Chapter 14

Energy

Energy is the lifeline of an economy and is a vital input to sustain industrial, commercial and domestic activities. Energy disruptions and energy shortages not only result in loss of economic growth and employment but adversely affect social cohesion in the society. Energy crisis in Pakistan had been brewing since 2007 and deepened in 2012 which hugely negatively affected the economic growth and employment. Absence of effective planning, an economically and financially viable strategy and incapacitated regulator resulted in supply-demand gap. The situation has been further compounded due to high transmission and distribution losses, development of black-market for power and declining revenue collection. This led to persistent accumulation of circular debt. Consequently, the federal budget had to absorb huge quantum of subsidies to bridge the financial gaps in power sector threatening the fiscal stability on the one hand, and increasing the public debt.

Nevertheless, realizing the gravity of situation and importance of energy for economic activities with particular emphasis on reviving the almost stalled industrial sector, job creation and income generation, the present government has put this issue on top of its economic reform agenda by pursuing a comprehensive plan to address these problems. In this context, government retired the circular debt (Rs 480 billion) immediately after taking oath which added 1752 MW of electricity into the system. In order to resolve the issue on permanent basis, government developed National Power Policy (2013) which was announced to provide an affordable energy in the country through efficient generation, transmission and distribution system. It is expected that the policy will set Pakistan on a trajectory of rapid economic growth and social development. More specifically, in order to reduce the cost of power generation to an affordable amount, a 84 MW New Bong Hydropower Project being the first hydro IPP in Pakistan/AJ & K has been commissioned while 10.5 MW Gas Based Davis Energen Project at Jhang started producing electricity and is contributing to FESCO's Network. Likewise 2 x 660 MW Imported Coal based Power Project at Port Qasim, Karachi has been inaugurated.

In short, the government has realized the challenges faced by Pakistan energy system. Thus efforts are underway to reform existing energy system to actualize the energy sector's aspirations. It is projected that by the end of the decade Pakistan will be transformed from an energy deficient to a regional exporter of power while the efficiency improvements in transmission and distribution will decrease the high cost of power to the end consumer which will bring prosperity and social development in the country.

Box-1: Salient Features of National Power Policy 2013

The Ministry of Water and Power has developed Power Policy to support the current and future energy needs of the country and to set Pakistan on a trajectory of rapid economic growth and social development. It will also address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan. To achieve the long-term vision of the power sector and overcome its challenges, following nine goals have been set:

i. Build a power generation capacity that can meet Pakistan's energy needs in a sustainable manner.
ii. Create a culture of energy conservation and responsibility
iii. Ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coal (Thar coal) and hydel.
iv. Minimize pilferage and adulteration in fuel supply
v. Promote world class efficiency in power generation
vi. Create a cutting edge transmission network
vii. Minimize inefficiencies in the distribution system
viii. Minimize financial losses across the system
ix. Align the ministries involved in the energy sector and improve the governance of all related federal and provincial departments as well as regulators

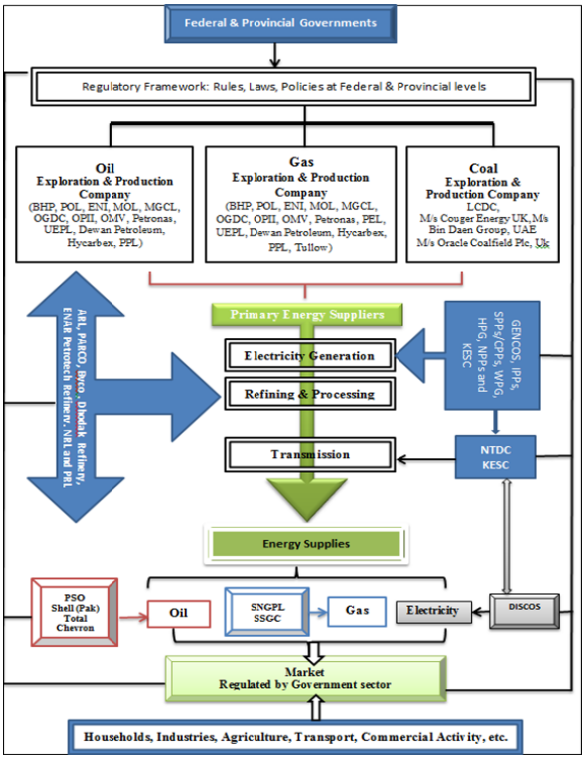
The main targets of this Policy for year 2017 are:

i. To fully eliminate load shedding;
ii. To decrease cost of generation from 12c/unit to 10c/unit;
iii. To decrease transmission losses from 25 percent to 16 percent
iv. To improve collection of bills to 95 percent.

14.1 Pakistan's Energy System

Figure below give us a visual presentation of the overall energy sector in Pakistan. Public sector (Ministry of Water and Power and the Ministry of Petroleum and Natural Resources) is the largest component in the whole system with its intervention from policy to generation and distribution chain. It impacts the energy market through rules, regulations and laws formed by the public sector institutions and organizations. There are two regulators National Electricity and Power Regulation Authority (NEPRA) and Oil and Gas Regulatory Authority (OGRA).

Fig-14.1: Pakistan's Energy System



The first stage is primary energy supplies where the government being prime supplier to the generation companies has solid hold. The government supply primary energy from domestic resources as well as from importing these from rest of the world.

The second stage is conversion process like electricity generation, refining and processing of oil etc. Energy in Pakistan is generated by public and private companies but most of the energy comes from public limited companies. During the conversion process, primary energy is supplied to various plants (heat, power, gas, petrochemical, liquefaction etc.), oil refineries and some of it is used by energy industry itself. Prior to 1985, the energy system of Pakistan mainly consisted of public sector. However, it was becoming difficult for Government of Pakistan to handle and finance the sector alone therefore it was decided to bring the private sector in. As a result in 1985, a 1292 MW Hub Power Project (HUBCO) was initiated as a major power project which was unique in Pakistan and the world as well. However, its installation process was very slow and it took the project 12 years to fully establish in 1997. Till 1994, the distribution of electricity was coordinated and managed by twelve Area Electricity Boards (AEBs). In early 90s there was a shift in global thinking towards market economy which led to a structural change in the power sector of Pakistan. The idea was to bring in more private investment. Following this, the government introduced number of policies in the early 90s. The first visible step in this direction was the unbundling of WAPDA, the process started in 1994 and completed in 1998. The government introduced the Power Policy of 1994. The impetus of this policy was to restructure the entire power sector. This policy resulted in de-regulation of the power sector, promotion of IPPs, restructuring of WAPDA and privatization of selected corporate entities. Till now private sector has also become a major player in power production. Under 18th Amendment, provinces have been given considerable autonomy to invest in the energy sector. However, due to unequal availability of natural resources in the provinces, lack of technical knowledge, inability of the provincial government to provide sovereign guarantees to the private sector for bringing the foreign direct investment and the absence of national coordination plan are reasons which are becoming critical for the provinces to handle such a complicated sector.

