.aspx>

Divisions within the domain of QESCO have shown poor performance in terms of curbing line losses from 2012-13 to 2013-14. Apart from Pishin, QillaSaifullah, and Khuzdar, where nominal fall in line losses occurred, all other divisions have inflated line losses in comparison to previous year. But its Naseerabad with sensational results, it is close to double in line loss increase just within a year.



The top areas and subdivisions with the highest line losses were found in PESCO and QESCO.

The following table gives an overview of the percentage of line losses by subdivision, with Deh Bahader in PESCO showing percentage losses of 70.9%. Jaffarabad in QESCO came a close second with 69.8% losses, and Surrani, a subdivision in PESCO was third, with 68.6% losses.

			UNITS	UNITS	UNITS	%AGE
		SUB DIV/ DIVN	RECEIVED	BILLED	LOST	LOSSES
1	PESCO	DEH BAHADER	49.43	14.39	35.04	70.9%
2	QESCO	JAFFAR ABAD	69.2	20.93	48.27	69.8%
3	PESCO	SURRANI	42.54	13.36	29.18	68.6%
4	PESCO	LANDI ARBAB	67.3	21.36	45.95	68.3%
5	PESCO	GHURI WALA	52.97	18.46	34.51	65.2%
6	PESCO	BANNU RURAL-II	19.92	7.03	12.88	64.7%
7	PESCO	MATTANI	74.3	26.56	47.75	64.3%
8	PESCO	KAKKI	24.73	8.96	15.77	63.8%
9	PESCO	TAJ ABAD	96.78	35.69	61.09	63.1%
10	PESCO	DOMAIL	76.77	28.37	48.4	63.1%
11	QESCO	USTA MUHAMMAD	114.16	43.12	71.04	62.2%
12	PESCO	BADABER	57.61	22.2	35.41	61.5%
13	PESCO	REHMAN BABA	47.2	18.84	28.36	60.1%
14	PESCO	BANNU URBAN	53.27	21.4	31.87	59.8%
15	PESCO	BANNU RURAL-I	23.14	9.57	13.57	58.6%
16	PESCO	HANGU	61.47	26.03	35.44	57.7%
17	PESCO	SHABQADAR	121.07	51.37	69.7	57.6%
18	PESCO	WARSAK-II	69.69	30.49	39.19	56.2%
19	PESCO	BANNU CANTT	101.13	44.58	56.55	55.9%
20	PESCO	GUMBILA	57.51	25.39	32.11	55.8%

Overall, the above data showed that there was a strong correlation between governance, law & order and security to the collection of bills in the country. Districts with a better law and order situation showed greater success in utility bills collection. 0.3% reduction of line losses goes to the credit of better energy governance in the country in 2013-14, as compared to 2012-13. However, after a thorough analysis of the geographical spread of utility losses, the Federal and Provincial Governments must move towards enhancing utility bill collection through strengthening governance mechanisms throughout the country, with a local accountability system.

1.2.8 CIRCULAR DEBT

Circular debt is the amount of cash shortfall within the Central Power Purchasing Agency (CPPA) and its inability to pay power companies. This cash deficit is due to the difference between the actual costs of supplying electricity against the revenue collected by power Distribution Companies. This deficit then flows through the entire energy supply chain (from electricity generators to fuel suppliers, refiners and producers) which then leads to the shortage of fuel for power generation and an increase in load shedding. The incumbent government settled circular debt amounting to Rs. 480 billion³⁸ in 2013.

However, records show rapid accumulation of circular debt at Rs.180 billion within six months and at Rs. 300 billion in the next 9 months of it being paid off .It is anticipated that if this

³⁸Ministry of Finance, 2014, *Memorandum on Economic and Financial Policies for 2013/14–2015/16*
http://www.finance.gov.pk/mefp/MEFP_201314_201516.pdf

situation continues then it will not only limit availability of electricity but will also slow down the economic growth of the country. A summary of components of circular debt and its growth since 2006 to 2012 is given in Table 5:

Table 5: Growth in Circular Debt (Impact of Circular Debt)-Billion Rs

Primary Causes	2006	2007	2008	2009	2010	2011	2012
Stock of Debt-Beginning of the Year 1	84.07	111.26	144.99	161.21	235.65	365.66	537.53
NON- COLLECTION							
DISCOs Receivables Form:							
Federal Government	0.22	0.35	0.08	0.15	1.79	1.57	0.19
FATA	10.87	6.36	9.43	10.24	-78.34	4.3	13.42
Provincial Governments	2.25	0.75	5.09	7.17	16.72	36.07	15.84
AJK Government	0.54	0.127	0.46	1.18	2	5.5	6.05
Agri-Tubewells	0.42	1.28	1.07	3.01	3.46	-3.68	-3.12
Private Consumers	9.08	7.96	9.64	19.88	25.59	39.29	54.55
Sub-Total	23.38	16.97	25.77	41.63	-28.78	83.05	86.92
CPPA Receivables from KESC	3.81	16.76	26.74	-11.87	4.04	-1.79	13.78
Total Non Collections ³⁹ 2	27.19	33.73	52.51	29.76	-24.74	81.26	100.69
TARIFF & SUBSIDY ISSUES							
Tariff Determination & Notification Delay ⁴⁰	N/A	N/A	N/A	N/A	N/A	N/A	72.19
Fuel Price Adjustments ⁴¹	N/A	N/A	N/A	N/A	N/A	20.1	33.19
Difference between DISCOs TDS claims Vs Actual Disbursed ⁴²	N/A	N/A	-36.29	39.66	134.84	48.68	106.02
Difference between DISCOs NEPRA allowed Vs Actual T & D Losses ⁴³	N/A	N/A	N/A	5.02	19.91	21.84	22.78
Sub- Total Tariff & Subsidy Issues 3	N/A	N/A	-36.29	44.68	154.75	90.62	234.18
TOTAL CIRCULAR DEBT (4=1+2+3)	111.26	144.99	161.21	235.65	365.66	537.53	872.41

³⁹ PEPCO DISCOs Performance Statistics Reports FY 2005-2012

⁴⁰ USAID PDP Analysis based on data from NEPRA's DISCO tariff determination 2012 (Data only available for the year shown)

⁴¹ Data from MoWP - Tariff Cell (Data only available for the 2 years shown)

⁴² Chief Engineer's Office - MWP

⁴³ USAID PDP Analysis

The escalating problem of circular debt is principally due to following reasons:

- A fuel price methodology delaying the infusion of cash in to the power sector.
- Poor governance
- Poor revenue collection by DISCOs
- Transmission and Distribution losses and Theft
- Delays in tariff determination by an inadequately empowered regulator coupled with interference and delay in notification by GOP.
- Prolonged stays on Fuel Price Adjustments(FPAs) granted by courts
- Delayed and incomplete payment by Ministry of Finance (MOF) on Tariff Differential Subsidy (TDS) and KESC contracts payments.

The role of federal government is also insignificant in passing appropriate legislation to control electricity theft, strengthen regulatory process, promote energy conservation, transparency and encourage an open and competitive market.

There are also some secondary issues exacerbating the problem of circular debt in Pakistan which includes: inadequate budgeting of TDS, non-improvement in tariff terms and conditions, poor thermal power plant efficiency, non-commercial/nonprofessional approach towards load shedding, unfavorable generation mix, GOP neglect in promoting demand side management and late payment surcharges (LPS) paid by CPPA to IPPs⁴⁴.

⁴⁴The Causes and Impacts of Power Sector Circular Debt in Pakistan. (2013). Commissioned by Planning Commission of Pakistan and funded by United States Agency for International Development (USAID).

1.3 Issues in Gas Sector

The country's demand for natural gas has been surpassing the supply for more than two to three years. According to officials the total gas demand on the system is 8 Billion Cubic Feet (BCF) against the total supply of 4 BCF, thus creating the shortfall of around 4 BCF. This gas shortfall has driven a severe power crisis leading to a tenacious shortfall of 5000-5500 MW as on 30th June,

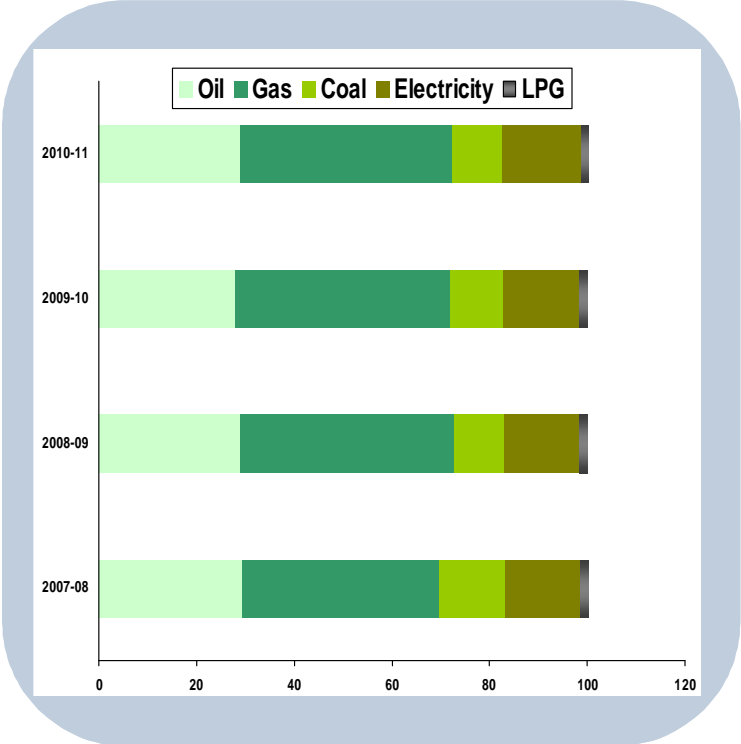


Figure 5: Sector Wise Primary Energy Consumption

2012⁴⁵. The contemporary crisis is a self-inflicted problem resulting from years of poor policies and reckless attitude on the part of concerned authorities. In 2010-11, more than 40%⁴⁶ of the primary energy needs are dependent on gas, the greatest as compared to any other source (See *Figure 4*).

This excessive dependence on natural gas continued and in 2012 the natural gas share reached 49.5% while oil imports accounted for 30.8%, LPG 0.5%, Electricity (Hydro, Nuclear & imported) 12.5% and Coal 6.6%⁴⁷. The following section will discuss the issues in gas sector.

⁴⁵ Pakistan Energy Outlook, 2011-12, Petroleum Institute of Pakistan, 2012
⁴⁶ The gas consumption for power generation and feedstock has been excluded here
⁴⁷ Pakistan Energy Year Book, 2011-12, Hydrocarbon Development Institute of Pakistan

1.3.1 Lack of Strategic Approach

This current gas crisis is due to lack of concrete natural gas policy and careless use of gas resources. The situation would not have transformed in to such gruesome condition in the presence of concrete natural gas policy, which would have prioritized the use of gas, thus maximizing the benefits of this valuable energy resource. It is significant to mention that in 1960s and 1970s which is marked as golden era in history of Pakistan, the priority for gas usage was given to manufacturing industries and fertilizer sector; however, gradual addition of domestic consumers and robust growth in thermal energy changed the priorities.

In addition to this, the present gas crisis also dates back to the decision that was undertaken in 2002-03 which dealt with converting a portion of Pakistan’s hydrocarbon based energy production (both for

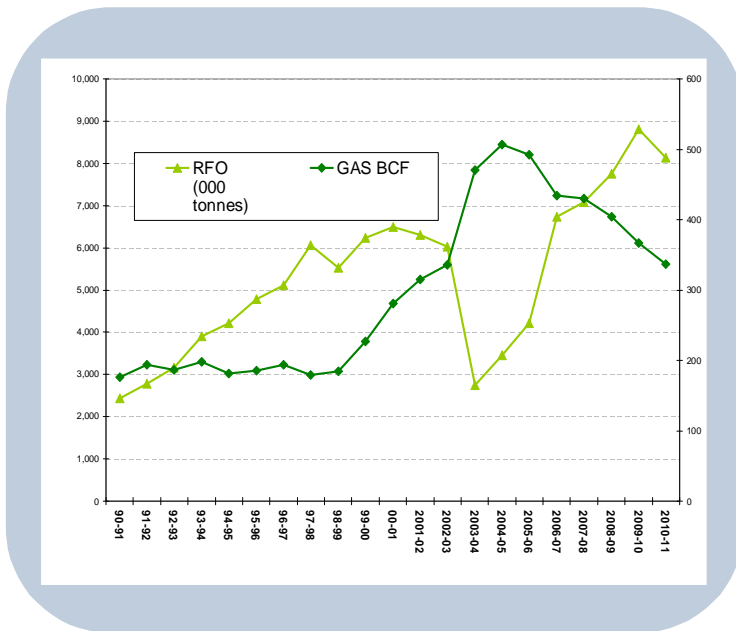


Figure 6: FO & Gas Consumption in Power

to gas, keeping in view that country is blessed with abundant gas resources and it should avoid expensive oil imports. (See Figure 6). This was the decision, which determined the fate of gas availability for catering the energy needs in future. However, in 2006-07 the power generation was again shifted back to FO due to the curtailment of gas and as shown in Figure the FO consumption is still increasing likewise.⁴⁸

⁴⁸Economic Survey of Pakistan, 2011-12, Ministry of Finance, Government of Pakistan, 2012.

1.3.2 Misallocation of resource

The decision undertaken in 2002-03 changed the conformation of whole energy sector. As gas usage was also enhanced in transport sector. During the same time the CNG stations were given countless licenses regardless of the availability of the gas reserves. Similarly Government of Punjab introduced CNG rickshaws for promoting a source of livelihood for poor people. This led to the increase in share of gas in transport sector from 2.1% in 2004-05 to 7.1% in 2009-10. To make the situation even worse, there was a continuous increase in number of domestic consumers due to increased urbanization and inauguration of gas schemes during election campaigns. Hence, the gas was allocated without any strategic or proactive approach and this poor management and unsustainable use of gas has led to prevalent situation.

1.3.3 Delay in Hydropower Projects & Gas Crisis

Another factor responsible for this prevalent gas shortfall is the persistent delay in completion of hydropower projects. This continuous delay in hydropower projects has increased the gas consumption in power sector, which has consequently decreased the gas availability for other sectors, including transport, industrial, commercial and domestic sectors, thus creating civil distress and havoc. It is significant to analyze the impact of non-completion of Kalabagh dam on gas availability in order

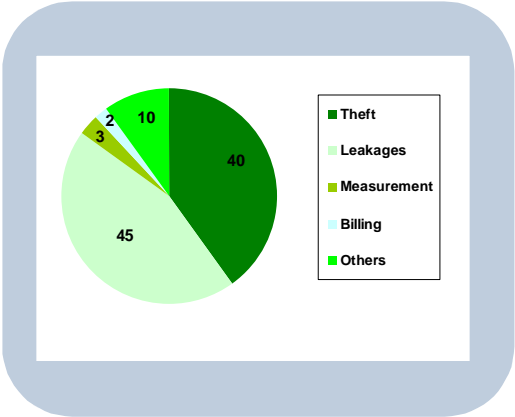


Figure 7: CAUSES OF UFG LOSSESS

to understand the relationship between delay in hydropower projects and gas crisis.

The proposed Kalabagh Dam was to become operational by 1993 (Haq, 1983) and its total annual production would have equaled 11,400 GWH by 2010. The operation of Kalabagh and

Tarbela would have cumulatively generated 336 million KWh of electricity in addition to its existing power production. However, as the project never entered the construction phase, the energy, which Kalabagh Dam would have supplied, was met through the exploitation of gas reserves. It is estimated that 161 billion cft of gas reserves has been utilized annually in order to produce the equivalent amount of energy that would have been produced by Kalabagh dam (Economic Survey of Pakistan, 2009). Thus since 1993 to 2009, the construction of Kalabagh dam would have saved minimum of 2.7 trillion CFt almost 24.7% of the total gas consumed during this period. In other words, the current gas crisis would have escalated had the Kalabagh dam been built timely. The energy demands of sectors which are dependent on natural gas would have been aptly met, and long hours of gas load shedding and closure of CNG stations would have effectively been averted.

1.3.4 Line Losses/Unaccounted for Gas (UFGs)

The line losses known as Unaccounted for Gas (UFG) of both systems of gas utilities—sui southern gas company limited (SSGCL) and sui northern gas company limited (SNGPL) hovering around close to 10% is another factor behind this gas crisis. This figure of 10% is an alarming figure when compared to 1-2% in world wide⁴⁹.

The UFG losses are those units that are not billed or lost during the transmission of gas to the consumers. More importantly, 40% of these losses are due to theft while 45% of these losses are attributed to leakages (see Figure 7). This 10% UFG is translated in to huge loss of around \$2 billion a year at the import of oil.

According to a study conducted by Planning Commission of Pakistan, 1.9BCF of gas gets wasted in the head of unaccounted for gas (theft and leakages) per day and with the increase of

⁴⁹ Bilston, K.(2012).A Strategy for Controlling Theft in the Distribution Systems of SSGC , Discussion Paper, 2012, Pakistan

every 100km distribution network, there is an increase of 0.002% of UFG due to underground leakages and aging of network. The addition of one domestic gas connection leads to an increase of around 12 leak points. Therefore, the high growth rate of domestic consumers, as a result of election campaigns to obtain votes contributes in increasing UFGs.

Moreover, the aged meters and networks causing under recording and measurement errors and underground-corroded pipes are themselves indicators of poor condition of gas transmission and distribution network. There is a fundamental fault in the investment standards by the GOP whose main focus is system expansion (even if the gas is not available) rather than timely operation and maintenance of this infrastructure, thereby worsening the gas availability to the consumers.

1.4 Issues in Oil Sector

The country's demand for Petroleum products stands around 385,000 Barrels of Oil per Day (BOPD) whereas the production from local resources is 67,140 BOPD for 2011-12 (See Figure 8). Thus currently 83% of the country's demand is met through imported oil while 17%⁵⁰ is fulfilled through indigenous resources. The issues pertaining to these excessive oil imports are discussed in detail in the section below.

⁵⁰ Petroleum Exploration and Production Policy , 2012, Ministry of Petroleum and Natural Resources, www.mpnr.gov.pk, (Retrieved on 17th June'2013)

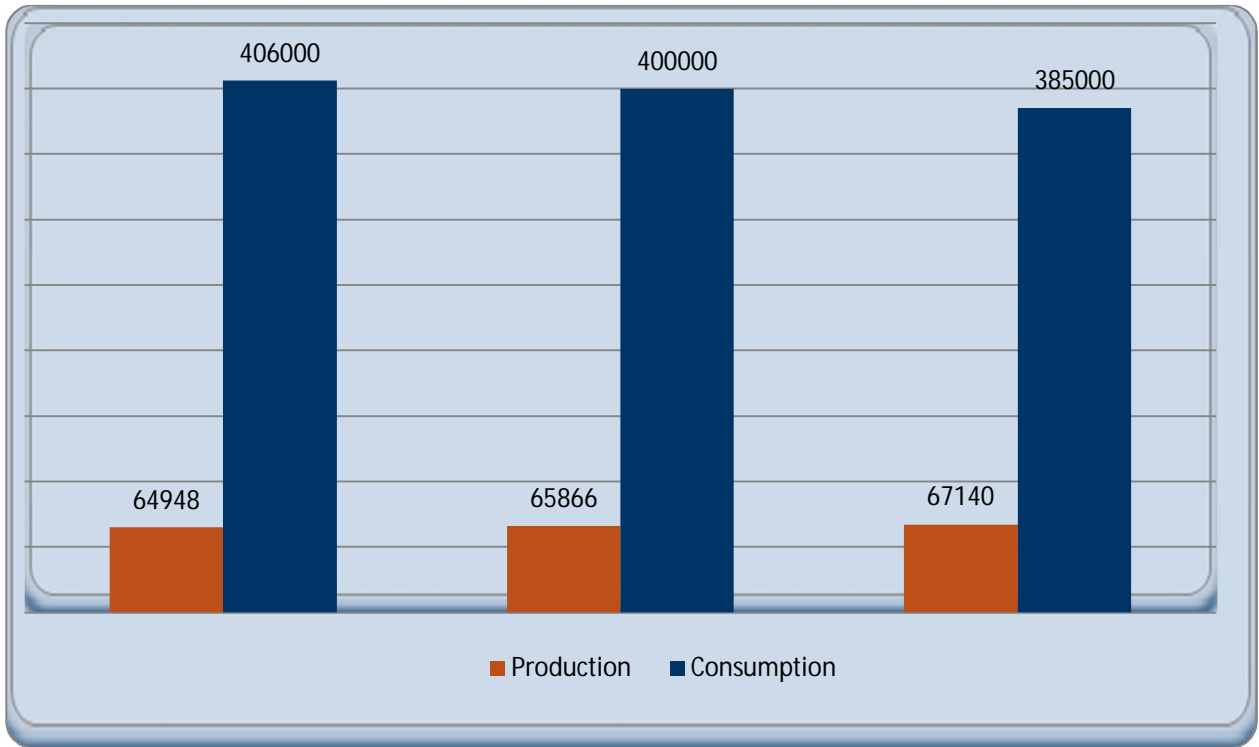


Figure 8: Production and Consumption of Oil

1.4.1 Issue of Adulteration in Imported Furnace Oil

The total import of petroleum products was 12.37 million and 53%⁵¹ of this import was Residual Fuel Oil (RFO). Currently, the transport and power sector are the largest consumers of imported oil out of which 47% is of transport sector while 37% is for power sector. The quality and quantity of imported oil play a very vital role and slight variation in fuel oil specifications such as specific gravity, viscosity and water content can have serious effects on the power plants output. It is significant to highlight here that irrespective of this heavy dependence on oil imports, the Purchase Agreement for fuel oil are devoid of any clause monitoring the quality or quantity of FO being procured. Internationally, these agreements are usually tailored with price adjusters for specific gravity, water and sulphur. In pursuance of

⁵¹ Economic Survey of Pakistan, 2011-12 Ministry of Finance, Government of Pakistan, 2012

these clauses the price varies with the specifications of FO. It is unfortunate that due to the lack of this monitoring mechanism, Pakistan purchased water from Middle East at the cost of Rs.42billion last year as 8% water was detected in one of the fuel storage tanks of GENCOs where the permissible limit according to Pakistan Standards for Quality Control Authority (PSQCA) is only around 0.5%⁵².

This substandard fuel for power generation directly affects the tariff received from end consumers in terms of increased FO consumption and increased O & M cost owing to the deteriorated imported fuel oil. In addition to this, the similar substandard oil when used in transport sector will also cause increased wear and tear of engine, thus enhancing the O & M cost coupled with decreased mileage. Thus, lack of quality and quantity assurance in terms of procuring fuel oil is one of the serious concerns in this sector that needs to be addressed on immediate basis.

⁵²Hagler Bailly. (2011). Technical Audit Study of Jamshoro, Guddu and Muzaffargarh Thermal Power Stations in Pakistan, Advanced Engineering Associates International, Islamabad



CHAPTER 2

STRATEGIC FRAMEWORK

2.1 Framework for Strategies

The fundamental objective of the proposed strategic plan is to supply the energy on an optimum energy mix through maximum utilization of indigenous resources. This will not only ensure the availability of energy to all sectors of economy at competitive price but will also create employment at massive scale, thus enhancing the economic activity within the country.

The strategic directions for developing energy sector include:

1. Optimize the utilization of country's indigenous resource base especially hydropower to reduce the dependence on imported fuel through an institutionalized strategy.
2. To ensure the supply of energy at optimum and competitive price to all sectors of economy
3. To engage the local people and create employment at massive rate through enhanced exploration of indigenous resources within the country. Hence this vision would provide a roadmap for employment generation till 2030.
4. To create conducive and healthy environment for the participation of private sector in energy sector development under the supervision of effective regulatory authority.

2.2 Components of Strategic Plan

The strategic plan comprises of following components:

1. Enhance the exploitation of renewable resources especially hydropower in order to optimize the energy mix and reduce the dependence on imported furnace oil. In this regard hydropower due to its cheap rate and other socioeconomic benefits is given prime importance among other renewable resources. The other renewable resources includes wind power, solar energy, geothermal energy, biomass and waste to power and their

collective share in energy mix is not greater than 5% realizing the fact that renewables are quite expensive at this stage for country like Pakistan and the basic purpose of the proposed strategy is to make the energy available at optimum rate to all consumers.

2. In addition to renewable resources, the strategic plan has also emphasized to utilize the available bagasse cogeneration and power potential from low btu gas.
3. The strategy has also proposed to initiate the exploration of available unconventional gas resources that is shale gas through an appropriate framework in order to capitalize the benefits associated with it as Pakistan lying at third position in Asia with reference to recoverable shale gas reserves (51 TCF) should take advantage of it.
4. Furthermore, the strategic plan would also address the identified issues including gas crisis, poor thermal power plant efficiency, adulteration in furnace oil, circular debt, passive role of institutes and high T & D losses.
5. The strategic plan is divided into short, medium and long term measures in all sub sectors of energy (Gas, Oil, Power and Coal) is explained in detail below:

2.3 Short Term Strategies

2.3.1 Gas

Currently more than 40% of the energy needs are dependent on gas resources, the greatest as compared to other sources of energy. It is evident that during July-March 2012-13, the gas consumption has been witnessed a negative growth (See Table 6).

Table 4- Sector Wise Gas Consumption

FiscalYear	Households		Commercial		Cement		Fertilizer		Power		Industry		Transport		Total
	Share	Growth	Share	Growth	Share	Growth	Share	Growth	Share	Growth	Share	Growth	Share	Growth	Growth
2000-01	18.3	0.7	2.7	-5.0	0.9	-18.5	22.8	-1.0	36.6	23.7	18.0	2.7	0.6	82.3	7.9
2001-02	17.5	2.3	2.7	7.3	0.9	1.2	21.5	1.3	38.2	11.9	18.4	9.3	0.9	66.6	7.4
2002-03	17.6	6.5	2.6	2.9	0.4	-51.2	20.7	1.7	38.5	6.6	18.9	9.0	1.3	53.6	5.8
2003-04	14.8	1.1	2.3	6.2	0.7	123.8	17.6	2.6	44.7	40.0	18.4	17.2	1.5	40.1	20.5
2004-05	14.8	10.9	2.3	12.	1.2	73.6	16.4	2.7	43.7	8.0	19.5	16.9	2.1	54.1	10.4
2005-06	14.0	-0.6	2.4	7.6	1.3	14.6	16.2	4.1	40.2	-3.1	22.8	23.3	3.2	59.1	5.4
2006-07	15.2	8.4	2.6	7.2	1.2	-4.2	15.8	-2.3	35.5	-	25.1	10.0	4.6	45.2	-0.1
2007-08	16.0	10.0	2.7	8.1	1.0	-13.3	15.7	3.3	33.7	-0.9	25.3	5.2	5.6	27.6	4.4
2008-09	16.9	4.9	2.8	4.8	0.6	-42.6	15.8	0.5	31.8	-6.0	25.1	-1.1	7.0	22.5	-0.5
2009-10	17.2	2.5	2.9	4.0	0.2	-73.4	17.2	9.5	28.7	-9.2	26.1	4.5	7.7	12.2	0.7
2010-11	18.7	5.9	2.9	-1.3	0.1	-29.1	18.4	3.8	27.2	-8.0	23.5	-12.5	9.1	14.2	-2.9

2011-12	20.3	12.8	3.1	8.7	0.1	-8.1	16.4	-7.3	27.8	6.2	23.0	1.5	9.2	5.3	3.8
Jul-Mar															
2011-12 P	21.5	10.5	3.1	8.1	0.1	150	16.6	-4.8	27.5	3.6	21.8	0.0	9.4	10.8	1.8
2012-13 P	23.2	3.9	3.3	1.9	0.1	-60.0	15.2	-	27.5	-3.7	22.6	0.0	8.2	-16.2	-3.7

Source: Economic Survey of Pakistan, 2013-14 (in-citation Hydrocarbon Development Institute of Pakistan)

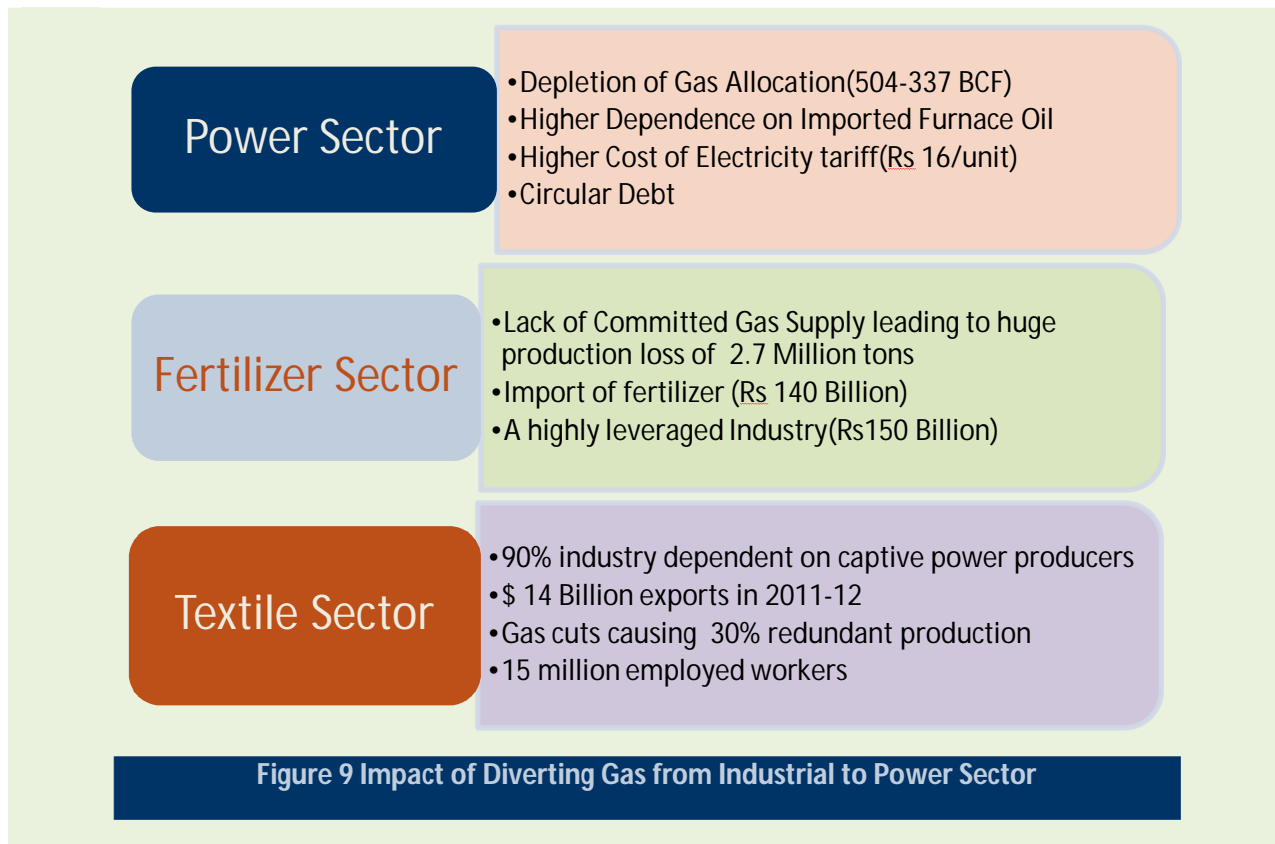
The Table6 identifies that power sector is the greatest consumer of gas (27.5%), followed by industry (22.6%), household, fertilizer industry and transport. While the commercial sector and cement industries hold share of 3.1% and 0.1% respectively. It is significant to mention here that in accordance with *Gas Allocation and Management Policy Framework, 2005*, the sectorial allocation of gas was prioritized in following manner in Table 7:

Table 5- Gas Allocation and Management Policy 2005

Category of Consumers	Priority Order
Domestic & Commercial	First
<ol style="list-style-type: none"> 1) Fertilizer Sector 2) Industrial Sector to the extent of their process gas 	Second
Independent Power Plants as well as WAPDA & KESC Power Plants having firm supply commitments under GSAs	Third
General Industries, CNG Sector & Captive Power Producers of export oriented Textile Industry	Fourth
<ol style="list-style-type: none"> 1) WAPDA & KESC power plants other than those listed against no.3 above 2) Captive Power Producers 	Fifth
Cement Sector	Sixth

However irrespective of this gas allocation policy framework, in purview of unprecedented energy crisis, it was decided in April 2012 to divert the gas from fertilizer industry from SNGPL system to Power sector in order to relieve the long hours of load shedding in both rural and urban areas. The impact of diversion of gas from industrial to power sector led to the

depletion of natural gas reserves owing to increased dependence on power generation and led to a huge production loss of 2.7million tons in case of fertilizer industry in 2012⁵³(See Figure 9) However, in 2013-14, the fertilizer sector witnessed a 46%⁵⁴ increase in gas allocation.



Hence in order to address this grave gas crisis leading to electricity shortfall and production loss in industries, there is a need to prioritize the use of gas in all sectors and then strictly adhere to that prioritization in order to address the grievances of this endemic energy crisis.

