Karachi Chamber of Commerce & Industry (KCCI)

The gateway to economic prosperity…

August 2013

ENERGY SCENARIO IN PAKISTAN

A product of
Research & Development Cell (KCCI)

Aiwan-e-Tijarat Road, Off: Shahrah-e-Liaquat, Karachi-74000
URL: www.kcci.com.pk
Email: res@kcci.com.pk

Published by KCCI
Aiwan-e-Tijarat Road, Off: Shahrah-e-Liaquat, Karachi-74000

This book has been prepared by the team of analysts of KCCI Research & Development Cell (KCCI Research), comprising of Uzma Taslim, Shehzad Mubashsher, Sidra Arshad and Bilal Ahmed. Although this book contains information from sources believed to be trustworthy it is not guaranteed that the matter is accurate or complete, nor KCCI accepts any responsibility for the consequence of its usage. Furthermore, the judgments included within do not necessarily reflect the views of KCCI's members and its management.

MESSAGE BY PRESIDENT

KARACHI CHAMBER OF COMMERCE & INDUSTRY

کراچی چیمبر آف کامرس اینڈ انڈسٹری

Muhammad Haroon Agar
President

Ref.: KCCI/President/1-8/65/2012-13/9335
Date: 21st January, 2013

Foreword by President KCCI

Karachi Chamber of Commerce & Industry (KCCI), to disseminate meaningful information to business and industrial community particularly about promoting trade and industry and allied matters, is in practice to publish trade directories, trade journals, sector specific reports and research publications. It is my privilege to present 'Energy Scenario in Pakistan', a research report by Karachi Chamber of Commerce & Industry based on internal research by its Research and Economic Development Department which is engaged in compiling dependable database, studies on trade and industry and reports on micro and macro-economics of the country.

The KCCI's book reveals present, past and future energy scenario of Pakistan. Energy: a luxury of past –a dire need for today, will act as lifeline for every segment of the society tomorrow. Presently, Pakistan is facing worst ever energy crises of its history. With the passage of time, demand of energy is surging with rapid speed. Every business associated with any line of activity requires sufficient quantity of energy to run the affairs and without it, business cannot stand its pace. To enhance Pakistan's GDP growth rate and to cater the needs of 180 million people, supply of energy necessitates for enhancement on war-footing. The prevailing energy crisis in Pakistan is taking away 2 to 4 percent of GDP or Rs380 billion from the economy, despite the government has spent Rs1.1 trillion as subsidy on these sectors in the last four years, which accounts for 2.5 percent of the total volume of economy.

Although, numbers of research reports are available on this subject, but this report underlines the effects of energy scarcity, on business and industrial activities. The KCCI's Research Report on Energy will enable the reader on one side to understand the actual situation and possible solutions to prevailing energy crises scenario and on other side underscore to make future plans and to prepare feasibilities for setting new units by public and private sector. As the energy-hungry country, the state of affairs demand to produce energy from all available resources vis-à-vis Coal, Wind, Solar, Thermal, Biofuel, Nuclear, and other alternate energy sources. The policy makers' attention is invited to explore the untapped energy-generation areas while studying energy models of Canada, USA and India. We hope that the policy makers would take cognizance to provide the necessary felicitation to the business community of Pakistan accordingly.

I recognize the patronage and guideline of Mr. Siraj Kassam Teli, Chairman Businessmen Group and former President KCCI to compile this book. I also appreciate Mr. A. Q. Khalil, former President KCCI for his effort and advisory to Research and Economic Development Cell of KCCI. I also congratulate Mr. Akhter Jameel Rehmani, Chairman of Research and Economic Development Sub-Committee and Mr. S.M.H. Rizvi, Secretary General of KCCI for their hard work and other personnel of KCCI who supported during compilation of research report till publication.

Karachi Chamber of Commerce & Industry, with its vision "Contributing in the Economic Prosperity of Pakistan", endeavours to bring more research publications soon.

Looking forward to have your valuable comments and suggestions.

Muhammad Haroon Agar

KCCI's Building, Aiwan-e-Tijarat Road,
Off: Shahrah-e-Liaquat,
Karachi-74000 (Pakistan)

E : president@kcci.com.pk
W : www.kcci.com.pk

D : +92 21 9921 8020/30
P : +92 21 9921 8001-9
F : +92 21 9921 8040

MESSAGE OF CHAIRMAN R &D

KARACHI CHAMBER OF COMMERCE & INDUSTRY

کراچی چیمبر آف کامرس اینڈ انڈسٹری

Akhter Jameel Rehmani
Member Managing Committee
Chairman
Research & Eco. Development Cell
Sub-Committee 2012-2013
Email:res@kcci.com.pk

MESSAGE

Energy is the most important part and parcel of every goings-on and it gains much importance if we talk about business activity. As the time passes on, the dearth of energy in Pakistan, surges like any other issue. KCCI, being as a torch bearer of the premier and largest Chamber of the Country, the management decided with a vision to highlight the importance of Energy and their importance on Business & Industrial Sector with a decisive research publication. Important particulars of Energy situation in Pakistan along with numerical and statistical data of imperative details has been collected in this Book which help to understand the scenario, the increasing demand of energy and the most important its impact on business .

I congratulate Research & Development Cell, KCCI for preparing this intensive research report. The R & D Cell has been working hard and has carried out important studies/reports related to trade and industry to provide maximum benefits to KCCI members in particulars and business community in general.

I pay my heartiest gratitude to Mr. Siraj Kassam Teli, Chairman Businessmen Group and Former President KCCI, Mian Abrar Ahmad, Former President of KCCI and other former office bearers, who took the initiative of publication under view, sitting office bearers Mr. Muhammad Haroon Agar, President KCCI, Mr. Shamim Ahmed Firpo, Senior Vice President KCCI and Mr. Nasir Mehmood, Vice President KCCI, Mr. A.Q. Khalil, Former President KCCI for their valuable support and encouragement at all the times.

In the end, I felicitate Mr. S.M.H.Rizvi, Secretary General KCCI and Research Team of R & D Cell for compiling and updating such a useful publication. I hope that this publication provides maximum facilitation and understanding to KCCI members to acquire data for their businesses.

Akhter Jameel Rehmani

FOREWORD

The energy situation in Pakistan has turned into a crisis marked with intense load shedding of electricity, gas outages, heavy oil import bill and cash crunch in the energy chain. The situation could not be controlled even though the country is blessed with enormous resources including several rivers, lakes, mountains, abundant fertile lands, live stocks, coal and other mineral resources, oil and gas reserves, strong wind flows, sea with wide coast lines, sharp sunny days and many other options that could be utilized as a source of energy or for electricity generation. Then what makes the situation uncontrollable and why a long lasting solution could not be achieved since long?

The country has to import crude oil and petroleum products to meet its energy requirement which remains an expensive proposition. Although, gas is a cheaper and more environment friendly alternative but the availability of this resource is also not sufficient to meet the demand. Gas is also being used to generate electricity from thermal power plants at relatively lower cost but the supply constraints have limited the power generation through this resource. As more and more locomotives have started to be run on compressed natural gas due to price differential with other POL products, the gas outages have further aggravated. There are abundant coal reserves in the country but this resource also remains mostly unutilized.

Long, scheduled and unscheduled hours of load shedding have become a norm leading to increased frustration in the general public which sometimes also takes the form of rampages and protests on the streets. The electricity cuts coupled with gas shortages have intensely hampered the functioning of industrial units, leading to closure of some units, lack of investment and more workforce getting unemployed. The continued energy crises for the past several years have restrained the GDP growth of the country.

Although, more than 3,000 MW of new electricity generation capacity has been added to the system over the past couple of years, the situation still remains precarious where demand supply continued to widen, possibly due to the reasons that the devised plans, strategies, controls and/or implementations are not adequate to manage the needs.

The severe issues of line losses and thefts have resulted in burdening the national kitty in the form of subsidies while it has also burdened the pockets of honest consumers of the utilities that pay their bills properly while also share the cost burden of thefts and line losses. This situation is further intensified with expensive power generation resulting in increased non-payment due to which circular debt continues to pile up.

The book tries to identify and explain the different energy sources, prevalent energy situation in Pakistan along with a comparison with world, possible reasons leading to energy crises, different alternatives available or could be developed in Pakistan and other measures that are required to meet the energy requirements. There is much more to what seems to be the apparent causes of energy crises. The book aims to identify the loopholes in the system and highlight feasible/possible solutions in the given economic and political situation of the country.

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INTRODUCTION

Energy is the most discussed subject and has become a basic necessity for the societies. It is an essential factor on to which economies depend and prevail. Self-sufficiency in energy leads to prosperity and economic growth in the country. The oil and gas reserves are limited and constantly depleting at an increasing rate to meet the growing demand in the world. The reserves would soon end if the consumption continues at the current pace of growth. For that reason, to maintain continuity of energy supply, alternative energy resources have gained more significance and therefore, they are being explored on a fast track.

The importance of energy generation cannot be underestimated due to its pivotal share in the industrialization process of the country. During the fiscal year 2011-12, the total power generated in the country was 98,664 GWh of which the share of thermal electricity generation was 66 percent, hydel power plants contributed 29 percent and nuclear power plants added 5 percent to the bulk.

The increasing share of expensive thermal electricity generation has led to increased receivables of the utilities companies. Hence, there is a strong need of the time to increase the hydel generation or explore other cheaper renewable and alternative energy sources. This means that Pakistan needs to rethink on its energy policy shifting towards more feasible options for the generation of electricity.

In the world, the share of electricity produced by the gas is 19 percent while in Pakistan it is 41 percent, nuclear energy's share in world total energy is 16 percent while in Pakistan it is only 2.84 percent, hydro-generated electricity's share in world is 16 percent which is 37 percent in Pakistan while electricity produced from oil is only 7 percent in world but in Pakistan it is 19 percent. Likewise, the share of electricity generation through coal is 40 percent in the world while in Pakistan it is 0.16 percent, as per the estimates of World Bank.

Although, the nameplate generation capacity of Pakistan is sufficient to meet the existing electricity demand of the consumers, however, the actual generation remains much below the capacity. The capacity mostly remain underutilized in the back drop of liquidity crunch due to circular debt and inefficiencies in power plants, due to which the electricity shortfall even widens to as high as 6000MW during peak times.

The power situation in KESC is also not very different from that of PEPCO's system. It is also experiencing load-shedding for hours but according to a policy of the KESC's management, the duration of load shedding is relatively low in certain areas where the theft level is low and consumers mostly pay their bills diligently and honestly. However, the situation still has a lot of room for improvement whereby theft could be properly controlled leaving no room for malpractices and continuous distribution of electricity is ensured.

The Government has formulated a new energy policy which envisages recommending an energy mix as a way forward where energy mix would mean regime change under which focus from thermal power will be shifted to cheaper energy production like coal-based power generation. It also proposed phasing out subsidy on the power sector but also recommending subsidy protection for consumers using 300 or below units of electricity per month.

The power generating capacity is planned to increase by 2026 MW in PEPCO's system in FY14 with the addition of Nandipur Power Project (425MW), Guddu New CC (747MW), Rehabilitation of GENCOs (245MW), Uch II power plant (404MW), Three Gorges Wind Farm (50 MW), Pakistan Wind Energy (5MW), Hydropower Dawood Power (50MW) and Foundation Energy I & II of 50MW each.

The reasons behind energy crises have been poor management, lopsided priorities and lack of accountability on part of those who stay at the helm of affairs. The circular debt remained a major contributor for aggravating the energy crises.

The circular debt began to surface in 2008 due mainly to the decision of the Government of Pakistan of not notifying various tariff increases by NEPRA from 2003 to 2007 and instead used to pay the differential cost from its own kitty in the form of subsidies. However, after the sharp increases in oil prices at the global level in 2008, the government lost the capacity to continue subsidizing the energy sector. Changing its stance of fully financing the tariff differential as subsidies, the GoP has more than doubled the tariffs since 2008.

On the supply side, circular debt had forced the Oil Marketing Companies to limit their supply to power producers, while at the same time the gas supply to the power sector has been at minimum levels. The government was impaired with the capacity to meet the financial requirements of IPPs which in turn hampered their productivity. Increased dependence on imported fuels also greatly undermined the GOP's efforts to overcome circular debt issue. Theft and line losses have remained yet another major contributing factor in piling up the circular debt which requires stringent administrative measures to control them. There should be no room for theft and dishonesty and prompt punishments and penalties should be enforced across the board without any exception.

Pakistan has the all the resources, skills and expertise to overcome the energy crises but what is missing is the concerted efforts, proper plans of action and strategies. At best there could be some short and long-term solutions to the crisis but they need immediate planning and execution with an enormous investment. Two key elements of a possible solution could be the change of attitude and change in lifestyles.

The country has many alternatives available which can be utilized to deal with the electricity shortfall. After analyzing different alternatives, we have come up with a conclusion that a multi-

pronged strategy is required and several projects accompanied by strict scrutiny and administrative measures are the need of the day. Pakistan should strive to expand the use of renewable energy to help bridge the gap of energy deficiency in the country. The country is blessed with natural resources that can be utilized to create electricity.

Renewable resources that are technologically viable and have prospects to be exploited commercially in Pakistan include wind energy, solar energy, micro-hydel, bio-energy, and emerging technologies like fuel cell. Pakistan can benefit from these resources and can supplement existing energy resources as well as can use as primary energy source when no other option is available.

PART I

TECHNICAL ASPECTS OF POWER & ELECTRICITY

Important Concepts of Energy Sector

The book includes several technical terms which may or may not be familiar to the readers. Therefore, in order to improve the understanding, brief explanations of some major terms have been highlighted below:

Watts or Mega Watts

It is crucial to understand the basic concepts before we start defining what we need. The term Megawatt is tossed around a lot. Watts (W) are the yardstick for measuring power. A one hundred Watt light bulb, for example, is rated to consume one hundred Watts of power when turned on. If such a light bulb were on for four hours it would consume a total of 400 Watt-hours (Wh) of energy. Watts, therefore, measure instantaneous power while Watt-hours measure the total amount of energy consumed over a period of time.

A MW is one million Watts and a kW is one thousand Watts. Both terms are commonly used in the power business when describing generation or load consumption. Many things can sustain the transfer or consumption of energy on this scale; some of these events or entities include: large electric motors, naval craft, engineering hardware, and some scientific research equipment. A large residential or commercial building may consume several megawatts in electric power and heating energy. The productive capacity of electrical generators operated by utility companies is often measured in MW. On railways, modern high-powered electric locomotives typically have a peak power output of 5 or 6 MW.

This confusion arises because power and energy are frequently confused by the general public. Power is the rate at which energy is generated and consumed. Watt is the measurement of Power and watt hour is the measurement of the energy. For example, if a light bulb with the power of 100 Watts is turned on for one hour, the energy used is 100 Watt-Hour (Wh) or 0.1 kilowatt-hour. This same quantity of energy would light a 40-watt bulb for 2.5 hours or a 50-watt bulb for 2 hours. A Power Station is rated in watts, but its annual energy output is in watt-hours (or kilowatt-hours or megawatt-hours). A Megawatt-hour is the amount of energy equivalent to a steady power of 1 Megawatt running for 1 hour. Therefore when we say that Pakistan has an installed capacity of 19,500 MW it means the total capacity of Power plants is to produce 19,500 MW of power every hour.

Capacity

It is defined as the amount of electric power for which a generating unit, generating station, or other electrical apparatus is rated either by the user or manufacturer. The term is also used for

the total volume of natural gas that can flow through a pipeline over a given amount of time, considering such factors as compression and pipeline size.

There are various types of electricity capacity:

- **Dependable Capacity**: The system's ability to carry the electric power for the time interval and period specific, when related to the characteristics of the load to be supplied. Dependable capacity is determined by such factors as capability, operating power factor, weather, and portion of the load the station is to supply.

- **Installed (or Nameplate) Capacity:** The total manufacturer-rated capacities of equipment such as turbines, generators, condensers, transformers, and other system components.

- **Peaking Capacity:** The capacity of generating equipment intended for operation during the hours of highest daily, weekly or seasonal loads.

- **Reserve Capacity:** Extra generating capacity available to meet peak or abnormally high demands for power and to generate power during scheduled or unscheduled outages. Units available for service, but not maintained at operating temperature, are termed "cold." those units ready and available for service, though not in actual operation, are termed "hot."

Capacity Factor

This is the ratio of what a power plant produces on average and its total or rated capability. For example a 100 MW rated wind farm has a capability of producing 100 MW during peak winds, but it will produce much less when wind speed is less. As a result over the course of a year this farm may produce only average 30 MW of power production. This means the wind farm has a 30 percent capacity factor (30 MW average productions divided by 100 MW rated capability).

Similarly, a 1,000 MW plant may produce on average 750 MW of production over one year period. This is because the plant will shut down for maintenance from time-to-time and the plant may be operated at less than its rated capability. Therefore the plant would have a 75 percent capacity factor (750 MW average divided by 1,000 MW rated capability).

For renewable energy such as wind or solar, the equivalent of capacity factor is even less because they typically produce less energy than conventional generators since their "fuel source" is intermittent**.** Then there are common sense basic factors such as that no one generator would be considered sufficient by itself to supply. All generators must be stopped for maintenance and

service. For these reasons power systems require the use of backup generation sources and occasionally electric energy storage, such as batteries, to ensure the amount of power generated always matches the load demand, every second.

Availability factor

Availability factor of a power plant is the amount of time that it is able to produce electricity over a certain period, divided by the amount of the time in the period. Occasions where only partial capacity is available may or may not be deducted.

Load Factor

This is calculated by dividing the average load by the peak load over a certain period of time. For example if the residential load was on average 5,000 MW over a year and the peak load was 10,000 MW, then the load factor for residential customers is 50 percent (5,000 MW average divided by 10,000 MW peak).

To properly plan a power system it is critical to know the peak and average demand. The power system must be designed to serve the peak load although the actual load will vary. The load might be peak at noon, but only 40 to 50 percent at midnight.

The capacity or load factor is used by planner to get the pattern of this variation. A 50 percent load factor would indicate large variations, while a 90 percent load factor would indicate little variation. Residential customers to have low load factors that is high variation, while industries will have very high load factors with minimal variation because they operate 24 hours a day, 7 days a week.

Ramp up Speed

This is change of power per hour: Watts per hour (W/h) is useful to characterize this ramp-up speed of power plants. For example, a power plant that reaches a power of 1 MW from zero in 15 minutes has a ramp-up rate of 4 MW/h. Hydroelectric power plants have a very high ramp-up speed, which makes them particularly useful in peak load and emergency situations.

British thermal unit (Btu)

It is the standard measure of heat energy. It takes one Btu to raise the temperature of one pound of water by one degree Fahrenheit at sea level. Another related term is the heating value which is the amount of heat produced by the complete combustion of a given amount of fuel. A term “mmbtu” is widely used when referring to energy sector which stands for one million British thermal units.

Distribution system (Electric utility) / Disco

The substations, transformers and lines that convey electricity from high-power transmission lines to ultimate consumers are referred to as the distribution system. While the distribution company (Disco) is a regulated electric utility entity that constructs and maintains the distribution wires connecting the transmission grid to the final customer. The Disco can also perform other services such as aggregating customers, purchasing power supply and transmission services for customers, billing customers and reimbursing suppliers, and offering other regulated or non-regulated energy services to retail customers.

Fuel Cell

It is a device or an electrochemical engine with no moving parts that converts the chemical energy of a fuel, such as hydrogen, and an oxidant, such as oxygen, directly into electricity. The principal components of a fuel cell are catalytically activated electrodes for the fuel (anode) and the oxidant (cathode) and an electrolyte to conduct ions between the two electrodes, thus producing electricity.

Gasification

The process where biomass fuel is reacted with specific quantities of air and oxygen usually under high pressure and temperature along with moisture to produce gas which contains hydrogen, methane, carbon monoxide, nitrogen, water and carbon dioxide. The gas can be combusted in an engine-generator to produce electricity. Gasification is also the production of synthetic gas from coal.

Geothermal Energy

Geothermal energy is the natural heat present within the earth, captured for production of electric power, space heating or industrial steam.

Independent power producer (IPP)

It is a private entity that operates a generation facility and sells power to electric utilities for resale to retail customers.

Load Management

Load Management includes steps taken to reduce power demand at peak load times or to shift some of it to off-peak times. This may be with reference to peak hours, peak days or peak seasons.

Dams

In case of Dams the water flow is restricted by making a huge storage device and the head of water is increased, then the water is allowed to flow by means of gates and pass through the turbines, the head of reservoir level is maintained to provide uniform power, and the water stored in peak season additionally is used for irrigation purposes in dry seasons. In run of river projects the water is diverted through the tunnels and once it gains the head allowed to fall and pass through the turbines and back to river. The water in these projects is continuously flowing and not being stored.

Renewable energy and resources

Renewable energy sources include solar, wind, geothermal, hydro, wood and natural heat in the earth. Renewable resources also include some experimental or less-developed sources such as tidal power, sea currents and ocean thermal gradients.

Renewable energy resources are naturally replenished though their flow is limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can probably be replenished. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy efficiency) technologies.

Turbine generator

A device that uses steam, heated gases, water flow or wind to cause spinning motion that activates electro-magnetic forces and generates electricity.

Heliostat

Heliostat is a device that includes a mirror which turns so as to keep reflecting sunlight toward a predetermined target, compensating for the sun's apparent motions in the sky. The target may be a physical object distant from the heliostat or a direction in space.

Typically heliostats are used for day lighting or for the production of concentrated solar power, usually to generate electricity. They are also sometimes used in solar cooking. A few are used for research and experiment purpose and even to reflect motionless beams of sunlight into solar telescopes.

Sources of electricity generation

Thermal power plant

A thermal power plant runs by converting heat energy to electricity. It is typically driven by steam where water is heated and turned into steam which spins the steam turbine and in turn the electrical generator. After passing through the turbine, the steam is condensed and recycled. To run the plant, different fossil fuels resources may be used for heating like furnace oil, coal and natural gas. Thermal power plants may also be through nuclear, geothermal, waste incineration or solar thermal electric source. The power plants that burn coal, fuel oil or natural gas are often termed as fossil fuel power plants.

Nuclear energy

Nuclear energy originates from the splitting of uranium atoms in a process called fission. Fission releases energy that can be used to make steam, which is used in a turbine to generate electricity. Though the share of nuclear energy is not significant but its importance cannot be denied. The nuclear energy is a source of electricity generation is being recognized very rapidly all over the world.

Hydro-electric power plants

Hydel or hydro power refers to the power derived from the energy of falling water and running water, which is converted into electricity by connecting it to turbine generators. Water flowing in the rivers has kinetic energy. This kinetic energy is used to drive turbines and produce electricity, and the power thus generated is called hydel energy. Power produced by the turbines depends on quantity of water flowing per minutes and the head of water available.

The power extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. Annual electric energy production depends on the available water supply.

The approximate electric power production at a hydroelectric plant can be calculated by the following simple formula:

Power in watts = density of water x height x flow rate x acceleration x co-efficient of efficiency

Where the density of water is measured in ~1000 kg/m^3; height in meters (m); flow rate in m^3/sec; acceleration due to gravity of 9.8 m/s^2 and co-efficient of efficiency ranging between 0 and 1 depending on the efficiency of the installed turbines.

Several techniques are associated with hydel source of electricity generation as stated below:

Pumped-storage

Under the method of pumped storage electricity is produced by moving water between reservoirs at different elevations to generate more electricity to meet the peak demand. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir. When there is higher demand, water is released back into the lower reservoir through a turbine. Pumped-storage schemes are the most commercially viable means of large-scale grid energy storage and improve the daily capacity factor of the generation system.

Run-of-the-river

Run-of-the-river hydroelectric stations are those hydel power plants that are available with small or no reservoir capacity, so that the water coming from upstream must be used for generation at that moment, or must be allowed to bypass the dam.

Tidal power

A tidal power plant makes use of the daily rise and fall of ocean water due to tides; such sources are highly predictable. If conditions allow constructing reservoirs, it can also be utilized to generate power during high demand periods. Less common types of hydro schemes use water's kinetic energy or undammed sources such as undershot waterwheels. However, tidal power is viable in a relatively small number of locations around the world.

Underground

An underground power station makes use of a large natural height difference between two waterways, such as a waterfall or mountain lake. An underground tunnel is constructed to take water from the high reservoir to the generating hall built in an underground cavern near the lowest point of the water tunnel and a horizontal tailrace taking water away to the lower outlet waterway.

Wind energy

Wind energy is a very cheap source of generating power, in windy areas. Wind power can be converted to electric power by using wind turbine. Wind energy has been utilized since ancient times where, conventional windmills were used for conversion to mechanical power, wind pumps for water pumping or drainage, or sails to propel ships.

Almost all large wind turbines have the same design — a horizontal axis wind turbine having an

upwind rotor with three blades, attached to a nacelle (cover) on top of a tall tubular tower. In a wind farm, individual turbines are interconnected with a medium voltage (often 34.5 kV), power collection system and communications network. At a substation, this medium-voltage electric current is increased in voltage with a transformer for connection to the high voltage electric power transmission system.

A wind farm is a group of wind turbines in the same location used for production of electricity. Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network. Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms provide electricity to isolated locations. Utility companies increasingly buy surplus electricity produced by small domestic wind turbines. The windmill can also be used for pumping water for crops, grinding corn crushing sugarcane thrashing, cutting of wood etc.

Biomass / Waste-to-Energy

Biomass/Waste to Energy has been recognized as a clean, reliable, renewable source of energy. Unfortunately in Pakistan this source of energy has not been utilized for power generation in the past. The growing urbanization and changes in the pattern of life has given rise to generation of increasing quantities of wastes and it's now becoming another threat to our environment. However, in recent years, waste-to-energy technologies have been developed to produce clean energy through the combustion of municipal solid waste in specially designed power plants equipped with the most modern pollution control equipment to clean emissions.

Biomass and waste to energy plants are used not only to generate sufficient power but also used to clean up the environment as well by conserving non-renewable fossil fuel resources and reducing the environmental impacts of trash disposal. Biomass and waste-to-energy facilities can also contribute to the country's economy by providing jobs apart from generating electricity.

Bagasse can be a good source and an available resource which can be utilized to generate electricity in Pakistan. Bagasse is the scrap of sugarcane or sorghum stalks left after the extraction of juice. It can be utilized as a good source of fuel which is relatively cheaper. Sorghum is a genus of numerous species of grasses, one of which is raised for grain and many of which are used as fodder plants, either cultivated or as part of pasture.

Biomass has several technological and environmental benefits which are highlighted below:

1. Biomass and waste to energy plants conserve fossil fuels by generating electricity. One ton of MSW combusted reduces oil use by about 45 gallons; or coal use by about 0.28 tons.
2. It has been estimated that one ton of MSW combusted rather than land filled reduces greenhouse gas emissions by 1.2 tons of carbon dioxide.
3. Biomass and waste to energy plants do not have the aqueous emissions that may be experienced in landfills, either now or in the distant future.
4. Biomass and waste to energy plants save the space required for land filling.
5. Biomass/Waste to Energy projects has the benefits over conventional energy resources projects that they do not emit any effluents, pollutants and residues. These are considered to be most environmental friendly technologies which are very much supportive in reducing emissions and developing healthy environment.
6. All over the world, renewable energy projects have been implemented to avoid dependency over the conventional resources which have been a source of effluent emissions and endangering the environment. The international organizations and institutes including financing organization have been encouraging such projects which utilize renewable energy technologies for the generation of power.

Biogas

Biogas, one of the most significant types of biomass energy, makes optimal utilization of the valuable natural resource of dung. It provides (soot-free) clean gas for meeting cooking and energy needs as well as enriched bio-fertilizer for improvement of fertility/ productivity of agricultural lands. Promotion of the biogas technology seems to be one of the best options, which cannot only partially offset the fossil fuel from wood consumption but also facilitates recycling of agro-animal residues as a bio-fertilizer. Moreover, being clean and renewable, it will also contribute towards environment protection, sustenance of ecosystem and conservation of biodiversity.

Biogas has proved to be a viable technology in the physical and socio-economic conditions. Pakistan is rich in Biogas potential, the technology provides nearly three times more useful energy than that dung directly burnt, and also produces nutrient-rich manure. Besides production of Biogas, the Biogas Plants can result in improving economic and financial conditions at micro as well as macro level and abating emission of greenhouse gases that has been polluting the environment due to its direct exposure.

Some waste treatment methods / technologies used to produce gas & electricity are indicated below:

- Through Gasification; electricity can be produced from hot gases.
- Through Anaerobic Digestion; gas can be extracted from the waste and can be used for the power generation purposes.
- Converting the waste into Refuse Derived Fuel (RDF).
- Through Plasma technology; electricity can be produced.

Biodiesel

Biodiesel is a clean-burning alternative to petroleum diesel made from domestic, renewable resources such as vegetable oils, recycled cooking oil and animal fats. Generally Biodiesel is produced by a process called trans-esterification. In this process, the vegetable oil or animal fat is reacted with methanol or ethanol and a catalyst, such as Sodium Hydroxide / Potassium Hydroxide, to produce a methyl ester - the Biodiesel. The methanol or ethanol and the catalyst used in the process are recovered and can be re-used. The by-product of biodiesel production is glycerin, which can be used for other purposes.

Biodiesel can be used in virtually any diesel engine without modification. It can be used in its pure form (called B100) or as a blend with diesel fuel at any ratio. The most commonly used form of biodiesel is a 20 percent blend of biodiesel with 80 percent petroleum diesel, known as B20.[1]

Jatropha plant can be used for the production of bio-diesel. It is a poisonous, semi-evergreen shrub or small tree which is resistant to a high degree of aridity, allowing it to be grown in deserts. Its seeds contain 27-40 percent oil that can be processed to produce a high-quality biodiesel fuel, usable in a standard diesel engine. It can be intercropped with high value crops such as sugar, coconut palm, various fruits and vegetables, providing protection from grazing livestock and protection action against pests and pathogens.

Solar Photovoltaic

Solar PV cells convert solar energy in to electricity that is used to charge batteries to provide lights during night. Solar energy has excellent potential in Pakistan that receives high levels of solar radiation throughout the year.

Solar energy is a potentially available renewable energy source in this region. This source can be utilized as an excellent alternative to fossil fuels for these areas. Solar energy resource is planned

[1] *http://www.aedb.org/BioDiesel.htm*

to successfully utilize for household applications and electrification of remotest villages of these areas. The outcomes of this program are social uplift, betterment and provision of basic amenities of life.

Solar Energy is available at a rate of 1000 watts per square meter in Pakistan. This can be converted to DC electricity with the help of Solar Photovoltaic cells, which may be used to pump water, operate fans, TV and telecommunications directly during daytime. The electrical energy generated during the day time (5-8 hours of sunshine), can also be stored in deep cycle lead acid batteries which can be used at night to provide power for lighting, radio, television and fans. The system will be user-friendly and designed as a stand-alone system for each household, who will be trained to operate and maintain it. The user will only be required to switch on/off the system, as is done in normal home lighting systems. In addition, Solar Photovoltaic Panels can generate enough electricity to pump water from depth of 350 ft., 700 ft. and up to 1000 ft.

Solar thermal energy (STE)

A solar thermal energy is a technology that utilizes solar energy for thermal energy which could be converted to electricity through a thermal power plant.

There are three types of Solar Thermal Technologies that are mature and are being installed in many developed places such as USA, Spain, Israel, Greece, and developing countries like Mexico, Morocco, India and Egypt. These technologies are Solar Parabolic Trough Technology[2]; power towers in which centrally located thermal receivers is illuminated with a large field of sun-tracking heliostats; and dish / stirling system.

Parabolic trough power plants utilize Concentrated Solar Power (CSP) technology. It is currently the cheapest and most proven technology for solar thermal power generation. Its major components are parabolic shaped mirrors, highly efficient absorber tubes and conventional turbines. The sunlight is concentrated on the absorber tube, located in the focal line of the mirrors. Using parabolic collector technology, solar power can be produced in capacities of up to over 200 MW.

A Stirling system consists of a parabolic dish concentration, a thermal receiver and a stirling engine or generator planted at the focus of the dish. The parabolic dish concentrator tracks the sun and diverts solar energy into a receiver where it is absorbed and transferred to the stirling generator. These systems have high efficiencies, low maintenance operation and high power densities. These units can be assembled into plants ranging in size from few kilowatts to tens of

[2] *http://www.aedb.org/Solarthermal.htm*

megawatts. These systems are generally used in water pumping, grid connected power in developing countries, end-of-line power conditioning and in remote areas.

Geothermal energy

Geothermal energy is referred to as the energy found and stored within the earth. It is mainly formed by the radioactive decay associated with very high temperatures at the core of the earth. The high temperature and pressure cause some adjacent rocks to melt, creating magma which further penetrates and heats rock and water in the crust of the earth. This energy can be converted into electrical energy by apply special technologies like dry steam power plants, flash steam power plants and binary cycle power plants.

Geothermal power stations are similar to other steam turbine thermal power stations - heat from a fuel source (in geothermal's case, the earth's core) is used to heat water or another working fluid. The working fluid is then used to turn a turbine of a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.

- **Dry steam power plants -** It is a simple plant that directly use geothermal steam to turn turbines.
- **Flash steam power plants -** Flash steam plants pull deep, high-pressure hot water into lower-pressure tanks and use the resulting flashed steam to drive turbines and require fluid temperatures of at least 180°C, usually more.
- **Binary cycle power plants –** It is a newer technology which can accept fluid temperatures as low as 57°C. The moderately hot geothermal water is passed by a secondary fluid with a much lower boiling point than water due to which the secondary fluid to flash vaporize and drives the turbines.

Second-generation biofuels

Recently, several researches are underway on the development of many second-generation biofuels like cellulosic ethanol, Algae fuel, bio-hydrogen, bio-methanol, DMF, BioDME, Fischer-Tropsch diesel, bio-hydrogen diesel, mixed alcohols and wood diesel. Cellulosic ethanol production uses nonfood crops or inedible waste products. The success of these technologies would further redefine the energy scenario in the world.

PART II
GLOBAL ENERGY DYNAMICS

Global Energy Scenario

The importance of energy generation cannot be underestimated due to its ability to illuminate and to run machines, thereby having a pivotal share in the improving the living standards and industrialization across the world. Electricity, which is the most essential of all other forms of energy, is considered to be a key element in the socio economic development of the countries. On the contrary, it is also the single largest contributor of climate-change and greenhouse-gas emissions. The global energy map is changing, with potentially far-reaching consequences for energy markets and trade. It is being redrawn by ever rising use of fossil fuel, rapid growth in the use of wind and solar technologies and by the global spread of unconventional gas production and could be further reshaped by a retreat from nuclear power in some countries.

As per International Energy Agency (IEA) estimates, global energy demand is expected to grow by more than one-third over the period to 2035 in the New Policies Scenario, with China, India and the Middle East accounting for 60 percent of the increase. Energy demand would barely rise in OECD (Organization for Economic Co-operation and Development) countries, although there is a pronounced shift away from oil, coal (and, in some countries, nuclear) towards natural gas and renewable energy sources[3].

Many countries have been subsidizing their energy sector to manage the local energy prices. The cost of fossil-fuel subsidies has surged considerably during last few years due to higher oil prices which have burdened many world economies. According to IEA, overall subsidies for fossil fuel consumption amounted to US$ 523 billion in 2011[4]. Subsidies utilized to maintain the supply of fossil fuels have more costs than benefits; therefore, subsidies should preferably be directed to contain pollution arising therefrom, and for conducting research activities to develop renewable or alternate sources of power generation and low carbon energy technologies.

Current Global Energy Statistics

According to the data provided by a private firm Enerdata, the total world primary energy production increased by 2.1 percent in the year 2012 where the total primary energy production of world stood at 13,399Mtoe in 2012 as against 13,127Mtoe in 2011[5].

Likewise, the total primary energy consumption inched up to 13,157Mtoe in 2012 as against

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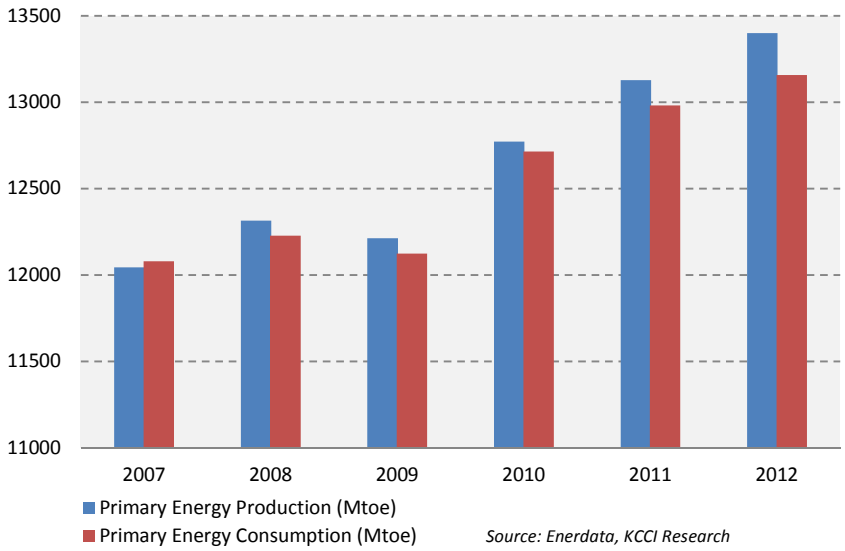
[3] *http://www.iea.org/publications/freepublications/publication/English.pdf*

[4] *http://www.worldenergyoutlook.org/resources/energydevelopment/globalstatusofmodernenergyaccess/*

[5] *http://yearbook.enerdata.net/*

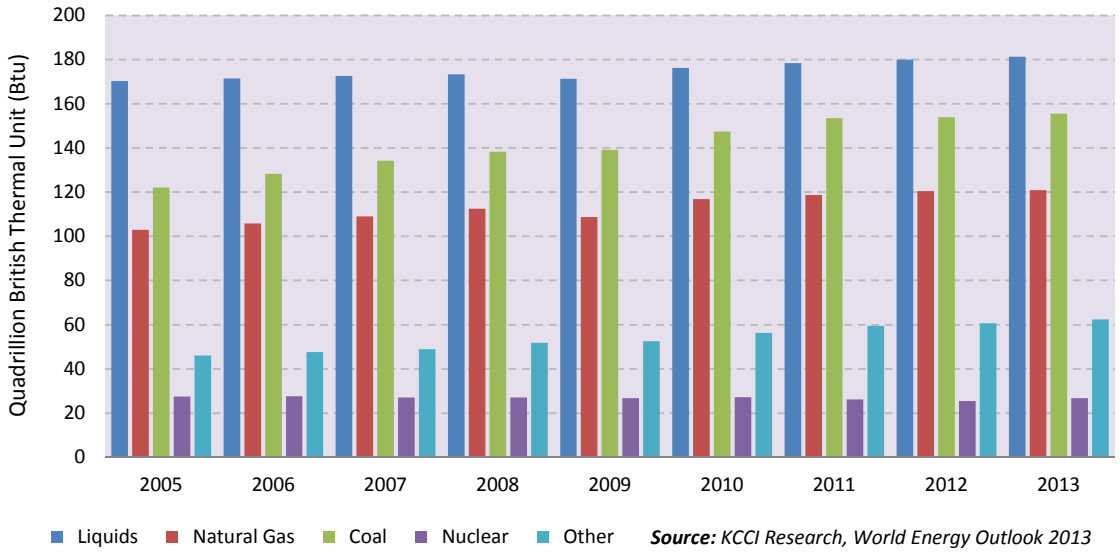
12,981Mtoe in the year 2011 showing an increase of 1.3 percent in the energy consumption of the world. China is the largest consumer of Energy with 2,713 Mtoe consumed units in 2012, followed by United States and India having yearly consumption of 2,152 Mtoe and 774 Mtoe, respectively.

Figure 1: Global Energy Production and Consumption



The energy production and consumption patterns have been changing throughout the world giving a complete new picture to the demand and supply levels. Fossil fuels still remains the major source of energy production and consumption while nuclear electric power and renewable energy sources followed the energy production and consumption. Petroleum products, natural gas and coal mainly constitute fossil fuels and their demand is still increasing on world level. However, world's reliance on nuclear electric power has been declining and enhanced emphasis has been given to renewable energy resources in order to limit carbon emissions and also to ensure energy availability in the long run.

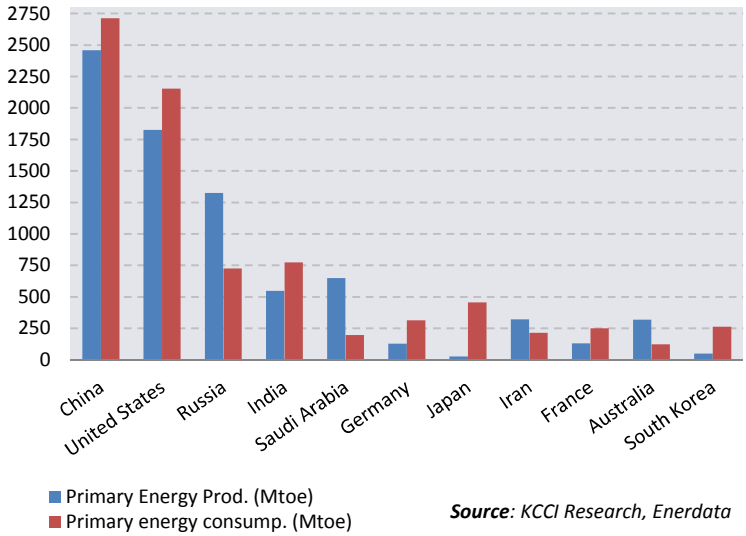
Figure 2: World Energy Consumption by Source



Source: *KCCI Research, World Energy Outlook 2013*

According to IEA, Emerging markets and developing economies would lead demand growth in 2014 with China to remain the main demand driver. Electricity generation represents the largest energy use as compared to energy utilization in industrial, transportation, residential and commercial sectors. Although, electricity has become a necessity in the lives of the people, around 1.3 billion people still do not have electricity available to them, as per IEA[6].

Figure 3: Top 10 Primary Energy Producer and Consumers (2012)



Source*: KCCI Research, Enerdata*

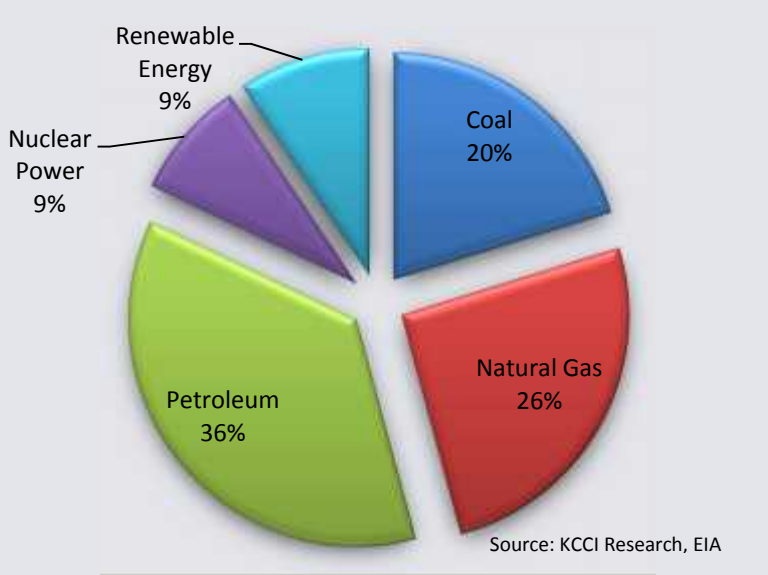
[6] *http://www.iea.org/publications/freepublications/publication/English.pdf*

Global Energy Scenario by Source

The economics of electricity are influenced by various factors like technology availability, environmental impacts, government incentives and policies, capital investment costs and fuel prices. These factors considerably change the landscape in determining the most economic fuels for generating electricity. Coal is a very competitive economic option for generating electricity but when costs arising from greenhouse gas policies are considered, natural gas becomes increasingly competitive, due to the fact that it emits up to 60 percent less carbon than coal during electricity generation.

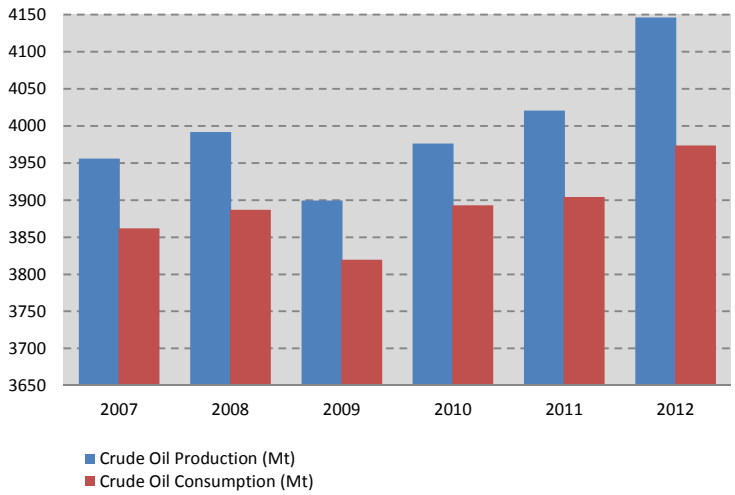
With the passage of time, various energy sources have come into existence that are more reliable and environment friendly for the world. However, the conventional sources of energy that are crude oil, coal, and natural gas are still reflected to be the significant sources that have been used by the energy consumers throughout the world. At present, renewable energy; comparatively new source of energy, has been estimated to be an important source that is rapidly growing and to some extent, it has replaced the conventional and less environmental friendly sources of energy like coal, natural gas etc.

