Business Project # 1

Analyzing Pakistan Electricity Generation Options

Class: EMBA-2K12

Submitted by: Muhammad Armughan Tufail

Roll No: NUST201260019MNBS75112F

Table of Contents

Introduction

The power sector in Pakistan is a mix of Hydel, Thermal, Nuclear and Solar units dominated by two vertically integrated public sector utilities that are Water and Power Development Authority (WAPDA) for all of Pakistan except Karachi, and the Karachi Electric Supply Corporation (KESC) for the City of Karachi and its surrounding areas. There are a number of independent power producers that contributes significantly in electricity generation in Pakistan. For years, the matter of balancing Pakistan's supply against the demand for electricity has remained a largely unresolved matter. Pakistan faces a significant challenge in revamping its network responsible for the supply of electricity. Due to an unrealistic power tariff, high inefficiencies, low payment recovery , high prices of fuel and the inability of the government to manage its subsidies mechanism that lead to a serious “circular debt” issue which is becoming a barrier for future energy sector investment. The economy is badly affected by electricity crisis with loss of huge capital. The solution to the current crisis lies in energy conservation at all level in the country. The use of alternate energy such as wind and solar power could be utilized to immediately reduce the shortages, while electricity projects from coal, baggase and large dam could provide a long-term solution to the electricity shortage. However Iran, India, Tajikistan and Kyrgyzstan have been offering to export electricity to Pakistan. The business project analyses the current electricity generation status in Pakistan and then suggest its recommendations in tackling the electricity shortage in Pakistan.

Background

Electricity is considered to be life line of any economy and most vital instrument of socioeconomic development of a country. Electricity is pivotal in running machinery in factories

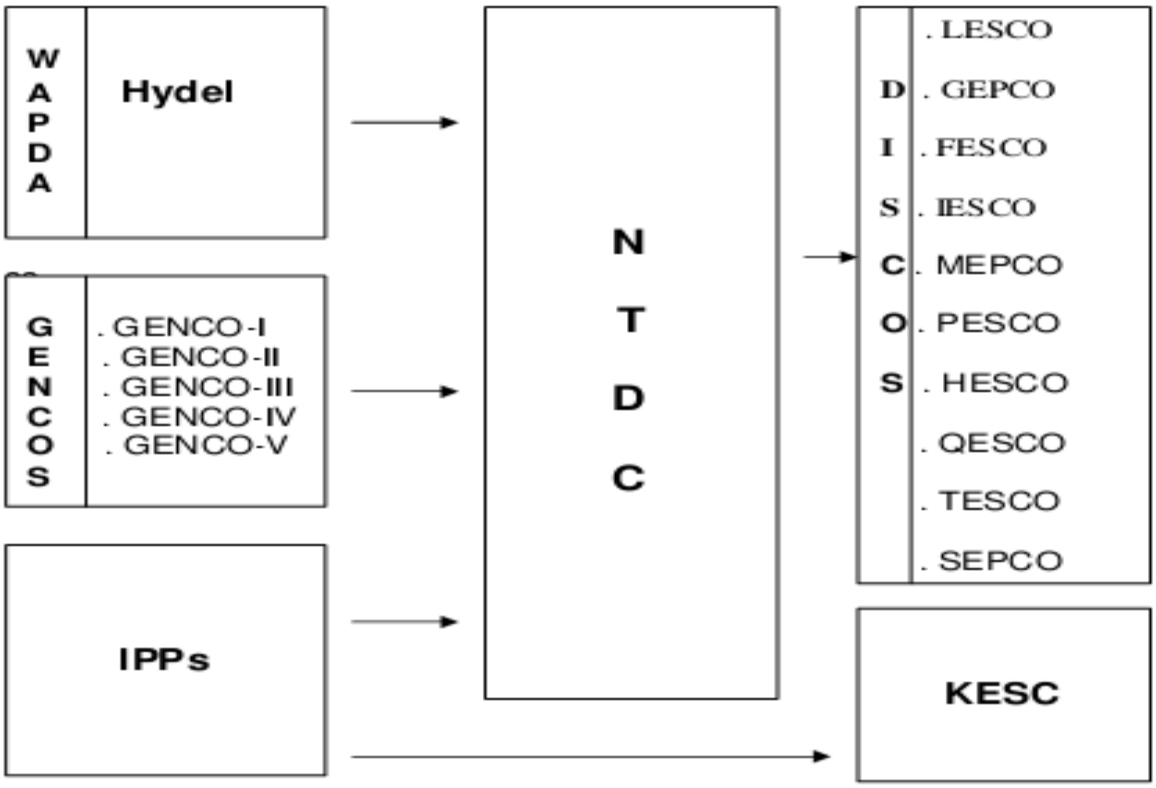
and industrial units, for lighting our cities and powering our vehicles. The challenge of ensuring electricity access for industries and providing increased access to the poor parts of the population is the key issue for any government. Pakistan's energy infrastructure is not well developed, rather it is considered to be underdeveloped and poorly managed. Currently thecountry is facing severe energy crisis. Despite of strong economic growth and rising energy demand during past decade, no serious efforts have been made to install new capacity of generation. Moreover, rapid demand growth, transmission losses due to outdated infrastructure, power theft, and seasonal reductions in the availability of hydropower have worsened the situation. Consequently, the demand exceeds supply and hence load-shedding is a common phenomenon through power

