RUTGERS BUSINESS SCHOOL – NEWARK & NEW BRUNSWICK

Pakistan Energy Crisis – Breaking the Vicious Cycle¹

"Pakistan has one of world's biggest untapped coal reserves, ..., Pakistan to tap coal riches to avert energy crisis." – Reuters, April 13, 2012

1. STARTING STORY

Ali is a plant manager in a large textile firm in Lahore, Punjab province, Pakistan. The textile industry, the back bone of Pakistan's economy, had a total export of 5.2 Billion USD in 2010. Ali was educated as a textile engineer and has ten years of industrial experience. Till 2007, Ali was very satisfied with his career and the industrial growth in the textile sector. But now things have changed drastically – the textile industry is facing severe problems due to the power shortages. There are 8-12 hours of electricity load shedding on a daily basis in major cities and industrial sectors of the county. The textile industry is unable to meet the export targets as the daily production is disrupted by long hours of electricity shortage. About 28 million people (38% of the total labor force) associated with the textile sector are facing unemployment due to the power outrage. [1]

The overall economic condition of the country is even worse and it is becoming increasingly difficult for Ali to cover the expenses of his family of two children. Even with 8-12 hours of electricity load shedding, the electricity bill has risen to 25% of his monthly salary. The inflation rate has risen to 17% (2010 est.) and the prices for food items have increased by 33% over a period of two years. Official figures indicate that there is a 20% increase in crime rate due to the increase in unemployment (15% in 2010, est.). [2]

"Is it better to leave the country as everything seems to be in a mess?" Ali says. "There is no job security even in one of the key industrial sectors of the country; expenses are too high and standard of living is deteriorating every day. I see neither a promising career for myself nor a bright future for my family in this country," he laments.

2. ECONOMIC BACKGROUND

The economy of Pakistan is the 47th largest in the world in nominal terms (GDP-\$174.8 billion-2010) and 27th (GDP \$464 billion-2009) largest in the world in terms of purchasing power parity (PPP). Pakistan has a semi-

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industrialized economy, which mainly encompasses textiles, chemicals, food processing and agriculture industries. Pakistan is classified as a developing country with the sixth largest population in the world and a population growth rate of 1.573% (2011 est.).[2] Pakistan was a very poor country at the time of independence in 1947 and dependent highly on its agricultural sector. Although it has been growing ever since, the Pakistan economy has been characterized as unstable, low growth and very vulnerable to external as well as internal factors. From 2005-2007, there was a steady economic growth at a rate from 6.1%-6.6%. Unfortunately, this unexpected growth was the beginning of an energy crisis era because the government was unprepared for the rising demand of the energy. The result was that in the following years, Pakistan's manufacturing sector faced a double digit cut in its growth rate due to the energy shortage. According to the World Bank, 40% of Pakistan's population is living below the poverty line (2010 est.), and more people were pushed below the poverty line as the unemployment rate jumped up to 15% (2010 est.). The debt of the country have amounted to 58 Billion USD (2010 est.) – about 1/3 of GDP in 2010. [3] Recent population growth rate, unemployment rate and GDP growth rate are listed in the *Exhibit 2.1*.



Exhibit 2.1: Population growth rate, unemployment rate and GDP growth rate in Pakistan

Pakistan's sixty-four years of political history is quite volatile and revolves around Indo-Pak wars and overthrow of the civil governments by the military rule. Factors that adversely affected the economy of Pakistan are the Asian financial crisis and 9/11 military action in Afghanistan, political war between parties, the 2005 earthquake, the floods in 2010-11, and on-going war against terrorism which resulted in 34,000 deaths and damage of USD 60 Billon. The overall economic condition of Pakistan is summarized in *Exhibit 2.2*, page 31.

Major Economic Power Houses

Pakistan has four provinces: Punjab, Sindh, KPK (formerly known as NWFP) and Balochistan, as well as some parts of Kashmir valley. The growth poles of Pakistan's economy are situated along the Indus River, where diversified economies of Sindh and Punjab's urban centers coexist with lesser developed areas.



Exhibit 2.3: Mainstay of Economy by Region



Exhibit 2.4: Industrial, Mining & Power Sectors Map of Pakistan

PUNJAB

Punjab province has 56% of the national population (170 million) and is the hub of the industrial and agriculture sectors. Punjab is the most industrialized province Pakistan; of its manufacturing industries produce textiles, sporting goods, heavy machinery, electrical appliances, surgical instruments, cement, vehicles, auto parts, metals, rickshaws, floor coverings, and processed foods. The major industrial cities are Lahore, Faisalabad, Gujranwala, Gujrat, Sialkot, Sheikhupura province and Multan. The manufactures approximately 90% of the paper and



paper boards, 71% of fertilizers, 69% of sugar and 40% of cement in Pakistan. Punjab contributes about 76% to annual food grain production in the country. Punjab also has more than 68,000 industrial units, including 39,033 small and cottage industrial units, and 14,820 textile units. The cities of Lahore, Faisalabad and Gujranwala have the largest concentration of small light engineering units. Faisalabad has a strong textile industrial base. The textile industry of Faisalabad constitutes more than 20% of the textile export of Pakistan. This makes Faisalabad's share of the total exports from Pakistan more than 15%. The district of Sialkot excels in sporting goods, surgical instruments and cutlery goods. Punjab has always contributed the most to the national economy of Pakistan. Its share of Pakistan's GDP was 59% as of 2010. It is especially dominant in the Service & Agriculture sectors of the Pakistan Economy. With its contribution ranging from 52.1% to 64.5% in the Service Sector and 56.1% to 61.5% in the Agriculture Sector, it is the major manpower contributor because it has the largest pool of professionals and highly skilled (technically trained) manpower in Pakistan. It is also dominant in the Manufacturing sector with historical contributions ranging from a low of 44% to a high of 52.6%. In 2010, Punjab achieved a growth rate of 6% against the total GDP growth of Pakistan at 4.3%.[4]

City	*Distance (Miles)	Population	Energy Gap 2010(MW)	Energy Gap 2015(MW)
Lahore	108	7,129,609	291	1019
Faisalabad	111	2,880,675	87	305
Rawalpindi	53	1,991,656	64	224
Multan	180	1,606,481	46	163
Gujranwala	48	1,569,090	46	163
Sargodha	67	600,501	30	110
Bahawalpur	230	543,929	30	100
Sialkot	74	510,863	30	100
Sheikhupura	64	426,980	28	90
Jhang	0	372,645	25	85

Exhibit 2.5: Major cities in Punjab and their energy gap (*distance from Salt Range - nearest coal fields in Punjab)

SINDH

Sindh has the second highest Human Development Index out of Pakistan's four provinces at 0.628. Main cities are Karachi, Sukkur, Mirpukhas, Nawabshah, Umerkot and Larkana. With an estimated population of 15 million, Karachi is the most populous city in the country. It is Pakistan's premier center of banking, industrial, economic activity and trade. It is the home to Pakistan's largest corporations, including those in textiles, shipping, automotive industry, entertainment, arts, fashion, advertising, publishing, software development and medical research. Karachi is the financial and commercial capital of Pakistan. In line with its status as a major port and the country's largest metropolis, it accounts for a lion's share of Pakistan's economy. Karachi's contribution to



Pakistan's manufacturing sector is approximately 30%. A substantial part of Sindh's gross domestic product (GDP) is attributed to Karachi – the GDP of Sindh as a percentage of Pakistan's total GDP has traditionally hovered around 28%-30%, Karachi's GDP is around 20% of the total GDP of Pakistan. A PricewaterhouseCoopers study released in 2009, which surveyed the 2008 GDP of the top cities in the world, calculated Karachi's GDP (PPP) to be \$78 billion (projected to be \$193 billion in 2025 at a growth rate of 5.5%). Karachi's high GDP is based on its mega-industrial base, with a high dependency on the financial sector. Textiles, cement, steel, heavy machinery, chemicals, food, banking and insurance are also the major segments contributing to Karachi's GDP. In February 2007, the World Bank identified Karachi as the most business-friendly city in Pakistan. Karachi has several large industrial zones. Its primary areas of industry are textiles, pharmaceuticals, steel, and automobiles. In addition, Karachi has a vibrant cottage industry and there is a rapidly flourishing Free Zone with an annual growth rate of nearly 6.5%. [5]