Figure 4: Global Energy Production by Source (2011)



Petroleum products which include Crude oil and other liquid fuels have remained an important source of producing energy world over. According to the Enerdata estimates:

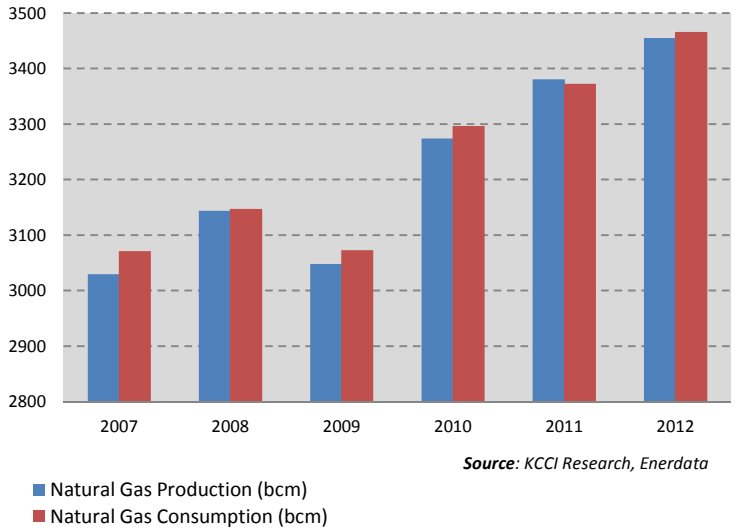
Figure 5: Global Crude Oil Production and Consumption



***Source**: KCCI Research, Enerdata*

During the last decade, natural gas has also become a very significant source of producing energy particularly electricity. As per EIA estimates, global natural gas production stood at 3,466bcm while consumption stood at 3,455bcm[7]. Earlier in 1970s and 1980s, generation plants were mostly operated through nuclear or coal power plants however since 1990s, electricity power generation plants are also being operated through natural gas power plants. The main reason of this transfer from coal to natural gas is the environmental pollution caused by coal.

Figure 6: Global Natural Gas Production & Consumption

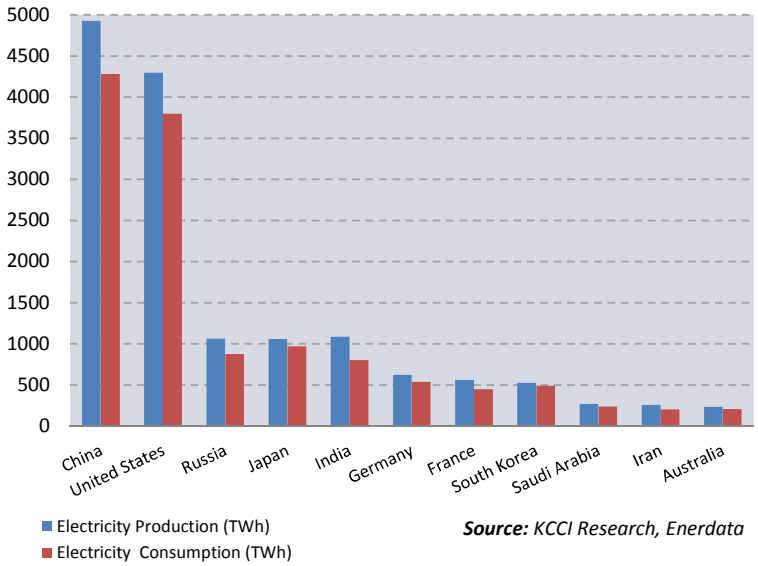


***Source**: KCCI Research, Enerdata*

[7]*Bcm refers to Billion Cubic Meter*

Electricity is one of the most significant forms of energy that is also quite imperative for the world's industrial production. According to the Energy International Administration (EIA) estimates, renewable energy would be the second largest global source of electricity generation by the year 2016. However, other than renewable energy, coal would still remain important source of electricity generation during the next few years. The total Electricity production of world in the year 2012 stood at 22,619TWh[8] as against 22,141TWh showing an increase of 2.1 percent, where the total Electricity consumption of the world was 19,462TWh in 2012 as against 19,054TWh showing an increase of 2.09 percent.

Figure 7: Top 10 in Electricity Production & Consumption



Source: *KCCI Research, Enerdata*

Coal, the largest source of producing energy in the world; it is estimated that in 2011, coal was considered to be the fastest source of producing energy other than renewables. The share of coal in the global market has increased to 30.3 percent in 2011 which has been highest since 1969. In 2011, the total production of coal on world level stood at 7,678Mt as against 7,201Mt in 2010 depicting a surge of 6.6%.

Renewable energy sources, as discussed above, are currently termed as one of the best ways of producing energy at low generating cost and in an environment friendly manner. In its second annual "Medium-Term Renewable Energy Market Report" (MTRMR), IEA states that generation from hydro, wind, solar and other renewable sources worldwide would exceed energy produced

[8] *TWh is Terra Watt hour*

by gas. These sources would also double the energy produced from nuclear by 2016. In 2012, global renewable generation rose by over 8 percent. In absolute terms, the 4,860 terawatt hours (TWh) of global renewable generation in 2012 exceeded the total estimated electricity consumption of China.

The use of renewable energy, including traditional biomass, was 1,684Mtoe in 2010, accounting for 13 percent of global primary energy demand. This share has remained steady since 2000, but with changing contributions of the different renewable sources. The share of traditional biomass out of total renewable energy fell from 50 percent in 2000 to 45 percent in 2010, while biofuels (transport fuels produced from biomass feed stocks) met a growing share of transportation fuel needs. Hydropower, the largest source of renewables-based electricity, remained stable. Electricity generation from wind grew by 27 percent and solar Photo Voltaics (PV) by 42 percent per year on average during this period.

According to a report of GTM Research consultancy, there is a surplus supply resulted in a crash price of solar panels. Globally, the production capacity of PV solar panels is at 59 GWs[9], nearly double the demand of 30GWs. The increase in production has forced many leading PV panel manufacturers in the US, Europe and Asia to shut down operations and may file for bankruptcy. The price of PV panels dropped more than 50 percent last year, taking many manufacturers in trouble because they have invested huge amounts in creating capacities. GTM Research stated that the price of panels would continue to go down further. Presently, they are being sold between 70 to 85 cents and expected to come down to 45 cents by 2015.

The IEA has stated in its medium term energy report that Hydroelectric projects will account for the majority of renewable energy growth, but other sources, such as wind, solar, bioenergy, and geothermal, would see their share of the global energy mix double from 4 percent in 2011, to 8 percent in 2018.

Global Power Tariff Structure

It is interesting to note that the maximum power tariffs are relatively lower in China which gives it competitive advantage by keeping the production costs relatively low. The maximum tariffs in Pakistan are higher than the regional countries depicting higher cost of production for industries, making it less competitive in the global markets.

The chart below shows the comparison of power tariffs in different countries of the world. It reflects upon the differences in electricity prices of different parts in the world. One of the

[9] *GWs is the abbreviation of Giga Watts which is equal to 1,000 Mega Watts*

reasons of these differences is that of the electricity demand and supply along with the energy production mix resource availability and its utilization along with the dependence on imported fuel.

Table 1: Comparison of Global Power Tariff Structure (2012)

Countries		Power Tariffs (US cents/kWh)		Sources
		Minimum	Maximum	
Developed Economies	U.S.A	8	17	EIA
	Canada	6.3	11.8	Toronoto Hydro-Electric System Ltd.
	Germany	-	31.41	Europe's Energy Portal
Emerging Economy	China	7.5	10.7	Shenzen Govt. Online
Developing Economies	Pakistan	2	15.07	LESCO, FESCO
	Thailand	10.50	21.73	Energy Regulation Commission of Thailand
	Malaysia	7.09	14.76	Tenaga Nasional Berhad
	India	2.52	10.7	State Regulatory Commission

***Source**: KCCI Research*

Energy Scenario in Region

The energy scenario has been observed to have different pattern in the international world. The developments in the energy sector of Asian countries mainly depend upon their economic growth and prosperity. In the following paragraphs, energy scenario prevailing in various Asian countries has been presented where India, Malaysia, Thailand and Taiwan have been chosen as the developing nations to reflect upon the situation of their energy sectors.

India: Shifting towards Solar Power generation

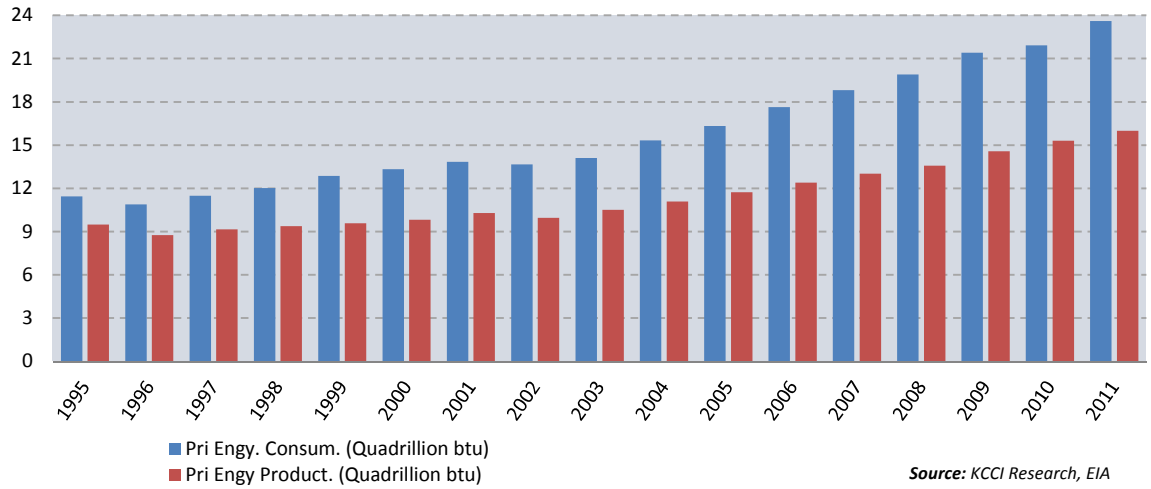
India having population of about 1.1 billion is ranked among the world's top countries in terms of annual solar energy yield, however, about 412Mn of its population is still living without electricity[10]. According to 2012 estimates, installed generation capacity of electricity in India was 211 GWs which is mostly powered by coal fired power plants. This electricity generation capacity is mostly clustered in Gujarat and Maharashtra that is the western part of India. However hydropower also plays pivotal role in the Indian power mix, making it the 7th largest hydroelectric power producer in the world with total installed capacity stood at 39,300MWs in

[10] *http://www.worldenergyoutlook.org/resources/energydevelopment/globalstatusofmodernenergyaccess/*

2012. Hydropower electricity accounted for about 20 percent installed generation capacity in 2012 as against 15 percent in 2011[11].

The government expects that rich countries may assist renewable projects in the developing world including India. The country faces energy deficit of around 16 percent and its high economic growth requires enhancing power generation on fast track to meet growing energy demand of the country.

Figure 8: Primary Energy Consumption & Production in India



Source: *KCCI Research, EIA*

India has also been facing severe power shortages for which several measures have been taken. In this regard, solar energy has gained much popularity in the power sector and Indian government is fully supporting the renewable energy sources. The government has unveiled plans to boost solar output to about 1,000MWs to 20,000MWs by 2022. The "Solar India" initiative program has been launched to electrify cities and rural areas and to boost the domestic solar energy industry.

Stepping towards Renewable Energy

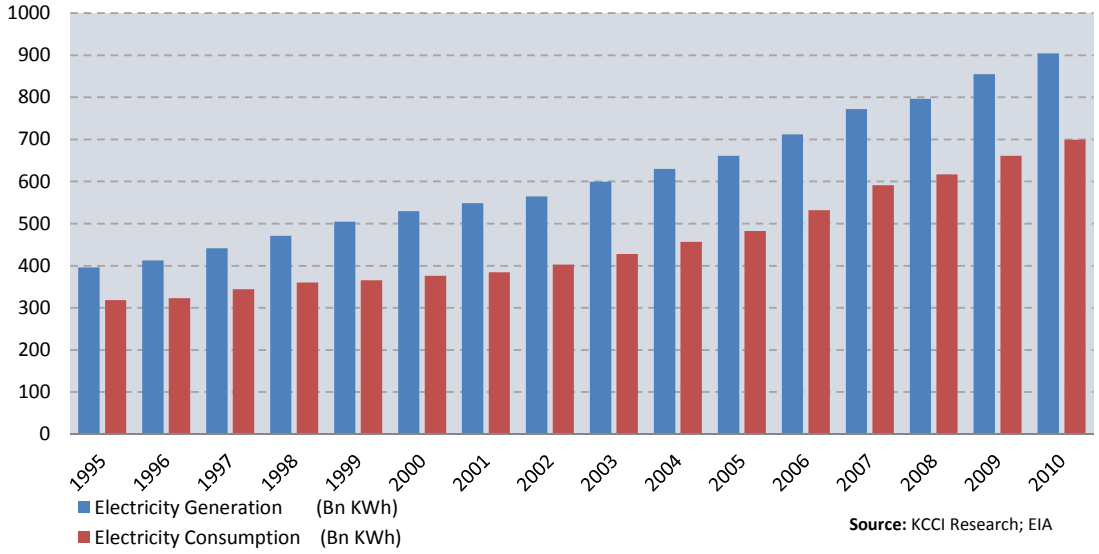
The renewable energy project is among eight key tasks of the national action plan on climate change. As a first step to popularize solar energy among Indians, officials have chosen the religious places to set up solar projects. The Indian government has devised various strategies for enhancing its power sector which also includes shifting subsidies from fossil fuels towards

[11] *http://www.eia.gov/countries/cab.cfm?fips=IN*

renewable power generation[12].

It is expected that solar energy will become more attractive as setting up and generating costs would decline in next few years due to technological advancement. The price of photo voltaic (PV) panels is decreasing sharply in recent months and India has availed this opportunity and its solar power producers have been the biggest beneficiaries of this sharp fall in the price of PV panels. India produced about 20MW of solar power in 2010-11 that rose to 940MW in 2011-12, because producers took advantage of the fall in panel prices and this trend is likely to continue in the next few years.

Figure 9: Electricity Generation & Consumption in India



Source: KCCI Research; EIA

According to World Energy Insight 2012[13], the costs of setting up solar energy unit reduced by 30 percent within a year; now it costs about US$1.8Mn to set up a 1MW solar power plant. PV modules account for half the cost of setting up a solar project. The sharp fall in the price of solar panels has also attracted a lot of foreign funding into the sector. According to US based Pew Charitable Trust, there was a seven fold jump in solar energy investments into India, which added up to $ 4.2 billion in 2011. The clean energy sector in India attracted $ 10.2 billion in investments, resulting in the country emerging as one of the top performing clean energy country.

Solar energy in India has achieved grid parity, i.e. the cost of generating one unit of solar power

[12] *http://www.worldenergy.org/wp-content/uploads/2012/10/PUB_World-Energy-Insight_2012_WEC.pdf*
[13] *http://www.worldenergy.org/wp-content/uploads/2012/10/PUB_World-Energy-Insight_2012_WEC.pdf*

is equivalent to the prevailing cost of conventional electricity sold through the grid. However, it is estimated that electricity from the new coal based projects that are in planning stage will be more costly than solar power in coming years.

Moreover, the Indian government has not only been actively taking steps to boost solar power production but also developing energy from other renewable sources including wind and biomass. The Jawaharlal Nehru National Solar Mission (JNNSM) has set a target of adding 20,000MW solar energy capacity by 2020. The program would be implemented in three phases during 2012-22. There is a process of reverse auction, where bidders have to quote the price of solar power that they would generate and sell to the grid. In the first phase, the prices were quoted around Indian Rs.10 for one kWh. However, in the second phase the prices may fall further. Solar direct was the lowest bidder, quoting IRs7.49 a unit for a 5MW solar energy unit. The average tariff bid for the 350MW under the mission was IRs8.8 per unit. Compared to this, three years ago the price was IRs18 for single unit of solar energy[14].

Ernst & Young, a consultancy company, ranked India and Germany second in its solar photovoltaic industry, after the US. It says India has 250 to 300 days of sunshine in the year, therefore, is one of the most promising locations for solar energy. India ranked fifth in renewable energy capacity, after USA, China, Germany and Spain. It has an installed capacity of 25,000MW in renewable energy, which is about 12.5 percent of the total power generation capacity of 200,000MW. It has been decided that the share of renewable energy in the power production during the 12th Plan period (2012-17) to be increased to about 30,000MW.

Coal as a Source of Power Generation

Coal is one of the main sources for power generation but due to an acute shortage of coal and the affordability and viability, the solar energy is taking off in a big way. Presently many of the new coal based power units generating power at tariffs that are very high. Now the power producers are forced to import expensive coal. Moreover, the central and state governments are announcing incentives for the solar energy sector, thereby giving way to renewable forms of energy being produced in the country.

In this regard, the Indian government is setting up an investment promotion cell to boost investments in renewable energy, by providing a single point contact for potential investors. It has been estimated that about $ 50 billion will be invested in renewable energy in India over the next five years. Solar would account for 50 percent of it, followed by wind IRS19 billion and

[14] *http://headwaysolar.com/blog/2012/01/07/indias-solar-power-greening-indias-future-energy-demand/*

hydro and biomass $ 3 billion each[15].

Moreover, the ministry of new and renewable energy (MNRE) has geared up to develop a separate entity to encourage biomass based power production, on the lines of the Solar Energy Corporation of India. For this purpose, it has also been planned to develop pilot power plants in order to give way to the technologies and products suitable to India. About half a dozen states including Gujarat, Rajasthan, Chhattisgarh, Maharashtra, Karnataka and Tamil Nadu, have been at the forefront of encouraging renewable energy. Gujarat established Asia's largest solar power park, with a capacity of 600MW spread over 3,000 acres of wasteland near the Rann of Kutch. The park will generate two thirds of India's 900MW of solar power production. The project by Gujrat Chief Minister Narendra Modi has been dedicated to India in order to contribute towards the campaign aimed at low carbon emission growth in India.

Role of Private Sector in solving Power Shortages

In order to overcome the power shortage on a fast track, India is keen to utilize the services of the private sector where the government is offering subsidies for setting up rooftop solar projects that would supply power to off grid remote towns and villages. The efforts were initially made in the year 2010 where it was estimated that these rooftop solar projects would have the capacity to generate power for their own use from their rooftops and would be able to sell the surplus power directly into the grid, without storing in batteries. It was also estimated that the cost of generating a unit of power from solar rooftops would be about IRs 8 or US cents 0.1712 to IRs 9 or US cents 0.1926 however with subsidies this may be brought down to IRs 5 or US cents 0.107. With the participation of private investors, India would not only be able to generate more electricity but also increase the reach out to far flung areas without significantly burdening the national exchequer in relatively shorter time frame[16].

Due to a number of measures taken by Indian government, it is expected that India would be one of the top producers of clean energy in the 21st century. Ranking the fifth highest five year rate of investment growth and eighth highest in installed renewable energy capacity.

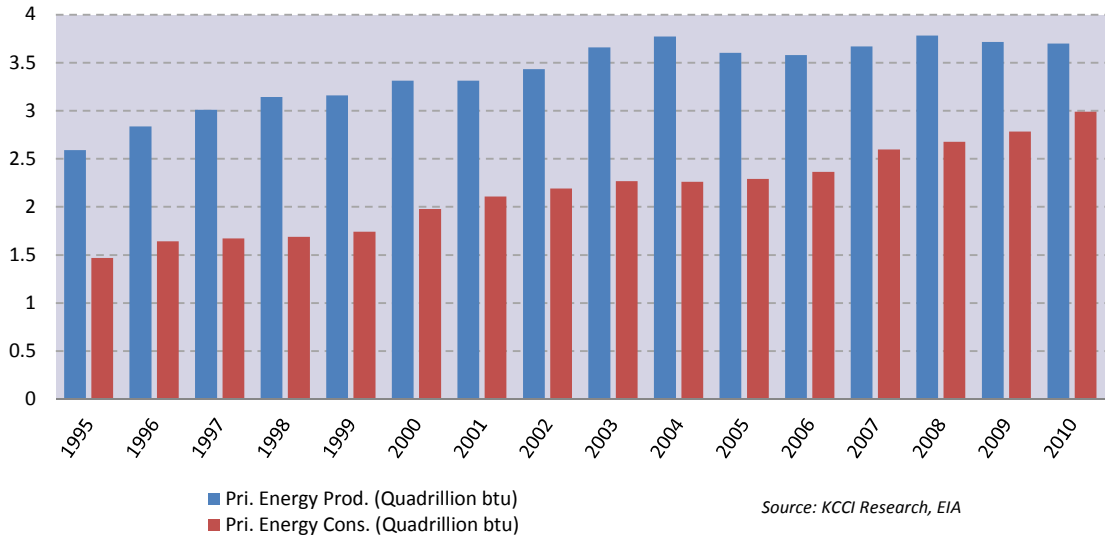
Malaysia: Fulfilling Energy demand of Region by oil exports

With oil consumption in the Asia-Pacific region increasing more than 30 percent since 2000, Malaysia has been bolstering its role as a major energy consumer as well as regional hub for energy trading. In cooperation with Singapore, Malaysia, who is a key exporter of oil and gas to

[15] *http://www.rediff.com/money/report/new-energy-india-setting-up-cell-for-attracting-investments/20120613.htm*
[16] *http://swaminomics.org/expensive-solar-power-can-mean-another-enron/*

Japan, is striving to become a global center of the energy industry. Malaysia has a healthy mix of energy resources like oil, natural gas, coal and renewable energies such as biomass, solar and hydro. In spite of having abundant alternative energy resources, the country is still quite dependent on fossil fuel for meeting its industrial and transportation sector demand.

Figure 10: Malaysian Energy Production & Consumption

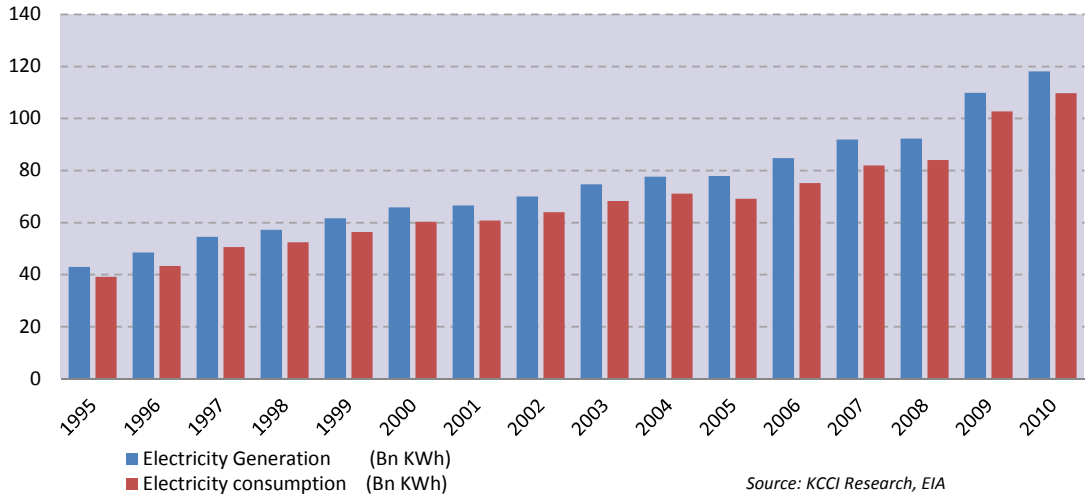


Source: KCCI Research, EIA

In 2012, the electricity production in Malaysia was 118 billion kWh while consumption of electricity was recorded at 112 billion kWh. Malaysia is an important exporter of Crude oil in the world market having oil reserves of 2.9 billion barrels (bbl) in the country[17].

[17] *https://www.cia.gov/library/publications/the-world-factbook/geos/my.html*

Figure 11: Electricity Generation & Consumption in Malaysia



Source: KCCI Research, EIA

Electricity Generation by Fossil Fuels

In 2009, 94.5 percent of electricity was generated by using fossil fuel such as natural gas, coal, diesel oil and fuel oil while Malaysia is still a net energy exporter. Concerns about energy security, the fluctuation of crude oil price and climate change are driving significant changes in how energy and specifically electricity, is generated, transmitted and consumed in Malaysia. In this regard, renewable energy resources are becoming attractive options for sustainable energy development in Malaysia particularly biomass and solar energy resources.

Malaysia has remained an active exporter of fossil fuels in the region. For this reason, developments in Japan are a major focus for Malaysia being a major buyer of Malaysian petro-chemical products. Since the 2011 disaster at the Fukushima No. 1 nuclear power plant, Japanese demand for LNG has increased significantly. Consequently, Malaysia has been taking measures to maintain continued supply of energy resources over the long-term.

In this regard, Malaysia plans to build 10Mn cubic meters of storage by 2017 in order to meet the expected growth in demand from China and India. Central to this will be a project that is currently under way in Pengerang, Johor. On 8,100 hectares of land facing Singapore, Malaysia is constructing a huge industrial complex of oil storage and refining facilities and LNG installations.

Leading Producer and Supplier of Oil & Gas

Malaysia has become a bridge between the European markets and those of China and the rest of Asia. Until now, Malaysia has developed as an oil and gas producer, but economic growth has pushed domestic demand for oil and gas to the point where supply capacity would probably decline in future, not just in Malaysia, but throughout Southeast Asia.

For instance, in FY11, Malaysia was the largest supplier of Liquefied Natural Gas (LNG) to Japan, but it later started to import LNG from elsewhere. Malaysia also initiated building facilities on the Strait of Malacca for the regasification of imported LNG for distribution across the country. According to the estimates of 2012, Malaysia exported 269,000bbl/day.

Electricity Tariff in Malaysia

According to the subsidy rationalization plan by the Performance Management and Delivery Unit of Malaysia, electricity tariffs are to be increased in every six months until July 2014. The last time tariff rates were adjusted was in June 2012 on the back of marked increase in natural gas price.

Table 2: Domestic Tariffs in Malaysia (2012)

Domestic Tariffs in Malaysia	Tariff Rates (sen /kWh)	Tariff Rates (US Cents /kWh)
For the first 200 kWh (1 - 200 kWh) /month	21.8	6.8
For the next 100 kWh (201 - 300 kWh) /month	33.4	10.4
For the next 100 kWh (301 - 400 kWh) /month	40	12.5
For the first 100kWh (401 - 500 kWh) /month	40.2	12.5
For the next 100 kWh (501 - 600 kWh) /month	41.6	13.0
For the next 100 kWh (601 - 700 kWh) /month	42.6	13.3
For the next 100 kWh (701 - 800 kWh) /month	43.7	13.6
For the next 100 kWh (801 - 900 kWh) /month	45.3	14.1
For the next kWh (901 kWh onwards) / month	45.4	14.1
The minimum monthly charge is RM3.00		

Source: *KCCI Research; Tenaga Nasional Berhad*

At present, the minimum tariff rates in Malaysia on household level are 21.8sen which is

equivalent to 7 cents on consuming first 200kWhs[18].

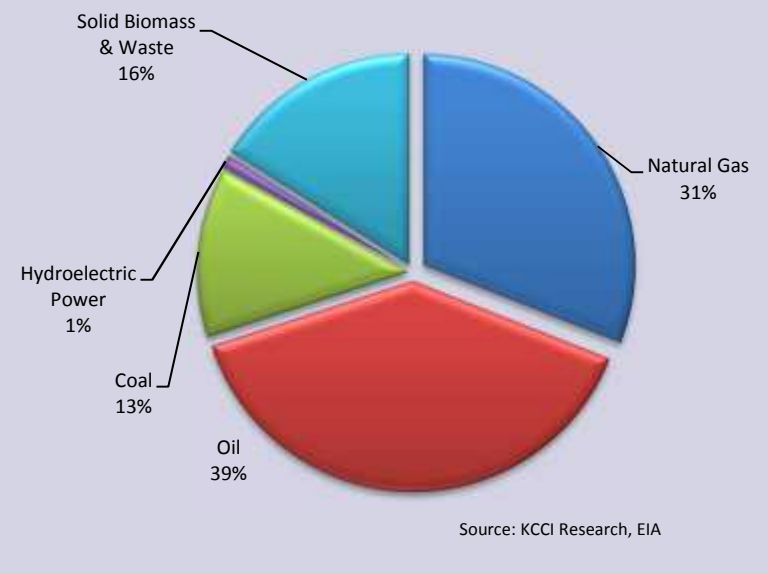
Thailand: Reliable electricity infrastructure

Thailand has limited domestic oil production and reserves, and imports make up a significant portion of the country's oil consumption. Thailand holds large proven reserves of natural gas, and natural gas production has increased substantially over the last few years. However, the country still remains dependent on imports of natural gas to meet growing domestic demand for the fuel. Thailand fulfill its natural gas requirements by importing it from Myanmar under an agreement of 30 years where Myanmar has been exporting 640Mn cubic feet gas from Yatanar oil and natural gas offshore field every day since 1998.

Primary Energy Consumption in Thailand

Thailand's primary energy consumption is mostly from fossil fuels, accounting for over 80 percent of the country's total energy consumption.

Figure 12: Total Energy Consumption in Thailand by Source (2010)

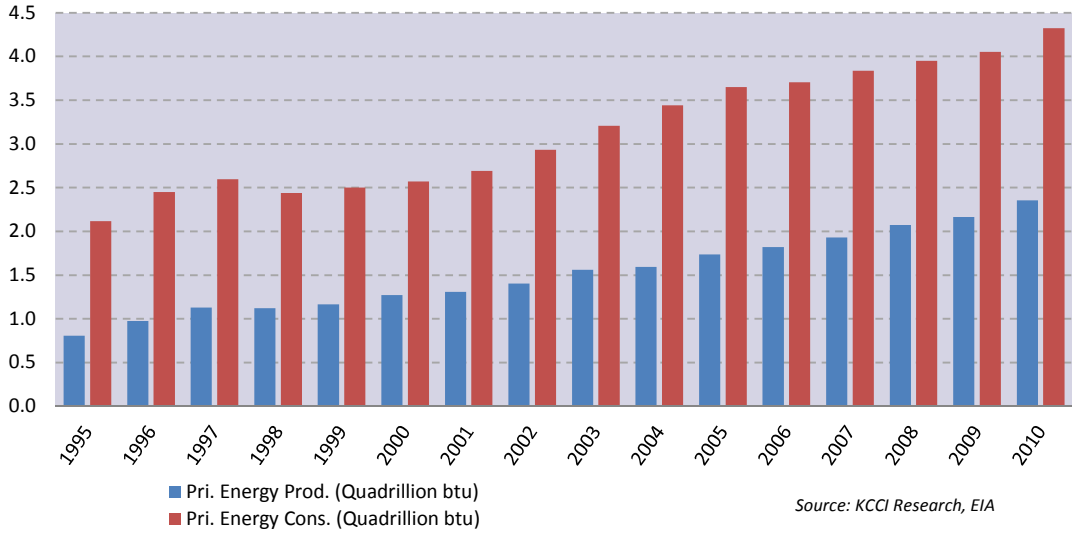


Oil was 39 percent of total energy consumption in 2010, down from nearly half in 2000. As the economy expanded and industrialized, Thailand consumed more oil for transportation and industrial uses. Natural gas has replaced some oil demand and is the next largest fuel, growing to nearly a third of total consumption mix. Solid biomass and waste have played a strong role as an alternate energy source in Thailand and comprise roughly 16 percent of energy consumption.

[18] *http://www.tnb.com.my/residential/pricing-and-tariff/tariff-rates.html*

Most biomass feedstock is from sugarcane, rice husk, bagasse, wood waste, and oil palm residue and is used in residential and manufacturing sectors.

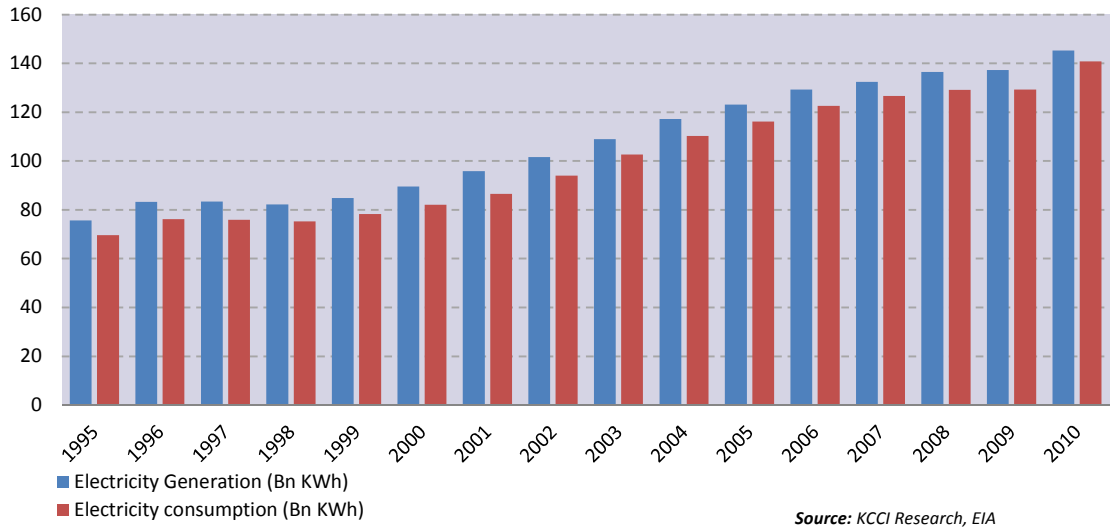
Figure 13: Energy Production and Consumption in Thailand



Source: KCCI Research, EIA

In Thailand, 99 percent population has access to the electricity with distribution and transmission losses standing at 8 percent. There are occasional brownouts and electricity service is considered to be quite reliable in the whole country.

Figure 14: Electricity Generation and Consumption in Thailand



Source: *KCCI Research, EIA*

The Metropolitan Electricity Authority (MEA) provides electricity to Bangkok, Nonthaburi and

Samut Prakan areas while Provincial Electricity Authority (PEA) is responsible for providing electricity to the rest of the country. Thus MEA is engaged in 30 percent of electricity distribution and retailing while PEA is responsible for 68 percent of the distribution and retailing of electricity. In Thailand, National Grid Coverage is 99 percent.

Table 3: Power Tariff Structure in Thailand

Consumer Category	Average Tariff (Baht/KWh)	Average Tariff (Cents/KWh)
Residential	3.86	12.39
Small General Services	4.21	13.50
Medium General Services	3.81	12.22
Large General Services	3.46	11.11
Specific Business	3.53	11.33
Non-Profit Organization	3.65	11.73
Agricultural Pumping	3.27	10.50
Temporary Power Customer	6.77	21.73

Source: *KCCI Research; Energy Regulation Commission of Thailand*

Electricity Tariff Model of Thailand

In Thailand, enhanced single buyer model has been used as a electricity structure where ~48 percent of electricity is generated through EGAT (Electricity Generating Authority of Thailand) generators, ~38 percent electricity is generated by Independent Power Producers (IPPs), ~7 percent is generated by Small Power Producers (SPPs), less than ~1 percent is generated by Very Small Power Producers (VPPs) while around 7 percent is imported by Thailand to fulfill its electricity demand in the country. The electricity generation by private power producers includes 16,551.6MWs power generation by IPPs, 8,764.52MWs power generation by SPPs while VSPPs are producing 5,355.09MWs.

Taiwan: utilizing solar energy for power generation

Taiwan has a well-established, solar energy industry and ranks among the leading solar battery suppliers worldwide. Taiwan uses photovoltaic technology to the significant extent. In December 2009, Taiwan opened its largest solar roof plant in Kaohsiung County; its 141 large size solar panels have an annual capacity of 1MW, enough to power 1,000 homes. Another project has been set up with a capacity of 4,600 solar panels in Kaoshiung in May 2010, generating 4.6MW annually. Taiwan plans to inject $250 billion over the next decade to develop its green energy industry, out of which $38 billion would go to renewable energy. Other than solar, areas to be

promoted include wind power, biofuels, fuel cells and electric vehicles. Taiwan also has one of the highest installed capacities of solar water heaters. The country would become a leading supplier of solar cells with an annual production value of $ 14Bn by 2025.

To meet the growing demand, parliament passed the island's first renewable energy development bill in June 2009 in a bid to raise renewable power generation capacity to 10,000MW within 20 years. About 70 Taiwanese companies are involved in the solar industry and produced polycrystalline silicon solar cells with a combined production capacity of 2 GWS last year, which is expected to increase to 3GWS this year. However, it is predicted that the solar cell prices would drop by 20 to 30 percent due to oversupply.

Taiwan is planning to increase the use of solar energy in order to cut carbon emissions. In 2010, 100,000 solar roofs program was launched. The government aimed to spend $ 280Mn in subsidies to encourage the locals to turn their rooftops into sun roofs. Initially, the government was to fit 20,000 roofs solar panels by 2012. In the first phase 60MW capacity expected to produce, 72Mn KWHs of electricity from solar power annually.

The remaining roofs would be completed in 5 to 10 years, and would be established by the private investors and may be multiplied annually by 2025. Taiwan has already set up solar panels on the roofs of 470 structures with a combined capacity of 6MWs that would be increased to 1,000MWs over the next 15 years. Under the program a stadium that hosted the 2009 World Games in the southern city of Kaohsiung was lighted through solar energy. A total of 8,800 solar panels were used to cover 14,155 square meters of the stadium's roof.

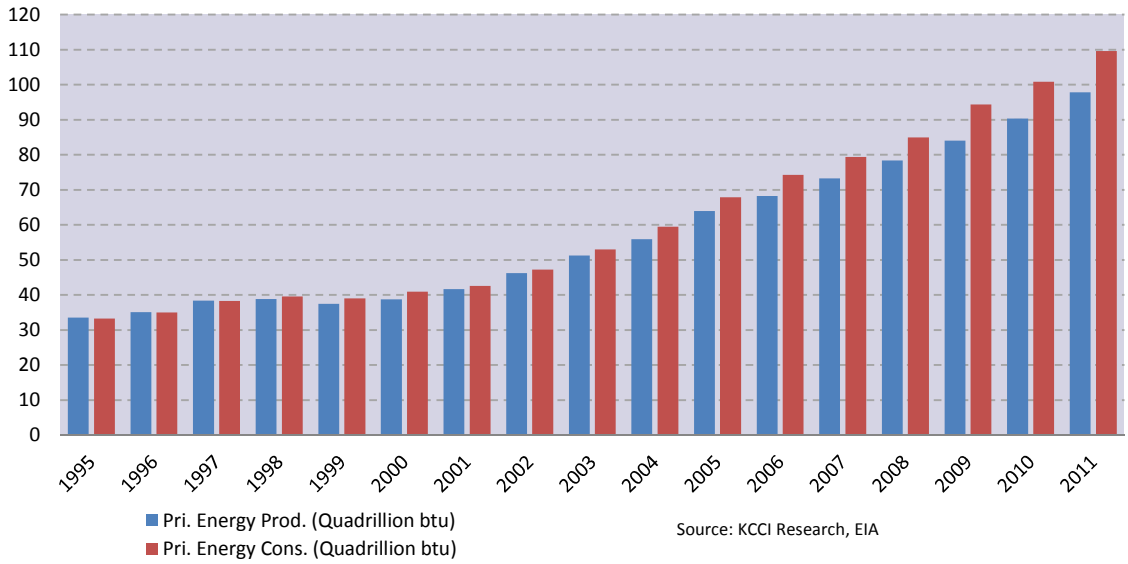
China: World's Emerging Power Producer

Being one of the world's largest energy producer and consumer, the Asian country is now realizing that coal will no longer serve its economic development. Hence, renewable energy is a necessity for the nation's inclusive growth and energy security.

China's hydropower sector is its most well-developed renewable energy source, accounting for 20 percent of the country's power generating capacity in 2010 and 22 percent of the global capacity in 2011. China is home to the world's largest hydropower station, the Three Gorges Dam spanning the Yangtze River. By 2015, China intends to produce 325GW from its hydropower sector and 430 GW in 2020, up from an original target of 380GW[19].

[19] *http://www.renewablefacts.com/country/china/1696-renewables-necessity-for-china-s-energy-security*

Figure 15: China's Energy Production & Consumption



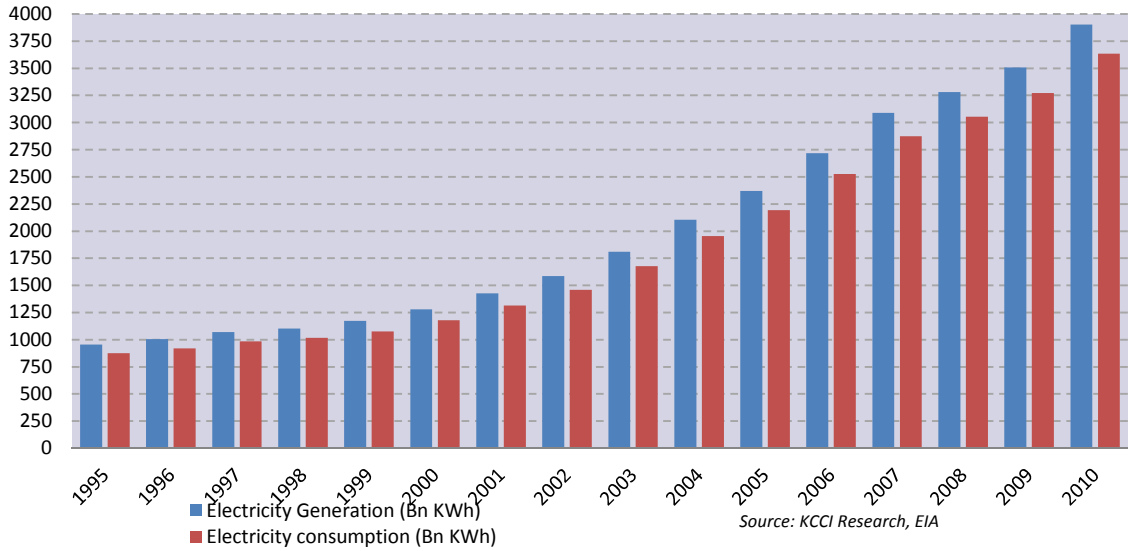
Similarly, China also held 107Tn cubic feet (Tcf) of proven natural gas reserves as of January 2012, 27Tcf higher than reserves estimated in 2009 and the second largest in the Asia-Pacific region. China's natural gas production and demand have risen substantially in the past decade. In 2011, China produced 3.6Tcf of natural gas, up around 9 percent from 2010, while the country consumed 4.6Tcf.

China also held estimated 128 billion short tons of recoverable coal reserves in 2011, the third-largest in the world behind the US and Russia, and equivalent to about 13 percent of the world's total coal reserves. Coal production rose 9 percent from 3.5 billion short tons in 2010 to over 3.8 billion short tons in 2011, making China the largest coal producer in the world.

China also holds 20.4 billion barrels of proven oil reserves as of January 2012, up over 4 billion barrels from three years ago and the highest in the Asia-Pacific region. China produced estimated 4.3Mn barrels per day (bbl/d) of total oil liquids in 2011, of which 95 percent was crude oil. China's oil production is forecast to rise by about 170 thousand bbl/d to nearly 4.5Mn bbl/d by the end of 2013[20].

[20] *http://www.eia.gov/countries/cab.cfm?fips=CH*

Figure 16: China's Electricity Generation & Consumption



Source: KCCI Research, EIA

Second Largest Wind Power Producer in World

China is the world's second largest wind power producer with the installed wind capacity of 63GW in 2011. However in 2010, it generated 48TWh units in 2010. Nonetheless, lack of transmission infrastructure to connect to the grid in this sector has left a significant amount of capacity underutilized, with an operational rate of just 22 percent. China is also investing in solar power and hoping to increase capacity from a mere 2 GW in 2011 to 25 GW by 2020.

Electricity Generation: One of the largest Power Capacities in World

China had an estimated total installed electricity generating capacity of 1,073 gigawatts (GW) in 2011, giving it the status of the largest power capacity in the world. China's capacity rose over 9 percent from 2010 and doubled in capacity from the 2005 level of 519 GW. Fossil-fired power has historically made up about three-quarters of installed capacity, and coal continues to dominate the mix with 65 percent of capacity in 2011. China is the world's second largest power generator behind the US, and net power generation was 3,965 Terawatt-hours (TWh) in 2010.

Active Promoter of Nuclear Power as Clean Source of Electrcitiy Generation

China generated about over 70TWh of nuclear power in 2010, making up about 2 percent of total net generation. The country is actively promoting nuclear power as a clean and efficient

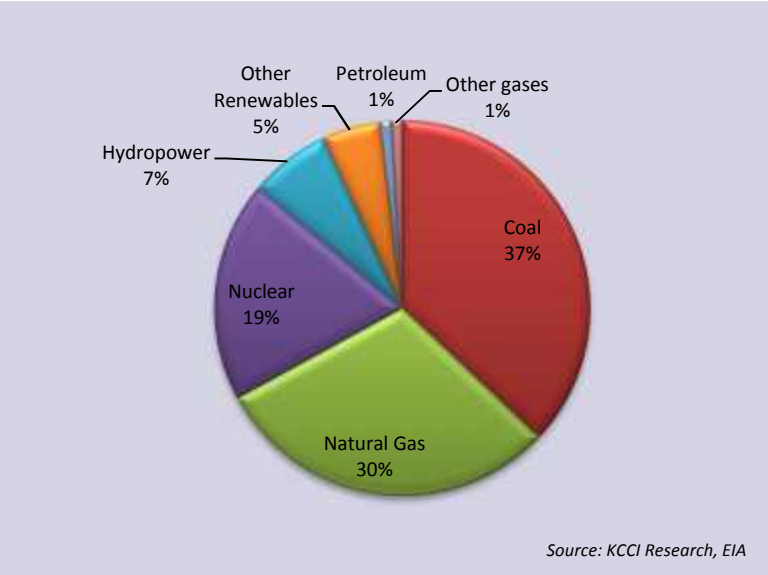
source of electricity generation[21].