The proposed priority order for allocation of gas is as follows:

⁵³ Pasha, K. B and Iqbal, J, 2012, "Impact of Diversion of Gas from Industrial to Power Sector, National Institute for Management", Islamabad, retrieved on <http://www.slideshare.net/bilalkhanpasha/gas-for-power-generation-or-for-industry-a-case-for-pakistan>.

⁵⁴ Ministry of Finance, 2013, "Economic Survey of Pakistan 2013-14"

1. Industry(including Large Scale Manufacturing Industry and Fertilizers)
2. Power
3. Domestic(cooking Only)
4. Commercial
5. Transport(CNG for public transport only)

a. **Power Sector:**

The gas should be supplied on priority basis to the efficient thermal power plants. The four gas based IPPs @38 MMCFD consumes 152 MMCFD gas which in turn produces 800 MW of electricity at an efficiency close to 50%⁵⁵. Whereas, the public sector (GENCOs) converts this gas to produce half the electricity. Therefore, diverting the gas supply to efficient power plants would not only reduce the cost of generation but will also make the gas available for using in other sectors a well.

It is also proposed that in order to reduce the excessive dependence on gas, the concerted efforts should be done for shifting of power generation from thermal to other low cost resources.

b. **Industries:**

Manufacturing sector of Pakistan plays a fundamental role in driving the economy of the country by linking to the other sectors of economy. Industries contribute significantly to the Gross Domestic Product (GDP), and the manufacturing sector contributed to 13.5%⁵⁶and

⁵⁵ "Integrated Energy Planning and Pakistan Energy Future: An Update on Continuous Energy Crisis", Position Paper Prepared by Pakistan Economic Forum, Energy Expert Group, 2013

⁵⁶ Ministry of Finance, 2013, Economic Survey of Pakistan 2013-14

14.1% of total employed labor force. Other industries remain stagnant at 7.1 to 7.3⁵⁷ percent of the GDP over the last 8 years.

The sector contains two sub-sectors that are Large Scale Manufacturing (LSM) and Small Scale Manufacturing (SSM). LSM accounts for 10.9% of the GDP, which presides over the rest of the sectors while Small Scale Manufacturing (SSM), holds a share of 1.7%.⁵⁸ It is unfortunate that after the remarkable growth rate of 19% in 2004-05 (see Figure 10), the industrial sector suffered slothful growth attributed to the unprecedented energy crisis, weak situation of law and order, sharp depreciation in rupee vis a vis US dollar.⁵⁹

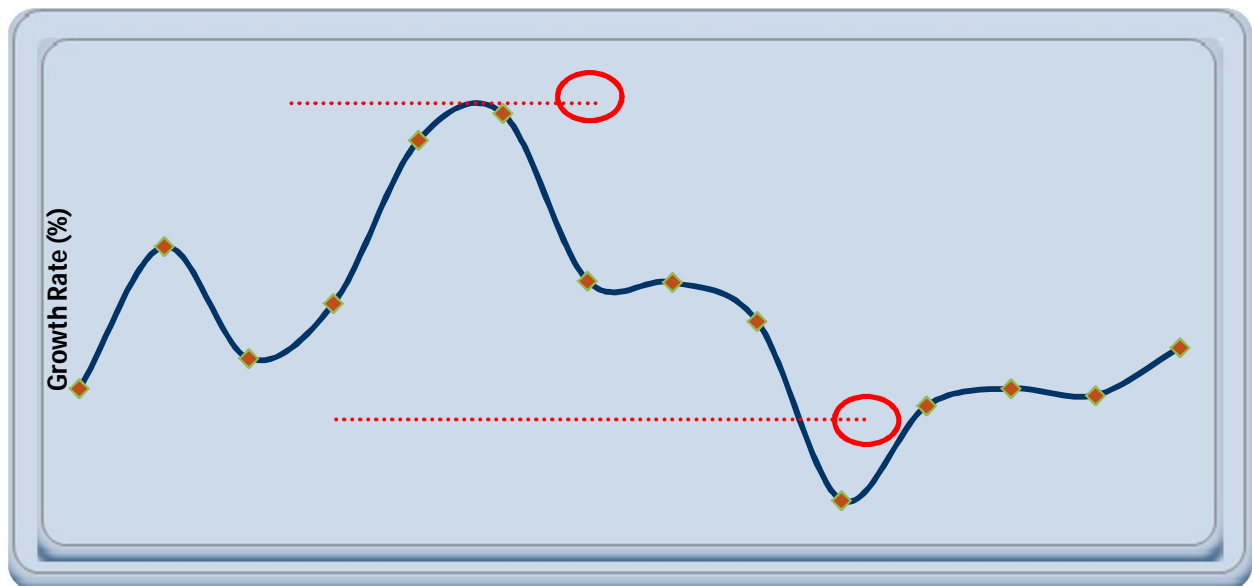


Figure 10: Large Scale Manufacturing (LSM) Units Growth Rate (1999-2013)(Source: Economic Survey of Pakistan(2008-13)

The current situation of LSM sector reveals that during the months of July-March 2013-14 the growth rate was 4.3% as compared to 3.5% for last year. Various sub sectors of industry such as rubber products declined in performance in FY 2013-14 in comparison to FY 2012-13 from

⁵⁷ Ministry of Finance, 2013, Economic Survey of Pakistan 2013-14

⁵⁸ Ibid.

⁵⁹ Economic survey of Pakistan 2008-09

17.6% to 9.48%⁶⁰, petroleum and coke products 13.32% to 7.48% board and paper from 17.82% to 8.03%. In fact, steel and iron products showed a dramatic decline from 13.24% in FY12-13 to only 3.38% in FY13-14. However, fertilizers showed improvement from -5.03% in 2012-13 to 21.64% in 2012-13. Leather products also showed improvement from -1.74% to 12.96%. Automobiles showed improvement from -11.95% in 2012-13 to -0.01% in 2013-14. Engineering products showed a decline from -15.44% in 2012-13 to -21.40% in 2013-14⁶¹.

Other energy intensive sectors in 2013-14 showed negative growths like in wood products it was -8.91%. Engineering products declined to -21.40%.

The major barriers halting the growth in aforementioned sectors are power shortage; increase cost of generation, unreasonable hike in taxes, increase in price of certain important components of an industry and lack of fuel availability. This has significantly hampered the growth of Pakistan and requires an immediate solution as manufacturing industries are the backbone of Pakistan's economy and without it the progress is unattainable.

It is proposed that the industries should be prioritized for allocation of gas as was done in the past, which was marked as the golden era in the history of Pakistan, characterized by remarkable economic growth. The gas relieved from inefficient thermal power plants should be allocated to manufacturing industries as these industries play very important role in revenue and job generation.

Similarly, the fertilizer industry has both forward and backward linkages in national economy and plays significant role in agricultural growth of country. It is estimated that urea accounts

⁶⁰ Ministry of Finance, 2013, Economic Survey of Pakistan 2013-14

⁶¹ All aforementioned statistics in this paragraph are from the Ministry of Finance, 2013, Economic Survey of Pakistan 2013-14

for 70%⁶² of the fertilizer demand within the country and the annual production of urea for 2012-13 is estimated as 4,063 thousand tones against the national demand of 6200 thousand tones per annum which is less than by sixty five (65) percent of installed capacity of urea fertilizer. This situation has emerged only due to curtailment of natural gas to urea manufacturing plants thus compelling the country for spending huge foreign exchange on urea

Gas Sales price for Domestic Consumers:

- Up to 1.77 M.cu.ft./month = 73.95 Rs/mcft
- Up to 1.77-3.55 M.cu.ft./month = 120Rs/mcft
- Up to 3.55-7.1 M.cu.ft/month = 240 Rs/mcft
- Up to 7.1-10.64 M.cu.ft/month=360 Rs/mcft
- Up to 10.64-14.20 M. cu.ft./month
- Up to 4.20 -17.75 M. cu.ft./month= 450 Rs/mcft

imports (about an estimate of 904 thousand tones for 2012-13). It is worth mentioning that since June 2012, the fertilizer plants on Sui Northern Gas Pipeline Limited (SNGPL) are closed totally on account of gas shortages, however, the only fertilizer plant located at Sui Southern Gas Pipeline Limited (SSGPL) is operational at 20

percent curtailment while the plants located at Mari Gas System are manufacturing urea at 12 percent gas curtailment. This policy of gas supply is deteriorating the fertilizer industry of country which is resulting into low production, undue price hike, increase in imports and subsidy, depletion of foreign exchange reserves and erosion of investment⁶³.

Thus to eliminate the difference between the domestic and international price the government has to pay subsidy. It is estimated that during 2012-13, subsidy of about Rs. 12.76 billion was

⁶²Ministry of Finance, 2014, *Memorandum on Economic and Financial Policies for 2013/14–2015/16*
http://www.finance.gov.pk/mefp/MEFP_201314_201516.pdf

⁶³ Economic Survey of Pakistan, 2012-13, Ministry of Finance, 2013

be paid on urea import while foreign exchange loss for these imports was around Rs. 34.11 billion (US \$ 359 million). The current figures estimates that the price of imported urea is around Rs 2300-2350/bag against the local price of Rs 1650-1675/bag and GOP has decided to distribute these bags to the farmers at the price of Rs 14500/bag, thus compelling to grant subsidy of around Rs700-750/bag⁶⁴.

Therefore, in purview of importance of Industrial sector and its economic impact, it is proposed to prioritize the industrial sector (LSM & Fertilizer) for the revival of economy of Pakistan.

c. Household:

In order to rationalize the use of gas in domestic sector, it is proposed to increase the tariff for slabs consuming gas greater than 3.55 M.cu.ft/month, thus discouraging the misuse of gas especially in winter season. The revised tariff for all slabs is given here in below:

d. Transport:

In case of transport sector, it is suggested to give CNG on priority basis to the public transport in order for encouraging its use. In addition to this, the dependence of gas is proposed to reduce gradually by exploring alternate fuel options for this sector.

However the commercial sector constitute negligible share therefore, the current strategy hasn't focused on these areas.

⁶⁴Ministry of Finance, 2014, *Memorandum on Economic and Financial Policies for 2013/14–2015/16*
http://www.finance.gov.pk/mefp/MEFP_201314_201516.pdf

However, it is important to note Pakistan's estimated high potential in Shale gas with 105 TCF and Shale oil of 9.1 billion barrels⁶⁵.

- **Shale as a National Agenda:** Pakistan has the potential to revolutionize its energy sector by putting Shale Gas. With the current natural gas consumption rate of 8 BCF/year, this unconventional source of energy is likely to meet the gas demand of Pakistan for 45 years. Similarly, the consumption of oil in the country is 125 million/annum, which is most likely to satisfy projected demand for 61 years. These figures show that if GOP takes concrete steps based on national interest for the exploration and development of shale oil and gas, then the demand for energy can be easily satisfied provided that expert analysis and consultation are used during the process. Although Pakistan has formulated Shale Oil and Gas Regulatory Framework through the efforts of OGDCL and the Ministry of Petroleum and Natural Resources (MPNR), it still needs further strengthening. It is important to place shale gas high on the government's energy priorities not only because it is a more environmentally friendly solution than Coal and other non-renewable options but also because this indigenous resource will reduce the burden on the national exchequer.

- **Responsible Shale Development:** Pakistan will need to approach cautiously in Shale Gas, learning from the examples of countries like China and Poland, which have failed to achieve the expected benefits from Shale despite heavy investments. Pakistan will have to analyze existing data and formulate risk evaluation of Pakistan's shale plays to avoid the challenges that were faced by China and Poland.⁶⁶ It will be essential for Pakistan to make careful and thorough assessments of the country's terrain and geography of shale basins. In fact, the extensive data available under the Pakistan Basin Study (2009) may need to be reanalyzed

⁶⁵ EIA, 2013

⁶⁶ Wall Street Journal, 2013

in the light of Shale Gas Development. Data will have to be analyzed for characterization of the Source Rock, through log data and identification of Total Organic Carbon (TOC). In the past, extensive stratigraphical analysis has been conducted in the Indus basin, and petrophysical models may also help in a better understanding of Shale Gas plays. Moreover, the properties of rock i.e. the mineralogy, petrography and petrophysical properties should be understood for the identification of sweet spots. In this regard, a Hydraulic Fracturing Program (HEP) needs to be formulated that would create feasibility reports on Shale reservoirs. Moreover, factors like fracture containment and induced seismicity should also be factored into the evaluation. Similarly, extensive geological mapping of fault lines will have to be carried out so that wells are not drilled near seismic zones and seismicity will have to be monitored at the pre and post drilling stages.

- **Unconventional Gas Technical Engagement Program (UGTEP) and Other Technical Assistance:** This report strongly recommends that Pakistan should engage with the US on Shale Gas, and conduct diplomatic consultations to become a part of the Unconventional Gas Technical Engagement Program (UGTEP), which was formerly known as the Global Shale Gas Initiative (GSGI). The MPNR will need to learn from and share the U.S. experience, in terms of technical trainings and in terms of establishing regulatory and fiscal frameworks and environmental protection for shale. Before Pakistan can prepare for shale gas bidding, the country will need to strengthen ties with the US State Department's Bureau of Energy Resources. Moreover, Pakistan will need to build greater cooperation on technical knowledge and training with key shale countries.

Another way of curtailing of gas shortfall is through the import LNG into the country. But it must be done so at a reasonable price, to make it a viable option. The incumbent government is planning on importing LNG from Qatar at \$17/mmbtu⁶⁷, excluding cost of regasification and shipping. Whereas the regional prices of LNG hover around \$12/mmbtu. India, for example, was importing LNG from Qatar at \$11/mmbtu⁶⁸ till 2013. In such a scenario, the import price of \$17/mmbtu is exuberant and disadvantageous for the economy.

After thorough analysis, following recommendations have been penned down to guide the aforementioned sector towards a prosperous future:

- LNG must be imported on a price of & 14 /mmbtu⁶⁹ as at a higher price LNG would lose its competitive advantage to oil.
- For effective utilization of LNG, higher efficiency of thermal power must be ensured coupled with LNG supply chain development costs and establishment of LNG terminal and regasification facilities.

3.2 Oil

The total oil resource potential is 27 million barrels with production of 66,032 barrels per day and currently 29% of the energy requirements are fulfilled through petroleum products⁷⁰. It is identified through statistics (See Table 8) that transport sector constitutes the greatest share

⁶⁷ Importing Liquefied Natural Gas (LNG): A Policy Analysis, 2013, <http://sdpi.org/publications/files/Policy%20Paper%20LNG.pdf>

⁶⁸ Ibid

⁶⁹ Ibid

⁷⁰ Ministry of Finance, 2014, *Memorandum on Economic and Financial Policies for 2013/14–2015/16* http://www.finance.gov.pk/mefp/MEFP_201314_201516.pdf

for oil consumption followed by power, industry and agriculture. However, the household and other government constitutes a negligible share. The major emphasis here is to reduce the dependence on imported oil in transport and household sector which is draining the national exchequer pertaining to surging oil import bills.

Table 6- Sector Wise Petroleum Consumption

Fiscal Year	Share in Total Consumption (%)					
	Household	Industry	Agriculture	Transport	Power	Other Govt
2001-02	2.00	9.50	1.33	47.28	37.18	2.73
2002-03	1.70	9.80	1.20	49.13	36.59	1.62
2003-04	1.70	11.10	1.37	63.07	20.41	2.30
2004-05	1.30	10.50	0.97	61.51	23.53	2.16
2005-06	0.90	11.50	0.56	55.77	28.84	2.45
2006-07	0.60	9.50	0.58	47.38	40.01	1.93
2007-08	0.70	5.90	0.60	51.90	39.18	1.72
2008-09	0.50	5.40	0.39	49.34	42.27	2.05
2009-10	0.50	5.10	0.30	46.32	46.07	1.69
2010-11	0.50	7.20	0.21	47.08	43.09	1.98
2011-12	0.40	7.60	0.12	49.61	40.66	1.58

Therefore, the strategic plan for oil sector revolves around transport and power sector and proposes to cut down its usage in power sector and restrict its use in transport sector only.

a. Power:

In order to address the issues of adulteration in imported fuel oil, in short term, the concept of real time monitoring should be introduced on immediate basis. Real time monitoring of quality and quantity of imported fuel oil through web based procurement system would not only monitor the procurement process but also reduce the extravagant fuel consumption and wear and tear in thermal power plants using that substandard fuel oil.

In addition to this, the Sales/Purchase agreement for importing the furnace oil should be tailored with appropriate clauses addressing the concerns of quality and quantity of imported furnace oil. It is significant to highlight that there should be price adjusters against any

deviation in required specification of imported furnace oil. Any increase or decrease in specification of furnace oil including specific gravity, sulphur and basic sediment and water content should be subjected to price adjustment.

The maximum allowable quantity of BS & W should not exceed six-tenth of one percent of the volume and if it increases by one tenth of one percent then the price per barrel decreases by USD 0.05. Similarly if the specific gravity goes above or below the 37.3 degree API then the price increases/decreases by USD 0.003. As for sulphur the price per barrel shall decrease by USD 0.02 for each 1/10th of a percent above 0.15%wt, sulphur in the fuel oil. Thus, the inclusion of price adjustment clause in agreement will enable to conform to the specifications as set according to the Pakistan Standards and Quality Control Authority (PSQCA) standards.

Moreover, in long term it is proposed to explore other indigenous resources to decrease the dependence on oil imports and become self-sufficient. The details of power generation plan utilizing other resources are explained later in this vision.

b. Transport:

The fuel oil should be prioritized for the transport sector, not gas. In order to promote the use of fuel oil instead of gas, it is suggested to revise its selling price. However, in long-term, the alternate indigenous resources should be explored with due diligence. The details for long term planning in transport sector are explained in next section.

c. Agriculture:

In order to reduce the use of diesel fuel in agriculture sector it is proposed to use more efficient pump sets and water frugal farming practices. A number of technical measures available for improving the efficiency of irrigation pumps includes: use of foot valves having low flow resistance, replacement of undersized pipes and reduction in number of elbows and other

fittings causing frictional losses. In addition to this, it is also essential to do timely operation and maintenance of diesel engines for optimizing the use of diesel.

2.3.3 Power

In case of power, the domestic/household sector is the greatest consumer with share of 46%, followed by industry (27.5%) agriculture (11.6%), commercial (8%) and streetlights (6.2%)⁷¹.

The strategic framework for optimizing and rationalizing the usage of electricity in all these sectors has been explained here in below:

a. Household:

There is a need to promote the energy conservation and good practices in short term to manage the demand side issues. However, in long term the supply side issues would be managed by exploring new avenues especially solar energy (explained in detail in next section).

b. Industry:

In case of industries, the priority should be given to the industries producing export quality products. While the other industries that are not involved in export or producing substandard products should be confined to single shift only, thus conserving the electricity for prioritized industries.

c. Agriculture:

The agriculture with share of 11%⁷² is also suggested to adopt good practices and promote the use of efficient tube wells and water pumps to reduce the extravagant electricity consumption.

⁷¹ Ministry of Finance, 2014, *Memorandum on Economic and Financial Policies for 2013/14–2015/16*
http://www.finance.gov.pk/mefp/MEFP_201314_201516.pdf

⁷² Ibid

d. Street Lights:

It is generally observed that the roadside streetlights remain in power during day time which results into wastage of power. Hence, this practice needs to be discouraged and timely electrical input needs to be given to the street lamps.

2.3.4 Transmission & Distribution (T & D) Losses

In order to address the T & D losses, the supply side issues should be taken in consideration for short term by allocating human resources on immediate basis, which have the required capacity and professional skills for addressing the technical component of line losses. As it has been experienced in KESC, that the T & D losses were not improved considerably (even after the power projects financed by AEDB) due to incompetency and lack of professional skills to use the purchased materials. The inspection of stocks within KESC identified that more than 32% of the purchased distribution material were not used. Therefore, this aspect should be considered on urgent basis. Moreover, it is also proposed to hire women in middle management in order to avoid conspiracies and corruption within the institutes.

Non-technical losses are losses not associated with mechanical/technical constraints. Measures to counter non-technical losses include setting up vigilance squads to check and prevent energy theft⁷³; severe penalties for meter-tampering, introduction of energy audits and strict check of energy sales and receipt; installation of tamper-proof meter boxes and numbered seals; formulation of time bound meter-checking and replacement in the case of defective meters; lastly, introduction of subsidies for poor consumers in the form of lower tariff can prevent electricity theft.

⁷³<http://www.ijser.org/researchpaper%5CMeasures-for-reducing-transmission-and-distribution-losses-of-Pakistan.pdf>

Micro-grid and Smart-Grid

Smart-grids are crucial to achieving the goal of energy efficiency. Local systems, with micro-grids work to centralize the electricity system on a small-scale, regulating the flow of electricity to consumers. Application of smart-grid technology may help Pakistan truly understand the nature of transmission and distribution losses, and help to minimize losses. Accurately detecting problems and identifying areas may help the National Transmission and Distribution Company (NTDC) regulate power usage, and minimize theft and pilferage. Moreover, the micro-grids may help increase reliability of energy supply, reduce Carbon emissions, and keep costs low.

2.3.5 Circular Debt

There should be immediate measures to recover PEPCO's receivables from public and private sector. The amount of receivables of provinces could be offset directly from their National Finance Commission (NFC) award amount through "Adjuster". The power supply (public or private sector) organizations having receivable amount outstanding for more than 3 months should be stopped and court proceedings to be brought forward for recovery⁷⁴.

2.4 Medium Term Strategies

In medium term, the strategic framework is focused on issues within the power sector only. While the grievances associated with other sectors are discussed in long term planning due to involvement of longer span of time and efforts.

⁷⁴ "Integrated Energy Planning and Pakistan Energy Future: An Update on Continuous Energy Crisis", Position Paper Prepared by Pakistan Economic Forum, Energy Expert Group, 2013

2.4.1 Thermal Power Plant Efficiency:

The poor efficiency of thermal power plants can be addressed through Energy Efficient Renovation and Modernization (EER) in medium terms. This EER would improve the energy efficiency of boiler, turbine generator and auxiliaries, resulting in improvement of unit heat rate, thus improving the availability of generation unit. This improvement would resultantly optimize the fuel consumption against increased production, thereby reducing the cost of generation and relieving the end consumer. It is estimated that increase of 10% efficiency increases power generation by 20%. Moreover, the emission factor of GHGs through power plants would be reduced and provide an opportunity for improved environmental control. In addition to this, the energy audits of all electric entities should be ensured on annual basis through NEPRA.

In order to address the energy crisis in a holistic manner, it is imperative to reduce cost of generation while keeping the environmental footprint minimal. However, the coal-based power plants in Pakistan have failed to do either. The exponentially high tariff set at Rs. 9.6/kWh⁷⁵ for coal based power plants is hurting the economy instead of providing relief to it by tackling the crisis.

Furthermore, the global trend is moving towards ultra-super critical power plants with average efficiency around 45%⁷⁶ whereas Pakistan is persisting to maintain lower standards with 38% efficiency in order to lure investment in the sector. Moreover, NEPRA has failed to devise a commercially viable tariff for coal-based plants, further straining the import bill. Following policy measures should be taken up by the incumbent government in order bring about a relief in the energy sector

⁷⁵ Coal-fired Power Generation in Pakistan: A Policy Paper, 2014, <http://www.sdpi.org/publications/files/June%206th%202014%20Coal%20Paper.pdf>

⁷⁶ Ibid

- Existing coal-fired power plants should be regulated under the principles of High Efficiency, Low Emissions (HELE)
- Upcoming projects to be in lieu with international standards with emphasis on the promotion of ultra-super critical power plants
- Renewed focus on thermal sector through regional cooperation in South Asia.

2.4.2 Reducing line losses

The electricity billing needs to be administered in FATA which would ensure that the consumers pay for their electricity consumption and to keep a vigilant check on the thefts. Therefore it is imperative to make the electricity billing system functional in FATA and in controlling the thefts there. As the consumers of FATA do not pay the units generated, upon proper billing much of the losses would be eliminated.

Other mid-term measures to remove non-technical line losses require mapping of primary and secondary distribution systems clearly depicting parameters such as conductor size line lengths, detailed distribution system studies considering expected electricity load development during the next 8-10 years; compilation of data regarding existing loads, operating conditions and forecast of load patterns; long-term plans for improvement of existing transmission and distribution systems; financial estimation of required and projected system improvement works for implementation and detailed system improvement schemes with required investment program for initial 5 years⁷⁷.

⁷⁷ Khan, M.A., Badshah, S., Haq, I.U., Hussain, F., 2013, "Measures for reducing transmission and distribution losses of Pakistan," International Journal of Scientific & Engineering Research, Vol. 4, Issue 4

2.4.3 Restructuring of Organizations:

There is a need to revamp the organization for appropriate energy sector development and capitalize the indigenous resources for economic growth.

In this regard, the regulatory role of NEPRA needs to be empowered and made completely independent of political influences for more effectiveness. There is a need to expedite the process for making amendments in NEPRA act and Performance standards for generation, transmission and distribution in order to accelerate the empowerment of NEPRA.

The appointment of chairman and other professionals should be transparent and strictly according to law as the country has already been suffering from unprecedented energy crisis for a decade and nepotism has played a pivotal role in whole process. NEPRA should set up a tariff research cell in conjunction with educational centers of excellence and think tanks to evaluate tariff restructuring to minimize subsidies. This research center should also work in close collaboration with similar international institutions and benefit from their expertise and experiences. The comparison of tariffs by fuel type indicates the reliability and cost of each type of power produced. It is therefore necessary to push for greater reliance on indigenous fuels that will provide greater sustainability and competitiveness for the economy.

It is suggested that NEPRA should be play as an active regulator along with the lines of State Bank so that it can:

- Actively regulate sector governance to control costs
- Monitor losses and thefts and financial status of DISCOs
- Monitor the thermal efficiency of all power plants
- Ensure a competitive market and promote the clean and green energy resources, the way it had advocated the IPPs and RPPs rigorously.

In addition to this, there is also need of strengthening AEDB, an authority that is delegated for renewable energy resources. The institutes since its inception has unfortunately failed to increase the share of renewables in energy mix. It is proposed that skilled staff should be inducted on urgent basis to accelerate the process, thus improving the quality of human resource. Moreover, the institution should also work in close collaboration with research centers to enhance their productivity.

It has also been observed that there is serious issue of lack of access to reliable and consolidated data regarding the state of energy within the country. Therefore, keeping in view this need, it is proposed to develop a consolidated data based on energy through collaboration with all relevant departments under the supervision of Ministry of Water and Power.

2.4.4 Expedite the projects in line on Fast Track Basis to Enhance Generation:

In purview of diversifying the energy mix and reducing the dependence on imported oil, it is recommended to expedite the completion of projects in line on fast track basis and increasing effort should be made to complete the projects in accordance with their commercial operational date. It is emphasized here again that the foremost importance should be given to hydropower projects keeping in view their socioeconomic benefits and cheap rate. Additionally, the power generation through coal and low BTU gas are also very promising in energy generation. For coal new technologies needs to be explored for thermal generation keeping in view the failure of UGC. The Table 9 identifies the projects that could be completed by 2015 and add 2525 MW in existing installed capacity.

Table 7- List of Projects to be completed during 2014-2015

S. No	Type	Power Project	Capacity(MW)
1	Coal	Punjab Power Project	150
2	Low Btu	Uch II Power Project	404
		Star Thermal Power Project	134
3	Hydro Power	Tarbela 4 th Extension	1450
		Basho	28
		Harpo	33
4	Thermal	Grange holding Power Project	163
		Radian Power Project	163

2.4.5 Mid-term Strategies on Shale Gas

- **Effective Regulatory Mechanisms:** Pakistan will need to ensure that the regulatory and licensing policies regarding the unconventional oil and gas sector should be favorable for investment. It is recommended that the Ministry of Finance, the MPNR, and the Planning Commission work in collaboration with the Oil and Gas Regulatory Authority (OGRA) to create favorable fiscal and regulatory policies for ensuring investment in unconventional resources so as to initiate the development of these reservoirs. Three key areas of shale gas development that is exploitation, environment and trade should be explored by the GOP. Efficient regulatory mechanisms will need to be developed to speed up the process and to ensure that private investment is not deterred through extensive bureaucratic processes. Moreover, clear division of responsibilities will need to be made, so that the investment process is streamlined.
- **Creating Fiscal Incentives:** Pakistan needs to create an effective fiscal regime for shale gas if it wants to replicate the US Shale Gas Revolution. In similarity to the UK

government's recommended proposal⁷⁸ on fiscal incentives on Shale, Pakistan too will have to create tax incentives for a long-term tax policy on shale. For example, shale gas projects may receive a pad allowance for early investment. Furthermore, the process will have to be clarified, and a positive impact on communities that host projects will have to be ensured. Such consultations will need to be led by the Shale Gas Industry.

- **Knowledge Management of Hydrocarbons:** Shale Oil and Gas as a new area of study for Pakistan will require thorough analysis and knowledge management. It is suggested that Pakistani institutes should create a database on the different aspects of the Shale oil, and the gas sector should be provided with the geological aspects of the exploration of unconventional resources. Furthermore, existing laboratories will need to be equipped to meet new academic demands. Hence, there is a need to carry out detailed surveys and studies to create understanding of reservoirs with the help of academic and research institutes in Pakistan.
- **Including Shale in the National Curriculum:** Engineering universities and institutes in Pakistan will need to include shale gas technology in their curriculum to develop professionals who have a good understanding of Shale Gas. Furthermore, vocational trainings in this area of study would help to create a skillset on Shale Gas. Additionally, Pakistan Engineering Council (PEC), as a statutory body is strongly recommended to play a pivotal role in creating this backbone of knowledge.

⁷⁸ Government of the UK, 2013, Harnessing the Potential of UK's Natural Resources: A Fiscal Regime for Shale Gas



CHAPTER 3

LONG TERM STRATEGIES

3.1 Long Term Strategies

3.1.1 Power:

a. Demand Side:

In the long term in order to manage the demand side issues in electricity, the following measures should be taken:

- Energy Efficiency should form a core part in building designs, with domestic buildings have a minimal usage of electricity, in daylight hours in particular.
- Industries should be designed in a way that it maximizes the usage of daylight, which would reduce electricity consumption. In addition to this, there should be an annual energy audits of all industries to avoid the wastage of electricity.
- In the long-term, street lights should be converted to Solar LEDs to minimize electricity consumption

b. Supply Side

In order to manage the supply side, the following measures have been proposed:

3.1.2 Power Generation Capacity Enhancement:

The strategic plan has proposed Power Generation Capacity Enhancement through exploitation of renewable resources with a prime focus on hydropower development. This is expected to optimize the energy mix and reduce the cost of power generation. Each component of the power generation plan is discussed below.

I. THERMAL AND HYDROPOWER

Global Scenario: Globally, hydropower usage is increasing, with over 159 countries using the using the aforementioned resource for the generation of electricity. According to the International Energy Agency, "16.3% of the world's electricity needs are met through hydropower (about 3500 TWh in 2010), more than nuclear power (12.8%), much more than wind, solar, geothermal and other alternative sources combined (3.6%). But fossil fuel plants (67.2%," still take up the maximum share in overall generation (IEA, 2010). Currently, the largest energy source still remains thermal energy, but countries like Norway are defying the odds with over 90% share of hydropower and a generation of 126 (TWh) (IEA, 2010).

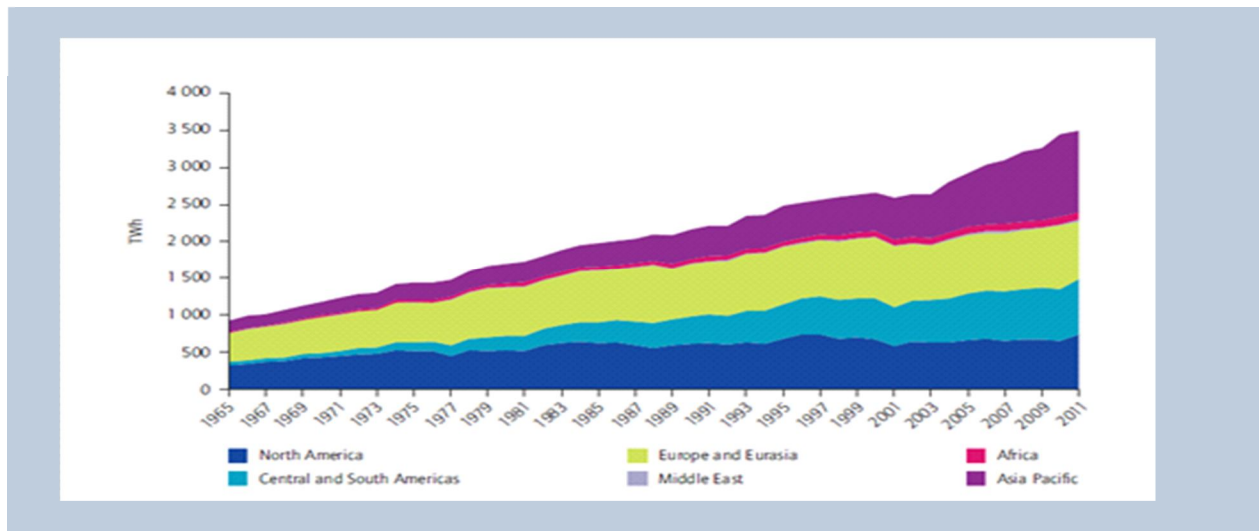


Figure 11: Hydroelectricity generation, 1965-2011 (Source: IEA, 2010)

As evident in Figure 11, the total global share of hydropower is showing an upward trend, with Asia Pacific showing the highest hydropower potential.