City	*Distance (Miles)	Population	Energy Gap 2010 (MW)	Energy Gap 2015 (MW)
Karachi	55	13,205,339	243	851
Hyderabad	50	1,578,367	30	103
Sukkur	216	493,438	25	100
Larkana	195	456,544	25	97
Nawabshah	108	272,598	20	85
Mirpur Khas	90	242,887	20	80
Jacobabad	243	200,815	17	70
Shikarpur	234	177,682	15	65
Dadu	18	146,179	15	60
Tando Adam	84	145,719	15	55

Exhibit 2.6: Major cities in Sindh and their energy gaps (*distance from Sonda - nearest coal field in Sindh)

3. THE ENERGY CRISIS

Current Status

Pakistan's energy sector is in crisis. Electricity shortages in the summer of 2011 have peaked at approximately 5,500-6,000 megawatts (MW)². Many rural areas have no electricity for up to 20 hours a day. Urban areas are experiencing outages of 10 to 12 hours per day. The growing energy shortages have made life difficult for Pakistanis across the board, stunted economic growth and limited employment opportunities. The scale of the present crisis is formidable and requires persistent structural reforms in the sector by the government, and expanded investments from both the government and the international community.

Previously, electricity demand was growing by 3%-4% annually until 2003-04. The growth rate increased in the subsequent years up to 10% in 2007-08 due to higher economic growth. The growth in demand was predicted 5 years ago³ but was not handled appropriately by planners due to the lack of institutional capacity to undertake effective, integrated planning, policy development, and implementation in the energy sector, as well as insufficient resources. Therefore, the capacity fell significantly behind demand in 2010 which resulted in the current large-scale power outage. The two primary energy ministries (Ministry of Water & Power, Ministry of Petroleum and Natural Resources) are not fully coordinated. For example, despite the fact that insufficient gas is available for electricity generation, subsidized gas continues to be provided to fertilizer companies, and new gas connections are promised in areas not yet connected to piped gas.

The energy shortages not only block the economic growth but also push more of the population into poverty that breeds extremism and violence in society at a time when the country is fighting a war against terrorism. The deterioration in security conditions has compounded the problems in the energy sector. Private investment in the energy sector has dwindled. Public investment has fallen as development spending is substituted by increasing military spending to finance the war against terrorism.

Energy Demand Outlook

The demand growth for energy (electricity) is driven primarily by the economic growth and the population growth. The current energy demand of each province along with the year-wise projected energy demand of the country is shown in Exhibit 3.1. In Exhibit 3.2, we show the relationship between energy shortage (gap) and economic growth in Pakistan.

Province	Population (Millions)	Consumption in 2010 (%)	Demand in 2010 (MW)	Availability in 2010 (MW)	Shortage in 2010 (MW)	Demand in 2015 (MW)
Punjab	95	62	15173	12267	2906	22454
Sindh	51	20	4894	3957	937	7243
NWFP	22.5	11	2692	2176	516	3983
Bolachistan	9	5.3	1297	1048	249	1919

 $^{^{2}}$ The watt is a derived unit of power in the International System of Units (SI). The unit defined as one joule per second, measures the rate of energy conversion. The megawatt is equal to one million (10⁶) watts.

³ Ninth 5-Year Plan, Medium-Term Development Framework, 2005-2010, Part V, Energy Security.

Installed Capacity (MW)	Projected Total Demand		Total Shortage (Energy Gan) (MW)
	YEAR	(MW)	Total Shortage (Energy Gap) (1111)
	2010	26,350	5,428
20 922	2015	36,217	15,295
20,922	2020	54,359	33,437
	2025	80,566	59,644
	2030	113,695	92,773

Exhibit 3.1: Current and Projected Energy Demand



Exhibit 3.2: Energy Gap vs. GDP growth rate (%)

Pakistan Energy Mix

In 2010, Pakistan's electricity generating capacity was 20,922 MW. Pakistan's electricity generation is highly dependent on oil (37.8%) and natural gas (29.4%) and hydro (29.4%). There is only a minor contribution of Nuclear (3.3%) and Coal (0.1%), see *Exhibit 3.3*.



Exhibit 3.3: Pakistan Energy Mix

Pakistan's electricity generation has a growing reliance on gas and imported fuel oil. There is insufficient diversification, as compared to, for example, countries like United States, China and India, which have a much more diversified energy mix relative to Pakistan. Imported energy is in the range of 30% of Pakistan total energy generation and has increased each year for the past 5 years.

The main reason for this increased reliance on imported fuel is the scarcity of the available resources of water and gas. In early 1980s, the energy generation of Pakistan was chiefly dependent on water resources (40-45%). The gradual decline of water bed in Pakistan along with the seasonality factor (the availability of hydro resource varies from 10% to 30% in a year) resulted in a shift from hydro to natural gas. Natural gas resource, found in 1952, was established as a major contributor for electricity ever since. But in recent years, the natural gas resources are depleting and thus cannot meet the increasing demand of the country. For instance, the current capacity utilization of the existing gas-based power generating facilities is about 75%-85%. Compressed natural gas stations are facing weekly closures due to the scarcity of gas. Along with the electricity load shedding, residents also face gas load shedding in the winter months. The scarcity of natural gas has led to an increasing reliance on fossil fuels to generate electricity. [6]

Pakistan has limited recoverable oil reserves, which stand at a total of 314 million barrels. Currently, Pakistan's internal crude oil production is around 6.57 million barrels per year. At this production level, the reserves will run out in 47 years. In recent years, over 75% of the crude oil supply was met by imports. Pakistan has five main oil refineries with an installed capacity of 13 million tons/year (270 KBBL/day). These refineries cover only half of the domestic demands; the rest is covered by



imports. In 2008-2009, imports of crude oil and oil products (18.4 MTOE) accounted for 83% of oil supplies consumed in Pakistan. Pakistan's fostered dependency on expensive imported oil has placed considerable strain on the economy by raising the external current account deficit and worsening the country's balance of payments position. [7]

4. PAKISTAN POWER RESOURCES

The major electricity sources in Pakistan are discussed in detail below.

4.1 HYDROELECTRIC SECTOR

The seasonal variations of reservoir levels and consequent fluctuation in power output of storage type hydel dams in Pakistan are very pronounced. For example, Tarbela Dam has a maximum head of 450 feet and experiences a variation of 230 feet; Mangla Dam has a maximum head of 360 feet and experiences a variation of 162 feet. During the lean flow (low head) period of Tarbela Dam from November to June, the power output reduces to as low as 1,350 MW against the maximum output of 3,692 MW during the heavy flow (high head) period from August to September (15% permissible overloading on Units 1~10). Lean flow period of Mangla Dam is from October to March when the minimum generating capability is 500 MW. The capability rises to as high as 1,150 MW during high head period (15% permissible overloading). In summary, WAPDA's (Water and Power Development Authority) hydel generating capability varies between the two extremes of 2,414 MW and 6,746.0 MW over the cycle of a year.[8] Another problem in the utilization of this resource is the geographical location of the Pakistani rivers – most of them flow from disputed territory of Indian Kashmir. The construction of dams on these rivers by India has resulted in decreased flow of water into the Pakistan territory. Another problem is the significant capital investment required and the lengthy construction time. For example, the planned Kalabagh Dam (2400 to 3600 MWs) would require \$15 Billion USD and estimated 8 to 10 years to complete. Keeping in mind the scarcity of the water resources, the poor economic condition of Pakistan and the immediate need for electricity, this resource does not seem to be a viable option to meet the immediate energy requirements of Pakistan.