Shut down.

Pakistan Electricity Sector Structure:

The Power sector was restructured in 1998 with the creation of PEPCO (Pakistan Electric Power Company. Prior to 1998, there were two vertically integrated utilities, i.e, KESC, which served the Karachi area and WAPDA which served the rest of the country. Later on, WAPDA's power wing has been structured into distinct corporate entities comprising of 4 GENCOs, 10 DISCOs and one TransCO (NTDC).

These 10 DISCOs are responsible for distribution to the end users. KESC meet its overall demand with its own generation plus purchase from NTDC, IPPs and from Karachi Nuclear Power Plant. The Current structure of the power sector is shown below.



Sources of Electricity in Pakistan:

Electric power in Pakistan comes from a variety of sources which are as follows

Thermal:

At present, thermal power generation stood at 8,300MW but these plants have low conversion efficiencies and are expensive to maintain and operate. Most of the thermal power plants installed by IPPs, use furnace oil which has become very expensive over the recent past. The furnace oil has to be imported and consumes our foreign reserves. Some of these plants can also use natural gas as fuel but the country has started feeling the pinch of short supplies of gas as well.

Hydro Power :

Hydro power is generated by using electricity generators to extract energy from moving water. Pakistan is having rich resource of energy in hydel power, however, only 34 % of total electricity generation is coming from hydro power. Currently we are having 6555 MW against the potential of 41000 to 45000 MW.

Thermal:

At present, thermal power generation stood at 8,300MW but these plants have low conversion efficiencies and are expensive to maintain and operate. Most of the thermal power plants installed by IPPs, use furnace oil which has become very expensive over the recent past.The furnace oil has to be imported and consumes our foreign reserves. Some of these plants can also use natural gas as fuel but the country has started feeling the pinch of short supplies of gas as well.

Wind:

Wind power harnesses the power of the wind to propel the blades of wind turbines. These turbines cause the rotation of magnets, which creates electricity.Though Pakistan has potentials of wind energy ranging from 10000 MW to 50000 MW, yet power generation through wind is in initial stages in Pakistan and currently 06 MW has been installed in first phase in Jhampir through a Turkish company and 50 MW will be installed shortly. More wind power plants will be built in Jhampir, Gharo, Keti Bandar and Bin Qasim Karachi

Solar:

Solar power involves using solar cells to convert sunlight into electricity, using sunlight hitting solar thermal panels to convert sunlight to heat water or air. Pakistan has potential of more than

100,000 MW from solar energy. Building of solar power plants is underway in Kashmir, Punjab, Sindh and Balochistan.