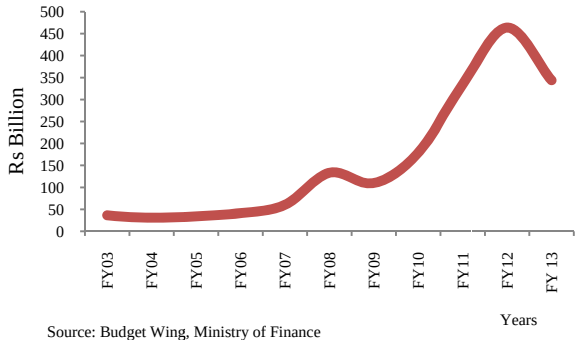
Presently, the generation of electricity by the public sector is done through hydel sources like Terbela and Mangla dams etc. while generation companies (GENCOs) generate electricity through thermal resources. The private sector electricity is generated by IPPs (Independent Power Plants), SPPs (Small Power Plants) / CPPs (Captive Power Plants), WPG (Wind Power Generation), HPG (Hydel Power Generation), Hub Power Company Limited

(HUBCO) and Karachi Electric Supply Company (KESC) while KESC is vertically integrated company. Some portion of electricity is also generated by NPPs (Nuclear Power Plants). Pakistan Electric Power Company (PEPCO) is an umbrella institution which manages the generation activities of all generation companies and thus has strong influence within the system

In the third stage, the generated energy is transmitted to energy services which are mainly done through National Transmission Distribution Company (NTDC) and KESC. The NTDC is further divided into power distribution companies (DISCOs) which include LESCO, QESCO, PESCO, IESCO, GEPCO, FESCO, MEPCO, HESCO, KESCO and SEPCO. However a major portion of energy is lost during transmission and distribution which is almost 25 percent. The present government is taking all possible measures to reduce these losses to minimum level and the target is to reduce these to 16 percent till 2017.

The interaction of suppliers and consumer of energy services occur through energy market. However, it should be noted that the determination of prices of energy products does not happen freely because the government heavily influence the market and bears part of the final price by paying subsidy on the final tariff as majority of consumers will not be able to pay the price if determined by free market forces. From FY03 to FY13 a total amount of Rs 1.7 trillion has been given as subsidy to power sector an amount which is much higher than the cost of Diamer Basha Dam. The trend of subsidies given in these years is shown in Figure 14.2 below:

Figure 14.2: Subsidies to Power Sector



Source: Budget Wing, Ministry of Finance

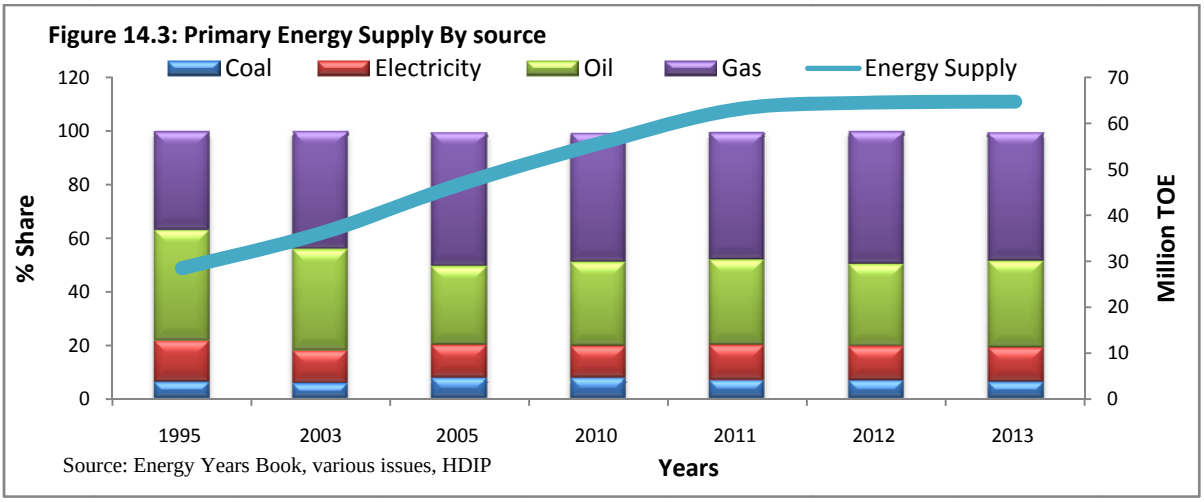
However, withdrawing the subsidy at once may cause huge socio-economic cost therefore the present government is trying to rationalizing the tariff and moving toward cheaper energy mix for energy supplies especially for electricity generation.

14.2: Energy Supply

In 2013, indigenous energy availability was 65,639 thousand tonnes of oil equivalent (TOE) while total primary energy supplies remained 64, 588 thousand tonnes of oil equivalent (TOE) showing that almost 2 percent of energy was lost during the conversion process.

Figure14.3 shows the trends of energy supply of Pakistan by sources.

Figure 14.3: Primary Energy Supply By source



Source: Energy Years Book, various issues, HDIP

In 1995 the total energy supply of Pakistan was 28 million TOEs. The main sources of energy supply at that time were Oil 41.6 percent, gas 36.8 percent, electricity 15.5 percent and coal 5.8 percent. In 2013 the energy supply of the economy increased to 64 million TOEs with an annual average (1995 to 2013) growth rate of 4 percent. There was not only increase in energy supply but also a very clear change in the patterns of energy sources had been seen. The share of oil decreased to 32.5 percent while the share of gas increased to 48.2 percent in 2013 on account of rise in oil prices internationally, which led the supplier to shift toward gas which is a relative cheaper source. However this shift exerted

pressure on domestic resources of gas, however, in terms of efficiency, oil is still considered as an efficient source of primary energy supplies.

14.2.1 Oil

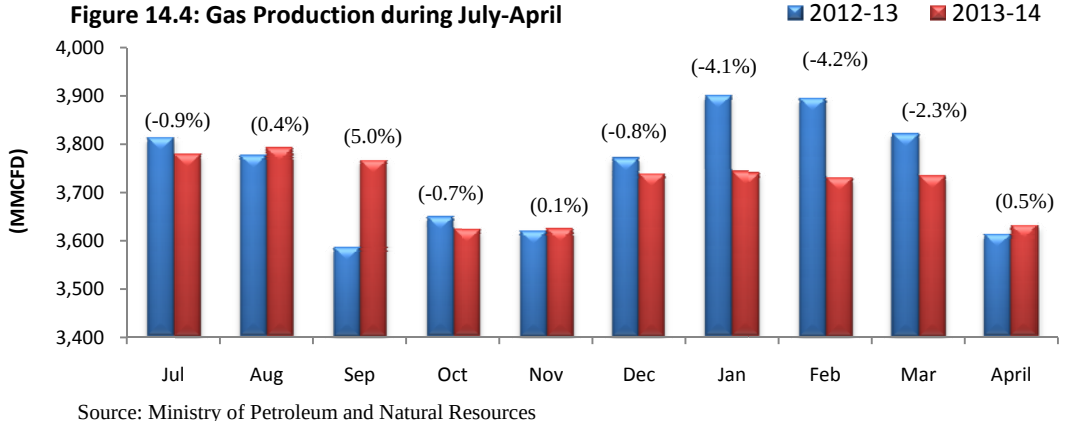
Overtime there was changing pattern in major sources of energy supply, still reliance on oil and gas is highest which has exposed the country to many risks and brought negative repercussions on the economy. Oil is mostly an imported source of energy for Pakistan, the price of which has been increasing continuously especially in last few years. The price of oil was $ 10 per barrel in 1995 which increased to $ 110perbarrels in May 2014 showing an increase of almost hundred times as compared to its price in 1995. This also led to an increase in oil prices domestically, escalating to Rs 107 per liter in May 2014 from Rs 9 per liter in 1995. The cost of generating one unit at IPP thermal plant has increased manifold i.e., Rs.18/- per KWh when produced on furnace oil and Rs.24/- per unit when produced through diesel, while the average sale price of electricity in Pakistan is about Rs. 9/- per KWh. In other words, every unit generated by an IPP involves a subsidy of Rs 9 to Rs 15 per KWh. That is the root cause of the growing problem of circular debt. Furthermore, Pakistan has exhausted more than half of the original domestic recoverable oil reserves. On June 30, 2013, original recoverable reserves were 1,102.6 million barrels with 731.5 million barrels(68 percent) cumulative production of oil and 371.0 million barrel (32 percent) balance recoverable reserves. Further a huge amount is paid on account of import of crude oil. The import of crude oil remained 44.9 million barrel during July-March FY 14 compared to 40.9 million barrels in corresponding period last year posting a growth of 11 percent while local crude extraction posted a growth of 12 percent as it stood at 23.0 million barrels in July-March FY 14 compared to 20.5 million barrels in corresponding period last year. In monetary values, US $ 4.3 billion was spent on import of petroleum crude compared to US $ 4.0 billion in corresponding period last year posting a growth 6.2 percent.