4.2 NATURAL GAS SECTOR

The bulk of Pakistan's power generation comes from thermal power plants burning natural gas and oil. [9] The total installed capacity of thermal power plants in the country is 13296 MW. As per Energy Yearbook 2010, the share of thermal power generation during 2009-2010 was 67 percent.

THERMAL ELECTRICITY GENERATION BY FUEL (Unit: MW)							
Fuel	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	ACGR
COAL	2	1.5	1.6	1.6	1.3	1.3	-7.8%
OIL	154	213	314	352	370	413	21.8%
GAS	496	471	409	376	339	320	-8.4%
Total	652	685.5	724.6	729.6	710.3	734.3	2.4%
Annual Growth Rate	9.67%	5.46%	6.12%	-0.15%	-2.60%	3.47%	

Exhibit 4.1: Thermal Electricity Generation in 2009-2010. Source: IPPs, KESC, WAPDA

Pakistan has a well-developed and integrated infrastructure for transmission and distribution of natural gas (one of Pakistan's success stories). This sub-sector is generally open to the private sector. Pakistan's gas reserves are 282 trillion cubic feet and current production is 4 billion cubic feet per day. There are indications of additional reserves of 35 trillion cubic feet in tight/difficult gas.

GAS	
Total Resource Potential	282 TCF
Production	4 BCF/day
Transmission Network	10,667 km
Distribution Network	95,866 km
Domestic Consumers	5.55 Million
Commercial Consumers	76,169
Industrial Consumers	9,810

The medium term (by 2014-15) decline in production of the seven largest gas fields (that account for 65% of the current total production) and their huge long-term decline (by 2019-20) represent a failure to attract more investment in gas exploration and production. [10] As a result, it is difficult to maintain a production plateau between 4,500 and 5,000 MMcfd of gas. Not much has been done to realize the tight gas potential and no real



incentives have been provided to exploration and production companies. With the current exploration cost of gas, it is not economically feasible to burn this energy source to produce electricity. In addition, gas system losses are increasing due to the aging network. On the other hand, gas demand is currently growing at an 8.5% annual rate. Thus, the gas deficit is increasing as production falls significantly behind demand. Due to the increasing gas shortages, there is rationing of piped gas in winter months.

4.3 OIL SECTOR

A summary of the oil sector of Pakistan is provided in the following table.

OIL	
Total Resource Potential	314 Million Barrels
Crude Oil Production	6.57 Million Barrels/year
Imports	18.4 MTOE (2008-2009)

Pakistan's fuels sector leans heavily on two main fuels which account for 84% of consumption, i.e. high-speed diesel (41%) mainly used for transportation and fuel oil (43%) primarily consumed in the power sector. [11] Pakistani ports cannot receive the large vessels deployed by oil suppliers; therefore, freight costs for delivered products and crude oil are high. Up country distribution is by road tankers, rail, and pipeline. Pakistan has a pipeline network of over 2,000 km (PARCO Network) for the upcountry movement of crude oil and oil products which is an economic means of transportation. [12] However, owing to limited capacity (1.2 million tons/yrs.), considerable upcountry fuel oil movement takes place on road tankers (over 4 million tons/year, or 100,000 40-ton trucks for long-distance hauls) which is the most expensive mode of oil transportation. There is no formal

policy on managing strategic oil stocks, and thus operational stocks sometimes fall to critically low levels. One key impediment is the lack of institutional capacity for developing logistics infrastructure and linking it with oil and energy development plans. The consumption of petroleum product by sector is shown in the chart. The major



issue in electricity generation with fuel is the fluctuating oil prices (*Exhibit 4.2*). [13] Due to the limited domestic reserve, lack of transportation infrastructure (freight etc.) and price volatility in international oil markets, this resource can hardly be used as a reliable and economically viable source of electricity.

4.4 NUCLEAR ENERGY

The current share of nuclear power in the total power generation capacity of Pakistan is 3.3 percent. At present, only two nuclear power plants with a total capacity of 462 MW are functional. PAEC (Pakistan Atomic Energy Commission) is the operator of the two nuclear power plants in Pakistan. Karachi Nuclear Power Plant (KANUPP), the first nuclear power plant of the country, was commissioned in 1971 in Karachi through a turn-key agreement with Canadian General Electric Company. The second Chashma Nuclear Power Plant-1 (CHASNUPP-I), was commissioned in the year 2000, also through a turnkey agreement with China National Nuclear Corporation. [14] After the successful experience of KANUPP and CHASNUPP-I, the Government of Pakistan has entered into another contract with China for construction of a second unit CHASNUPP-II. The construction of the unit is in progress and it is expected that the unit will be commissioned by the end of 2011. The capital investment for a typical 1154 MW nuclear power plant is about 8 billion USD and the estimated construction period is 6-8 years.

Break-up of Nuclear Generation Capacity(MW)				
Power Stations	Capacity(MW)			
Karachi Nuclear Power Plant(KANUPP)	137			
Chashma Nuclear Power Plant(CHASNUPP)-I	325			
Total	462			
CHASNUPP-II (Commercially Not Available)	325			

Source: Pakistan Energy Book 2010(HDIP)

In March 2009 the Pakistan government announced that it was proceeding with design of CHASNUPP-III and IV, with China. PAEC said Beijing was financing 85% of the US\$ 1.6 billion project. Contracts for CHASNUPP-I and II were signed in 1990 and 2000, before 2004 when China joined the Nuclear Suppliers Group (NSG), which

maintains an embargo on sales of nuclear equipment to Pakistan, but there are questions about China's supply of Chasma-III & IV. On September 24, 2010, China informed the IAEA that it will implement an agreement with Pakistan on the export of two nuclear reactors for Islamabad's Chashma nuclear complex. Beijing has said that the reactor deal is part of a 2003 agreement between the two countries, a claim many have questioned, though Germany has accepted. Still this issue is not finalized, and concerns continue about the lack of safety features incorporated into the Chashma-III and Chashma-IV reactors, which are alleged to use a design which is not considered safe enough to build in China along with the international pressure by NSG. [15] As a result the future for this type of energy source is not promising as Chashma-III and Chashma-IV projects require clearance from NGS.

4.5 ALTERNATIVE / RENEWABLE ENERGY

Pakistan has abundant and inexhaustible renewable energy (RE) resources, such as wind and solar power, which, if tapped effectively, can play a considerable role in contributing towards energy security and energy independence of the country. In May 2003, Alternative Energy Development Board – AEDB was established to act as a central agency for development, promotion and facilitation of renewable energy technologies, formulation of plans, policies and development of a technological base for manufacturing of renewable energy technologies can produce 5% of total national power generation capacity by year 2030. [16] At present, the total renewable energy produced in the country is 40MW which accounts for about 0.21% of total installed generation capacity of all sorts. The investment requirement for the renewable energy sector of the country from short to medium term is over 16 billion USD. Keeping in mind the economic condition of Pakistan, it is a huge investment which is not feasible under current financial circumstances.

Renewable Energy Potential in Pakistan				
Wind	0.346 Million MW			
Solar	2.9 Million MW			

Source: Alternative Energy Development Board(AEDB)

5. PAKISTAN COAL RESOURCES

5.1 COAL RESERVES

Pakistan has approximately 186 billion tons of coal reserves, most of which remain untapped. [17] Pakistan's Coal reservoirs are ranked seventh in the world which is equivalent to approximately 300 billion barrels of oil, which exceeds the combined oil reserves of Saudi Arabia and Iran. *185 billion tons* of coal reserves are worth *USD 25 trillion*. According to a study, 50,000 MW can be harnessed for 500 years with these coal reserves. It would not only cater to the electricity requirements of the country for next several decades, but would also help reduce the

oil import bill by USD 4-4.50 billion annually and help FOREX reserves to swell. The coal power generation would cost Pakistan ⁴PKR 4.0 per unit whereas the power generated by Independent Power Projects (Oil & Natural Gas) costs PKR 9.27 per unit. *Exhibit 5.1* provides a summary of the coal reserves in Pakistan.