However, private vendors are importing panels / solar water heaters for consumption in the market. Alternative Energy Development Board (AEDB) is working for 20,000 solar water heaters in Gilgit Baltistan. Mobile companies have been asked by the government to shift supply of energy to their transmission towers from petroleum to solar energy panels.

Agricultural biomass /Biodiesel:

Biomass production involves using garbage or other renewable resources such as sugarcane, corn or other vegetation to generate electricity. When garbage decomposes, methane is produced and captured in pipes and later burned to produce electricity. Vegetation and wood can be burned directly to generate energy, like fossil fuels, or processed to form alcohols. Brazil has one of the largest renewable energy programs from biomass/biodiesel in the world, followed by USA. AEDB of Pakistan has planned to generate 10 MW of electricity from municipal waste in Karachi followed by similar projects in twenty cities of country.

Nuclear:

Nuclear power stations use nuclear fission reaction to generate energy by the reaction of uranium inside a nuclear reactor. Pakistan has a small nuclear power program, with 425 MW capacity, but there are plans to increase this capacity substantially.

Since Pakistan is outside the Nuclear Non-Proliferation Treaty, it is excluded from trade in nuclear plant or materials, which hinders its development of civil nuclear energy. Remaining

issues in development of nuclear energy are enrichment of uranium from U235 to U238, controlling chain reaction and dumping of solid waste.

Total Install Capacity:

There are four major power producers in the country, which include:

a) Water and Power Development Authority (WAPDA)

b) Karachi Electric Supply Company (KESC)

c) Independent power producers (IPPs)

d) Pakistan Atomic Energy Commission (PAEC).

WAPDA:

In March 2010-11, the electricity generation from hydro has increased by 14.4 percent while thermal decreased by 2.4 percent as compared to the same period last year, Furthermore, the share in total energy generation by hydro generation remained at 36 percent while thermal generation stood at 64 percent during the period under review.

.

Table : Electricity Generation by WAPDA **(GWh)**

Year	Hydro	Share (%)	Thermal	Share (%)	Total
2001-02	19,056	31.3	41,804	68.7	60,860
2002-03	22,350	34.9	41,690	65.1	64,040
2003-04	27,477	39.8	41,617	60.2	69,094
2004-05	25,671	34.9	47,849	65	73,520
2005-06	30,855	37.5	51,370	62.5	82,225
2006-07	31,942	36.4	55,895	63.6	87,837
2007-08	28,667	33.23	57,602	66.77	86,269
2008-09	27,763	32.90	56,614	67.10	84,377
2009-10	28,492	31.90	60,746	68.10	89,238
July-March					
2009-10	21,072	32.45	43,862	67.55	64,935
2010-11	24,105	36.02	42,823	63.90	66,928

Total generation includes purchase from IPPs and imports

Source PEPCO, NTDC

KESC thermal power capacity:

Thermal Power Station Korangi 316MW, Gas Turbine Power Station Korangi 80MW, Gas

Turbine Power Station SITE 100MW, Thermal Power Station Bin Qasim 1260MW. KESC's total installed capacity: 1,756MW.

IPPs thermal power capacity:

The capacity of IPP's thermal power plant is as follows:

Hub Power Project 1,292 MW, AES Lalpir Ltd Mahmood Kot Muzaffargarh 362 MW, AES Pak Gen Mahmood Kot Muzaffargarh 365 MW, Altern Energy Ltd Attock 29 MW, Fauji KabirWala Power Company Khanewal 157 MW, Gul Ahmad Energy Ltd Korangi 136 MW, Habibullah Coastal Power Ltd 140 MW, Japan Power Generation Lahore 120 MW, Kohinoor Energy Ltd Lahore 131 MW, Liberty Power Limited Ghotki 232 MW, Rousch Power Khanewal 412 MW, Saba Power Company Sheikhupura 114 MW, Southern Electric Power Company Ltd Raiwind 135 MW, Tapal Energy Limited Karachi 126 MW, Uch Power Ltd Dera Murad Jamali Nasirabad 586 MW, Attock Gen Ltd Morgah Rawalpindi165 MW, Atlas Power Sheikhupura 225 MW, Engro Energy Ltd Karachi 217 MW, Kot Addu Power Company Limited 1,638 MW. IPPs' total installed capacity: 6,365MW.