The International Energy Agency has a vision of increasing the technical potential for hydropower, through short-term and long-term goals of deployment by the year 2050. The

map shows (see Figure 12) global hydropower potential, which shows that Asia has a large percentage of undeveloped hydropower, a resource that can be tapped (IEA, page 18).

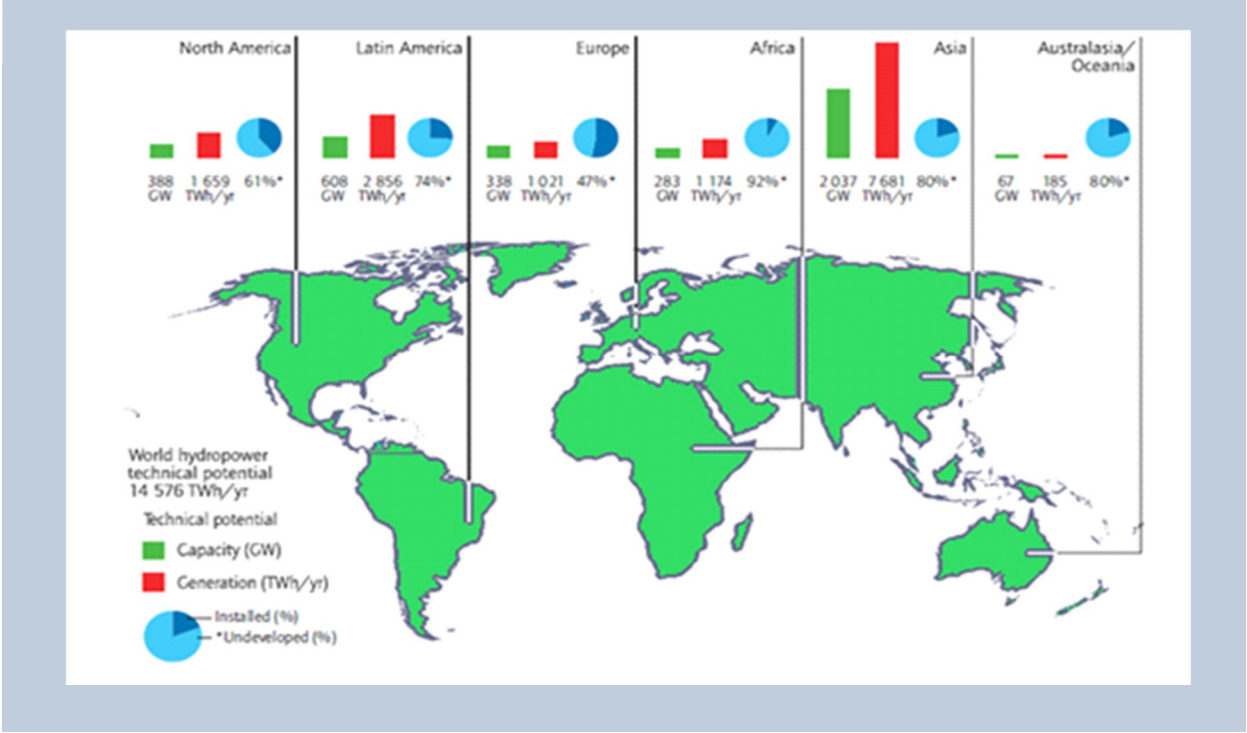


Figure 12: World Hydropower Potential (Source: IEA. 2010)

The IEA predicts that the total hydropower capacity in Asia will be 852 GW by 2050, with half in China and one quarter in India, leading to hydroelectricity totals reaching 2930 TWh, (Hydropower Today, 19). In the South Asian context, Nepal (potential of 84 GW), Bhutan (24 GW) and Burma (100 GW) are leaders in the region for hydropower technology, with a hydropower potential that is in excess to their domestic needs.

The world’s power generation scenario is shown in Figure13 from the period of 1990-2030. Most of the power generation will be through coal till 2020 but after that hydropower, nuclear

and renewables will take over. The power generation by oil will remain in a decreasing trend till the proposed future projects till 2030 are commissioned. Worldwide hydropower will get a boost but most of it will be in the Asia-Pacific due to their greater hydropower potential but power generation through oil will globally and locally reduce.

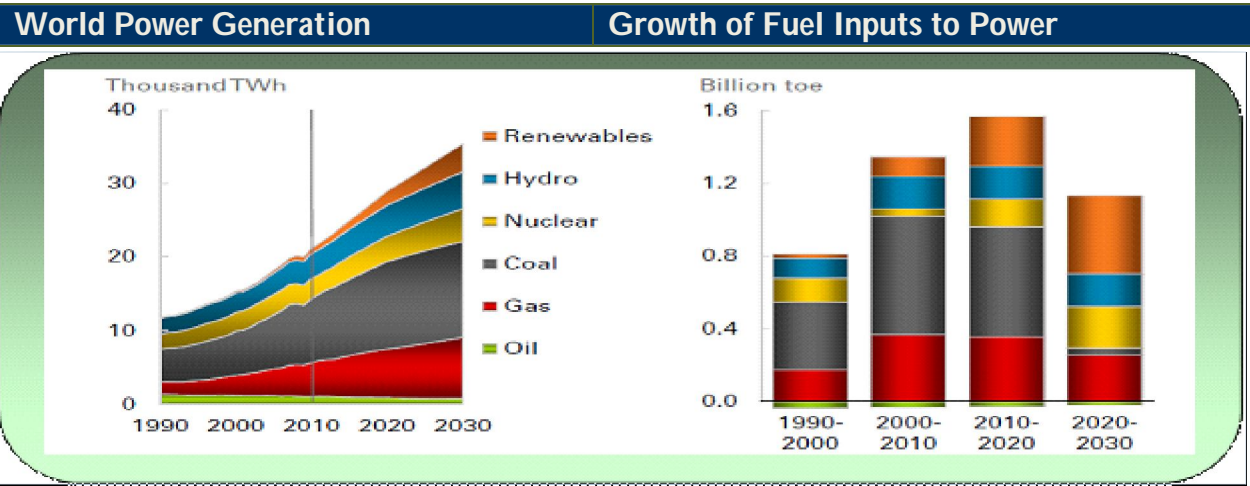


Figure 13: World Power Generation and fuel inputs

Current Scenario of Pakistan: Pakistan has a great potential of hydropower with over 120,000 MW, and is therefore a resource that is a natural option for energy generation. Historically, Pakistan has had a series of hydropower projects, with the initiation of the multipurpose Tarbela and Mangla dams, which were landmark projects of hydropower deployment. Hydropower development has a strong correlation with economic growth, and past projects have helped fuel sustainable development. The Tarbela dam, for example, a project completed in 1997, resulted in a total benefit of Rs. 221,902 million for the national economy by December 2007. This is 13.5 times the original cost of the project (WAPDA Annual Report, 2007-08). Pakistan has an even greater hydropower potential, and with 74.9% potential in the Indus River Basin (see Figure 14), untapped hydropower resources need to be tapped to counter Pakistan's energy problems.

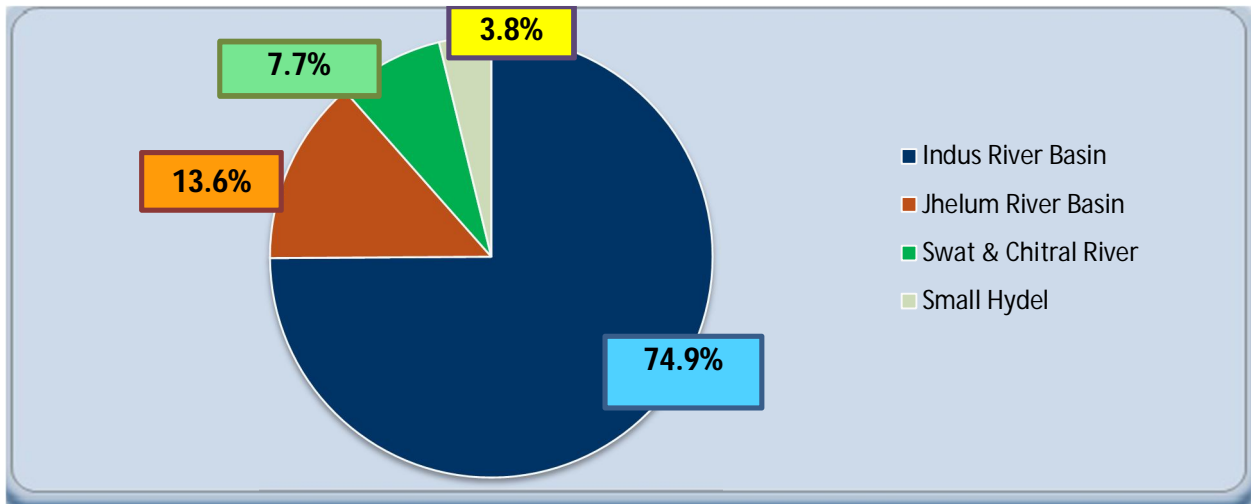


Figure 14: Pakistan's hydropower potential

The current total installed capacity of Pakistan's hydropower stations is about 6795 MW. Out of this total installed hydel generation capacity, the largest share is of KPK, with a total of 3767 MW. Moreover, at the moment, there are 1698 MW in Punjab, and 1036 MW in Azad Kashmir (See Figure 15). The lowest capacity at the moment is in the Northern Areas, with only 140 MW (WAPDA, 2013). It is to be noted that the KPK has an even greater potential, Malakand-III is a project on Swat River with an 81 MW (WAPDA, 2013). Thus this potential needs to be tapped on urgent basis.

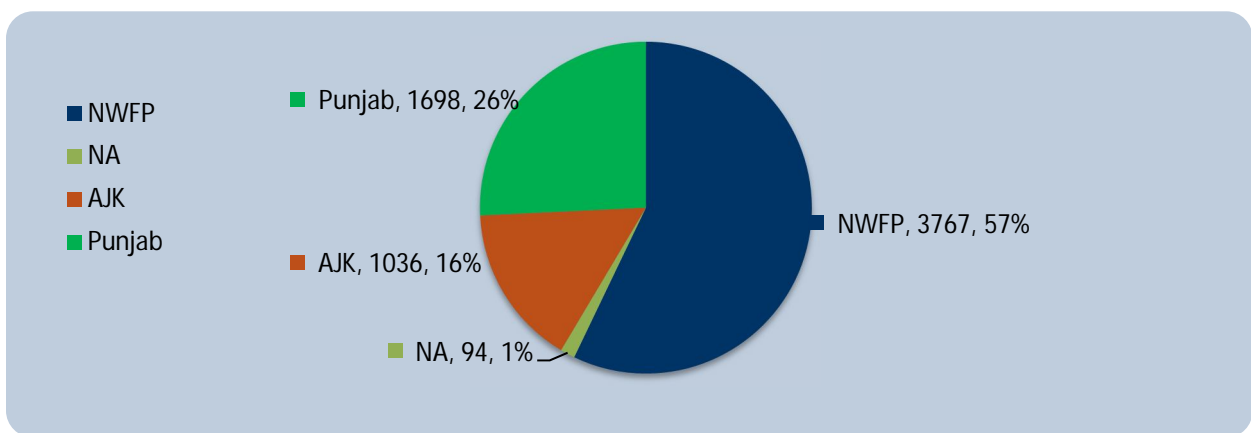


Figure 15: Province wise Installed Hydel Generation Capacity (6,595,032) (Source: WAPDA 2012)

Pakistan continues to face an acute energy crisis since 2007 (Pakistan Energy Outlook, 2013). As discussed above (See section 1.2.2: Increased Dependence on Furnace Oil) this energy crisis is exacerbated by an undiversified energy mix which lacks a focus on renewable energy. There has been a significant change in the Generation Mix over the years such as in 1960, the hydropower to thermal power ratio was 44:56 but within a decade, the hydro to thermal energy mix ratio equalized. From 1970 to 1985, the hydro to thermal share was 67:33, which was more than 65% of the total power generation. This happened mainly due to the major developments in this period (1970-1985).

This shows that Pakistan has the potential to generate power through hydropower. Unfortunately, after 1990, the share of hydropower became lesser in ratio than thermal energy.

This report shows that hydroelectricity is the best solution for the country, not only in helping Pakistan produce cleaner energy but also by ensuring a reliable electricity supply, through a diversified energy mix. The following sections discuss how the water resources of Pakistan can be effectively used towards the goal of power generation.

Strategy for Hydropower: The 'Energy Vision' is geared towards overcoming the energy crisis of Pakistan, through the use of indigenous resources, and forecast energy supply demand scenarios. In the light of these goals, this Vision illustrates a roadmap for hydropower as it is a clean, reliable, sustainable, indigenous resource and has a low cost of generation. A greater ratio of hydropower in the energy mix will help towards the goal of lower cost of power generation and may help:

- To effectively utilize Pakistan's hydropower potential and reduce power generation from thermal power plants

- To help conserve the available fossil fuels and produce cleaner energy
- Provide reliable, consistent and low cost electricity through hydropower
- Reduce the import bill of Pakistan

Roadmap for Hydropower Development till 2035: In the light of above discussion, it is evident that in-line hydropower projects need to be commissioned to meet the rising demand of the country. The current capacity of hydropower projects is 7324MW which is likely to reach by 53000MW by 2035 by bringing in the in line projects. Figure16 shows the hydropower projects roadmap for both scenarios I and II, in which hydropower capacity additions have been made on the basis of planned and on-going projects. From the figure below, it can be seen that there have been significant increases in the capacity from 2020 to 2025 about 18,781 MW, as major dams like Dasu, Diamer Basha, Bunji, Thakot, Pattan, Kohala, will come into the grid with an overall average capacity of 3770MW. On the contrary, the roadmap of thermal power plants shows a reduced reliance on furnace oil for thermal power generation till 2035 as the share of renewables and coal may increase.

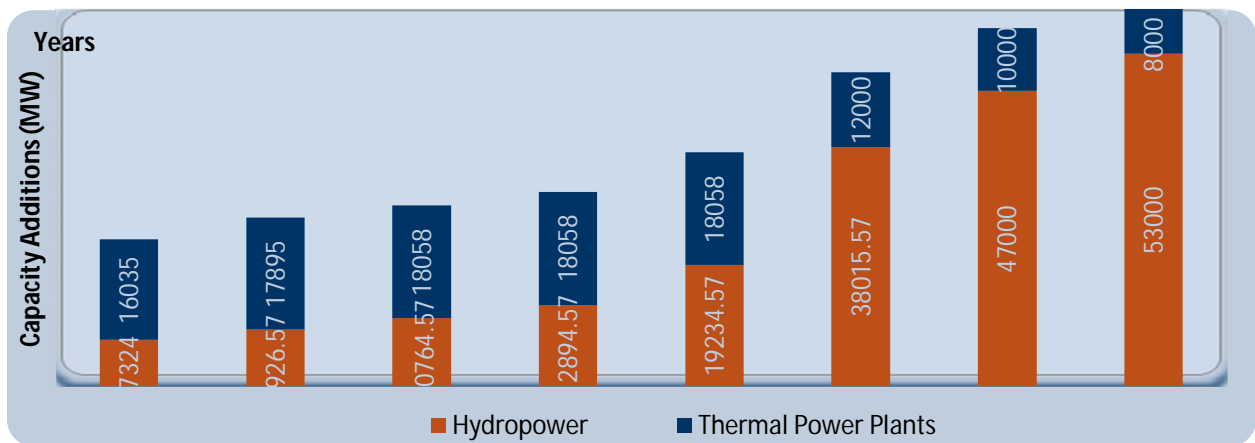


Figure 16: Roadmap of Hydropower till 2035 for Scenario I and II

Thus, hydropower may bring about a significant change in the prevailing energy crisis, which is likely to persist in the coming years unless, the most viable option is adopted which is power generation through hydropower plants.

Barriers for Hydropower Project Plants: Pakistan with its vast hydropower potential requires a strong and stable rationale to augment the current hydropower capacity of 7324MW. There are a number of challenges that first needs to be tackled in order to start on the roadmap of hydropower projects. The issues involved in the development of hydropower potential are as follows:

- **Nepotism:** It is observed that over the years, there was a strong inclination towards Independent Power Plants's and generation through thermal sources, while ignoring the hydel sector. This led to the fall in the ratio of hydel energy in the overall energy mix.
- **Lack of Provincial consensus:** Lack of consensus has led to the failure of development of many hydropower projects. Kalabagh Dam is one of the major projects that could not initiate because of clashes between provinces.
- **Myths about Hydropower:** There are few misconceptions about the hydropower potential that the wind and solar sources of energy are far cleaner and cheaper than hydropower but statistics reveal in this report and in other studies that hydropower generates far more than the other renewable resources and has the lowest cost of generation as compared to solar and wind energy.

Once these barriers are addressed the rationale of hydropower can be redefined by setting the focus on the hydropower projects that are in completion phase and the ones under study so that the finances could be diverted to those projects so they could commence. The gradual additions

of projects till 2035 will revert the energy mix so that maximum generation can be done through hydropower. If the barriers listed above and according to the roadmap envisioned in this report then the prospects for developing hydropower is discussed in the following section.

Prospects for Developing Hydropower in Pakistan

Cost Analysis of Hydro and Thermal Power:

In Pakistan power generation is done through both hydropower and thermal power plants. Currently, thermal power plants have more shares in the power generation than hydropower. The report signifies hydropower, therefore costs and benefits associated with hydropower and thermal power plant needs to be closely looked. The following discussion shows a comparative analysis between the two.

- **Fuel Costs:** The main fuels used for thermal generation are gas and furnace oil (FO). The exploration of natural gas proved at the time that it was sufficient to meet the energy demands of Pakistan, so in FY 2003 all the thermal power plants were shifted from FO to gas. Though cheaper energy was available through natural gas from FY's 2003 to 2007 but then reserves of natural gas started depleting which lead to the reverting of thermal power plants on FO. The major issues related with the FO for thermal generation (main fuel for power generation) are as follows.
 - **Availability of FO:** One of the main concerns for Pakistan's energy sector is the heavy reliance on imported oil for the power generation, which at present uses 35%⁷⁹ of it. For this reason the import bill alone for FY 2011-12 increased by 26% since 2010-11. The total import of petroleum products was 12.37 million and among them RFO constituted

⁷⁹This will help in reducing the power losses.

53% of the import (Economic Survey of Pakistan, 2010-11). Thus, the reliance on imported oil is increasing with years that are making Pakistan a vulnerable country with the existing energy crisis.

- **Rising Fuel Cost:** The import bill is increasing is time so are the fuel prices. This is due to the fact that the fossil fuels are non-renewable sources of energy, and major reserves of these fossil fuels are either reaching their threshold or have reached. This leads to the exploration of new sites and the new sites may have an additional transportation cost. Moreover, with the worldwide increasing demand of energy has lead to the rise in price of oil. Pakistan being a developing nation and with the current energy crisis has to deal with the increasing fuel price as fuel is mandatory for power generation.
- **Environmental Concerns:** The country has to follow the environmental standards of air emissions and water standards. The air emissions and water discharge from the power plants need to be controlled through various technologies to be used on and off site.

The issues listed above imply that there are serious concerns related to thermal power plants. As for hydro power projects the fuel for generation is water which is readily available through Indus Basin, therefore the fuel availability and its costs does not imply on the hydro projects. Additionally this reduces the import bill of Pakistan if the major energy needs are met through hydro power. As for environmental concerns, hydro power also has environmental concerns associated with it but it does not require an investment in clean technologies. The hydro power may or may not cause any environmental problems. If the area for development is clear then no resettlements would be required but in some hydro power sites settlements are required. Thus, in hydro power projects environmental concerns vary from site to site.

Generation Costs: Different parameters have been taken to compare thermal power plant with that of hydro power plants. In the first case a low capacity hydropower project is compared with that of thermal power plant while in the second case hydropower with greater capacity than thermal power plant is compared in order to see the costs associated with them. Table10 shows the first case in which the hydropower project is of 106MW while thermal power plant is of 425MW which is four times the capacity with that of thermal power plant. In this way the project cost is higher for the thermal power plant.

Table 8: Comparative Analysis between Hydropower (106MW) and Thermal Power Plant (425MW)⁸⁰

Parameters	Hydro: Golen Gol	Thermal Plant (RFO based)
Plant Capacity (MW)	106 MW	425 MW
Total Project Cost (Rs. Millions)	Rs. 863.233	Rs. 12525.93
Plant Load Factor (%)	0.66	60.00%
Auxiliary Consumption (%)	2.15%	3.30%
Fuel Consumption (FO/year)	---	2000 tons of furnace oil per day
Fuel Cost (Rs./ Year Millions)	---	Rs.11282.70
O & M Cost (Rs/Year)	Rs.44.989	Rs.1243.23
Completion Time Period (Months)	48 months	Approx 36 months
Cost of Generation (Rs./kWh)	Rs. 2.00	Rs. 14.00

The three most important parameters which assess the cost effectiveness of hydro power according to the Table10 results are:

⁸⁰ WAPDA, 2013

- **Fuel Cost:** Hydropower projects either of higher or lower capacity the fuel consumption and fuel cost is absent while all thermal power projects have high costs for fuel. In this scenario hydropower project saves upto Rs.11283 million from fuel costs.
- **Cost of Generation:** Hydropower projects cost of generation is very low as compared to thermal power projects which makes the hydropower a suitable option for Pakistan. Hydropower is readily available, consistent, does not require importing of fuel and it is available at a cheap rate. Hydropower can also be compared with other means of power generation such as solar, wind, biomass power, bagasse cogeneration etc and among all the options hydropower has the lowest cost of generation. Figure 17 shows the average cost of generation (excluding other wheeling and capacity charges) of different sources responsible for power generation. The cost of generation for thermal generation is very high and only second to solar power with a difference of Rs7/Kwh.

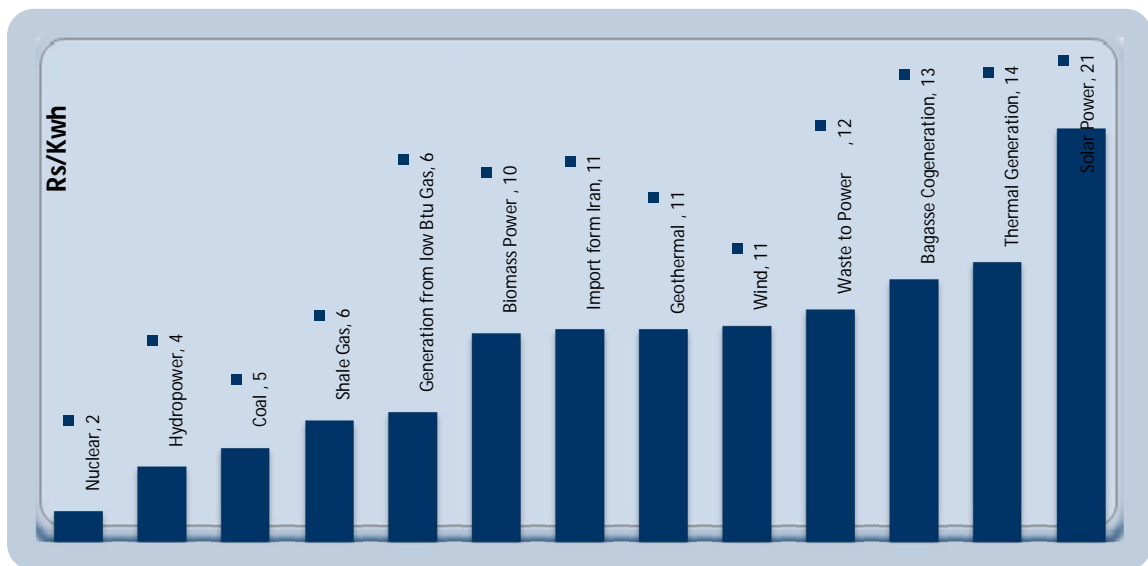


Figure 17: Average Tariff Source Wise

The Figure17 vividly shows that hydropower has the lowest cost of generation followed by coal and shale gas. If thermal power plants generate electricity even on gas still then the generation cost is higher than hydropower plants. Thus, it can be said that hydropower is the best option for developing nation like Pakistan.

- **Life of Plant:** The general plant life of hydropower plants is long, ranging between 50-100 years, while thermal power plants life span is about 25 years. In other words thermal power plants have half the life with that of hydropower plants and are still not cost effective in terms of fuel. Although in hydropower projects seasonality factor needs to be undertaken whereas in thermal power plants no such considerations are required but there is heavy dependence on imported fuel, which can be affected because of the supply and specifications of fuel oil. Moreover, these commodities have a varying price in the market, therefore, whatever the price maybe will have to be paid by the consumer.

On the basis of the above discussion, the Table11 shows the second comparison which is between a hydropower plant capacity of 3478MW and thermal power plant capacity of 425MW.

Table 9: Comparative Analysis between Hydropower (3478MW) and Thermal Power Plant (425MW)

Parameters	Hydro Projects: Tarbela	Thermal Plant (RFO based)
Plant Capacity (MW)	3478 MW (actual)	425 MW
Total Project Cost (Rs. Millions)	Rs. 983234	Rs. 12525.93
Plant Load Factor (%)	0.49	60.00%
Fuel Consumption (Coal in ton/year)	----	2000 tons of furnace oil per day
Fuel Cost (Rs./ Year Millions)	----	Rs. 11282.70
O & M Cost (Rs./Year Millions)	Rs. 21526	Rs. 1243.23
Completion Time Period (Months)	101 months	Approx 36 months (from 2007 to 2010)
Life of the Plant (Years)	Predicted: 85 years (initially 50 years)	
Cost of Generation (Rs./kWh)	Rs. 2.00	Rs. 14.00

As seen from the Table11 the generation cost of hydropower is much lower than the thermal power plants. Moreover, the fuel costs are saved in hydropower projects. The imperative point here is the Operational and Maintenance Costs (O & M). In the first scenario thermal power plant was four times the capacity with that of hydropower project. In the second scenario the hydropower project is eight times the capacity with that of thermal power plant. The O & M cost on the contrary contradicts with the capacities. The thermal power plant with lower capacity has a high O&M cost as compared to a hydropower project which is eight times the capacity of thermal power plant. Therefore, hydropower projects not only have low generation costs but also have low O&M costs.

Benefit Analysis: The benefits associated with the hydropower generation are shown in Figure18 which is explained below. The benefits have been divided into three sections namely power generation, project operation and environmental measures.

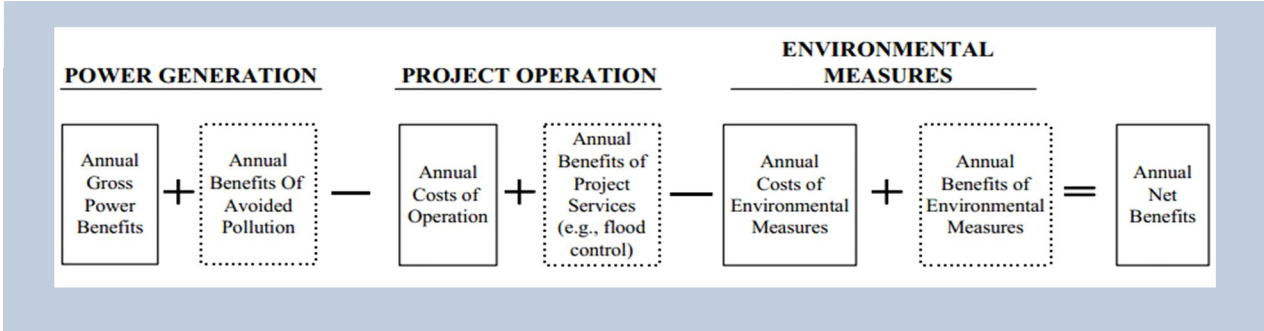


Figure 18: Benefits of Hydropower projects, Source:

Solid-line box shows the quantified estimate. Dotted-line box shows items that are assessed either qualitatively or quantitatively.

- **Annual Gross Power Benefits:** The benefits that reflect the avoided cost of replacing a project's power generation and dependable capacity with power and equally reliable capacity from an alternative source.

- **Annual Benefits of Avoided Pollution:** This is relative to alternative types of power generation, like coal fired plant, hydropower production produces less air pollution.
- **Annual Costs of Operation:** This cost reflects past investment costs owed on the project, expected future investment costs and current operation and maintenance (O&M) costs.
- **Annual Benefits of Project Services:** Besides power generation hydroelectric projects offer other benefits like flood control, irrigation, river navigability and water supply.
- **Annual Costs of Environmental Measures:** Many licensing decisions set up operating conditions to protect, mitigate or improve environmental quality. These are direct costs associated with it such as installing fish passage facilities.
- **Annual Benefits of Environmental Measures:** The benefits that are separate from power generation often referred to as non-power benefits such as, fish screens can improve fish and wildlife resources. To estimate annual net benefits, the costs of project operation and environmental measures are subtracted from the quantitative and qualitative benefits of gross power generation, avoided pollution, environmental measures and project services.

Employment Opportunity: In the past hydropower has proven to be very successful not only in terms cost of generation but also beneficial in terms of generating employment opportunities both for skilled and unskilled labor. The historic data of hydropower projects are sufficient to validate the point under discussion (Abbasi, 2012).

The Malakand project created 946 jobs in its execution phased, and generated employment for 400 unskilled laborers. In the Table below, the job distribution of this project is clearly presented. The Malakand project imparted technical and training skills, e.g. tunnel boring. In the areas of AJK, Gilgit-Baltistan and Khyber Pakhtunkhwa, this will help in alleviating poverty and contribute positively to the economy. In a paper titled *Impact of Hydropower Projects on Economic Growth of AJK*, it was determined that hydropower will create a positive impact on job creation.

	Professional Technical	Skilled	Unskilled	Administrative	Other
Client	17	14	0	5	15
Consultant	30	30	30	10	5
Contractor	40	200	400	80	70

Table: Job Generation due to Malakand Project (Source: Abbasi, 2012)

The paper identified six mechanisms through which employment will be generated in AJK:

1. *Direct creation*
2. *For production and transportation of construction material*
3. *Multiplier effect caused by increased expenditures; (Rehman, 2008)*
4. *Provision of electricity to more and more industries;*
5. *Surplus revenue; (Rehman, 2008)*
6. *Gender Development (Rehman, 2008)*

These mechanisms show that there would be an increase in employment across a wide spectrum, from direct creation of jobs to multiplier effects like increased expenditure raising the demand for hydropower, and stimulating employment opportunities.

The revenue generated from the hydropower has remained a reliable source as compared to solar, wind, waste to energy and biomass. The current tariff shows that among all the renewable and alternative energy sources, hydropower generates the cheapest yet plentiful energy with lower carbon emissions. The Table12 depicts a comparative analysis of the generation of employment in nuclear, hydropower and thermal power plants. The employment generation has been divided into two phases; construction and operation phase. The sum of all power plants in each category and in both construction and operation phase, the employment generation (per MW) comes out maximum for hydropower which is 131MW, followed by nuclear power plants 30.7MW and lastly are the thermal power plants with only 11MW of employment.

Table 10: Employment Opportunities between Different Power Plants

Power Plants	Project	Capacity (MW)	Employment Generation		Employ per MW	
			During Construction	After Construction	Construction Phase	Operational Phase
Nuclear	Chashma Nuclear Unit 3&4	600.0	2,000.0	1,550.0	3.3	2.6
	Chashma Nuclear Unit 3&4	300.0	6,676.0	750.0	22.3	2.5
Hydro Power	Dhannan Hydro Ajk	1.7	150.0	28.0	88.2	16.5
	New Golan Gol	106.0	1,236.0	328.0	11.7	3.1
	Construction Of Malakand III	82.0	946.0		11.5	
Thermal	Korangi	360.0	2890**	554*	8.0	1.5
	Combined Cycle Plant Nandipur	400-500	72.0	308.0	0.1-0.2	0.6-0.8
	Combined Cycle Power Plant At Dadu	500.0	75.0	311.0	0.2	0.6
	Combined Cycle Power Plant At Faisalabad	500.0	75.0	311.0	0.2	0.6

*(including no.of persons for local and foreign training - ***(excl. contractors)

Contribution to CO₂ abatement through Hydropower: Switching to a greater share of hydropower technology will allow a shift away from thermal energy, which is not a green source of energy rather towards better and more renewable sources of technology. One of the largest benefits is the abatement of CO₂. This greenhouse gas poses a significant threat to the environment, but if the roadmap of hydropower is followed, then a significant level of CO₂ can be controlled by increasing the share of hydropower (IEA, 2010).

Moving towards a low-carbon economy is a key step that is imperative to meet the climate change needs of the present and the future. It is essential that renewable energy is endorsed as the primary energy supply of the state, and not only is hydropower more environmentally friendly but it is also more economical.