Province	Resources in Million Tons	*How much is this Coal
Sindh	184,623	✤ Worth of USD 25 trillion.
Balochistan	217	 Exceeds the combined oil reserves of Saudi
Punjab	235	Arabia and Iran.
NWFP	91	 ✤ 50,000 MW of electricity for 500 years can
AJK	9	be produced,
Total	185,175*	 ♦ or 100 Million Barrel diesel for 500 years.



Exhibit 5.1: Coal reserves of Pakistan

Exhibit 5.2: Coal Reserves of Pakistan

⁴ PKR=Pakistani Rupee (1 USD = 86 PKR)

The current coal production and consumption by sector is shown in the following exhibits which show about 3.5-4.5 million tons of coal are produced each year and about 1.5% of which is used for power generation.



Sindh Coal Fields Information (Thar, Soda and Lakhra)

Sindh has the largest reserves, 175 billion tons of lignite coal, located in the Thar Desert. All coal reserves in Sindh are listed in the following table. The infrastructure refers to all constructions (road, building, power & water supply) and equipment required to enable mining.

Coal Fields Information	Lakhra Coal Field	Sonda Coal Field	Thar Coal Field
Distance from Karachi	193 km	100-150 km	410 km
Total Area	1,309 sq. km	1,822 sq. km	9000 sq. km
Coal Reserves	1.328 Billion Tons	7.112 Billion Tons	175 Billion Tons
Infrastructure Status for Mining	No infrastructure	Minor Development	Minor Development
Infrastructure Development Time	1-2 Yrs	1-2 Yrs	4-5 Yrs

Punjab Coal Fields Information (Makerwal/Gullakhel, Salt Range)

Currently, no infrastructure exists to mine the Makerwal/Gullakher and Salt range coal reserves.

Coal Fields Information	Makerwal/Gullakhel Coal Field	Salt Range Coal Field
Distance from Lahore	90 km	270 km
Coal Reserves	22 Million Tons	213 Million Tons
Infrastructure Status forMining	No infrastructure	No infrastructure
Infrastructure Development Time	1-2 Yrs	1-2 Yrs

5.2 COAL MINING COST ESTIMATION GUIDE*

The following types of costs are considered in estimating coal mining costs.

Mine and Prep Plant Cost Models: It includes costs for a broad range of sizes and types of theoretical surface and underground mines and prep plants⁵.

⁵ A coal preparation plant (CPP) is a facility that washes coal of soil and rock, preparing it for transport to market. A CPP may also be called a "coal handling and preparation plant" (CHPP), "prep plant," "tipple," or "wash plant".

- Coal Production Data: It includes historical and current perspectives of coal production by coal rank and geography. This data provides distribution, resources and technical data for coal producing areas.
- Transportation: It includes truck, rail and pipeline (for slurry) shipping charges for coal, equipment and supplies.
- Mining Taxes: It includes federal, state and provincial taxes and how they apply to your proposed project. All taxes are covered including income, sales, property and all other mining-specific taxes in all of the coal producing states or provinces.
- Mining Wages: Mining wages are considered along with wage scales, benefit plans and employment taxes to help you estimate labor costs.
- Utility Costs: Current industrial electric power and natural gas rate schedules as applied to mining are considered to determine project's utility costs.
- Mine and Processing Equipment: It includes estimates about processing equipment items, from 2 hp pumps to 3,400 hp trucks, drills, locomotives, ventilation equipment, crushing and grinding equipment, pumps, motors, continuous miners and more.
- Mine, Processing, Safety and Reclamation Supply Costs: It includes every supply item in cost estimate, including safety equipment, fuel, reagents, drill bits, tires, rock bolts, reclamation materials and much more.

*Theoretical Example (For 5,000 Tons per Day Open Pit Cost Model): This mine is an open pit mine producing 5,000 tons ore and 5,000 tons waste per day. The total resource to be mined is 18,715,000 tons. Ore is hauled 1,068 meters to an ore stockpile. Waste is hauled 535 meters to a waste rock dump. Rock characteristics for both ore and waste are typical of those of granite or porphyritic material. Operating conditions, wage scales, and unit prices are typical for western U.S. mining operations. The key design criteria; operating schedule, equipment, personnel and supply requirements; and costs are listed below in the table.

Capital Costs		
Equipment	\$8,066,100	
Haul Roads	1,095,600	
Pre-production Stripping	393,500	
Buildings	1,632,700	
Electrical System	63,600	
Working Capital	1,258,200	
Engineering & Management	2,025,300	
Contingency	1,453,500	
Total Capital Costs	\$15,988,500	
Total per Daily Tonne Ore & Waste	\$1,599	

5.3 COAL TRANSPORTATION METHODS

Coal can be transported in the following ways from coal fields to power plants:

a) *Rail Network:* The most cost effective method of coal transportation is rail network. The initial cost is high but coal can be transported over a long distance through a dedicated network for the coal transportation.



- *Road Network:* Coal can be transported through road network with large trucks within the range of 100-120 km. For distances more than 120 km, cost of transportation increases substantially and is not economically feasible.
- c) *Pipeline Network (In slurry form):* Another method of coal transportation is converting the coal into slurry (grounded coal mixed with water) and transporting that slurry through a pipeline network. Examples of pipeline networks up to 430 km can be found for the transportation of coal in slurry form.
- d) *Waterways:* Waterways can be used for transportation of the coal depending upon the location of the demand points.

Railway Network in Pakistan

Rail services in Pakistan are provided by the state-run Pakistan Railways, under the supervision of the Ministry of Railways. [18] Pakistan Railways provides an important mode of transportation in Pakistan, catering to the large-scale movement of people and freight. The railway network has a total length of 8,163 km, of which 7,718 km are 1,676 mm (5 ft 6 in) broad gauge tracks, including 293 km of electrified track, and the remaining 445 km are 1,000 mm (3 ft 3 3/8 in) narrow gauge tracks. Earning from Passenger rail service comprise of approximately 50%

of the total revenue. Pakistan Railways carry 65 million passengers annually and daily operate 228 mails, express and passenger trains. Pakistan Railways also operate special trains for various occasions. The Freight Business Unit (FBU) with 12000 personnel operates over 200 freight stations on the railway network. The FBU serves the Port of Karachi and Port Qasim as well as various other stations along the network and generates revenue from the movement of agricultural, industrial and



imported products such as wheat, coal, fertilizer, cement, and sugar. About 39% of the revenue is generated from the transportation of petroleum, 19% from imported wheat, fertilizer and rock phosphate. The remaining 42% is earned from domestic traffic. The freight rates structure is based on market trends in road transport which is the

main competitor to rail transport. Rail-transported coal is typically moved in unit trains that operate in dedicated shuttle service between a mine and a destination.

- Cost of building a new railway track of 1km = \$178 Million Approx.
- Annual Maintenance Budget = 16,120 \$/ km
- The cost of transportation for one short ton of coal /km by Rail is approximately \$5-8.
- Time required to build 100 km of railway track = 1-2 Yrs

Cost-Time Estimates for Proposed New lines-Track Doubling

The table below shows the data for the type of railway project, location, length, cost and time estimates.

Type of Project	Location	Length	Cost	Time
New Line	Gwadar and Quetta	700 km	1.25 billion USD	4 years
	Shahdara Bagh- Lalamusa	126 km	166 million USD	3 years
	Khanewal – Raiwind	246 km	98 million USD	5 years
Track Doubling	Shahdara Bagh – Faisalabad	135 km	123 million USD	3 years
	Lalamusa – Chaklala	152 km	280 million USD	4 years
	Golra Sharif - Peshawar Cantt	160 km	230 million USD	4 years

Road Network in Pakistan

Motorways of Pakistan: The construction of motorways began in the early 1990s with the idea of building a world class road network and reducing the load off the heavily used national highways throughout the country.