PAEC's nuclear power capacity:

KANUPP 137 MW, CHASNUPP-1 325 M , CHASNUPP-2 325 MW. PAEC's total capacity is 787 MW.

Electricity Consumption:

Annual Electricity Consumption

During the period 2001-02 to 2009-10, the consumption of electricity has increased at an average of 4.9 percent per annum while in July-March 2010-11, electricity consumption has increased by 2.8 percent.

Fiscal Year	Consumption (GWh)	Change (%)
2001-02	50,622	4.2
2002-03	52,656	4.0
2003-04	57,491	9.2
2004-05	61,327	6.7
2005-06	67,603	10.2
2006-07	72,712	7.6
2007-08	73,400	0.9
2008-09	70,371	-4.1
2009-10	74,348	5.65
Avg.9 years		4.9
July-March		
2009-10	54,653	-
2010-11	56,194	2.8

Source: Hydrocarbon Development Institute of Pakistan

Sectoral Consumption of Electricity:

Table : Consumption of electricity by Sectors

Year	House hold		Commercial		Industrial		Agriculture		Street Light		Other Govt.		Total
	GWh	Change (%)	GWh (000)	Change (%)	GWh (000)	Change (%)	GWh (000)	Change (%)	GWh	Change (%)	GWh (000)	Change (%)	
2001-02	23.2	1.8	3	7.1	15.1	5.6	5.6	14.3	212	-0.5	3.5	0	50,622
2002-03	23.7	2.2	3.2	6.7	16.2	7.3	6	7.1	244	15.1	3.4	-2.9	52,656
2003-04	25.8	8.9	3.7	15.6	17.4	7.4	6.7	11.7	262	7.4	3.7	8.8	57,491
2004-05	27.6	7.0	4.1	10.8	18.6	6.9	7	4.5	305	16.4	3.8	2.7	61,327
2005-06	30.7	11.2	4.7	14.6	19.8	6.5	7.9	12.9	353	15.7	4	5.3	67,603
2006-07	33.3	8.5	5.4	14.9	21.1	6.6	8.2	3.8	387	9.6	4.4	10.0	72,712
2007-08	33.7	1.2	5.6	3.7	20.7	-1.9	8.5	3.7	415	7.2	4.5	2.3	73,400
2008-09	32.3	-4.2	5.3	-6.2	19.3	-6.6	8.8	3.5	430	3.6	4.3	-5.0	70,371
2009-10	34.2	5.9	5.6	5.7	19.8	2.6	9.7	10.2	548	6.51	4.5	4.7	74,348
July-March													
2009-10	24.9	-	4.1	-	14.7	-	7.2	-	364	-	3.3	-	54,653
2010-11	25.8	3.8	4.2	1.9	15.8	7.3	6.6	-9.0	321	-11.8	3.5	4.1	56,194

Source: Hydrocarbon Development Institute of Pakistan

The role of Independent Power Producers (IPPs)

The IPP is an entity, which is not a public utility, but that owns facilities to generate electric power for sale to utilities end users. In Pakistan, private power producers control about 30 percent of the total generation capacity, the electricity market was opened to IPPs in 1990. Subsequently, 15 IPPs achieved commercial operations under Pakistan's first power policy 1994.

For several years afterwards, the IPP program remained stagnant, only to be revived as a huge power shortage hit the country in 2006-07. In a regional context, Pakistan offers a relatively sophisticated operational and regulatory framework for the IPPs.

Independent Power producers contribute significantly in electricity generation in Pakistan but unfortunately, IPPs are producing below capacity as a result of working capital shortage caused due to outstanding amount of receivables from PEPCO.