Realizing the risk and challenges involved due to high use of petroleum crude, the Government of Pakistan is trying to explore domestic resources. Thus on January 21, 2014 the government provisionally awarded 50 petroleum exploration blocks to eight companies including both local and foreign companies. The total area of these blocks is about 103,348 Sq. Kms which is around 38 percent of the area already under exploration. Out of 50 blocks, 21 blocks are located in Baluchistan, 15 in Punjab, 8 in Khyber Pakhtunkhwa and 6 in Sindh. After execution of agreements for these blocks, the exploration activities in the country will pick a new momentum and provinces will get immediate financial benefits in terms of social welfares and rentals. During the current fiscal year, 73 numbers of wells have been spudded and 18 discoveries have been made. Although oil is efficient primary energy supply yet due to continuous rise in its prices, gas has substituted oil in many ways being a cheaper source of energy supplies.

14.2.2 Gas

The original domestic recoverable reserves of natural gas were 55.6 trillion cubic feet on June 30, 2013. 30.9 trillion cubic feet (56 percent) was the cumulative production and 24.7 trillion cubic feet (44 percent) was balance recoverable reserves. When compared with domestic recoverable reserves of natural gas on June 30, 2012, these were 56.0 trillion cubic feet which represent that 0.38 trillion cubic feet of natural gas reserve are depleted. A comparison of gas production during July – April for current year and last year is shown in Figure 14.4 below:

Figure 14.4: Gas Production during July-April



Source: Ministry of Petroleum and Natural Resources

The worrisome factor is that our gas reserves are depleting and if gas consumption grows annually even at moderate rates, the present recoverable reserve will largely be exhausted by 2025. As this limit approaches the marginal cost of gas supplies will rise.

To avoid such a situation we have two choices: efficient use of gas and an increase in the gas exploration rate along with diversification of energy mix. Realizing this fact, the government is attracting foreign investment to explore new fields. Although exploring of natural gas is sub-component of mining and quarrying, yet on a positive note it should be noted that both private and public gross fixed capital formation in mining and quarrying at basic prices of 2005-06 had shown positive growth of 25 percent in FY 14 that earlier had declined to 14 percent in FY 13.

Increasing demand of natural gas with its limited supply has made room for Liquefied Petroleum Gas (LPG) which is also a primary source of energy. Currently about 1000 tons/day LPG is being produced domestically contributing less than 1 percent to the total energy supply mix. Because of its characteristics LPG is fast becoming a fuel of choice in the areas, where natural gas distribution network is not available. Pakistan Petroleum Limited (PPL) is the pioneer of the natural gas industry in the country which operates six producing fields in Sui, Kandhkot, Adhi, Mazarani, Chachar and Hala while Oil and Gas Regulatory Authority (OGRA) is empowered to regulate the LPG sector under OGRA Ordinance 2002 and LPG (Production & Distribution) Rules 2001 w.e.f 15th March, 2003. OGRA has simplified the procedure for grant of LPG license and the same is granted on fast track basis once the requirements are met / compiled. During July-Dec, 2013 two licenses for construction of LPG storage and filling plants were issued. In addition, OGRA has also issued 15 licenses for construction of LPG auto refueling station. OGRA is playing a vital role to increase private investment on midstream and downstream petroleum industry, During July- December, 2013 an investment of Rs. 0.264 billion has been made in LPG infrastructure whereas total investment in the sector till end of this fiscal year is estimated about Rs. 17.464 billion.

Natural gas and LPG are considered as cheaper than oil but both are expensive than coal and fortunately Pakistan has huge coal resources estimated to exceed 185 billion tons which generally ranks from lignite to sub-bituminous. However, less focus has been given to this cheaper primary energy supply.

14.2.3 Coal

The share of coal in energy supply is almost stagnant to 6 percent since 1995. The federal and provisional governments have started giving importance to coal exploration and development activities. The federal government has been striving hard for optimum development and utilization of indigenous coal resources and pursuing the policy of promoting coal based power generation. A summary of the efforts made in this regard is presented below:-

i. The federal government sponsored discovery and evaluation of Thar coal deposits, development of infrastructure in this coal-field and studies to determine its mine ability and for gasification incurring more than Rs 2.000 billion.

ii. Lakhra Coal Development Corporation has been set up as a joint venture of Pakistan Mineral Development Corporation, WAPDA and Government of Sindh to fulfill coal requirement of 150 MW Khanote Power Plant.

iii. The Finance Division has sponsored under PSDP a pilot project for Underground Coal Gasification at Thar Coal Block- V.

iv. Federal Government is pursuing the policy of promoting coal based power generation and conversion of oil and gas-based power plants to indigenous/imported coal that would later on, be replaced by Thar coal depending upon its availability.

Government of Sindh has leased out a coal block for an integrated mining project and power generation to increase the share of coal. The details are as under:-

a) Government of Sindh has entered into a joint venture with M/s Engro Powergen (Pvt) Limited for Coal Mining in Block-II and established a Company under Companies Act, 1984 viz. “Sindh Engro Coal Mining Company” for development of Coal Mine and installation 600-1000 MW Power Plant.

b) M/s Cougar Energy UK limited has been allocated Block-III in Thar coalfield for extraction Underground Coal Gasification and establishing 400 MW Power Plant.

c) M/s Bin Daen Group, UEA has been allocated Block-IV in Thar coalfield for developing Coal Mine and installing 1000 MW Power Plant.

d) One Block has been allocated to Planning Commission of Pakistan for Plot Project 50 MW based on Underground Coal Gasification Project in Block-V Thar coalfield. In this connection, the Government of Sindh has notified Governing Body under the chairmanship of Dr. Samar Mubarakmand for the project.

e) M/s Oracle Coalfield Plc, UK has been allocated Block –VI in Thar coalfield for developing Coal Mine and installing Power Plant of 300 MW extendable up to 1000 MW.

f) M/s China National Machinery Import and Export Corporation of China (CMC) conducted feasibility study for 400 MW integrated coal mining and coal-fired power plant at Sonda-Jerrick in district, Thatta.

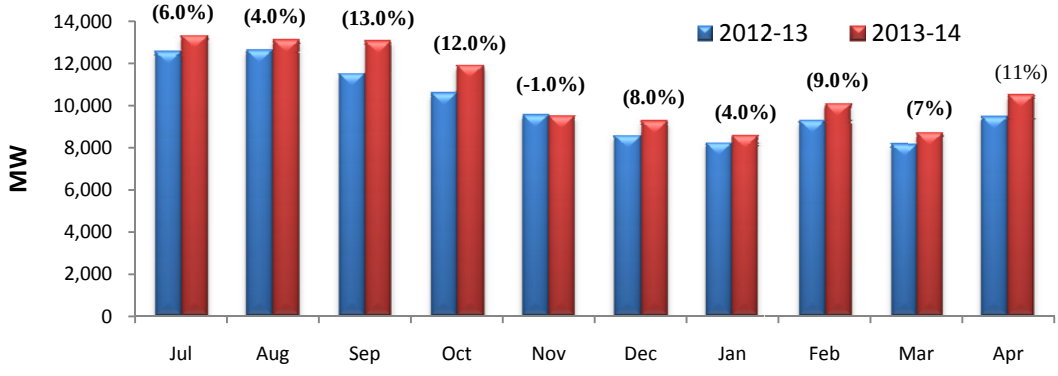
g) Government of Sindh entering into another J.V with M/s Al-Abbas Group Company with allocated area in Badin coalfield for developing Coal Mine and installing Coal-fired Power Plant of 300-600 MW.