Performance of Hydropower

Hydropower plants are divided into three major categories: run of river, storage hydropower and pumped storage. These hydropower plants are classified on the basis of operation and type of flow; which in turn determines the size of dam, depending on the topography and hydrology of the watershed. Very small to very large hydropower plants can be made. Performances of any hydropower plant are determined by the following parameters:

- Amount of available water
- Water loss due to flood spill, leakage or bypass requirements
- Difference in head upstream intake and downstream outlet
- Hydraulic losses in water transport due to friction and velocity change
- The efficiency in energy conversion of electrochemical equipment

The above mentioned parameters are for all types of hydropower plants. As this section will emphasize on the run of river hydropower plants therefore the first parameter which is availability of water is critical for run of river hydropower plants. This is so as run of river hydropower plants draws energy from the flowing river. These plants may have short term storage (daily, hourly), allowing for some adaptations to the demand profile, but the generation profile will to varying degrees be dictated by local river flow conditions. Hence, the generation relies on precipitation and runoff and may have considerable daily, monthly or seasonal variations. There is a close link between the availability of the run of river water and the performance generation of hydropower plants. With greater variation in the run of river flows the generation will be restricted accordingly, however if the run of river flow is consistent the hydropower generation will also be steady. Figure 19 shows the run of rivers of Pakistan and India, revealing that power generation is determined according to the availability of the river water.

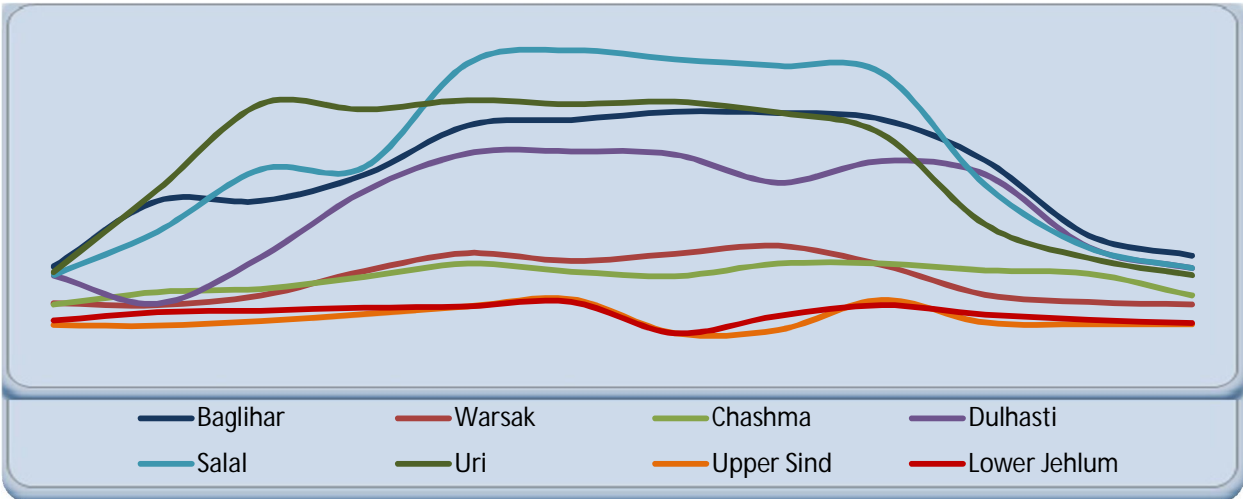


Figure 19 Monthly Performance of Pakistan and India hydropower plants

Sharp monthly variations are observed in Salal, Uri and Baglihar hydropower stations of India. On the contrary Warsak and Chashma hydropower plants have very less variation. Similarly

Dhulasti hydropower plant performed the poorest in the month of February while Upper Sind and Lower Jhelum shows zero performance in July and August months while Jhelum in July month respectively. The Figure 19 clearly indicates the consistent supply of water to Chashma and Warsak hydropower plants as compared to Salal, Uri and Baglihar. Hydropower plants. This shows that these hydropower plants will be dependent on other source for energy during the months their performance is very low to meet the demands. Thus, proving that Warsak and Chashma, though of lower capacity but due to consistent and regular supply of water means they can be used for power generation without any interruption irrespective of the season.

Framework for Hydropower: It is integral to meet the energy needs of Pakistan through self-sufficient projects. Pakistan's vision should be focused on promoting the development of hydropower plants, and move towards a greater share of hydropower in the energy mix by the year 2035. The energy generated by hydropower is expected to increase by a massive 24,000MW by 2035 if the forthcoming projects are completed in time. However, there is a need to further secure the hydro energy potential in order to raise its share up to 50,000 MW to meet the growing demand. Following projects are in the pipeline for future:

Hydel Projected Generation for 2035				
S.No	Project	Resource category	Capacity MW	Commissioning year & province
1	Patrind Hydropower Project	Hydel	147.0	2017-KPK/AJ&K
2	Gulpur Hydropower project	Hydel	100.0	2018-AJ&K
3	Sehra Hydropower Project	Hydel	130.0	2019-AJ&K
4	Suki Kinari Hydropower Project	Hydel	870.0	2020-KPK
5	Karot Hydropower Project	Hydel	720.0	2020-Punjab
6	Azad Pattan Hydropower Project	Hydel	640.0	2022-AJ&K

7	Chakothei-Hattian Hydropower Proje	Hydel	500.0	2022-AJ&K
8	Kohala Hydropower Project	Hydel	1,100.0	2023-AJ&K
9	Lower Palas Valley Hydropower Project	Hydel	665.0	2022-KPK
10	Lower Spat Gah Hydropower Project	Hydel	496.0	2022-KPK
11	Harpo Hydro Power Project	Hydel	34.5	2017-GB
12	Diamer Bhasha	Hydel	4,500.0	2018-GB
13	Keyal Khwar Hydropower Project	Hydel	122.0	2016-KPK
14	Basho Hydropower Project	Hydel	40.0	2015-GB
15	Patan Hydropower Project	Hydel	2,000.0	2020GB
16	MBC-5 & 6 Machai Branch Canal Mardan	Hydel	2,400.0	2018KPK
17	Bezai Canal HPP,Sediment Excluder at MKD-III, Dargai	Hydel	2,320.0	2018KPK
18	Excluder at MKD-III, Dargai	Hydel	750.0	2023KPK
19	Jamal Ghari Irrigation Canal	Hydel	10.0	2022KPK
20	Shah Pasand Kali	Hydel	32.0	2022KPK
21	MBC-13 at Machai Branch canal mardan	Hydel	966.0	2022KPK
22	Matiltan HPP, Swat	Hydel	84.0	2016-KPK
23	Lawi HPP, Chitral	Hydel	69.0	2017-KPK
24	Karora HPP, Shangla	Hydel	9.3	2016-KPK
25	Jabori HPP, Manshera	Hydel	2.3	2016-KPK
26	Koto HPP, Dir	Hydel	8.8	2016-KPK
27	Sharmai HPP, Dir	Hydel	150.0	2017-KPK
28	Shusghai HPP Chitral	Hydel	144.0	2018-KPK
29	Shogosin HPP, Chitral	Hydel	132.0	2018-KPK
30	Ranolia Khwar HPP, Distt	Hydel	17.0	2015-KPK
31	Daral Khwar, HPP Swat	Hydel	36.6	2015-KPK
32	Arkai Gol HPP Chitral	Hydel	79.0	2018-KPK
33	Barikot-Patruk HPP, Dir	Hydel	34.0	2018-KPK
34	Patruk-Shringal HPP, Dir	Hydel	21.0	2018-KPK
35	Shigo Kach HPP, Dir	Hydel	26.0	2018-KPK
36	Ghorband HPP, Shangla	Hydel	14.0	2018-KPK
37	Nandihar HPP, Batgaram	Hydel	10.0	2018-KPK
38	Mujigram Shogohore Chitral	Hydel	51.0	2018-KPK

39	Istaru Buni HPP, Distt Chitral	Hydel	52.0	2018-KPK
40	Balakot HPP, Manshera	Hydel	190.0	2020-KPK
41	Naran HPP, Manhsara	Hydel	210.0	2020-KPK
42	Gharit Swir Lasht HPP, Distt Chitral	Hydel	334.0	2020-KPK
43	Koragah Parit HPP, Distt Chitral	Hydel	223.0	2020-KPK
44	Iaspur Miragram HPP, Chitral	Hydel	133.0	2020-KPK
45	Neelum Jhelum HPP	Hydel	936.0	2016-Aj&K
46	Patrind HPP	hydel	147.0	2019-AJ&k
47	Taunsa Barrage	Hydel	120.0	2020Punjab
48	Mahl Hydro Power Project	Hydel	600.0	2021Punjab
49	5 ADB Funded Package 1 project	Hydel	25.0	2020Punjab
50	5 HPP sites Package 2 Projects	Hydel	55.0	2022Punjab
51	Community based Micro-Hydel	Hydel	1,000.0	2022Punjab
		Grand total	23,455.5	

The GOP needs to adopt a leadership role in creating a climate that is conducive to hydropower industry investment. It has been forecasted by the author that yearly investment required in the hydro sector would be following till 2035 to keep pace with the growing demands. Table below shows invest needed per year in USD million.

Hydro Investment requirements		
S.No.	Year	USD million
1	2015	4,367.0
2	2016	5,163.0
3	2017	5,012.0
4	2018	4,141.0
5	2019	5,537.0
6	2020	6,000.0

7	2021	8,336.0
8	2022	7,674.0
9	2023	6,529.0
10	2024	5,234.0
11	2025	3,239.0
12	2026	2,358.0
13	2027	1,224.0
14	2028	1,224.0
15	2029	735.0
16	2030	705.0
17	2031	555.0
18	2032	986.0
19	2033	859.0
20	2034	2,368.0
21	2035	3,540.0
Total		75,786.0

Moreover, an overall financial analysis of forth coming hydro projects in helpful in deducing the per unit tariff cost of electricity to be generated in the future by them. The table below explains the unit cost of generation from hydro plants for selected years.

Cost of generation from hydro power plants for selected years

Year	USD million						Hydro production GWh	Hydro unit costs US cent /kWh
	Oper. Expense	Depr. Expense	Interest expense	Income taxes	Return on equity	Average revenue required		
2015	146	264	383	381	888	2,061	31,776	6.49
2020	353	390	1,503	841	1,963	5,590	60,028	9.31
2025	1,051	1,859	2,637	1,486	3,468	10,501	165,170	6.36
2030	1,515	2,100	1,984	1,649	3,848	11,082	195,686	5.67
2035	1,842	2,267	2,008	1,872	3,922	12,009	201,800	4.02

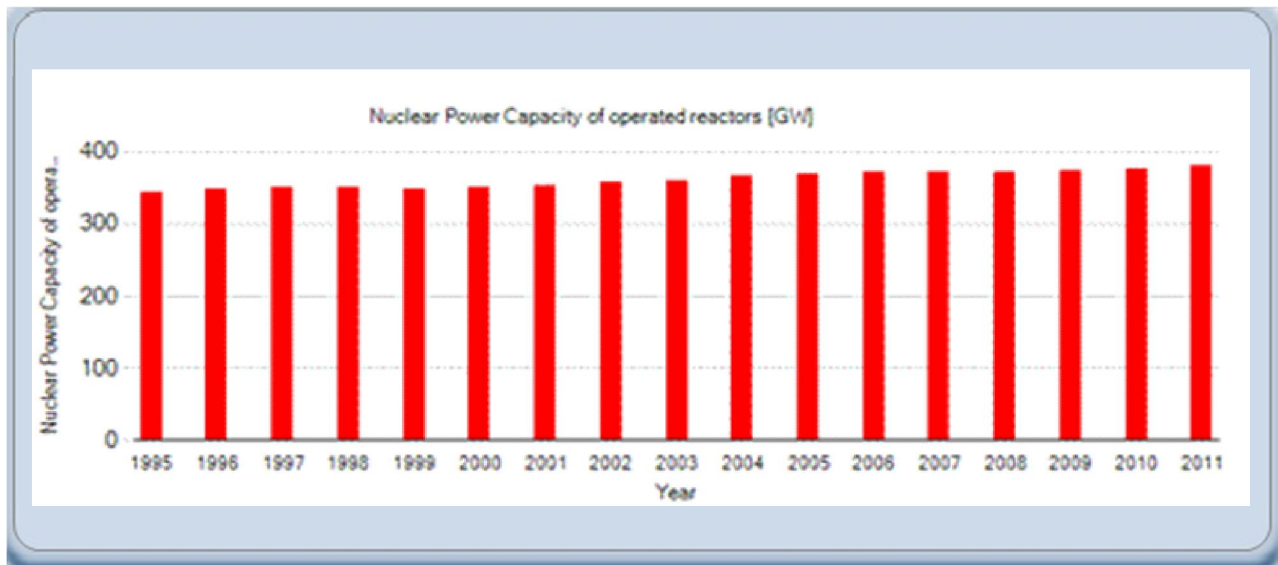
The GOP should take the following steps to make this possible:

- Establish an inventory of hydropower potential, for upgrading or redeveloping existing plants to increase performance; assess feasibility of adding hydropower units to dams originally developed for flood control, irrigation, navigation or drinking.
- Prepare hydropower development plans with targets; and track progress towards meeting these targets.
- Develop and promote a policy framework and market design for appropriate and sustainable hydropower projects (IEA, 2010).
- NUCLEAR

The nuclear technology, obtaining the energy by splitting the atoms of certain elements was developed in 1940. During the World War the initial focus was on producing bombs by splitting the atoms of particular isotopes of either uranium or plutonium. However in 1950s the attention turned to the peaceful purposes of nuclear fission, notably for power generation and

first commercial nuclear power plant came operational in 1950s. The installed capacity of nuclear powered reactors since 1959 to 2011 is given in figure below. The figure identifies a continuous increase in installed nuclear capacity with largest contribution from USA. As USA constitutes 31.2% of world electricity produced through nuclear energy followed by France, Japan and Russia with 15.8%, 10.8% and 6% share respectively⁸¹.

Nuclear Power Capacity of Operated reactors (GW)



As of January, 2013 437 nuclear power plant units with an installed electric net capacity of about 372 GW are in operation in 31 countries(See Figure 19) and 68 plants with an installed capacity of 65 GW are under construction in 15 countries. These nuclear powered reactors are providing 13.5% of world’s electricity as continuous and reliable base load power.

⁸¹Nuclear Power Plants, Worldwide, <http://www.euronuclear.org/info/encyclopedia/n/nuclear-power-plant-world-wide.htm>, retrieved on July 10th, 2013.

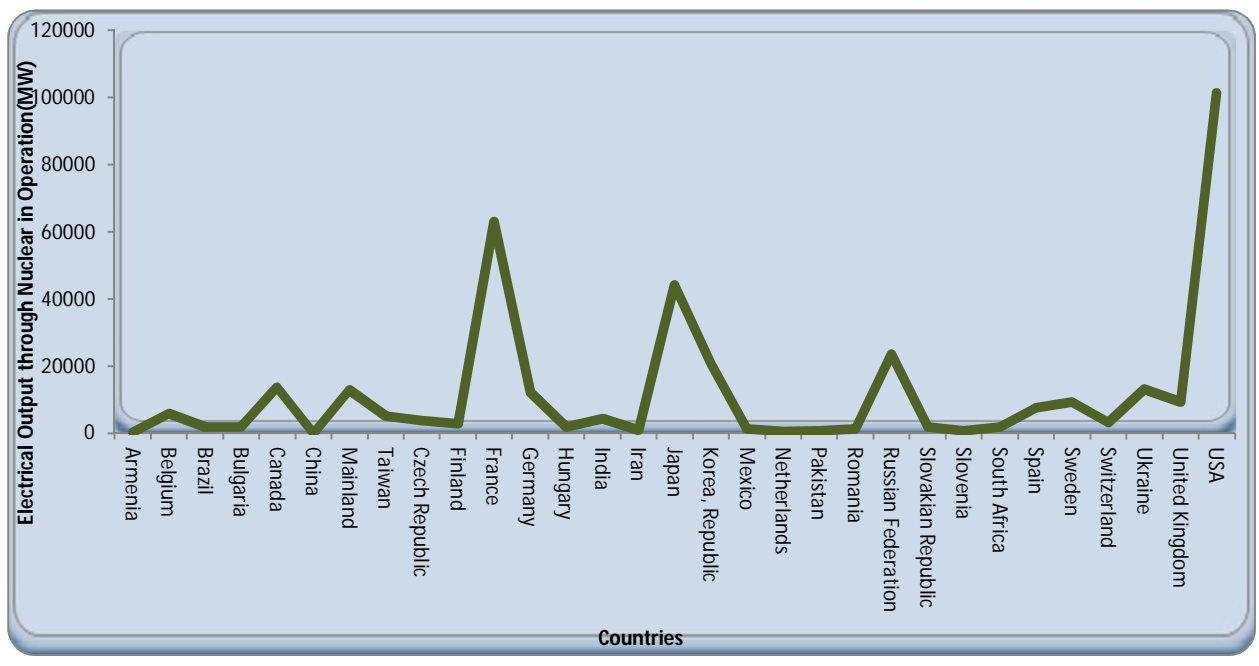


Figure 20: Different Countries Electrical Output Through Nuclear

It is expected that the increasing trend of nuclear powered reactors will be followed in near future and would be centered in Asian countries⁸².

Keeping in view the current energy demand and improvement in efficiency of nuclear power plants, Pakistan has targeted to generate 8800 MW through nuclear energy by 2035(see Figure 20). As nuclear power is load based electricity generation option and helps to enhance the security of supply⁸³. Moreover, nuclear power lead to suitable electricity pricing as compared to their fuels due to low fuel cost share in electricity generation i.e. 10-15% in case of nuclear as compared to 20-45% in coal, 50-70% in case of gas and 60-80% in oil.

⁸² Nuclear Power Today, <http://www.world-nuclear.org/info/Current-and-Future-Generation/Nuclear-Power-in-the-World-Today/#.Udp3Evn7Bic>, retrieved on July, 10th, 2013.

⁸³ International Atomic Energy Commission, Nuclear Energy Scenario of Pakistan, A presentation made in International Seminar on National Safety and Security, Islamabad, 2011.

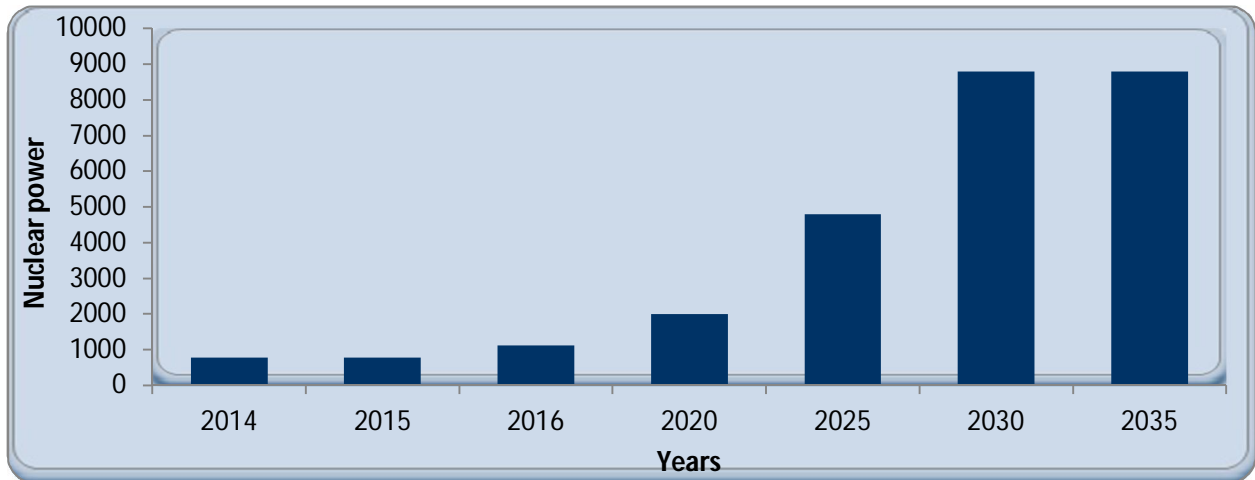


Figure 21: Nuclear Power Generation over the Years

As provision of electricity at affordable rates is the prime mandate of this strategic framework, therefore, it has been suggested to add at least 8800 MW of nuclear power in national grid keeping in view the nuclear power expansion in France, Russia and Asia.

II. RENEWABLES

a) Waste to power

Waste-to-energy (WTE) or energy-from-waste (EFW) is the process of creating energy in the form of electricity or heat from the incineration of waste source. Most WTE processes produce electricity directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels. It is estimated that one ton of combusted biomass reduces oil use by about 45 gallons; or coal use by about 0.28 tons.

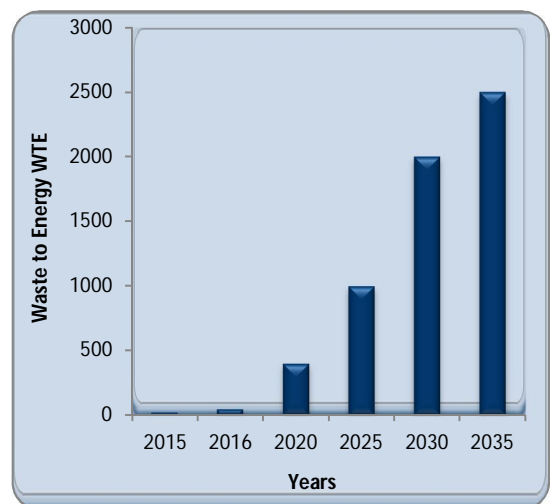


Figure 22: Roadmap of Waste to Wind Energy

Globally, 130 million tons of waste is combusted annually in 600 WTE facilities that produce electricity and steam for direct heating and recovered metals for recycling. Currently, the European nations are recognized as global leaders of the WTE which is followed by Asia Pacific region and North America respectively⁸⁴.

Major cities of Pakistan have the potential to generate electricity from this waste. In this regard, KESC as part of its fuel diversification and sustainable development vision has initiated the World's largest and Pakistan's first Waste to Power Project near Landi cattle colony in Karachi. The potential of this Waste to Power project is 22 MW fueled from biogas alone. It is estimated that this project would not only generate 22 MW of green power but will also produce 300tons/day of organic fertilizer as a meaningful byproduct. This fertilizer has special application for eroded soil and generation of energy in environment friendly manner would also help to earn significant amount of carbon credits. Thus, keeping in view the economic viability, it has been proposed not only to expedite this project and make it operational by 2014 but also replicate this idea in other mega cities and add approximately 2500 MW in national grid through this source, as targeted by AEDB(See Figure 21). The jobs generated against the subsequent additions in WTE installed capacity is given in Annex.

b) Power generation via biomass

Biomass refers to the organic materials which undergoes the process of combustion or conversion to generate energy. The biomass sources include bagasse, wood chips, nut shells, sewage sludge, olive pipes, bone meal, leather waste, animal litter, oil seed rape husks and rice and corn husks. Biomass may be used either directly or indirectly. The direct use refers to

⁸⁴ Insight to WTE Industry, <http://www.ecomena.org/tag/waste-to-energy-market/>, retrieved on July 8th, 2013

direct combustion and energy generated is used for cooking and heating whereas the indirect use refers to more advanced use of biomass including gasification and electricity generation. The global installed capacity of biomass power generation in 2010 was between 54,000 MW and 62,000 MW thus representing 1.2% of the total global power generation capacity and providing around 1.4% to 1.5% of global electricity production. The 85% of this global installed biomass power generation capacity is in Europe, North America and South America. Pakistan has recently taken initiative in this

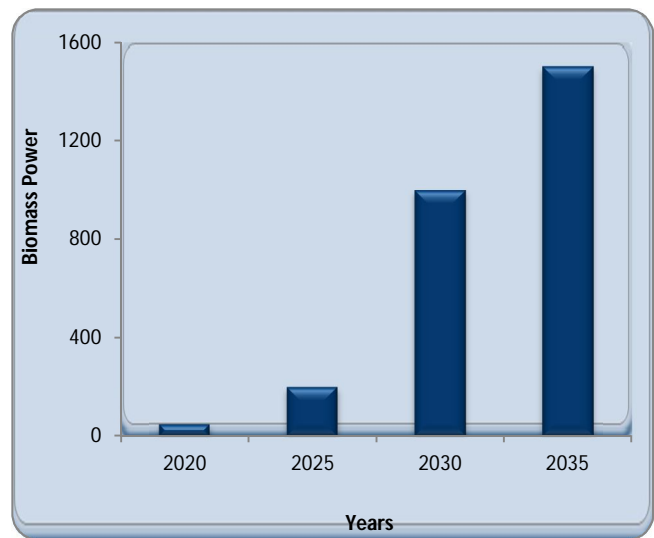


Figure 24: Roadmap of Bagasse Cogeneration

regard by approving tariff of two projects of 24 MW, 12 each by SSJD and Lumen Energia

in Sind and Punjab respectively. Keeping in view, this positive initiative and prospective potential for agricultural country like Pakistan, it has been proposed in this strategy to harness this potential constructively and add approximately 192 MW by 2035(See Figure 22).

It is proposed that private sector should be involved in this regard and these projects are not only economically viable in terms of tariff as compared to oil but also involves local people and creates employment opportunities (directly and indirectly).

In addition to power generation through biomass, it has been proposed to utilize the bagasse, a byproduct of sugar mills with coal and install a cogeneration plant. A cogeneration plant power plant with conventional steam turbine technology would be installed alongside of sugar mills.

The scheme is based on dual fired boiler and a turbo generating set. The boiler will be designed for steam generation to meet the steam requirement during season and off season operations. The boiler shall be capable to burn bagasse-coal mixture during season and will run 100% on coal during off season. The bagasse will be supplied from nearby sugar will during season and coal used during and off season will be either imported or local. It is proposed to accelerate the cogeneration projects in line and add 525 MW in national grid by 2016(See Figure 23). The economic activity created through co-firing bagasse with coal.

c) Power generation through Biogas

Biogas refers to the gas produced after organic material is fermented in the absence of air with the help of bacteria, in a process that is known as “Anaerobic fermentation.” The gas content is mostly methane, and occurs naturally. However, it can also be produced in a digester, and the process takes about 15 days to convert to methane. The process is renewable and greener energy, and animal and human waste is excellent feedstock for biomethanation, as it is available in bulk⁸⁵.

All around the world, biogas is being explored as an alternative energy source. The largest biogas program in the world is in China, with over 25 million⁸⁶ households using biogas. China’s regulatory framework and policies in renewable energy, such as subsidies helped the growth of biogas in China. To support the development of renewable energy resources, China adopted multiple strategies⁸⁷ in fostering its market (including protection of industries), exploitation of resources, technical support, improving pricing mechanisms, cost sharing etc.

Biogas plants in India were experimentally introduced in the 1930⁸⁸ and now more than four million biogas plants have been installed. According to a UNEP report, India will witness the creation of around a million jobs in the biogas sector alone by 2012.

In Nepal, over 140000⁸⁹ domestic biogas plants have been installed since 1992. What has been particularly effective in Nepal is workshops on the manufacturing process of biogas appliances and over 62 construction companies for biogas are operational in Nepal. The biogas projects are further helped by good financing mechanisms by more than 140 microfinance⁹⁰ institutes for smaller loans. The social impact of biogas projects is a better life for more than 800000⁹¹ people. In fact, an average household saves by the reduced use of firewood.

⁸⁵ Mital, K.M., 1997, Biogas Systems: Policies, Progress and Prospects

⁸⁶ Abbasi, T., Tauseef, S.M., Abbasi, S.A., “A Brief History of Anaerobic Digestion and “Biogas,” Biogas Energy, Environmental Science, Vol. 2, 2012, pp. 11-23

⁸⁷ Ibid.

⁸⁸ Sewage Purification Station at Dadar in Bombay, Indian Agriculture Research Institute, New Delhi.

⁸⁹ Abbasi, T., Tauseef, S.M., Abbasi, S.A., “A Brief History of Anaerobic Digestion and “Biogas,” Biogas Energy, Environmental Science, Vol. 2, 2012, pp. 15.

⁹⁰ Ibid.

⁹¹ Ibid.

Similarly, in Bangladesh, the biogas technology program was undertaken in Bangladesh in year 1999, with 5000 digesters installed. Now over 36000⁹² biogas plants have been installed, and are functioning well⁹³.

The table below shows the progress of some South Asian countries in biogas:

Table 11 - Source: Abbasi, T., Tauseef, S.M., Abbasi, S.A., "A Brief History of Anaerobic Digestion and "Biogas," Biogas Energy, Environmental Science, Vol. 2, 2012, pp. 11-23

Biogas Plants in South Asia				
	Pakistan	India	Nepal	Bangladesh
Estimated Potential in Million	57 ⁹⁴	10.7	1.9	3
Unit Installed	4875	4067345	204069.	34,484⁹⁵
Achievement %	0.087	37.97	11	1.15

In the rural areas of Pakistan, *gobar* from livestock is widely used. However, that process is not as energy efficient as its conversion to biogas before usage. As Pakistan ranks 13th in cattle population and is the fifth largest milk producer in the world. Livestock and livestock products are a good source of cash income (43%) at the national level followed by 34% in remittances and 20%⁹⁶ in crops. Although the biogas technology has been introduced in 1974, so far only 4867

⁹²Abbasi, T., Tauseef, S.M., Abbasi, S.A., "A Brief History of Anaerobic Digestion and "Biogas," Biogas Energy, Environmental Science, Vol. 2, 2012, pp. 16.

⁹³ Abbasi, T., Tauseef, S.M., Abbasi, S.A., "A Brief History of Anaerobic Digestion and "Biogas," Biogas Energy, Environmental Science, Vol. 2, 2012, pp. 11-23

⁹⁴ Authors work based on Livestock Census 2006

⁹⁵Talukder, M.F 2009, "Impact assessment of biogas plants: A case study in Bangladesh

⁹⁶Bajgain, S., Pandey, B., 2007, "Feasibility Study of Domestic Biogas in Pakistan," UNDP, Winrock International, SNV,

Biogas units have been commissioned as far as against the potential of five million biogas plants⁹⁷, as shown in the calculation below.

Table 12: Calculation of potential of household biogas plants based on cattle and buffaloes (Source: Bajgain, S., Pandey, B., 2007, "Feasibility Study of Domestic Biogas in Pakistan," UNDP, Wincrock International, SNV)

Particulars	Number of Household
Total households with cattle/buffalo	10 million
Households with only one cattle/buffalo	(2 million)
Households unsuitable for biogas since they are served by natural gas supply or likely to be, low temperature, insufficient water or land	(3 million)
Total biogas potential households	5 million

However, the Rural Support Program Network (RSPN) has developed a plan to set up 300,000⁹⁸ biogas plants across Pakistan. The first module of PDBP, aims at 14,000 biogas plants being setup in Central Punjab and so far, RSPN installed 1172⁹⁹ plants built in eight districts. This is an on-going project of Rs. 356 million with a Dutch grant¹⁰⁰. More recently, the Alternative Energy Development Board issued a letter of intent to Pak Ethanol private for a biogas plant of 9 MW in Matli Sindh¹⁰¹.

⁹⁷ Bajgain, S., Pandey, B., 2007, "Feasibility Study of Domestic Biogas in Pakistan," UNDP, Wincrock International, SNV,

⁹⁸ RSPN Development Plan

⁹⁹ Website RSPN http://rspn.org/our_projects/pdbp1.html

¹⁰⁰ Ministry of Finance, 2014, "Economic Survey of Pakistan," pg. 201

¹⁰¹ Ibid.

Biogas potential is determined by availability of animal dung and water, warm temperature, availability of construction materials, land and availability of human resources for plant construction. According to the Economic Survey of Pakistan, livestock contributes to 55.9 percent in agriculture, and the population of cattle is over 39.7 million¹⁰².

Table: Total Population of Cattle in Pakistan¹⁰³

Livestock in million	Cattle	Buffalo	Sheep	Goat	Camel	Total
Livestock Census 2006	29.6	27.3	26.5	53.8	0.9	138.1
Economic Survey 2013-14	39.7	34.6	29.1	66.6	1	171

It is estimated that some 10 million households in the country keep these animals. In the Pakistan the cattle are estimated to produce an average of 15- 20 kg of dung every day. In terms of construction, the materials are easily available, and Pakistan’s road networks are also well-developed to facilitate the construction phase. While calculating the potential number of household biogas plants, the feasibility reports from WINROCK and UNDP suggest two adult cattle/buffaloes per household, but in practical application, about 30% households are not feasible for biogas because of ready access to natural gas in the region acting as a deterrent.

Other factors can include low temperatures in the winter months and lack of water. Taking into account the above parameters, the study conducted by WINROCK and UNDP estimated that at least 5 million biogas plants can be installed in Pakistan, based on cattle/buffalo dung. The potential was calculated to be 1147.75 million cubic feet per day, but the author’s calculations estimate the potential to be closer to 688.65 million cubic feet per day. This number may be increased if horses, mules and poultry waste is included. The Authors estimates suggest that biogas will lead to the creation of jobs all across the biogas supply chain, from manufacturing to construction and operation and maintenance etc.