Energy Scenario in Developed Nations

United States: One of the top ranking energy producers

The U.S. energy infrastructure fuels the economy and meets the energy demand of the country. More than 80 percent of the country's energy infrastructure is owned by the private sector, supplying fuels to the transportation industry, electricity to households and businesses, and other sources of energy that are integral to growth and production across the nation. The energy infrastructure is divided into three interrelated segments, including: electricity, petroleum, and natural gas.

Figure 17: Electricity Generation by Source (2012)

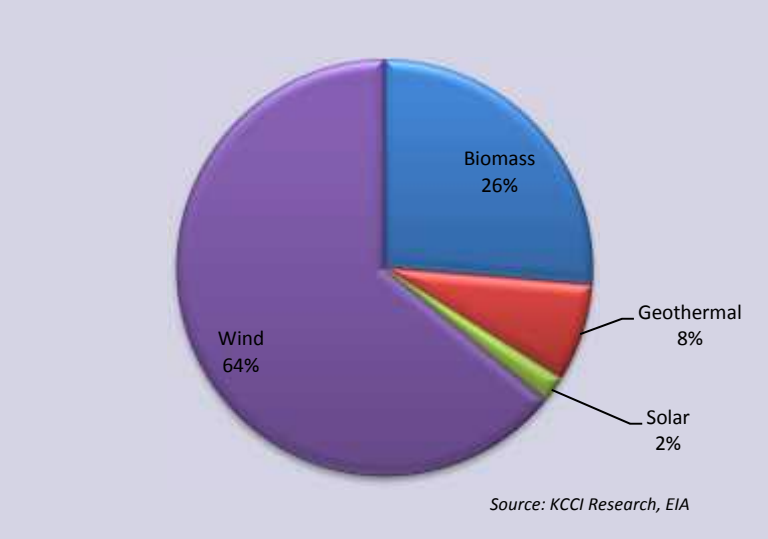


The U.S. electricity segment contains more than 6,413 power plants (this includes 3,273 traditional electric utilities and 1,738 nonutility power producers) with approximately 1,075GWs of installed generation. Approximately 48 percent of electricity is produced by combusting coal (primarily transported by rail), 20 percent in nuclear power plants, and 22 percent by combusting natural gas. The remaining generation is provided by hydroelectric plants (6 percent), oil (1 percent), and renewable sources (solar, wind, and geothermal) which constitutes 3 percent to electricity supply. The heavy reliance on pipelines to distribute products across the

[21] *http://www.eia.gov/countries/cab.cfm?fips=CH*

nation highlights the interdependencies between the Energy and Transportation Systems Sector.

Figure 18: U.S. Renewable Energy by Source (2012)



The US is a leader in the production and supply of energy, and is one of the world's largest energy consumers. U.S. energy companies produce and manage oil, natural gas, coal, nuclear power, renewable energy and fuels, and electricity services, as well as supply energy and electricity technologies worldwide. US made energy and electricity equipment dominates the domestic market and commands a strong market share abroad. Growing consumer demand and world class innovation combined with a competitive workforce and supply chain capable of building, installing, and servicing all energy technologies make the United States the world's most attractive market in the $ 6Tn global energy market[22].

Renewable Energy Sector of the United Sector

The US is home to a thriving renewable energy industry, with globally competitive firms in all technology subsectors, including the wind, solar, geothermal, hydropower, biomass, and biofuels sectors. In 2011, more than one-third of all new power capacity additions used a renewable technology (39 percent), according to the Energy Information Administration. By 2030, Bloomberg New Energy Finance (BNEF) expects the share of renewables in US power generation mix to grow up to 27 percent. In fact, by 2030, the US is projected to have 343GWs of renewable energy capacity– an increase of 420 percent from 2010 totals.

To achieve these gains, BNEF projects that just under $ 700 billion would be invested in the U.S.

[22] *http://selectusa.commerce.gov/industry-snapshots/energy-industry-united-states*

renewable energy sector during the next two decades with investment opportunities cascading across the industry's deep and multi-faceted supply chain. Today, the United States produces more geothermal energy than any other country (3,187 MW); more biomass power than any other country (13,700 MW); enjoys the second largest wind industry (46,990 MW); the third largest hydropower industry (96,000 MW); and the fifth largest solar industry (5,700 MW).

With access to abundant natural resources, the pellet and ethanol industries are also increasing their capacity – particularly to serve overseas markets such as Europe. America's ethanol industry is the largest and most efficient in the world, and incorporating technological innovations to produce nearly 14 billion gallons in 2011[23]. Investment opportunities exist for both conventional ethanol and advanced biofuels, particularly for the aviation sector. The U.S. International Trade Commission projected that U.S. wood pellet production capacity would rise by more than 50 percent in 2012 alone provided all announced projects for new plants and expansions come online.

Revolutionizing Natural Gas Industry

The US is undergoing a revolution in oil and natural gas production from shale. U.S. companies have developed techniques for extracting hydrocarbons from shale, altering the U.S. oil and gas sector and the domestic energy landscape. Increased oil and gas production from North Dakota's Bakken shale and the Marcellus Shale in the northeastern region of the United States among other shale plays have been the source of increased onshore oil and gas production. In addition to shale, the U.S. Gulf of Mexico and Alaska are once again the focus for new investment. The U.S. Department of Interior has released a new five-year (2012-2017) leasing program on April 24, 2013 for high-resource areas under the U.S. Outer Continental Shelf Oil and Gas Leasing Program.

The US holds the world's largest estimated recoverable reserves of coal and is a net exporter of coal. Approximately 72 percent of coal production originated in Wyoming, West Virginia, Kentucky, Pennsylvania, and Texas. Coal is used to generate 40 percent of the electricity in the United States, and is also used for industrial applications such as cement making, and conversion to coke for the smelting of iron ore at blast furnaces to make steel. The US is also developing carbon capture and sequestration technologies[24] with the goal of capturing 90 percent of CO2 emissions from coal.

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[23] *Estimates taken from http://www.ethanolrfa.org/pages/statistics*

[24] *Carbon Capture and Sequestration Technology refers to capture, utilize and storage of CO_2 from large stationary sources. For further information, visit http://sequestration.mit.edu/*

The US operates the most nuclear reactors, having the largest installed nuclear power capacity, and generates the most nuclear power in the world. Nearly 20 percent of U.S. electricity is produced at 104 nuclear reactors in 31 states. By 2015, the first of 26 new nuclear reactors are expected to come online. Subsectors of the civil nuclear industry are represented by companies that produce nuclear components like reactors, nuclear monitoring instruments, boilers, heat exchangers etc., nuclear fuel, nuclear engineering and construction, and nuclear advisory services. The international civil nuclear marketplace is estimated at more than $ 500-740 billion during the next decade and has the potential to generate more than $ 100 billion in U.S. exports[25].

The market for achieving greater energy efficiency in the United States is large and growing. According to the EIA, existing policies, such as Federal appliance standards, along with other Federal and State policies, and market forces are drivers of energy efficiency in the US. In August 2012, President Obama signed an Executive Order supporting industrial energy efficiency and combined heat and power which is expected to encourage industrial facilities to modernize their domestic manufacturing capacity, and contribute to significant energy cost savings by as much as $ 100 billion. Moreover, for the first time, the US President has also permitted to put solar panels on the White House roof. The costs will be revealed once the Department of Energy selects a company to install the systems. The administration said the systems would save about $ 3,000 a year.

The United States is an international leader in the development and deployment of smart grid technologies and services. The United States remained the world's fourth largest exporter of electric grid equipment, holding a 9.3 percent world market share with exports exceeded $ 22.5 billion in 2011.

The US government has announced that about $ 3.4 billion would be invested in a project to be set up at the DeSoto Next Generation Solar Energy Center in Arcadia, Florida. This is the largest modernization of the US electricity grid in history, which would open a new era of renewable energy consumption plans.

Germany: Largest Energy consumer in Europe

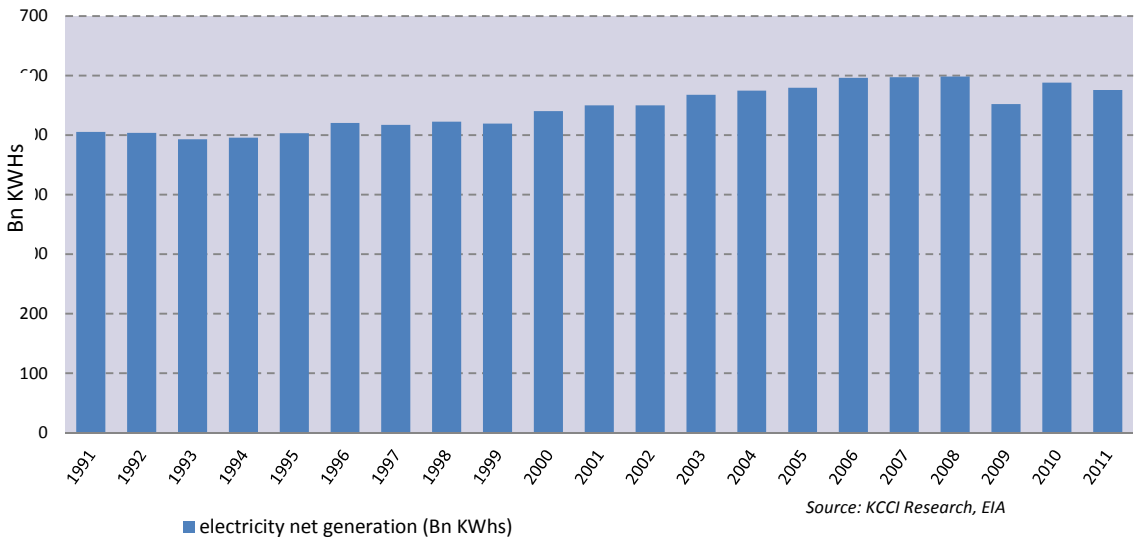
According to the International Energy Agency, Germany is amongst the largest energy consumers in Europe and the seventh largest energy consumer in the world. Its size and location gives it a considerable influence over the European Union's energy sector. However, on the other hand, the country must rely on importing energy to meet the majority of its energy

[25] *Estimates taken from http://www.nei.org/Issues-Policy/Exports-Trade*

demand. In Germany, oil is considered to be the primary source of producing energy as it could be observed that oil made up 38 percent of Germany's total primary energy consumption in 2011.

Germany is a regional world leader on several categories of renewable energy use. In 2011, it was the largest European producer of non-hydro renewable electricity, wind energy, and biofuels (primarily biodiesel). The country is one of the largest solar electricity producers in the world with the solar PV capacity of more than 32.3GWs until December, 2012. The German government has aimed to produce 35 percent of electricity from renewable energy sources by 2020 while 100 percent of electricity generation from renewable energy through 2050. The government has also started replacing nuclear energy with renewable energy for producing electricity so that healthy environment can be given way in Germany. In this regard, the German government has stated that it will continue to shift its energy sources from nuclear power to that of renewable energy sources.

Figure 19: Net Electricity Generation in Germany



Source: KCCI Research, EIA

In 2011 the gross electric power generation in Germany totaled 575 billion kWh. A major proportion of the electricity supply is based on lignite (24.9 percent), hard coal (18.6 percent) and nuclear energy (17.6 percent). Natural gas has a share of 13.7 percent. The share of renewable energy in total electricity production accounts for 19.9 percent (wind, water, biomass and photovoltaic).

The transportation sector makes up the majority of petroleum product demand, although the

government's 2010 "Energy Concept" publication advocates for one million electric vehicles on the road by 2020 and six million by 2030.

At 2.2Mn barrels per day of crude refining capacity, Germany is one of the largest refiners in the world, and second in Europe after Russia. Germany imports oil through four crude pipelines and one petroleum product pipeline, as well as four main sea ports. The country's sole deep-water port at Wilhelmshaven handles a large portion of Germany's international oil trade.

Germany has no liquefied natural gas (LNG) terminals, so it must import natural gas exclusively through several major cross-border pipeline networks. Almost all natural gas imports come from Russia via the Nord Stream system (completed in 2011), Norway via Norpipe and Europipe systems, and the Netherlands via four main pipelines. However, natural gas use in Germany has continued to decline from its peak in 2003 at rate of 3.2 percent per year through 2011, largely because of energy efficiency improvements.

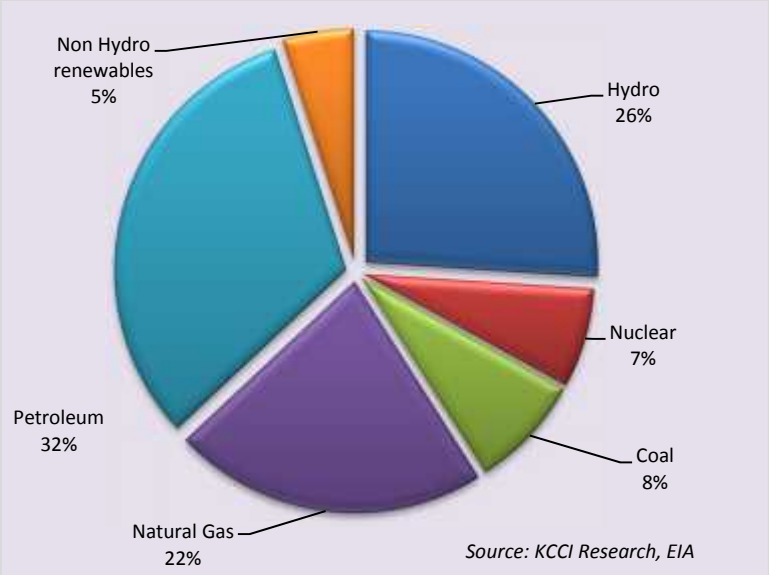
Germany was the sixth largest generator of nuclear energy in the world in 2011 with 102.6TWHs (Tera-Watt hours), and historically it was an important exporter of nuclear technology. Following the Fukushima accident in March 2011, the German government decided to close eight reactors launched before 1980 because of public protests, and to close Germany's nine remaining nuclear reactors before 2022.

Although coal is Germany's most abundant indigenous energy resource, its role in the country's energy mix, albeit significant, has been decreasing steadily over time. However, coal use has increased since the Fukushima reactor accident since it can be used as a substitute for nuclear power in electricity generation. Germany was the world's eighth largest producer of coal in 2011. Nearly all coal goes to the power and industrial sectors.

Canada: An important energy producer in the World

Canada is among the world’s top five energy producers in the world where it partners with China in relation to its primary energy sources along with the use of renewable energy sources in producing energy; electricity, in particular. The energy sector in Canada has pivotal role in its economy where trade, investment, employment and income generation all are connected with it. It is, being an important power producer on the world map, possesses all major sources of energy production which include nuclear power, coal, natural gas, oil and renewable energy sources. Canada is the world’s largest producer of Uranium and third largest producer of natural gas and hydroelectric generators; producing in the world and net exporter to the United States. It is also the seventh largest crude oil producer with sufficient proven oil reserves.

Figure 20: Canada's Energy Consumption by Source (2010)



The energy mix in Canada is different and unique in its own kind as large part of energy consumption is fulfilled by Petroleum, hydroelectric and natural gas. The Renewable energy is also making its way to the Canadian energy mix. Amongst the renewable energy sources, Hydropower and Wind energy are the efficient forms of producing renewable energies. Considering the fact that hydropower is the most effective way of producing electrical energy, the country converts 90 percent of available hydropower energy into electricity. The hydropower also runs the fossil fuel power plants with approximately 60 percent efficiency[26].

Sarnia photovoltaic project is an important hydroelectric power plant developed by the Canadian government with the aim of providing power supply to the power grid of Ontario and is located in Southern Ontario. This photovoltaic project has generation capacity of 97MW which provides electricity to approximately 12,800 homes.

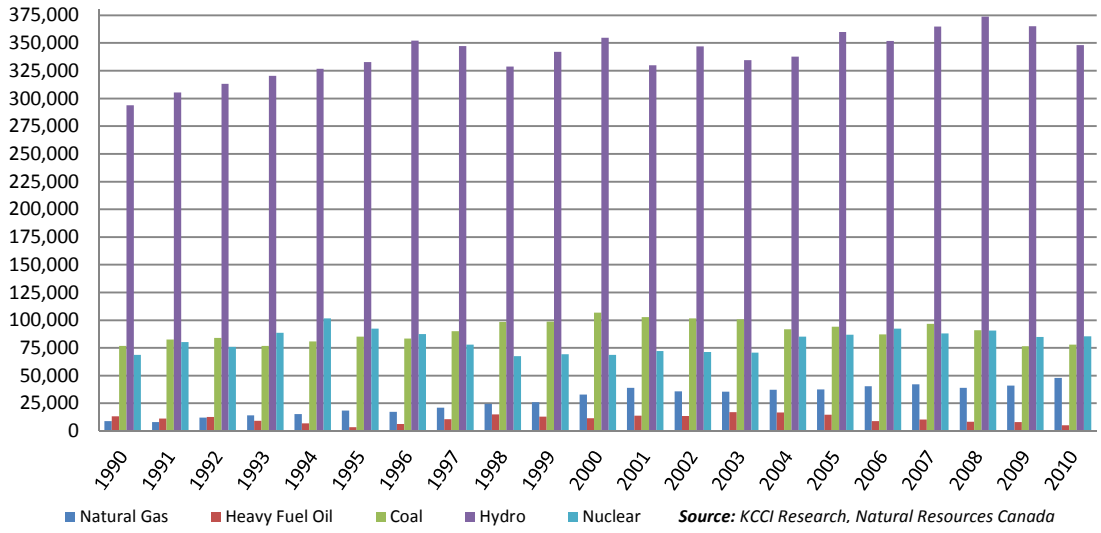
The Ontario's new Niagara Tunnel is also in service facilitating the Canadians with cleaner renewable energy at low cost[27].

The wind energy that is the second most reliable form of renewable energy has also been made great use in Canada. Recently, it has been estimated that the country has a capacity to produce 55,000MWs[28] through domestic wind power. The share of wind energy during 2012 grew by

[26] *https://canadahydro.ca/hydro-facts/hydro-in-5-points*
[27] *http://www.opg.com/power/hydro/new_projects/ntp/index.asp*
[28] *http://business.financialpost.com/2013/08/06/smart-wind-turbines-will-boost-canadas-renewable-energy-portfolio/?__lsa=ddfc-963d*

around 20 percent bringing over $ 2Bn in investments while creating 10,500 persons-years of employment.

Figure 21: Electricity Generation by Energy Sources in Canada

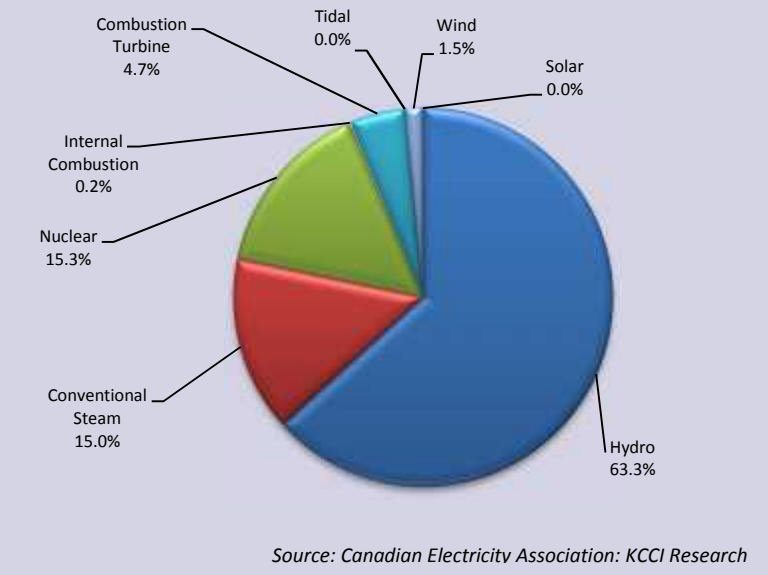


The industry of Wind energy installed total of 936 Mega Watts in 2012, making the total capacity 6,200 megawatts at the end of 2012[29]. The projects of wind energy have built and commissioned at Alberta, British Columbia, Ontario, Manitoba, Quebec, Northwest Territories and Nova Scotia. Canadians are engaged in designing larger wind turbines that are more reliable and efficient than that of the current ones so that clean renewable energy could be available at competitive prices.

The nuclear power is yet another viable option available to the Canadian government for powering the energy sector of the country. It has been estimated by the World Nuclear Association around 15 percent of the Canada's electricity has been generated through nuclear power plants comprising of 19 reactors that are mostly powered in Ontario pumping power capacity of 13.5GWe.

[29] *http://www.canwea.ca/pdf/canwea-factsheet-FedProInitiatives-final.pdf*

Figure 22: Canada's Electricity Consumption by Fuel Type (2012)



Similarly, total 636Bn kWh units of energy were produced in Canada in 2011 out of which 14.3 percent were produced from the nuclear power generation as against 59 percent from hydro, 13 percent from coal and 8.4 percent through gas. However, it was estimated that each individual in Canada use around 14,000 kWh which is regarded as one of the highest consuming units in the world. The government of Canada has planned to magnify the number of its nuclear power plants by developing two new reactors in future[30].

Canada is a country that has the most cleanest and renewable electricity system among all large economies of the world. With the increase in number of electric vehicles and other such automobiles, the demand of energy will grow with the passage of time. Catering the future demand of energy, enhanced energy levels have to be maintained and Canada is fully prepared as the country possesses outstanding potential of fulfilling its energy demand through hydropower electricity generation with hydropower resources available in most of the regions.

[30] *http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Nuclear-Power/#.UgHywpKnq9Q*

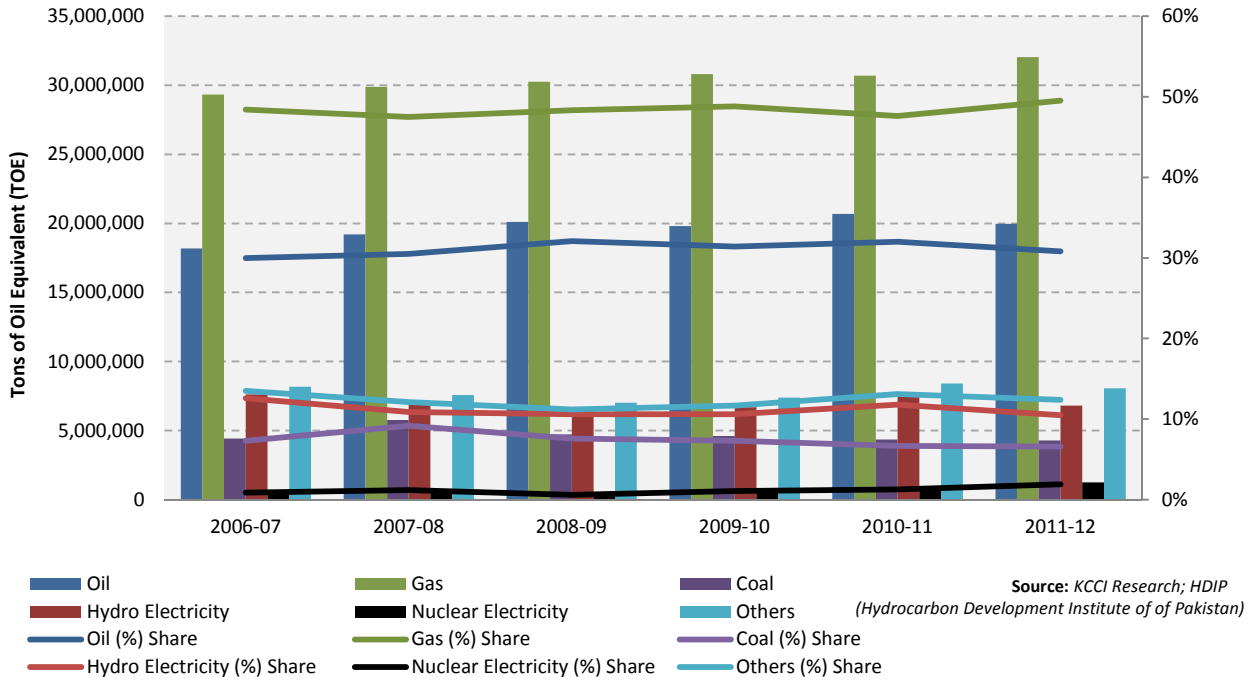
PART III
ENERGY SITUATION IN PAKISTAN

Current Energy Scenario of Pakistan

Pakistan has been facing a persistent unprecedented energy crisis owing to ever increasing demand and supply gap. The country's current energy needs are reliant on oil and gas and the demand far exceeds its domestic supplies. Thus, its primary energy supplies are heavily dependent upon imported crude oil and imported petroleum products due to which the country's oil import bill has risen to approximately US$ 15 billion in FY13, which is a huge burden on the economy and its forex reserves.

Oil and gas are two key components of primary energy mix contributing almost 80 percent (oil 31 percent and gas 49 percent) share to the 64.73 million TOE[31] of energy supplies during FY12 while share of coal and nuclear is almost 7 percent and 2 percent, respectively. During 2012, net primary energy supply remained at 64.73Mn TOEs compared to 64.52Mn TOEs during FY11, thus posting growth of 0.32 percent. However, on average, the growth rate of net primary energy supply remained 1.3 percent for last six years.

Figure 23: Source-wise Primary Energy Supply

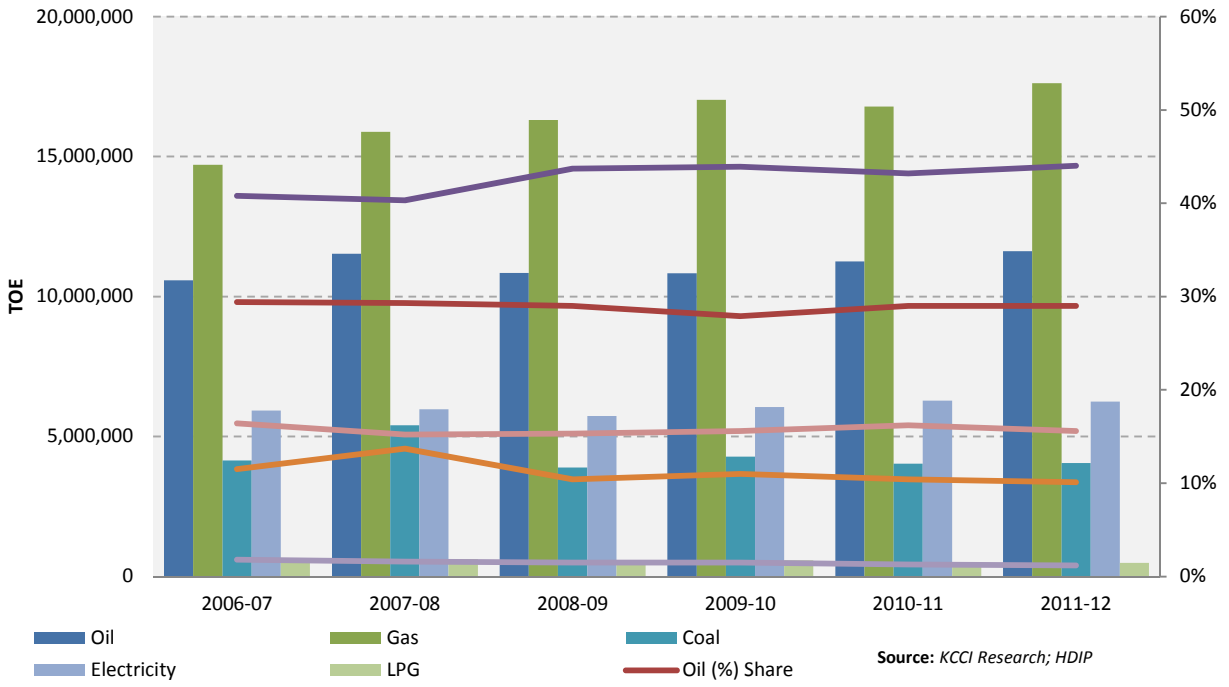


Source: *KCCI Research; HDIP (Hydrocarbon Development Institute of of Pakistan)*

[31] *Tons of Oil Equivalent: It is a normalized unit of energy and is equivalent to the approximate amount of energy that can be extracted from one ton of crude oil.*

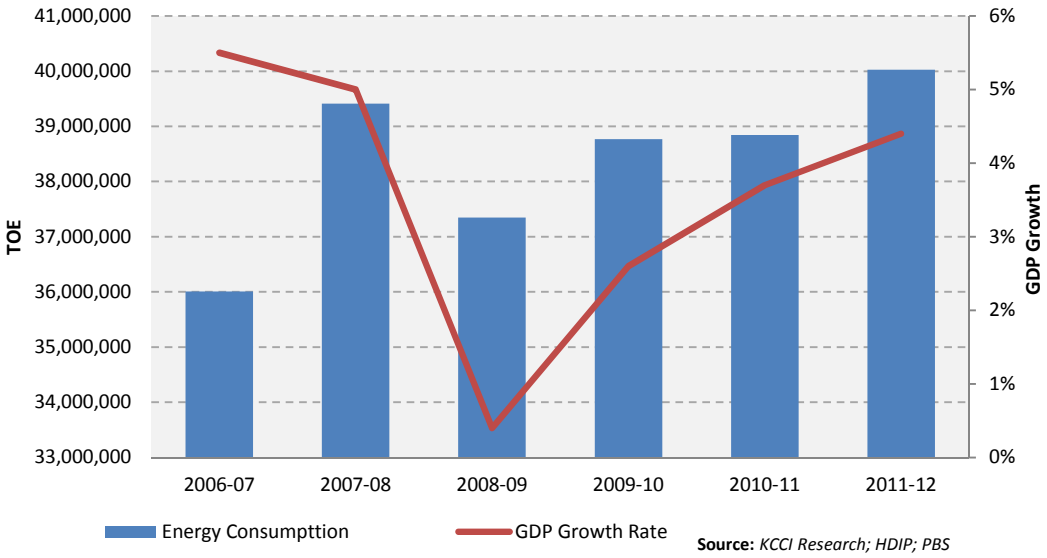
The final energy (which includes energy from both secondary and primary sources) consumed during FY12 came at 40.03Mn TOE. When compared with final energy consumed in FY11, there is a 3.1 percent growth, as it was 38.84 Mn TOEs in FY11. However, on average, the growth rate of final energy consumption remained 2.10 percent for last six years. Statistics on energy consumption by source revealed that gas and oil had largest share, as shown in following figure:

Figure 24: Source-wise Final Energy Consumption



Electricity and gas outages have hampered economic growth of Pakistan for last few years. Further, since early 2000s, the electricity sector has received greater attention because of the higher rate of growth in its demand. There is no doubt that there exists high correlation between growth rate of GDP and that of energy consumption. The following graph depicts that periods of high growth rate of energy consumption usually coincides with high growth rate of GDP and periods of lower energy consumption coincide with lower growth in GDP.

Figure 25: GDP and Final Energy Consumption



Source: *KCCI Research; HDIP; PBS*

Crude Oil and Petroleum Products

The reserves of crude oil in the country are estimated at 342 million barrels as of June 30, 2012. Oil and Gas Development Company Limited of Pakistan (OGDC) has claim to 60 percent of Pakistan's total discovered and recoverable oil reserves followed by Hungarian Oil and Gas Company (MOL), which has 15 percent of the oil reserves. A snapshot of the major exploration companies and their respective crude oil reserves is presented in the table below.

Table 4: Pakistan's Crude Oil Reserves (June 30, 2012)

Operator/ Company	Original Recoverable Reserves (Mn Barrels)	Cumulative Production (Mn Barrels)	Balance Recoverable Reserves (Mn Barrels)	Share of Balance Recoverable Reserves (%)
OGDC	454.47	250.63	203.85	59.62%
MOL	60	9.9	50.1	14.65%
POL	194.21	165.28	28.93	8.46%
PPL	56.3	29.26	27.04	7.91%
UEPL	217.05	191.57	25.48	7.45%
BHP	11.3	7.7	3.6	1.05%
OPL	57.7	56.11	1.59	0.46%
BG	1.35	-	1.35	0.39%
Total	**1,052**	**710**	**342**	**100.00%**

OGDC= Oil & Gas Development Co; MOL= MOL Pakistan; POL= Pakistan Oilfields Ltd.; PPL= Pakistan Petroleum Ltd.

UEPL= United Energy Pakistan Ltd.; BHP= BHP Billiton Petroleum; OPL=Ocean Pakistan Ltd; BG=BG Group

Source: KCCI Research; DGPC

Pakistan has the capacity to produce around 27 million barrels of oil per annum with daily production of approximately 66,032 bpd[32]. There are thirteen companies involved in crude oil production which cumulatively produced 67,140 bpd in FY12. Amongst these, Oil and Gas Development Company Limited of Pakistan produced the highest volume of as 38,284 bpd, having the highest percentage share of 57. United Energy Pakistan (UEPL), Pakistan Petroleum Limited (PPL) and Hungarian Oil and Gas Company (MOL) contributed around 10 percent each. 24.51 Mn barrels (67,140 bpd) of crude oil was extracted or produced locally during FY12 while almost 47.10 Mn barrels were imported in the period, a figure which is nearly double that of the domestic production.

Table 5: Pakistan's Domestic Crude Oil Production 2011-12

Operator/Company	Crude Oil Production (Bpd)	Crude Oil Production (Barrels)	Share of Production
OGDC	38,284	13,973,660	57.02 %
MOL	8,375	3,056,875	12.47 %
UEPL	6,977	2,546,605	10.39 %
PPL	6,658	2,430,170	9.92 %
POL	2,710	989,150	4.04 %
BHP	2,283	833,295	3.40 %
OPL	870	317,550	1.30 %
MGCL	352	128,480	0.52 %
ENI	333	121,545	0.50 %
Dewan Petroleum	188	68,620	0.28 %
Petronas	65	23,725	0.10 %
OMV	46	16,790	0.07 %
Hycarbex	0	0	0.00 %
Total	**67,140**	**24,506,100**	**100.00 %**

MGCL=Mari Gas Co. Ltd.; ENI=ENI Pakistan Ltd.; OMV=OMV Pakistan; Hycarbex= Hycarbex-American Energy Inc.

Source: *KCCI Research; DGPC*

Petroleum products are produced when crude oil is refined at oil refineries and the liquid hydrocarbons are extracted at natural gas processing plants. These products are further classified into Energy and Non Energy products. Energy products include Motor Spirit, Kerosene,

[32] *Bpd: Barrels per day. 1 barrel is equivalent to 119.24 liters*

High Octane Blending Component (HOBC), High Speed Diesel Oil (HSD), Light Diesel Oil (LDO), Furnace Oil (FO), Aviation Fuels, Naphtha and Liquefied Petroleum Gas (LPG). The non-energy products include Lube Oil, Solvent Oil, Mineral Turpentine (MTT), Jute Batch Oil (JBO), Asphalt, Process Oil, Benzyne Toulene Xylene (BTX), Wax and Sulphur etc.

Seven oil refineries are operating in the country with a cumulative refining capacity of 14 million tons.

Table 6: Crude Oil Processed by Domestic Refineries (Tons) 2011-12

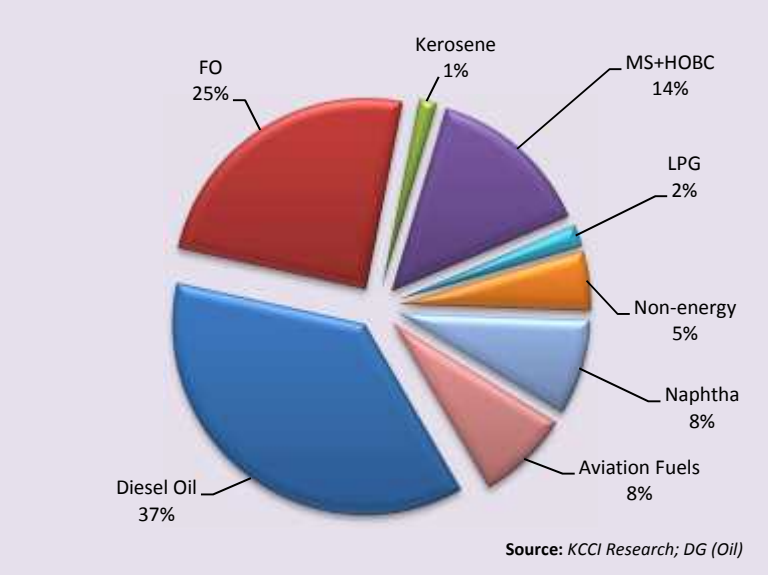
Refinery	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Attock Refinery	1,836,244	1,926,779	1,697,568	1,743,987	1,838,791	1,872,583
Byco Refinery	712,240	817,739	944,438	722,105	457,515	126,536
Dhodak Refinery	100,918	64,164	16,764	8,102	4,893	-
ENAR Petrotech Refinery	94,242	99,797	102,607	102,607	94,937	107,999
National Refinery	2,792,545	2,733,798	2,423,687	2,138,635	2,420,655	2,275,090
Pak-Arab Refinery	3,723,769	3,868,218	3,663,986	3,555,763	3,358,294	3,166,721
Pakistan Refinery	1,983,317	2,179,497	1,887,193	1,596,454	1,599,201	1,641,733
Total	11,243,275	11,689,992	10,736,243	9,867,653	9,774,286	9,190,662

Source: *KCCI Research; DG (Oil); Oil Refineries; OGDC*

Due to massive domestic demand of oil, a large quantity of crude oil is imported every year and refined domestically. Byco Oil Pakistan has just recently commissioned 120,000 bpd new refinery while the provincial government of Khyber Pakhtunkhwa in Pakistan has agreed to allocate 1.62 square kilometers (sq. km) of land for a Pakistan State Oil proposed refinery.

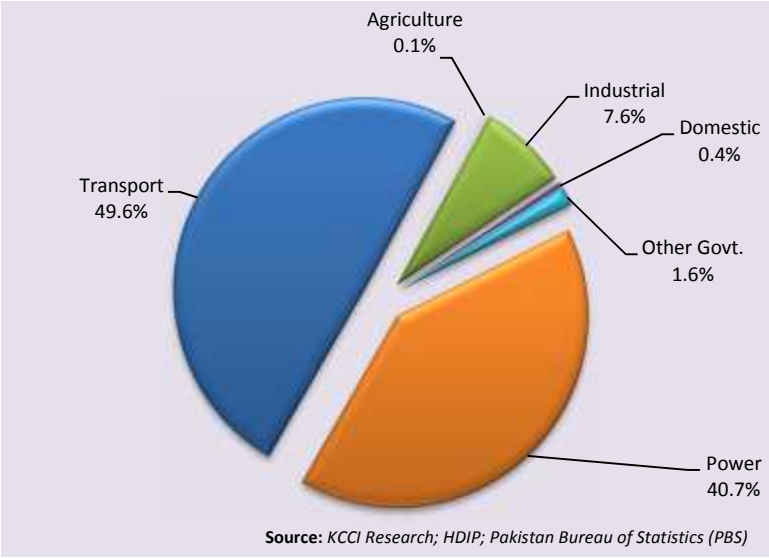
In FY12, 8.85 Mn tons of finished POL products, were produced domestically from processing of 9.19Mn imported and domestically extracted crude oil, while 13.2 Mn tons were imported. These imports were instrumental in raising the country's import bill to more than US$ 15 billion during the year. The share of domestic production in total POL consumption thus turns out to be 40%.

Figure 26: Distribution of Product Wise Production by Refineries 2011-12



The main sectoral users in the consumption of petroleum products are transport and power sectors which jointly have almost 90 percent share in total consumption as shown in the table below. The reason for high petroleum usage in the power sector is the country's almost 65 percent electricity generation using thermal resources.

Figure 27: Sector-wise Consumption of Petroleum Products 2011-12



Usage of natural gas is considered as a cheaper substitute of oil in generation of power especially when the country has to import oil to meet domestic demand.

Oil & Related Products' Trade Landscape

The energy sector is greatly dependent on the imports of crude oil and petroleum products which grab a major chunk of Pakistan's import bill. As figure-28 shows, the situation is much self-explanatory with the imports of Crude Oil, HSFO (High Sulfur Fuel Oil) and MOGAS (petrol) having major share of 39.96 percent, 27.42 percent & 10.40 percent respectively. On year on year basis, the overall imports surged by 3.16 percent in FY13 as against a decline of 8.03 percent in FY12. The overall cumulative average growth rate (CAGR) of oil imports of Pakistan since the period of FY05 till FY13 has been 3.28 percent and with the depreciating value of rupee in the international market has deteriorated the situation even more.

Pakistan imports crude oil mainly from the Middle East, Saudi Arabia and U.A.E. Imports from Iran, have now been restricted under US led sanctions imposed on Iran. The major petroleum products imported are High Sulphur Furnace Oil (HSFO), High Speed Diesel (HSD) and Motor Spirit. Their share in the POL products import bill is 48 percent, 32 percent and 16 percent, respectively.

During FY12 Pakistan imported 19.2 million metric tons of petroleum, oil and lubricants (POL). This included 13.2 million metric tons of petroleum products and 6.0 million metric tons of petroleum crude. However, during July-March FY13, the quantum of POL imports declined by 0.18 percent. The major petroleum commodities imported by Pakistan are:

High Sulphur Furnace Oil (HSFO): 49 percent of is imported from UAE, while 27 and 12 percent is respectively imported from Saudi Arabia and Kuwait.

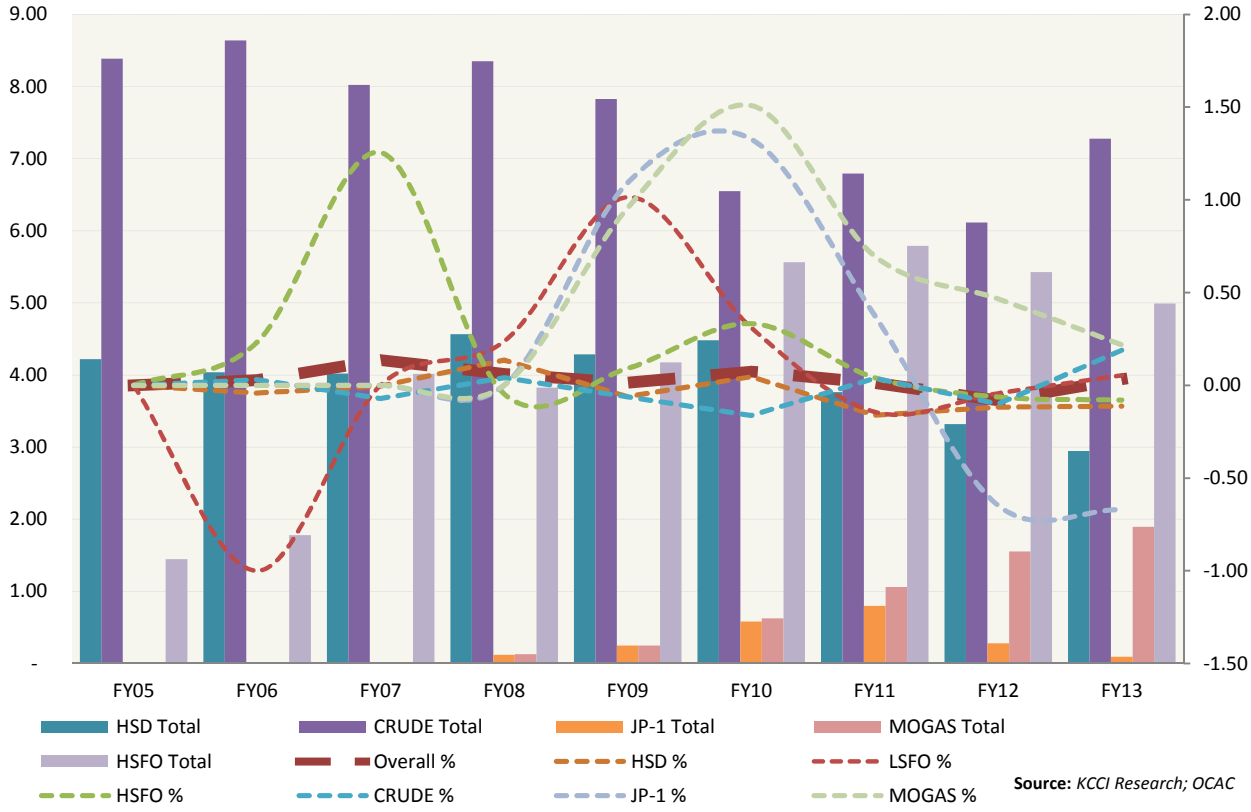
High Speed Diesel (HSD): Almost 93 percent of High Speed Diesel (HSD) is imported from Kuwait. The domestic production of HSD has been given incentives by providing a fixed percentage margin (called deemed duty) to refineries on sales of the product. However, profits earned from deemed duty protection are supposed to be invested in technology up gradation but instead have been accumulated as a buffer against volatility in refining margins resulting from immense oil price fluctuations.

Motor Spirit (Mogas): 72 percent is imported from UAE, 12 percent from Oman and 10 percent from France.

At present, crude oil and petroleum product imports is handled at two terminals: Keamari and

Port Qasim. The combined cargo handling capacity for POL products at ports is 33 million metric tons (MT) (24.0 million MT at Keamari and 9.0 million MT at Port Qasim). Both ports are located in Karachi and connected via a 25 km pipeline having a capacity of 24.0 million tons per annum.