It is expected that with ongoing efforts of both federal and provincial governments, the share of coal in primary energy supply will increase and will lead to cheaper energy mix which when use in electricity generation will reduce the cost.

14.2.4 Electricity

Electricity is a secondary energy source which is obtained by converting primary sources like gas, oil, coal, nuclear power and other natural sources. There was decline in share of electricity in energy supply as it declined from 15.5 percent in 1995to 12.9 percent in 2013. The installed capacity in the PEPCO system is 22,812 MW as of June 2013; with hydro 6,773 MW, thermal 15,289 MW and nuclear 750 MW. Thus the hydropower capacity accounts for 29.7 percent, thermal 67.0 percent and nuclear 3.3 percent. Of this 11,493 MW is owned by WAPDA and ex-WAPDA GENCOs, 2,216 MW by KESC, 750 by PAEC, and rest by IPPs. However, one critical issue is that electricity generated is almost fifty percent of installed capacity due to inefficient recovery system, lack of wear and tear of plants and inappropriate fuel mix. A comparison of electricity generation during July – April for current year and last year is shown in Figure 14.5below:

Fig-14.5: Comparative Data of Electricity Generation July-April



Source: Ministry of Water and Power

Private Power and Infrastructure Board (PPIB) is a 'One Window' facilitator to the private investors in the field of power generation on behalf of the Government of Pakistan (GOP). PPIB, since its inception has successfully managed capacity addition of around 8,657 MW through establishment of twenty nine (29) IPPs. PPIB is currently processing nineteen (19) multiple fuel (Oil, Coal, Gas and Hydel) based Independent Power Producer (IPP) projects with a cumulative capacity of around 8,835 MW. Out of these nineteen in process IPP projects, fifteen (15) projects having a cumulative capacity of 6,948 MW are based on hydro, whereas, the remaining four (4) projects having a cumulative capacity of 1,887 MW consist of two (2) gas based projects, one (1) oil based project and one (1) coal based project.

Government of Pakistan aims to achieve power generation mix through development of indigenous energy resources particularly hydel and coal. The government is committed to arrange timely finances for these projects and monitor their development regularly in order to complete them as per schedule. It is expected that 16, 564 MW power generation will be added in the national grid system through various resources by completing the new projects which will reduce / eliminate load shedding during next four years. The detail of the project is given below:

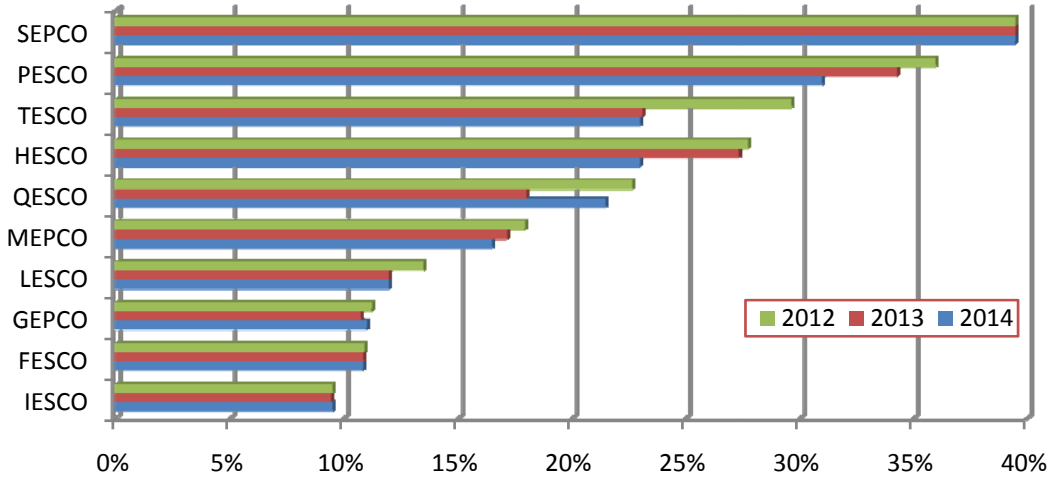
Table 14.1: New Projects

Year	Name of Project	Capacity	Agency	Fuel
2014	Guddu-1	(243 MW)	GENCOs	Gas
	Nandipur Power Project	(425 MW)	GENCOs	Oil
	Guddu-2	(243 MW)	GENCOs	Gas
	Quaid-e-Azam Solar Park (Phase-I)	(100 MW)	PPDB	Solar
	Quaid-e-Azam Solar Park (Phase-II)	(300 MW)	PPDB	Solar
	Guddu Steam (3)	(261 MW)	GENCOs	Gas
2015	Quaid-e-Azam Solar Park (Phase-III)	(600 MW)	PPDB	Solar
2016	Neelum Jhelum Hydel	(969 MW)	WAPDA	Hydel
	Golen Gol	(106 MW)	WAPDA	Hydel
	Patrind HPP	(147 MW)	PPDB	Hydel
2017	Terbela 4th Extension	(1410 MW)	WAPDA	Hydel
	Coal Plant at Sahiwal	(1200 MW)	PPDB	COAL
2018	Coal Plant at Jamshoro	(1320 MW)	GENCOs	COAL
	Thar Coal Plant	(1320 MW)	GENCOs	COAL
	Coal Plant Larkana	(1320 MW)	GENCOs	COAL
	Gaddani Power Park	(6600 MW)	Public + Pvt	COAL
Upto 2018 Total Generation Addition		**16564 MW**		

Source: Pakistan Electric Power Company Ltd

After generation of electricity, the Distribution Companies (DISCOS) are mainly responsible for supplying electricity to consumers and collecting bills. So another critical point after inefficiency in the generation stage is that the main DISCOs do not perform well in terms of transmission and distribution (T & D) losses.

Figure 14.6: Comparison of T & D losses among DISCOs



Source: National Electric Power Regulatory Authority

Another worrisome factor is that NEPRA recommends a tariff structure with incentive to efficient DISCOs and punishment to inefficient ones in order to reduce their respective transmission and distribution losses. However, the unified tariff structure notified by the government disallows this incentive as a result the combined losses of the inefficient DISCOs have to be borne by the federal government. Thus electricity generation become over expensive one due to costly input and other due to transmission and distribution losses. This high cost of generation coupled with rise in price of furnace oil substantially has raised the cost of thermal power generation. The government thus intervenes through subsidies realizing that the power being necessity of life will become unaffordable to majority of people. However, this also results in circular debt and when the present government paid

the unsustainable level of circular debt there was 1752 MW increase in capacity utilization.

To diversify the primary energy supply in the generation, Pakistan Atomic Energy Commission (PAEC) produce electricity through nuclear plants. By this time three nuclear power plants are operational. The first nuclear power plant i.e. Karachi Nuclear Power Plant (KANUPP) completed its 30 years design life in 2002.