Contractual framework of IPPs:

Like most other countries, here, IPPs face single buyer market. Water and Power Development Authority is the key buyer of IPP power. IPPs negotiate a tariff with the regulatory authority, NEPRA, under a transparent competitive bidding process. Investors are generally insulated from underlying economic risks through tightly written, long-term PPAs with underlying take-or-pay contracts, supported by explicit government guarantees and credit enhancements.

The fundamental principle underlying the contractual framework is to limit, as far as possible, the risks borne by the Project Company. A fundamental assumption is that all parties abide by the terms of their contracts.

List of IPPs:

- Atlas Power Limited
- Attock Gen Limited
- Bestway Power Limited
- Blue Star Energy
- Cavlalier Energy Corporation (Pvt.) Limited (CECPL)
- Dawood Power (Pvt.) Ltd. (DPPL)
- Eastern Power Company Ltd. (EPCO)
- Engro Powergen Qadirpur Ltd. (EPQL)
- Foundation Power Company (Daharki) Limited
- Gujranwala Energy Ltd (GEL.)
- Grange Power Limited (GPL)
- Green Electric (Pvt.) Limited (GPL)
- Green Power (Pvt.) Ltd.
- Halmore Power Generation Company (Pvt.) Limited (HPGCL)
- Hub Power Company Ltd. (HUBCO)
- JDW Power (Pvt.) Ltd. (JDW)
- Japan Power Generation Ltd. (JPGL)
- Kohinoor Energy Limited (KEL)
- Laraib Energy Limited (LEL)
- Liberty Power Tech Ltd. (LPTL)
- Milergo Pakistan Ltd. (MPL)

- Nishat Chunian Power Limited (NCPL)
- Nishat Power Limited (NPL)
- Orient Power Company (Pvt.) Limited (OPCL)
- Pakistan Suger Mills Association
- UCH-II Power (Pvt.) Ltd
- Warda Power Generation (Pvt) Ltd

Risks faced by IPPs:

The risks faced by IPPs are:

a) **Economic Risk:**

Any change in exchange rates, inflation or costs of finance are considered economic risk factor.

b) **Market Risk:**

As per the PPA, IPP can sell power only to one single customer, WAPDA. This contractual arrangement exposes IPPs to the single customer risk. While the Government has given a guarantee to compensate the IPPs for WAPDA's defaults on its contractual payments, the recent IPP crises has shown that Government is not willing to honour such guarantees on the plea that WAPDA could not afford to pay the exorbitant IPP dues.

c) **Political Risk:**

This largely refers to the government guarantees to IPPs through the Implementation Agreement. Foreign investors were reluctant to invest due to wars, nationalizations and prolonged military rule.

d) **Completion and Cost Overrun Risk:**

The greatest period of risk in a power plant project occurs during the construction phase with the financial providers putting up most of the capital before construction starts and supporting this exposure till the plants is complete.

e) **Performance Risk:**

The IPP should ensure that its Power Plant generates electricity according to technical specifications and deliver the required power to WAPDA. This risk is borne by the Project Company and the lenders financing the project. To ensure performance, the company incurs maintenance expenses which are passed through in the tariff.

SOLUTIONS TO END ELECTRICITY SHORTAGE AND CHEAP ELECTRICITY GENERATION

In view of existing ground realities, it is impossible to overcome the crises by short measures, however, we implement short term measures to reduce the crises. In order to address this crises a two dimensional implementation measures are required. These are:

a) Short term measures

b) Long term measures

Short term measures:

The following short term measures can be taken immediately in order to reduce the intensity of existing power crises:

- With power needed immediately, wind turbines look suitable because they are relatively fast to install whereas dams and nuclear plants take five to six years to complete and thermal power plants need two years at least. Wind power can play a big part of solving Pakistan's energy shortages, and now that comprehensive wind maps already been researched in the country.

- Government authorities should ensure overhauling all of the countries existing power plants to achieve maximum generation as well as prevent it from overloading which has been a source of power outages.

- The private sector should be allowed to set up power plants with their own equity and loans based on project feasibility with the government's role limited to determining a fair price of power through an independent commission of representatives of the government, citizens, industry, power producers and experts by consensus.