Figure 28: Imports of Oil by Pakistan



Source: *KCCI Research; OCAC*

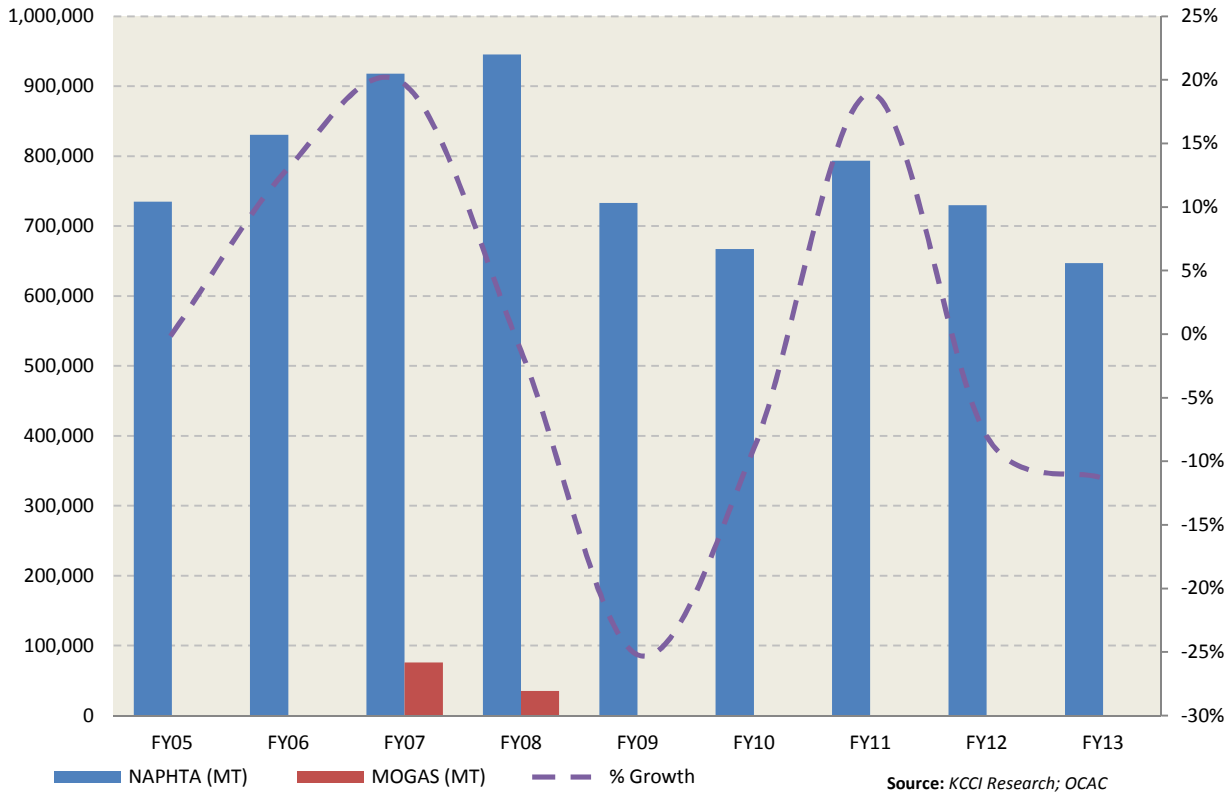
Whereas on the other side of the picture, shown in figure-29, the exports of petroleum products from Pakistan have declined by 11.35 percent in FY13 from –8.03 percent in FY12 with NAPHTA being the major contributor to the exports of the country. The overall CAGR of oil exports from FY05 to FY13 has been -1.58 percent which indicates the criticality of the situation.

The point of concern is the gap between the exports and imports of oil and related products; the demand in the domestic and industrial sector for these items is increasing while there are very less alternatives explored in-house by the state to meet them.

The deteriorating position of rupee against US dollar is the biggest elevating constraint which would hurt the economy more if the imports keep on surging more than exports. The projects of fossil energy development on which the government is focusing currently should be prioritized

and strategy needs to be developed to explore the sources through which energy would be achieved through economical means rather than going for the costlier and unfavorable solution which would hurt the economy in the long run.

Figure 29: Exports of Oil by Pakistan



Source: *KCCI Research; OCAC*

Pakistan's import bill is not only inflated by imports of crude oil and petroleum products but coal is also being imported to meet the energy demands of the country. Despite having around 185 billion tons of coal reserves, in FY11, the import of coal was 4,267 million ton. Therefore, government needs to make hardcore efforts to use this potential source which the country has been blessed with. If coal resources are effectively utilized, it would benefit the country in many ways including power generation, fuel supply, relatively lower import bill and reduced cost of electricity for the consumers. Pakistan may also export coal and on other side coal gasification can be another option and a resourceful means for energy generation.

POL Pricing

In April 2006, Oil and Gas Regulatory Authority (OGRA) was given the task to compute and notify prices of petroleum products as per the federal government approved formula. In June 2011, the govt. decided to deregulate the prices of petroleum products of MS, HOBC, LDO, and aviation

fuel at the refinery and depot level, subject to a ceiling of import parity price plus incidentals for ex-refinery prices. As a result, Oil Marketing Companies (OMCs) and refineries determine and announce prices of the same. The key components of ex-depot prices include OMC and dealer commissions, government taxes and Inland Freight Equalization Margin (IFEM).

OGRA now computes and notifies ex-refinery/ex-depot price of Superior Kerosene Oil (SKO) and HSD only, while it continues to compute and notify IFEM. Furthermore, OGRA also monitors the pricing of petroleum products and submits quarterly reports on pricing of petroleum products indicating the trend in international markets and petroleum products. It also keeps a check on prices determined by OMCs /refineries and submits its analysis, findings and suggestions, if any on regular basis to the Economic Coordination Committee (ECC) of the government.

Natural Gas

Pakistan is one of the largest consumers of gas in the region and has total resource potential of 27 trillion cubic feet and production of almost 4.26 billion cubic feet per day. During 2012 total production remained 1,559 billion cubic feet that is equivalent to 32 million TOE, which shows a growth of 6 percent when compared to last year in billion cubic feet while in TOE it shows a growth of 4.5 percent. There are 146 non-associated gas fields (meaning that gas reservoirs are present in isolated states only while 44 associated gas fields (meaning that gas is present along with other fossil fuels like crude oil and coal) are operating under 15 companies. The details of the companies having major share in supply of gas are given below:

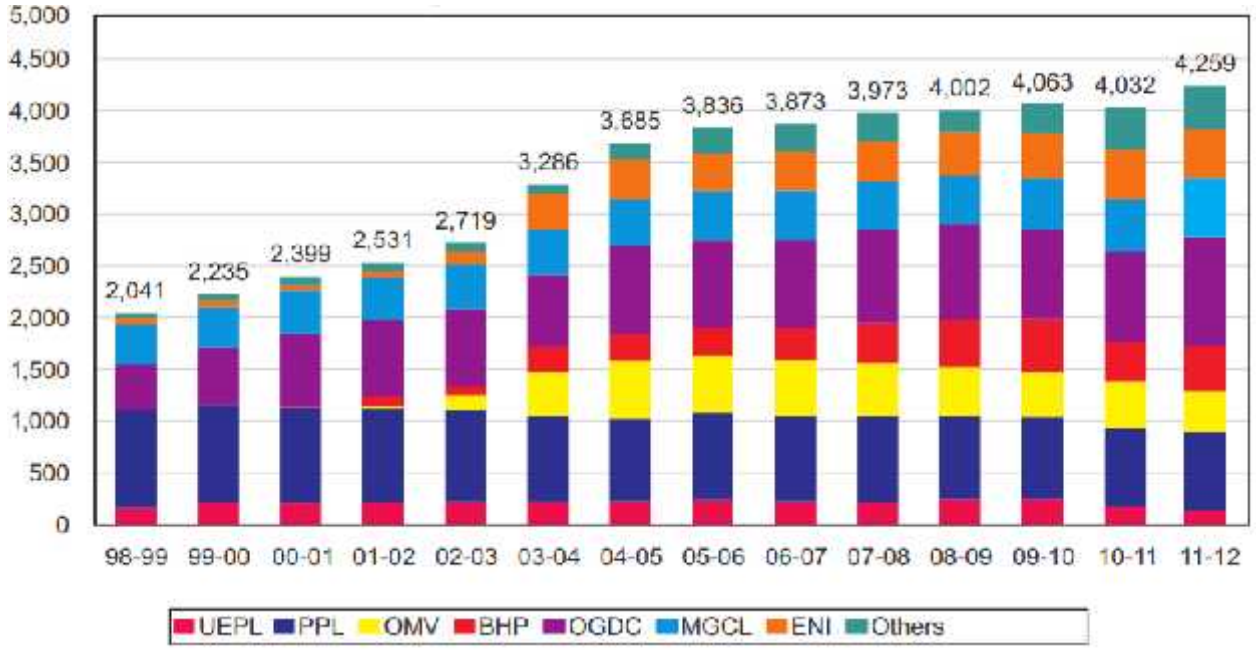
Table 7: Natural Gas Production FY12

Operator/Company	Gas Production (Million Feet^3)	Share of Production
OGDC	386,460	24.79 %
PPL	281,967	18.09 %
MGCL	205,937	13.21 %
ENI	176,315	11.31 %
BHP	161,899	10.39 %
OMV	142,421	9.14 %
MOL	114,614	7.35 %
UEPL	50,124	3.22 %
Dewan Petroleum	9,686	0.62 %
PEL	8,880	0.57 %
POL	7,116	0.46 %
OPL	6,249	0.40 %
Petronas	4,609	0.30 %

Hycarbex	2,682	0.17 %
Total	**1,558,959**	**100.00 %**
		Source: KCCI Research; PEL= Petroleum Exploration (Pvt.) Ltd.

Pakistan's power sector is heavily depended on gas. Reduction in supply of gas to the power sector owing to reduced availability has severely crippled its performance. The country is witnessing gas shortage due to misallocation of natural gas and low growth in its supplies in relation to high growth in demand. The chart below gives a trend of the growth in supply of gas.

Figure 30: Operator wise natural gas production pattern (mmcfd)



Source: *HDIP*

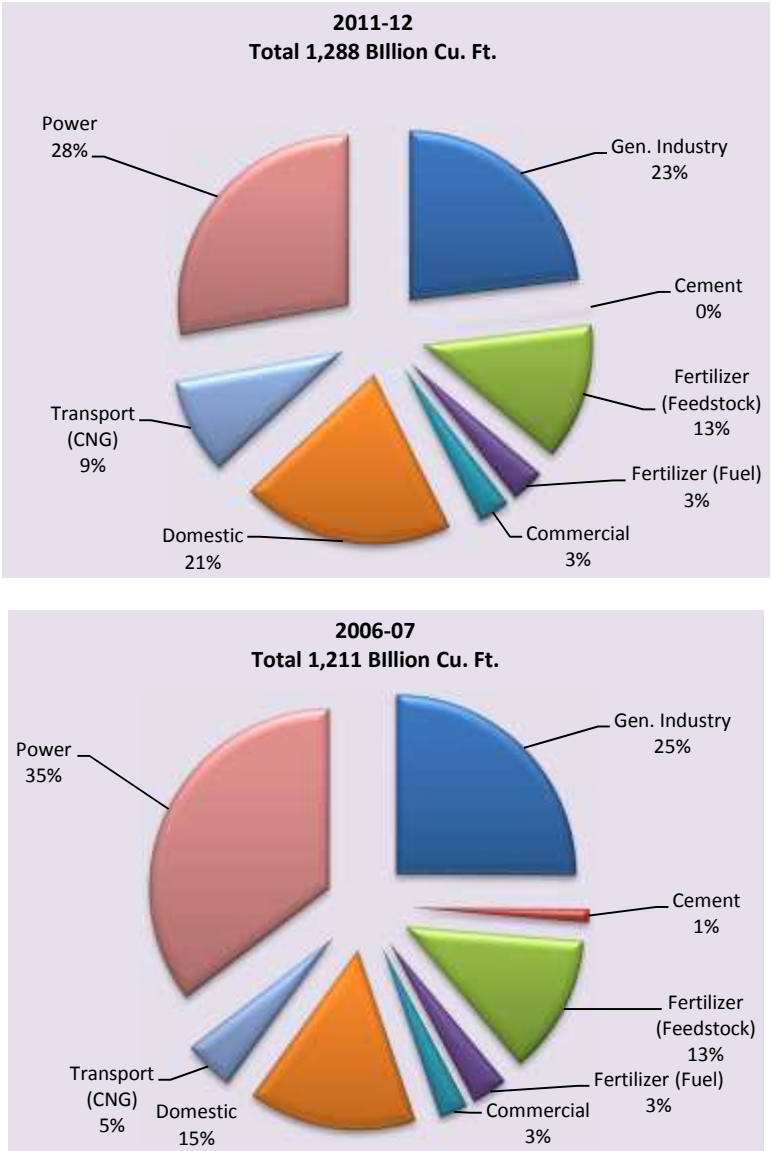
During July-March FY13, gas supplies remained 1,139,253 million cubic feet (mmcfd) as compared to 1,164,915mmcf in the same period of FY12, indicating a negative 2.2 percent growth. Efficient allocation of domestic gas supplies is of utmost importance. The Gas Allocation and Management Policy formulated in 2005 highlights a merit order of gas allocation when supply falls short of demand. However, the policy has been put on the back burner as actual gas allocation has been in blatant violation of the policy by the gas companies since 2005.

According to Gas Allocation Policy 2005 industry & CNG sector were fourth on priority list but gradually became the largest beneficiary of incremental gas supplies from FY05-11. Even

fertilizer sector witnessed an increase in gas allocation with 46 percent share in the incremental gas supplies. Power sector was the major loser during this period, where gas was actually diverted from the power to other sectors with absolute reduction of 33 percent in gas allocation during the period. Low gas supplies have been substituted by expensive oil imports. Thus, the reduction of gas was compensated with increased furnace oil generation which resulted in a surge in cost of electricity generation.

A comparison of the consumption pattern of gas by different users in FY07 and FY12 is presented below:

Figure 31: Comparison of natural gas consumption pattern FY07 and FY12

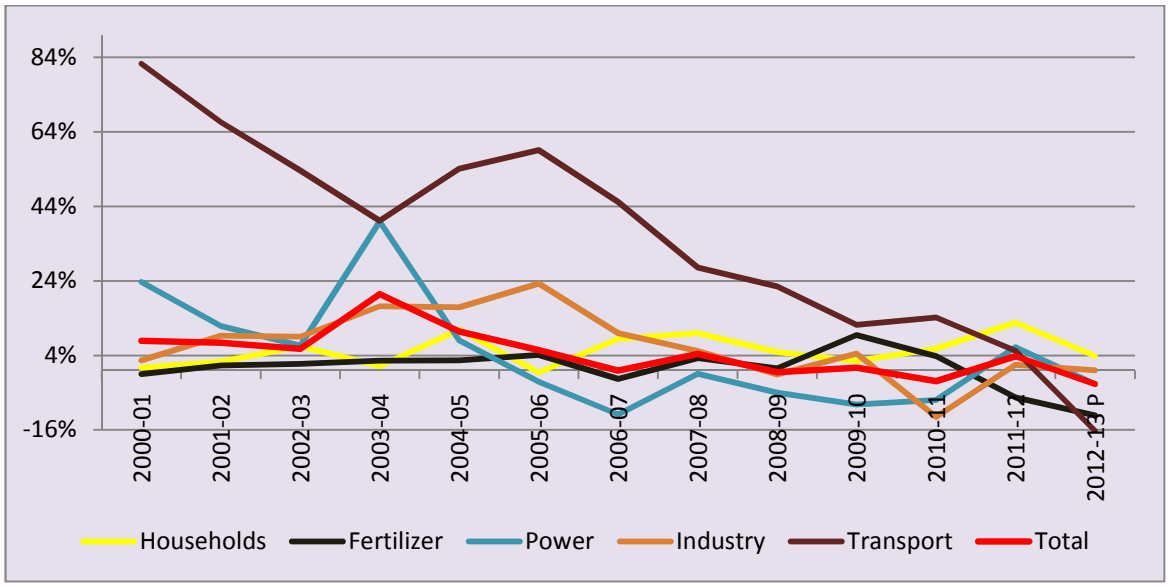


Source: *KCCI Research; HDIP*

As the government continued to accord priority to gas provision to households in the period under consideration, the share of household in gas consumption increased to 21 percent from 15 percent in FY07. Moreover, as mentioned above, the trend of providing gas to power sector is declining since FY07 except in 2012 where there was positive growth of 6 percent.

The transport sector is the other significant sector that posted a positive growth in gas consumption of 5.2 percent during 2011-12. However, during July-March 2012-13 a negative growth of 16 percent has been witnessed in this sector as compared to July-March 2011-12, as the govt. has put the transport sector on low priority of gas allocation. Although its share in total consumption of gas has increased from 0.6 percent to 9.2 percent in last ten years, but now due to gas load management its growth is declining. Though the fertilizer industry has been under turmoil for receipt of less gas than required, its share is still significant at (16 percent); however there was negative growth of 7 percent in 2012 when compared with 2011.

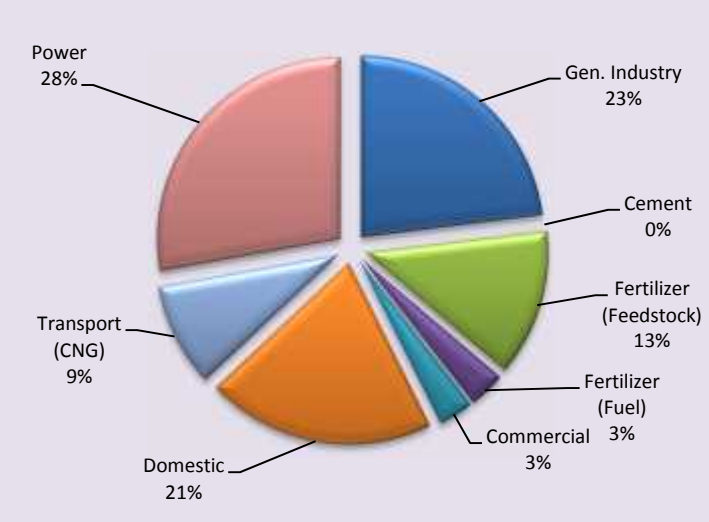
Figure 32: Natural Gas Consumption Category-wise Growth Rate



Source: *KCCI Research ; HDIP*

As per the provisional figures for 9MFY13, overall there was negative growth in the total consumption of gas. The analysis of the sectoral consumption of gas indicates that during July-March 2012-13, the highest share in consumption of gas remained in power sector (28%) followed by general industry (23%).

Figure 33: Natural Gas Consumption Pattern Jul-Mar 2013



Source: *KCCI Research ; HDIP*

While the short-term gas production outlook is stable, it would be impossible for Pakistan to maintain gas self-sufficiency in the long run. As is evident from Figure-30 above, production growth has been flat at best, as new explorations are compensating for the dwindling production from Sui. On the other hand, consumption continues to rise rapidly, as thermal power generation is on the rise by start-up of additional gas-fired power stations. To cater to the increasing demand in the short term, imported LNG is set to become part of the energy mix. In the meantime, Pakistan looks likely to attempt to privatize more of its various state-controlled energy companies and stimulate investment in domestic oil and gas production.

Gas allocation comparison with Pakistan's neighbors

Pakistan's gas allocation is in contrast to regional peers. Power sector gas allocation in India and Bangladesh is on an upward trend. In FY05, India allocated 39 percent (1,171 mmcfd) of gas to power which was increased to 53 percent (2,652 mmcfd) in FY12. India produces bulk of its power from coal (69%), while gas has a small share of 12 percent in power sector. Still almost half the import of LNG is also dedicated to the power sector. Likewise, in Bangladesh from FY05 to FY11, power sector has witnessed an absolute increase of 42 percent in gas allocation from 578 mmcfd in FY05 to 823 mmcfd in FY11.

Extension in Gas Transmission Network

During July 2012 to February, 2013, the two Gas utility companies Sui Northern Gas Pakistan Ltd.

(SNGPL) and Sui Southern Gas Co. Ltd. (SSGCL) have laid 14 Km long gas transmission network lines, 4,326 Km long distribution and 831 Km long services lines, and have connected 261 villages/towns to their gas networks. It is expected that gas will be supplied to approximately 39,000 new consumers and about 350 new towns/villages will be connected to the gas network during the fiscal year 2013-14.

During this period, the gas utility companies have invested Rs 1,513 million on transmission projects, Rs 11,925 million on distribution projects and Rs 1,898 million on other projects, thus bringing total investment to about Rs 15,336 million in 8MFY13. During this period, 237,588 additional gas connections including 236,997 domestic, 221 commercial and 370 industrial were provided across the country. Gas utility companies have planned to invest Rs 17,437 million on transmission projects, Rs 27,265 million on distribution projects, and Rs 11,165 million on other projects bringing the total investment of Rs 55,867 million during the fiscal year 2013-14.

Natural Gas Pricing

The Oil and Gas Regulatory Authority (OGRA) determines the gas prices to the extent of revenue requirements of the gas companies whereas the consumer's sale prices are fixed by the federal government under the OGRA Ordinance 2002. Revenue requirement of gas companies consists of the following three components:

(1) Cost of gas

(2) Operating cost and

(3) Return on average net operating assets in the accordance with the federal government's policy guidelines which is currently 17.5 percent in case of SNGPL and 17.0 percent in case of SSGCL.

The federal government under Section 9(3) of the Ordinance advises the sale prices for each category of consumers which are then notified by OGRA in the official gazette.

Compressed Natural Gas (CNG)

The government has been promoting use of Compressed Natural Gas (CNG) to reduce pollution and to improve the ambient air quality. During past few years CNG Industry had observed a tremendous growth. Today Pakistan is the world leading CNG user country with more than 2.7 million NGVs (Natural Gas Vehicles) plying on the roads and about 3,500 CNG filling stations nationwide. The choice of conversion was mainly due to the fact that price of CNG is significantly less than petrol price. However, this rapid expansion in the CNG sector has become a problem

for the government, as the gas consumed by the CNG sector has resulted in reduced provision of gas to the power and fertilizer sector, with households in Punjab and Khyber Pakhtunkhwa also facing gas load shedding in winter. Lower provision of gas to the power sector has also resulted in massive electricity load shedding and constant increase in the price of electricity due to high usage of expensive fuels in place of the low costing gas. OGRA also determines and notifies the maximum sale price of CNG to be charged by the CNG stations from the consumers for vehicular use.

Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) is a colorless and environmental friendly mixture of inflammable hydrocarbons. It contributes to about 0.5 percent of country's total primary energy supply mix. Use of LPG as a domestic fuel is being encouraged. It reduces deforestation (cutting of trees) in the areas where supply of natural gas is technically not viable.

The government has approved the LPG (Petroleum & Distribution) Policy Guidelines in early 2013, which aims to enhance availability of LPG through imports and indigenous production. To encourage imports, the government has charged Petroleum Levy on indigenous LPG production as provided in the Petroleum Products (Petroleum Levy) Ordinance, 1961. However, the said levies as well as few other provisions of LPG Policy have been challenged in the Lahore High Court and litigation is in progress.

Liquefied Natural Gas (LNG)

Liquefied natural gas or LNG is natural gas that has been converted to liquid form for ease of storage or transport. Liquefied natural gas takes up about 1/600th the volume of natural gas in the gaseous state. It is odorless, colorless, non-toxic and non-corrosive. Faced with increasing gap in the supply and demand of CNG, the government intends to import LNG into the country and blend it with CNG for transmission across the network. In order to encourage LNG import to bridge widening gap between gas demand and supply, the government has notified LNG Policy, 2011.

Coal

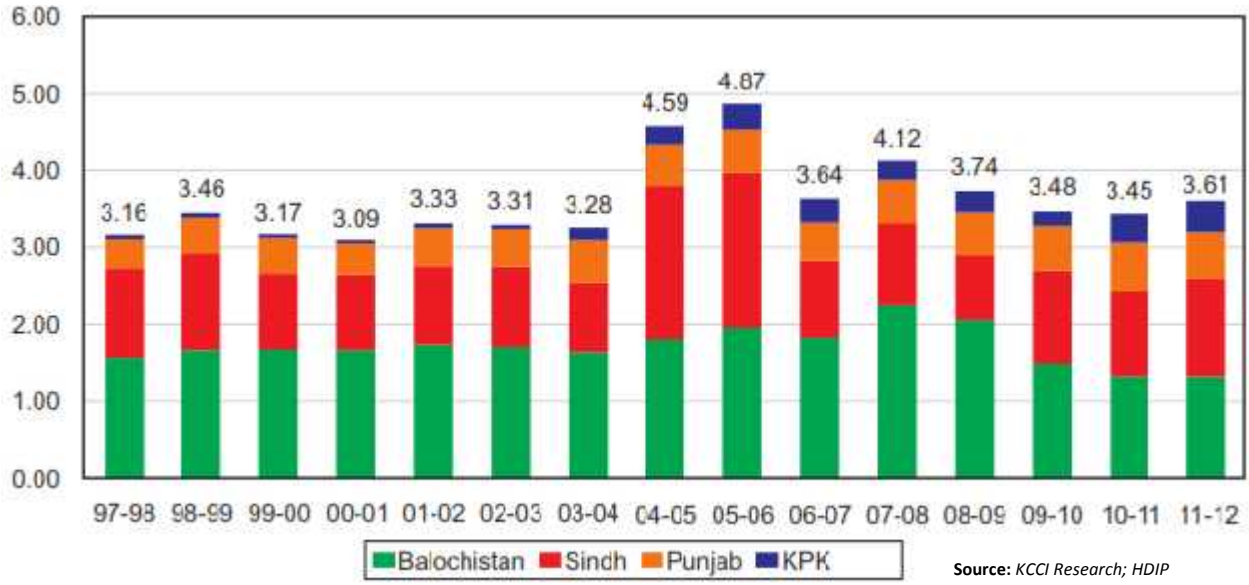
Pakistan's proven coal reserves are the world's sixth largest. The country has huge coal resources estimated at over 186 billion tons including 175 billion tons, identified at Thar coalfields. Pakistan's coal generally ranks from lignite to sub-bituminous [33]which is less consumed

[33] *Lignite and subbituminous coal are generally yellow to dark brown coal. They are considered inferior to higher-ranked coals (e.g., bituminous coal) in calorific value, ease of handling, and storage stability.*

domestically. Therefore, to cater to domestic demand, almost 4 million tons of coal is imported annually. On average, import of coal has remained more than domestic production for the last many years, which give weightage to the claim that domestic resource is of inferior quality, having low BTU, and that it is better to import coal rather than process it locally because of high cost. However, in this era of modernization, technology and boilers are available that can bum any kind of coal with great efficiency.

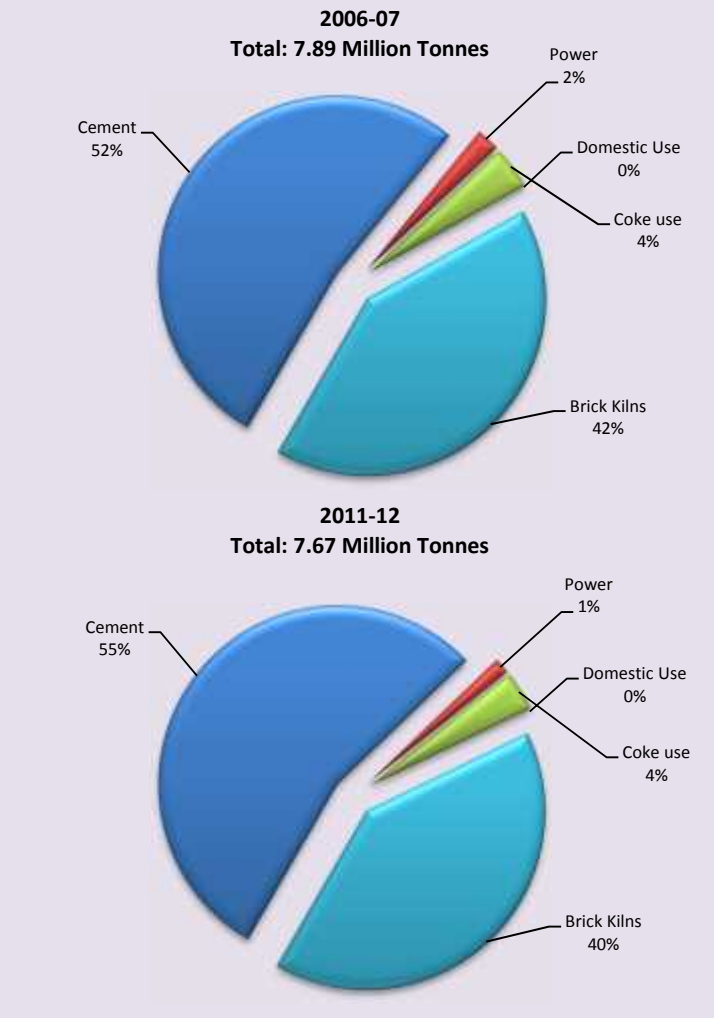
The major users of coal are the cement manufacturers and brick kilns; about 58 percent of total coal was consumed by cement producers while 41 percent was consumed by the brick kiln industry during FY12. The longer term trend analysis shows that for the last ten years, on average the cement sector and brick kilns have been the highest consumers of coal.

Figure 34: Coal Production in Pakistan (Mn Tons)



Source: *KCCI Research; HDIP*

Figure 35: Comparison of coal consumption pattern FY07 and FY12



Source: *KCCI Research; HDIP*

The reason for the high share of consumption of coal in the cement industry is due to switching over to coal from furnace oil which has increased the utilization of indigenous as well as imported coal. Thus measures are needed to increase the share of coal in the overall energy mix.

Nuclear Energy

Pakistan Atomic Energy Commission (PAEC) is responsible for planning, construction and operation of nuclear power plants i.e. Karachi Nuclear Power Plant (KANUPP) and Chashma Nuclear Power Plant (CHANUPP) Unit-1 and 2 (C-1 & C-2). The construction of two more units C-3 and C-4 is in progress.

KANUPP, located at Karachi, completed its design life of 30 years in 2002. After necessary refurbishments and safety retrofits, it is now operating on extended life. KANUPP, generated highest ever electricity in a calendar year in 2012 in its 40-years history.

C-1 and C-2 located' at Chashma are also performing very well. C-1 achieved record of continuous operation of 239 days in July 2012. The commercial operation of the under construction nuclear power plants C-3 and C-4 of 340 MW each is planned in December 2016 and October 2017 respectively. At present, the construction activities are three months ahead of the schedule.

The government has also mandated Pakistan Atomic Energy Commission (PAEC) for the installation of 8,800 MW nuclear power capacities by the year 2030. PAEC has technical and engineering infrastructure is place to provide technical support to existing under construction and future nuclear power plants. It also has a network of in-house educational and training institutions that encompass all major facets of nuclear science and technology.

Electric Energy

Electric energy is the secondary source of energy being derived from natural primary physical form of energy. The country is facing a number of challenges and crisis in this sector. Successive governments have been trying to bring improvements in this sector, but have been unable to put an end to massive load shedding and in alleviating the problems caused to the general public and the industries by shortfall of electricity. It is claimed that financial, technical, and administrative issues are key to resolve this crisis.

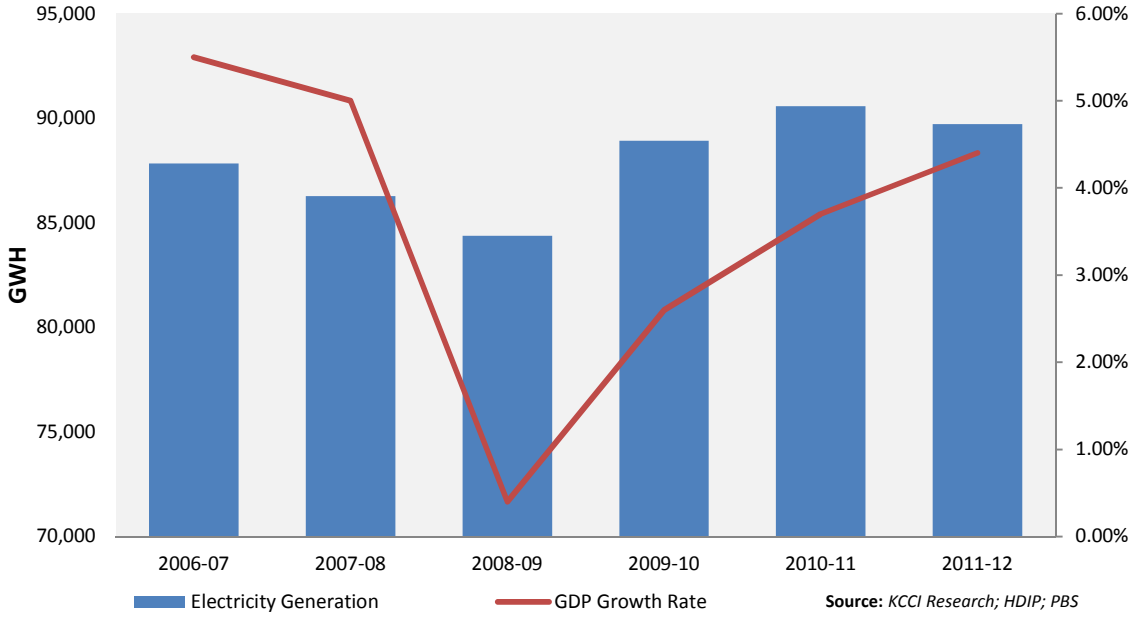
To bring some improvement in the output capacities and performance of generation companies (GENCOs), international donor agencies have been providing technical and financial support to GENCOs in their rehabilitation and up gradation efforts. Similarly, rehabilitation for additional capacity of hydropower plants with the help of international donor agencies would be completed over next couple of years. National Transmission and Dispatch Company (NTDC) plans to add 6100 MVA of new 500/220 kV grids over the next two years. Similarly, it has planned to add 6400 MVA of new 220/132 kV grids over next three years. NTDC has also initiated reinforcement and extensions in two of its 500/220 kV and six of its 220/132 kV grid stations.

There exists a strong relationship between GDP growth and electricity growth as shown in figure-34 below:

It can be understood that periods of low or negative growth in electricity generation have induced low GDP growth rate, while periods in which electricity growth has picked up has higher

GDP growth rates.

Figure 36: GDP and electricity consumption



Pakistan's electricity generation is highly dependent on imported oil, as a major proportion of generation is carried out using the thermal mechanism. Thus pronounced shift from hydro to thermal generation, and more recently from natural gas to fuel oil as the primary fuel for electricity generation have caused fuels crises in Pakistan's power sector. Further these trends have contributed to an increase in power supply costs. Thus there is need of immediate shifting of fuel mix from expensive to cheaper. It can be seen from the following table that Pakistan has largest share of oil in electricity generation as compared to its regional peers.

Table 8: Peer Comparison of Fuel Mix in Power Generation (FY12)

Country	Gas	Oil	Coal	Hydel, Nuclear or import
India	9.20%	0.80%	71.00%	19.00%
Bangladesh	73.00%	20.40%	3.40%	3.20%
Pakistan	29.00%	35.00%	0.10%	35.70%

Source: *KCCI Research; NEPRA*

Organization of Pakistan's Energy and Electricity Sector

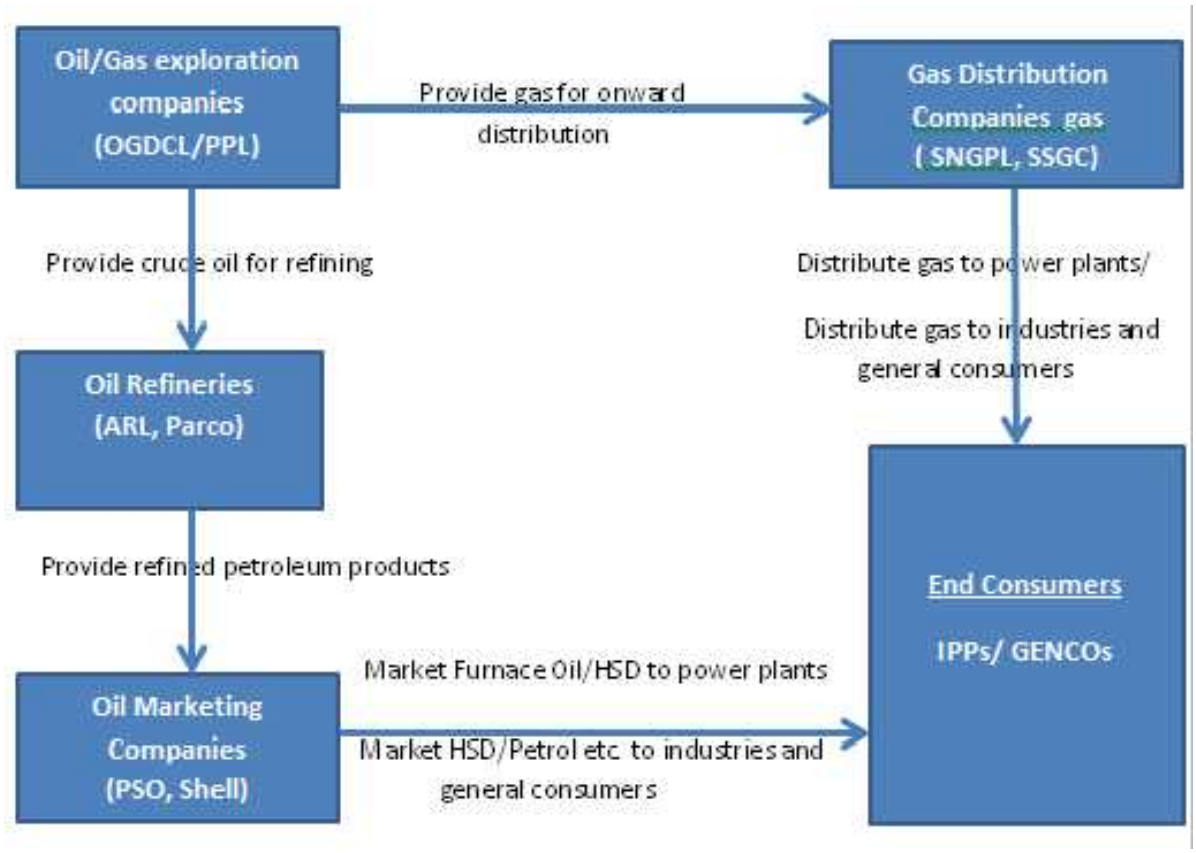
Pakistan's energy sector is composed of numerous stakeholders who can be broadly categorized into two sections, a) Suppliers of primary energy and b) Power generation and distribution companies as elaborated below:

Suppliers of primary energy:

This category consists of the providers of oil and gas which are two major forms of primary energy. The players in this category form a supply chain which begins from the extraction of crude oil and gas at the fields, passes through the refining process and culminates at the doors of the power producers or the end consumers. The four main sub-categories of stakeholders are:

i) Oil/Gas Exploration Companies (e.g., OGDCL and PPL),
ii) Oil Refineries (e.g., ARL, Parco)
iii) Gas Distribution Companies gas (e.g., SNGPL, SSGC)
iv) Oil Marketing Companies (e.g., PSO, Shell).

Figure 37: Structure of Pakistan's primary energy supply



Source: *KCCI Research*

Power generation and distribution companies:

(i) PEPCO (formerly the electricity wing of WAPDA) is the core entity in the energy sector. It is an umbrella institution managing:

i. Power Generation Companies (GENCOs),

ii. Power Distribution Companies (DISCOs),

iii. National Transmission and Despatch Company (NTDC)

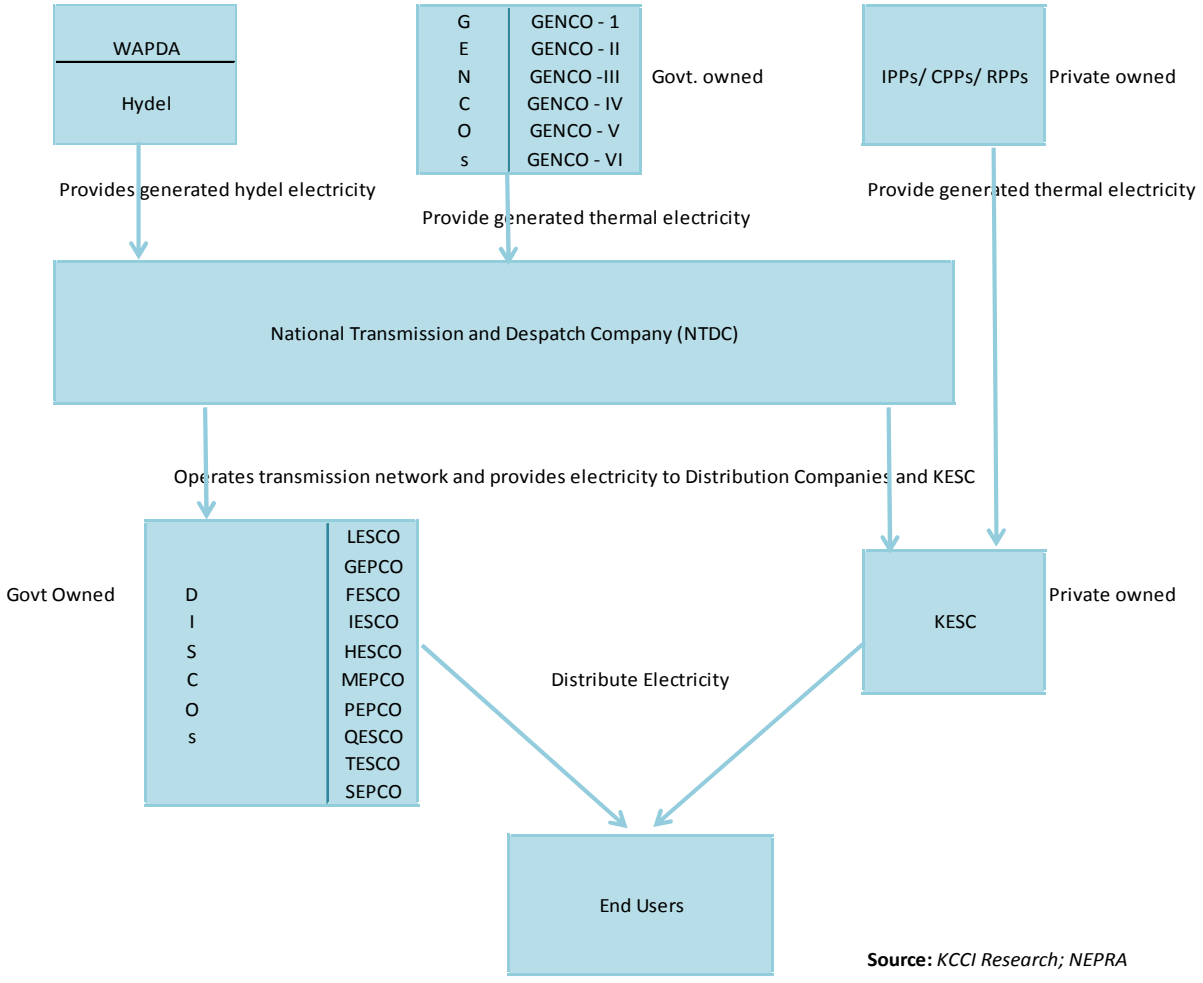
(ii) WAPDA Hydel

(iii) Karachi Electric Supply Company (KESC) (a vertically integrated company)

(iv) Independent Power Producers (IPPs) (HUBCO, KAPCO)

(v) Captive power producers (CPP), Rental power producers (RPP)

Figure 38: Structure of Pakistan's electricity supply



Source: *KCCI Research; NEPRA*

Pakistan's Electricity Scenario – Present Status of Affairs

Pakistan's electricity scenario does not present a very bright picture. The country faces chronic electricity shortage due to demand growth, less than adequate additions to generation capacity and a host of other issues including high system losses, seasonal reductions in the availability of hydropower and circular debt. High power demand and lower generation has created a situation where frequent power outages occur owing to incessant load shedding. High load on the existing equipment results in system tripping leading to further power breakdowns. Further, there still exist many rural areas which are without electricity.

Low access to better energy services is one aspect of poverty as energy choices of poor households are influenced by poverty. However, deprivations caused by energy scarcity on human development are much more significant than the poverty itself. Such deprivations generally have a larger impact on rural households, and women in particular. Heavy use of biomass directly affects human health due to indoor air pollution, while the heavy workload for managing biomass resources not only consume more time and energy but can cause other health problems particularly in women.

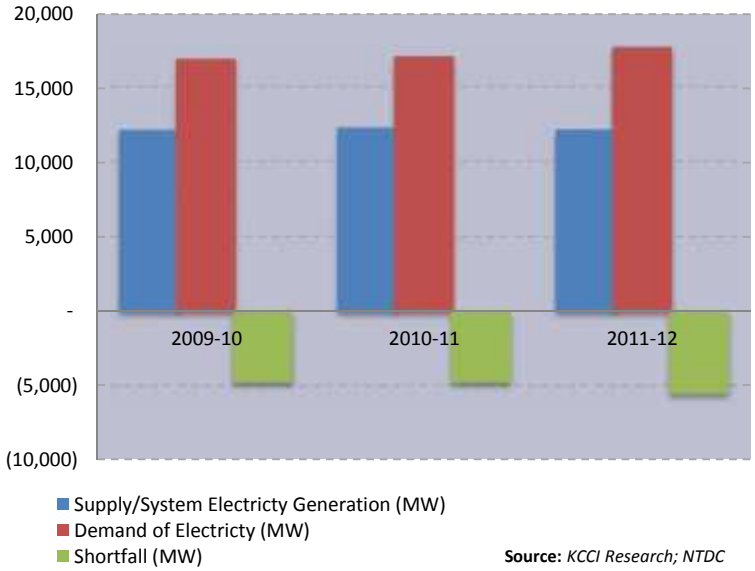
The industrial output has failed to pick up mainly due gas and electricity outages. The precarious situation has shaken the confidence of industrialists where long hours of load shedding and frequent power breakdowns accompanied by high cost of electricity have made it difficult for the industry to remain competitive in local and international markets. There are even examples of export deadlines being missed and companies getting black-listed, due to the ongoing energy crises.