14.2.5 Nuclear Energy

Pakistan Atomic Energy Commission (PAEC) is responsible for planning, construction and operation of nuclear power plants in the country. PAEC is currently operating three nuclear power plants Karachi Nuclear Power Plant (KANUPP), Chashma Nuclear Power Plant Unit-1 (C-1) and Unit-2 (C-2). The construction of two more units C-3 and C-4 of 340 MW each is in progress. The second and third nuclear power plants i.e., (C-1 and C-2) are performing very well. Performance of all three operating nuclear power plants is given in the following Table 14.3:

Table 14.2: Electricity generation

S.No	Source	Capacity addition (MW)
IPPS – Fuel Operated Plants		
1	KAPCO	282
2	HUBCO (RFO)	363
3	HUBCO Narowal (RFO)	204
IPPS – Gas Operated Plants		
4	Liberty (Gas)	193
5	Saif Power (Gas & HSD)	56
6	Halmore (Gas & HSD)	48
GENCOs		
7	Jamshoro (RFO)	388
8	Guddu (Gas)	136
9	Muzaffargarh (RFO)	82
	Total	**1,752**

Source: Ministry of Water and Power

Table 14.3: Performance of the Operating Nuclear Power Plants in Pakistan

Plants	Gross Capacity (MW)	Grid Connection Data	Electricity sent to Grid (million KWh)	
			July 1, 2014 to March 31, 2014	Lifetime upto March 31, 2014
KANUPP	100	18-Oct-71	291	13,004
C-1	325	13-Jun-00	1,840	26,781
C-2	330	14-Mar-11	1,866	6,096

Source: Pakistan Atomic Energy Commission

The construction of fourth and fifth nuclear plants, Chashma Nuclear Power Plant unit 3 & 4 (C-3 and C-4) at Chashma site, is ahead of the schedule. The Domes on containment buildings of C-3 and C-4 were placed on the 6th March, 2013 and 2nd January, 2014, respectively. Status of under construction nuclear power plant is given in the following Table 14.4:

Table 14.4: Status of under construction nuclear power plant

Plants	Gross Capacity (MW)	First Concrete Pour Date	Target Commercial Operation Date
C-1	340	4-Mar-11	30-Apr-16
C-2	340	18-Dec-11	31-Dec-16

Source: Pakistan Atomic Energy Commission

PAEC is implementing nuclear power program 2030 set by Energy Security Plan of the Government of Pakistan. The ground breaking ceremony of Karachi Coastal Power Project (K-2 and K-3) was held on 26th November, 2013. To meet the targets, sites are being identified for more under power plants. Technical and engineering infrastructure is in place to provide technical support to existing under construction and future nuclear power plants

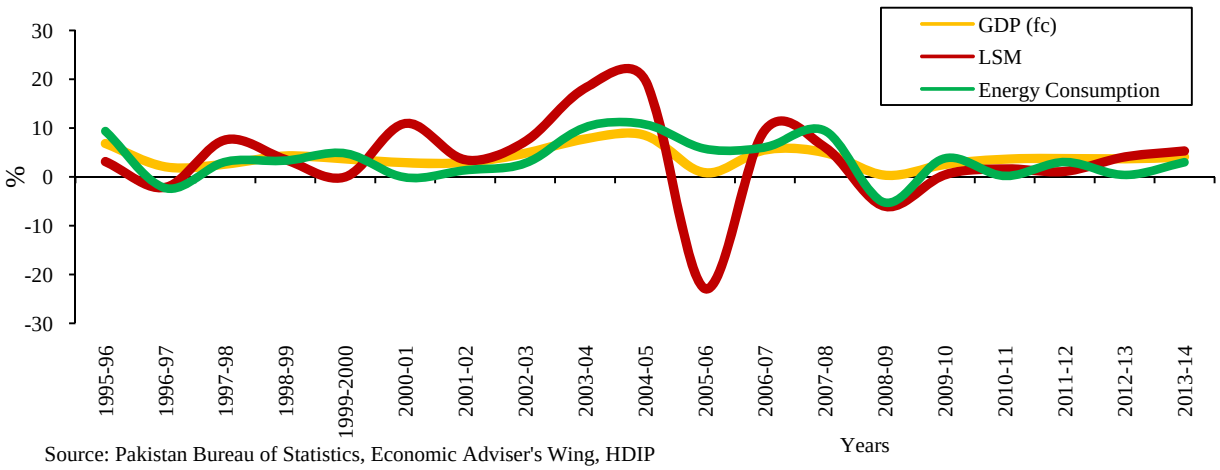
One reason of energy crises is expensive input and if timely efforts are not made for cheaper energy mix, the problem can be more severe in future. The government is committed to achieve less oil dependent power generation mix through development of indigenous energy resources particularly hydel and coal. Recently, the Executive Committee of the National Economic Council (ECNEC) approved four development projects in power sector having a combined generation capacity of 3,511 MW. The approved projects include K-I and K-II Nuclear Projects situated in Karachi (Province of Sindh; generation capacity 2,200 MW), Nandipur (Province Punjab; generation capacity 425 MW; cost Rs 57,380 million) and Neelum-Jhelum hydroelectric project (AJK; generation capacity 969 MW). Government of Pakistan is committed to arrange timely finances for these projects and monitor their development regularly in order to complete them as per schedule. Also one other

diversification in using energy mix in the generation of electricity is by producing electricity by Co-Generation for which government is seriously thinking. Co-Generation is a high efficiency energy system that produces both electricity (and mechanical power) and valuable heat from a single fuel source. Pakistan being the fifth largest sugarcane producer in the world has the potential to generate electricity of almost 2,000 MW through Co-Generation. Bagasse (process waste of sugar industry) is a fibrous residue of cane stalk obtained after crushing. When burned in quantity, bagasse produces sufficient heat energy to supply all the needs of a typical sugar mill, with energy to spare. To this end, a secondary use of bagasse is in Co-Generation. Development of Co-Generation plants based on high pressure boilers is gaining momentum worldwide. Thus Co-Generation by sugar mills by utilizing bagasse and coal provides one of the most economically viable options for thermal power generation, earlier it remained unexploited in Pakistan.

14.3.Energy Consumption

Energy consumption is the amount of energy left for final use after subtracting energy lost in transformation and distribution from primary energy supplies. It is considered as the oxygen of an economy and the lifeline of the economic growth particularly in the industrialization stage of an emerging economy. The importance of energy consumption in the economic growth can be realized from the fact that the excessive productivity slowdown around the world in 1970s which was primarily due to oil crises. Prior to 1970s, economic growth and prosperity of a country in the long run depends on the basic factors of production like labor, capital and land. Economists mostly link the relationship between these factors of production and economic output through the production functions. However, for considerable amount of time, economists did not consider energy as a factor of production and ignore its importance in the production process. Arrow's learning by doing and Hick's induced innovation did not include resources or energy explicitly in their models. However lately, the geological economists have given energy a key role in the production process. They placed huge emphasis on the role of energy and its availability in the production and growth processes. These models have shown that scarcity of energy imposes a strong hindrance in the economic growth of a country. Similarly is the case of Pakistan. In past, Pakistani policy maker and planners had given less importance to energy in development plan. During period of higher economic growth, failing to implement proper energy plans for addressing future needs of the country resulted in cyclical pattern in their relationship. The fluctuation in energy consumption affected the large scale manufacturing growth which in turn affected the real GDP growth as shown in figure below:

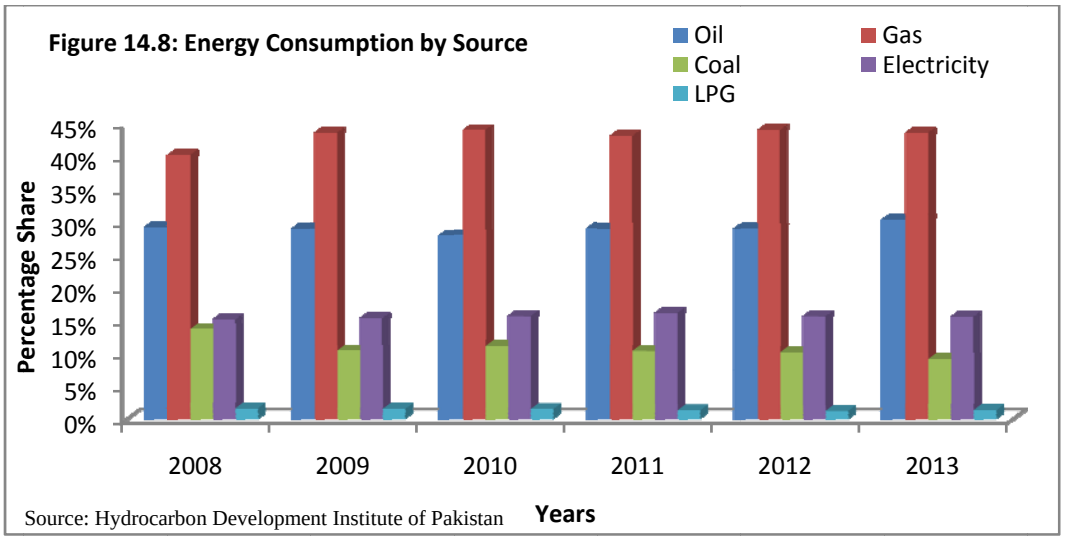
Fig-14.7: Relationship between growth rate of Real GDP, LSM and Energy Consumption



Source: Pakistan Bureau of Statistics, Economic Adviser's Wing, HDIP

During FY 13 energy consumption was 40,185 million TOEs compared to 40,026 million TOEs in FY 12 showing a growth of 0.4 percent. The current fiscal year much improvement has been seen in economic activity due to better available energy for usage on account of relatively less losses in transformation and distribution as compared to last year.

Although by source gas has the major share in energy consumption, however, since 2008 its share is almost stagnant 43 to 44 percent and due to rise in prices of oil there is decline in its share in energy consumption.

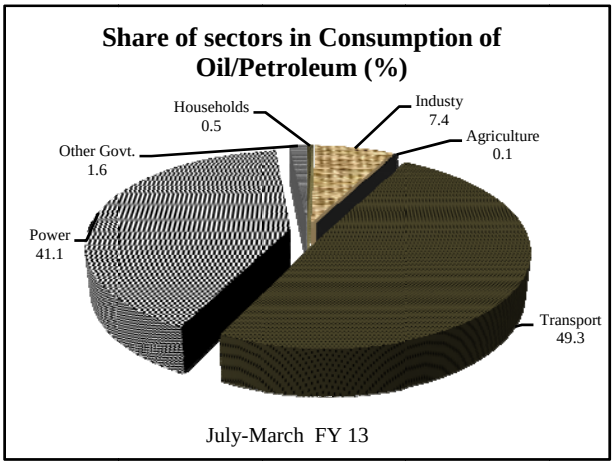


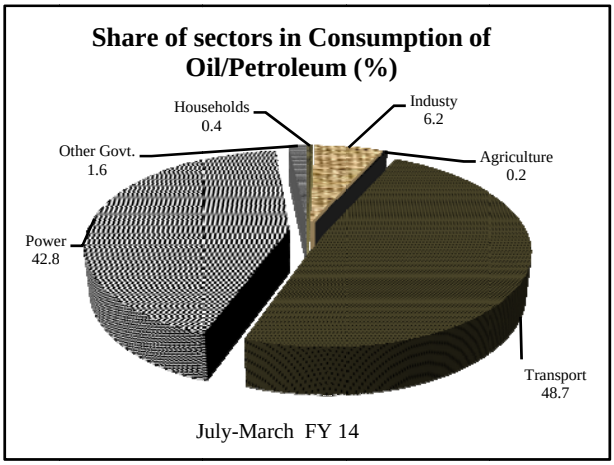
Source: Hydrocarbon Development Institute of Pakistan

14.3.1 Oil (Petroleum Product)

Transport and power sectors remained the highest sector in the usage of oil / petroleum products. However, during last two decade there is significant increase in the usage of oil in power sector as the share increases to 40.0 percent in 2013 while usage of oil in transport sector is almost stagnant, the reason is that majority of commercial transport still use oil and there is negligible shift toward CNG while usage of oil in household decline that show the shift toward CNG from oil. The decline in usage of oil in agriculture and industry could be linked to decline in activity due to power shortage. During July-March FY 14, the composition of usage of oil / petroleum product is little variant from that in corresponding period last year as shown below:

Figure 14.9: Share of sectors in consumption of Oil / Petroleum





Source: Hydrocarbon Development Institute of Pakistan

During July – March FY 14, share of power in oil consumption is increased by 1.7 percentage points while share of transport and industry decreased by 0.8 and 0.6 percentage point, respectively, when compared the same during July – March FY 13.

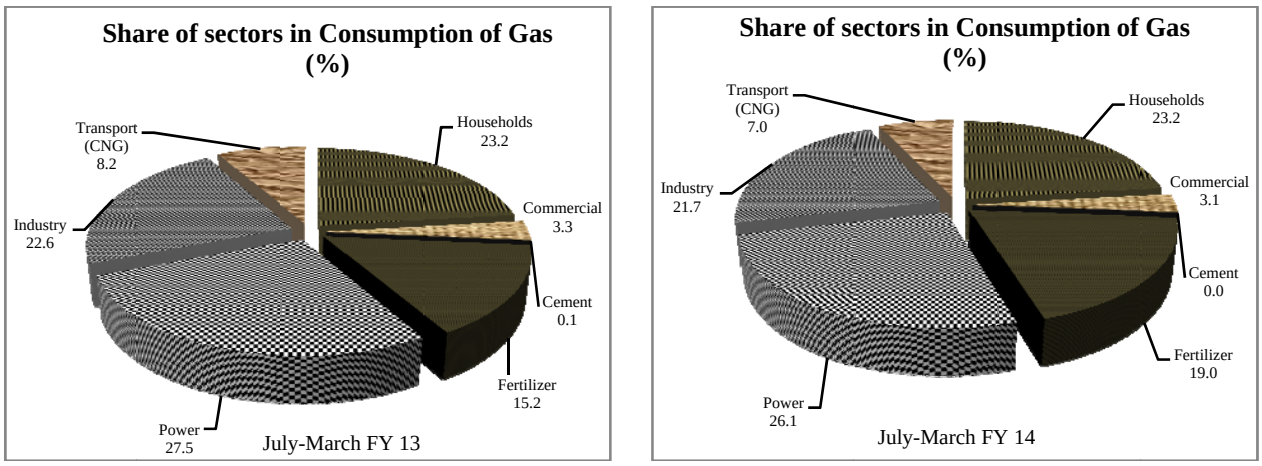
During FY 13 the import bill of petroleum group was US $ 14.9 billion. If to look into quantity terms it was 19.2 million metric tons including 12.3 million metric tons of petroleum products and 6.9 million metric tons of petroleum crude. During July-March FY 14, the import bill of petroleum posted a negative growth of 1.3 percent. The value of import of petroleum products stood at US $ 6.6 billion during July-March FY 14 compared to US $ 7.0 billion during corresponding period last year posting a negative growth of 5.6 percent. However, value of import of petroleum crude increased by 6.2 percent as it was US $ 4.3 billion during July-March FY 14 compared to US $ 4.1 billion during corresponding period last year. There was positive growth in quantities of both petroleum products and petroleum crude (5.0 percent and 4.3 percent respectively). The main reason attributed to the increase in quantity and

decrease in value of petroleum product is declining prices of petroleum products globally. Even there was global increase in price of petroleum crude, no change in its consumption pattern had been seen which reflect that petroleum crude is an inelastic product.