¹⁰² Ministry of Finance, 2014, *Economic Survey of Pakistan*, Pg. 37

¹⁰³ Ibid.

	Total employment generated
Year 2020	2.28 million
Year 2030	1.71 million

Employment generation in biogas¹⁰⁴

Netherlands Development Organization (SNV) and UNDP carried out a study in central Punjab on feasibility of a household biogas program in the country in 2007¹⁰⁵. Some problems that were faced were due to lack of proper training, according to the study. No regular feeding

In the feasibility analysis, it was anticipated that training and orientation on operation and maintenance would be necessary for the success of biogas projects in Pakistan. The importance of regular feeding and monitoring will have to be underscored. Other barriers to the development of biogas may include improper water-dung ratio, ignorance of users on feeding-requirements, improper use of main gas valve, zero maintenance of defective parts etc. The study also suggested that investment was slow in domestic biogas projects because of expensive floating drum design, which was adversely affected by an increase in the price of steel. Moreover, the market was limited to subsidized digesters or those constructed by NGOs in rural communities. In fact, a lack of organization of demand and supply sides of biogas was considered a barrier in the large-scale development of biogas projects in Pakistan.

¹⁰⁴ Ministry of Finance, 2014, *Economic Survey of Pakistan*, Pg. 37

¹⁰⁵ Bajgain, S., Pandey, B., 2007, "Feasibility Study of Domestic Biogas in Pakistan," UNDP, Wincrock International, SNV,

An analysis of Pakistan’s Renewable Energy Policy 2006 shows that biogas was not a significant target of the government in previous years, as it was only briefly mentioned in connection to the effect of subsidies. Biogas will have to be properly organized to encourage greater investment in biogas projects.

d) Power generation through Low Btu gas

In Pakistan, Uch Power (Private) Limited (UPPL) set precedence, when the company installed 586 MW ‘Low, BTU gas’ based thermal power plant in Dera Murad Jamali, District Naseerabad in the province of Baluchistan. The plant is utilizing low BTU gas of Uch Gas Field (UGF) having heating value only 425 Btu/Kwh⁸². In 2010, the power

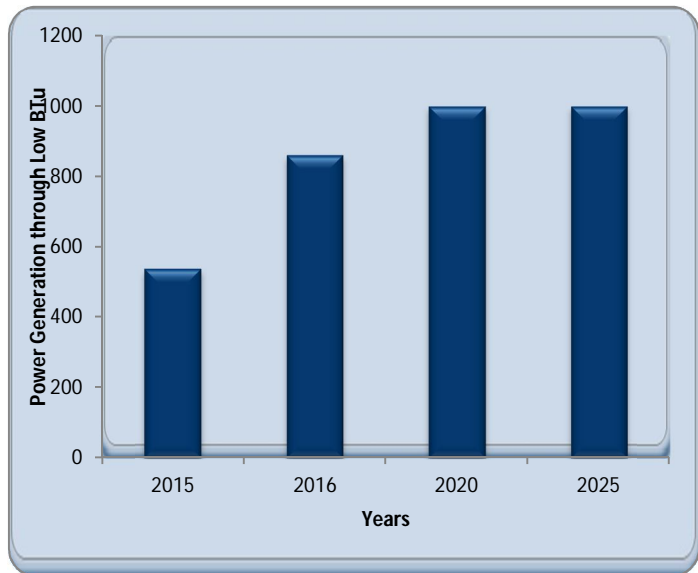


Figure 25: Roadmap for Power Generation through Low Btu

plant generated 422183 GWh of electricity, and its average fuel cost was PKR 2.22 per unit, and the overall cost of generation was PKR per 5.07 Unit, while the gas consumed to generate one unit of electricity was only 7.71 Cubic Feet. It is estimated that Pakistan is having approximately 6TCF low BTu gas reserves having heating value of less than 500 Btu/Kwh. It has been proposed in this strategy to replicate this model of Uch power plant accelerate the progress of Low Btu projects under development and add approximately 798 MW by 2035(See Figure 24).

a) Power generation through Geothermal energy

Most of the high enthalpy geothermal resources of the world are within seismic volcanic activity. A global seismic belt passes through Pakistan and the country has long geological history of geotectonic events.

Keeping in view the availability of geothermal energy, it has been proposed

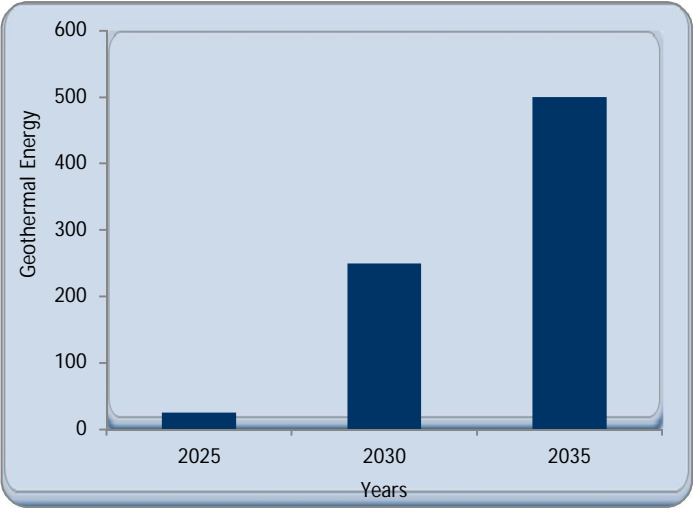


Figure 26: Roadmap of Geothermal Energy

to promote the installation of decentralized units by involving private sector as done in Indonesia and determine a feed in tariff for purchasing power from these decentralized units by GOP and should come up with at least 500 MW by 2035(See Figure 25).

III. WIND

In recent times, harnessing the potential of wind power on a commercial scale has emerged as the fastest growing energy technology and world-wide wind capacity has reached 282275 MW in 2012 (See Figure 26 below).

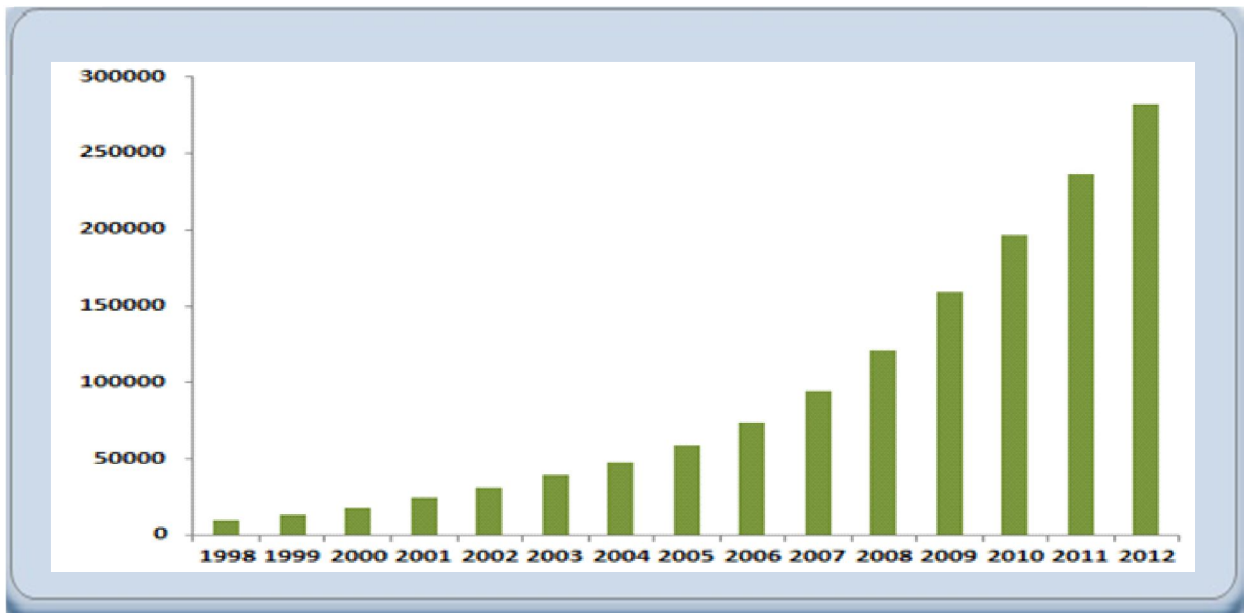
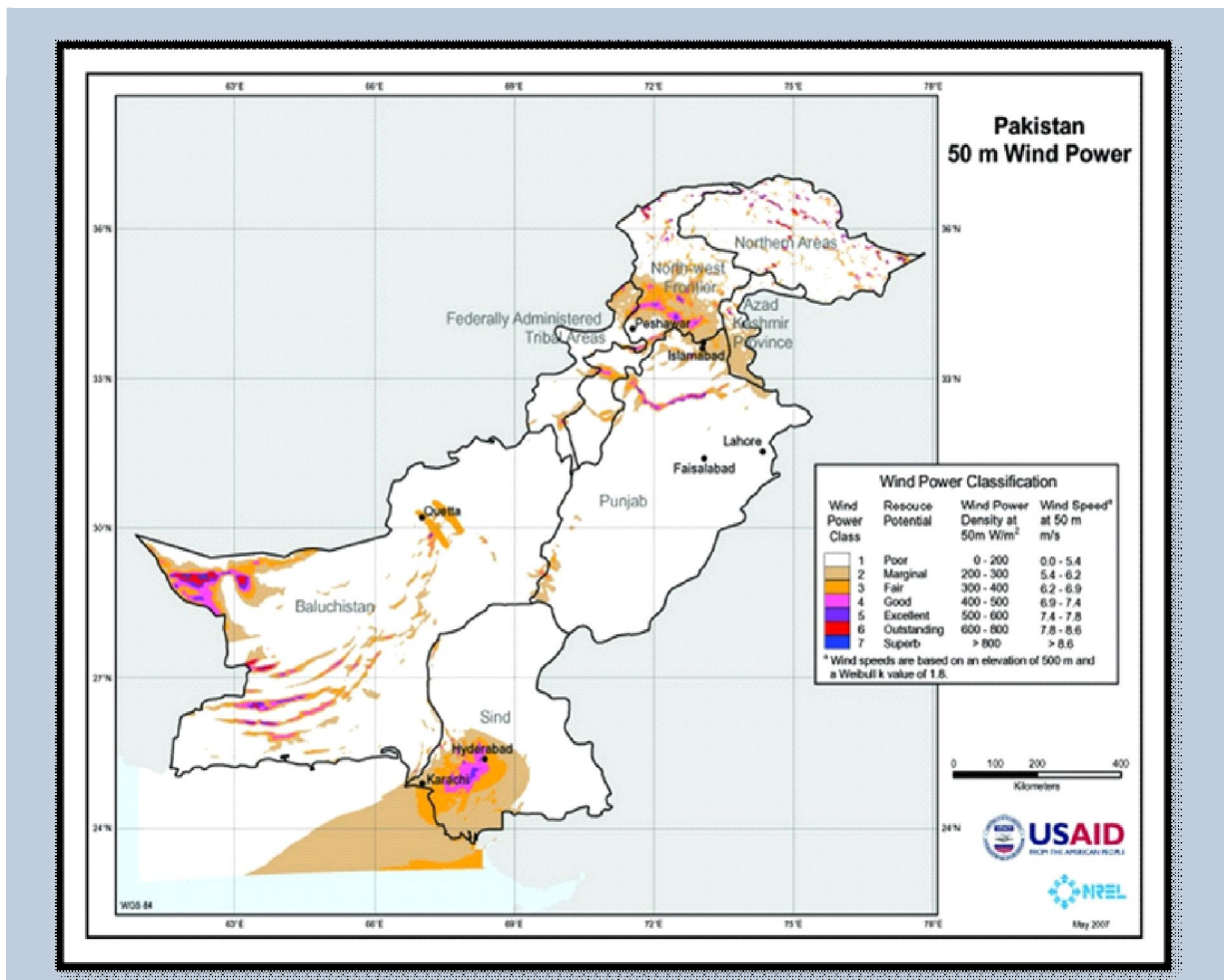


Figure 27: World-wide Wind Installed Capacity

It is estimated that the average annual growth rate for developing wind energy in 2012 was 19.2%, the lowest in more than a decade and all wind turbines with installed capacity of 282275MW were able to generate 580 TWH per annum which is more than 3% of the global electricity demand. It is estimated that Asia accounted for largest share of new wind power installations i.e. 36.3% followed by North America, 31.3% and Europe 27.5%. However, Latin America stood for 3.9% and Australia/Oceania for 0.8% and Africa is still a tiny wind market with 0.2% share in these new installations.

Wind Energy in Pakistan

According to estimates, Pakistan has been endowed with a great potential for the generation of energy through wind with the velocity of wind in certain areas of the country strong enough to run turbines and consequently generate power. The country lies in the region's trade wind corridor which presents a unique opportunity to utilize the priceless potential for energy generation through wind.



¹⁰⁶ The wind map for Pakistan has been developed by National Renewable Energy Laboratory (NREL), USA in collaboration with USAID

The wind map of Pakistan developed by National Renewable Energy Labs(USA) identified that wind with good to excellent speed is available in many parts of Pakistan and estimated the total wind potential of about 340,000 MW(See Figure). However Pakistan has only recently ventured into the field of wind technologies and to date has no significant large scale wind generation project in operation. In 2010, the preliminary wind potential has been calculated as 346, 000 MW. ⁱ Nevertheless, the energy generation through wind power in Pakistan in 2013 stands around 384,000KWh through Zorlu wind power project.

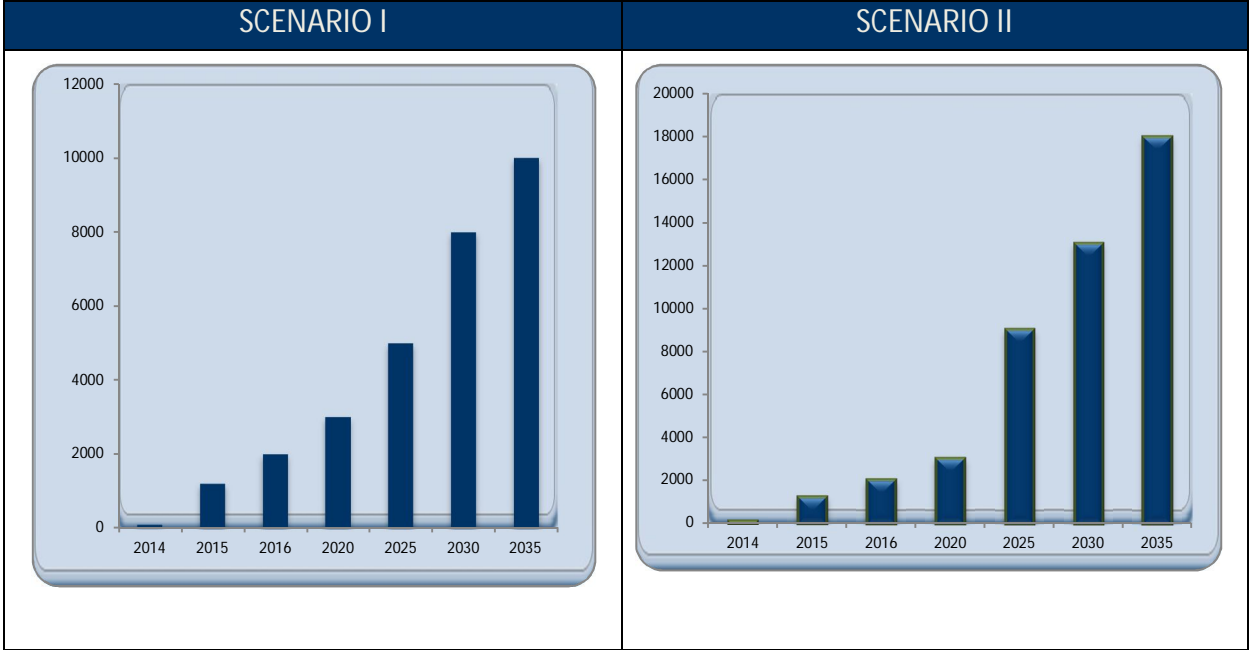
Road Map for Wind Energy Projects:

In purview of wind potential in Pakistan and objectives of maximizing the indigenous resource potential, the current strategic framework has at first proposed to expedite the wind powered projects and connect them to grid as soon as possible. It is recommended to complete the projects no longer than 2016. Thus through commissioning of these projects on time, the wind energy would be able to add 904 MW in 2016. It is noteworthy here that two scenarios have been proposed in this regard. The Scenario I projects the wind power installations of 10,000 MW by 2030, provided that wind energy has now matured in Pakistan and physically all the commissioned projects have been completed and need to be connected to the national grid¹⁰⁷. This wind power installation of 10,000 MW has been projected if the exploration and development of shale gas began in 2025 as it has been predicted worldwide that shale gas boom would surpass the renewable energy development¹⁰⁸.

¹⁰⁷ Arif Allaudin, Managing Director, ENERCON, July, 8th, 2013

¹⁰⁸ IEA,

However, in case if we would not have been able to develop this alternate gas resource provided the lack of availability of technology in Pakistan, then, wind power installation would touch the figure of 18,000 MW(Scenario II), thus possessing 14% share in electricity generation mix.



The development of wind energy for power generation is also source of generating direct and indirect employment and jobs generated through subsequent wind power installations since 2014 to 2035.

The Gharo Ketu Bandar Wind Corridor, in South of Pakistan with wind potential of 50,000 MW is considered as an attractive option for investors. It is estimated that wind speed on the coastal line of Sind and Baluchistan and Gharo wind corridor stands on average between 5-7m/s.

The monthly wind speed, at Gharo wind corridor, with reference to height, is given in Table below:

Table Monthly Benchmark Wind Speeds for Khuttikun and Bhanbhore sites at Gharo

Month	Monthly Benchmark Wind Speed			
	30m	50m	60m	67m
January	4.70	5.10	5.20	5.30
February	5.10	5.40	5.50	5.60
March	5.30	5.70	5.80	5.90
April	7.00	7.30	7.40	7.60
May	8.90	9.40	9.60	9.70
June	10.30	10.90	11.10	11.20
July	8.40	8.90	9.00	9.20
August	9.30	9.80	10.00	10.20
September	7.60	8.10	8.20	8.30
October	4.30	4.60	4.70	4.70
November	3.80	4.10	4.20	4.30
December	4.60	4.90	5.10	5.20
Annual Avg.	6.60	7.00	7.10	7.20

Thus, the Gharo wind corridor, due to excellent resource potential, wind speed and close proximity to load centers and national grid serves as the most attractive option for investors. But unfortunately, at present only 0.75 MW of wind power capacity has been connected to the grid while 18 wind power projects of 50 MW each are underway.

WHY NOT TO HARNESS THE WIND POWER POTENTIAL IN PAKISTAN

The total wind power installed capacity in India as on 2012 stands around 2300MW. But the average wind speed in India except Kerela, Karnatka and Tamil Nadu is not greater than 5 m/s at 50 m which is far less than average wind speed of 7m/s available at wind corridors in Pakistan. It is significant to highlight here that wind speed is directly proportional to energy generation and capacity factor and inversely proportional to tariff. It is estimated that in Kerela, Karnatka and Tamil Nadu, where the wind speed is around 7m/s, the capacity factor is greater than 17% and tariff ranges between 3.5-3.7 INR/Kwh. On the other hand, in other states of India, where the speed is not greater than 5m/s, the capacity factor is not greater than 15% and tariff ranges between 4.2-4.5 INR/Kwh. Moreover, the Gwh/MW ratio in India is not greater than 1.5 whereas in Pakistan it is around 2.5. Therefore, keeping in view the available resource potential and wind speed, it is pertinent to ask here that why we lying far behind in harnessing this potential and capitalizing the benefits associated with this resource.

It is unfortunate that wind speed in Pakistan is greater in summer season as compared to winters as is the case with hydropower. The wind energy would have been even more beneficial by many folds if had available during winter season when hydropower is not available. However, in purview of present scenario and GWh/MW ratio which in case of hydropower is around 4.5 as compared to 2.5 in case of wind power, it is strategically recommended to harness the hydropower on priority basis provided its multiple benefits followed by development of wind and other renewable sources of energy.

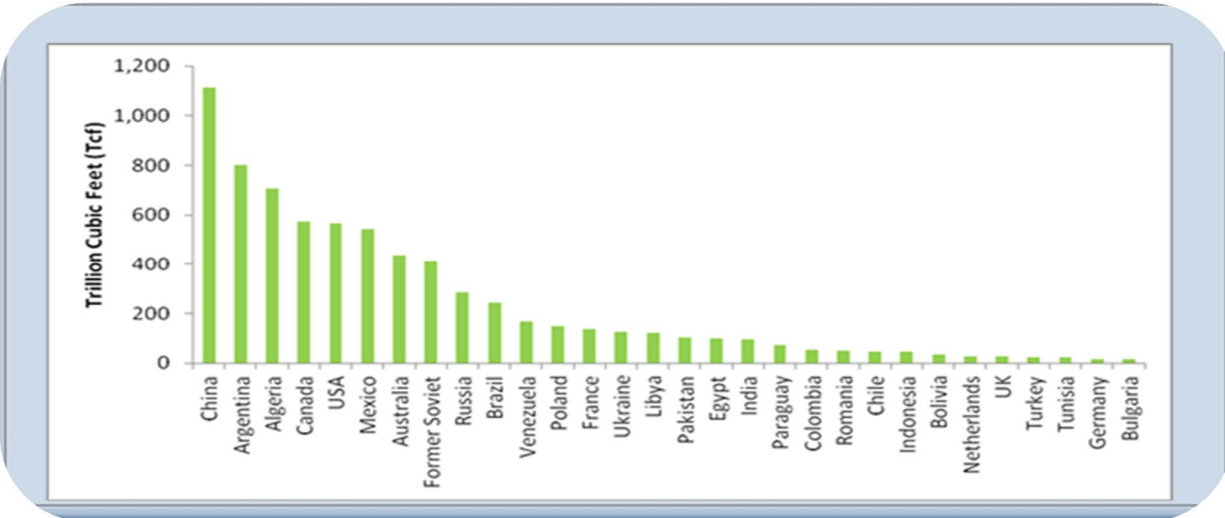
V. SHALE GAS

Background: Shale gas is the natural gas which is extracted from shale rock formations. It is one of the unconventional sources of natural gas while other unconventional sources include like coal bed methane etc.¹⁰⁹ The shale gas reservoirs are different from conventional gas reservoirs as shale acts as both source for the gas and also the zone, known as reservoir, in which the gas is trapped. Hence, it is titled unconventional gas. The commercial exploitation and drilling of this gas has been made possible with the advancement of technology. The following sections discuss the current scenario of shale gas worldwide and the potential and rationale of shale gas in Pakistan.

Global Scenario: In 2013, the US DOE's Energy Information Administration (EIA) evaluated and identified 137 shale formations in 41 countries outside US¹¹⁰. The report "Technically Recoverable Shale Oil and Shale Gas Resources" highlighted the geochemical characteristics of these shale formations and quantified technically recoverable reserves in shale formations across the globe. Figure 10 shows the global recoverable shale reserves.

¹⁰⁹ Regeneris Consulting, 2011, Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK, www.regeneris.co.uk, Regeneris Consulting Ltd,

¹¹⁰ US Energy Information Administration (EIA). (2013). *Technically Recoverable Shale Oil and Shale Gas Resources*. US Department of Energy



As shown in Figure 10 and according to the EIA assessment it has been identified that globally, the risked Shale Gas in place ranges from 30,000 - 31,138 Tcf while technically recoverable resources are estimated to be around 7,299 Tcf . Currently, the US has been leading the world in shale exploration. A natural gas boom through the development of Shale plays in US has revolutionized global energy politics and abundant natural gas obtained through unconventional methods has created a deep impact on the structure and dynamics of natural gas markets. The Shale Gas revolution in the US has not only increased gas availability but has also created employment opportunities at a massive scale and also lured foreign investment.

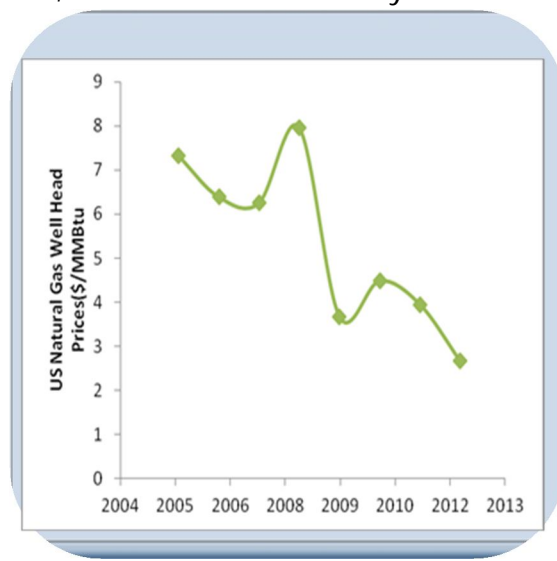


Figure 28 US Natural Gas Well Head Prices

Inspired by the economic impact and growth driven by shale gas in the US, other countries outside the North America are now actively pursuing the development of unconventional resources to decrease their dependence on oil imports. However, China and Poland are the only countries outside North America which have been successful in producing natural gas through shale plays. Nevertheless, countries like Argentina, India and Mexico are striving to develop these unconventional beds yet they face several challenges in doing so.

It is estimated that shale oil and gas production has decreased the well head prices of natural gas from nearly US\$8 per thousand cubic feet(MMBtu) just before the Shale Gas revolution in 2008 to around US\$2.66 per thousand cubic feet (See Figure). This has led to a 10% decrease in electricity prices. There has also been a considerable decrease in US natural gas prices which has prompted electricity generators to switch to gas from coal. The US gas is trading at \$ 4 per MMBtu¹¹¹ , which is 2.5 times cheaper than the rate in Europe and four times cheaper than the rate in Asia. Power production through coal, which is easy and cheap to transport, has declined sharply due to its competition with Shale Gas.

In Europe where the coal prices were predicted to be around \$100 and \$130 per ton¹¹² , the prices are standing around \$80 per ton. It is estimated that US coal which is unwanted at home is increasingly finding its way to European markets, where it has displaced more expensive gas as feedstock for power stations¹¹³ . Europe has increased coal power generation and substituted natural gas with coal in power generation. This trend has emerged due to low coal prices of imported coal primarily of US origin as compared to the prices for natural gas. The UK is one of the European countries where coal is being used as feedstock for power stations and this has significantly increased Green House Gas Emissions (GHGs), estimated to be more than 3% in 2012¹¹⁴ . However, many experts believe that coal's European revival will be short lived, and that it is essentially the last gasp of a fuel with no long-term future.

Moreover, the revolution has also provided immense opportunities to the US, as it has now become an exporter of Liquefied Natural Gas (LNG) through the Gulf of Mexico, which was originally designed for importing natural gas to US. The flooding of natural gas due to abundance of gas available at cheaper rate has led to discount in LNG prices as compared to oil indexed LNG prices. The current margin between North American gas on gas and oil indexed prices is driving the Asian LNG buyers to go for cheaper option. Moreover, the move to secure

¹¹¹ Rutsaert,N and Vergine,E.(2013). The Ongoing Shale Gas Revolution. DEXIA Asset Management

¹¹² Ibid.

¹¹³ U.S. Energy Information Administration(EIA).(2013). US Coal Exports. Quarterly Coal Reports, January-March 2013

¹¹⁴ World Wild Life Fund(WWF).(2013). Parliamentary Briefing: Is There really a Coal Renaissance in EU.WWF UK. Panda House,Weyside Park

the Henry Hub prices is an attempt by Asian buyers to put pressure on existing suppliers to move away from oil indexed contracts¹¹⁵.

Shale Gas in Pakistan: Pakistan has more than 827,365 Km² sedimentary basin area (611,307 Km² Onshore & 216,058 Km² off shore) against the total area of 796,095 Km²¹¹⁶. This sedimentary area is enriched with thick sequence of shale formations as a source and has proven petroleum system.



Figure 28: Pakistan’ Shale Gas Resources (Source: Pacwest Consulting Partners, 2011)

¹¹⁵ LNG Unlimited.(2013). LNG Journal

¹¹⁶ Sedimentary Area in Pakistan.(2010). Internal documents of Ministry of Petroleum and Natural Resources(MPNR).

A significant amount of gas has been trapped within the unconventional reservoirs including Tight Gas, Coal Bed Methane and Shale Gas apart from oil and gas resources within the conventional reservoirs¹¹⁷. The conventional gas reservoirs have been explored and developed in Pakistan, however very little work has been done so far in developing these unconventional reservoirs. It is estimated that apart from proven conventional gas reserves, the country has been bestowed with approximately 200Tcf of unconventional gas resources within the shale formations¹¹⁸. The studies conducted by PacWest Consulting Partners(2011) has identified that approximately 70%¹¹⁹ area of Pakistan is covered by Shale Gas(See Figure below).

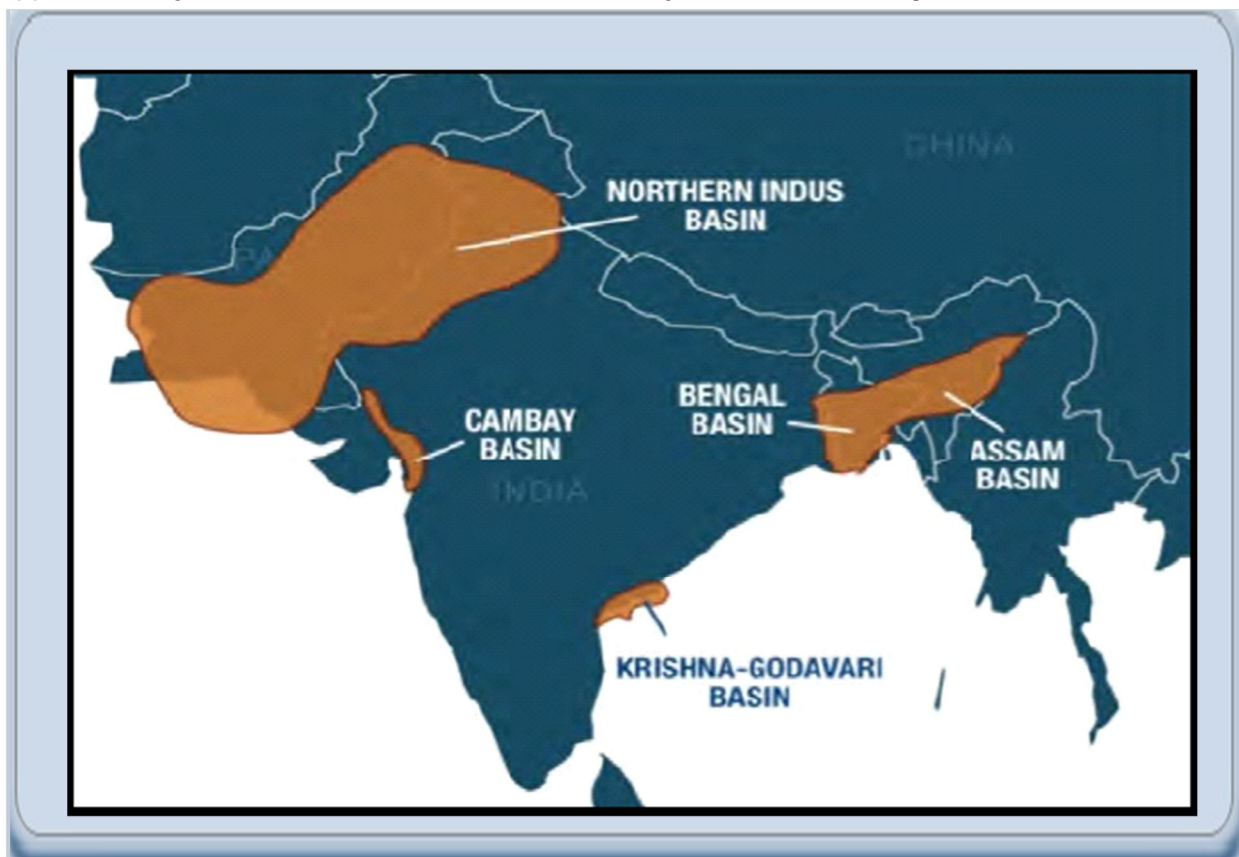


Figure 29: Pakistan’ Shale Gas Resources (Source: Pacwest Consulting Partners, 2011)

¹¹⁷ Ibid

¹¹⁸ Unconventional Resources in Pakistan.(2012). Internal Documents of Ministry of Petroleum and Natural Resources (MPNR).

¹¹⁹ Assessment of Unconventional Resources in Pakistan.(2011). PacWest Consulting Partners

The study highlights that shale has been distributed throughout the upper, middle, lower Indus, Baluchistan and Offshore basins as thick sequence. It is estimated that most of the shale resources are in mature stage for hydrocarbon generation and are estimated to be thicker than the shale plays in North America. Therefore these shale resources in Pakistan have potential to become good resource play. Jadoon (2011) in his study on Sembar, Ghazij and Talhar formation identifies that Pakistan on average has Shale Gas ranging from 180-210 Tcf.