- There are some non-operating power stations in the country which only require a little investment and technical improvements to revive them. Such power units should be made effective to pull the economy out of complete doom. Resultantly, these projects will maintain the smooth flow of energy and will at least prevent any further widening in the demand-supply gap.

Long term measures:

The following long term measures should be taken keeping in view the projected increase in power consumption in the future.

- Pakistan has estimated as the world's third-largest known coal reserves of 33.0 trillion tons in the south-eastern part of the country i.e. Thar. The answer to long term solution of power crisis in Pakistan lies in using local coal for power generation. The electricity production from coal is also cheaper than thermal generation as 2 percent usage of Thar coal could produce 20,000 Megawatts electricity.

- In the long-term, Pakistan should also build more nuclear plants and dams. Government could benefit from the technical expertise of the Norwegian and Chinese companies in the field of dam construction and producing hydro electricity. Construction of new water reservoirs and dams assumes additional significance to overcome the rising water shortages problem.

- Rehabilitation and replacement of the outdated transmission and distribution systems is also a long term measure through which the country can overcome the perennial problem of line losses and thefts by unscrupulous consumers.

- Power generation by natural gas is about Rs6 KWh as compared to Rs14.5 KWh by furnace oil. In the last five years natural gas allocation for power has been reduced from 53 per cent to 27 per cent and furnace oil use in power generation has increased from 17 per cent to 38 per cent. This has increased the cost of generation by Rs130bn in 2010, raising circular debt leading to higher power rates. The power crisis can be alleviated by reallocating gas towards power production as power production must take precedence over other sectors.

- Most important in the long term planning and goals must be to streamline the foreign policy of the country according to its economic and energy needs. Improving and increasing ties with future energy rich countries must not be neglected.

- The markets and shopping centers should be strictly enforced to close their business till 10 pm at night. This save power in different parts of each city can be diverted towards the domestic consumers by means of an effective administrative local system.

- The theft of electricity must be considered and declared a heinous crime and any violations by domestic or industrial users should be liable to legal penalties and complete power cut off for such consumers.

- Educating the stakeholders and workers in the industrial and agricultural sectors on adoption of new and efficient practices of water and energy consumption will tend to reduce the wastage of energy.

Purchasing Cheap Electricity from other Countries

Pakistan-China electricity agreement:

To overcome the acute power crisis in Pakistan, the first Pakistan-China Joint Energy Working Group (JEWG) meeting was held in 2011.Given the significance of renewable energy, China tries to dominate the renewable energy technologies from solar panels to wind turbines to constructing huge hydro-projects. Pakistan has considerable renewable energy potential such as hydro, wind and solar but this resource potential has not been utilized fully due to resource constraints and politicization of projects of national interests such as Kalabagh Dam that depicts the real picture of political uncertainties in Pakistan.

Due consideration is being given to hydropower plants that produce about 24 percent of the world's electricity and supply more than one billion people with power. Indus River system alone has 35,000 MW power potential. The prospects for Pak-China cooperation in hydro-power projects are bright as the Chairman of China Three Gorges Project Corporation (CTGPC) a state owned enterprise and China's largest hydropower developer had already offered financial and technical assistance to develop hydro and wind power projects in Pakistan.

These ongoing projects include Karot, Taunsa, Kohala and Bunji hydro-power projects. Bunji dam will be constructed some 83km from Gilgit on Skardu Road. After completion it will generate 7200 MW electricity. The government of Pakistan has signed an agreement with China for the construction of the dam in 2009.