14.3.2 Natural Gas

Pakistan is the larger consumer of the gas. The households, power, fertilizer and industry are the major end user of gas. In last two decades the pattern of consumption of gas among its users is changed. There was sharp decline in gas consumption in fertilizer industry which had negatively affected performance of fertilizer sector. In FY 13, the main reason of abnormal reduction in gas supply was due to frail functioning of SNGPL-based fertilizer plants, confronting the worst gas crisis which caused a sharp decline in the overall production. Four fertilizer plants on the SNGPL network, including Pakarab, Dawood Hercules, Engro's new plant and Agritech, remained the main sufferers of the gas shortages. During July-March FY 14, the share of fertilizer industry in gas consumption increased to 19 percent which was 15 percent in corresponding period last fiscal year. This major upturn was due to commitment of the government to provide gas to household, power industry and fertilizer industry on priority basis. However, the usage of gas in power industry is declining as power industry can substitute oil with gas. Till FY 13, there was increase in the use of gas (CNG) as input in transport, however due to load management in gas sector there were prescribed hours / days for supplying CNG that had caused decline in the share of transport in gas consumption as shown below:

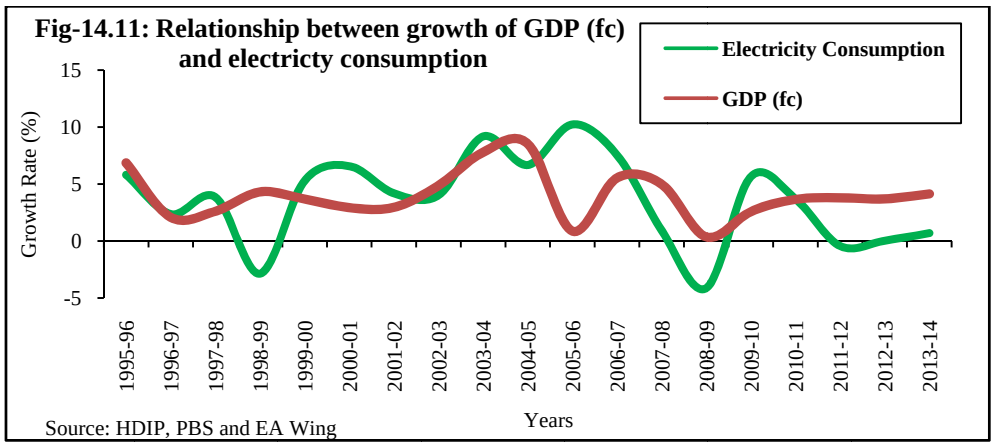
Figure 14.10: Share of sectors in consumption of Gas



Source: Hydrocarbon Development Institute of Pakistan

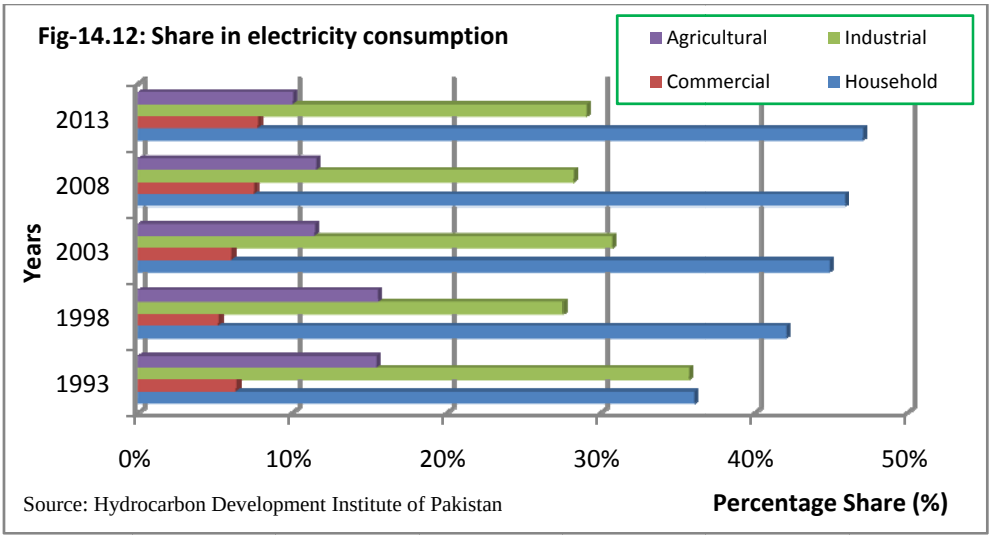
14.3.3 Electricity

The consumption of electricity has increased rapidly and is the highest among all sources of energy. One prime reason is technological advancement which also brought significant change in lifestyle of people. There is cyclical relationship between economic growth and electricity consumption. It implies that the period of higher growth is followed by higher growth rate of electricity consumption which is obvious in the sense that growth improves the standard of living or production by utilizing advance technological goods. Likewise, lower growth of GDP will negatively affect the growth of consumption of electricity as shown below:

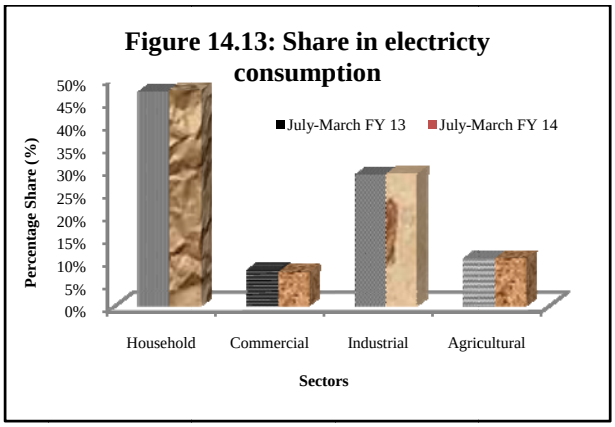


Source: HDIP, PBS and EA Wing

The lower growth in electricity consumption can be occurred due to loss of growth momentum and lower growth in consumption of electricity in one period will lower the growth of GDP in next period. Policy makers need plans to address the growth in consumption of electricity that will occur due to higher growth in GDP which otherwise will slow down the pace of growth in coming years.



Prior to unbundling of WAPDA to present, all sectors exhibit a change in their electricity consumption pattern, especially industry and household. The share of industry decreased from 36 percent in 1993 to 29 percent in 2013 because large industrial units are using own captive unit because of load shedding. Increase in usage of electrical home appliance due to technological improvement made the share of residential electricity consumption increased to 47 percent in 2013 from 36 percent in 1993. In case of agriculture sector, electricity consumption decreased from 15 percent in 1993 to 10 percent in 2013, this show the structural transformation away from agriculture sector to industrial and services sector. The share of agriculture in real GDP declined to 21 percent from almost 26 percent in 1990s.However, there is no significant change in the consumption pattern of commerce. However, during July-March FY 14, the composition of share of electricity consumption is almost similar to that in corresponding period last year as shown below:



14.3.4 Coal

Pakistan's coal generally ranks from lignite to sub-bituminous. Coal consumption is varying since 2000. About 39.1 percent of total coal consumed in the country has been utilized by brick kilns industry and 56.1 percent by cement factories, showing decrease of 3.46 percent and increase of 1.83 percent, respectively. Almost whole cement industry has been switched over from furnace oil to coal hence utilization of ingenious coal is gaining momentum.