Inefficiencies in the power sector have significantly drained the budget costs of Pakistan during the past several years. The growth has been slowed down by at least 2 percent per annum due to power crises which means 10 percent of GDP growth has been lost during the last five years, as per the report by Planning Commission titled "The causes and impacts of Power Sector circular debt in Pakistan".

Although about 3,000 MW of new generation has been added to the system over the past couple of years, there is a large quantum of suppressed demand which is getting higher each year and is outpacing the new addition to generation. Also, the new generation capacity added in the system during last two years could not be operated at full due to constraints in fuel availability and cash liquidity. Thus gap between supply and demand in the system remains at around 4,000 to 5,000 MW for most part of the year. Further reduction in supply due to constraints in the transmission and distribution networks has led to load shedding of up to 12

hours in some urban areas, whereas the rural areas experience load shedding for 18 to 20 hours a day. It is feared that the gap between supply and demand would continue to widen, as the current plans would not be adequate to meet the needs of the sector even around 2020. The chart below gives an indication of the increase in the electricity demand supply gap in the country.

Figure 39: Pak Electricity Shortfall Snapshot

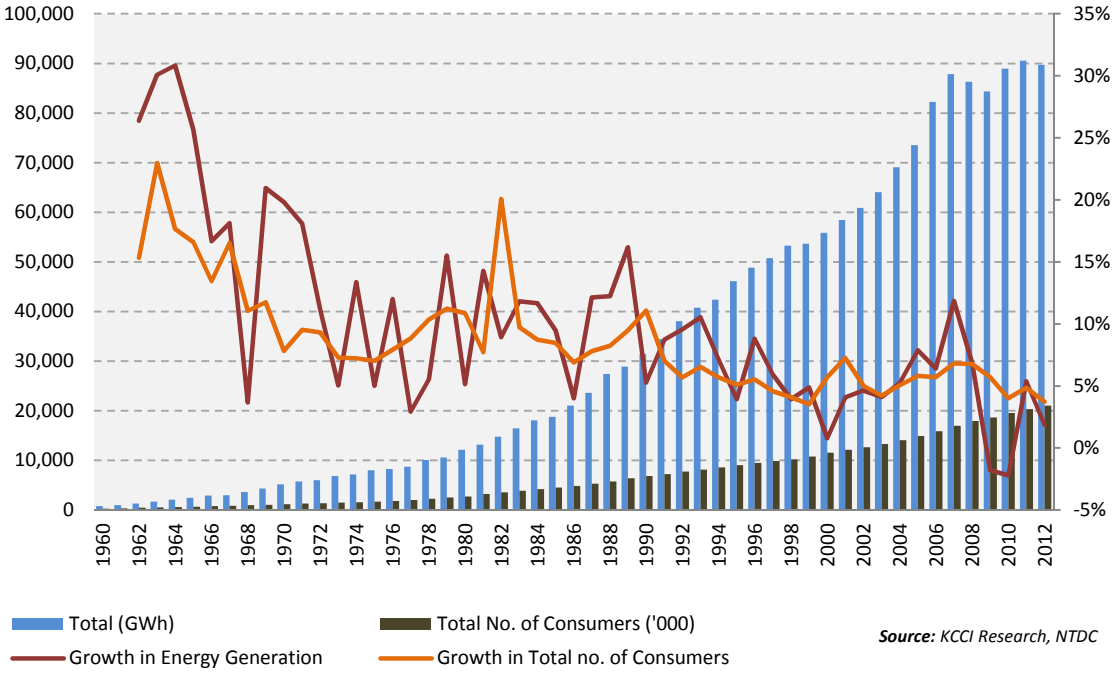


Source: *KCCI Research; NTDC*

Consumers vs. Electricity Generation

Though the generation capacity of Pakistan at current scenario is so much so that it can meet the demand of the consumers provided if the electricity generations plants are run at their full potential. But, in the existing situation as per the increasing rate of consumers; the electricity generation is not up to the mark to meet their demands. As evident from the chart below, the average growth in generation of electricity is 0.46 percent as compared to average growth of consumers is 4.38 percent during the period from FY08 to FY12 which indicates an alarming situation of electricity in the country.

Figure 40: Growth in consumers compared to growth in electricity generation



Source: *KCCI Research, NTDC*

The number of consumers in the country has been increasing rapidly due to high urbanization and expansion of large cities, brisk extension of electricity network to villages and other un-electrified areas. As of March 2013, the number of consumers has been increased to 21.70 million. The trend of increase in number of consumers along with growth in electricity generation is given in the following table:

Table 9: Consumers and Generation at a Glance

Fiscal Year Ending 30th June	Total (GWh)	Growth in Energy Generation	Total No. of Consumers ('000)	Growth in Total no. of Consumers
1960	781	-	312	-
1961	987	26.38%	359	15.34%
1962	1,284	30.09%	442	22.98%
1963	1,680	30.84%	520	17.65%
1964	2,111	25.65%	606	16.61%
1965	2,463	16.67%	688	13.44%
1966	2,909	18.11%	801	16.52%
1967	3,016	3.68%	890	11.06%
1968	3,648	20.95%	995	11.75%
1969	4,371	19.82%	1,072	7.82%
1970	5,162	18.10%	1,175	9.53%
1971	5,740	11.20%	1,284	9.33%

1972	6,029	5.03%	1,378	7.29%
1973	6,836	13.39%	1,477	7.22%
1974	7,179	5.02%	1,581	7.03%
1975	8,041	12.01%	1,707	7.93%
1976	8,276	2.92%	1,857	8.84%
1977	8,734	5.53%	2,050	10.36%
1978	10,089	15.51%	2,280	11.24%
1979	10,609	5.15%	2,528	10.87%
1980	12,124	14.28%	2,723	7.72%
1981	13,206	8.92%	3,270	20.07%
1982	14,768	11.83%	3,588	9.73%
1983	16,492	11.67%	3,901	8.73%
1984	18,055	9.48%	4,232	8.46%
1985	18,780	4.02%	4,524	6.91%
1986	21,058	12.13%	4,877	7.80%
1987	23,634	12.23%	5,279	8.24%
1988	27,456	16.17%	5,780	9.49%
1989	28,905	5.28%	6,419	11.07%
1990	31,432	8.74%	6,871	7.03%
1991	34,439	9.57%	7,261	5.68%
1992	38,071	10.55%	7,736	6.55%
1993	40,796	7.16%	8,176	5.68%
1994	42,401	3.93%	8,592	5.09%
1995	46,131	8.80%	9,067	5.53%
1996	48,863	5.92%	9,482	4.57%
1997	50,786	3.94%	9,869	4.08%
1998	53,263	4.88%	10,217	3.53%
1999	53,687	0.80%	10,800	5.70%
2000	55,873	4.07%	11,585	7.27%
2001	58,455	4.62%	12,166	5.02%
2002	60,860	4.11%	12,678	4.21%
2003	64,040	5.23%	13,318	5.05%
2004	69,094	7.89%	14,091	5.80%
2005	73,520	6.41%	14,896	5.71%
2006	82,225	11.84%	15,911	6.81%
2007	87,837	6.83%	16,987	6.76%
2008	86,269	-1.79%	17,955	5.70%
2009	84,377	-2.19%	18,674	4.00%
2010	88,921	5.39%	19,582	4.86%
2011	90,575	1.86%	20,309	3.71%
2012	89,721	-0.94%	21,047	3.63%

Source: *KCCI Research; NTDC*

Karachi Power Situation

The power situation in KESC is also not very different from that of PEPCO's system. As the industrial and commercial hub and largest city of the country, it is also host to about 10 percent of the country's total population. Karachi alone has 2.14Mn registered connections, which is approximately 10 percent of Pakistan's 21.05Mn connections.

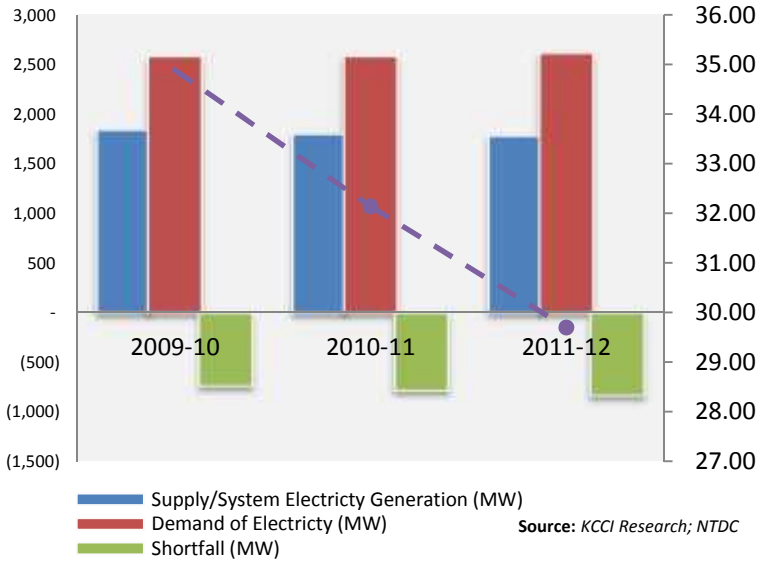
Table 10: Dynamics of Electricity in Karachi

Fiscal Year Ending 30th June	2010	2011	2012
Maximum Demand (MW)	2,562	2,565	2,596
Energy Sales (GWh)	9,905	10,071	10,277
No. of Consumers (000)	2,052	2,110	2,140
System Losses (%) including Auxiliary Consumption	35	32	30

Source: *KCCI Research; KESC*

Karachi, like other parts of the country, is also experiencing load-shedding hours but according to a policy of the KESC's management, industrial category of consumers is not subjected to power cuts in the metropolitan. The load shedding for most consumers vary between one hour to two and half hours on daily basis. However the load is shed for longer hours i.e. for around 3-6 hours per day in areas where electricity theft and pilferage is rampant, and where lower bill recovery ratios have persisted.

Figure 41: Snapshot of Karachi's Electricity Shortfall



Source: *KCCI Research; NTDC*

Electricity Generation Scenario

The power sector in Pakistan is a mixed industry of thermal, hydro and nuclear power plants. Pakistan mostly used to rely on hydel power generation with its share being 67 percent in 1985 and that of thermal power being 35 percent in the installed power capacity. But with the passage of time, due to different reasons, more expensive thermal generation was added which gradually resulted in reduced share of hydel generation in the overall installed capacity. At present, hydel power, which has low costs of production, has a share of only 29 percent while thermal power (including IPPs) commands a share of 68%. As on June 30, 2012, the total installed power production capacity of the country stood at 23,538 MW of which the share of thermal power plants (including IPPs) is 16,035 MW (68%) followed by hydel power plant 6,716 MW (29%) and nuclear power plants 787 MW (3%). It is a drawback of the country that its power production is dominated by thermal power plants running on oil and gas in spite of having five large rivers and an abundance of smaller waterways. As a consequence, Pakistan is heavily dependent on import of oil for its domestic energy requirement due to large number of oil-fired power plants.

Figure 42: Installed Generation Capacity (MW) in June 2012

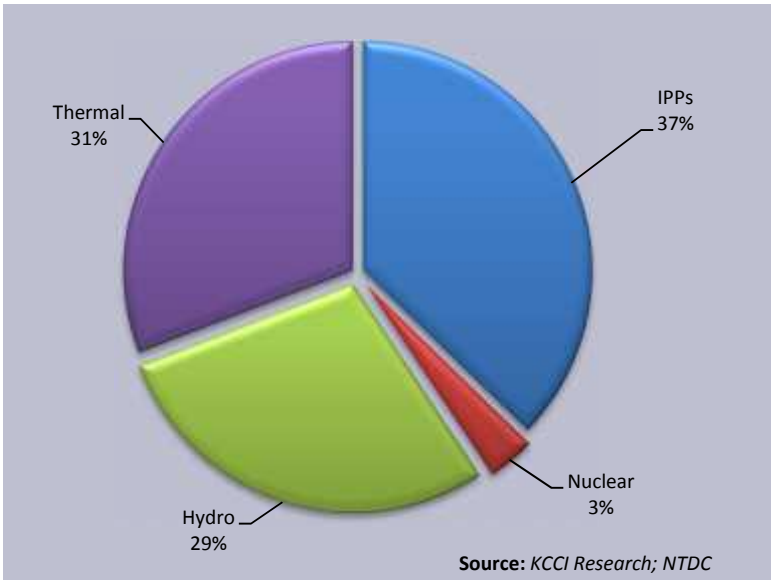
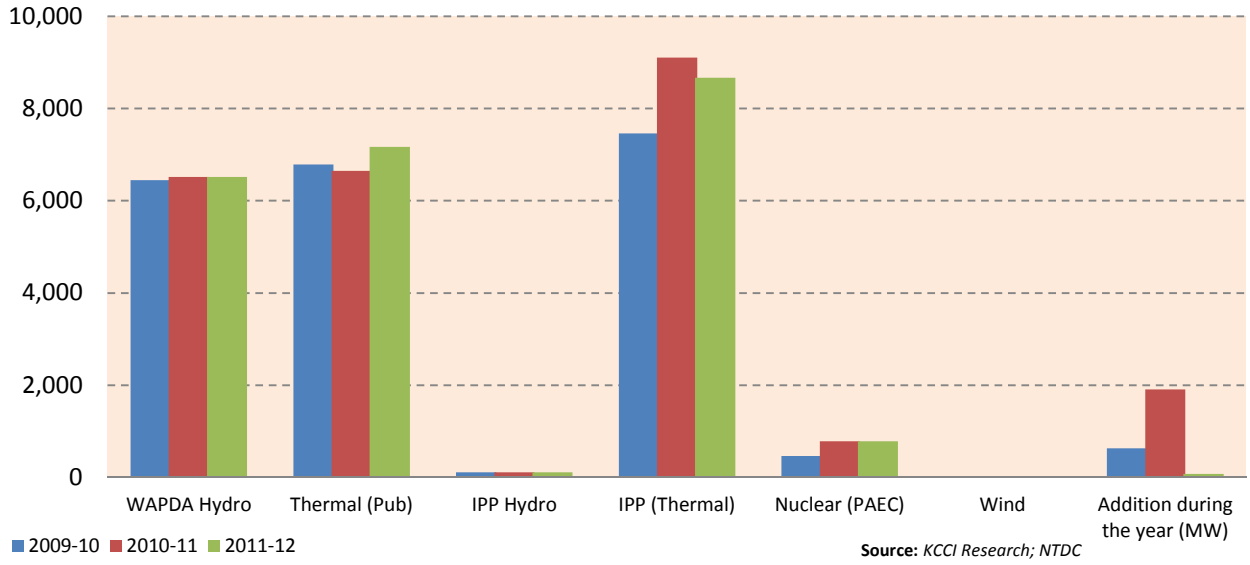


Figure 43: Trend of installed Generation Capacity in Pakistan (MW)



Source: *KCCI Research; NTDC*

Available power generation capacity compared to installed capacity

The power production capability of generation units varies as per their age, auxiliary consumption, fuel (gas) availability and plant site conditions. The availability of different power plants (technology-wise) against their installed capacity recorded during the fiscal year 2012 has been reported in the following table:

Table 11: Installed Power Generation Capacity by type (MW)

As on 30th June		2008	2009	2010	2011	2012
THERMAL						
GENCOs with PEPCO		4,899	4,900	4,885	4,720	4,720
KESC Own		1,756	1,846	1,946	1,821	2,381
IPPs	Connected with PEPCO	5,773	5,956	7,060	8,325	8,308
	Connected with KESC	262	262	262	252	252
RPPs	Connected with PEPCO	286	286	122	403	0
	connected with KESC	0	50	50	50	50
CPPs/SPPs connected with KESC		239	239	272	324	324
Sub-Total		13,215	13,539	14,597	15,895	16,035
Percentage share		65.32	65.86	67.53	68.14	68.12
HYDEL						

WAPDA (Hydel)	6,444	6,444	6,444	6,516	6,587
IPPs (Hydel)	111	111	111	129	129
Sub-Total	6,555	6,555	6,555	6,645	6,716
Percentage share	32.4	31.89	30.33	28.49	28.53
NUCLEAR					
CHASNUPP (1&11)	325	325	325	650	650
KANUPP	137	137	137	137	137
Sub-Total	462	462	462	787	787
Percentage share	2.28	2.25	2.14	3.37	3.34
Total Installed Generation Capacity of the Country	20,232	20,556	21,614	23,327	23,538

Source: *KCCI Research; NEPRA*

The table below signifies that out of the total 16,822 MW thermal and nuclear generation capacity of the country, only 14,257MW are available, a ratio of 85%. Thus 15 percent of the installed capacity (thermal and nuclear) remains unavailable in the peak summer time.

Table 12: Installed and Available Power Generation Capacity (MW)

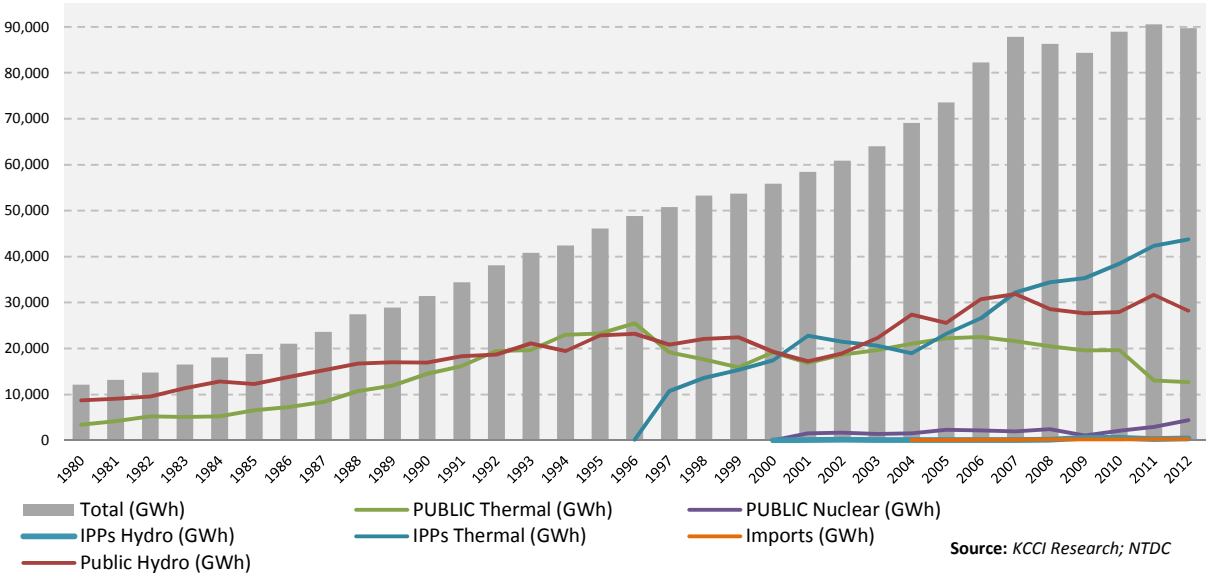
	PEPCO	KESC	PEPCO	KESC	PEPCO	KESC	PEPCO	KESC	PEPCO	KESC
	2007-08		2008-09		2009-10		2010-11		2011-12	
Installed Capacity										
Thermal	10,958	2,257	11,142	2,397	12,067	2,530	13,448	2,447	13,028	3,007
Nuclear	325	137	325	137	325	137	650	137	650	137
Total	11,283	2,394	11,467	2,534	12,392	2,667	14,098	2,584	13,678	3,144
Available Capacity										
Thermal	6,564	1,644	9,353	1,854	10,411	2,018	11,865	1,787	11,271	2,287
Nuclear	296	n.a.	300	80	300	82	615	84	615	84
Total	6,860	1,644	9,653	1,934	10,711	2,100	12,480	1,871	11,886	2,371
Available Percentage of Installed Capacity										
Thermal	59.9	72.84	83.94	77.35	86.28	79.76	88.23	73.03	86.51	76.06
Nuclear	91.08	n.a.	92.31	58.39	92.31	59.85	94.62	61.31	94.62	61.31
Total	60.8	68.67	84.18	76.32	86.43	78.74	88.52	72.41	86.9	75.41

Source: *KCCI Research; NEPRA*

During the fiscal year 2011-12, the total energy generated in the country was 98,664 GWh of which the share of thermal electricity generation was 65,149 GWh (66%), hydel power plants were 28,643 GWh (29%) and nuclear power plants were 4,872 GWh (5%). The increasing share of thermal electricity generation increased the utilities financial burden particularly in foreign exchange. Hence, it is a strong need of the time to increase the hydel generation by adding new

hydropower plants. The share of private sector within power generation is increasing as compared to the public sector. Electricity generation by source and sector during fiscal years 1990 to 2012 are shown in the following chart.

Figure 44: Power Generation by Sector and Source FY80-12 (GWh)



The following section tries to give a brief overview of the major sources of power generation in Pakistan:

Thermal Generation

Majority of Pakistan's power generation is thermal, with furnace oil, high-speed diesel and natural gas as fuels; coal is almost non-existent. During fiscal year 2012, the share of thermal power generation in the energy mix of Pakistan was 66%. Further, most of the upcoming power projects in the country oil and gas are gas operated. The addition of thermal power plants running on furnace oil and diesel will result in higher oil imports and would increase the current account deficit which in turn will further deplete the nation’s stock of forex reserves. The import of oil and oil products (Petroleum, Oil, & Lubricants - POL) is one of the main reasons of current account deficit as POL imports command the highest share of Pakistan’s total imports. Any strategy to cut current account deficit would be unsuccessful unless a strategy is devised to cut down the POL imports. For this very reason, it is essential to reduce electricity generation through furnace oil and diesel. Similarly, the thermal power plants running on natural gas has a negative externality: the economic loss resulting from deficiency of natural gas due to excessive reliance on gas fired power generation.

Table 13: Thermal Electricity Generation (GWh)

		2007-08	2008-09	2009-10	2010-11	2011-12
Thermal Generation by:						
GENCOs		20,427	19,520	19,594	13,018	12,753
KESC Own Power Plants		8,662	8,262	7,964	7,826	8,029
IPPs	PEPCO Area	33,195	33,702	37,590	41,209	42,222
	KESC Area	1,750	1,112	1,246	1,538	933
RPPs	PEPCO Area	938	914	254	546	-
	KESC Area	-	163	358	158	-
CPPs/SPPs/	PEPCO Area	306	725	854	585	730
	KESC Area	328	321	477	287	154
Total Thermal Generation		65,606	64,718	68,337	65,167	64,821
Thermal Generation using:						
Gas	PEPCO Area	28,514	32,003	25,544	30,910	22,991
	KESC Area	6,462	7,571	7,013	5,578	6,001
	Total	34,976	39,574	32,557	36,488	28,992
FO and HSD	PEPCO Area	26,216	22,745	32,632	24,382	32,577
	KESC Area	4,278	2,286	3,009	4,188	3,115
	Total	30,494	25,031	35,641	28,570	35,692
Coal	PEPCO Area	136	113	116	66	66
	KESC Area	-	-	23	43	-
	Total	136	113	139	109	66
Total Thermal Generation		65,606	64,718	68,337	65,167	64,821

Source: *KCCI Research; NEPRA*

The table above highlights the fact that Pakistan's thermal power generation has declined by 5 percent in the last two years. The probable primary reason for this decline is lesser availability of fuel to the power plants; power plants had less capacity to buy fuel as a direct consequence of cash flows being stuck up in circular debt.

Thermal Power Generation and Fuel Consumption

The charts below show the relative share of different fuels in thermal power generation, while also giving an idea of the amount of fuel used in power generation.

Figure 45: Fuel Consumption Mix for Thermal Power Generation FY12

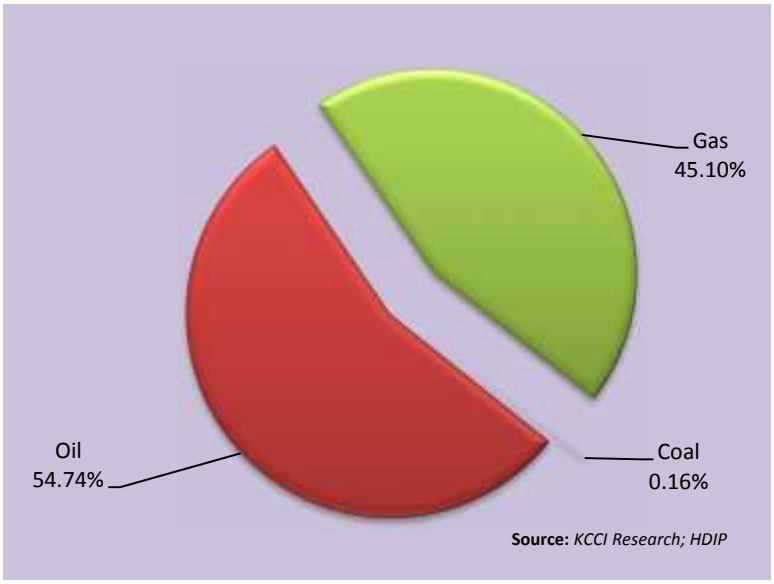


Table 14: Trend of Fuel Consumption for Thermal Power Generation (GWH)

Fuel	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	ACGR
Coal	136	136	113	116	88	96	-6.80%
Share of Coal %	0.21%	0.21%	0.18%	0.18%	0.15%	0.16%	
Oil	28,025	30,818	32,423	36,175	33,186	33,562	3.70%
Share of Oil %	43.81%	48.25%	52.12%	56.20%	56.10%	54.74%	
Gas	35,811	32,923	29,678	28,079	25,879	27,650	-5.00%
Share of Gas%	55.98%	51.54%	47.70%	43.62%	43.75%	45.10%	
Total	63,972	63,877	62,214	64,371	59,153	61,308	-0.80%
Annual growth rate	**6.12%**	**-0.15%**	**-2.60%**	**3.47%**	**-8.11%**	**3.64%**	

Source: *KCCI Research; HDIP*

It could be observed that during the year 2011-12, the share of thermal electricity generated using gas in the total electricity generation of the country was 45.10 percent, depicting an increase of 1.35 percent over the year 2010-11. This increase in share is due to the government's increased focus on providing high priority to the power sector. Contrarily, share of oil in electricity generation in the total electricity generation of the country was 54.74 percent, a decline of 1.36 percent from 2010-11.

Apart from coal, natural gas is the cheapest fuel for power generation, followed by Furnace Oil and High Speed Diesel being the most expensive. The following table calculates the cost per KWh in Paisa for power generation using different fuels.

Table 15: Fuel Consumption and Cost of Electricity Generation in GENCOs

	2007-08	2008-09	2009-10	2010-11	2011-12
GAS:					
Generation on Gas (GWh)	12,474	11,120	9,968	7,184	7,843
Quantity of Gas Used (000 MCF)	155,004	145,621	129,176	97,029	103,294
Consumption/kWh (Cft)	12.43	13.1	12.96	13.51	13.17
Cost/kWh (Paisa)	256.45	362.83	386.94	428.81	494.88
FURNACE OIL (FO):					
Generation on Furnace Oil (GWh)	7,816	8,240	9,324	6,802	5,653
Quantity of Furnace Oil Used (000 Mn Tons)	2,088	2,189	2,562	1,882	1,542
Consumption/kWh (Kg)	0.27	0.27	0.27	0.28	0.27
Cost/kWh (Paisa)	811.5	918.74	1,127.66	1,367.49	1,854.17
HIGH SPEED DIESEL (HSD):					
Generation on HSD (GWh)	1	48	185	35	11
Quantity of HSD Used (000 Ltrs.)	926	13,410	49,701	10,057	3,460
Consumption/kWh (Ltr)	0.73	0.28	0.27	0.29	0.32
Cost/kWh (Paisa)	1,805.24	1,350.90	1,607.71	1,840.24	2,447.40
COAL:					
Generation on Coal (GWh)	136	113	116	66	66
Quantity of Coal Used (000 M.Tons)	162	121	125	96	105
Consumption/kWh (Kg)	1.19	1.07	1.08	1.09	1.09
Cost/kWh (Paisa)	202.92	211.87	248.52	278.26	339.29
Overall Fuel Cost and Cost of Fuel per kWh					
Overall Fuel Cost used in GENCOs (Rs Mn)	95,717	116,936	146,981	124,721	144,225
Overall Cost of Fuel (Paisa/kWh)	466.72	597.55	748.33	883.91	1,060.24

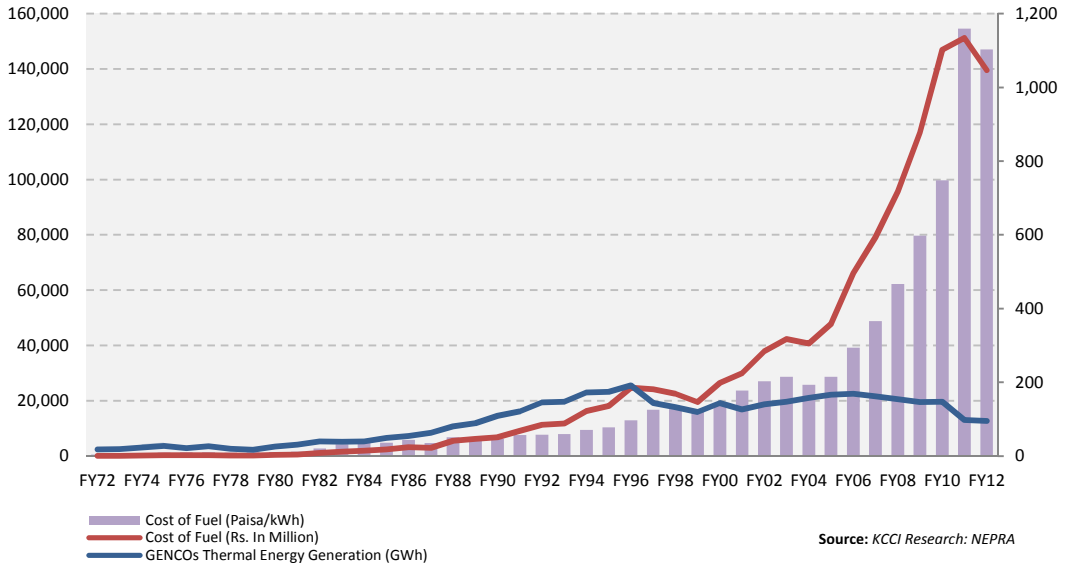
***Source**: KCCI Research; NTDC*

A closer look at the table shows that costs of electricity generation using gas, Furnace Oil and HSD have increased by 15%, 36 percent and 33 percent respectively in FY12, as compared to FY11. As oil based generation contributes 55 percent to total thermal generation, the high cost and higher increase in Furnace Oil and HSD have increased the cost of overall thermal power by 20 percent to Rs 10.60 in 2012.

As a consequence of higher thermal power generation, the total cost of fuel has drastically increased, as has the fuel cost per unit of electricity produced. To bring this point in proper

perspective, the cost of fuel per kWh has risen by 443 percent in the 10 year period from 2002 to 2012. The following chart aptly depicts this rise in the fuel costs.

Figure 46: Average Fuel Cost



The following table details the cost of power production of various power stations of KESC and the IPPs connected with KESC system. In line with the increase in cost of thermal generation, cost of generation of KESC has also increased with time.

Table 16: Fuel Consumption and Cost of Generation Data - KESC

Power Station	Fiscal Year	Gen. on Gas (GWh)	Gas Consumption Total MMCFT	CFT kWh (Avg.)	Gen. on FO (GWh)	FO Consumption Total (000 M. Tons)	(kg/ kWh)	Gen. on HSD (GWh)	HSD Cons. (000 Ltr.)	Cost of Gen. (Paisa /kWh)
KESC (Own GENCOs)										
Bin Qasim TPS-I	FY08	4,817	55,759	11.58	2,488	638.84	0.26			426
	FY09	5,247	60,535	12	1,149	313.1	0.27			451
	FY10	3,742	43,029	11.5	1,764	481	0.27			519
	FY11	2,492	28,756	11.54	2,576	681	0.26			798
	FY12	2,577	29,279	I 1.36	2,127	560	0.26			934
BQTPS-II	FY12	1,139	II, III	9.75	-	-		0.62	364	440
Korangi TPS	FY08	716	10,214	14.27	14	4.36	0.31			347
	FY09	914	12,176	13	8	2.27	0.3			440
	FY10	222	2,886	13	-	-				440
	FY11	271	3,533	13.06	-	-				498

	FY12	163	2,199	13.48	-	-				564
Korangi Town GTPS-I	FY08	269	4,875	18.12	-	-				405
	FY09	310	5,476	18	-	-				540
	FY10	66	1,135	17.22	-	-				493
	FY11	I	12	19.92	-	-				700
	FY12	0	0	0	-	-				0
Korangi Town GTPS-II	FY10	465	4,767	10.25	-	-				368
	FY11	675	7,112	10.53	-	-				0
	FY12	595	6,188	10.39	-	-				461
Site GTPS-I	FY08	358	6,392	17.85	-	-				406
	FY09	294	5,365	18	-	-				571
	FY10	3	62	17.85	-	-				559
	FY11	0	2	20.49	-	-				700
	FY12	0	0	0	-	-				0
Site GTPS-II	FY09	9	96	11	-	-				355
	FY10	505	5,207	10	-	-				345
	FY11	586	6,075	10.36	-	-				4
	FY12	416	4,333	10.41	-	-				440
Korangi CCPP	FY09	330	3,404	10	-	-				346
	FY10	1,197	11,229	9	-	-				326
	FY11	1,226	10,704	8.73	-	-				333
	FY12	1,011	8,678	8.59	-	-				393
IPPs (Connected with KESC System)										
Gul Ahmed	FY08	-	-	-	847.75	182.46	0.21			811
	FY09	-	-	-	456	99	0.21			1,262
	FY10	-	-	-	608	132	0.21			1,160
	FY11	-	-	-	745.01	n.p.	n.p.			1,324
	FY12	-	-	-	-	-				1,860
Tapal Energy	FY08	-	-	-	847.75	182.46	0.21			800
	FY09	-	-	-	655.65	141.79	0.21			1,027
	FY10	-	-	-	637.5	139.05	0.21			1,173
	FY11	-	-	-	793.16	172.92	n.p.			1,330
	FY12	-	-	-	-	-				1,796

Source: *KCCI Research; KESC*

Hydel Generation

Pakistan has a potential of about 50,000 MW hydropower due to its vast network of waterways, whereas the installed hydel power capacity of Pakistan at the end of fiscal year 2012 is only 6,474 MW. The share of existing hydel power installed capacity to the total installed generation capacity of the country is only 29 percent while this share in year 1985 was around 67 percent and 32 percent in 2011. Most of the installed hydel power capacity of the country is owned by

public sector (WAPDA). The availability of hydel power generation is subject to seasonal variation i.e. it depends upon the reservoir levels, inflow of water and discharge of water from the reservoirs.

Table 17: Trend in Pakistan's Hydel Power Generation Capacity (MW)

Period	Punjab	Sindh	KPK	Baluchistan	AJK	Total
Pre-Wapda	23	0	44	0	0	67
1958-80	63	0	904	0	600	1,567
1981-00	109	0	3,766	0	1,000	4,875
2001-06	1,697	0	3,766	0	1,000	6,463
2007-12	1,697	0	3,747	0	1,030	6,474

Source: *KCCI Research ; WAPDA*

Nuclear Generation

Pakistan Atomic Energy Commission (PAEC) undertakes the projects of nuclear power plants' development, operation and maintenance in the country. The 1st Nuclear Power Plant of the country, namely Karachi Nuclear Power Plant (KANUPP), was commissioned in 1971 in Karachi through a turnkey agreement. The total installed capacity of this plant was 137 MW and the useful life of this plant was 30 years. However, after completion of 30 years life, the Pakistan Nuclear Regulatory Authority (PNRA) extended the operational life of this plant, by another 15 year at reduced capacity. The 2nd Nuclear Power Plant of the country, namely the Chashma Nuclear Power Plant (CHASNUPP-I) was commissioned in year 2000 also through a turnkey agreement by China National Nuclear Corporation. The 3rd Nuclear Power Plant namely Chashma Nuclear Power Plant (CHASNUPP-II) was commissioned on May 18, 2011. The installed capacity of this plant is 325 MW.

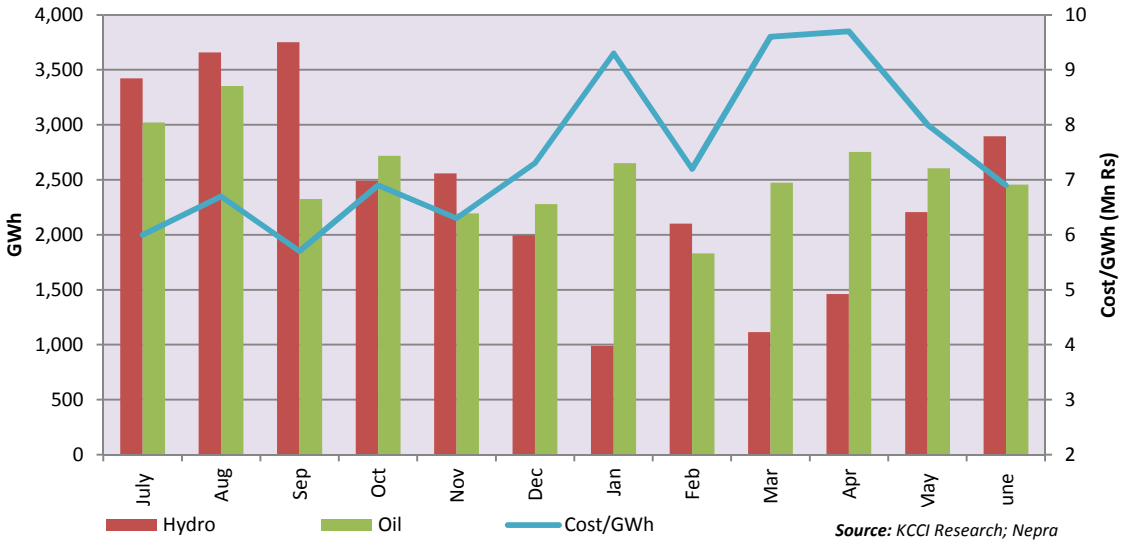
Total installed capacity of nuclear power plants, as on June 30, 2012, in the country is 787 MW as against the total installed electricity generation capacity of 23,538 MW, which constitutes a share of nuclear power plant to the total installed generation capacity as 3 percent.

However, the electricity generated through nuclear power plant was increased by 35.75 percent during 2011-12. The share of electricity generated through nuclear power plants in the country, during 2011- 12, was recorded as 4,872 GWh (4.94%) as against 3, 130 GWh (3.1 %) in the preceding year.

Thermal and nuclear generations are highly expensive sources of electricity as compared to

hydro power. Though the initial project costs for hydel electricity are astronomical comparatively, the maintenance and operational costs are quite low. In addition, hydro power provides a radiation and pollution-free green environment. Moreover, apart from population relocation issues, a hydro power project does not radically impact the ecology and human population of the project area. We give a snapshot of the costs of the different power sources during FY 2012.

Figure 47: Cost Analysis of Electricity Production between Oil and Hydro (FY12)



The above figure presents a clear idea as to the variation in the cost of electricity with different combinations of oil and hydel in the mix. It can be observed that through June to November, when the hydro contribution in the energy mix is more than the furnace oil based electricity, the cost per GWh is less, while cost of energy from December to May is clearly higher, when the hydro contribution in the energy mix is less than the furnace oil based electricity.

Renewable Energy

Pakistan, like other developing countries of the region, is facing a serious challenge of energy deficit. Hence, Pakistan is working to expand the use of renewable energy to help bridge the gap of energy deficiency in the country. The country is blessed with natural resources that can be utilized to create electricity.

Renewable resources that are technologically viable and have prospects to be exploited commercially in Pakistan include wind energy, solar energy, micro-hydel, bio-energy, and emerging technologies like fuel cell. Pakistan can benefit from these resources and can supplement existing energy resources as well as can use as primary energy source when no

other option is available.

The Coastal Belt of Pakistan is blessed with a wind corridor that is 60 km wide (Gharo - Keti Bandar) and 180 km long (upto Hyderabad). This corridor has the exploitable potential of 50,000 MW of electricity generation through wind energy. In addition to that there are other wind sites available in Coastal Area of Balochistan and some in Northern Areas. Technically the grid can take upto 30-40 percent of wind energy. Most of the remote villages in the south can be electrified through micro wind turbines. More than 5000 villages can be electrified through wind energy in Sindh, Balochistan and Northern Areas.

The Government of Pakistan established the Alternative Energy Development Board in 2003 to create an environment in the country that is conducive to investment from the private sector in renewable energy. The Government of Pakistan is putting greater emphasis on renewable energy and has set a target of 10 percent share of renewable energy or 2,700 MW in the country's energy mix by 2015. However, progress on this front is slow, particularly in comparison to regional peers, who have already established many mega projects of electricity generation through renewable energy sources.

Electricity Consumption Scenario

The electrical load pattern in the country varies from season to season. The peak hour timing in the system is normally from 6 PM to 10 PM. The maximum demand in PEPCO and KESC systems for the years 2007-08 to 2011-12 and the year-wise percentage change in maximum demand are given in the following table.

Table 18: Maximum Electricity Demand in the Country (MW)

Financial Year ending 30th June	2007-08	2008-09	2009-10	2010-11	2011-12
PEPCO area	17,084	18,881	19,288	20,559	21,997
KESC area	2,443	2,462	2,562	2,591	2,596
Un-diversified energy demand	19,527	21,343	21,850	23,150	24,593
Diversified energy demand	16,269	16,193	16,540	16,596	N/A

Source: *KCCI Research; NTDC*

The overall electricity consumption in the country since 2000 was growing steadily. However, during the fiscal year 2011-12 electricity consumption in the country decreased by 0.61 percent as shown below. The reason for lesser consumption is effectively lesser power generation, as mentioned in sections above.

Table 19: Annual Growth Rate of Electricity Consumption

		2007-08	2008-09	2009-10	2010-11	2011-12
PEPCO area						
Total	GWh	66,791	65,245	68,843	69,183	68,489
Percentage change	percent	-1.17	-2.31	5.52	0.49	-1
KESC area						
Total	GWh	10,116	9,429	9,925	10,098	10,311
Percentage change	percent	8.01	-6.79	5.26	1.74	2.11
Country area						
Total	GWh	76,907	74,674	78,768	79,281	78,801
	percent	6.76	-2.9	5.48	0.65	-0.61

***Source**: KCCI Research; NEPRA*

The sector-wise electricity consumption and their share in total electricity consumption of the country, for the years 2007-08 to 2011-12 are given in the following table.

Table 20: Category-Wise Energy Consumption in PEPCO and KESC System (Gwh)

	2007-08	2008-09	2009-10	2010-11	2011-12
PEPCO System					
Domestic	28,960	27,754	29,462	29,492	28,574
Commercial	4,356	4,205	4,466	4,523	4,398
Industrial	17,296	16,036	16,394	17,319	17,992
Agricultural	8,394	8,694	9,583	8,592	8,156
Public Lighting	340	348	372	306	290
Bulk Supply	3,323	3,187	3,349	2,447	2,465
Others + Traction	50	39	30	1,055	931
Supplied to KESC	4,072	4,982	5,187	5,449	5,684
Total in PEPCO area	66,791	65,245	68,843	69,183	68,489
KESC System					
Domestic	4,271	3,989	4,168	4,257	4,564
Commercial	1,145	1,004	1,091	1,043	1,128
Industrial	3,533	3,226	3,387	3,447	3,342

Agricultural	95	100	104	125	134
Public Lighting	74	83	87	82	117
Bulk Supply + Others	933	994	1,068	1,118	994
Supplied to NTDC	65	33	20	26	32
Total in KESC area	10,116	9,429	9,925	10,098	10,311
Country					
Domestic	33,231	31,743	33,630	33,749	33,138
Commercial	5,501	5,209	5,557	5,566	5,526
Industrial	20,829	19,262	19,781	20,766	21,334
Agricultural	8,489	8,794	9,687	8,717	8,290
Public Lighting	414	431	459	388	407
Bulk Supply + Others	8,443	9,235	9,654	10,095	10,106
Total in the Country	76,907	74,674	78,768	79,281	78,801
Source: *KCCI Research; NEPRA/ NTDC/KESC*					

The following tables give an idea about the distribution of electricity usage by different categories of consumers. As is evident from the data, domestic consumers form the largest category of users, in terms of both number of consumers and share of electricity usage. Industrial users, though relatively less in terms of number of consumers, form the second largest category as per usage of electricity.