National Highways: During the 1990s, Pakistan began an ongoing project to rebuild all national highways throughout the country specifically to important financial, cargo and textile centers. [19] The National Highway Authority or NHA is responsible for the maintenance of all national highways in Pakistan. The right map shows the road network. Truck transportation is used to move coal instead of a water or rail carrier or for direct shipment to the customer. Trucks have the advantage of routing flexibility and modest capital



requirements, but coal can be economically transported for at most about 120 km due to the high unit cost of moving a low-value product in relatively small batches. Coal-carrying vehicles are typically end-dump trucks with a carrying capacity of roughly 25 to 50 tons depending on local road conditions and safety regulations.

- Cost of building a two lane highway road = 3.5 Million \$/km approx.
- Annual Maintenance Cost = 14085 \$/Km
- The cost of road transportation for one short ton of coal per km is approximately \$8-10.
- Time required to build 100 km(120 km constraint) road network = 1-2 yrs

*(Cost of relocation of underground utility services, cost of demolitions required to widen the road, and mainly the cost of Land Acquisition are NOT included in this estimate. Similarly cost of major bridges, duct banks, culverts, overhead pedestrian bridges, etc. are NOT included.)

Pipeline Network in Pakistan

The pipeline network of Pakistan is comprised of two gas marketing companies: Sui Northern Gas Pipeline Limited (SNGPL) and Sui Southern Gas Company Limited (SSGCL), and one crude oil-cumproduct pipeline company (PARCO). The total natural gas infrastructure network comprises 10,740 kilometers (km) of transmission lines and 101,733 km of distribution lines with the appropriate compression facilities designed to achieve system efficiency. The cost of transportation for one short ton of coal slurry per km by pipeline is \$2-5.



SNGPL (Sui Northern Gas Pipeline Ltd.)

The SNGPL transmission system extends from Sui in Balochistan to Peshawar in the NWFP comprising over 7,016 km of transmission system (Main lines & Loop lines). SNGPL's transmission and distribution (T&D) system extends from Sui in Baluchistan to Peshawar in Khyber-Pakhtunkw⁶ passing through Punjab, and accounts for 1788 million cubic feet per day (MMcfd⁷), or 48% of total gas in the country. [20]

SSGC (Sui Southern Gas Company)

The SSGC transmission system is over 3,080 km including (Main lines & Loop lines). SSGCL operates in the southern part of the country (Baluchistan and Sindh) and accounts for 1,157 MMcfd or 30% of total gas in the country. [21] The rest (22%) of the gas supply is transported via independent systems.

PARCO (Pak Arab Refinery Ltd.)

Parco operates a network of crude oil-cum-product pipelines running over 2000 kilometers across the country.

- Cost of building 36 inch diameter pipeline =540\$/meter=540000\$/km
- Annual Maintenance Cost = 2 % of the setup/capital cost
- The cost of transportation for one short ton of coal slurry per km by pipeline is \$2-5.
- Time required to build 100 km of pipeline network = 1-2 yrs

Waterways

The waterway network in Pakistan is in its infancy with Karachi being the only major city situated next to the Arabian Sea. Still plans are being proposed for the development of the waterways in the country along the Indus River and through the Punjab as it would boost employment opportunities and the economic and social development of Pakistan. But no project is currently



⁶ In the aftermath of the adoption of the 18th Amendment to the Constitution of Pakistan, the North Western Frontier Province was renamed Khyber-Pakhtunkhwa.

⁷ The cubic foot is an Imperial and US customary (non-metric) unit of volume, used in the United States and the United Kingdom. It is defined as the volume of a cube with sides of one foot (0.3048 m) in length. MMCFD = For millions of cubic feet per day.

underway to use these waterways as an alternative mode of transportation. Following is a list of dry ports and sea ports in Pakistan.

- Port of Gwadar Gwadar, Balochistan
- Port of Karachi Karachi (City Centre), Sindh
- Port Qasim East Karachi, Sindh
- Port of Pasni Pasni, Balochistan

Rivers: Among the Pakistan Rivers, the Indus is the most important river. Without Indus and its tributaries, Pakistan would have been a dry barren land long ago. Apart from Indus, the other important rivers in Pakistan are Sutlej, Chenab, Beas, Ravi and Jhelum. These rivers merge into the Indian rivers at the India-Pakistan border. The cost of transportation for one short ton of coal /km by river is \$5-8.

5.4 COAL-FIRED POWER PLANTS

There are two types of coal operated power plants in the market.

- Conventional Coal Power Plant
- Coal Gasification Power Plant

The cost of a conventional coal fired power plant of 500 MW is about 2 Billion USD and takes 24-36 months to build. The coal gasification power plant of the same capacity requires a capital cost 25% more than the conventional power plant. The typical costs associated with a coal power plant are:

- Capital Cost
- Operation & Maintenance Cost
- Carbon Cost



Exhibit 5.3: Coal Power Generation Chain

Diagram of a typical coal-fired thermal power station



Exhibit 5.5 estimates the cost of a coal-fired power plant project for Thar coal field.

For 2015-Electricity Gap = 15,000 MW approx.	% of GDP = 36%
Cost of one Power Plant (500 MW) = 2 Billion \$	Time required to establish this infrastructure:
To cover this gap of 15000 MW= 30 power plants	For power plants = 24-36 months (if all started at once)
Cost of Power Plants = 30 x 2 = 60 billion \$	For transmission network of $10,000 \text{ MW} = 5-10 \text{ years}$
Cost of infrastructure for 10,000 MW electricity proposed at Thar = 1.74 Billion \$	For additional 5000 MW= 5 years
(Including water, electricity, road network, railway links, effluent disposal costs)	Time taken for building road/rail network to far distant places from Thar= 5 years
Cost of infrastructure for an additional 5000 MW of electricity = 870 Million \$	Costs (Not included):
Total cost = 60 + 1.74 + 0.87= 62.6 Billion \$	O&M cost of power plants (annually)
GDP (2011) = 174.8 Billion USD	O&M cost of road network (annually)
Sector-wise contribution in GDP: Agriculture: 20.8%, Industry: 24.3 %, Services: 54.9%	O&M cost of rail network (annually)
Inflation rate (2011) = 16-17%	O&M cost of electricity transmission network (annually)
Unemployment = 15%	Extension of road/rail network (From Thar to outside network)
Standard Poor Rating = B-	Transportation carriers (rail cars/trucks cost)

Exhibit 5.5: Cost of coal power plant project – A hypothetical frame work for 15,000 MW of electricity from Thar Coal

The coal requirement for an average size power plant (500 MW) is approximately is 5000-9000 metric tons daily. The conventional transportation modes available are truck, rails, water-way as well as slurry (water + crushed coal) through pipelines (see Section 5.3 for details).

6. CURRENT ENERGY SUPPLY CHAIN

The key players of Pakistan's power sector are energy producers, transmitters, distributors, and Pakistani energy administrations. The organizational infrastructure of Pakistan's power sector with all key players is shown in Exhibit 6.1.