The Exploration Department in Pakistan is also concerting their efforts towards harnessing this resource potential and they are especially focusing on shales of Lower Goru Formation namely Turk Shale, Badin Shale, Jhole Shale, Upper Shale, Shales of Middle Sands, Lower Shale, Shales of Basal Sand, Talhar Shale and Shales of Massive Sands in Lower Indus Basin. It is estimated that based on the available data(mu log, gas logs, wireline logs and geochemistry), most of the shales indicate encouraging results regarding Shale Gas, Shale Oil, Oil Shale and Tight Gas Potential¹²⁰.

In addition to the aforementioned formations, initial work regarding wells for Shale Gas, Shale Oil, Oil Shale and Tight Gas has been started on Patala, Chichali, Datta, Kingriali, Mianwali, Dandot/Sardhai, Kussak, Shales of Salt Range (upper Indus Basin), Warchha, Sembar, Shales of Lower Goru(Middle Indus Basin), Shales of Rakhshani, Wakai, Kharan, Hosab and Panjgur Formations(Baluchsitian Basin) and Shales of Sembar and Ranikot(off Shore).

The recent estimates by EIA Assessment have shown that the total Shale Gas reserves in Pakistan are estimated around 586 Tcf. However, the technically recoverable Shale Gas resources are close to 100-105 Tcf. In addition to this, the shale oil reserves of approximately 227 billion¹²¹ barrels have also been found in Pakistan, and the technically recoverable shale oil reserves for Pakistan are estimated around 9.1 billion barrels (See Figure 17).

¹²⁰Internal Documents of Ministry of Petroleum and Natural Resources (MPNR).

¹²¹EIA. (2013). *EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States*, Advanced Resources International, Inc



Figure 30: Shale Resources in Pakistan (Source EIA/ARI, 2013)

It is worth mentioning that a comprehensive and rigorous analysis of the available data of the shale source rock and petroleum systems needs to be carried out in detail. In addition to this, a detailed and inclusive assessment of Upper, Middle, Lower Indus Basin, Baluchistan and Offshore Basins by developing geological, petro physical, geophysical and geo mechanical models are required for identifying the prospective area for developing shale plays.

3.3 Resource Assessment Methodology

The assessment of shale oil and gas resources has been adopted from a joint study conducted by U.S. Department of Energy and Advanced Resources International (ARI). The methodology for conducting the basin- and formation-level assessments of Shale Gas and shale oil resources includes the following steps:

1. Conducting preliminary geological and reservoir characterization of shale basins and formation(s).
2. Establishing the areal extent of the major shale oil and gas formations.
3. Defining the prospective area for each shale oil and gas formation.
4. Estimating the risked shale oil and gas in-place.
5. Calculating the technically recoverable shale oil and gas resource.

Box 3: Shale Reserves in Pakistan

The recent estimates have identified that Pakistan has approximately 11,720 Million Tons of Oil Equivalent (MTOE) of Shale Gas and of 31,780 MTOE shale oil reserves which needs to be confirmed by the companies operating in the respective areas.¹²² These reserves, if tapped, have the potential to determine a new economic era in the history of Pakistan, by not only catering the mounting energy demands, but making it self-sufficient and energy secure country. Interestingly, shale oil and gas and reserves in Pakistan, if recovered are greater than the collective reserves of all Central Asian States (See Table below).¹²³

States	Gas Tcf	Gas MTOE	Oil Million Barrels	Oil MTOE
Kazakistan	85	1700	30,000	4200
Krgystan	0.2	4	40	5.6
Turkumanistan	280	5600	600	84
Tajjistiskan	0.2	4	10	1.4
Uzbekistan	66	1320	594	83.16
Total	431.4	8,628	31,224	4,374.16
Pakistan	586	11,720	227,000	31,780

Thus eliminating the need of importing the energy from these states. It is also pertinent to highlight here that, the energy sovereignty of Pakistan lies in strategic use of these unrecovered resources, rather than consuming them recklessly as we did with 'Natural Gas'. The strategic and wise use of these resources could demarcate a new economic era leading to peace and prosperity in Pakistan.

The shale reserves in Pakistan are restricted to Southern and Central Indus Basin (Lower Indus Basin) which is located along the Western border with India and Afghanistan. The basins are bound by the Indian shield on East and highly folded mountains on the West.

Hence, the Lower Indus basin has two types of shale formations which is Sembar and Ranikot formations and each is discussed in detail below.

¹²²EIA. (2013). *EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States*, Advanced Resources International, Inc

¹²³ Asian Development Bank. (2010). *Energy Resources Enormous Development Potential*. Central Asia Atlas of Natural Resources

3.4 Geological Characteristics of Shale Basins in Pakistan



In the beginning of the chapter it has been discussed that the unconventional rocks are mostly found in the Lower Indus Basin. This section details the properties of both Sembar and Ranikot formations located within the lower Indus Basin.

3.4.1 Sembar Formation

The Sembar Formation was deposited in a passive margin setting with sediments supplied from Indian Continent to the South East. It mainly consists of clastic rocks, typically shale with lesser quantities of siltstone and sandstone in the Lower Indus. The sand content increases towards the Southeast in the Lower Indus Basin. However, in the Middle Indus Basin, the formation is composed of siltstone with few marl and shales. Similarly in the Eastern part of the Sulaiman Fold belt, it becomes sandy within the lower part while in the basal section, phosphatic nodules, pyritic and sandy shales are developed. Shale in Sembar Formation is basically medium hard, pyritic, moderately indurated and slightly calcareous in the area. The gross thickness varies from >50m to <800m. This thickness increases from East to the West.

On the other hand the subsurface depth varies from >1000m to <5000m and this depth increases towards Fore deeps¹²⁴. In Punjab Platform and Lower Indus the depth varies from 1000 to 4000m¹²⁵. Likewise Sulaiman and Kirthar Fore deeps have <5000m depth while Sulaiman and Kirthar Fore belts depth ranges between 1000 to 3000m.

Hence, the lower Cretaceous Sembar Formation shales tend to have low clay content and high brittle component which responds more favorably to hydraulic stimulations as compared to the formations with higher clay content(See Table below for detail characteristics). The recent estimates by EIA have assessed approximately 31,320 mi² prospective area for dry Sembar Shale Gas (Ro >1.3%), a 25,560 mi² prospective area for wet and condensate (Ro between 1.0% and 1.3%), and a 26,700-mi² prospective area for oil (Ro between 0.7% and 1.0%) against the massive area of 91,000-mi²¹²⁶covered by Lower Indus Basin.

Table 13: Properties of Shale Gas and Oil Reserves within Sembar Formation

	Basin/Gross Area		Properties of Shale Gas			Properties of Shale Oil	
	Shale Formation		Sembar			Sembar	
Basic Data	Geologic Age		L. Cretaceous			L. Cretaceous	
	Depositional Environment		Marine			Marine	
Physical Extent	Prospective Area(mi²)		31,320	25,560	26,700	25,560	26,700
	Organically Rich	Thickness(ft)	1,000	1,000	1,000	1,000	1,000
	Net		250	250	250	250	250
	Interval	Depth(ft)	10,000-16,400	6,000-10,000	4,000-6,000	6,000-10,000	4,000-6,000
	Average		13,000	8,000	5,000	8,000	5,000
Reservoir	Reservoir Pressure		Normal	Normal	Normal	Normal	Normal

¹²⁴ Sembar Formation.(2013). EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale oil Resources: AN Assessment of 137 Shale Formations in 41 countries outside United States. Advanced Resources International.Inc.

¹²⁵EIA. (2013). EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States, Advanced Resources International, Inc

¹²⁶ Ibid

Properties	Average TOC (wt.%)	2.00%	2.00%	2.00%	2.00%	2.00%
	Thermal Maturity (% Ro)	1.50%	1.15%	0.85%	1.15%	0.85%
	Clay Content	LOW	LOW	LOW	LOW	LOW
	Porosity (%)	5-7%¹²⁷				
Resource	Gas Phase	Dry Gas	Wet Gas	Assoc Gas	Condensate	Oil
	GIP Concentration (Bct/mi²)	82.7	57	14.3	9.1	36.6
	Risked GIP(Tcf)	310.8	174.7	45.9	27.9	117.4
	Risked Recoverable (Tcf)	62.2	34.9	37	1.12	4.7

Source: EIA/ARI, 2013

It is estimated that TOC is the fundamental characteristic defining the hydrocarbon potential of the reservoir. The table identifies that the TOC and thermal maturity (Ro) of Sembar formation as per exploration targets is around 2% and 1%-1.6% respectively¹²⁹. The thermal gradients in the basin increase from east to west, from 1.31°F/100 ft on the Thar Slope in the east to 2.39°F/100 ft in the Karachi offshore in the west. The average thermal gradient in the basin is 2.1°F/100 ft. It is apparent from Table 4 that the properties of the reserves are subjected to variation with reference to changes in the depth of the reservoir. The greater the depth, the better would be the thermal maturity as in case of shale oil within the Sembar formation where the depth of 10,000-16400 m is characterized by thermal maturity(% Ro) of 1.15%¹³⁰ (see Figure 11) which is greater than

Box 4: Geology of Kohat-Potwar

In the Kohat Basin of Upper Indus, sediments were selected for analyzing the TOC and HI to determine the type of kerogen. Among these, Patala and Hangu Formations were found with good TOC and HI indicating Kerogen type II and III. Patala Formation has an HI in the range of 182-347 mg/g. Similarly Hangu Formation showed rich organic sediments with TOC of 2.3% and HI was 257 mg/g.¹²⁸

¹²⁷ Ahmad, N., Mateen, J., Shehzad, K., Mehmood, N., Arif, F. (2012). *Shale Gas Potential of Lower Cretaceous Sembar Formation in Middle and Lower Indus Sub-basins*. Pakistan

¹²⁸ Chapter 2. 2009. Geological Settings and Descriptions of Samples

¹²⁹ EIA. (2013). *EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States*, Advanced Resources International, Inc

¹³⁰ Characteristics of the Reservoir. (2013). *EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States*, Advanced Resources International, Inc

1.15% and 0.85% obtained at the depth of 6000-10,000m and 4,000-6,000m. A similar trend has been observed in gas reserves within Sembar formation. However, the TOC (wt.%) and clay content of the reservoir do not undergo any change with varying depth. The oil and wet gas windows within the Sembar Shale are present in the Lower Indus portion. The lower limit of the oil window is around 3500- 4,000 ft, of the wet gas/condensate window at 6,000 to 10,000 ft and of the dry gas window at 10,000 ft (See Figure).

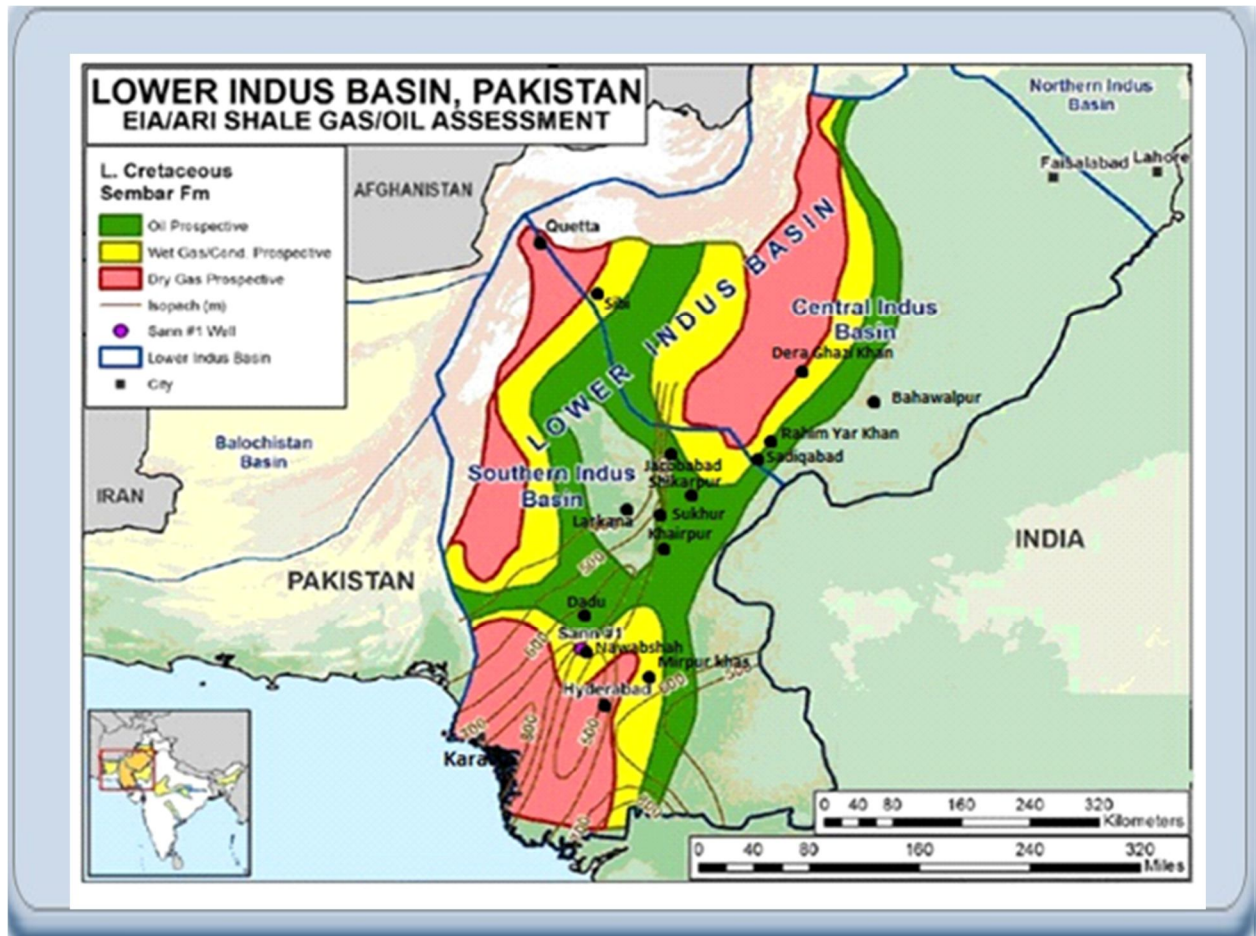


Figure 31: Sembar Shale Formation (Source: EIA/ARI, 2013)

The recent estimates by EIA have identified the oil and gas prone areas in Sembar formation depending upon the Kerogen type present within the area. It is estimated that the oil window is present in areas of Jacobabad, Shikarpur, Sukhur, Khairpur, Larkana and Dadu. The wet gas window is concentrated in Sibi, Nawabshah, Mirpurkhas and its surrounding areas (See Figure). The areas including Quetta, Karachi, Hyderabad and including other nearby areas are characterized by dry gas window. There are also some areas enriched with both wet and dry gas; these areas include Dera Gazi Khan, Rahim Yar Khan and Sadiqabad.

Thus, the EIA assessment highlights that the Sembar in lower Indus basin has an estimated resource potential of 83Bcf/mi² of dry gas, 57 Bcf/mi² of wet gas and 9 million barrels/mi² of condensate against the 31,320-mi² dry gas prospective area and 25,560-mi² wet gas and condensate prospective area. In the case of shale oil, a resource potential of 37 million barrels/mi² has been estimated in Sembar Shale within the 26,700 mi² oil prospective area. Within the overall prospective area of the Lower Indus Basin, the Sembar Shale has risked Shale Gas in-place of around 525- 531 Tcf, with 90-101 Tcf as the risked, technically recoverable Shale Gas resource. In addition, the Sembar Shale has a potential of 145 billion barrels of shale oil in-place, with 5.8 billion barrels as the risked, technically recoverable shale oil resource which estimates needs to be confirmed by companies operating in respective areas

3.4.2 Ranikot Formation

The shale in Paleocene Ranikot Formations is primarily upper carbonate unit which is tailored with fossiliferous limestone inter-bedded with dolomitic shale, calcareous sandstone and abundant bituminous material. The upper unit has been deposited in a restricted marine environment and therefore, the Ranikot formation in West of Karachi Trough axis is predominantly shale (Korara Shale) with deep marine deposition. The southern portion of the Lower Indus Basin for Ranikot Shale has been characterized by 26,780mi² for prospective oil (Ro of 0.7% to 1.0%). While the Eastern, Northern and Western boundaries of the Ranikot Shale prospective area are set by the 300 misopach contour; the Southern boundary of the prospective area is the offshore¹³¹.

¹³¹ Ranikot Formation.(2013). *EIA/ARI World Shale Gas and Shale Oil Resource Assessment: Technically Recoverable Shale Gas and Shale Oil Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States*, Advanced Resources International, Inc

The prospective area of the Ranikot formation has thickness of around 1,000-3,000ft with net shale thickness of 200 ft (See Table 14).

Table 14 Properties of Shale Gas and Oil within Ranikot Formation

Basic Data	Basin/Gross Area		Properties of Shale Gas	Properties of Shale Oil
		Shale Formation		Ranikot
	Geologic Age		Paleocene	Paleocene
	Depositional Environment		Marine	Marine
Physical Extent	Prospective Area(mi ²)		26,780	26,700
	Organically Rich	Thickness(ft)	1,000	1,000
	Net		200	200
	Interval	Depth(ft)	6,000-13,000	6,000-13,000
	Average		9,000	9,000
Reservoir Properties	Reservoir Pressure		Normal	Normal
	Average TOC (wt.%)		2.00%	2.00%
	Thermal Maturity (% Ro)		0.85%	0.85%
	Clay Content		LOW	LOW
	Porosity		4-25%	
Resource	Gas Phase		Assoc. Gas	Oil
	GIP Concentration (Bct/mi ²)		17	25.4
	Risked GIP(Tcf)		54.8	81.7
	Risked Recoverable (Tcf)		4.4	3.27

Source: EIA/ARI, 2013

The TOC in this type of shale formation is estimated around 2% and thermal maturity is around 0.75-1.0%¹³², placing the Ranikot formation in oil window.

¹³² Ibid

Long-term strategies on Shale Gas will include the streamlining of short and medium term strategies, while also a focus on the following:

- **Environmental Assessment:** Pakistan's Environmental Protection Agency (EPA) is recommended to work in close collaboration with all regulators of Shale Gas in the region, and to conduct detailed environmental analysis of the impact of Shale Gas technology, including the addressing of concerns on water management, rain water harvesting, land management etc.
- **Community Engagement:** Although most of Pakistan's higher TOC shale basins are located in low population density areas, it is still essential to engage the communities where exploration and drilling will be conducted from the beginning of the process. Moreover, the public will have to be engaged so that they can understand the facts about shale gas; in this context, local authorities will need to play a key role.
- **Shale Gas Best-Practices:** Regulating authorities are recommended to observe and improve their policy through regular review and revamping in the light of global best practices on shale. The government will have to offer contractors a policy cover and allow for co-development in operations. Furthermore, it is recommended that for unconventional oil and gas, separate financial and contractual accounts should be maintained to avoid disagreements.

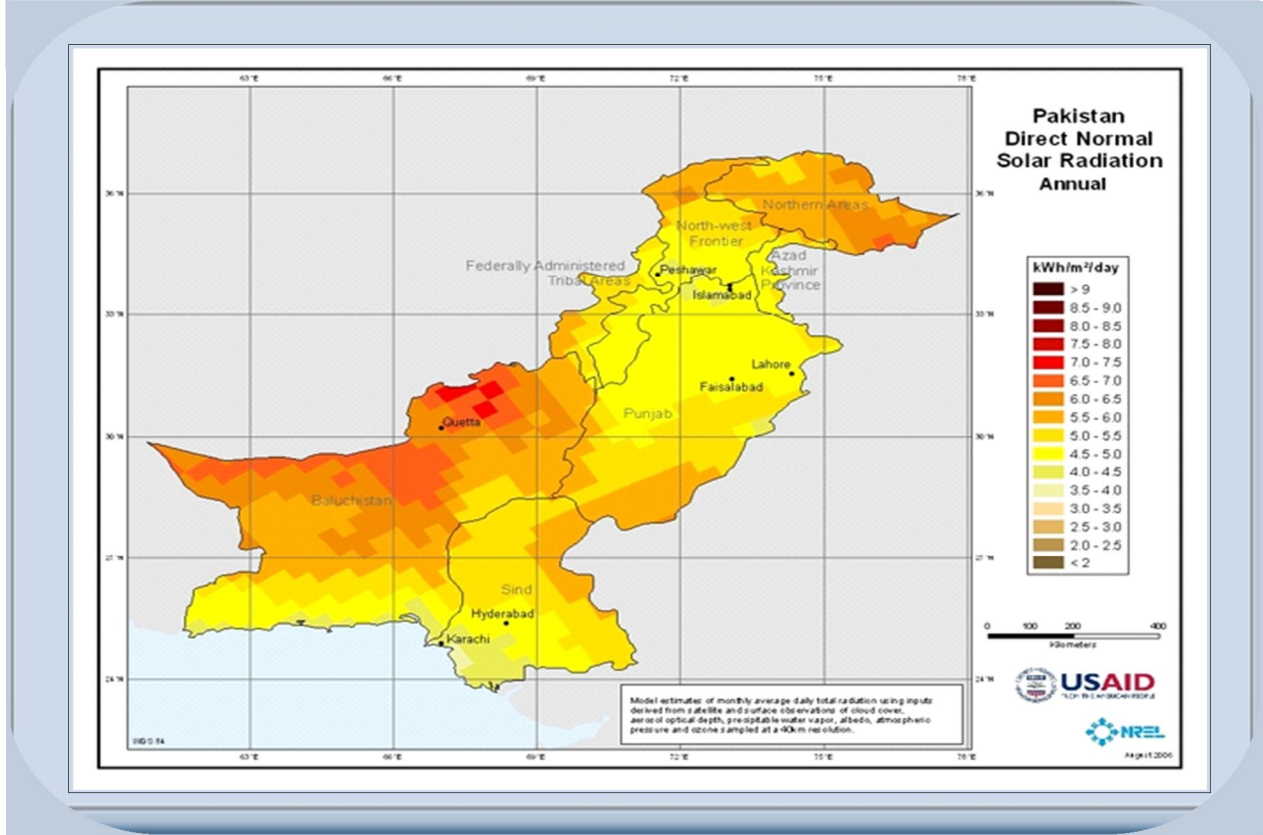
VI. SOLAR

Introduction: The Solar energy is radiant light and heat from sun which has been harnessed since generation for cooking, heating, lightening and power generation. A large number of technologies have been employed in this regard to capture this widely and abundantly available solar energy. A wide spread use of solar energy is not only a renewable source available worldwide, but also termed as environment friendly and can be used as an instrument in lowering the emissions in energy sector when compared with fossil fuels. It is estimated that a one-kilowatt solar system eliminates the burning of about 170 pounds of coal, 300 pounds of carbon dioxide from being released into the air, and saves up to 105 gallons of water supply consumption monthly.ⁱⁱ

Solar Energy in Pakistan

Pakistan lies between the latitudes 24° and 36° placing it an ideal location to take advantage of energy technologies. The mean global radiation falling on the horizontal surface of Pakistan is about 200-250 watt per m² in a day with about 1500-3000 sunshine hours in a year, with an annual mean sunshine duration of 8-8.5 hours of sunshine. The country receives on average global insolation of 19 mega joules per square meter of solar energy daily.ⁱⁱⁱ The solar potential for most parts of Pakistan lies in the range of 150-300 KWh /m²/year.^{iv} The western province of Baluchistan displays the largest potential for harnessing solar energy in the country, followed by areas in South Punjab and specific locations in the Northern Areas. In Baluchistan, 77% of the population is living in the rural areas and about 90% of the villages are yet to be electrified. Large distances with absolutely no link roads separate these villages. Furthermore, due to the rough terrain of the aforementioned province, lying of transmission

lines has an exponentially high cost. Therefore, Pakistan can make use of this widely available solar energy for improving the socioeconomic conditions of the people living in these far-flung areas. It is estimated that approximately 40,000 remote villages can be electrified through solar energy. The solar radiation level in Pakistan has been mapped by NREL (See Map below) and total solar energy potential in Pakistan is estimated to be 2.9 million MW^v of which only a meager portion has been harnessed to date.



Current Status of Solar Energy in Pakistan

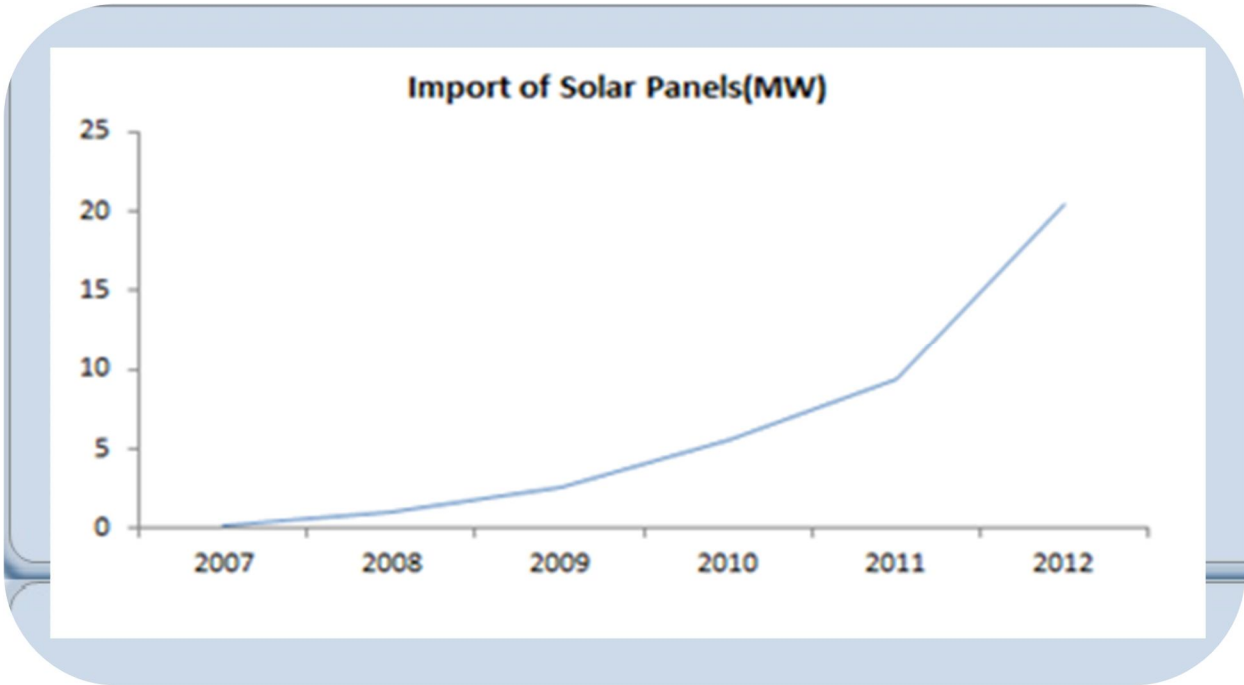
The use of Solar Technologies can be categorized into Photovoltaic and Solar Thermal technologies both of which have been introduced in Pakistan to various degrees. While photovoltaic can be used to directly feed into the grid, solar thermal application can be used to diffuse the demand for fossil fuels.

Photovoltaic

Pakistan began its thrust into solar energy utilization by installing PVs to electrify 18 villages as far back as the 1960s.^{vi} This was followed by the installation of 18 PV systems with a composite output of 440 kW installed in various areas creating a momentum to generate a further increase in the use of PVs and other renewable technologies at that time. However, due to the lack of technical knowledge about their operation and maintenance and failure to follow up on the installed systems, these systems failed to perform as expected. For the same reason, seven other PV systems with a total output of 234 kW, which were installed in the Pakistani part of the Hindu Kush in the late 1980s, are no longer in operation.^{vii}

Currently, PVs are once again being looked at as feasible options of providing energy especially in remote, rural areas. For this reason, PCRET and AEDB are making concentrated efforts of expanding the use of PVs in the country. A total of about 650KW of PVs^{viii} have been installed in the country till now with further projects in the pipeline. It is estimated that both private and public sectors are playing their roles in the popularization and up grading of photovoltaic activities in the country.

A number of companies are not only involved in trading photovoltaic products and appliances but also manufacturing different components of PV systems. They are selling PV modules, batteries, regulators, invertors, as well as practical low power gadgets for load shedding such as photovoltaic lamps, battery chargers, garden lights etc. Recently, a commercial scale solar cell manufacturing facility has also been set up by private sector. In addition to this, AEDB in light of SRO.575 (1) /2006 issued duty by exemption certificates for a large number of solar panels/solar modules to private sector companies for installation /generation of almost 20 MW of energy in the country. These solar panels /solar modules are deployed all over the country.



The graph above identifies that the import of solar panels (MW) have been increased from 0.14 MW in 2007 to 20.4 MW in 2012, in order to promote the use of this abundantly available solar energy.

Rural Electrification in Pakistan through Solar Power

The access of electricity to both rural and urban areas is a challenge for developing world including Pakistan. In rural areas bulk of population is living but access to electricity is not available to all. In order to address this issue in Pakistan, the Government of Pakistan in collaboration with private investors has been pursuing to electrify the rural areas by utilizing this abundantly available sunlight. Under the solar electrification program, 3,000 solar home systems have been installed in 49 villages of district Tharparkar, Sindh. Another 51 villages in Sindh and 300 villages in Baluchistan have also been approved for electrification using solar energy and will be implemented on release of funds.

Photovoltaic Lighting the Way for Remote Areas

Provision of energy is inextricably linked to development yet many rural areas in Pakistan still distances from the national grid compounded with difficult terrain in some instances, it is not economically sound to connect these villages to the main electrical supply. In these circumstances, Photovoltaic technology presents itself as a viable alternate to provide power to remote, rural areas remain divorced from the national grid causing the scheme of underdevelopment to persist in these areas which have placed the poor populations in a spiral of darkness. 70% of the population resides in about 5,000 villages dispersed throughout the country. With relatively small populations and large which otherwise would not have access to power. High levels of solar radiation falling in most parts of the country and the mobility of Solar Photovoltaic technologies make them ideally suited for small power requirements and remote area applications. The energy needs of these areas are largely met through firewood, cow dung, coal, kerosene, petroleum, LPG, cell batteries etc. In the absence of a reliable, cost effective source of energy, the development of these villages is severely impeded. The installation of Photovoltaic panels in these villages can cater to the energy needs of the small population and initiate a scheme of development that would only be possible once basic energy needs are met. Owing to these advantages, AEDB has launched a comprehensive Rural Electrification Program through solar Photovoltaic technology which hopes to spur a program of development by realizing the following aims; access to electricity, access to communication & information facilities, access to new technology, improved living conditions, access to safe drinking water, improved health conditions, more employment opportunities and increased income, poverty alleviation, more working hours, increased social interaction, increased girls' enrollment & decreased dropout rate and better exam results amongst others. Several villages have been electrified through this program, the success of which is prompting the extension of such programs to other villages. For rural populations in Pakistan who have had no access to a reliable source of energy for generations, the introduction of Photovoltaic technologies is initiating a process of development in remote villages and illuminating and changing lives of its poor inhabitants.

FIT/Upfront Tariff: A Proposed Support Mechanism for Solar Powered Project

Feed in/UP front tariff is the best-known policy for encouraging investment in the solar sector. It encourages the growth/generation of renewable energy industry by guaranteeing the payment for the produced energy from renewable sources such as solar, geothermal, wind and other recourses. Feed in Tariff (FIT)/Upfront tariff is a fixed level of price paid to producers of power per Kwh generated.

The FITs/upfront tariffs, determined by the regulatory authority are generally long term framed (15-25 years) contracts in which the power producers are encouraged to produce

renewable electricity generation by paying a cost based price and they are guaranteed for purchasing this electricity generated from renewable energy source.

It is estimated that at least 41 countries have adopted FIT/Up front tariff that has supported a significant renewable energy development in last 10 years .In 2008 FIT/Up front tariff supported 75% of global photovoltaic capacity and 45% of global wind capacity generation.

Similarly, in order to attract the local and foreign investment in solar sector in Pakistan, the Authority has announced the FIT/Upfront Tariff in pursuant to NEPRA Feed in Tariff Regulations 2011. The prime purpose of this FIT/up front tariff was to ensure a tariff entailed with margin to make profit and provide them an opportunity to make business out of it. While establishing the principle for FIT/Upfront tariff, it was considered that the figure or number announced should be lucrative enough that it should attract the private sector. This tariff is a single figure announced once for the whole solar sector for the tariff review period. The tariff review period is the period for which FIT/Up front tariff remains effective and applicable and it usually lasts for three years. It is noteworthy here that the FIT issued in 2012 for period of three years for the whole solar sector was around US 23.29 cents/Kwh which is applicable to indexation and escalation by NEPRA on quarterly basis. This FIT/upfront tariff is applicable to generation facilities that generate electricity by utilizing solar PV as the sole renewable energy source. The minimum installed capacity must be 1 MW and the maximum installed capacity must be 100 MW and the Authority may allow a deviation up to 11%. In addition to this the Government of Pakistan is also obliged to prepare a standardized power purchase/Energy Purchase Agreement (EPA) and make it available to IPPs within one month of announcement of the FIT/Upfront Tariff. The EPA should constitute all necessary clauses

For sale-purchase of electricity and should be acceptable to all IPPs, lenders and Power Purchasers. The instance of deploying solar powered system using this FIT mechanism is explained in Box below.