Table 21: Main Electricity Statistics of the Country

	2007-08	2008-09	2009-10	2010-11	2011-12
Consumers (Nos.)					
Domestic	15,226,442	15,858,823	16,672,413	17,321,552	17,977,777
Commercial	2,229,408	2,291,552	2,362,317	2,421,224	2,482,677
Industrial	242,401	253,089	263,508	273,067	286,393
Agricultural	245,640	258,368	271,268	280,603	286,287
Public Lighting	7,337	7,680	8,112	8,386	8,698
Bulk Supply + Others	4,138	4,602	4,606	4,650	4,778
Total in PEPCO Area	17,955,366	18,674,114	19,582,224	20,309,482	21,046,610
Domestic	1,518,664	1,531,971	1,582,403	1,632,604	1,659,766

Commercial	433,416	437,463	445,164	452,667	456,537
Industrial	21,453	20,751	20,693	20,595	20,537
Agricultural	2,038	2,073	2,157	2,233	2,536
Public Lighting	140	112	71	57	67
Bulk Supply + Others	1,415	1,376	1,476	1,467	427
Total in KESC Area	1,977,126	1,993,746	2,051,964	2,109,623	2,139,870
Total in the Country	19,932,492	20,667,860	21,634,188	22,419,105	23,186,480
Average Sales Price (Paisa/kWh)					
PEPCO Area	474	521.9	521.9	625	n.a.
KESC Area	514	617.72	710.82	828.86	883.2
Per Capita Electricity Consumption					
PEPCO system					
Population (Mn)	153.4	156.48	159.59	163.6	n.a.
Energy Sale (GWh)	66,791	65,245	68,843	69,183	68,489
Per capita electricity consumption (kWh)	434	417	432	438	n.a.
Average Sale/Consumer (KWh)	3493	3227	3251	3138	2984
KESC system					
Population (Mn)	13.02	13.14	13.44	13.84	14.34
Energy Sale (GWh)	10,116	9,429	9,925	10,098	10,311
Per capita electricity consumption (kWh)	777	748	766	570	586
Average Sale/Consumer (kWh)	5084	4713	4827	4774	4804

Source: *KCCI Research; NEPRA/ NTDC/KESC*

Table 22: Category-wise Consumers and their Electricity Consumption (percent)

		2007-08	2008-09	2009-10	2010-11	2011-12
PEPCO Area (Consumers and Consumption as percentage of total)						
Domestic	Consumers	84.8	84.92	85.14	85.29	85.42
	Consumption	43.36	42.54	42.8	42.63	41.72
Commercial	Consumers	12.42	12.27	12.06	11.92	11.8
	Consumption	6.52	6.44	6.49	6.54	6.42
Industrial	Consumers	1.35	1.36	1.35	1.34	1.36
	Consumption	25.9	24.58	23.81	25.03	26.27
Agricultural	Consumers	1.37	1.38	1.39	1.38	1.36
	Consumption	12.57	13.33	13.92	12.42	11.91
Public Lighting	Consumers	0.04	0.04	0.04	0.04	0.04
	Consumption	0.51	0.53	0.54	0.44	0.42
Bulk Supply +	Consumers	0.02	0.02	0.02	0.02	0.02
Traction + Others	Consumption	5.05	4.94	4.91	5.06	4.96
Supplied to KESC	Consumption	6.1	7.64	7.53	7.88	8.3
KESC Area (Consumers and Consumption as percentage of total)						
Domestic	Consumers	76.81	76.84	77.12	77.39	77.56
	Consumption	42.22	42.31	41.99	42.16	44.26
Commercial	Consumers	21.92	21.94	21.69	21.46	21.33
	Consumption	11.32	10.65	10.99	10.33	10.94
Industrial	Consumers	1.09	1.04	1.01	0.98	0.96
	Consumption	34.92	34.21	34.13	34.14	32.41
Agricultural	Consumers	0.1	0.1	0.11	0.11	0.12
	Consumption	0.94	1.06	1.05	1.24	1.3
Public Lighting	Consumers	0.01	0.01	0	0	0
	Consumption	0.73	0.88	0.88	0.81	1.13
Bulk Supply +	Consumers	0.07	0.07	0.07	0.07	0.02
Others	Consumption	9.22	10.54	10.76	11.07	9.64
Supplied to NTDC	Consumption	0.64	0.35	0.2	0.26	0.31
Whole Country (Consumers and Consumption as percentage of total)						

Domestic	Consumers	84.01	84.14	84.38	84.54	84.69
	Consumption	45.67	45.57	45.72	45.73	45.34
Commercial	Consumers	13.36	13.2	12.98	12.82	12.68
	Consumption	7.56	7.48	7.55	7.54	7.56
Industrial	Consumers	1.32	1.32	1.31	1.31	1.32
	Consumption	28.62	27.65	26.89	28.14	29.19
Agricultural	Consumers	1.24	1.26	1.26	1.26	1.25
	Consumption	11.67	12.62	13.17	11.81	11.34
Public Lighting	Consumers	0.04	0.04	0.04	0.04	0.04
	Consumption	0.57	0.62	0.62	0.53	0.56
Bulk Supply +	Consumers	0.03	0.03	0.03	0.03	0.02
Others	Consumption	5.85	6	6	4.83	4.73
Traction	Consumers	0	0	0	0	0
	Consumption	0.07	0.06	0.04	1.43	1.27
Source: *KCCI Research; NEPRA/ NTDC/KESC*						

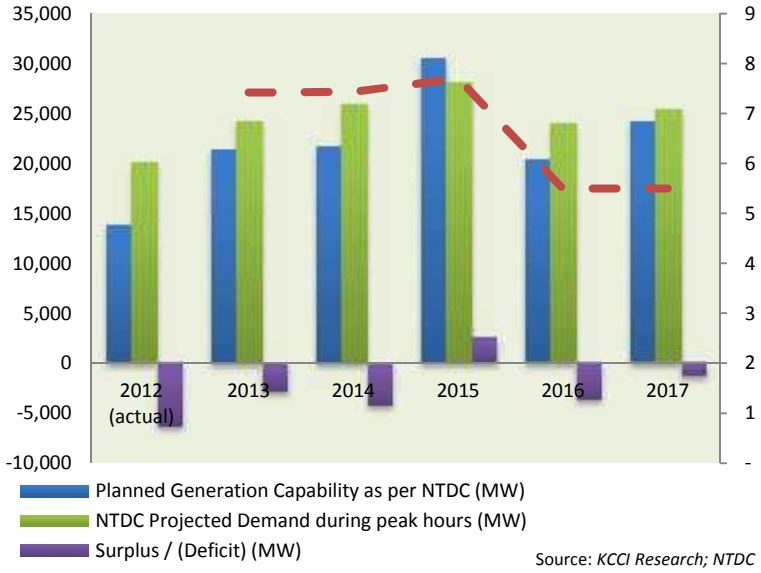
Electricity Demand Forecasts

According to NTDC, the annual electricity demand growth rate is forecasted to hover around 5 to 6 percent over next ten years. The peak demand in the system is forecasted to be around 32,000 MW in the year 2020. To satisfy such volumes of electricity demand, not only induction of large power generation facilities are required every year but to support such generation additions, the transmission and distribution systems are also required to be strengthened at a huge scale.

A review of future requirement of electricity and its supply position shows that by 2015, the overall demand at the peak hours at the country level would be around 26,000 MW. To meet this demand without shedding load demand, and with a minimum margin for reserve generation, the installed generation capacity has to be closer to 36,000 MW; an increase of more than 12,000 MW over a period of three years. Similar conclusions may be drawn for power supply and demand position in the year 2020. With the current expansion plans and progress on the implementation of on-going projects, it is expected that the crises in the power sector would continue well beyond 2020, unless major hydropower plants power generation or power projects on indigenous coal are inducted.

The chart below presents 5-year projections of the demand and supply in the system till 2017.

Figure 48: Projected Supply and Demand in NTDC System



Source: *KCCI Research; NTDC*

Electricity Tariff - Getting farther from the reach of the people

The determination of tariff for electric power services is one of the primary responsibilities of NEPRA. NEPRA determines electricity tariff, keeping in view the principles of economic efficiency and service quality according to the prescribed Tariff Standards and Procedure Rules, 1998. Under Section 7(3) of the NEPRA Act, NEPRA has been expressly conferred the power to determine tariff, rates, charges and other terms and conditions for the supply of electric power services by generation, transmission and distribution companies and to recommend these to the Federal Government for notification.

The procedures and standards in accordance with which tariffs are determined, modified or revised are prescribed in the NEPRA (Tariff Standards and Procedure) Rules, 1998 and are highlighted below:

NEPRA tariff determination standards

I. Tariffs should allow licensees the recovery of any and all costs prudently incurred to meet the demonstrated needs of their customers, provided that assessments of licensees' prudence may not be required where tariffs are set on other than cost-of-service basis, such as formula-based tariffs that are designed to be in place for more than one year.

II. Tariffs should generally be calculated by including a depreciation charge and a rate of return on the capital investment of each licensee commensurate to the earned by other investments of comparable risk.

III. Tariffs should allow licensees a rate of return which promotes continued reasonable investment in equipment and facilities for improved and efficient service.

IV. Tariffs should include a mechanism to allow licensees a benefit from, and penalties for failure to achieve, the efficiencies in the cost of providing the service and the quality of service.

V. Tariffs should reflect marginal cost principles to the extent feasible, keeping in view the financial stability of the sector.

VI. The Authority shall have a preference for competition rather than regulation and shall adopt policies and establish tariffs towards that end.

VII. The tariff regime should clearly identify interclass and inter-region subsides and shall provide such subsides transparently if found essential, with a view to minimizing if not eliminating them keeping in view the need for an adequate transition period.

VIII. Tariffs may be set below the level of cost of providing the service to consumers consuming electric power below the consumption levels determined for the purpose from time to time by the Authority, as long as such tariffs are financially sustainable.

IX. Tariffs should, to the extent feasible, reflect the full cost of service to consumer groups with similar service requirements.

X. Tariff should take into account Government subsidies or the need for adjustment to finance rural electrification in accordance with the policies of the Government.

XI. The application of the tariffs should allow reasonable transition periods for the adjustments of tariffs to meet the standards and other requirements pursuant to the Act including the performance standards, industry standards and the uniform codes of conduct.

XII. Tariffs should seek to provide stability and predict ability for customers, and;

XIII. Tariffs should be comprehensible, free of misinterpretation and shall state explicitly each component thereof.

NEPRA is required to determine electricity tariff so as to protect the interest of the consumers as well as electric power producers/suppliers. Any raise in tariff requested by the producers/suppliers of electricity has to be allowed or rejected by NEPRA after analyzing all the

costs involved in the proposed sale price. For any determination of tariff, the following points are generally considered by NEPRA in addition to other points on case-to-case basis:

i) The utility company should be able to recover its costs with some surplus for capacity expansion or return on equity.

ii) The average sale rate should provide for a reasonable rate of return.

Quarterly Adjustments of electricity prices

On the basis of annual assessment, certain adjustments with respect to the different components of Power Purchase Price (PPP) (being pass through to the consumers) has to be done on quarterly basis. Thus, the scope of these adjustments would be limited to:

i) The adjustments pertaining to the capacity and transmission charges.

ii) The impact of Transmission & Distribution losses on all the components of PPP.

iii) Impact of extra or lesser purchases of units on account of PPP.

iv) The overall consumer-end tariff to be adjusted keeping in view the GOP policy with respect to Life line and Agricultural consumers categories.

Monthly Fuel Adjustments

To capture variations in fuel prices, fuel price adjustments to the reference values of PPP as calculated under annual assessments are made every month. Since the information of a billing month is provided by NTDC/CPPA[34] over the next month, therefore the adjustments are reflected in the consumers' electricity bills in the subsequent months.

In accordance with the notified mechanism total 10 fuel charge adjustments were made during the FY 2011-12. Due to increase in fuel price from Rs 45,000 /ton to Rs 70,000/ton and increase in share of the furnace oil (FO) in the generation mix, the fuel charge adjustment during the FY 2011-12 was unfavorable which ranges between Rs 0.59/kWh to Rs 3.03/kWh.

Major reasons behind Pakistan's power sector woes

There are numerous factors hurting the power sector in Pakistan. As earlier mentioned, the power sector is in total disarray. There are technical and financial issues to resolve. Essentially,

[34] *NTDC: National Transmission and Despatch Co. Ltd.*

Central Power Purchasing Agency (CPPA) acts on behalf of DISCOs for procurement of power from GENCOs, Hydel Plants & IPPs. The role of CPPA is currently being performed by NTDC.

the culprit behind the electricity shortage is not the installed capacity, as the installed generation capacity in the system is 23,578 MW, which is more than sufficient for Pakistan's current needs. On most of the times, it is the lack of money on the part of generation companies for buying expensive fuel oil which forces them to curtail their electricity outputs.

On many instances, the problem lies in available capacity which remains less than 14,000 MW. Technical availability and efficiency of generation plants is often compromised due to lack of timely maintenance and rehabilitation, resulting in a curtailment of 1,500 to 2,000 MW in the system. Around 1,500 to 2,000 MW always depends on the flow and level of water in dams. Therefore, the capacity is not the real issue; it is the corporate debt issue, which has fully engulfed operations of the sector. The absence of monetary discipline among the stakeholders resulting into breakdown of chain of payments and buildup of a colossal circular debt is the most damaging of all.

Circular Debt – taking the nation hostage

The term 'circular debt' in the context of the power sector connotes a wide spread and ingrained problem which has done much damage to the population and production of the country. In general terms, circular debt arises when one party which is short of cash flows to discharge its financial obligations to its suppliers withholds its payments to them. When it does so, the problem affects other entities in the supply chain, each of which withholds its payments to its own suppliers for want of cash flows from its debtors, resulting in operational difficulties for all service providers. In terms of the power sector, shortage of liquidity in any link of the supply chain restricts other links from functioning at full capacity, which eventually causes lower power production leading to unnecessary load shedding.

Of particular note is the fact that the circular debt numbers that get reported in the press tend to be the sum of the receivables of each link of the electricity supply chain, which ends up exaggerating the amount, simply because of double counting. After all, one party's payables are the other party's receivables, and logically these should cancel out when we subtract one from the other.

To be able to understand the circular debt problem its daily buildup, we need to comprehend a simplified and abridged version of the supply chain which results in electricity being provided to us as consumers.

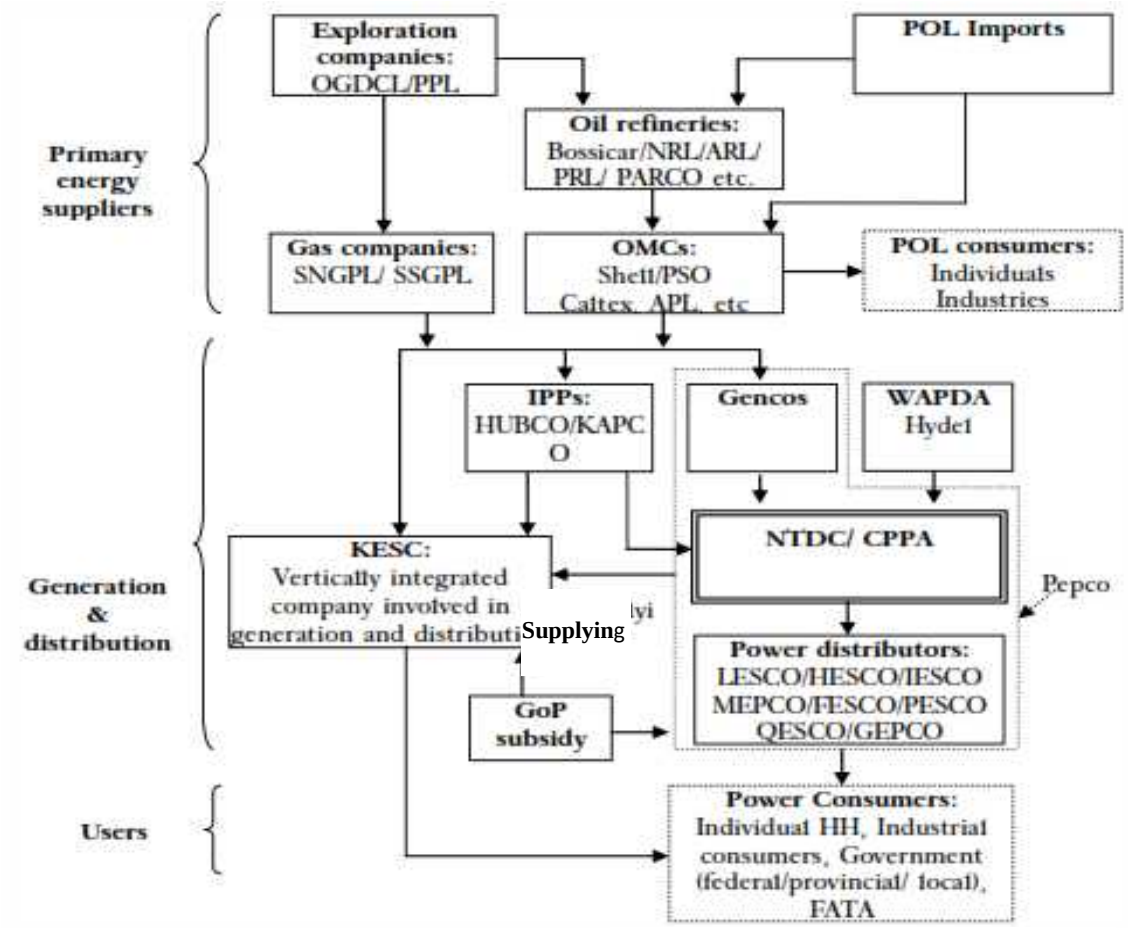
Exploration companies provide crude oil to refineries, which in turn provide oil to Oil Marketing Companies (OMCs). As a large proportion of the crude oil is imported and suppliers abroad have

to be paid for them to maintain supplies, there can be no debt beyond the terms agreed for the supply of oil on the part of refineries. Furthermore, owing to a demand and production gap of petroleum products refined by local refineries, OMCs also directly import products like HSD to be used in thermal generation by generation companies called GENCOs.

The oil marketing companies sell fuel to the IPPs or the Wapda-owned electricity generation plants (e.g. Jamshoro Power Generation Company Limited-I (GENCO-1)) which produce electricity and sell it to the government-run distribution companies referred to as DISCOs (for example Lahore Electric Supply Co. (LESCO)) which provide power to domestic, commercial and industrial users. The tariff at which the Gencos sell to the DISCOs and the tariff at which electricity is supplied to consumers is determined by Nepra.

If the power generation plant is running on gas, then the OMC in the supply chain are replaced by the Gas Distribution Cos (e.g. SSGC). Gas Distribution Companies obtain gas from oil exploration companies and supply it to the GENCOs.

Figure 49: Pakistan's energy chain



Source: *The Lahore Journal of Economics (September 2010*

It may be noted that bills paid by the electricity consumers are eventually used to make payments at various stages of the energy supply chain (i.e., to GENCOs, DISCOs and suppliers of primary energy).

The circular debt in the energy sector is closely related to cash flow problems in PEPCO. Since PEPCO is the core entity in the energy sector and manages the financial flows of all entities under its control in an overarching manner, any problem in PEPCO cash flows is cascaded to other links in the electricity supply chain. PEPCO collects bills from its customers for the supply of electricity (and tariff subsidies from the government), and pays suppliers (IPPs, OMCs, and gas companies) for the procurement of power and fuel. In an ideal scenario, PEPCO's bill collection should be in line with the cost of electricity supplied, i.e., inflows should match outflows. But the case is usually different; cash outflows to IPPs for power, and OMCs and gas companies for fuel are more or less certain, as these are contractual in nature. On the other hand, inflows in the

form of receipts from power consumers are uncertain as a result of line losses, electricity theft, absence or delays in electricity payments, amongst other reasons. This means that inflows always lag behind outflows creating mismatch in PEPCO's cash flows.

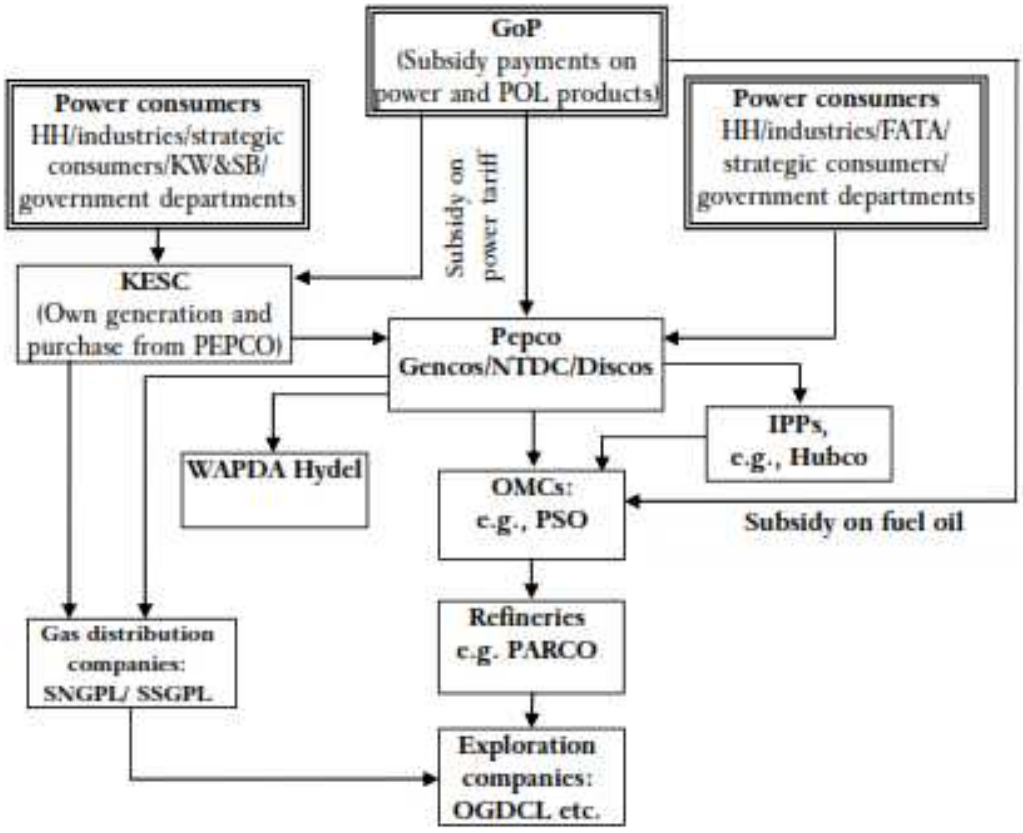
How did the circular debt problem get out of hand?

During November 2003 to February 2007, end-consumer tariffs remained stagnant. This was because on govt. intervention, NEPRA did not allow any revision in tariffs despite requests from DISCOs. Post February 2007, NEPRA did allow some upward revision in tariffs in response to the increase in the power purchase price. But still the government-notified tariffs remained lower than those determined by NEPRA reflecting the government's reluctance to take the unpopular decision of completely passing on the tariff increase to end-consumers, and hence paying the differential from its own kitty as subsidy.

On the supply side, electricity tariffs for power suppliers continued to incline as a consequence of rising fuel prices and the depreciating value of the rupee against the US dollar. Specifically, the year 2008-09 was the most difficult year for PEPCO as payable kept on rising as international oil prices hit their peak and inflows dwindled as the government (and its various departments) fell short on their payments and subsidies due to fiscal constraints. The government usually provides only the budgeted amount against tariff differential claims, and with growing fiscal constraints, the government was finding it difficult to settle PEPCO's claims on a timely basis.

This buildup of receivables and piling up of payables eventually led PEPCO to delay (or altogether suspend) payments to its suppliers. Inevitable as it was, arrears seeped into other segments of the energy supply chain and are still haunting the whole system. The chart below depicts the flow of liquidity across the electricity supply chain.

Figure 50: Flow of liquidity in Pakistan's electricity supply chain



Source: *The Lahore Journal of Economics (September 2010)*

To reiterate, the circular debt began to surface in 2008 due mainly to the decision of the Government of Pakistan (GoP) of not notifying various tariff increases by NEPRA from 2003 to 2007. In order to maintain electricity prices at certain levels and to reduce financial burden on the masses, the GoP did not pass on the cost of higher electricity charges to the consumers from 2003 to 2007 and instead used to pay the differential cost from its own kitty in the form of subsidies. This practice continued and the GoP used to provide the subsidy to the sector as long as the fuel prices were manageable. However, after the sharp increases in oil prices at the global level in 2008, and unpredictable trends for the future oil market, the GOP found itself at a stage simply where it could not carry the burden of sustained support to the sector players.

Changing its stance of fully financing the tariff differential as subsidies, the GoP has doubled the tariffs since 2008. Yet it has also provided more than a trillion rupees as subsidy for the reason that the tariff differential, if fully passed on, would result in a huge surge of electricity rates. But the problems are not yet under control.

On the supply side, circular debt had forced the Oil Marketing Companies (OMCs) to limit their

supply to power producers, whereas the gas supply to the power sector has been at minimum levels. The government is unable to meet the financial requirements of IPPs who operate their plants on day to day basis as and when the Government pours in money. At the same time, the cost of imported fuel is again touching the alarmingly high levels leading to further widening of the gap between the NEPRA determined and government notified tariffs. It has been observed that increased dependence on imported fuels has greatly undermined the GOP's efforts to overcome circular debt issue.

The major reasons for continued increase in circular debt are:

i) Non-payment/delayed payment of tariff differential subsidy (difference between NEPRA's determined tariff and GOP's applicable tariff) by GOP.

ii) Poor recovery of energy billed in DISCOs like HESCO, QESCO, PESCO and SEPCO. The phenomenon is a result of over-billing and fudging in consumers' bills by some of the DISCOs, to report lower distribution losses.

iii) Distribution losses due to pilferage and/ or theft. As a case in point, in FY11 the actual reported losses by the DISCOs were in the range of 9.75 percent in the case of IESCO and 37.25 percent in the case of PESCO. The 2nd highest losses of 33.81 percent were reported by HESCO.

iv) Inability of DISCOs to pass on entire monthly fuel charge adjustment impact due to large number of cases pending before the Honorable High Courts of Pakistan.

v) Due to the relief granted by the Honorable Lahore High Court for non-recovery of the fuel adjustment charge from residential consumers up to 350 units, the financial gap widened.

To elaborate on the list mentioned above, the first problem in this whole chain occurs when the tariff is unable to meet the costs of power generation and distribution owing to upward changes in fuel prices. For instance, if the price of fuel inclines in the global market and tariffs are not revised upwards to account for this increase, the government is obliged to fill this tariff gap by granting subsidy. Although NEPRA determines the tariffs, the government has a key role as these tariffs become legally binding only after being notified by the government. This severely limits NEPRA’s operational independence.

So one component of what constitutes circular debt is the lower rate at which electricity is being charged to the consumer than the cost of its generation and distribution. By failing to pay this subsidy bill, the government builds up the circular debt. As a case in point, tariff determinations

given by Nepra in May-June 2013 indicate an increase in the financing gap to Rs550 billion per annum from Rs350 billion due to the widening gap between the applicable electricity tariff and the tariff approved by the Nepra.[35] In other words, users would have to pay an aggregate of Rs 550 billion (or about 2.5 percent of the GDP) to prevent further accumulation of circular debt or the situation will continue to deteriorate. The government has now decided in principle to revise tariffs upwards on a timely basis and fuel as fuel adjustment charges are retrospectively billed to the consumers in their subsequent bills after a lag of about six months.

The second problem lies with the higher cost of electricity associated with the inefficiencies of government owned generation and distribution companies. Irregularities in deals struck out with providers of rental and private power plants, overstaffing at the GENCOs and DISCOs, free provision of electricity to Wapda employees, poor maintenance of plant equipment and failure to timely upgrade the machinery, obsolete technologies resulting in technical losses and corruption, all add to the cost of electricity that consumers are being constrained to bear with through tariff increases. The government's failure to upgrade and make capital investments in old facilities like Jamshoro and Guddu thermal power plants not only caused the production to fall but also contributed to higher cost of generation. Due to poor maintenance of the power stations, public sector power plants lost nearly one-third of their capacity and nearly 17 percent of their thermal efficiency due to plant degradation. In addition, negligence has resulted in low production efficiencies of hydel power plants over the years.

The third issue lies in the massive theft of electricity, pilferages and line losses. In spite of many drives by different DISCOs, the "kunda" system freely prevails in most parts of the country. Furthermore, as a case in point, FATA does not generally pay for any electricity that its population consumes.

The fourth issue pertains to poor collection of electricity bills from government departments, provincial governments and powerful private individuals. Powerful corporates are also defaulters as are those who in collusion with Wapda employees do not pay without being disconnected.

To summarize, the underlying issues are failures to revise electricity tariffs on a timely basis, prevent electricity theft, and ensure collection of billings speedily and disconnecting those not paying their bills. Disconnections will actually also reduce the extent of load-shedding. In other words, the main issue is that of poor governance.

[35] *See: http://x.dawn.com/2013/06/03/energy-crisis-calls-for-a-radical-policy-change/*

Implications of Circular Debt

The cash flow tightening resulting from the circular debt has added to the operational inefficiencies of IPPs, GENCOs and DISCOs in the power sector. In most case, power generation companies are operating quite below their production capacity as a result of liquidity constraints.

Perhaps the biggest implication of the circular debt is its contribution in increasing supply-side constraints. Already faced with a huge trade deficit, lower power availability has resulted in lower exports produce and higher costs of production, emanating from self-power generation and delayed deliveries. It can also be understood that the buildup of circular debt has led to a reduction in the potential gross domestic product (GDP) of the country. Thus any policy stimulus to growth could be less effective in terms of achieving the desired results if this problem is not resolved.

Furthermore, the build-up of circular debt has led banks to accumulate alarmingly high exposures on the energy sector.

Exploration companies and refineries have mostly used their own resources to finance the liquidity crunch emanating from the circular debt. This in turn has affected their expansion plans over the year, which is having adverse consequences for the country's ability to meet its energy needs indigenously.

Current Status of Circular Debt

As of May 31, 2013, the stock of circular debt stood at Rs 503 billion. The new government, in line with its announced intention of eliminating the circular debt within 60 days of coming into power, has cleared Rs 480 billion out of the total stock of debt and hence only Rs 23 billion remain as claims pending settlement, as of July 23, 2013.[36] The payment was made in two phases, whereby Rs 322 billion were paid to the stakeholders on June 29, 2013, and Rs 158 billion were paid around July 22, 2013. As part of the payment arrangement, the government and Independent Power Producers signed a memorandum of understanding for clearing of dues. According to the MoU, the IPPs accepted the government's demand to increase power generation by 1,700MW. The IPPs also accepted the government's demand regarding increase in credit period from one month to 60 days. A MoU was also signed regarding the conversion of four thermal power plants, namely Hubco, Lalpir, Pakgen and Saba Plant to coal from oil and gas.

Clearance of the circular debt is a very welcome development as it is the root cause of Pakistan's power sector woes. As stakeholders in the energy chain have relatively free flow of liquidity along the chain, IPPs have regained the capability to maintain enough fuel to run power plants at

[36] See: http://www.nation.com.pk/pakistan-news-newspaper-daily-english-online/business/23-Jul-2013/rs-480b-circular-debt-cleared

higher capacity.

Resolution of Circular Debt Issue

We believe that government's decision to clear the stock of circular debt from its own resources is just a short term solution to this chronic problem. While the payment of Rs 480 billion will enable power producers to generate more power and reduce load shedding in the immediate term, the circular debt will rear its head again if a long term strategy to address the causes of circular debt is not evolved. Further, for longer term sustainability, tactful strategies are required to get foreign investors in the country to build high yielding projects and that too in a short time frame.

Moreover, circular debt issue cannot be resolved unless the menaces of theft and line losses are not strictly dealt with. There should be no room for theft and dishonesty and prompt punishments and penalties should be enforced across the board without any exception. However, in order to extend benefit to population living below the poverty line there should be special provision for them to avail subsidized electricity through a legitimate connection thereby, exempting them from paying taxes on electricity consumption and application of low tariff rates.

High cost of energy mix in electricity production

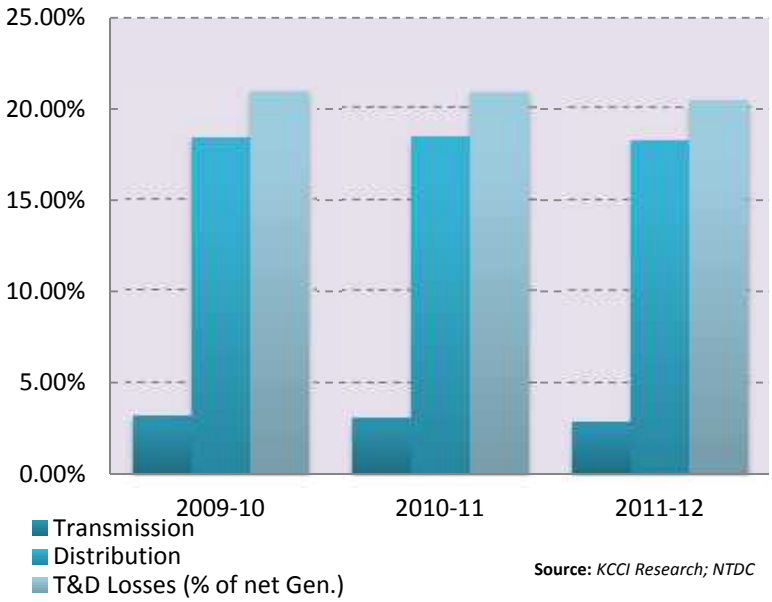
The high cost of energy mix is yet another important reason contributing to the circular debt pile up. After the depletion of gas reserves, the share of oil including Furnace Oil (FO) and High Speed Diesel (HSD) in the energy mix is increasing. Therefore, cost of energy is highly dependent on oil prices. Curtailment of natural gas necessitating usage of expensive Furnace Oil, and overall decline in the share of hydel generation in the total generation has resulted in a sustained higher cost input for the DISCOs. High energy cost leads to higher circular debt, therefore to reduce energy mix costs the GOP needs to take some drastic steps.

The average fuel component of generation cost on furnace oil has gone from Rs 13.67 in FY11 to Rs 18.54 per kilowatt hour in FY12. On hydro, the costs are less than Rs 0.5 per kilowatt hour. It may also be noted that the share of hydro has decreased from 35 percent to 32 percent in FY12. Hence, the higher cost of furnace oil has made electricity costlier. The fuel component of generation cost on coal is around Rs 3 per unit. The next better-ranked fuels are nuclear and gas. Any increase in hydro and coal based generation will greatly help in reducing the cost of energy mix. Even if the capacity costs are relatively higher for hydro and coal than furnace oil based generators, their costs per unit still remain lower than FO based generation. It is therefore, imperative that hydro and coal share in the electricity generation is increased substantially, to have any sort of reduction in the power purchase costs of DISCO.

High losses and low recovery losses of DISCOs; capability and availability of GENCOs

To add to the problems is the non-performance of DISCOs in improving their losses and recovery ratios. There have been leakages in electricity transportation from grids to the ultimate consumers. The losses in a number of DISCOs remained in the range of 30 to 40 percent. Transmission and distribution losses of the DISCOs are one of the most critical areas, which instead of showing any improvement, deteriorated further over the past three years. Even such DISCOs, which earlier have shown defendable losses, have now reported higher losses. LESCO for instance, which had earlier reported to have T&D losses of around 12.5 percent, has claimed to real losses of more than 13 percent in FY12. LESCO has submitted that its earlier reported losses especially in respect of the transmission network did not reflect true losses. A high percentage of theft is also part of these losses. High loss making DISCOs also have low recoveries, therefore, the overall revenue falls short of cost of energy. Similarly, other DISCOs have not been able to improve their performance according to the standards prescribed by NEPRA. It is noted that one of the major reasons for the below par performance of DISCOs is the lack of administrative and financial independence.

Figure 51: Electricity losses by DISCOS during transmission and distribution



Source: *KCCI Research; NTDC*

The distribution losses have remained a major constraint in resolving the energy crises and circular debt issue. The table below shows that Pakistan ranks amongst the top countries having high distribution losses.

Table 23: Electricity Distribution Losses (as % of power generated)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Nepal	21.1%	19.7%	19.7%	27.4%	28.7%	30.0%	30.6%	32.2%	34.8%	34.5%
India	30.3%	28.9%	29.0%	27.8%	27.2%	25.7%	24.0%	23.2%	23.3%	23.3%
Pakistan	27.4%	27.7%	26.2%	26.0%	25.3%	23.3%	20.5%	21.9%	20.7%	16.9%
Iran	16.8%	17.9%	17.8%	19.5%	19.1%	19.6%	20.1%	18.6%	17.1%	15.1%
Turkey	20.0%	19.4%	18.0%	16.1%	15.6%	14.8%	14.6%	14.6%	15.7%	15.0%
Sri Lanka	19.6%	19.3%	19.5%	17.3%	16.8%	18.5%	16.4%	16.7%	15.2%	14.3%
Saudi Arabia	6.0%	7.4%	4.9%	8.6%	11.2%	8.1%	8.8%	9.2%	8.8%	10.1%
Indonesia	13.7%	17.1%	18.0%	12.5%	11.8%	11.7%	11.3%	10.7%	10.1%	9.9%
United Kingdom	8.9%	8.5%	8.6%	9.0%	7.5%	7.4%	7.2%	7.6%	7.8%	7.6%
United Arab Emirates	7.6%	7.0%	7.0%	7.0%	7.8%	7.8%	7.8%	7.8%	7.8%	7.3%
Singapore	6.2%	6.8%	5.7%	6.1%	5.2%	5.1%	5.2%	5.2%	7.3%	7.3%
Afghanistan	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
Malaysia	8.5%	8.5%	8.4%	8.5%	8.5%	8.5%	8.5%	8.5%	6.4%	6.9%
France	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	6.2%	6.9%	6.6%
China	7.2%	7.4%	7.0%	6.8%	7.2%	6.8%	6.7%	6.5%	6.4%	6.6%
United States	5.4%	6.4%	5.9%	6.7%	6.7%	6.6%	7.2%	7.0%	6.6%	6.4%
Japan	4.7%	5.0%	5.1%	4.8%	4.9%	4.9%	4.8%	5.0%	5.1%	4.7%
Germany	6.0%	5.0%	4.8%	4.9%	5.1%	4.8%	4.9%	5.0%	4.5%	4.1%
Bangladesh	14.7%	13.5%	12.2%	8.8%	7.9%	6.3%	5.4%	5.1%	2.4%	2.2%

Source: *KCCI Research, EIA*

The problems of faulty distribution system, tampered or defective meters, line losses, etc. are common issues that needs to be addressed as part of energy crises resolution. Proper root-cause analysis needs to be done along with corrective measures to minimize losses.

The GoP, in order to provide more independence to DISCOs, had decided to appoint Board of Directors and CEOs from the private sector. However, the staff and the officers throughout all the DISCOs so vehemently opposed the steps that the GoP had to postpone appointment of new CEOs. The status quo can be seen by the mere fact that DISCOs continued to operate at the same inefficiency levels from where they began. The level of losses, recovery ratios have remained low throughout, and there are no sign of any improvement. The directions by the regulator in leading these entities to improved levels and bringing discipline in their working

have been totally ignored. It is felt that the centralized role of PEPCO had a lot to do with such reactions in these entities. It was the prime objective of PEPCO to lead unbundling of WAPDA into independent financial units, however by maintaining status quo, mainly due to its central control, the progress on reforms is negligible even after more than a decade of PEPCO's creation.

It is noted that the sense of ownership is missing in these utilities and unless the culture is changed completely, these utilities in all likelihood would not show any improvement. They need real financial independence for any measurable improvement.

GENCOs' performance in terms of their capability and availability further declined over the last year. Rehabilitation work on certain power plants has been initiated through funding provided by international agencies. The GOP has also created a GENCO Holding Company Limited to oversee the performance of GENCOs. However, the centralized control as mentioned above in any form may not prove beneficial for moving forward.

Lack of planning resulting in cost over-runs

Among many other problems, some major issues faced by the country are the lack of planning, implementation and post implementation administrative controls. Adequate planning is always crucial for the success of any project which should be followed by proper implementation along with stringent administrative controls to ensure smooth functioning of the project to achieve the desired results. Any inefficiency or negligence at any of the three levels would result in cost elevation, wastage of resources, time lags or in extreme case it may even turn the project into a failure.

Lessons need to be learnt from the available project as to what the costs are to be borne due to lack of planning and inefficient performance. The cost of the projects with the passage of time have increased and with the recent trend of steep devaluation of Pak Rupee, it may increase to manifolds, if rapid steps are not taken and projects are not initiated, managed and completed within the stipulated time frame.

As a case in point, we try to highlight the element of cost over-runs in hydel power projects in Table 24. The last column of the table exhibits the increase in cost of electricity production due to administrative and planning issues. Negative values imply decrease in costs.

Table 24: Cost comparison for Hydel Projects for NPSEP[37]

		NPSEP Data-2011				Updated Data-2012				Difference (2012 Data-NPSEP 2011 Data)		
S. No.	Project	Capacity (MW)	Project Cost (Rs Mn)	Project Cost (US$ Mn) 1US$=80Rs	US$ / kW	Capacity (MW)	Project Cost (Rs Mn)	Project Cost (US$ Mn) (Rs Mn)	US$ / kW	Cost (Rs Mn)	Cost (US$ Mn)	US$ / kW
1	Allai Khwaar	121	8,392	104.9	867	121	14,595	162	1,340	6,203	57.3	473.3
2	Khan Khwar	72	3,929	49.1	682	72	10,281	114	1,587	6,352	65.1	904.5
3	Duber Khwar	130	9,127	114.1	878	130	19,509	217	1,667	10,382	102.7	789.8
4	Jinnah	96	940	11.8	122	96	5,754	64	666	4,814	52.2	543.6
5	Neelum Jhelum	969	130,356	1,629.5	1,682	969	144,650	1,607	1,659	14,294	-22.2	-22.9
6	Skardu	1,600	669,280	8,366.0	5,229	1,600	742,500	8,250	5,156	73,220	-116	-72.5
7	Yugo	520	243,360	3,042.0	5,850	520	270,000	3,000	5,769	26,640	-42	-80.8
8	Diamer Basha*	4,500	430,196	5,377.5	1,195	4,500	581,100	6,457	1,435	150,904	1,079.2	239.8
9	Golen Gol	106	10,400	130	1,226	106	7,035	78	737	-3,365	-51.8	-489
10	Kurram Tangi*	83	36,400	455	5,482	83	38,714.65	430	5,183	2,314.65	-24.8	-299.2
11	Tarbela 4th Ext.	960	57,440	718	748	1,410	83,520	928	658	26,080	210	-89.8
12	Munda*	740	72,852	910.7	1,231	740	81,958.50	911	1,231	9,106.50	0	0
13	Kohala (IPP)	1,100	172,400	2,155	1,959	1,100	224820	2,498	2,271	52,420	343	311.8
14	Keyal Khwar	122	19,760	247	2,025	122	15,986	178	1,456	-3,774	-69.4	-568.7
15	Phandar	80	5,600	70	875	80	6,360	71	883	760	0.7	8.3
16	Basho	28	2,880	36	1,286	28	3,607	40	1,431	727	4.1	145.6
17	Harpo	33	3,520	44	1,333	34.5	4,050	45	1,304	530	1	-29
18	Lawi	70	6,720	84	1,200	70	7,954	88	1,263	1,234	4.4	62.5
19	Dasu	4,320	416,480	5,206	1,205	4,320	734,113	8,157	1,888	317,633	2,950.8	683.1
20	Bunji	7,100	547,040	6,838	963	7,100	719,272	7,992	1,126	172,232	1,153.9	162.5
21	Akhori	600	264,000	3,300	5,500	600	297,000	3,300	5,500	33,000	0	0
22	Lower Spat gah	496	55,760	697	1,405	496	66,638	740	1,493	10,878	43.4	87.5
23	Palas Valley	665	61,040	763	1,147	665	73,038	812	1,220	11,998	48.5	73
24	Pattan	2,800	487,280	6,091	2,175	2,800	540,000	6,000	2,143	52,720	-91	-32.5
25	Thakot	2,800	480,000	6,000	2,143	2,800	540,000	6,000	2,143	60,000	0	0
26	Dudhnial	800	146,160	1,827	2,284	960	239,063	2,656	2,767	92,903	829.3	483.2
27	Yulbo	3,000	548,080	6,851	2,284	2,800	607,500	6,750	2,411	59,420	-101	127
28	Tungas	2,200	341,200	4,265	1,939	2,200	378,000	4,200	1,909	36,800	-65	-29.5
29	New Bong Escape	84	17,040	213	2,536	84	19,350	215	2,560	2,310	2	23.8
30	Gul Pur	100	12,720	159	1,590	100	14,310	159	1,590	1,590	-	-
31	Rajdhani	132	13,680	171	1,295	132	15,390	171	1,295	1,710	-	-
32	Kotli	97	13,600	170	1,753	100	15,300	170	1,700	1,700	-	-52.6
33	Patrind	147	18,960	237.00	1,612	147	32,580	362	2,463	13,620	125	850.3
34	Sehra	130	27,520	344.00	2,646	130	30,960	344	2,646	3,440	-	-

[37] *National Power System Expansion Plan 2030*

35	Karot	720	117,600	1,470.00	2,042	720	132,300	1,470	2,042	14,700	-	-
36	Asit-Kedam	215	32,400	405.00	1,884	215	36,450	405	1,884	4,050	-	-
37	Madyan	157	35,040	438.00	2,790	157	39,420	438	2,790	4,380	-	-
38	Azad pattan	222	26,640	333.00	1,500	640	86,400	960	1,500	59,760	627	-
39	Chakothi	500	60,160	752.00	1,504	500	105,930	1,177	2,354	45,770	425	850
40	Suki Kinari	840	86,480	1,081.00	1,287	840	97,290	1,081	1,287	10,810	-	-
41	Kaigah	578	65,760	822.00	1,422	548	73,980	822	1,500	8,220	-	77.9

The project cost shown in the table is 65 percent of the total cost of the project and the rest is used for irrigation purposes.* ***Source:* *KCCI Research; WAPDA*

Issues faced by KESC

The performance of KESC has been mixed. Whereas it showed improvements in the operational performance of its transmission and distribution systems by reducing tripping and outages, it could not bring down its distribution losses, which hover around 35 percent. Similarly, KESC is always criticized for not operating its own power plants while preferring importing from NTDC's system.

We highlight some major issues faced by KESC

(i) Non-operation or under-utilization of FO based Power Plants:

One of the major issues concerning KESC is the non-operation or under-utilization of its FO based power plants while resorting to load shedding. According to KESC, operation of its expensive power plants would add to the cost of energy generation and since the GoP is unable to provide for existing subsidy requirements, a higher subsidy requirement would considerably add to the burden of GoP. On the other hand, it is argued that NTDC, for fulfilling its obligation of supplying 650 MW to KESC is forced to operate even those power generation plants, which are lower in merit order than KESC's available but non-operational power generation plants. In commercial terms it might make sense for KESC not to operate such generation facilities, however KESC is guilty of not providing electricity to its consumers although it has the capacity of supplying them. Additionally, it is uneconomic at the national level to operate inefficient power plants in NTDC system, while relatively more efficient power plants in KESC system, are kept non-operative.