Exhibit 6.1: Organizational infrastructure of Pakistan power sector

6.1 MAIN ELECTRIC POWER PRODUCERS IN PAKISTAN

The main electric power producers in Pakistan are Water and Power Development Authority (WAPDA), Karachi Electricity Supply Company (KESC) and Pakistan Atomic Energy Commission (PAEC, the operator of the two nuclear power plants). Besides these three main power producers, a number of independent power producers (IPPs) established since 1994 are also contributing significantly to the electricity sector of the country.

a. Water and Power Development Authority (WAPDA): WAPDA was created in 1958 as a semiautonomous body for the purpose of coordinating and providing a unified direction to the development of the water and power sectors. [22] These sectors were previously managed by the respective electricity and irrigation department of the provinces. Since October 2007, WAPDA has been bifurcated into two distinct entities: WAPDA and Pakistan Electric Power Company (PEPCO). WAPDA is responsible for water and hydropower development whereas PEPCO is responsible for the management of WAPDA's fourteen public limited companies in the areas of thermal power generation, transmission, distribution and billing. These fourteen (14) corporate entities are:

- Four (4) Thermal Power Generation Companies (GENCOs)
- One (1) National Transmission & Power Dispatch Company (NTDC)
- Nine (9) Distribution Companies (DISCOs)

b. *Karachi Electric Supply Company (KESC):* The company was privatized in November 2005 with the transfer of 73% shares of the Government of Pakistan along with Management Control to the new owner KES Power & others. Currently, the Ministry of Water and Power looks after the affairs of this company at the federal level. KESC is principally engaged in generation, transmission and distribution of electric energy to industrial, commercial, agricultural and residential consumers under the Electricity Act in 1910 as amended to date and

NEPRA Act 1997, to its licensed areas. [23] The company owns 1,756 MW of generation capacity (oil- and gasfired), of which 1,534 MW is operational. The demand for power in the city is at least 2300 MW. To meet the supply-demand gap, KESC has to purchase power from WAPDA, Independent Power Producers (IPPs) and KANUPP. Whenever any of these outside entities fail to provide power or there is a breakdown in KESC's own installed generation base, the company has to resort to load shedding.

c. Pakistan Atomic Energy Commission (PAEC): PAEC is the operator of the existing two nuclear power plants in Pakistan. Karachi Nuclear Power Plant (KANUPP), the first nuclear power plant of the country, was commissioned in 1971 in Karachi through a turn-key agreement with Canadian General Electric Company. The second Nuclear Power Plant was commissioned in the year 2000 also through a turnkey agreement with China National Nuclear Corporation.

d. Independent Power Producers (IPP): The gross power generation capacity of IPPs is 5,822 MW. KAPCO and HUBCO are the two largest companies with a production of 1,466 MW and 1,292 MW respectively.

6.2 ELECTRICITY TRANSMISSION

In Pakistan, two companies are engaged in electric power transmission; they are National Transmission and Dispatch Company (NTDC) and the Karachi Electric Supply Company Limited (KESC). NTDC is the national grid company of Pakistan and is exclusively responsible for electric power transmission for the entire country except the area covered by KESC.

- Capital cost of electricity transmission line = 0.3 Million/km Annual Maintenance cost = 2% of the setup/capital cost Time Required to build 100 km of transmission line/1000 MW = 1-2 yrs

a. National Transmission and Dispatch Company (NTDC): NTDC is responsible for overall reliability, planning and coordination of the electricity transmission in Pakistan except the area under KESC. NTDC is a public sector company and came into existence as a result of restructuring of WAPDA in 1998 and obtained a transmission license from National Electric Power Regulatory Authority (NEPRA) in 2002 to engage in the exclusive transmission business for a term of thirty (30) years.

b. Karachi Electric Supply Company Limited (KESC): The second company engaged in electric power transmission business in Pakistan is KESC. It has two separate licenses; electric generation and distribution, while its application for a transmission license is currently under consideration by NEPRA.

6.3 ELECTRICITY DISTRIBUTION

As a result of restructuring and unbundling of the power of Water and Power Development Authority (WAPDA), DISCOs are responsible for channeling electricity to the transmission substations. The end users are classified as residential, commercial, industrial, agriculture and street lights etc. Overall, the distribution system, especially in an urban area, is overstressed and needs to be upgraded, augmented and expanded. Besides these distribution companies, Karachi Electric Supply Company (KESC) is a private limited company and is engaged in distribution of electric power in the area of Karachi. In addition to one private and nine public distribution companies, National Power Regulatory Authority (NEPRA) has so far granted seven distribution licenses to small power producers (SPPs) for supply of electric power to designated bulk power consumers.

Losses in the transmission and distribution: One of the major problems in Pakistan's electricity transmission is the unsafe and unreliable transmission and distribution of electricity. Due to weak grid infrastructure and significant theft of electricity, losses from the transmission and distribution network ranged from 20.6% to 21.6% during 2009-10.

Electricity Consumption Sector Wise: Having consumption of 46.1% of electricity, the domestic sector is the major consumer of electricity in Pakistan, followed by industrial 26.7%, agricultural 13% and commercial 7.5%



7. ENERGY SUPPLY CHAIN ISSUES

Currently there are more than 20 organizations engaged in developing electric power projects, such as, WAPDA Hydroelectric, Pakistan Electric Power Company (PEPCO), the unbundled ex-WAPDA entities, Private Power and Infrastructure Board (PPIB), the Alternative Energy Development Board (AEDB), the Thar Coal and Energy Board, the Infrastructure Project Development Facility (IPDF) and provincial power and irrigation departments with the responsibility to develop small hydropower projects of under 50 MW and other off-grid renewable energy projects. The issues are:

a. Stalled Privatization: Pakistan's investment needs in the energy sector cannot be met by the public sector alone as private sector investment is crucial to address the energy gap. Private sector investment in energy is also critical to tap offshore capital resources, to inject new technology and management expertise, to develop domestic financial sector capabilities, and to generate greater efficiencies in the delivery of energy and services. The entities earmarked for privatization (including exploration and production in the oil and gas sector) are Oil and Gas Development Company Limited (OGDCL), Pakistan Petroleum Limited (PPL) and Pakistan State Oil (PSO). The two big gas supply companies, SSGCL and SNGPL, along with key assets in the power sector including selected electricity distribution companies and a power generation company, are also targeted for privatization.

b. Regulatory Challenges: There is a lack of uniform regulation in the energy sector that creates distortions between the gas and electricity sectors. Inconsistent regulations between the National Electric Power Regulatory Authority (NEPRA) responsible for the power sector and the Oil and Gas Regulatory Authority (OGRA) responsible for the oil and gas sectors send confusing signals to investors and create disharmony in pricing strategies between gas and electricity.

c. Inefficient and Below-Cost Recovery Tariff Structures: Previously, the government froze tariffs between 2003 and 2007 at a very low level. The subsequent tariff increase in the following years did not make up for the shortfall while crude oil and gas prices were increasing globally. Even now the notified electricity tariffs by the government are below the cost-recovery level. Between FY2004 and FY2008, the price of imported furnace oil, which represents about one third of the fuel mix for power generation, increased by 76%. Gas prices have

increased by 78% over FY 2004-05 levels. High technical and commercial losses of DISCOs also led to the increased cost of service. The government provides a tariff differential subsidy (TDS) to DISCOs to cover the gap between the cost of service tariff as determined by NEPRA and the notified uniform tariff. The government's



notified uniform tariff is for each customer class set at a rate that is lower than the lowest NEPRA-determined tariffs of all eight DISCOs. The graph shows the size and growth of the cost of electricity subsidies and the growing gap between the cost of service and the level of subsidy between FY2004-05 and FY2009-10.

d. Efficiency Losses: Pakistan's industry is energy inefficient. This is attributable to high energy losses, waste throughout the energy supply chain, and inadequate investment in replacing obsolete infrastructure. For each dollar of GDP, Pakistan uses 15% more energy than India and 25% more than the Philippines. The power sector experiences transmission and distribution losses currently at about 21.9%; these losses are substantial and raise the cost of electricity and contribute to shortages. Therefore there are potentially dramatic gains in supply from improving energy efficiency. Pakistan's total energy savings potential is estimated at 11.16 MTOE. Savings from energy efficiency could reach 18% of total energy consumed in the country. This corresponds to a 51% reduction in net oil imports. According to the National Energy Conservation Centre (ENERCON), annual energy savings of up to 25% are possible in all sectors which translate into approximately \$3 billion in savings annually.