Second important project has been Taunsa hydroelectric project in Punjab that will generate 120MW electricity. Another proposed project is Kohala hydro-power project in district Muzaffarabad that will have capability to generate 1100 MW electricity. Karot hydro-power project that will generate 720MW electricity will be completed in four years time. In addition to above mentioned hydro projects deliberations have been continued on some other hydro projects. Pakistan has been currently facing 6,000 megawatts power deficit which may grow further but the investment in hydro-power projects could add 10,000 MW to Pakistan's main grid over the next 10 years. China has developed expertise in coal energy and nearly 80 % of its electricity comes from coal. India is generating 75 percent of its electricity by using coal while Pakistan is generating 0.3 percent electricity from coal. Pakistan is among some of the states having large coal reserves in the world and has potential to generate electricity from coal. Pakistan has potential to develop wind power. The wind corridor in the coastal area of Sindh has the capacity to generate 50,000MW electricity. India presents a good example of a country that is utilizing

wind energy and has added its electricity generation capacity. China has become the world's largest maker of wind turbines. China has offered help in the construction of 50 MW wind power project in Jhampir (Sindh) that is to be completed in 2012. Moreover, China has planned to invest in 300 MW solar power projects in Pakistan.

Pakistan-Iran electricity agreement:

Iran is currently exchanging electricity with Afghanistan, Armenia, Azerbaijan, Iraq, Pakistan, Turkey and Turkmenistan. According to the Iranian Energy Ministry statistics, the country will be exporting up to USD 1 billion of electricity by March 2012. Iran's total power generation capacity stands at 63,403 MW while total length of the power grid exceeds 780,000 km.

Import of 35 MW from Iran will be enhanced later to 70 MW, while all the matters of 100 MW import project have been finalized and are ready for groundbreaking. Pakistan and Iran would move forward on import of 1,000 MW power project from Iran.

Iran wants to install 1400 MW power project in Zahidan near Pakistan border from where the electricity to be transmitted to national grid of Pakistan, not on the basis of local Iranian oil price but on international fuel cost price.

With a view to importing the 1000 MW of electricity, 7500 kilometers long 500 KV transmission line is needed to be laid down. On behalf of Pakistan, NesPAK (National Engineering Services Pakistan) and from Iran SUNIR are appointed as consultants to make the feasibility for laying down the said transmission line to materialize the project.

Iran is rich in electricity in other parts of the country and if the electricity is importing from other parts of Iran which is far away from area bordering Pakistan, the line losses would increase

manifold and the rate of the electricity would also be unaffordable. So Iran needs to install the power plant near Pakistan border to materialize the project to import 1000 MW of electricity.

Pakistan-Tajikistan electricity agreement:

Central Asia South Asia (CASA-1000) is one of the biggest regional projects through which Tajikistan would export up to 1000 MW of electricity to Pakistan. The project is a regional effort to construct high voltage electricity transmission lines for electricity exports from Kyrgyzstan and Tajikistan to Pakistan via Afghanistan.

Tajik plans to sell electricity to Pakistan from Roghun hydroelectric dam, which has faced decades of delay. The dam is being built on the Amu Darya River, which also runs through Uzbekistan and benefits Turkmenistan. The project will provide cheapest power that costs around five cents per unit. It envisages a 750-kilometre long High Voltage Direct Current (HVDC) power line to Pakistan through Afghanistan.

In the years ahead, Kyrgyzstan will use the transmission line to sell 300MW to Pakistan and Afghanistan. It is for this reason that Pakistan, Afghanistan, the Kyrgyz Republic and Tajikistan have agreed to set up a special purpose vehicle to lay the line through Sangtuda (Tajikistan), Kabul (Afghanistan) and Peshawar (Pakistan).

Power agreements with other countries:

Bilateral relations with Russia, Central Asian, East African states needs to be strengthened. These countries are the new energy hubs of the world, and being mostly land locked (Central Asian States) can make use of Gwadar port and in return assist Pakistan as well.

References:

1. An overview of electricity sector in Pakistan by Islamabad Chambers of Commerce
2. Hydrocarbon Development Institute of Pakistan, “Pakistan Energy Yearbook 2010”.
3. Http://www.pepco.gov.pk/pow_situation.php
4. Http://wapda.gov.pk/htmls/future-index.html
5. Http://www.adb.org/publications
6. Http://www.ntdc.com.pk/WapdaPowerHistory.php