(ii) Gas Supply Issue:

According to KESC, due to inadequate gas supply, KESC had been constrained to increase reliance on the comparatively four times more expensive furnace oil for generation. The shortage in gas supply has a large impact on KESC's ability to maintain minimum load shedding. At the same time, KESC has not been able to arrange the required quantity of fuel from the market to operate these plants on alternative fuel due to its weak liquidity position.

KESC claims mainly due to insufficient supply gas, full benefit of the new 560 MW BQPS-II

Combined Cycle Power Plant project of KESC situated at Bin Qasim could not be reaped. The test run of the gas dependent electricity generation project has been conducted in 2011 but its full potential has still not been exploited as it requires additional 130 mmcfd of sustained gas which has already been committed to it by the federal government but not supplied in entirety. With the addition of this plant, KESC's cumulative requirement of gas has gone up to 1300 mmcfd whereas it is getting gas to the extent of around 50 percent of its requirement. If proper cost and benefit analysis for this project is being performed and priority based allocation of resources is done, this project can add commendable contribution to the national grid.

(iii) Liquidity Crunch-Circular Debt:

The total outstanding receivables of KESC mounted to over Rs 60 billion in late FY12 from government and related sovereign entities (i.e. Strategic Customers, Federal and Provincial Bodies etc.). This has resulted in a serious liquidity crisis, as KESC's working capital is severely strained with dues from public service companies such as CDGK[38] and KWSB[39] continuously going up. According to KESC, the continuous liquidity crunch is severely limiting the KESC's ability to undertake system enhancement schemes, which in turn adversely affect the performance improvement of distribution system.

(iv) Poor Security Environment:

Karachi city remains regularly disturbed due to worst law and order situation in areas like Orangi Town, Korangi, Baldia, Lyari, SITE, Malir, Shah Faisal, etc. causing long delays in rectification of faults, installation of new connections and system improvement work resulting in non¬compliance to NEPRA Distribution Performance Standards. KESC management has coordinated with local and provincial governments to provide assistance for securing access to the troubled areas, but the situation has not been very satisfactory. KESC installations and employees' are regularly threatened and even targeted resulting in employees' fatalities in these areas.

(v) Theft of Conductors and Cables:

Unprecedented increase has been observed in theft of extra high tension overhead conductor wires and cable leads from substations, especially in rural and coastal areas. This results in long duration interruptions to area consumers.

(vi) Increasing Number of Illegal Connections:

[38] *City District Government Karachi*
[39] *Karachi Water and Sewerage Board*

Number of illegal connections is at an increase due to un-planned city growth resulting in land encroachment and Kucchi Abadis. This adds to interruptions to consumers.

(vii) Resistance to Transformation:

The effort to bring a change to a performance based working is resisted, often violently, by the lower staff of KESC. This severely disrupts the normal working of the company.

(viii) High Tension (HT) to Low Tension(LT) ratio:

KESC inherited a system with very low HT/LT ratio[40] of 1:2.4 as compared to international standard of 2:1 due to majority of congested urban population where extension of HT system is not possible. This system constraint, because of low HT /L T ratio results in an increased number of long duration interruptions and voltage variation to consumers.

[40] *High tension/low tension ratio implies efficiency of electricity transmission; the higher the ratio, the more efficient the transmission*

PART IV
THE WAY FORWARD

Resolving the power sector woes

Keeping in view the power crisis in the country, including acute shortage of electricity, over reliance of the country on thermal power generation, persistent trend of increase in oil prices in the international markets, coupled with depletion of gas reserves in the country and high cost of generating electricity from the imported fuels, some radical measures are needed to be taken by the government of Pakistan, targeting short term and long term objectives. Immediate steps are needed to bring the cost of energy mix down. This may require converting existing oil fired power generation plants to coal and putting higher emphasis on hydro power and other forms of renewable energy.

A comprehensive energy policy is being envisaged by the prevailing government to overcome the energy crises which include several mega projects of dams and power plants. In this respect, incumbent Prime Minister Nawaz Sharif visited China shortly after attaining power to solicit Chinese contribution in resolving the energy issues in the country.

To resolve Pakistan's power crises on an urgent basis, several new projects are underway, some of which are near completion. Similarly, to enhance the productivity of existing projects, rehabilitation of hydropower plants for additional capacity and expansion of thermal power stations would also be completed over the next couple of years, along with a paradigm shift towards renewable energy.

Investment Plan for Power Generation Projects

The investment plan for power generation projects for the years to come, are listed in the following tables respectively. Further, the investment plan for power generation projects under KESC has also been kept separate in Table 25.

Table 25: Expansion Plan of Installed Generation Capacity (KESC System)

Year	Name of Plant	Capacity (MW)	Nuclear	Thermal	Wind	Total	Cumulative Total
Existing Capacity							
2011-12		3,144	137	3,007	0	3,144	3,144
Plan of Capacity Addition							
2012-13	KCCPP Closing of GT-I & 2 Cycles	26	0	26	0	26	3,170
2013-14	Cycle closing at SGTPS-II & KGTPS-II	18	0	18	0	18	3,188

Source: *KCCI Research; KESC*

Table 26: Investment Plan for Power Generation Projects (KESC)

S. No.	Name of the Project	Capacity (MW)	Expected Commissioning Year	Estimated Cost
1	BQPS-I Coal Conversion - Phase 1*	420	2015	US$ 250 million
2	BQPS-I Coal Conversion - Phase 2*	420	2017	US$ 250 million
Plan to induct IPPs in KESC system				
1	Thar Coal Power Plant	300	2016	US$ 450 million
2	Karachi Waste to Energy Project (Bio Gas)	22	2014	US$ 60-70 million

** Conversion of existing units so no capacity addition in KESC system* *Source: KESC; KCCI Research*

Table 27: Investment Plan for Public Sector Thermal Power Gen Projects (approved PC-1)

S. No.	Name of the Project	Capacity (MW)	Expected Commissioning Year	Estimated Cost
				(Million Rupees)
1	Combined Cycle Power Plant Chichoki Malian	525	30 months after opening of LIC expected by 31st Dec., 2012	18,050.00
2	Combined Cycle Power Plant Nandipur	425	Tentatively by June, 2013	22,334.78
3	Combined Cycle Power Plant Guddu	747	Tentatively by August, 2013	59,775.41

***Source**: NTDC; KCCI Research*

The new government has taken several decisions to resolve the energy crises by adding electricity generation in to the national grid. The power generating capacity in PEPCO's system is being planned to increase with the addition of several power projects like Guddu New Combined Cycle (CC) (747MW), Rehabilitation of GENCOs (245MW), Uch II power plant (404MW), and numerous alternate energy projects like Three Gorges Wind Farm (50 MW), Pakistan Wind Energy (5MW), Hydropower Dawood Power (50MW) and Foundation Energy I & II of 50MW each.

Moreover, the Executive Committee of the National Economic Council (Ecnec) has approved five energy projects which include; K-I and K-II Nuclear projects in Karachi with generation capacity of 2,200 MW having estimated cost of Rs 958.7 billion, Nandipur project in Punjab, having generation capacity of 425 MW, costing Rs 57.4 billion, Neelum-Jhelum hydro-electric project in AJK, generation capacity 969 MW, costing Rs 274 billion.

In the table below, we list various electricity projects that are in process and their current status. Timely completion of these projects would alleviate the country's electricity problems to some extent.

Table 28: Investment Plan for Private and Public-Private Sector Power Generation Projects

S. No.	Name of the Project	Capacity (MW)	Investments (Mn US$)	Achieved/ Expected COD	Latest Status of the Project
A: OIL					
1	Grange Holding Power Project	163	251	December, 2014	Project under financial closing
2	Radian Power Project	163	200	December, 2015	Tariff determined by NEPRA.
3	Gulf-II Power Project	75	75	-	Project registered/ approved for processing
4	Attock Oil Power Project	200	200	-	Project registered/ approved for processing
5	Asia Petroleum Power Project	90	90	-	Project registered/ approved for processing
6	Kohinoor Energy Project	70	70	-	Project registered/ approved for processing
7	Technovision Power Project	175	175	-	Project registered/ approved for processing
8	SKANS Power Project	90	90	-	Project registered/ approved for processing
9	PARCO Power Project	500	500	-	Project registered/ approved for processing
B: PIPELINE QUALITY GAS/DUAL-FUELING					
10	Odean Power Project	140	140	-	Project registered/ approved for processing
C: DEDICATED GAS FIELDS					
11	Uch-II Power Project	404	494	December, 2013	Project under construction
12	Star Thermal Power Project	134	196	July, 2015	Project under financial closing
13	Kandra Power Project	120	90	December, 2016	Project under Tariff Determination/ Negotiation
D: HYDEL					
14	New Bong Escape Hydel Project	84	215	Completed	Completed
15	Patrind Hydropower Project	147	362	December, 2016	Project under construction
16	Gulpur Hydropower Project	100	159	June, 2017	Project under financial closing
17	Rajdhani Hydropower Project	132	171	December, 2017	Project under financial closing
18	Kotli Hydropower Project	100	170	December, 2017	Project under financial closing
19	Suki Kinari Hydropower Project	840	1081	December, 2018	Project under financial closing

20	Sehra Hydel Project	130	344	June, 2017	Project under Tariff Determination/Negotiation
21	Karot Hydel Project	720	1470	December, 2017	Project under Tariff Determination/Negotiation
22	Chakothi-Hattian Project	500	1177	December, 2017	Project under Tariff Determination/Negotiation
23	Madian Hydropower Project	157	438	December, 2018	Project under Tariff Determination/Negotiation

Source: *NTDC; KCCI Research*

There are several other thermal and nuclear projects which have just crossed the conceptualization stage. A list of these projects is given below:

i) Dubai-based M/s Burj Power is all set to develop a coal-fired Independent Power Project (IPP) at Port Qasim with a capacity of 300MW. M/s Burj Power, a Dubai-based company has shown interest in jointly developing a coal-fired power plant at Port Qasim Authority (PQA) covering an area of 140 acres. The project's capacity would later be enhanced to 600MW. M/s Burj Power would bring its own financial and human resources to develop and run the power plant in line with the policies of Private Power & Infrastructure Board (PPIB).

ii) The government has also decided to go ahead with work on the 1100MW nuclear power plant in Karachi with Chinese assistance, in an effort to ease energy shortages in the country. In this regard, the Pakistan Atomic Energy Commission (PAEC) would build the power plant named Karachi Coastal Power costing an estimated $9.5 billion of the total cost of Rs 950 billion ($9.5 billion), which would be initiated during FY14, as per news reports.

iii) The government is contemplating to set up a 600MW coal fired power plant in the country as per news reports. The Nishat Group is likely to be assigned this task, along with being the first in line to convert its IPP, AES Lalpir, to coal. The financing for the project is likely to come from same Chinese engineering and construction companies that are likely to get the contracts for coal-conversion. The plant will use a mix of imported and Thar coal and will be set up with an additional $900 million loan acquired from the Asian Development Bank (ADB).

Current Projects at GENCOs and DISCOs

To bring improvement in the output capacities and performance of GENCOs, international donor agencies have been providing technical and financial support to GENCOs in their rehabilitation

efforts. These efforts include the following measures and plans:

i) National Transmission and Dispatch Company plans to add 6100 MVA of new 500/220 kV grids over the next two years.

ii) Similarly NTDC has planned to add 6400 MVA of new 220/132 kV grids over next three years. It has also initiated reinforcement and extensions in two of its 500/220 kV and six of its 220/132 kV Grid Stations. However, will NTDC system be strong enough and ready for the huge generation capacity additions needed in the system over next six years, the question is yet to be addressed.

iii) The DISCOs on NEPRA's directions continued installation of Time of Use (TOU) energy meters. Except for three DISCOs and KESC, other DISCOs have achieved more than 70 percent progress of the total requirements. Two DISCOs i.e. Islamabad Electric Supply Company Limited (IESCO) and Multan Electric Power Company Limited (MEPCO) have completed 100 percent installation of TOU meters. However, the overall shortage of electricity in the country has defeated the prime objectives of installation of such meters till yet.

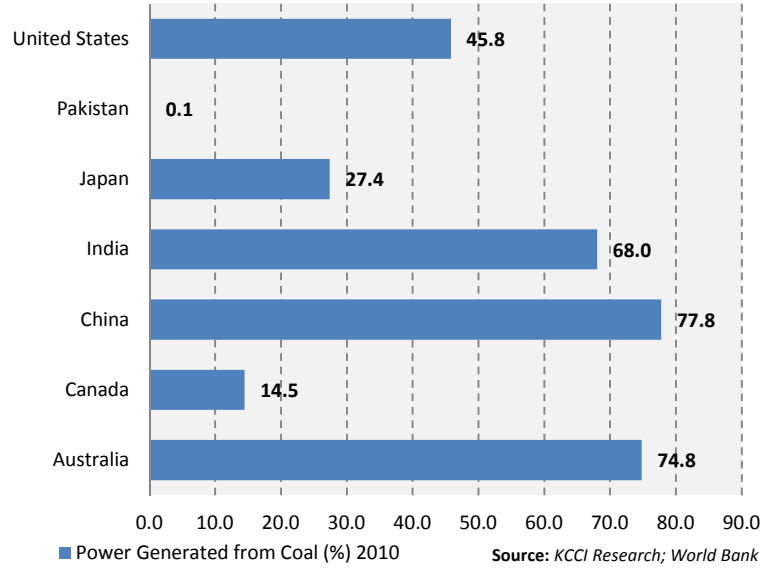
iv) Some of the DISCOs have also initiated system studies on NEPRA's directions for analyzing their technical and administrative losses reflecting progressive working approach. International donor agencies are also supporting DISCOs in different technical and financial areas.

Electricity generation from coal

Coal based electricity generation is a good and cheaper source and is being used globally for the same purpose. Many developed and developing countries in the world are using coal to produce electricity because of it being an economical resource and its ability to replace gas as a fuel source for electricity generation, so gas could be used in other value added segments.

There are 929 billion tons approx. coal reserves available in the world. 40 percent of total coal mined globally is used in electricity generation. It is interesting to note that Australia and China produce more than 74 percent electricity from coal. Likewise, India produces 68 percent of its power from coal. Pakistan has around 0.1 percent production of coal based electricity, which is miniscule as compared to others.

Figure 52: Power Generated from Coal as % of Total Generation



Pakistan has 185 billion tons of estimated coal reserves. For long term resolution of Pakistan's energy crises and sustainable development of Pakistan's economy, exploitation of indigenous resources of coal is necessary. In Pakistan, keeping in view the requirements and the infrastructure development for producing coal based generation, it is estimated that at least 10,000MW of power should be generated based on local coal of Thar, Lakhra and Sonda Jharak. In addition, 3000MW based on imported coal near coastline is also being conceptualized.

Coal reserves are found in sufficient quantities at Thar (176 billion tons), Thatta (4 billion tons) and adjoining areas in Sindh to meet long term energy requirements. Thar coal reserves have the potential to meet not only energy shortfall in the short term but also in the long term as well as ensuring that the generation cost is much lower than what the country pays for thermal generation. Experts differ as to the quality of coal reserves in Thar for power generation purposes. Therefore captive power plants of industrial units mix imported coals with local coal for power generation.

The federal government has developed the infrastructure of Thar coal field, i.e. roads, water supply, communication network, airstrip and railway track etc. The establishment of experimental small scale open pit mining was also under consideration to collect data for large scale mining, as a guideline for investors. Although, many steps have been taken to generate the electricity from Thar coal during the three to five years, there is still a need to expedite the

projects and ensure their timely completion. Such power generating projects would save huge foreign currency which is spent on the import of oil.

To promote and increase the share of coal in energy production:

i) The 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, namely - Sindh Engro Coal Mining Company for development of coal mines and installing 600 to 1000MW power plant.

ii) M/s Cougar Energy UK Limited has been allocated Block-III in Thar coalfield for extraction of underground Coal Gasification and establishing a 400MW power plant.

iii) M/s Bin Daen Group, UAE, has been allocated Block-IV in Thar coalfield for coal mine and installing 1000MW power plant.

iv) One block has been allocated to Planning Commission of Pakistan for a Pilot Project of 50MW based on Underground Coal Gasification Project in Block-V.

v) M/s Oracle Coalfield Plc, UK, has been allocated Block-VI in Thar coalfield for developing coal mine and installing power plant of 300MW extendable up to 1000MW.

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

vii) In Badin coalfield, an area has been allocated for M/s Al-Abbas Group of Company for developing coal mine and installing coal fired power plant of 300 to 600MW.

viii) Engro Corporation has announced plans to set up its Thar coal power plant in the next two-and-a-half years. Work will start on project site in the beginning of CY14 and proceed till the target date. The Thar coal project will produce electricity at Rs 12 per unit, as compared to Rs 23 per unit by GENCOs and Rs 18 per unit by IPPs.

Table 29: Status of Project at Thar Coalfield

Thar Coal Blocks	Status / Timelines
Block-I *Global Mining Company of China* Open cast Mining of 10 mtpa 900 MW Coal supply to local thermal plants and cement industry after briquetting	Bankable Feasibility completed March, 2012 Mining Lease issued May, 2012 Coal Production to start by 2015 Power Generation by 2015-16
Block-II *Sindh Engro Coal Mining Company* (JV: 40 percent GoS; 60 percent Engro) Open cast mine of 6.5 mtpa & 1200MW	Bankable Feasibility completed 31st Aug. 2010 Mining Lease issued August, 2011 Project financing activity continued. Chinese Funding through JEWG (Joint Energy Working Group) is being solicited
Block-V *UCG Project* Under Ground Coal Gasification Project 2X50 MW IGCC Power Plant Planned	36 bore holes have been drilled. Test Burn done in Dec. 2011 Power Plant of 8-10 MW is being established.
Block-VI *Oracle Coalfields, PLC (UK)* Open cast mine of 5 mtpa MoU signed with KESC for 300MW	Detailed Feasibility Completed Oct. 2011 Mining Lease issued May 2012 Start of Mine development by mid-2013
	Source: *KCCI Research; Coal & Energy Development Department, Sindh*

Likewise, power generation projects on imported coal that are in the pipeline include:

i) A 1,200MW IPP sponsored by AES and a 1,000 MW IPP sponsored by MITSUI on imported coal. These projects are at an advanced stage of development.

ii) About 700MW power generation capacity using bagasse and coal mix has also planned to be added to the system under the GOP Policy for Power Co-Generation by sugar industry during 2009. Power generation by these projects when implemented will provide cheaper and affordable electricity compared to fuel oil.

iii) Prime Minister Nawaz Sharif has announced in the beginning of August 2013 that China has agreed to set up four coal-fired power plants of 660 MW each at Gadani Power Park Project in Balochistan. The first power project of 5200MW would be set up by the govt. of Pakistan itself. Ten power plants would be established of 6600MW at Gadani power park project at a cost of more than Rs 50 billion. The govt. would establish a jetty 7km deep into sea. The PM also indicated further plans for the next 25 to 30 years to meet a demand of 50,000MW of electricity for which four or five more such parks would be needed and a proposal was being considered to set up an LNG terminal at the power park.

Coal Gasification

Prospects for underground coal gasification (UCG) are also being explored in parallel. As mentioned above, the Government of Sindh has awarded a mining concession to Cougar Energy under which Thar Block-III shall be developed for UCG, leading to commissioning of a 400MW power project.

The Underground Coal Gasification (UCG) Project at Thar is suffering badly because of the unconcern of authorities and diversion of funds towards unapproved projects. Over the past two years the project had been given only 10 percent of the amount allocated for it. It is one of the best coal in the world for gasification that can produce cheapest electricity.

Contrary to a general perception that UCG was an unviable collection, more than 40 countries, including Russia, China and South Africa, had been producing electricity from underground coal gasification for more than 3 decades because of its low capital expenditure. The expenditure comes to $0.9 per watt compared to $1.6 per watt on coal power projects based on coal mining, $4 per watt on solar energy and $3 per watt on wind.

The electricity produced through UCG at Thar would cost about Rs 4 per unit (kWh) while the cost is Rs18-19 per unit of thermal power stations. The carbon content of Thar coal, commonly known as lignite, is 28 percent. This is considered suitable for power generation by experts.

Apart from power production, Thar coal through underground gasification could be utilized for conversion to naphtha, diesel, waxes, car fuel, fertilizer, town gasification, and a number of other chemicals. The conversion of Thar coal into town gas would cost only half of the current cost of Sui gas.

A reputed scientist, Dr. Samar Mubarakmand has also proposed UCG. On the contrary some experts believe this process will contaminate ground water thereby negatively impacting the people living in the area.

Captive Power Generation

A captive power generating plant is a power plant set up by an industry to generate electricity primarily for its own use. Captive power generation, particularly on coal, is comparatively more cost effective and efficient. On an average, one kilogram of coal produces 2.2 m^3 of coal gas and 1Kwh of electricity. If the proxy price of coal is taken as Rs 6000 per ton, one unit of electricity produced from it will cost about Rs7.5 per unit, excluding overhead and other costs. Presently,

industries are buying electricity from the grid station at Rs12 to Rs16 per unit. So the off grid electricity is much cheaper while long transmission line costs are also saved.

For producing cheap coal based electricity, surface gasifiers are available in sizes from 300KW up to several MW per hour of electricity. Engine generator sets are also available from 400KW to 1500 KW.

However, industries are not proactive in adapting towards coal based captive power generation. Factors responsible for slow response from industries include time high cost of installation and creation of hurdles from certain interest groups. Hence industries prefer to produce expensive energy through furnace oil. So far, very few manufacturing units have installed surface gasifiers to generate their own gas and electricity from coal.

Officials are strongly advocating captive power generation for the industry, at least until the long term national grid solutions are drawn up. Methods like coal gasification and burning of solid waste to produce energy can be encouraged through lowering tax and duty exemptions to industrial units.

Coal Conversion, Feasibility vs. Liability?

The question that arises is that despite several studies on reducing coal related emissions in power plants, coal has its inherent environmental constraints. As coal is hazardous and has its own inherent constituents which can be very harmful to human health, additional steps are required to minimize pollution, like utilizing clean coal technology. Clean coal technology is a collection of technologies developed to mitigate or minimize the environmental impact of coal energy generation.

The authorities need to keep a check on such projects which are planned to be operational near human dwellings as it could harm their health related wellbeing. The potentially hazardous power project should not be set up in close vicinity of population clusters while keeping welfare of the community and human health on the top priority.

Nuclear Energy

Nuclear energy is also a vital resource to generate the electricity. The country produced only 4,872 GWh of electricity from nuclear energy in FY12, which is only 5 percent of the total energy production. Contrary to this, in the world 16 percent electricity is being produced by nuclear energy. Nuclear energy power plants are high cost projects which could be initiated by the government through foreign investment, assistance from donor agencies or from friendly countries that are willing to extend a helping hand to Pakistan, in this regard. China has

remained a major contender for such projects.

Renewable Energy

Pakistan's natural gas reserves are depleting rapidly therefore, it is necessary that electricity be produced by alternative resources and dependency over the natural gas should be lessened. If alternative resources available in Pakistan are adequately used, the country would be in a position to export the additional energy to neighbor states. No doubt self-sufficiency in energy is the first key in attaining the country-wide economic and social development.

Thus there is a need for encouraging the generation of electricity through alternative sources. Pakistan has large, economically viable resources in Wind, Solar, Biomass, Waste, Geothermal and Hydel power, waiting to be harvested.

In the sections below, we provide an overview of renewable energies and the status of such ongoing projects in Pakistan, if any.

Hydel Energy Source

In the recent past, Pakistan's energy sector has witnessed a gradual shift of focus from non-renewable energy to renewable and alternate energy. The most common form of renewable energy is Hydro or water based. The total hydropower resource potential in the country has been estimated at over 50,000 MW. However, presently it only generates 8,000 MW of electricity against an installed capacity of 11,327 MW. Most of the resources lie in the northern region of the country, which offers sites for large scale (100 MW to 7,000 MW) power projects. Smaller (less than 50 MW) sites are available throughout the country.

Geographical conditions are of paramount importance in choosing a suitable site for the hydro project and it evolves a very serious time and money consuming study. Hydel energy is usually generated through waterfalls, dams. There are many dams in the country which play a great role in the generation of electricity for household, business and industrial sector. Since the beginning, huge amounts have been allocated for the development of hydel energy as it is a main source of electricity generation in the country as a result of this the generation of electric power through Hydel energy has been increased from 68MW in 1947 to 6,928MW in June 2013.

A number of hydro-based projects have been commissioned over the last years, which are detailed as below:

i) The largest of these projects is the 720 MW Karot Hydropower Project, envisaged to be set up on the Jhelum River near Karot Village, some 74 kilometers upstream of Mangla

Dam. The project is expected to deliver a net annual energy of 3,401.8 GWh with a plant factor of 54.48 percent. The sponsorship for this project has been taken up by China Three Gorges International Corporation (CTGI). This project is being implemented on Build-Own-Operate-Transfer (BOOT) basis that is it shall be transferred to the government of Pakistan at the end of a concession period of 30 years. In order to facilitate the project sponsors for funding of this project, the authority has approved an indicative tariff of US Cents 5.3977/kWh based on the feasibility study of the project.

ii) The 84 MW New Bong Escape Hydropower Project located on Jhelum River, some 7.5 km downstream of Mangla Dam in Azad Jammu and Kashmir, is a run-of-the-river hydropower project which is one of the first private sector hydropower projects. This project will deliver an estimated net annual energy of 470 GWh to the national grid. This project has already materialized and has achieved full commercial operation in the fourth quarter of FY13. The project has been sponsored by Laraib Energy Limited, a subsidiary of HUBCO. The Authority has approved a levelized tariff of US Cents 8.5453/kWh on the basis of firm EPC contract price of $ 152.80 million and total project cost of $ 214.85 million.

iii) Another significant hydropower project which is at an advanced stage (i.e. Engineering, Procurement and Construction stage), is the 150 MW Patrind Hydropower Project located on Kunhar River, near village Patrind in Azad Jammu and Kashmir. The project will deliver an estimated net annual energy of 632.63 GWh to the grid. The project is being sponsored by Star Hydropower Company Limited, who has entered into a firm EPC contract with Daewoo-Sambu Construction Company of Korea. The Authority has approved Power Purchase Agreement (PPA), initialed between CPPA and the project sponsors, at a negotiated tariff of US Cents 8.2936/kWh levelized over a 30 years concession period. The project is expected to achieve commercial operation within four years of achieving its financial close.

iv) Nandipur power project has been lingering on for many years due to various reasons including political, however, the newly elected government has shown its intention to complete this project on fast track. The government has also approved revision of cost to Rs 57 billion for this combined cycle power plant, whose capacity has been increased from 425 to 525MW. It has been reported that the cost of the project has increased from Rs22 billion to Rs57 billion because of mismanagement by the previous government.

The project was stalled and due to plant lying on the port since long it has been incurring demurrage charges. A request for waiver of Rs1 billion demurrage charges on machinery lying at Karachi port was rejected because of a possible revenue loss which has added to the project cost.

A fresh Rs 24 billion restructuring plan has been prepared for the Nandipur project. In this regard, the government is to issue a fresh letter of comfort to assure the Chinese contractor of the government's commitment to go ahead with the plan so that it could re-mobilize its equipment to resolve longstanding issue of non-implementation Project.

Moreover, the ECC decided to provide Rs23 billion guarantee for the project. A special purpose vehicle (SPV) will be created — funded by Rs16 billion through government equity and the remaining amount by banking sector contribution. This will also be part of the summary to be sent to Ecnec for approval. While a parallel exercise would be launched to convert the Nandipur project to coal-based generation within 22 months so that the SPV could be ultimately taken up for privatization.

v) Kalabagh Dam comes in to news time and again but due to objections by Sindh and KPK it has been put on shelf. However, it can be revived again with some difference that its storage water would not be used in Punjab and would be used only for power generation or its height would remain to some given level so that water level in fertile area of KPk may not elevate.

vi) Ghazi Brotha Hydel Power Project is another project of immense importance but due to lack of funds the progress very slow. This project can be moved further potentially through public private partnership.

vii) Diamer Bhasha Dam Project located on Indus River, about 315 km upstream of Tarbela Dam, 165 Km downstream of Gilgit and 40 km downstream of Chilas. The proposed dam would have a maximum height of 270 m and impound a reservoir of about 7,500,000 acre feet (9.25x 109m3) with live storage of more than 6,400,000 acre feet (7,89x109m3). Mean annual discharge of Indus River at the site is 50,000,000 acre feet (6.2x1010m3).

Other than these large and medium sized hydropower projects, NEPRA has approved tariffs for some small run-of-the-river hydropower projects during this fiscal year.

viii) The Riali-II Hydropower Project to be located at Muzaffarabad in the State of Azad Jammu and Kashmir is one such run-of-the-river project. Having an installed capacity of 4.8 MW, this project will deliver an estimated net annual energy of 28.629 GWh into PESCO's system. The authority has approved a levelized indicative tariff of US Cents 6.8391/kWh, based on the feasibility study of this project.

ix) The 2.4 MW Ghanool Hydropower Project is another small run-of-the-river project. This project is envisaged to be located at Ghanool Katha (Nullah) on Balakot-Naran Road, District Mansehra, Khyber Pakhtunkhwa. The project will deliver an estimated net annual energy of 12.662 GWh into PESCO's system at an annual plant factor of 60.23 percent. The Authority has approved a levelized indicative tariff of US Cents 7.5437/kWh, based on the feasibility study of the project.

x) The 4.8 MW Sahiwal Hydropower Project being sponsored by Chenab Energy (Pvt.) Limited is also a run-of-the-river project to be located at Lower Bari Doab Canal, District Sahiwal, Punjab. This project will deliver an estimated annual energy of 28.86 GWh into MEPCO's system at 68.97 percent plant factor. The Authority has approved a levelized indicative tariff of US Cents 7.2085/kWh, based on the feasibility study of the project.

*Wind **Energy Source***

Pakistan has been gifted with an immense wind resource. The wind map of Pakistan has been developed after extensive analysis carried out by National Renewable Energy Laboratory (NREL), USA in collaboration with USAID, Pakistan Meteorological Department (PMD) and Alternative Energy Development Board (AEDB) using data available from PMD meteorological sites and satellite imagery.

The wind map of Pakistan identifies that wind with good to excellent speeds is available in many parts of the country with a total potential of about 340,000 MW. Specifically, the Gharo-Keti Bandar Wind Corridor, in the South of Pakistan, spreading 60 km along the coastline of Sindh province and more than 170 km deep towards the land alone has a potential to generate more than 50,000 MW of electricity is the most attractive to investors at this point due to good resource potential as well as its close proximity to major load centers and the national grid. Ground data for other potential areas in the country is also being gathered and verified. Development of wind projects can be an option to produce more electricity. Wind projects utilize the power of wind to turn a turbine which drives a generator which feeds the grid.

AEDB is also approaching relevant forums for installation of wind masts in Baluchistan province and other parts of the country to assess the wind potential to explore the opportunities of investment for private sector. This will enable public sector investment in promotional, demonstrative and trend setting wind energy projects that would result in devising measure to support the private sector in mobilizing and financing wind power projects in Baluchistan province and other parts of the country.[41]

The private Sector has been triggered to invest in Wind Power. Currently, 48 projects of around

[41] *http://www.aedb.org/respot.htm*

3,200 MW are under process. Government of Sindh has leased around 26,000 acres of land for 18 projects with a cumulative capacity of 906 MW which are at various stages of development.

A Chinese Company has shown its intention to set up a 50MW wind energy project in Gharo reportedly. The cost of the project has been estimated at $120 million while the project has been initiated by Hydro-China Dawood Power Limited (HDPPL) - a jointly incorporated company. The financial closure is expected to be reached either by December 2013 or by July 2014. The company is also considering to initiate nine more such projects of 50 MW each, in the near term.

While considering the advantages of electric power generation from wind viz. shorter construction period, no fuel costs, no supply dependence on imported fuels, etc. NEPRA has decided to facilitate the development of wind power generation by developing and approving an upfront tariff for wind power generation. After detail deliberation, the upfront tariff for wind power projects was developed and determined on October 6, 2011.

Potential of Wind Energy

Wind energy is an important natural resource which can be utilized as an alternative energy source and it is also environment friendly. Minimum 13 kilometer per hour wind blowing is supposed to be sufficient. Luckily, Pakistan can explore wind potential which is abundantly available into the coastal areas of Karachi, Thatta, Jiwani and Baluchistan's coastal belt and other areas situated in northern areas and Azad Kashmir. This resource has been effectively utilized by the different countries, like Germany generates 18,000MW of electricity from wind, USA produces 7,000MW, and Spain gets 8,000MW from wind energy.

Pakistan should also take necessary measures to generate electricity from wind. This resource can also be utilized by making way for the consumers to setup small or large wind power plants by extending technical and/or financial assistance to the interested consumers to generate electricity through wind power either for their own consumption or even to sell it to the national grid.

*Solar **Energy Source***

Solar energy is an important source of energy which can be converted to electricity through a solar panel. A study reveals that the energy received from the sun in one hour is more than the whole world's total produced energy in a year. As per analysis if only half of total desert land is used to generate electricity from solar energy, it would sufficient to meet the energy demand of the entire world. Pakistan has immense potential for solar energy because Pakistan is receiving 19 mega joules per square meter in a year through which 90 percent of rural area can be provided electricity. This is suitable for both Photovoltaic (PV) and Thermal i.e., Concentrated Solar Power (CSP) applications. The Annual Direct Normal Solar Radiation (which indicates the

potential for CSP) is in the range of 7 to 7.5 kWh/m2/day in many parts of Baluchistan and between 6.5 to 7 kWh/m2/day in other parts of Baluchistan; 5 to 5.5 kWh/m2/day in Southern Punjab and Northern Sindh and around 4.5 to 5 kWh/m2/day in rest of Pakistan.

There are more than 40,000 villages which are so far from the grid that it becomes costly and uneconomic to extend the grid to these locations. These villages are prime candidates for village electrification using renewable energy, for which the Government has launched Rural Electrification Program (REP), using Solar Home Systems (SHS).

Current Status:

i) Eight Solar powered projects with an aggregate capacity of 226 MW are at various stages of development under the Letter Of Intent issued to them.

ii) Under Solar Village 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 are approved for electrification using solar energy and will be implemented on release of funds.

iii) Under the Parliamentarian Sponsored Village Electrification Program, 32 feasibilities have been prepared and submitted of which funds for 3 schemes have been released under Public Works Program-II and these schemes are being implemented.

iv) Pilot Program for Conversion of Electric/Diesel driven Tube-wells to 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.

v) 750 units of solar water pumping systems have also been imported in the country. These water pumping systems are installed for community drinking and agriculture purpose all over Pakistan.

Following the government policy of duty/tax exemption on solar technology, import/ installation of equipment for solar technology has increased manifold. As in case of wind power plants, government can also provide technical and/or financial assistance to private sector parties to utilize solar energy for power generation.

Ground Water Pumping Through Renewable Energy Resources

In the agricultural sector, there are around one million agriculture tube-wells presently in

operation and approximately 26 percent (260,000) are electric-operated with the installed capacity of 2,500 MW and consume approximately 15-20 percent of the total energy delivered by the national grid. Another 850,000 Diesel Water Pumps consume 72,000 TOE of Diesel annually. They offer an opportunity to be replaced with Solar Powered Efficient Pumps.

Furthermore, government has been heavily subsidizing electric tariff for agriculture tube wells in many areas putting additional burden on national exchequer on one hand and inducing inefficiencies in water and energy usage on the other. Agriculture sector having groundwater as the irrigation source is worst hit by present energy crises as the availability of grid electricity in remote areas is around six hours per day on an average. Therefore, a reliable, efficient, sustainable and cost effective energy option for agriculture sector in Pakistan is direly needed.[42]

The operation of community water supply schemes has been taken over by the governments because most of them were rendered non-operational as the population is poor and cannot afford the cost of energy services. The deficit operation of these schemes has put additional burden on already dejected national budget.

Another industry that is affected by low supply of electricity is fish farming. Fish farming is a lucrative business and is practiced in most parts of the country especially in central and lower Punjab, Sindh and Western Baluchistan where climate is conducive for such activity. Continuous flow of clean water in the fish ponds is essential for which a reliable source is required. As the rural areas are getting electricity for a meager time, this industry is being badly affected in the present energy crises.

The solar pumps can meet with the daily water requirements of small to medium size communities and fish farms. For agriculture tube wells, the power requirement to pump groundwater from continuously depleting water table is ever increasing affecting the financial viability and technical capability of renewable energy options. However, it is possible to decrease the energy requirements by optimizing irrigation and pumping system designs for maximum possible efficiency to make it competitive.

It is pertinent to consider the option of replacing/supplementing existing source of power (grid electricity) for driving tube wells with renewable energy resources (solar and wind) to relieve the grid from load stress. AEDB has initiated a study to validate the technical, economic and social viability of the intervention leading to a national rollout program.

The study includes:

[42] *http://www.aedb.org/pump.htm*

i) An academic activity to design pilot project

ii) Implementation of the pilot project

iii) Evaluation of the pilot project

iv) Design of the rollout program

Biomass / Bagasse Energy Source

NEPRA has been receiving tariff petitions for multi-fuel biomass based power plants to be set up in the country under IPP mode. Although Biomass power plants are not considered to be renewable energy power plants, they fall under the domain of alternate energy and rely on indigenous resources. Unlike wind power plants, biomass based power plants are base load plants and can supply electricity consistently into the grid to meet the minimum load requirement at a much lower cost per kWh, when compared with other thermal power plants such as HSD and FO based power plants.

Fatima Group has reportedly made all the arrangements to set up a 119MW co-generation power plant in Muzaffargarh at an estimated cost of $ 234.72 million. To be built adjacent to a sugar mill owned by the group in district Muzaffargarh, the plant will utilize bagasse co-produced by the sugar mill along with other biomass and imported coal. The project is being developed through a public limited company, Fatima Energy Limited. Commercial operations are scheduled to achieve financial close on March 31, 2016, allowing a construction period of 30 months.

Tariff Petitions have been filed for two 12 MW biomass based power plants to be set up in Punjab and Sindh by Lumen Energia (Pvt.) Limited and SSJD Bioenergy Limited respectively. NEPRA's determination in respect of SSJD's tariff petition has been finalized; a 30 year levelized tariff of US Cents 12.9412/kWh has been worked out. The tariff petition filed by Lumen Energia (Pvt.) Limited is under process and is expected to be decided in the near future.

Waste-to-Energy Source

Pakistan produces huge amount of municipal waste (Karachi 9,000 tons/day and other cities about 2,000 to 6,000 tons/day) and agriculture waste in the form of Cotton Sticks and Rice Husk, and cattle dung. The Cattle Colony in Karachi, which is home to one of Asia's largest milk producing area, produces thousands of tons of bio waste from cattle. Converting this waste to energy can generate up to 3,000 MW of power. Pakistan offers lucrative opportunities in this sector in which a number of projects are already under preparation.

Bio Diesel Energy Source

Bio Diesel is a renewable alternative fuel created from vegetable oils, animal fats, and greases through a chemical process. Bio Diesel can be used in any diesel engine in pure form or blended with petroleum diesel at any level. Pakistan, being an agricultural country is having huge prospects of plantation of non-edible seeds from which oil is extracted. These seeds are found in Jatropha Curcas, Castor, Sukh Chain plants etc. Around 35 million hectares of marginal/degraded land is available in different parts of the country that is best suited for this purpose. Currently, Pakistan consumes around 8 million tons of petroleum diesel per annum; half of which is imported.

The GOP has set indicative target of bio-diesel blending; 5 percent by volume of the total diesel consumption by the year 2015. This share by volume is to be increased to 10 percent by the year 2025. GOPs targets of bio-diesel blending make it a potential sector for investment.

Geothermal Energy Source

Pakistan also possesses a good regime for geothermal energy. Many hot water springs, some generating surface water temperature up to 83°C lie in the North of Pakistan. Geothermal sites have also been identified in Baluchistan and Sindh. Although detailed surveys have not been conducted, it is estimated that over 5,000 MW of Geothermal resources can be commercially tapped in the short run.

The following table shows the pros and cons of different electricity generation sources which are desirable to be taken into consideration before opting for any specific source of power generation.

Table 30: Comparison of Different Sources of Electricity Generation

Source	Pros	Cons
Thermal Power from fuel oil	Easier to setup, reliable generation, fuel availability	High rates of carbon emissions, costly generation, dependence on imports, supply depleting
Wind Power	It is a renewable source of energy. There is no fuel cost, no emissions or waste and commercially viable source of power	Variable energy resource, transmission issues, environmental concerns with regards to noise and interaction with birds,
Hydroelectric	Many potential sites in Pakistan, well established technology, able to meet incremental capacity needs, reduction in greenhouse gas emissions	Regulatory approval can be costly and time consuming, access to grid, local opposition to new development

Biomass	Biomass Uses landfill gas, wood pellets, and waste products to create electricity, reduces greenhouse gas, high availability of sites	High capital equipment and fuel costs; produces some emissions; access to transmission, competition for biomass materials use
Geothermal Energy	Reliable source of power, low fuel and operating costs, clean and renewable source of energy	High capital costs, connecting to the grid can be difficult.
Solar PV	Solar PV Reliable, renewable energy source with zero emissions and silent operation, fuel is free, suitable for areas where fossil fuels are expensive or where there is no connection to the grid.	Restrictive and lack of grid connection for remote areas, not cost competitive, sun does not always shine and potential varies across regions.
Ocean Energy	Ocean Energy Costs are expected to decline as technology develops, intermittent, but predictable source of green energy.	Potentially intrusive to marine life, heavy investment is needed to promote research and development.
Coal Power	Huge reserves available in Pakistan, cheaper than petroleum oil	High level of carbon emissions, limited resources
		Source: *KCCI Research*

Policies and measures by government

National Power Policy 2013-18

The Government has formulated a new energy policy after taking the consent by the Prime Minister Nawaz Sharif which has also been approved by the Council of Common Interests (CCI). The new policy envisages recommending an energy mix as a way forward where energy mix would mean regime change under which focus from thermal power will be shifted to coal-based power generation or alternative energy for cheaper energy production. It also proposed phasing out subsidy on the power sector but also recommending subsidy protection for consumers using 200 or below units of electricity per month.

It is aimed to address the major challenges of the power sector and to provide relief to the public. The salient features of the policy are stated below:

Pakistan will develop the most efficient and consumer centric power generation, transmission and distribution system that meets the needs of its population and boosts its economy in a sustainable and affordable manner.

Pakistan's power sector is currently afflicted by a number of challenges that have led to a crisis:

- A yawning supply-demand gap where the demand for electricity far outstrips the current generation capacity leading to gaps of up to 4,500 - 5,500 MW. The supply-demand gap has continuously grown over the past 5 years until reaching the existing levels. Such an enormous gap has led to load-shedding of 12-16 hours across the country.
- Highly expensive generation of electricity (~Rs 12/unit) due to an increased dependence on expensive thermal fuel sources (44 percent of total generation). FO, HSD, and Mixed are the biggest sources of thermal electricity generation in Pakistan and range in price from ~Rs 12/unit for mixed, to ~Rs 17/unit for FO, and a tremendously expensive ~Rs 23/unit for HSD. Dependence on such expensive fuel sources has forced Pakistan to create electricity at rates that are not affordable to the nation and its populace.
- A terribly inefficient power transmission and distribution system that currently records losses of 23-25 percent due to poor infrastructure, mismanagement, and theft of electricity. The cost of delivering a unit of electricity to the end consumer has been estimated at Rs 14.70 by the NEPRA. This means that the inefficiencies are costing the tax payers additional 2.70 rupees per unit over and above the cost of generation (~Rs 12). The Ministry of Water and Power (MoWP) has estimated the true cost of delivering a unit of electricity to the end consumer at greater than Rs 15.60 after taking into account the collection losses and the real losses to the distribution companies. If the system assumes the NEPRA suggested transmission and distribution loss of 16%, the theft alone is estimated to be costing the national exchequer over Rs 140 billion annually.
- The aforementioned inefficiencies, theft, and high cost of generation are resulting in debilitating levels of subsidies and circular debt. Reducing these losses would lead to significant improvement in the bank ability and profitability of the sector, and could be used to improve the efficiency of the power system I network as a whole.
- The limited and crumbling transmission system of Pakistan has created serious issues of access to electricity, particularly in Baluchistan and other far flung rural areas of the country,

To achieve the long-term vision of the power sector and overcome its challenges, the Government of Pakistan has set the following nine goals:

- Build a power generation capacity that can meet Pakistan's energy needs in a sustainable manner.
- Create a culture of energy conservation and responsibility
- Ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coat (Thar coal) and hydel.
- Minimize pilferage and adulteration in fuel supply
- Promote world class efficiency in power generation
- Create a cutting edge transmission network

- Minimize inefficiencies in the distribution system
- Minimize financial losses across the system
- Align the ministries involved in the energy sector and improve the governance of all related federal and provincial departments as well as regulators.

A clear strategy has to be articulated for each of the aforementioned goals in order to actualize the power sector's aspirations.

Pakistan has set key targets in terms of the demand-supply gap, affordability, efficiency, financial viability and governance of the system. The extent to which the policy can meet these targets will measure the success of the policy and the nation's ability to overcome the key problems afflicting the power sector.