8. CURRENT STRATEGY OF COAL

According to estimates recently compiled by the National Electric Power Regulatory Authority (NEPRA), the average cost of generating electricity from water resources stood at about 50 paisa per unit $(0.0058 \, \phi)$ (1 USD=86 Rs. & 1 Rs. = 100 paisas), Rs 4.50 from gas, Rs 12 per unit from furnace oil and more than Rs 16 per unit from

diesel. Estimates also show that the electricity to be produced from block-5 of the Thar coal field would cost a maximum of Rs 4 per unit. In addition, Pakistan could produce 10,000 MW of electricity for 30 years from only one percent of the total Thar coal reserves.

Realizing the potential of coal, the Pakistan government is shifting its energy mix from imported oil and dwindling gas reserves to coal. There has been a long history and many efforts of developing the Thar, Sonda and Lakhra coal fields, but none of them were successful. The existing situation of the Sindh and Punjab coal fields is described below.

SONDA Coal Field: The Sonda coal field is located 150 km northeast of Karachi. Supporting infrastructure, such as railway, power transmission network, and road network is available in its proximity. Ever since its discovery in 1981 by the Geological Survey of Pakistan (GSP), the Sonda coalfield in the Thatta district has been investigated in detail and a Chinese firm started underground hydrological surveys in Sindh as part of a coal-mining and power generation project in January 2009. "China National Machinery Import and Export Corporation (CMC) has entered concluding stages of evaluation process of its leased area of 57 sq km in the Sonda Jerruk coal field of District Thatta," a company official said. According to the company, Sonda-Jherruk coal mine and power plant project was expected to generate around *405 MW* of electricity using coal. The hydrological survey department was assisting to ascertain the amount of underground water, essential for power generation purpose. Another *205 MW* Integrated coal mining cum Power Project at Sonda-Jherruk by M/S Dadabhoy Hydrocarbon Energy Ltd. was expected to start soon. Unfortunately both companies abandoned their projects due to disputed tariffs and the lack of interest of the government in developing the required mining infrastructure.

LAKHRA Coal Field: The Lakhra coalfield is at a distance of 50 km off Hyderabad and 175 km from Karachi. The Lakhra coalfield is connected by road through the Indus Highway, and a rail track is also available near Khanot, which is also located on the Indus Highway. There is a well-established electricity transmission infrastructure available in Hyderabad. After the first discovery of coal in Lakhra, many geological investigations have been conducted in the Lakhra area by national and international organizations. Interests in large-scale exploration of coal for power generation began to develop in the early 1960s when GSP performed a systematic geological investigation of the area. GSP's tests found Lakhra coal unsuited for hard coke production, but suitable for power generation. In 1966, GSP engaged a Polish firm to undertake a mining and power generation feasibility study on Lakhra coal. In 1978, GSP carried out additional technical, financial and economic feasibility studies. In 1981, GSP reported positive results and concluded that a 300 MW plant was technically feasible, but estimated the coal production cost to be very high. The government of Pakistan asked USAID to review all studies on Lakhra and make recommendations on the technical and economic feasibility of a coal-fired power station. USAID completed its Lakhra feasibility study by 1986 and confirmed GSP's appraisal, but proposed changes in design of the plant, lowering the estimated cost. The USAID feasibility study concluded that a Lakhra coal mine, supplying coal for a 2 x 250 MW units power plant, was technically sound and socially and environmentally feasible. The government has invited EOIs for the development of a 450 MW integrated project of coal mine and

power plant in Lakhra through press advertisement but no further action was taken by the government office. Lakhra coal fields have no established mining infrastructure available for the utilization of coal resources.

THAR Coal Field: The government has a plan to develop the Thar coal fields to solve the energy crisis once and for all by building coal fired power plants at Thar. The power generated at Thar will be transmitted through a transmission network to the rest of the country. The plan is primitive in terms of allocation of resources and the development of infrastructure. From the government's point of view, there are benefits to having several projects in close proximity to Thar, as grid facilities could be shared by the different projects. Also the usage of ground water by several projects will lower the water table in the region, making coal mining more easy and cost effective. The possibility of using one mine service facility will be helpful for all mines and power plants and common location/facilities for all power plants in the complex.

Thar coal fields are 410 km east of the city of Karachi. These fields are located in the desert without any established infrastructure. The estimated infrastructure development cost to connect Thar coal field with the outside networks is 1.74 billion USD, including water, electricity transmission, road network, railways link, effluent disposal systems etc. The details for the development plan for Thar are as follows:

- Construction of canal water carrier with capacity of 300 cusecs.
- Construction of 50 cusecs drainage and wastewater effluent channel from mining area of Thar coal field.
- Improvement and widening of road network from seaport Karachi to Thar coalfields (360 km).
- Transmission line setup to Thar coalfields: National Transmission & Dispatch Company (NTDC), with the support of ADB (Agricultural Development Bank) funding, has initiated a feasibility study for constructing a 1300 km electricity transmission line from Thar coalfields to upcountry load centers for dispersal of 2500-3000 MW power. The process/configuration of a transmission system (including line/grid/switching station) will cater for the evacuation of at least 10,000 MW of power, and can be replicated for an additional 10,000 MW. Total estimated funding required for the transmission line is approximately 1 billion USD and the estimated construction period is 5-10 years.
- Establishment of broad-gauge railway link to Thar coalfield areas.

SALT RANGE/ MAKERWAL Coal Fields: Salt Range and Makerwal coal fields are underdeveloped due to the lack of interest of the Punjab government. The area is highly populated with a well-established road and rail network. The coal belt in the **Salt Range** extends from 20 miles north of Khushab to 15 miles northeast of Khewra, an area of about 100 sq. miles. The coal is high volatile bituminous with a high ash and sulphur content.

The **Makarwal** coal-mining area lies in the Trans-Indus Salt Range and extends from eight miles west of Kalabagh to west of Makarwal. The coal is of slightly better quality than that of the Salt Range.

9. PAKISTAN ENERGY SECTOR FINANCING

HUBCO – A Success Story: Power network construction requires significant and long-term capital investments. Such projects cannot be feasible without financing from various sources. One successful example in the history of Pakistan is Hubco, the largest oil-fired power plant, which began production from its 4 × 323 MW oil-fired units in March 1997. The oil-fired plant is built near the Hub River about 40 km northwest of Karachi, in the province of Baluchistan. This was the first time in Pakistan history that a private power project had been backed by multilateral (World Bank) and bi-lateral (French, Japanese, US, and Italy) funds in association with commercial banks. The project cost \$1.8 billion and was financed as a build, own, operate (BOO) arrangement, under a term of 30 years, which will be up for assessment at the end of 23 years. Citibank was the lead arranger for over \$686 million in commercial loans raised to push the project to financial closure in January 1996. The principal contractors are Mitsui of Japan, Ansaldo Energia of Italy, Campenon Bernard SGE of France, and Ishikawajima-Harima Heavy Industries of Japan.

The talks for the Hubco project began in 1985, when the Pakistani government invited offers for IPP proposals. [24] Following the initial letter of intent, sponsors formed a construction consortium to accelerate negotiations, even though financial closure was not reached. The project finally reached financial closure in January 1995 when consortium-leader British National Power Company agreed to raise its stake in Hubco from \$40 million to \$100 million equity (the second largest member is Saudi Arabia's Xenel with \$90 million); which finally persuaded bankers to fund the project. The project is not only unique in its size but the way in which the international consortium was able to combine equity, debt and guarantees. The breakdown in finances includes: \$175 million from international and local equity investors and \$689 million from international banks – the majority of the balance came via a \$589 million subordinated loan provided by the World Bank. Although the World Bank traditionally only lends to government, the consortium was able to circumvent this convention by channeling the World Bank contribution through the government's private sector development fund. In addition, the consortium was also able to incorporate some financing from traditional Islamic banks.