Pakistan has huge coal resources estimated to exceed 185 billion tons; including 175 billion tons, identified at Thar coal fields (Sindh Province) alone. The power project at Port Qasim had a special significance due to importance of Karachi in Pakistan's economy and it can play a crucial role in the economic development of Pakistan. Since the production of electricity from the coal fired power plants is cheaper, ten coal-fired power projects, with a capacity of 660 MW each, are being initiated at Gadani in Baluchistan, which would add a total of 6,600 MW in the national grid.

14.4 Alternative Sources of Energy

The Government of Pakistan (GoP) is taking all possible measures to ensure energy security and sustainable development in the country. The government in its bid to diversify its energy mix, has been giving due attention towards fast track development of Alternative / Renewable Energy (ARE) resources in the country. Alternative Energy Development Board (AEDB) has been mandated to

act as a central agency for development and promotion of Alternative & Renewable Energy (ARE) technologies in the country and to facilitate the private sector investment in this sector.

Steps Taken By AEDB to Attract Investment in the Sector

AEDB has undertaken a number of supportive measures in order to promote ARE technologies and to attract private sector investments, which include;

- Identification of new corridors for wind and solar energy projects development. Resource assessment of these corridors is underway.
- National Grid Code for wind power projects has been amended. Grid Integration Plan 2010 -2015 for wind power projects has been developed by AEDB to support NTDC.
- Local manufacturing of micro wind turbine has been started. Manufacturing for large wind turbines is also being encouraged. M/s DESCON has setup a wind turbine tower manufacturing facility and has provided towers for the first wind project in Pakistan. M/s Three Gorges Corporation / CWE (China) has also established a tower manufacturing facility which will be upgraded to wind turbine assembling facility in future.
- Issues related to financing of projects have been resolved and now leading financing agencies like International Finance Corporation (IFC), Asian Development Bank (ADB), Overseas Private Investment Corporation (OPIC), Economic Cooperation Organization (ECO), Trade Bank etc. are offering financing to wind power projects in Pakistan.

14.4.1 Wind

- Thirty five wind power IPPs holding LOIs issued by AEDB are at various stages of project development.
- Operational (Achieved Commercial Operations Date)
  - FFC Energy Limited: 49.5 MW wind project, Jhampir, Distt. Thatta, Sindh
  - Zorlu Enerji (Pvt.) Ltd. 56.4 MW wind project, Jhampir, Distt. Thatta, Sindh.
- Under Construction
  - 50 MW Three Gorges First Wind Farm Pakistan (Pvt.) Ltd., Jhampir Sindh
  - 50 MW Foundation Wind Power I Ltd. Khuttikun, Gharo, Sindh
  - 50 MW Foundation Wind Power II (Pvt.) Ltd., Khuttikun, Gharo, Sindh
- Twelve projects with a cumulative capacity of 630 MW are expected to achieve Financial Close by 2014.
- NERPA announced a new upfront tariff of US cents 13.5244 per kWh on 24th April 2013 for 500 MW wind power projects. The wind power companies interested in opting Upfront Tariff will have to achieve Financial Close of their project by September 30, 2014.

14.4.2 Solar

- In Solar Energy, 24 LOIs for cumulative capacity of approximately 792.99 MW On-Grid Solar PV power plants have been issued. Four (4) companies have submitted the feasibility studies of their projects and one feasibility study is approved by AEDB. Other sponsors are at the stage of preparation of feasibility studies
- Solar Village Electrification Program was initiated under PM's directive. 3000 Solar Home Systems have been installed in 49 villages of district Tharparkar, Sindh. Another 51 villages in Sindh and 300 villages in Baluchistan have been approved for electrification using solar energy and will be implemented shortly.
- AEDB in light of SRO 575(1)12006 issued duty exemption certificates for a large number of solar panels / solar modules to private sector companies for installation / generation of almost 64.57MW of energy in the country. These solar panels / solar modules are deployed all over the country.
- AEDB issued tax exemption certificate for import of almost 16715 units of Solar Water Heaters in the country. These heaters are deployed all over the country especially in Baluchistan, Gilgit-Baltistan, Khyber Pakhtunkhwa and Northern Punjab.
- AEDB also issued tax exemption certificate for import of about 1429 units of Solar Water Pumping System in the country. These water pumping systems are installed for community drinking and agriculture purpose all over Pakistan.

14.4.3 Biomass / Waste-to-energy

Framework for power Co-Generation has been approved by ECC for bagasse/biomass based sugar industry projects. 1500-2000 MW of power is expected to be generated in next 2-3 years. LOIs has been issued to following investors / sugar mills under this framework;

- M/s JDW Sugar Mills Unit-II (26 MW), Rahim Yar Khan, Punjab.

- M/s JDW Sugar Mills Unit-III, (26 MW), Ghotki, Sindh.
- M/s Hamza Sugar Mills Ltd., (15 MW)
- M/s RYK Sugar Mills Ltd., (19 MW) Rahim Yar Khan, Punjab.
- M/s Chiniot Power Plant, (15 MW), Chiniot, Punjab.

14.4.4 Small / Mini / Micro Hydro

- Eight hydro projects have been initiated under the Renewable Energy Development Sector Investment Program (REDSIP) with the support of Asian Development Bank (ADB). These projects are being implemented in Khyber Pakhtunkhwa and Punjab with an estimated cost of US $ 290 Million.
- Another 02 small hydro power projects have been initiated under REDSIP. PC-I for these projects have been approved. Loan approval from ADB is awaited.
- The Government of Punjab issued LOIs to private investors for establishment of 10 small hydro projects with a cumulative capacity of 142 MW at different location in Punjab.
- AEDB is building capacities for private sector investment in Khyber Pakhtunkhwa (22 projects of cumulative 92 MW capacity through Pakhtunkhwa Hydel Development Organization (PHYDO) and Punjab (30 projects of cumulative 240 MW capacity through Energy Department / Punjab Power Development Board (PPDB).
- AEDB initiated a program with the assistance of GIZ support to assist the provinces solicit private investments in small hydro sector; under this program Pre-Feasibility Studies for 25 hydro sites in AJK, Sindh, Punjab and Khyber Pakhtunkhwa with the cumulative capacity of 284.14 MW have been completed.
- Public sector Hydro power projects initiated in:
  - Khyber Pakhtunkhwa (worth U$ 150.99 Million, of 17.0MW, 36.6MW and 2.6 MW)
  - Punjab (worth U$ 138.74 Million, of 5.38MW, 4.04MW, 2.82MW, 4.16MW and 7.64MW)
  - Gilgit-Baltistan(worth U$ 71.12 Million, of 26MW and 4MW).

14.4.5 Clean Development Mechanism (CDM)

CDM is one of the instruments that developers of the Alternative and Renewable Energy (ARE) Projects pursue and earn financial returns by getting their projects registered with CDM Executive Board and selling the accrued Certified Emission Reduction (CER) certificates in the international carbon market.

Way Forward

Realizing the criticality of energy for economic growth, it is the main focus of Pakistan Vision 2025. The vision aims at ensuring uninterrupted access to affordable and clean energy for all sections of the population and aimed at resolving structural changes within the energy sector are fundamental to future economic prospects. The main elements of this vision include:

1. Optimize energy supply mix–economic, scalable, indigenous by 2025
2. Reduce “cost per unit”
3. Reduce supply gap by 2018 and exceed demand gap by 2025
4. Create and encourage culture of conservation and efficiency in the usage of energy

Nonetheless, these projects have long digestion period and would come in to system in few years. It is also highlighted that through efficient reallocation of natural gas based on economic sense is essential to get best value for money.