- To decrease supply demand gap from 4500 - 5000 MW today to 0 by 2017.
- To decrease cost of generation from 12c/unit today to -10c/unit by 2017.
- To decrease transmission and distribution losses from -23-25 percent to -16 percent by 2017
- To increase collection from 85 percent to 95 percent by 2017.
- To decrease decision making processing time at the Ministry, related departments and regulators from long to short durations
- The exact processing times are not currently available; will be established in the due course of time

The process of policy and strategy formulation is informed by the following organizing principles: (i) efficiency, (ii) competition, and (iii) sustainability.

i) Efficiency is the cornerstone of developing competitiveness. The principle of efficiency will be predicated on three pillars: merit order, transparency, automation, and accountability.
    - Merit order will be observed all across the system - fuel allocation, dispatch, payments, and power mix. Merit order allocations will obviously come into play once the supply and demand gaps have been minimized.

    - Transparency will be achieved by providing seamless access to information through a public website Accountability will be ensured by hiring professionals solely on the basis of competency, signing performance contracts, and exercising zero tolerance towards corruption and poor performance.

ii) Competition creates the edge essential for developing a robust energy cluster. The principle of competition will be built on three pillars: infrastructure development, up front tariff and competitive bidding, and key client management.

- Infrastructure will be developed and incentives provided to attract greater private sector investments. Government would like to limit its role to policy making, and unless necessary, service delivery will be promoted through a fiercely competitive and transparent private sector.

- In this light, NEPRA will be strengthened to create a world class regulatory authority with sophisticated and efficient capacity to establish tariffs and set the foundation for a competitive bidding process.

- The government will assign "key client managers or relationship managers at the MoWP who will act as a 'one-window operation' for investors in the power sector and ensure the timely completion of investments and projects.

iii) Sustainability is the underpinning of long term transformation. The principle of sustainability will be grounded on three pillars: low cost energy, fair and level playing field, and demand management.

- Altering the fuel mix towards less expensive fuels will lead to low cost energy. Investments required for the low cost fuel mix will necessitate rationalization of the electricity tariff.

- Fairness will be ensured by protecting the poor and cross-subsidizing their consumption from the affluent. A level playing field will be created by providing power at comparable prices to all industrial users.

- Demand management will be introduced through novel policy, pricing and regulatory instruments.

The Government of Pakistan has designed strategies for each of the goals to actualize its vision and overcome the power crisis. The following strategies will be pursued by the government:

Supply Strategy

- Build a power generation capacity that can meet Pakistan's energy needs in a sustainable manner.

- Overall, the strategy to achieve the above goal is focused on attracting and directing local and foreign investments toward rapidly expanding the power generation capacity. Investments can only be encouraged if the sector is made attractive and bankable by eliminating all subsidies, except for those that target the abject poor, to prevent build-up of circular debt. The poor (consumers using up to 200 units) will be protected from any price escalation. To the extent possible tariff rationalization will Minimize or eliminate subsidy within the industrial, commercial and bulk consumers.

- In developing new power generation projects, a preference shall be afforded to up-front or feed-in tariff which shall set the upper ceiling. In addition, competitive bidding may be used to minimize the cost of generation. Previous policy frameworks (such as 2002 power policy) may also continue to be operational. However, the 2013 power policy shall override any other policy in relation to energy issues to the extent of inconsistencies.

- In the short run, the government has already brought the existing capacity online by retiring the circular debt. This action has provided financing to plants that were previously dormant due to a lack of feedstock and I or disputes. The retirement of debt has resulted in an additional supply of over 1700 MW. In tandem, an aggressive rehabilitation and expansion programme for the Gencos under way which would add 1,447 MW within a year: rehabilitation projects at Guddu, Jamshoro, and Muzzafargarh will yield 700 MW while the expansion of Guddu will add 747 MW.

- The maximum delay limits for payables set for FO and gas (listed in the diagram above) should also apply to hydel IPPs and Wapda in order to ascertain that national power generation capacity does not sit idle in the future.

- In the medium term, the MoWP will attract new investments and expedite the pipeline projects on a war footing. A number of projects have reached or will reach financial closure within 2013 - these include 50 MW FFC Energy Limited, 56MW Zorlu Jhimpir project, 50 MW Foundation Wind Energy I, 50 MW China Three Gorges, and 50 MW Foundation Wind Energy II. Thus 256MW have already reached financial closure this year, and an additional 100 MW (Sapphire and Metro) will reach financial closure by the end of 2013. The Uch-II power project (404 MW) has reached financial closure already and is expected to come online by

December 2013. Grange Power Holdings is also scheduled to reach financial closure shortly and should be online by October 2014.

- In addition to the above listed projects that have reached financial closure, LOS' have been issued for 450MW worth of wind energy projects and an additional 2,276MW of wind projects are currently in the feasibility assessment process. This cumulative 2,726 MW of wind electricity (if deemed feasible) could come online in 2016. At the same time, 341MW of solar energy projects are also currently in the feasibility assessment process and could come online by 2015 if deemed feasible. There is also a push towards Bagasse which could yield 83 additional megawatts of electricity by 2016,

- A significant push will also be made towards building medium and long-term hydel capacity in the country. Six projects totalling 388MW of hydel power are expected to be completed by February 2015. The smaller Patrind and Gulpur hydropower projects are expected to be completed by December 2017 and will add 247MW to the grid. An additional 969MW is anticipated from the Neelum-Jhelum HPP project by November 2016. A number of hydel projects are expected to come online in 2017 including the fourth and fifth Tarbela expansions which have the potential to add 1,910 MW (1,410 MW in fourth expansion, 500 MW in fifth expansion).

- The government is also poised to announce a coal corridor with a capacity to generate 6000-7000 MW in the near future.

- In the long run, large infrastructure programs including the Indus Basin Cascade will be aggressively developed. Dasu has a potential of generating 2,160MW, Patan 2,800 MW, and Thakot 2,8OO MW. The detailed engineering design for these projects is being carried out and will optimally be constructed using a BOT PPP method.
- Other longer-term projects are also under consideration, such as Bunji (7,100 MW potential) and Diamer-Bhasha (4,500 MW potential) whose competition by 2020 could ensure the energy independence and security of Pakistan.

- To achieve its medium and long terms goals, the government will develop infrastructure and provide incentives to attract greater private sector investments. The government will set the foundations of energy cities and corridors, and sponsor public-private partnership (PPP) for coal and run of river projects. The government will assign "key client managers or relationship managers" at the M0WP who will act as a 'one window operation for investors in the power sector and ensure the timely completion of investments and projects.

- The government is actively considering innovative business models including various wholesale business models supported by wheeling charges. These innovative business models once concluded may allow the generation companies to sell electricity to NTDC, Discos and the private sector alike. Successful implementation of these models will encourage rapid investments in power generation, bring power generation closer to the load centers, and result in a reduction in electricity prices.

- Encouraging the private sector to participate in the utility market necessitates a world-class regulatory function.

- NEPRA will be strengthened in this regard, and a world-class regulatory authority will control the Tariff and Competitive Bidding process. Up-front tariffs will be set for low cost fuels and competitive bidding will be used to push the costs further downwards.

Demand Strategy

- To create a culture of conservation and responsibility. The government will pass energy conservation legislation aimed at three key areas: a) technology/product labeling standards, b) power time of use, and c) improving the energy efficiency of the existing and new infrastructure.

- The strategy will set energy conservation and product labeling standards which would ban the import of inefficient electronics into the country. The local industry will be granted a three-year exemption period to bring its product production to the required levels of power efficiency. Green energy building codes will be established and introduced across the country.

- Energy services companies may also be encouraged in the private sector to audit and improve the energy efficiency of the existing industrial, commercial and residential footprint and create a culture of conservation and productivity.

- The strategy may also impose timing restrictions for evening commercial activities and introduce 'time of use' metering to discourage utilization during the peak hours by charging different rates for on- and off-peak timings. Solar and alternative power solutions will be encouraged for end users, street lighting, electronic billboards, neon lighting, shop front signage, etc. In addition, the price signal articulated through reducing and targeting subsidy (mentioned in the above section) will naturally optimize demand and utilization.

- A conservation program based upon energy saver lighting is already underway with a potential of saving 1000 MW if all 50 million consumers were to be converted to florescent bulbs. In addition, technology solutions such conical bafflers for water heaters will be introduced.

Affordable Power Strategy

- Ensure the generation of inexpensive and affordable electricity for domestic, commercial & industrial use.

- The strategy focuses on shifting Pakistan's energy mix toward low cost sources such as hydel, gas, coal, nuclear and biomass. Local and foreign investments will be aggressively sought for small and medium size run of river hydel projects. Selected hydel projects under development will be positioned for privatization. Multilateral agencies will be invited to partner in large infrastructural hydel projects. LNG terminals will be developed on war footing to rapidly increase the gas supply for the power and industrial sectors. In addition, gas will be preferentially directed to the power sector by eliminating UFG. Nuclear power will be developed in close collaboration with friendly countries such as China. Development of coastal energy corridors based upon imported coat (mixed later with local coal), rapid proliferation of coal mining all across the country - especially at Thar, and conversion of expensive FO based plants to coal are the central tenets of coal policy. The proposed strategy will change the energy mix of Pakistan in favor of low cost sources and significantly reduce the burden of energy to the end consumer.

Supply Chain Strategy

- Minimize pilferage and adulteration in fuel supply.

- Once the relief from load-shedding is forthcoming because of a decreased supply and demand gap, this strategy will focus on redirecting the supply of fuel from inefficient Gencos to the most efficient IPPs. This reallocation alone has the potential of saving Rs 3 billion per month and generation an additional 500MW of electricity. At the same time, the MoWP will sign performance contracts with Gencos, PSO, and fuel transporters and hold them accountable for the quality and theft of oil. Fuel procurement contracts may be made open sourced to eliminate the power of a single supplier. Leakage will be plugged by building fuel pipelines where possible and open decanting. More specifically a 22 KM pipeline will be constructed to plug the supply chain leakage in Muzzafargarh. In the event that fuel is found to be missing or adulterated, the full economic value of the fuel will be appropriated to the end receiver.

Generation Strategy

- Promote world class efficiency in power generation.

- The strategy focuses on establishing plant efficiency through external heat rate testing, building a merit order accordingly, and allocating fuel to the more meritorious plants. Merit order will privilege fuel allocation on the basis of efficiency and optimise dispatch and payments. Transparency will be achieved by providing greater and easier access to information through a public website. Allocations will be made public online to increase the transparency. The strategy calls for the privatisation or O&M-based leasing of Gencos.

Transmission Strategy

- Create a cutting-edge transmission network.

- The strategy is based on installation of upgraded SCADA software to optimise transmission and monitor its losses. Dispatch will be based on economic order and internal/audit controls will be established on dispatch and payment.

- The transmission strategy requires the redesigning of the national grid in a manner that minimises line losses Plants will be built closer to load centers; high voltage transmission lines will be expanded; and the 220kv rings around cities will be strengthened.

- Private sector will be provided incentives to build and strengthen the transmission infrastructure. Innovative business and regulatory models who be deployed to weaken the monopolies, increase efficiencies, and decrease costs through competition. Wheeling charges and whole sale markets may be introduced to introduce multiple buyers and sellers in the market place.

- Regional transmission networks may also be encouraged to promote power trade and optimise deficits and surpluses.

Distribution Strategy

- Minimize inefficiencies in the distribution system.

- In the short-term, performance contracts will be signed with the heads of DISCOs (distribution companies) and their respective boards focused on reducing distribution losses due to technical reasons, theft, and lack of recovery/collections. Board independence and appointment of competent board members is the corner stone of improving the performance of Discos.

- Smart meters will be installed at the feeder and CDP level, profit and loss accounts will to be managed at the feeder level, and the accountability will be appropriated to the Executive Engineer. A regime of reward and punishment will be used to improve efficiency and decrease theft. A Theft Act will be passed that would harshly punish defaulters and other electricity thieves to eliminate theft at the consumer level.

- In the medium term, the efficiency will be improved by privatizing a selected number of Discos. The remaining Discos will be privatized over a period of time.

Financial Efficiency Strategy

- Minimize financial losses across the system.

- GST refunds will be collected from the FBR and a mechanism will be built to avoid future build-ups.

- The financial efficiency strategy is geared towards punishing private defaulters and proposes severing the electric connections of defaulters after 60 days of non-payment and only reconnecting them to the grid with pre-paid meters. External collection agencies may also be sourced to improve cash flows. At the same time, load-shedding may be focused on areas of high theft and low collections as opposed to the current structure of indiscriminate load-shedding.

- The strategy also covers the independent audit of all financial transactions within the power sector. An independent firm will be used to audit these transactions and ensure the greatest degree of financial propriety within the power sector.

Governance Strategy

- Align the ministries involved in the energy sector and improve governance.

- The governance strategy calls for the notification of an Official Co-ordination Committee comprising the Ministry of Water & Power, the Ministry of Petroleum, the Ministry of Finance, he Ministry of Planning and Development a member from each province, and a representative from AJK and GB each This council will ensure information integration between all these ministries and will assist in policy formulation and decision making related

to energy. The CCI will provide monitoring and oversight to the implementation of the National Power Policy.

- The strategy requires the reformation of structural and regulatory aspects of NEPRA and OGRA to improve efficiencies. New business models including power exchanges and wheeling charges will be explored. NEPRA's reform will include a change in the establishment period for the base tariff from 8-10 months to 90 days; the aim of this reform will be to minimize the potential for circular debt accumulation.

- Finally, the Ministry of Water and Power will be restructured to strengthen its functional expertise. Directorates will be created for key functions (i.e. generation, transmission, and distribution) and key organizations such as CPPA, PPIB, AEDB, and NTDC will be reformed.

The strategy has been prioritized to maximize the impact of the various strategic initiatives. In the short term we will bring existing capacity online, stop thefts of all form, rationalize the tariff, sign performance contracts, and ensure transparency. In the medium term we will bring low-cost pipeline projects online, and jump start coal and hydro PPP projects. Finally, in the long term we will finish large infrastructure hydel projects and retire high cost energy contracts to ensure that Pakistan moves towards cheap electricity generation.

The policy envisages that the successful implementation of this policy will lead to enormous improvement within the power sector. By 2017, the supply-demand gap could be eradicated completely; and by the end of the five-year term of the current government the country will have a power surplus which can then be regionally traded. In essence, by the end of the decade Pakistan could be transformed from energy strapped, importer of power to a regional exporter of power. The cost of power generation will be reduced to an affordable amount, and the efficiency improvements in transmission and distribution will decrease the burden of power to the end consumer. In summary, prosperity and social development will become a reality in a Roshan Pakistan.

Annual Plan 2013-14

The Planning Commission of Pakistan has disclosed the Annual Plan for 2013-14, which also encompasses issues and projects pertaining to the energy sector. The implementation of reform process under Framework for Growth Strategy for Energy Sector, which focuses on improved governance, rationalization of energy prices, enhanced energy generation and efficient use.

Oil and Gas

The Government intends to pursue policies of attracting private investment in the energy sector with greater reliance on indigenous resources. In order to reduce this burden, Government has introduced new Petroleum Policy, LPG Policy, LNG Policy, Tight Gas Policy etc. to attract investment and ensure energy security at affordable price.

New Petroleum Policy 2012 has been promulgated wherein further incentives have been provided to attract local and multi-national companies for investment in oil /gas sector of Pakistan. Bidding of over fifty eight (58) blocks for exploration of oil & gas reservoirs have been conducted for award of exploration licences on competitive basis in FY13.

Tight Gas (Exploration & Production) Policy, 2011 offers 40-50 percent premium over the respective zonal price of Petroleum Policy 2009. Moreover, an additional 10 percent premium will be given for those Tight Gas volumes that are brought into production within 2 years of announcement of this policy. Low BTU Gas Pricing Policy, 2012 was approved wherein additional incentives to investors have been given to develop Low BTU fields. Moreover, Marginal/Stranded Gas Fields-Gas pricing criteria and Guidelines 2013 Policy was also approved.

Natural Gas

To further strengthen the supply situation of Natural gas, Sui Southern Gas Company Ltd. (SSGCL) has launched a five year Unaccounted for Gas (UFG) reduction plan at a cost of Rs 30 billion funded mainly by the World Bank and approved by ECNEC (Executive Committee of the National Economic Council). Oil and Gas Regulatory Authority (OGRA) allowed Rs 3.58 billion in FY13 in the revenue requirement of SSGCL to initiate the project.

Other Projects

Setting up of Oil Refinery

An Oil Refinery of 120,000 barrels/day of M/s Byco Oil Pakistan Limited (BOPL) situated at Hub, Baluchistan, has been set up. The approximate investment of the project was US$ 337 million. It has improved the petroleum refining capacity available in Pakistan thereby reducing the dependence of importing relatively expensive refined petroleum products to meet the local energy demand.

Oil Storages / Oil Terminals

A new oil storage jointly owned by M/s. Bakri Trading Company Pakistan Limited & M/s Overseas Oil Trading Company Pakistan (Pvt.) Limited has been completed at Machike which has the storage capacity of 10,200 million tons.

Liquefied Natural Gas (LNG)

In order to encourage LNG import to abridge widening gap between gas demand and supply, the government has further improved/liberalized its LNG import policy in the form of LNG Policy, 2011. The LNG policy removed bottlenecks of the previous policy and encourages private parties to develop LNG projects and sell RLNG to their end consumer's mutually negotiated price by using the gas network of gas utility companies.

Two Long Term Integrated Projects

SSGCL intends to seek proposals for delivery of 400 MMCFD Re-gasified Liquified Natural Gas (RLNG) under two separate projects through open competitive bidding under PPRA Rules. The selected party will perform all activities i.e. securing LNG supply, marine transportation and establishment of LNG terminal and injection of RLNG into SSGCL's network. The bids will be evaluated based on the gas price at SSGC delivery point. The contract will be for 5 years with 5 years price review clause.

In order to reduce pipeline vulnerability due to degradation over a period of time, vandalism and terrorist attacks, SSGC embarked upon installing improved SCADA System. SSGC intends to completely revamp Telecom and SCADA System from Shikarpur to Quetta (Terminal) via Sibi at an estimated project cost of 3.91 million US$ during FY 2013-14.

Financial Allocations

The National Economic Council (NEC) has approved Rs 1155 billion development budget for the FY14 with federal Public Sector Development Program (PSDP) earmarked at Rs 540 billion, 50 percent more than the current year's allocation. Federal PSDP allocation included Rs 109 billion foreign component. The block allocation of Rs 115 billion was made in the federal PSDP which would be utilised to implement the development schemes. The NEC approved Rs 615 billion for FY14 provincial Annual Development Plan (ADP).

The energy sector was given top priority by allocating Rs 225 billion for the FY14 with Rs 107 billion under PSDP and Rs 118 billion would be arranged by WAPDA while Rs 52 billion has been approved for Wapda and Pepco and Rs 59 billion for the water resources. Allocation of Rs 186.2 billion including foreign aid component of Rs 46.29 billion was made for power sector and Rs 0.8 billion was allocated for fuel sector during FY13.

Table 31: National Development Program 2012-13 & 2013-14

Ministry / Division	(Million Rupees)					
	PSDP 2012-13			PSDP 2013-14		
	Foreign Aid	Rupees	Total	Foreign Aid	Rupees	Total
A. Federal Ministries:						

Pakistan Atomic Energy Commission	27,450.0	11,717.4	39,167.4	26,138.0	26,162.0	52,300.0
Pakistan Nuclear Regulatory Authority	-	400.0	400.0	-	316.0	316.0
Petroleum & Natural Resources Division	-	387.1	387.1	-	50.0	50.0
Planning & Development Division	1,970.0	19,749.7	21,719.7	120.0	10,538.6	10,658.6
Water & Power Division (Water Sector)	2,800.0	48,473.3	51,273.3	2,722.9	55,117.3	57,840.2
B. Corporations:						
WAPDA (Power)	21,655.0	5,500.0	27,155.0	33,706.0	17,737.4	51,443.4
Source: *KCCI Research; Planning Commission of Pakistan*						

National Power System Expansion Plan 2030

The NTDC developed the National Power System Expansion Plan 2030 (NPSEP) in FY12 under which a detailed strategy has been drawn to expand the nation's power resources. The table below lists the power projects initiated in the past two years and expected to be completed in FY14, and their current status under the plan. Proper allocation of funds to the projects and adequate monitoring and performance management of the project is of utmost importance.

Table 32: National Power System Expansion Plan 2030 (FY11-14)

Year	Project	Inter-connection Voltage (kV)	Unit Additions				Status
			Type	# of units	Unit net capacity (MW)	Total net capacity (MW)	
2010-11							
2011-12	Nandipur Power project	132	CC	1	364	364	Nandipur Power Project was to be completed in 2011, but due to non-release of necessary equipment by the former federal government, this national power project was inordinately delayed.
	CHASHNUPP-II, Punjab	220	Nuclear	1	320	320	Project Completed in May 2011
	Khan Khwar	132	Hydro	1	71	71	The 72 megawatt project was formally inaugurated on July 14, 2012
	Jinnah	132	Hydro	1	95	95	Physical Progress *99.19 percent. UNIT No.1, 2, 3 are operational while work is being carried on the rest of the 5 units.

	Fauji and Zorlu	132	Wind	2	50	100	Fauji Foundation is under process of achieving financial close for two wind projects (50MWs each) at Gharo, Thatta District. The EPC contractors are Nordex and Descon with Nordex as the lead contractor. Once the aforementioned projects reach financial close, these will have 15 months for being fully operational (i.e., dispatch of energy under EPA). Work on the projects is on-going.
2012-13	UAE G.T, F/Abad Punjab	132	GT	2	134	267	Gas Project, no updates yet.
	Jamal Din Wali R.Y. Khan	132	Bagasse	1	76	76	Co-Gen policy for investors has been formulated for investors. Around 80 sugar mills are producing electricity for their own using bagasse. It is proposed in the policy to use bagasse in crushing season (Nov till Feb) and use coal as alternate by mills during off season.
2012-13	BQPS 560, KESC	KESC	CC	1	546	546	Karachi Electric Supply Company has achieved Gross Dependable Generation Capacity of 2,052 Megawatts with the completion of 560-MW Bin Qasim Power Station-II, but KESC's request for supplying the already approved additional 130MMCFD gas quota for the new plant is still pending with the Government.
	KESC Bio Waste to Energy	KESC	Bio waste	1	23	23	The International Finance Corporation (IFC), a member of the World Bank Group, had signed a joint development agreement with KESC, Aman Foundation and their collaborative initiative, Karachi Organic Energy Limited (KOEL), on June 28, 2013 to co-develop this waste to energy project.
	Bin Qasim, KESC (2x210 MW oil to coal conversion)	KESC	Coal	2	176	352	Project is underway, MoU has been signed with Oracle Coalfields UK & Bright Eagle Enterprises Group Limited (BEEGL) to extract coal from Thar region and development of conversion-to-coal project respectively. Work is in progress.
	Allai Khwar	220	Hydro	1	121	121	Commercial generation has started in March 2013. Allai Khwar is the second of the three high-head hydropower projects, which has gone operational after 72MW Khan Khwar. The third is 130MW Duber Khwar hydropower projects.
	Duber Khwar	132	Hydro	1	130	130	

2013-14	Guddu-New	500	CC	2	329	658	The construction activities related to civil/structural works have entered into an advanced stage. Gas turbines and generators have been placed on their foundations whereas installation/erection works are in progress. The project is expected to be completed in August, 2013.
	Kurram Tangi	132	Hydro	1	83	83	Work on Kurram Tangi Dam, a multi-purpose project in North Waziristan Agency, is under progress.
	New Bong Escape, IPP	132	Hydro	1	83	83	The project has been completed and inaugurated by PM in June 2013.
Source: *KCCI Research; NTDC; Newsflows*							

Other longstanding mega energy projects

TAPI – A potential project to bridge energy shortfall

Turkmenistan-Afghanistan-Pakistan-India (TAPI) Gas pipeline project has been under negotiation for many years to supply gas from Turkmenistan to other party countries. Some progress was made in 2012 on the construction of 1,800 km natural gas pipeline under TAPI project after more than 20 years had been spent on negotiations. Turkmenistan-Pakistan and Turkmenistan-India bilateral Gas Sales Purchase Agreements (GSPAs) were signed on 22nd May 2012 by the heads of respective commercial entities responsible for the development and management of the TAPI that will lead to the supply of up to 90 million cubic meters of natural gas per day via TAPI natural gas pipeline. At the same time, Afghanistan also signed a Memorandum of Understanding on long term gas cooperation in gas sector with Turkmenistan. GSPA between Afghanistan and Turkmenistan is also expected to be finalized in the due course of time. The next step is for the four TAPI nations to attract commercial partners to build, finance, and operates the pipeline, was estimated in 2008 to cost at least $7.6 billion and the first gas flow was planned in 2017.

Pakistan, Afghanistan and India during trilateral session 16th - 17th April 2012, in Islamabad, three countries agreed on the transit fee rate. On indexation mechanism, India proposed a US dollar based indexation as the transit fee rate has been agreed in US dollars whereas Afghanistan proposed combination of Pakistan and Indian CPIs, however, they were likely to agree on Indian proposal. Out of the expected transit fee of $400 to $750 million a year, Pakistan may earn about $14 billion in 30 years, including $8 billion in transit fee, $1 billion in taxes and $5 billion in foreign exchange savings.

According to details, TAPI initial agreement was signed in Ashkabad on December 11, 2010. The 56 inch diameter gas Tapi pipeline would have a capacity to transmit 3.2 billion cubic feet per

day (bcfd) gas from South Yolotan gas field in Turkmenistan. Pakistan would get 1,325 mmfcd of gas and the same quantity is supposed to be received by India. Under the agreement, Pakistan and India will get 42 percent of the supply quota each and the remaining 16 percent would go to Afghanistan. The TAPI pipeline route passes through Taliban strongholds areas of Kandahar and Helmand, therefore would not be easy to construct and implement. Previously supply source was Daulatabad, now it changed to South Yolotan/Osman and adjacent gas fields would supply gas for this project. The proposed route, of gas pipeline would be through supply source fields of Kirat-Kandhar-Chamman-Zhob-DG Khan, Multan, and Fazilika (Pak-India board).

The British company Gaffney Cline Associate has submitted the gas reserve audit certificate to all the stakeholders. The audit certificate verifies the presence of 4 to 14 trillion cubic meters of gas in Yolotan/Osman and adjacent gas fields. However, the Turkmenistan's President stated that gas reserves at the field are about 22 trillion cubic meters.

Historical Background of TAPI

Historical background indicated that the original project started in March 1991 when a memorandum of understanding between the governments of Turkmenistan and Pakistan for a pipeline project was signed. The TAPI pipeline project was again revived in 1995, however, could not be implemented for 15 years due to many reasons, of them Taliban insurgency in Afghanistan was the most important. In August 1996, as Central Asia Gas Pipeline Ltd. Gas consortium for construction of a pipeline was setup by Unocal. On October 27, 1997, Central Asia Gas was incorporated in formal signing ceremonies in Ashkabad, Turkmenistan. In January 1998, the Taliban selected Central Asia Gas over a Brazilian competitor, signed an agreement that allowed the proposed project to proceed. In June 1998, Russian Gazprom relinquished its 10 percent stake in the project. Unocal withdrew from the consortium on December 8, 1998.

Again the deal on the pipeline was signed on December 27, 2002, by the leaders of Turkmenistan, Afghanistan and Pakistan. In 2005, the Asian Development Bank (ADB) submitted the final copy of a feasibility study designed by British company, Penspen. After the US military overthrew the Taliban government, the project was stalled including the construction of the Turkmen part which was to start in 2006.

Security concerns for TAPI

Although, Afghan government assured that its forces would provide security during the construction and later on protecting the pipeline but it is a big question that whether they would be able to do so. However, to make work easy the Afghan government has planned to employ local people to guard the pipeline, which would be buried underground, making it harder to attack. Afghanistan would deploy five to seven thousand security persons to safeguard the pipeline route.

On the other hand, attacks on pipelines in Pakistan had cost Rs 382 million to the national exchequer during the last three years. In this situation how Pakistan would be able to protect and construct this gas pipe line is not hard to imagine.

India has already expressed security concerns with respect to any pipeline that passes through Pakistan. However, it is clear that the expenditure on extra security of the project would add significant amount to the total cost. The Taliban are busy in a fierce battle for the past more than seven years. Construction of the pipeline through tough terrain and hostile attitude might delay to complete the project.

The details of the document were not fully disclosed and exact cost and the tentative date when work will actually start is not indicated. Even the ADB's representative at Ashkabad has not confirmed about funding, perhaps due to security reason. Despite all this, TAPI would be a viable alternative option to help meeting shortfall of gas and the future gas deficit, if and when the project comes online.

Iran Pakistan gas pipeline project

The project of Iran Pakistan gas pipeline was envisaged in early nineties wherein gas was to be imported in the Pakistan from Iran's South Pars gas field. The pipeline is planned to traverse a distance of 1,150 km up to the Iran-Pakistan border, which will be built and operated by Iran. Iran has already completed a 900-km portion of 56-inch diameter pipeline from Assaluyeh to Iran Shehr. The remaining 200 km up to the Pakistan border is under design, and is supposed to be completed by the end of 2014. The Pakistan section of the pipeline is to be laid close to the Makran costal highway from Iran-Pakistan border up to Pakistan off-take point at Nawabshah covering a distance of over 781 km.

The pipeline is planned to carry 750 mmcfd gas and is scheduled to come online by the end of December 2014. It would be suitable for power generation and would support around 4,000MW electricity generation capacity, which would help in overcoming the crippling power shortage crisis.

The project continued to linger on mainly due to opposition of the US in wake of sanctions on Iran. However, in May 2009, an Inter-Governmental Framework Declaration (IGFD) was signed by President of Pakistan and Iranian counterpart for early implementation by the governments. Subsequently, the Gas Sale and Purchase Agreement (GSPA) were also signed on 5th June 2009, which become effective on 13th June 2010 after completion of required conditions precedents. In this regard, sovereign guarantee was also issued by the Government of Pakistan on May 28, 2010 while, President Asif Ali Zardari and Iran's President Ahmadinejad inaugurated the final construction phase of the pipeline on March 11, 2013. The ceremony was to commemorate construction of work up to the Pakistani border.

Recently, the government has officially announced that it will implement the Iran-Pakistan gas pipeline project in the Annual Plan 2013-14. It has planned to procure equipment and material to begin construction in the financial year 2013-14. According to the energy strategy unveiled by the Pakistan Muslim League-Nawaz government, the project's cost has been reduced to $1.25 billion against earlier estimates of $1.5 billion. The following progress has been made on the IP gas pipeline so far:

- Bankable Feasibility Study (BFS) - September 2012
- Front End Engineering Design (FEED) - September 2012
- Detailed Route Survey (DRS) - September 2012
- Social Environmental impact Assessment (SEIA) - September 2012
- Initialization of Cooperation Agreement with Iran - December 2012
- Cabinet approval to give effectiveness to the Cooperation Agreement - January 2013
- Installation of concrete markers on Right of Way - February 2013
- Land Acquisition (384 Km) - February 2013
- Initialization of Engineering, Procurement and Construction (EPC) Contract along with the Financing Agreement - February 2013

Moreover, there were serious concerns regarding the imposition of penalty by Iran in the wake of delay in the commissioning of the project beyond the stipulated time. The gas sale-purchase agreement has a take-and-pay clause according to which Pakistan would have to pay a penalty equal to the gas bill for 750mmcfd, which is estimated to cost $8 million. However, during a meeting between Federal Minister for Petroleum Khaqan Abbasi and Iranian Ambassador Alireza Haghighian in Islamabad on June 19, 2013, Tehran offered Islamabad relief from the penalty in case the project could not be commissioned by December 2014.

Project of LNG Imports from Qatar, India still in doldrums

Pakistan plans to import around 500,000 million cubic feet per day (mmcfd) of LNG from Qatar. Qatar will provide LNG to Pakistan on a sovereign guarantee from Islamabad. After finalization of the plan with Qatar, Pakistan is expected to use the terminals to bring LNG into the country by paying for the operators. About 1300mmcfd gas equivalent of LNG would be imported as the channel could not handle a ship carrying 500mmcfd equivalent LNG. The price of imported LNG will be included in the weighted average and consumers would have to pay higher price for gas. The average consumer price for local gas supplies is $3.5mmBTU as compared to LNG price of $18mmBTU. This will considerably increase gas prices in the domestic markets. Moreover, a study was conducted by Port Qasim Authority which termed the construction of any LNG terminal a security risk. They said that even if government went ahead with its plans the international shippers would not enter the channel, as it was against the international standards.

Pakistan is pressing ahead with importing LNG from Qatar on government-to-government basis despite Doha's offered volumes being lower and price higher than those in the LNG tender recently scrapped by the Economic Co-ordination Committee (ECC). The ECC, sources said, has directed the Petroleum Ministry to negotiate import of 500 mmcfd LNG from Qatar, which official sources is within the realm of impossibility as Qatar is unable to offer more than 300 mmcfd LNG to Pakistan.

In March 2013, Qatar offered to provide 250mmcfd to Pakistan at $17.437/mmbtu. But this offer did not include the cost of infrastructure necessary to receive and relay LNG in Pakistan. With the infrastructure cost of at least $200 million factored in, Qatar LNG works out at $19.521/mmbtu. In comparison, the lowest-evaluated bidder in the just-scrapped LNG tender - the third in Pakistan - offered 400mmscfd of LNG at an all-inclusive price of $17.7074/mmbtu.

Dr. Asim Hussain, petroleum minister in the former government, had signed a Memorandum of Understanding (MoU) between Pakistan and Qatar on February 6, 2012, for 350mmcfd of LNG. In addition to the Qatar option, the new government is also considering importing LNG from India. The plan envisions using Indian LNG terminals in Gujarat and bringing the gas not to Sindh, which is adjacent to Gujarat state, but directly to the Punjab.

The Indians have offered a price of $22/mmbtu, which is the most expensive offer so far received. Pakistan wants India to waive off taxes to make the product more affordable. These discussions are ongoing and the process is allegedly being championed by a powerful businessman. The LNG tender which was scrapped was overseen by London-based QED Consulting at the recommendation of USAID. Three parties put in their bids: Engro, Pakistan Gasport, and Global Energy of Turkey.

Lighting up Pakistan’s future

Pakistan is in the grip of a serious energy crisis that is affecting all sectors of the economy and the various segments of the society. There are no overnight solutions to end the present crises and require serious commitment and long-term planning. Similarly, addition of new large power plants, though critical for the sustainability and meeting the gap between supply and demand, requires considerable lead times. Under such conditions, importing electricity from neighboring countries like India and Iran can help alleviate the electricity shortages in a relatively shorter time. However, it would still be preferable to capitalize on internal resources to attain self-sufficiency.

All-out efforts are required to set up imported and indigenous coal based projects. The country

needs large coal based power plants to run as base load plants as a substitute for gas and oil based plants. Similar efforts are required for the development of small and large hydropower plants. To complement these efforts, wind power should also be vigorously pursued. The huge potential of solar energy must also be harnessed. Although, set up cost of solar power is currently high relative to wind, technologies are rapidly evolving accompanied by mass production which is expected to reduce the cost of solar power plants.

Furthermore, the reform process of the energy sector, as initiated by the govt., must continue with long-term objectives of deregulation and privatization of entities.

Further, the GOP may need to revise upward its applicable tariffs in order to minimize the gap between NEPRA determined tariff and GOP applicable tariff. Allocation of gas should be made only based on efficiency of the generation facilities. Instead of allocating gas to small generation facilities, which are evidently inefficient, gas preferably be diverted to bigger and new IPPs. Originally, a number of combined cycle IPPs which were inducted in the system to operate on gas, have been compelled to operate on more expensive fuel oil due to gas supply shortfall.

Public Private Partnership Model

Public Private Partnership can be utilized as potential catalyst for the uplift of the economy. Ingenious public private partnership models can be designed and developed through which more electricity could be generated efficiently while the burden and risk is shared by both the government and the private sector.

In order to develop renewable energy, the government has taken several steps like doing away with duties on imports of solar and wind panels for electricity generation. It can be more beneficial and advantageous for the consumers and authorities if the burden is shared amongst the stakeholders. An effective model can be devised through which government and the consumers may share the load of procuring the solar panels; with government bearing a portion of the cost with the consumers to procure the solar panels and related equipment. It can also lease the equipment out or sell it to the consumer on agreed installments and when the installments are matured, consumers can reap the benefit of low cost electricity generation through solar power either for their own consumption or by selling the energy to the government to add it to the national grid or sell it on private basis based on agreed terms with the concerned authorities. In many parts of the world this model has been implemented and encouraging paybacks have been reaped out of it. This would encourage the local consumers to buy the solar equipment and at the same time would contribute in somewhat minimizing the load of electricity demand. In federal budget of 2013-14, the government has allocated Rs 115 billion in PSDP (Public Sector Development Programme) for new development initiatives; it

would be fruitful if it could come up with such out-of-the-box projects to curb the obstacles of energy crisis in Pakistan.

What is required on grass root level?

As the situation stands today, there are hardly any immediate solutions to resolve the issue. The reasons behind energy crisis are poor management, lopsided priorities and lack of accountability on part of those who stay at the helm of affairs. We must try our best to adopt energy conservation as individual and at national level. A change of attitude and a change of life style is needed at the national level which should be triggered by the ruling elite and followed by all segments of the society that have access to electricity. At best there could be some short and long-term solutions to the crisis but they need immediate planning and execution with an enormous investment. Two key elements of a possible solution are: change of attitude and change in lifestyles.

A multi-pronged strategy is the need of the day

Pakistan has the all the resources, skills and expertise to overcome the energy crises but what is missing is the concerted efforts, proper plans of action and strategies. The country has many alternatives available which can be utilized to deal with the energy shortfall particularly that of electricity. After analyzing different alternatives, we have come up with a conclusion that a multi-pronged strategy is required and several projects should be taken simultaneously.

Other than already implemented and the on-going energy plans like setting up power plants to generate electricity from Thar Coal, mega Dam Projects like Diamer Bhasha, Neelum Jhelhum etc. there can be many other alternatives which are cost effective and relative simpler and easier to establish. We have highlighted selective viable options below:

- Allocation of gas should be made only based on efficiency of the generation facilities instead of allocating gas to small generation facilities, which are evidently inefficient. A number of IPPs which were inducted in the system to operate on gas, were required to operate on expensive fuels which increases the cost of electricity to the public.

- Country receives sufficient solar energy; therefore, several small and medium scale solar power plants could be set up privately or through public private partnership.

- Concept of community based power management can be introduced where several colonies can be supervised or trained to setup power plants for their own areas and manage it in entirety. It would not only minimize the load shedding in the respective area but would also resolve the issue of theft and line losses due to local management while making cheap electricity source available in the locality.

- A large number of small-scale, totally or partially indigenous hydel power plants can be set up on small streams, canals and rivers to supply electricity in the adjacent areas at low cost and relatively short time period as compared to the mega projects which require huge amount of money and takes several years to come online.

- Pakistan is blessed with a wide coastal belt which is a good source of tidal and wind energy that can be efficiently utilized by setting up many small clustered or scattered wind power plants which could be combined with tidal power plants to make more viable hybrid power plants on the coastal area.

- Far flung villages usually have dispersed dwellings where people live in small clusters mainly associated with agriculture business. To meet their energy requirement, it becomes costly to connect them with the national grid. Such places usually have abundant supply of biomass energy source in the form of dung, bagasse, plant waste etc. which could be converted to electricity by setting up small scale power plants running on such renewable energy sources. The government can provide them with the requisite technical and financial assistance to become self-sufficient in their energy requirements at much affordable electricity costs.

- Replacing/supplementing existing source of power (grid electricity) for driving tube wells with renewable energy resources (solar and wind) can be a viable option. Sun is available for 300 days a year with 6-8 hours effective time in most parts of Pakistan. Similarly considerable potential of wind energy is also identified in isolated corridors. Both Solar Photo-Voltaic and Wind technologies can be used for this application.

- The concept of introducing municipal bonds to raise capital to set up power plants by the local towns and districts can be employed. The generation of funds through municipal would result in execution of projects without burdening the national kitty to the extent of the amount raised from investors and people would get uninterrupted power supply and at the same time it would still be managed and controlled by the government bodies.

- Municipal waste is available in bulk quantities in urban areas like Karachi which is largely remains unmanaged. It can be utilized as an abundant source of electricity generation while improving the health conditions of the area. Special plans can be formulated to encourage the people to segregate plastic, food waste and other non-food waste which could be easily shifted to recycling, compost preparing units and power plants respectively thereby, conserving this massive resource to the greater benefit of the

public.

- Another convenient source of power that could be converted to electricity is the traffic or locomotives that run on the roads. Special equipment like specially designed speed breakers fitted with rotors or hydraulics and connected with electricity generator(s) and battery storage(s) can be used to supply electricity to the traffic signals which would ensure continuous power supply to traffic signals at least on the busy roads in cost efficient manner.

- Several new energy conservations plans could be launched which may include the following:

    - Setting solar lights in the lanes, streets, parks and other public places;
    - Placing small turbines below the overhead water bodies / tanks through which water is distributed and this energy could be reused to run the associated motors and machines;
    - Replacement of conventional gas geysers with automated electronic gas geysers at homes would save this scarce resource. These automatic gas geysers use gas only while the warm water is being used, thus, more gas available for better and productive use.
    - Heliostats could be introduced and used to direct day light to areas which remain dark and require lights during the day also. Such heliostats could be supplemented with a solar panel to generate electricity.

Thus, there can various other innovative techniques with which the energy crises could not only be managed but also made cost effective. In this regard, the services of qualified engineers and even engineering students from local universities could be availed to prepare and submit viable and innovative solutions for power generation and conservation. The successful projects could be provided with financial, operational and technical assistance by government agencies to implement such projects.

The Karachi Chamber of Commerce and Industry will continue to strive for improving the standards of living of the public, bringing economic prosperity, safeguarding the rights of business community particularly in Karachi and contributing towards making a better Pakistan.

KCCI R&D CELL

Contributing to economic prosperity

KCCI R&D Cell – Contributing to economic prosperity

The Research & Development Cell at Karachi Chamber of Commerce and Industry is proactively striving to provide valuable economic, financial and trade information and insight to the esteemed members, office bearers and staff of KCCI, government policy makers and other stake holders. The fast pace of globalization and high growth of international trade has made it imperative that governments, commercial attaches, international trade development bodies and business delegations frequently interact with each other. The Research & Development Cell strives to keep members and office bearers of KCCI abreast of latest developments at the international level while also advising the government on trade enhancement and foreign investment facilitation. In this context, research products have been developed by the Research & Development Cell seeking to provide analyses and information which aid in fruitful discussion and negotiations with foreign delegates and visitors. A brief description of the products offered by Research & Development Cell is listed below:

KCCI E-Bulletin

A daily product of the R&D Cell, the KCCI E-Bulletin is based on news flows covering news-flows of the domestic and global economy. Additionally, the E-Bulletin covers latest updates on commodity and currency prices, economic indicators, graphical presentation of data and motivational quotes.

Contributions to Economic Horizon magazine

Regular contribution to KCCI's flagship Economic Horizon magazine is another important product of the Research & Development Cell. The department provides quality articles and selected quantitative information covering a vast range of important topics for the magazine. Analysis of issues affecting the ongoing economic activities of the country with implications on the trade and industrial sectors of the economy is also included.

KCCI Country Wrap

The Research & Development Cell prepares a report titled "KCCI Country Wrap". The report covers a brief overview of the specific country and its trade relations with Pakistan. It includes snapshot of the economic and trade data of the country in relation to Pakistan. The idea behind this product is to update members on enhancing trade potential with different countries.

Reports on Federal Budget 2013-14

The Research & Development Cell produced three reports on the Federal Budget 2013-14. The reports include: i) A pre-budget report which sought to predict the proposals to be contained within the Finance Bill 2013, ii) A post-budget summary which outlined the budget proposals actually presented by the Finance Minister in the National Assembly and were part of the Finance Bill 2013 and iii) Highlights of the revised Finance Bill 2013 as expected to be approved by the Parliament after debate on the budget was winded up.

Infonalysis– a topic based research product

Recently, a new product has been introduced, titled "Infonalysis", which incorporates research on specific topics in a detailed report form. The product aims to apprise the readers with in-depth knowledge on various domains like economy, sectors (manufacturing, SMEs), industries (leather, textile etc.) and commodities (energy, sugar etc.).

KCCI Research & Development Cell – Creating new horizons

KCCI's Research & Development Cell was revamped and redefined during the year 2012-13, under the able leadership of Mr. Siraj Kassam Teli, Chairman Businessmen Group (BMG) and Former President KCCI whose dynamic guidance turned this vision into a reality.

The Research & Development Cell is managed by the Director Research, Ms. Uzma Taslim. Mr. Shehzad Mubashsher, Deputy Director Research, Mr. Bilal Ahmed and Ms. Sidra Arshad, both Research Analysts, are working under the Director's guidance.

The scope of the Research & Development Cell is very wide in terms of its working parameters. The department provides its analytical views and research products on not only Pakistan's economy but also on the global economy so that the office bearers and members of KCCI could be facilitated with timely and in depth analysis with respect to trade and commerce. It also readily makes available statistical data and analyses on the economic indicators of Pakistan and other countries. The Research & Development Cell also conducts analysis of policies and procedures proposed or adopted by the government, economic and trade bodies / associations, government and quasi- government institutions / organizations and then present views over their probable impact on the traders, investors and the business community in Pakistan, particularly in Karachi. As a case in example, the Research & Development Cell produced three analytical reports on the Federal Budget 2013-14 and disseminated them to the members for timely decision making.

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Karachi Chamber of Commerce & Industry

The gateway to economic prosperity...

Our Vision

To be recognized as the leading voice of the Karachi business community.

Our Mission

To advance human progress through an economic, political and social system based on individual freedom, incentive, initiative, opportunity, and responsibility.

Address:

Aiwan-e-Tijarat Road,
Off: Shahrah-e-Liaquat,
Karachi-74000

Phone: 92-21-99218001-09 Ext.:136
Fax: 92-21-99218040
E-mail: info@kcci.com.pk, res@kcci.com.pk
Website: www.kcci.com.pk