Road Map for Utilizing Solar Energy in Pakistan

In the light of above discussion, the strategy intends to utilize this widely available solar energy in terms of on grid and off grid projects. It is proposed to enhance the investment in solar powered projects through newly approved FIT/Up front tariff policy, which intends to encourage the energy generation through renewable energy sector while keeping in view the profit margins for investors.

CASE STUDY OF DEPLOYING SOLAR POWERED SYSTEMS IN PAKISTAN THROUGH FIT SYSTEM

Pakistan Engineering Council (PEC) has installed two solar powered modules, each with a capacity of generating 180 KW power at PEC and Planning Commission of Pakistan. These projects were financially supported from Japan at the cost of 480 Million Yen and have been generating energy since 2012. This solar powered system is not only supplying electricity to six storied PEC building but the excess of power generated through system is also purchased by IESCO through power purchase agreement.

Pakistan Engineering Council (PEC) is the pioneer in introducing the concept of Feed in Tariff (FIT) in Pakistan, which utilizes smart grid solar technology and encourage investment in solar powered equipment. The NEPRA and Government of Pakistan in collaboration with PEC has announced the FIT of US 23.2934 cents per kilowatt hour of electricity delivered by the eligible facility at the interconnection point on LIBOR based financing and this FIT will be applicable for tariff review period i.e. for three years. The indexation and escalation on this tariff would be announced quarterly basis by NEPRA. The power purchase agreement and its modalities have also been announced after the FIT determination. Thus, the introduction of FIT will encourage the investment in solar and other renewable energy sector and there is a need to replicated these concepts in others areas on immediate basis.

On Grid utilization of Solar Energy:

While following the global trend of investing in alternative energy, Pakistan recently inaugurated its first on grid solar park, having a generation capacity of 1000MW. Installation of photovoltaic technology has already begun in the Quaid-E-Azam Solar Park Cholistan, which is expected to complete by December 2014. The government is further planning on raising the capacity up to 1500MW in the coming years. This would shoot the total share of solar in generation up to 5%. Even though having cleaner energy in the grid system would lead to low carbon emissions, the exponentially high per unit tariff of Rs.21/kWh would burden the already teetering economy.

Comparatively the total percentage share of solar energy in the neighboring India is around 1%. China, Pakistan's main exporter, where the Photovoltaic industry is thriving, is not relying majorly on solar energy for generation of electricity. The high cost of installation and maintenance is the reason behind low share of solar power in the energy mix of this region. Third world countries are usually not in a position to afford such expensive electricity. All these countries have invested in more economical projects to lower the overall cost of generation.

It is therefore imperative for Pakistan to concentrate on the induction of off grid photovoltaic technology to the areas where there the transmission and distribution lines have yet not penetrated. It would help cut back on line losses as well as cost of lying grids. Currently the focus should be on minimizing cost of generation and exploring ways to use indigenous

resources in power generation. Following off grid solar energy projects have been undertaken to date:

- Under solar Village Electrification Program, 51 villages in Sindh and 300 villages in Baluchistan are approved for electrification using solar energy and will be implemented on release of funds.
- Under the Parliamentarians Sponsored Village Electrification Program, 32 feasibilities have been prepared and submitted of which funds for 3 schemes have been released under Pasadena Water and Power (PWP)-II and these schemes are being implemented.
- Pilot Program for Conservation of Electric/Diesel driven Tube –Wells with Solar Energy has been initiated under World Bank assistance to study the technical, financial and social viability of conversion. On successful implementation of the pilot, the World Bank will consider multimillion-dollar loan for up- scaling the national program.

VII. COAL

Coal Resources in Pakistan

The presence of coal deposits in Pakistan was identified before independence, but its economic value was realized in 1980 when large coal reserves were discovered in Lakrha and Sonda areas in Sind. This was followed by discovery of another huge coal deposit of 175.5 billion tons in an area of 10,000sq.km in Tharparkar District of Sind, providing a quantum increase in coal resources of Pakistan. Thus, after these discoveries, Pakistan is now at sixth position across the world in terms of coal resources. Coal resources available to Pakistan exist in all four provinces and in AJK. The total coal reserves are estimated at 185.5 billion tonnes, whose details are in Table 15.

Table 15 Coal Resources in Pakistan

Sr. No	Prov-ince	Locations	Resource mn Tones	Heating Value (Btu/LB)	Moisture %	Ash Content %	Volatile Matter %	Fixed Carbon %	sulfur %
1	Sindh	Thar, Lakhra, Indus East, Badin, Sondra Jherruck, Meting-jhimpir, Indus East and Badin.	184,623	5,219 - 13,555	16.1-47.2	3.3-37.5	19.1-39.8	10.96-43.46	0.6-10.8
2	Baluchistan	SorRange/Degari, Khost-Sharigh-Harnai-Ziarat, Mach, Duki.	217	9,637 - 15,499	4.05-13.4	7.2-27.37	24.05-43.95	31.725-44.52	2.825-7.11
3	Punjab	SaltRange, Makarwal	235	9,472 - 15,801	3-8.4	9.35-37.5	26.5-40.95	30.3-44.87	2.7-8.25
4	KPK	Hangu, Cherat	91	9,386 - 14,217	0.1-7.1	5.3-43.3	14-33.4	21.8-76.9	1.1-9.5
5	AJK	Kotli	9	7,336 - 12,338	0.2-6	3.3-50	5.1-32	26.3-69.5	0.3-4.8
6	Total		185,175	8210-14282	4.69-16.42	5.69-39.134	17.75-38.02	24.217-55.85	1.505-8.092

The coal resources available in Pakistan vary from lignite to sub-bituminous coal as largest coal reserve in Sind is characterized by high moisture content and low Btu value thus making it difficult to capitalize this resource potential for power generation. However, irrespective of the problems associated with the low quality coal, it has been used widely across the world for fulfilling the energy needs.

Utilization of Coal Resources: The cement and brick kilns are among the major consumers of coal for past 10 years, with cement constituting 58% share followed by brick kilns 41% for 2012. The reason for the high share is because the cement industry switched from furnace oil to coal which increased the utilization of both indigenous and imported coal. However, the power generation through coal has not been developed for more than three decades due to lack of infrastructure, insufficient financing and absence of modern coal mining technical expertise.

Currently only one power plant i.e. GENCO IV Lakhra Power Generation Company Limited (LPGCL) of 32 MW is operational and using FBC technology for burning coal. It is significant to highlight here that irrespective of the low heating value of high moisture content of lignite coal/low quality coal, it is used widely for power generation throughout the world. As vast reserves of 414 680 Mt of lignite and sub-bituminous coal are available across the world and majority of this low rank coal is used for power generation (See Figure 28).

Currently, the Pulverized Coal Combustion (PCC) is the dominant technology for power generation using low quality coal with net unit efficiency of 30-36% (Lower Heating Value) for super critical PCCs. Another technology for power generation from lignite or low quality coal is Circulating Fluidized Bed (CFB) which is also quite effective. In this technology, coal is mixed with lime stone and is burned in a fluidized bed. The

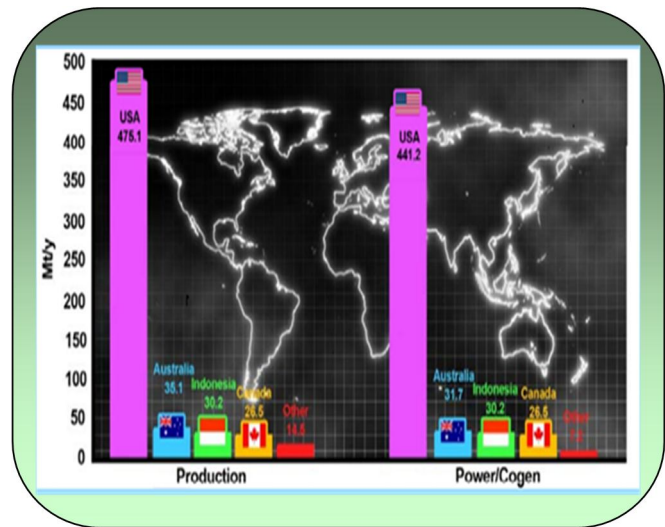


Figure 32: Coal Reserves

sulphur content gets absorbed by calcium carbonate and the emissions are free from sulphur dioxide. However, the Integrated Gasification Combined Cycle (IGCC) technology for firing the low quality fuel hasn't matured yet as currently only 3 plants are in operation while 2 are under construction. Thus, in purview of above discussion, there is a need to look in to technologies other than Underground Coal Gasification(UCG), that are used worldwide for power generation in order to capitalize this resource potential and reduce the dependence on imported fuel.

By exploring new avenues in the world of technology through public-private partnership, it is possible to achieve at least the target of 22000MW by 2035(See Figure 29).

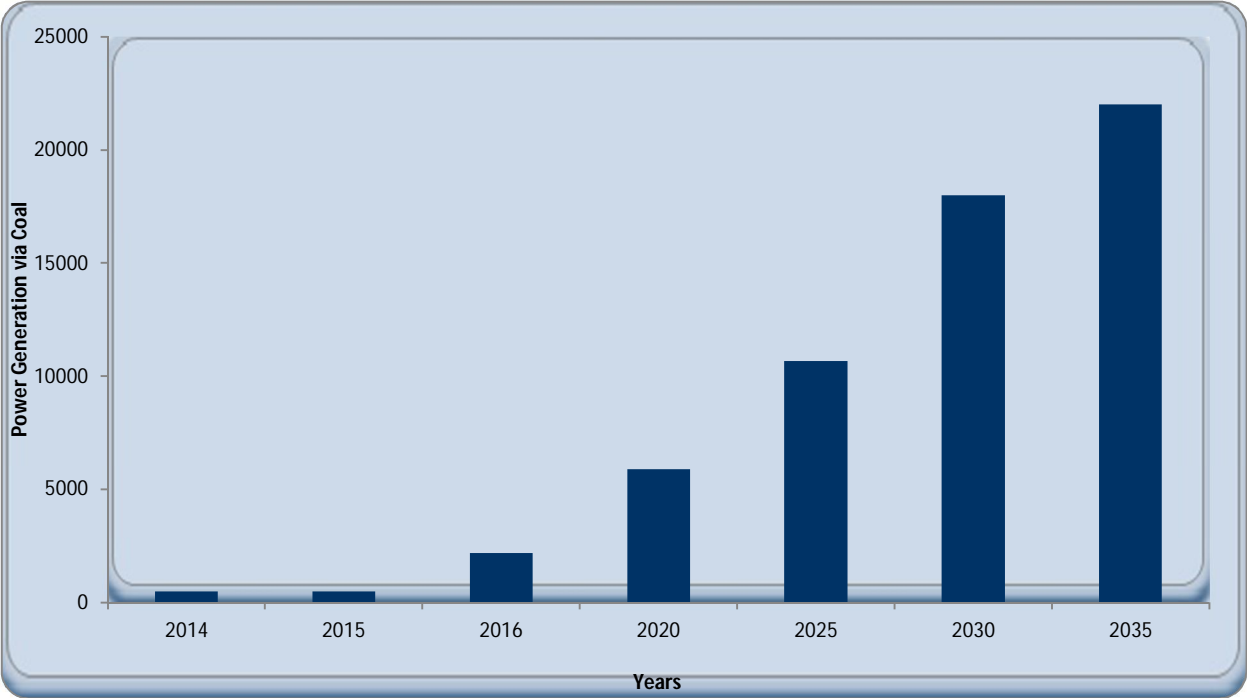


Figure 33: Roadmap of Coal¹³³

In Pakistan, the challenge is to meet the energy demand and to keep tariffs low, while ensuring low risk to environment-vulnerability. In fact, a dig into the environmental impact assessment of these projects shows the increased vulnerability of the country to Climate Change. Coal consumption would not only increase carbon emissions, water requirement but also the tariff for more than 24.5 million electricity consumers. Moreover, efficiency is indirectly linked to the monster of circular debt that exacerbates the existing energy crisis by incurring a massive subsidy of 1.7 trillion rupees. An economic analysis of the projects of 6000 MW coal-fired power plants each at Port Qasim and Punjab shows that at an average annual generation of 8

¹³³ IEA Clean Coal Center, 2013

GWh per MW, at the projected high tariff of 9 cents will incur a loss to the national exchequer to the tune of a hefty sum of USD 4.8 billion per year!

Total Installed Capacity MW	Average Annual Energy Generation GWh	Total Annual Electricity Generation GWh	Loss to Nation Rs Million at a rate of 9 cents	USD Billion
12,000	8.00	96,000	480,000	4.80

Yet, at present, the regulation of the efficiency of existing gas and oil-fired thermal power plants is being neglected by NEPRA. NEPRA documents¹³⁴ show that it relaxed key parameters of efficiency, project cost as well as O&M (Operation & Maintenance) costs for the upcoming coal-fired power projects. In fact, the Ministry of Water and Power (MOWP's) claimed US\$ 3.24 million/MW cost for advanced coal technologies (as per documents published in 2013¹³⁵).

In the quest for investment on coal projects, the larger interest of efficiency in coal-power generation has been seriously neglected, pushing upfront tariffs higher resulting in unsustainable "dirty" energy. The tariffs proposed for 220 MW, 660 MW and 1000 MW are US Cent 9.7, 9.5 and 9.12 respectively, and these can best be termed as an example of egregious misjudgment and gross professional negligence by the National Power Regulator. NEPRA, in the process of jacking up the tariff, has fixed an upfront tariff of 8 to 9.67 cent per unit for coal power plant of 200MW, whereas levying of 8 to 9.54cent/unit for a power plant of 600MW, and 8 to 9.11 cent/unit for coal power plant of 1,100MW has been formalized.

¹³⁴ NEPRA Coal Hearing on 9th April 2014

¹³⁵ NEPRA, 2013

This serious negligence on the part of NEPRA has resulted in a failure to provide a commercially viable tariff to the consumers. It is also a serious breach of NEPRA's mandate whereby it is advised to act as an "independent and objective regulatory entity"¹³⁶. By ignoring the international best practices in coal power generation, Pakistan is left vulnerable to the impediments of climate change.

In light of the above findings and analysis, some of the policy recommendations that this paper makes are:

- Regulation of coal-fired power generation to operate under the principles of High Efficiency, Low Emissions (HELE)
- Revision of the stated efficiencies of thermal units according to the international standards of ultra-super critical power plants
- Establishment of a transparent investment process on coal-fired power plants, stressing on the best coal-power generation technology possible, i.e. replicate the model of 2,000MW Coal Fired Zhejiang Jiaxing Ultra-supercritical Power Generation Project etc.
- Reformation of energy regulations. Institutional reform of NEPRA, with advice from independent and professional engineers and economists. There is also a pressing need for a Board of Governors for NEPRA including representatives from the Industry, Academia and other credible experts for vital decisions such as tariff determination in the larger interest of the nation.

¹³⁶ NEPRA, <http://www.nepa.org.pk/nepa.htm>

- Exploration of low-cost power generation, keeping in mind the parity that has been achieved in coal and wind tariffs in India. Exploitation of Pakistan's renewable energy potential in hydropower and wind energy. A renewed focus on regional cooperation in South Asia on renewable energy.

Reestablishment of the link between energy security and sustainable development in Pakistan.

It is strongly recommended to deploy energy efficient and clean energy technologies to meet the joint challenges of energy security and climate change.

T & D Losses: Smart Grid System, case study of LESCO: The performance of DISCOs can be improved by having a good approximation of both technical and non-technical losses. The concept of smart metering in Lahore Electric Supply Corporation (LESCO) which successfully reduced the line losses from 17.8% to 3.5% within 10 months needs to be replicated in other DISCOs as well. A smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of all users. It records the consumption of electrical energy in intervals of an hour or less and communicates this information back to the utility for monitoring and billings, thus helping in reducing the line losses and improving the recovery from consumers. Therefore, in long term the smart grid for all DISCOs can address the grievances associated with swelling line losses.

Strategies for Oil & Gas

Domestic & Industrial Sector:

In long run in order to reduce the dependence on thermal energy resources in domestic and industrial sector, it is proposed to promote the use of solar thermal technologies. The use of solar thermal technologies in domestic and industrial sector is documented here in below:

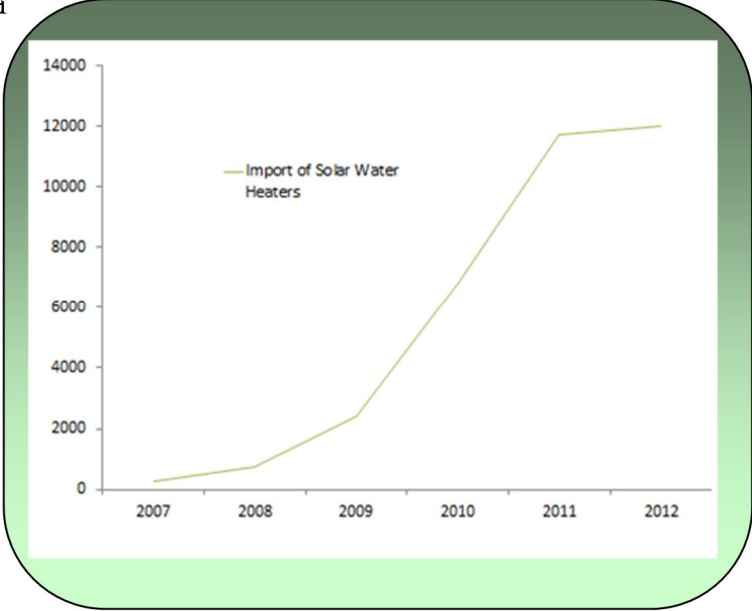
Solar Water Heaters/Solar Gysers: Solar water heaters (SWT) are an efficient way of using sunlight as a source of energy and providing hot water for domestic and industrial purposes. It serves the heating requirements of domestic household and additionally can be used to generate electricity. Solar water heaters (storage tank) are horizontally mounted above the solar collectors on the roof. Hot water naturally rises into tank through thermo siphon flow so no pumping is required.

These SWH have been widely used in China (about 70.5% of global SWH existing capacity), Europe, India, Turkey, Japan and Israel. However, in Pakistan the application of SWH is limited due to relatively high capital cost when compared with conventional ones operating on natural gas.

Nevertheless, in purview of current gas crisis and depleting natural gas reserves, the importance of Solar Water Heaters has been enhanced by many folds, especially in northern areas where cold climate and difficult terrain which limits the supply of natural gas in these areas. It has been estimated by AEDB that solar water heaters can serve to reduce 40-60% of costs of domestic water heating.

Thus, keeping in view the current unprecedented crisis and advantages associated with SWH the Government of Pakistan is facilitating the production and commercialization of this

technology in private sector. There are atleast 32 qualified companies in Pakistan who are installing SWH for domestic and industrial uses. The first SWH manufacturing plant was established in country in 2009 and a comprehensive program of installing SWH throughout the country was launched in May 2010 in collaboration with World Bank and AEDB and its prime purpose was to promote the use of solar energy and save the depleting natural gas reserves.



One of the main disadvantages of using solar water heaters is low hours of sunshine during the winters when incidentally the demand for hot water is also high. However improvements in technologies are seeking to overcome this hurdle while currently, other sources of energy are used to make up for the decreased heating abilities of solar water heaters in the winter. The graph above shows the upward trend that is expected in the import of solar water heaters

Solar Cooker: Solar cookers are the form of outdoor cooking that can cook anything which can be prepared in conventional ovens or stoves by using sunlight as source of energy. Recently, they have been popularized in regions with diminishing source of cooking fuel and poor communities having limited access to expensive thermal sources. Solar cookers can proved to be a good option for Pakistan, keeping in view the current fuel crisis, larger proportion of population living in rural areas and abundantly available solar energy. It is estimated that

Pakistan has been ranked third in World in terms of its potential for solar cookers, according to Solar Cookers International. Therefore, a number of public and private sector organizations have been working on development of low cost and efficient designs of both box and concentrator type solar cookers, thus popularizing the use of solar cooker in the country. The private sector has so far played very important role in this regard and supplied a number of cookers in rural areas where communities previously rely on fuel wood for cooking and heating purposes. The number of solar cookers in use in Pakistan is more than 2000, but it is still far less than that being used in China (60,000) and India (about 14,500).

Box : Gender Empowerment through the Use of Solar Cookers

Wilson and Ramphela (1989) noted that the concept of development must include processes that facilitate the widening of opportunities for choices and income generation for individuals and communities. The solar cooker has the potential to contribute to such outcomes. The link between improved household energy sources and enterprise possibilities has great potential for the empowerment of rural women, as many projects in a number of countries have shown. Cooker projects in Kenya for example, indicated that the improved cookers had a direct effect on the emancipation and general development of women (Kammen, 1993). Housewives with better cooking facilities were more likely to become involved in development projects and were proactive in enhancing their living conditions (Kammeenn, 1993; Karekezi and Ranja, 1997).^{ix}

In Pakistan much like other developing countries, the woman is designated with the role of cooking and caring for the family. In rural and remote areas where access to gas is limited or too expensive, women are burdened with the task of fuel collection. Fuel wood scarcity has a disproportionate impact on women undermining their ability to generate income through agriculture or small businesses. While the forest resources dwindle due to massive deforestation, women are forced to walk greater distances and devote more of their time to collecting fuel wood which continues to serve as one of the primary sources of fuel especially in the Northern Areas. The introduction of solar cooker use at home would allow women to fulfill their responsibility as the main provider of



food and fuel for daily meals while also allowing more time for income gene would significantly reduce the health hazards associated with cooking fires, gathering fuel and indoor smoke.^x Smoke from cooking fires is increasingly recognized as a major health threat, particularly for women and young girls in developing countries. The health effects include acute respiratory infections, eye infections, asthma and increased risk of tuberculosis and cataracts. Smoke is also linked to low-birth weight and infant mortality. Solar cooking is clean and smoke-free, and can benefit the health of all family members.^{xi}

The advantages of solar cookers have been noted to offer disproportionately more benefits to women who are more likely to use and operate these solar devices. Through Improvements in health as well as allowing more time for pursuit of education and income generating activities, solar cookers will work to directly empower women.

Solar Desalination: Solar desalination is a technique to convert the salt water to fresh water in order to make it suitable for human consumption or irrigation. It is a simple, low cost and low technology that can be easily adopted by local populations, thus making it an attractive option for rural communities where skilled labor is limited. Moreover, this technology can reduce the dependence on water pumps which are fueled by conventional thermal sources of energy.

In 1960s, a solar desalination plant was set up in Gwadar and 250 stills were installed with the capacity to clean water up to 6000 gallons per day. This project was largely successful and helped to improve the lives of local population and was therefore followed by other small plants of capacity 250 gallons per day. All these plants were set up by PECRET to convert the brackish water in to potable water. However, these projects could not pave the way for rapid development of solar desalination and the progress in this regard was quite slow. It is significant to discuss here that unavailability of drinkable water in various parts of Baluchistan, Sind and Southern Punjab can be encountered by installing solar desalination projects which are effective and economic way of converting saline, underground water to drinkable and useable water. Thus, such kind of projects should be considered and installed at aforementioned suitable areas by involving private sector.

Box: Solar Desalination Helps Water Trickle Back to the Village

Jat Mohammad is a village situated along the Indus delta in Sindh province in south-eastern Pakistan where the inhabitants have been facing acute water shortages since the early 1990s. This caused the populations to purchase water from the nearest town of Kharo Chaan. Each liter costs 30 to 40 Pakistani rupees (35 to 47 U.S. cents). On top of this, it costs 1,000 rupees (approximately 12 U.S. dollars) to hire a boat to get to Kharo Chaan and back for fetching water. The village has a population of about 1,500 and is marked with rampant poverty.



Today the village which was once surrounded by freshwater is now surrounded by seawater from the Arabian Sea. The village finally saw a trickle of hope when the non-governmental Sindh Radiant Organization (SRO), in collaboration with the WWF, installed a small solar desalination plant in their community as part of the program. The solar-powered desalination plant has the capacity to convert 40 gallons of seawater every day into drinking water. The plant is made up of 16 desalination units, each measuring 8 feet by 4 feet. The plant technology was developed by the Pakistan Council of Scientific and Industrial Research (PCSIR), a private research outfit based in Karachi. Built at a cost of 500,000 rupees (5,952 dollars) with the villagers providing labor, the plant is expected to provide clean water to the village inhabitants for 20 years.

Thus the facility has sparked renewed hope for clean water among the inhabitants of Jat Mohammad. Without it they would have suffered the fate of their neighboring villages, which were forced to migrate to where potable water was available. Scarcity of water along the Indus River has fueled mass migration among many of its inhabitants. However as the solar desalination plant has demonstrated in the village of Jat Mohammad, there is an opportunity to counter the increasing water scarcity in certain areas. The federal Government's Ministry of Science as well as local officials have already shown interest in replicating the desalination plant in other villages. Even local NGOs have visited Jat Mohammad to see if the plant is a viable option for other water-starved communities in Pakistan.

Agriculture Sector

Use of Efficient Diesel Engines & Motors: It is proposed to select the efficient motors and diesel engines for restricting the excessive consumption of diesel. However, in long run, it is proposed to gradually shift towards the solar powered devise including: solar water pumping stations, solar tube wells and solar dryers.

Solar Water Pumping Stations/Solar Tub wells: A typical solar power pumping system/station consists of a solar Panel array that is mounted or sometimes placed on passive trackers (which use no motors). Solar panel array are fixed to increase the pumping time and volume and it also gives power to bore or surface pump. In solar water pumps the water is often pumped from the ground or stream into a storage tank that provides a gravity feed, in that case energy storage is not needed for these systems¹³⁷.

Solar water pumping systems are used to pump water from ground for livestock, plants and human beings. In developing countries solar pumping stations are very economical, simple, and reliable and extensively used to pump water from wells and rivers to villages for domestic consumption and irrigation of crops.

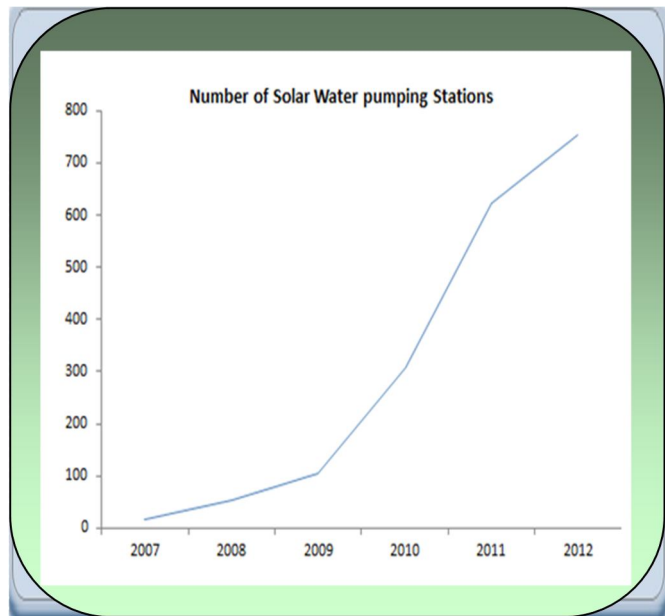


Figure 34: Number of Solar Water Pumping Stations (Source: State of Industry Report, 2012)

¹³⁷ "Energy Matters", <http://www.energymatters.com.au/renewable-energy/solar-power/pumping/>, retrieved on July 5th, 2013.

AEDB in this regard has also issued tax exemption certificate for import of about 650 units of Solar Water Pumping System in the country. The graph identifies that the installation of solar water pumping systems have been increased from 17 in 2007 to 754 in 2012. These water pumping systems are installed for community drinking and agricultural purpose all over Pakistan.

Solar Dryers: In order to reduce the usage of diesel in long run in agriculture sector, the use of solar dryers has been proposed. Solar dryers are specialized devices that control the drying process and while drying, it poses no harm to the agricultural yield. The basic principle of operating solar dryers is the use of greenhouse effect to heat the air in a collector and the hot air then dries the produce in drying chamber.

Solar dryers can play a pivotal role for agricultural country like Pakistan where agriculture forms the backbone of economy and tends to be the source of livelihood for millions of people. The solar food dryers is an appropriate food preservation technology for a sustainable world^{xii} especially for the Northern Mountainous areas of Pakistan where tons of fruits is wasted annually due to lacks the basic infrastructure and drying facilities. PCRET has already Installed 21 solar dryers with total capacity of drying 5230 Kg/day fruit.^{xiii} These dryers are now being used to dry large quantities of apricots and other fruits grown in Northern Mountainous areas of Pakistan, which are transported and sold later in the urban market. It has been reported that this practice has had a positive impact on the economy of these areas which had been marred due to lack of developmental activities. In addition to this four community size solar dryers have been planned to be installed by PCRET in date growing areas of Punjab,

Sindh and Baluchistan.^{xiv} It is expected that with the installation of solar dryers in these areas, the date industry would be boosted by improving the quality of produce. As unfortunately, at present, nearly 70% of the produce is traditionally processed and sold at low price to avoid expected losses due to rain. However, with the installation of solar dryers, it is expected that Pakistan being the 5th largest date producer country would be able to pave the way for exporting dates.^{xv}

Alternate Fuel for Fertilizer: As mentioned above like all industries, the production of fertilizer is severely hampered due to non-availability of natural gas and is currently importing urea for fulfilling the shortfall. It is estimated that for 2012-13 the annual urea production is only 4,063 thousand tons against a demand of 6200 thousand tons, thus presenting a shortfall of 5000 thousand tons per annum. Therefore, in purview of current gas crisis and depleting gas reserves, it is strongly suggested to explore alternate fuel to be used as feed stock in fertilizer manufacturing. The most vital input required to meet the fertilizer demand is ammonia and it can be prepared from alternate routes including Naphtha, fuel oil and coal. It is estimated that 17% of the energy needs in fertilizer sector is fulfilled through coal and the coal gasification plants are successfully operating in countries like Africa, China, USA and Netherland due to cost competitiveness with the natural gas feedstock. In China, 70% of the ammonia production is done through coal gasification and the cost of production of ammonia is 20%-30% times less as compared to natural gas. The fundamental economics based on Feed Stock cost for 2500 tons per day ammonia is given in *Table 5*

Table 16 Fundamental Economics for producing 2500 tons per day Ammonia

Item	Natural Gas	Coal
Total Energy Mkcal/T Ammonia	7-7.3	10.000
Cost \$/MMBtu	7.500	1.500
Feed Stock Cost (\$ Million/day)	0.505	0.170

Therefore, a country like Pakistan being blessed with huge reserves of 185 Million tons of coal resources which haven't yet employed substantially are proposed to be explored for using it as an alternate feed stock in fertilizer manufacturing industry keeping in view the successful experience of using coal as feed stock in US, China, India and Netherland. This will not relieve the burden from national exchequer but will also generate jobs thus creating an economic activity within the country.

Transport Sector:

In 2012-13, the oil consumed by transport sector accounts for 49.57% of Pakistan's oil and petroleum supply and gas consumption stood at 8.2mm cft¹³⁸. Thus, in order to reduce the dependence on thermal resources and relieve the import bill, following strategies have been proposed in long run:

Vehicle Fuel Economy: The concept of minimizing the fuel consumption in vehicles is very imperative for a country like Pakistan that is heavily dependent on oil and where the surging import bills have been draining the national exchequer. It is strongly suggested to promote the timely operation and maintenance of vehicles to optimize the fuel consumption. Moreover, the efficiency can be improved through the use of engine efficiency technologies including lightweight materials, improved body aerodynamics and improved vehicle components such as air conditioning and low rolling resistance tyres. It is significant to highlight here that it has been targeted globally to reduce the fuel consumption in cars by 50% by 2030¹³⁹. It is

¹³⁸ Economic Survey of Pakistan, 2012-13, Ministry of Finance, 2013

¹³⁹ www.globalfueleconomy.org

noteworthy here that in addition to the use of new technologies for improving efficiency the strong political support and policies equally play an important role. Governments with strong fuel economy standards such as EU, Japan, India and China have seen rapid improvement in fuel economy in recent years. These countries have implemented standards that eliminate the worst models and constricted it with time to push all models towards better efficiency. While other countries that have not had strong standards such as United States, Australia have seen little improvements.

Promoting Mass Transits: Decreasing the number of vehicles on the nation's road is of critical importance to reduce the fuel consumption at first. One approach to achieve this goal is to introduce the mechanism of carpooling such as the introduction of High Occupancy Vehicle (HOV) lanes on the nation's highways. The other way is to introduce comprehensive and reliable mass transit system. It is estimated that by 2030 more than half of the people in developing world will not have access to a car and public transit system will be critical for providing mobility services¹⁴⁰. In this regard Bus Rapid Transit (BRT) is the most popular form of mass transit due to its low cost and wide applicability along with excellent performance. These BRT systems were firstly commercialized in Curitiba, Brazil, Bogota and Colombia, where high speed and articulated buses, rapid boarding and dedicated lanes at large create highly efficient transport systems. However, the dedicated lanes for these buses are required and these lanes are often taken away from other users (primary car drivers). Moreover, a strong political will is required on part of Government to implement BRTs plan. Nevertheless it is significant to highlight here that these BRTs have high load factors and much shorter trip time

¹⁴⁰International Energy Agency(IEA), 2012, "Emerging Economies, Developing Countries and the Private-Public Sector Interface".

as compared to other modes and can play an important role to curb the excessive fuel consumption in terms of huge traffic of large number of private cars. In addition to this this way of commuting would also save time provided with the provision of defined routes.