According to the agreement between Hubco and the Government of Pakistan, the average Base Tariff (or Reference Tariff) was decided to be at 2.94 cents/kWh (during year 1-5), 1.73 cents/kWh (during year 6-15) and would fall to 1.38 cents/kWh during the years 16-27 of project life (the last year being 2027). Over the three year period 1996-99, the tariff increased to 5.6 cents/kWh over the average reference tariff. 39% of the tariff increase can be explained by fuel price hike, 25% by rupee devaluation, 20% by the high cost of foreign exchange risk premiums charged by the State Bank of Pakistan and which are quite high in the initial years of insurance coverage, 7% by inflation and 8% by other miscellaneous factors.

The state-owned Water and Power Development Authority (WAPDA) purchases power from Hubco and the power purchase agreement assures a guaranteed revenue equivalent to 60% of gross capacity utilization, irrespective of the actual take off from the power station. According to the agreement, Hubco will supply power to WAPDA at 5.6 cents/kWh (for the remaining 27 years life of the project). Moreover, if the authority uses up to

64.4% of total production; in the case of higher usage, then the cost falls to 5 cents/kWh. By establishing a standard agreement for power investment – especially in implementation, fuel supply, and power purchase agreements – the national government ensured that all investors are treated equally in the negotiation process. One major incentive was the government agreement to provide foreign exchange risk cover for the principal and interest payments under the debt facilities.

PAKISTAN DEBTS & IMF (International Monetary Fund): Pakistan has relied on the IMF to prop up its economy for a few years. Since 2008, the IMF has disbursed \$7.27 billion, including the last release of \$1.13 billion in May 2010. But reports suggest the Fund was dissatisfied with Islamabad's progress in dealing with its chronic fiscal problems and promised structural reforms. "Economic growth has been negatively affected by the last year floods (2010) and the high price of oil, inflation remains persistently high, and budgetary problems are undermining macroeconomic stability," reports said. The IMF also urged an increase in government spending on health, education, and infrastructure, and stronger monitoring of the financial sector to ensure stability.

The IMF suspended its loan program in May 2010 due to the government's failure to implement tax reforms. The suspension has pushed the country into a fiscal emergency. The government is forced to borrow from the central bank to run its affairs, while the central bank is printing money to provide the government about 2 billion Pakistani rupees (23.5 million USD) a day. As a result, Pakistan's economy suffers high inflation and the value of the Rupee has fallen from 60 to 1 USD to over 86 to 1 USD in a few months. Meanwhile Pakistan's debts have accumulated to 58 billion USD (2010 est) – about 1/3 of Pakistan's GDP in 2010. Pakistan is on the verge of bankruptcy as the trade deficit is increasing, tax collection is low and the industrial sector is crumbling with the energy crisis. The government is trying to generate revenue by increasing oil prices and collecting a petroleum tax. Also the security concerns stemming from the nation's role in the War on Terror have created great instability and led to a decline in Foreign Direct Investment (FDI) from a height of approximately \$8 billion to \$3.5 billion for fiscal year 2010.

Facing all these challenges, the national government, for the first time in years, has sought external funding as Balance of Payments support. Consequently, S&P lowered Pakistan's foreign currency debt rating from B to CCC-plus, just notches above a level that indicates default. Pakistan's local currency debt rating was lowered to B-minus from BB-minus. [25] Credit agency Moody's Investors Service cut its outlook on Pakistan's debt from stable to negative due to political instability, though it maintained the country's rating at B2. The cost of protection against a default in Pakistan's sovereign debt trades at 1800 basis points, according to its five year credit default swap, a level indicating that investors believe the country is already in or will soon be in default.

10. CALL FOR ACTIONS

Pakistan's current energy mix is highly imbalanced which depends heavily on crude oil and natural gas. The country is spending \$10-12 billion a year to import crude oil and petroleum products. The deficit is gradually

increasing and such an energy mix is not sustainable and cannot meet the increasing demand in the long run. The dilemma faced by the country is that while Pakistan is bestowed with huge natural coal reserves labeled as "black gold," the country is in a deep financial and energy crisis, and thus unable to finance projects to develop and utilize the resource. This vicious cycle is shown more explicitly in the right figure: to develop the energy infrastructure based on coal, Pakistan needs significant capital; however,



with the current debts and credit rating, it is hard for the government to borrow such funds and even if it is possible, it will come with significant interest. To change the financial condition of the country, Pakistan must grow the economy, however, without energy, it is just infeasible. Another serious concern is timing – the industrial sector needs immediate energy to survive and is almost on the verge of collapse. The high inflation and unemployment rate is pushing more people into poverty. As a result, the political and social infrastructure is crumbling. In summary, for the future energy security and economic prosperity of Pakistan, the country must come up with a creative plan to develop the energy supply chain around coal resources to address both the immediate and long-term needs.

QUESTIONS

- 1. What do you think about the government's plan of exploring Thar coal fields? How long will it take and how much will it cost? Can the country afford it and wait for it under the current condition?
- 2. How to set realistic objectives for the country to meet its energy needs in the short and long-term to prevent significant economic and social losses?
- 3. What would you recommend to build up an energy supply chain utilizing the coal resources to meet both the immediate and long term objectives of the country?

Appendix

Rank	27 th (PPP), 47 th (Nominal) by (IMF)	
Currency	1 Pakistani Rupee (PKR)	
	1 USD=86 PKR	
	1 Rs. = 100 Paisas	
Fiscal year	July 1–June 30	
Trade organizations	ECO, SAFTA, ASEAN, WIPO and WTO	
Statistics		
GDP	\$174.8 billion (nominal)(2010)	
	\$464 billion (GDP-PPP) (2009)	
GDP growth	2.7% (2011)	
GDP per capita	\$2400 (2010)	
GDP by sector	agriculture: 19.6%, industry: 26.8%, services: 53.7% (2007)	
Inflation (CPI)	16-17% (2009-2010)	
Population below poverty line	40% (2010)	
Labor force	55.88 million (2009 est.)	
Unemployment	15% (2011 est.)	
Main industries	Textiles, chemicals, food processing, steel, transport equipment,automobiles, telecommunications,machinery, beverages, construction,materials, clothing, paper products	
Ease of Doing Business	83 rd	
Ralik External		
	\$24 hillion (2011 act.)	
Exports	(67th)	
Export goods	textile goods (garments, bed linen, cotton cloths, and yarn), rice, leathergoods, sports goods, chemicals manufactures, carpets and rugs	
Main export partners	United States 22.4%, UAE 8.3%, UK6%, China 15.4%, Germany 4.7% (2006 est.)	
Imports	\$28.31 billion f.o.b. (2009 est.)	
Import goods	Petroleum, Petroleum products, Machinery, Plastics, Transportation equipment, Edible oils, Paper and	
	paperboard, Iron and steel, Tea	
Main import partners	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.)	
Main import partners Public finances	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%, UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.)	
Main import partners Public finances Public debt	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010)	
Main import partners Public finances Public debt Revenues	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010) \$23.21 billion (2009 est.)	
Main import partners Public finances Public debt Revenues Expenses	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010) \$23.21 billion (2009 est.) \$30.05 billion (2009 est.)	
Main import partners Public finances Public debt Revenues Expenses	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%, UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010) \$23.21 billion (2009 est.) \$30.05 billion (2009 est.) Standard & Poor's	
Main import partners Public finances Public debt Revenues Expenses	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010) \$23.21 billion (2009 est.) \$30.05 billion (2009 est.) Standard & Poor's B- (Domestic)	
Main import partners Public finances Public debt Revenues Expenses Credit rating	paperboard, Iron and steel, Tea China 14.7%, Saudi Arabia 10.1%,UAE 8.7%, Japan 6.5%, United States5.3%, Germany 5%, Kuwait 4.9% (2006 est.) \$58 billion (2010) \$23.21 billion (2009 est.) \$30.05 billion (2009 est.) Standard & Poor's B- (Domestic) B- (Foreign)	

Exhibit 2.2: Economy of Pakistan

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