Non-Motorized Transport: In purview of broader interest towards the sustainable development, the use of non-motorized mode i.e. bicycles as well as walking are becoming quite popular in many parts of the world. The provision of sidewalks and bike lanes is suggested to be the integral part of road and urban planning and construction within the country for coming future. Moreover, efforts are needed to not only make this type of road infrastructure part of urban planning but also make it safe and convenient. It is pertinent to state here that the United Nations Environment Programme has a plan called Share the Road that promotes investment policies for sustainable urban transport, with a particular focus on walking and cycling road infrastructure (UNEP, 2010).

Revamping of Railway: The usage of petroleum products in transport can be reduced through modernization of railway system and electrify the both passenger and cargo trains as practiced in many countries including Italy, Austria, Sweden, France, India, UK, China, Australia and US. (See *Figure 4*). It is believed that rail electrification can

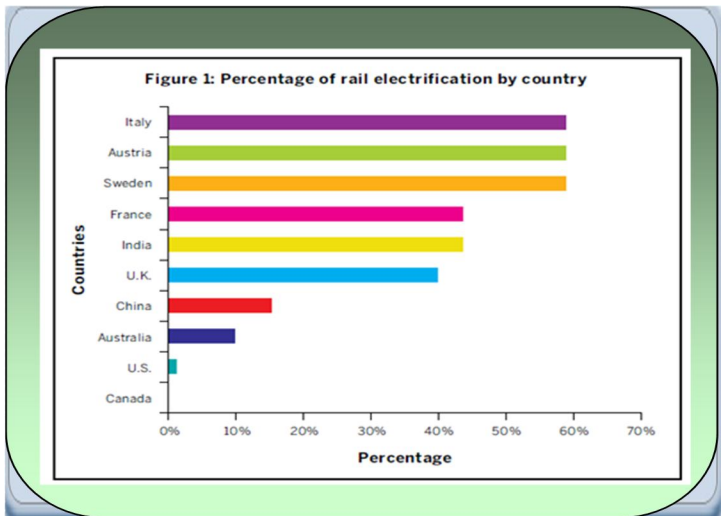


Figure 35: Percentage of Rail Electrification by Country

lead to significant emission reduction, health benefits and long term economic and operational advantages compared with diesel oriented services.

The diesel systems are usually used due to their low initial costs and commissioning time period. There short term benefits are waived off in terms of long term reoccurring costs such as daily inspection of fuel tank coolant and electrical connections close to the moving parts. Moreover, the diesel train also needs additional fuel space for storage and require more time and fuel to warm up. Thus the reoccurring maintenance and volatility of fuel prices ensures the operational cost are consequential to the profitability of transit systems. However, in case of electrified system, the initial cost is higher and commissioning time is longer which is off set by the reduced daily maintenance activities which primarily consisted of remote monitoring of power utility and overhead wires. Furthermore, the electricity cost tend to be more stable as compared to the oil prices and electrification of current railway system can be profitable in a foreseeable time once the infrastructure costs have been incurred.

Long Term benefits of Electrification of Railway System

Several Studies including U.K. Report (Network Rail, 2009) identified the following benefits of electrification of railways systems in terms of long term costs:

- 50% reduction in rolling stock operating costs
- 15% reduction in infrastructure operating costs such as track maintenance due to lightweight trains
- 3% increase in rolling stock availability
- 22% reduction in vehicle leasing costs

It is estimated that around 1000MW of electricity would be required in modernizing the whole railway track which if implemented would play a pivotal role in reducing the burden of import component in circular debt.

Use of Biogas: It is estimated Pakistan is the 13th largest country in cattle production can produce biogas with high concentration of methane required in biogas buses. Thus, this increased amount of waste shouldn't be wasted and utilize to reduce the dependence on oil.

Biogas Bus: A Case Study

Biogas buses were introduced in Stockholm, Sweden in 2004, and now over 130 buses are operational. (BalticBiogas Bus, 2012). When organic matter decomposes through anaerobic digestion (in the absence of Oxygen), biogas (mainly Methane and Carbon dioxide) is produced. It is a green vehicle fuel as it produces low emissions (CO₂ and other particles), and are part of the natural cycle. Optimally, the gas is upgraded to at least 97% methane content, as higher methane content leads to a better combustion process.

Stockholm's Experience: Busslink is the company that runs most of Stockholm's biogas buses. This is part of the city government's initiatives for a greener city. Stockholm has reached its goal of 25% fossil free transport in 2006, and it aims to reach 100% by 2050. The buses follow three models:

- 1: 6 Nm³/10 km
- 2: 8 Nm³/10 km
- 3: 6.5 Nm³/10 km

The buses can drive up to 22 hours without refueling with one tank. They need to be refueled once a day. They are supplied materials through the Henriksdals Waterworks sewage treatment plant though a direct connection to the storage tank. Extra supplies are burnt because greenhouse potential of methane is 23 times higher than CO₂s (BalticBiogas, 2012). The average storage capacity is around 50,000 Nm³ at 350 bar. The pressure needs to be 250 bar in the tank though. Through fast-filling, the refueling process takes a maximum of 10 minutes for an empty tank. The maintenance cost of the compressors is around \$30,000/year (SEK 200,000/year). The initial investment is very high since the required facilities include a biogas production plant, direct pipeline connecting to the production plant, gas storage, dispensers and bus purchase.



Challenges: One of the problems faced is when valves and filters freeze as raw gas reaches -5c. Another problem is regarding different gas qualities of natural gas and biogas, which creates problems when mixed. Although typically natural gas and biogas have the same gas quality. Thirdly, oil contamination presented a challenge to the use of biogas as fuel. Sometimes when biogas is compressed, consume oil used for lubrication may leak into the biogas. This has been addressed by improving compressor systems through the addition of inter-stage separators and coalescer filters. Biogas is more environmentally friendly than ethanol, as ethanol is in competition with food production (mainly produced through sugar canes). Moreover, biogas fuel is a form of "waste valorization" and provides a solution to waste management and alternative fuels.

Strategies for Coal

In long term, there is a need to explore the coal resources in Baluchistan, Punjab, KPK and AJK having heating value around 9000 Btu/LB -15000Btu/LB which is greater than the heating value of Thar coal resources i.e. 5000-13000Btu/LB

Technical Details of Coal Resources in Pakistan

Sr. No	Province	Locations	Resource	Heating Value	Moist ure	Ash Content	Volatil e Matte r	Fixed Carbon	sulfur
			mn Tones	(Btu/LB)	%	%	%	%	%
1	Sindh	Thar, Lakhra, Indus East, Badin, Sondra Jherruck, Meting-jhampir, Indus East and Badin.	184,623	5,219 - 13,555	16.1- 47.2	3.3- 37.5	19.1- 39.8	10.96- 43.46	0.6- 10.8
2	Baluchistan	SorRange/Degari, Khost-Sharigh-Harnai-Ziarat, Mach, Duki.	217	9,637 - 15,499	4.05- 13.4	7.2- 27.37	24.05- 43.95	31.725- 44.52	2.825- 7.11
3	Punjab	SaltRange, Makarwal	235	9,472 - 15,801	3-8.4	9.35- 37.5	26.5- 40.95	30.3- 44.87	2.7- 8.25
4	KPK	Hangu, Cherat	91	9,386 - 14,217	0.1-7.1	5.3-43.3	14- 33.4	21.8- 76.9	1.1-9.5
5	AJK	Kotli	9	7,336 - 12,338	0.2-6	3.3-50	5.1-32	26.3- 69.5	0.3-4.8
6	Total		185,175	8210- 14282	4.69- 16.42	5.69- 39.134	17.75- 38.02	24.217- 55.85	1.505- 8.092

In addition to this, new options should be explored for power generation using coal. In this regard, Coal Water Slurry (CWS) is quite cost effective option and its retrofitting cost in case of coal conversion of thermal power plants is comparatively less than other technologies. Moreover, it is also suitable for using low quality Thar coal having greater moisture content (16%) as compared to other coal resources in Pakistan. Therefore, this new technology needs to be scrutinized with due diligence.



CHAPTER 4

FUNDING & STAKEHOLDERS

4.1 Funding Requirement

There are two scenarios considered for the Energy Vision, one with the ideal scenario and other without the shale gas. Both scenarios budget has been calculated and has been annexed. The grand total of ideal scenarios budget is Rs.12442790 million while the grand total of second scenario is Rs.19195861 million. It is evident that the ideal scenario is cost effective than the scenario where there would be no shale gas exploration. This shows that shale gas will play a vital role in the energy supply for the country. Hence, to bring in the in line projects and proposed capacities the required budget is necessary to meet the energy supply of the country. The means through which funding will be generated are discussed below.

4.2 Financing Strategies

Financing of any project is the greatest problem in any project. In most of the cases the developer does not have adequate funds for self-financing or enough funds to give security for bank loan. The general practices such as bank loans, co-development with financially strong partner, leasing and Build Own Operate Transfer are used in Pakistan for fund generation. Unfortunately, projects conducted in Pakistan are still under stress because of funds. Hence, some other means of funding that, if, adopted may facilitate the government and the private sector of Pakistan.

- **Use of in House Funds:** The developer's accumulate reserves may also be used for financing a project. This may contain the company's in-house funds such as OGRA, EOBI, PPIB etc or personal reserves. Mega projects like hydropower projects relatively involve

large up-front investments which cannot solely be dependent on in-house funds rather these funds can be used completely for small projects like small dams.

- **Pay-back Using Electricity or Other Goods:** An alternative to debt payment in cash, the lender may accept payback in the form of electricity or other goods. For example, a company with high power consumption may agree to finance a hydropower project. In return it receives electric power from the developer.
- **Government Budgetary Support:** Each Government allocates budget for power sector which needs to be effectively utilized for bringing in the proposed capacities. Unfortunately, the budget is not sufficient to bring all the projects as proposed in Table. Therefore, for this purpose and to curb the energy crisis, proper budget analysis needs to be done before allocating the budget for each sector.
- **Savings from Import Bill:** Every year GOP spends millions on importing furnace oil for power generation. The total import bill of crude oil for FY 2010-11 was 6.65 million tones with a cost of 4685.59 million US\$. According to vision of this report, the reliance on furnace oil will be reduced in the coming years and will save the import bill of Pakistan. These savings in turn can be used in bringing cleaner hydropower projects. As the greatest share will be of hydropower therefore, these funds should be transferred to the hydropower sector.

4.3 Stakeholders

Pakistan power sector is under direct or indirect control of government departments or other official organizations. For the success of proposed capacities to be commissioned each year stakeholders need to play a vigilant role. All ministries, distribution companies,

Transmission Company, Private entrepreneurs, Independent Power Producers, Government departments such as National Electric Power Regulatory Authority, Planning commission, Research and Development Companies, Indus River System Authority and Pakistan Atomic Energy Commission. All these stakeholders need to collaborate with each other where required or else work independently and to perform their duties in orderly manner in order to bring Pakistan out of the energy crisis.

ANNEXURES

Scenario I

A(I). Details of Power Projects for Ideal Scenario I

Installed Capacity(MW)	Thermal Power Projects	Commissioning Date
525	Combined Cycle Power Plant Chichon Ke Malian	2014
425	Combined Cycle Power Plant Nandipur	
747	Combined Cycle Power Plant Guddu	
163	Grange Holding Power Project	
163	Radian Power Project	2015
Low Btu Projects		
404	Uch II Power Project	2014
134	Star Thermal Power Project	2015
202	FPDCL	2016
120	Kandra Power Project	
140	Odean Power Project	2020
402	Proposed Capacity Installation	2030
100	Proposed Capacity Installation	2035
Coal Projects		
31.2	FBC Lakhra	2014
150	Punjab Power Project	
300	Oracle Block 6	
300	Thar Coal Power Plant	2016
50	Coastal Saba Pvt Lts	
50	Nobel Power Pvt Ltd	
50	Elektro Power Ovt Ltd	
50	Malakwal Power Pvt Ltd	
300	PPDB	
900	Sino Sind Coal Project	
300	Proposed Capacity Installation	
1200	PEPCO Coal Based Project	2020
1305	AES Imported Coal Project	
1200	Proposed Capacity Installation	

1200	Engro Thar Coal Project I	2025
1200	Engro thar Coal Project-II	
1200	Habibullah/Dadabahi Energy	
1200	Engro Thar Coal Project III	
7315	Proposed Capacity Installation	2030
3999	Proposed Capacity Installation	2035
Hydro Projects		
121	Allai Khawar	2014
72	Khan Khawar	
130	Duber Khawar	
96	Jinnah	
106	Golen Gol	
83	Kurram Tangi	
1450	Tarbela 4th Extension	
3.2	Sharian	
0.6	Hillan	
0.6	Rangar-I	
0.32	Halmat	
0.45	Ranger-II	
3	Sharda	
3	Qadirabad	
3.2	Rehra	
4.8	Battar	
1.7	Dhannan	
43.5	Jagran- II	
14.4	Jhing	
3	Hajira	
6.4	Chamfall	
4.8	Battar Hydro Power Project	
1.7	Dhannan Hydro Power Project	
43.5	Jagarn II Hydro Power Project	
14.4	Jhing Hydr Power Project	
28	Basho	

33	Harpo	2015
800	Power Projects in Punjab(PPDCL, PPDB)	
63	Luat	
39	Nagdar	
46	Dowarian	
14	Janawahi	
16	Taobut	
52	Shountar	
21	Hariyola	
24	Jagran-IV	
15	Changan-II	
36.6	Daral Khwar HPP	
12	Ranolia HPP	
2.6	Machai HPP	
84	Matiltan HPP	
18	Koto HPP	
8	Jabori HPP	
7.5	Karora (New) HPP	
115	Sharmai HPP	
34	Barikot Patrak HPP	
21	Patrak Shringal	
26	Shigo Kach HPP	
14	Ghor Band HPP	
10	Nandihar Khwar HPP	
24	Arkari Gol HPP	
210	Naran Dam	
65	Batakundi HPP	2016
969	Neelum Jehlum	
122	Keyal Khawar	
80	Phandar	
70	Lawi	
89	Private Sector Projects up to 50 MW	
740	Munda	

1100	Kohala	2020
4500	Diامر Basha	
4320	Dasu	2025
496	Lower Spat	
7100	Bunji	
665	Phalas	
600	Akhori	
2800	Thakot	
2800	Pattan	
80	Phandar	2030
3000	Yulbu	
800	Dundhyal	
2200	Tungas	
1600	Skardu	
520	Yugu	
Geothermal projects		
25	Proposed Capacity Installation	2020
25	Proposed Capacity Installation	2025
200	Proposed Capacity Installation	2030
300	Proposed Capacity Installation	2035
BagasseCogen Projects		
80	JDW Cogeneration Project	2015
100	Ramzan Cogeneration	
60	Janpur Cogeneration	
100	Fatima Cogeneration	2016
65	Chistia Cogeneration	
120	Dewan Cogeneration	
175	Proposed Capacity Installation	2020
475	Proposed Capacity Installation	2025
500	Proposed Capacity Installation	2030
100	Proposed Capacity Installation	2035

Waste to Power Projects		
22	Biogas Plant at Karachi	2015
378	Proposed Capacity Installation	2020
600	Proposed Capacity Installation	2025
1000	Proposed Capacity Installation	2030
500	Proposed Capacity Installation	2035
Wind Projects		
56.4	Zorlu Enerji Pakistan Ltd. (ZEPL)	2014
49.5	Master Wind Energy (MWEL)	2015
49.5	Arabian Sea Wind Energy (Pvt.) Ltd. (ASWEL)	
50	Foundation Wind Energy-II (Pvt.) Ltd	
50	Gul Ahmed Wind Power Ltd.	
50	Metro Power Company Ltd. (MPCL)	
49.5	Sachal Energy Development (Pvt) Ltd (SEDPL)	
49.5	Sapphire Wind Power Company Ltd. (SWPCL)	
49.5	Tenaga Generasi Ltd.	
50	Yunus Energy Ltd.	
49.5	Zypher Power (Pvt.) Ltd.	
50	FFCEL	
250	Milergo Pakistan Ltd. (MPL)	
49.5	Three Gorges First Wind Farm	
150	Proposed Capacity Installation	
800	Proposed Capacity Installation	2016
1000	Proposed Capacity Installation	2020
2000	Proposed Capacity Installation	2025
3000	Proposed Capacity Installation	2030
2000	Proposed Capacity Installation	2035
Biomass Projects		
	SSJD	2016
24	Lumen Energia	2020
152	Proposed Capacity Installation	2025
800	Proposed Capacity Installation	2030
500	Proposed Capacity Installation	2035

Solar Projects		
90	Access Solar	2016
30	Proposed Capacity Installation	2020
170	Proposed Capacity Installation	2025
800	Proposed Capacity Installation	2030
900	Proposed Capacity Installation	2035

B (I). Budget Scenario

Budget(Rs Million)	Sources	Year
150018.13	Thermal	2014
49174.67	Low Btu	
68328	Imported Coal	
74268	Local Coal	
74490.42	Hydro	
0	Geothermal	
0	Bagasse Cogen	
0	Waste to Power	
14310.76	Wind	
0	Biomass	
0	Solar	
	Shale	
430589.98	Total	
Budget(Rs Million)	Sources	
171014.13	Thermal	
19511.8	Low Btu	
0	Imported Coal	
0	Local Coal	
223160	Hydro	
0	Geothermal	
23,892	Bagasse Cogen	
0	Waste to Power	
1820.81	Wind	
0	Biomass	
0	Solar	
	Shale	

439,399	Total	
Budget (Rs Million)	Sources	
0	Thermal	2016
29168.15	Low Btu	
186168	Imported Coal	
195788	Local Coal	
568529	Hydro	
0	Geothermal	
28372	Bagasse Cogen	
0	Waste to Power	
2096	Wind	
1972.96	Biomass	
26627.98	Solar	
	Shale	
1038722.09	Total	
Budget (Rs Million)	Sources	
0	Thermal	2020
13937	Low Btu	
198052	Imported Coal	
365435	Local Coal	
1320093	Hydro	
7427	Geothermal	
17421.25	Bagasse Cogen	
36833	Waste to Power	
2620	Wind	
1972.96	Biomass	
7684.79	Solar	
	Shale	
1971476	Total	
Budget (Rs Million)	Sources	
0	Thermal	2025
0	Low Btu	
12080	Imported Coal	
12000	Local Coal	
2911373	Hydro	
7427	Geothermal	
47286.24	Bagasse Cogen	
39820	Waste to Power	
5200	Wind	
11895.49	Biomass	

204413.32	Solar	
	Shale	
3251495.05	Total	
Budget(Rs Million)	Sources	2030
0	Thermal	
9955	Low Btu	
20100	Imported Coal	
20000	Local Coal	
1937853	Hydro	
59420	Geothermal	
47286.24	Bagasse Cogen	
76653	Waste to Power	
7596	Wind	
39419.37	Biomass	
207051.23	Solar	
	Shale	
2425333.84	Total	
Budget(Rs Million)	Sources	
0	Thermal	
9955	Low Btu	
10560	Imported Coal	
10500	Local Coal	
2482893	Hydro	
62000	Geothermal	
9955	Bagasse Cogen	
39820	Waste to Power	
5040	Wind	
24806.33	Biomass	
230244.95	Solar	
	Shale	
2885774.28	Total	
12,442,790	Grand Total	

SCENARIO II

A (II). Details of Power Projects

Installed Capacity(MW)	Thermal Power Projects	Commissioning Date
525	Combined Cycle Power Plant Chichon Ke Malian	2014
425	Combined Cycle Power Plant Nandipur	
747	Combined Cycle Power Plant Guddu	
163	Grange Holding Power Project	
163	Radian Power Project	2015
	Low Btu Projects	
404	Uch II Power Project	2014
134	Star Thermal Power Project	2015
202	FPDCL	2016
120	Kandra Power Project	
140	Odean Power Project	2020
402	Proposed Capacity Installation	2030
100	Proposed Capacity Installation	2035
	Coal Projects	
31.2	FBC Lakhra	2014
150	Punjab Power Project	
300	Oracle Block 6	
300	Thar Coal Power Plant	2016
50	Coastal Saba Pvt Lts	
50	Nobel Power Pvt Ltd	
50	Elektro Power Ovt Ltd	
50	Malakwal Power Pvt Ltd	
300	PPDB	

900	Sino Sind Coal Project	
300	Proposed Capacity Installation	
1200	PEPCO Coal Based Project	2020
1305	AES Imported Coal Project	
1200	Proposed Capacity Installation	2025
1200	Engro Thar Coal Project I	
1200	Engro thar Coal Project-II	
1200	Habibullah/Dadabahi Energy	
1200	Engro Thar Coal Project III	
9315	Proposed Capacity Installation	2030
2000	Proposed Capacity Installation	2035
Hydro Projects		
121	Allai Khawar	2014
72	Khan Khawar	
130	Duber Khawar	
96	Jinnah	
106	Golen Gol	
83	Kurram Tangi	
1450	Tarbela 4th Extension	
3.2	Sharian	
0.6	Hillan	
0.6	Rangar-I	
0.32	Halmat	
0.45	Ranger-II	
3	Sharda	
3	Qadirabad	
3.2	Rehra	
4.8	Battar	
1.7	Dhannan	

43.5	Jagran- II	
14.4	Jhing	
3	Hajira	
6.4	Chamfall	
4.8	Battar Hydro Power Project	
1.7	Dhannan Hydro Power Project	
43.5	Jagarn II Hydro Power Project	
14.4	Jhing Hydr Power Project	
28	Basho	2015
33	Harpo	
800	Power Projects in Punjab(PPDCL, PPDB)	
63	Luat	
39	Nagdar	
46	Dowarian	
14	Janawahi	
16	Taobut	
52	Shountar	
21	Hariyola	
24	Jagran-IV	
15	Changan-II	
36.6	Daral Khwar HPP	
12	Ranolia HPP	
2.6	Machai HPP	
84	Matiltan HPP	
18	Koto HPP	
8	Jabori HPP	
7.5	Karora (New) HPP	
115	Sharmai HPP	

34	Barikot Patrak HPP	
21	Patrak Shringal	
26	Shigo Kach HPP	
14	Ghor Band HPP	
10	Nandihar Khwar HPP	
24	Arkari Gol HPP	
210	Naran Dam	
65	Batakundi HPP	
969	Neelum Jehlum	2016
122	Keyal Khawar	
80	Phandar	
70	Lawi	
89	Private Sector Projects up to 50 MW	
740	Munda	
1100	Kohala	2020
4500	Diامر Basha	
4320	Dasu	
496	Lower Spat	
7100	Bunji	
665	Phalas	
600	Akhorl	
2800	Thakot	
2800	Pattan	
80	Phandar	2030
3000	Yulbu	
800	Dundhyal	
2200	Tungas	
1600	Skardu	

520	Yugu	
Geothermal projects		
25	Proposed Capacity Installation	2020
25	Proposed Capacity Installation	2025
200	Proposed Capacity Installation	2030
300	Proposed Capacity Installation	2035
BagasseCogen Projects		
80	JDW Cogeneration Project	2015
100	Ramzan Cogeneration	
60	Janpur Cogeneration	
100	Fatima Cogeneration	2016
65	Chistia Cogeneration	
120	Dewan Cogeneration	
175	Proposed Capacity Installation	2020
475	Proposed Capacity Installation	2025
500	Proposed Capacity Installation	2030
100	Proposed Capacity Installation	2035
Waste to Power Projects		
22	Biogas Plant at Karachi	2015
378	Proposed Capacity Installation	2020
600	Proposed Capacity Installation	2025
1000	Proposed Capacity Installation	2030
500	Proposed Capacity Installation	2035
Wind Projects		
56.4	Zorlu Enerji Pakistan Ltd. (ZEPL)	2014
49.5	Master Wind Energy (MWEL)	2015
49.5	Arabian Sea Wind Energy (Pvt.) Ltd. (ASWEL)	
50	Foundation Wind Energy-II (Pvt.) Ltd	

50	Gul Ahmed Wind Power Ltd.	
50	Metro Power Company Ltd. (MPCL)	
49.5	Sachal Energy Development (Pvt) Ltd (SEDPL)	
49.5	Sapphire Wind Power Company Ltd. (SWPCL)	
49.5	Tenaga Generasi Ltd.	
50	Yunus Energy Ltd.	
49.5	Zypher Power (Pvt.) Ltd.	
50	FFCEL	
250	Milergo Pakistan Ltd. (MPL)	
49.5	Three Gorges First Wind Farm	
150	Proposed Capacity Installation	
800	Proposed Capacity Installation	2016
1000	Proposed Capacity Installation	2020
6000	Proposed Capacity Installation	2025
4000	Proposed Capacity Installation	2030
8000	Proposed Capacity Installation	2035
	Biomass Projects	
	SSJD	2016
24	Lumen Energia	2020
152	Proposed Capacity Installation	2025
800	Proposed Capacity Installation	2030
500	Proposed Capacity Installation	2035
	Solar Projects	
90	Access Solar	2016
30	Proposed Capacity Installation	2020
170	Proposed Capacity Installation	2025
800	Proposed Capacity Installation	2030
900	Proposed Capacity Installation	2035

B (II). BUDGET

Budget (Rs Million)	Sources	Year
150018.13	Thermal	2014
49174.67	Low Btu	
68328	Imported Coal	
74268	Local Coal	
74490.42	Hydro	
0	Geothermal	
0	Bagasse Cogen	
0	Waste to Power	
14310.76	Wind	
0	Biomass	
0	Solar	
	Shale	
430589.98	Total	
Budget (Rs Million)	Sources	2015
171014.13	Thermal	
19511.8	Low Btu	
0	Imported Coal	
0	Local Coal	
223160	Hydro	
0	Geothermal	
23,892	Bagasse Cogen	
0	Waste to Power	
181276.85	Wind	
0	Biomass	
0	Solar	
	Shale	
618,855	Total	
Budget (Rs Million)	Sources	2016
0	Thermal	
29168.15	Low Btu	
186168	Imported Coal	
195788	Local Coal	
568529	Hydro	
0	Geothermal	
28372	Bagasse Cogen	
0	Waste to Power	
208643.93	Wind	

1972.96	Biomass	
53196.24	Solar	
	Shale	
1271838.28	Total	2020
Budget(Rs Million)	Sources	
0	Thermal	
13937	Low Btu	
198052	Imported Coal	
365435	Local Coal	
1320093	Hydro	
7427	Geothermal	
17421.25	Bagasse Cogen	
36833	Waste to Power	
260804.91	Wind	
1972.96	Biomass	
175595.37	Solar	
	Shale	
2397571.49	Total	2025
Budget(Rs Million)	Sources	
0	Thermal	
0	Low Btu	
12080	Imported Coal	
12000	Local Coal	
2911373	Hydro	
7427	Geothermal	
47286.24	Bagasse Cogen	
39820	Waste to Power	
1542292.83	Wind	
11895.49	Biomass	
363733.26	Solar	
	Shale	
4947907.82	Total	2030
Budget(Rs Million)	Sources	
0	Thermal	
9955	Low Btu	
27940	Imported Coal	
27800	Local Coal	
1937853	Hydro	
59420	Geothermal	
47286.24	Bagasse Cogen	
76653	Waste to Power	

996633.13	Wind	2030
39419.37	Biomass	
1243292.86	Solar	
	Shale	
4466252.6	Total	
Budget (Rs Million)	Sources	2035
0	Thermal	
9955	Low Btu	
11760	Imported Coal	
11700	Local Coal	
2482893	Hydro	
62000	Geothermal	
9955	Bagasse Cogen	
39820	Waste to Power	
2036667.38	Wind	
24806.33	Biomass	
373289.48	Solar	
	Shale	
5062846.19	Total	
19,195,861	Grand Total	

ⁱⁱ <http://www.carbonfeet.com/solar-energy-facts-you-should-know/>

ⁱⁱⁱ U.k. mirza status and outlook of solar

^{iv} Pakistan. Planning Commission. Task Force on Climate Change. *Final Report of the Task Force on Climate Change*. 2010. 32. Print

^v <http://www.research.org.pk/Databank/Power%20Sector%20Overview.pdf>

^{vi} http://www.pcret.gov.pk/files/success_story.html

^{vii} http://www.sari-energy.org/PageFiles/Countries/Pakistan_Energy_detail.asp

^{viii} PCRET

C. Shale Gas Framework for First Three Pilot Projects (SOURCE: Government of Pakistan, after Economic Coordination Committee (ECC) approval)

The following special incentives and standards are recommended for pilot project testing and production phase. However, once the Phase I of pilot projects is concluded and a better understanding of the resource potential attained, the economic conditions of the projects could be reviewed with mutual understanding of Government and the E&P company concerned.

(i) Shale Gas Price

Shale Gas Price will be set through bidding process. The lowest price quote with at least commitment of minimum work program and expenditure requirement defined in this frame work will get the area.

(ii) Licensing Regime

In order to expedite exploitation of shale gas and keeping in view the current licensing regime, it is suggested that the competent Authority may invite bids from E&P companies to grant special concessions for exploration and production of shale gas as provided below:

- (a)** *Free Area (which is currently not held by any company): special concession for shale gas to be awarded through open bidding process to companies for pilot projects under this Framework. The competent authority when evaluating the aforementioned bids shall take into account other considerations such as the organization, technical, financial and R&D capabilities to carrying out such pilot projects, as detailed in the attached Annexure-1.*

- (b) *Existing Exploration License Area: Interested companies pioneering work on shale gas may apply for grant of rights in any License Area. DGPC will notify the area for bid from all interested parties including the existing license holder. The competent authority shall evaluate the bidders technical and financial capabilities on the criteria attached as Annexure-1. In case of a joint venture each party has to qualify the said evaluation criteria.*
- (c) *Existing Lease Area: Interested companies pioneering work on shale gas may apply for grant of rights in any Lease Area. DGPC will notify the area for bid from all interested parties including the existing lease holder. The competent authority shall evaluate the bidders technical and financial capabilities on the criteria attached as Annexure-1. In case of a joint venture each party has to qualify the said evaluation criteria.*
- (d) *Subject to qualification on the criteria the competent authority may award the area to the party committing the minimum work program and expenditure as provided in this framework and bidding for the minimum gas price per MMBTU in terms of gas price or crude oil price percentage (%) with a floor and ceiling. The successful party will provide all financials of the project (s) in advance and also to the Government of Pakistan as and when required till the completion of the project, as to evaluate the actual cost of the project. If it is lower than the actual cost provided, then the price per MMBtu will be reduced by due negotiation.*
- (e) *The existing license / lease holder shall have preferential rights to match the best offered gas price provided they commit the minimum work program and expenditure requirement and qualify the evaluation criteria provided in Table*

(f) In case any special concession for shale gas, as outlined above, is granted, notwithstanding the terms and conditions of an existing license or lease, the terms and the minimum work programme for such special concessions for shale gas shall be:

		Minimum Work & Financial Commitment
Initial Term	Phase I (3 years)	<p>1st Year: G&G Study Drilling of 1st vertical exploration well with multiple data frac, specialized coring and logging within shale horizons (Firm). USD 20 million</p> <p>2nd Year: Detailed lab analysis of cores and ditch cutting samples including geochemical, geo-mechanical and petrophysical studies. USD 2 million Planning for drilling of Appraisal well (Horizontal) along with frac-feasibility study.</p> <p>3rd year: Drilling of an Appraisal well (Horizontal) with specialized coring, logging and fracing of selected shale intervals (Firm). USD 30 million</p>
	Phase II (3 years)	<p>1st Year: Detailed lab analysis of cores and ditch cutting samples including geochemical, geo-mechanical and petrophysical studies. USD 2 million Drilling of an Appraisal well (Horizontal) with specialized coring, logging and fracing of selected shale intervals (Firm). USD 30 million</p> <p>2nd year: Preparation and submission of Field Development Plan (Contingent).</p> <p>3rd year: Drilling of one development well (Contingent) - USD 30 million</p>
	1 st Renewal (2 years)	<p>Installation / commissioning of Production Plant (Contingent) – USD 20 million Drilling of one well each year (Contingent) - USD 60 million</p>
	Appraisal period (up to 7 years)	<p>Drilling of two development wells USD 60 million. Production Performance Study production performance from shale gas wells: at least 6 wells - USD 10 million</p>

- (g) In case of discovery, lease life shall be for 20 years with 20 years renewal possible.
- (h) Each bidder shall be required to submit with the bid a bank guarantee equivalent to 25% of phase-1 minimum expenditure commitment or a parent company guarantee or any other guarantee as provided in Petroleum Policy 2012.
- (i) The companies where GOP has a majority shareholding will not be required to submit the guarantee.

Annexures

