MEETING PAKISTAN'S ENERGY NEEDS

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Introduction

With a population of 152 million, the economy in Pakistan is currently growing at a rate of over 8% supported mainly by an expanding industrial sector that currently contributes to 38% of the economic output and is growing at a rate of 12.5%. Per capita energy consumption of the country is estimated at 14 million Btu, which is only a fraction of other industrializing economies in the region such as Thailand and Malaysia. With 40% of the households that have yet to receive electricity, and only 18% of the households that have access to pipeline gas, the energy sector is expected to play a critical role in economic and social development.

Population:	152 Million
Per capita income:	US$ 847
GDP growth rate:	8.4%
Industry growth rate:	12.5%
Literacy:	50%
Population below poverty line:	24%
Households with electricity:	60%
Households with natural gas:	18%

Source: Pakistan Economic Survey 2004-05 Latest GoP estimates for per capita income and population below poverty line

Policy Framework

Key elements of the policy response of the country to meet the energy requirements of an expanding economy are summarized below:

- ***Adequate Energy Supplies:*** The energy sector plans focus on development of indigenous energy resources, import of energy at competitive prices to meet the deficits, infrastructure for delivery of energy to the consuming sectors, and systems to assure reliability, efficiency, and economy of supply.
- ***Security of Energy Supply:*** Recognizing the uncertainty in the international energy markets and emerging requirements of other developing economies such as India and China, the energy plans focus on maximum utilization of indigenous energy resources to lower the dependence on imported energy, and diversification of the energy mix to manage risks and external shocks.
- ***Long-term Viability of the Energy Sector:*** The cornerstone of the government policy to assure long term sustainability of the energy sector is shifting from a predominantly state controlled industry to a structure where the government maintains a strategic presence, while the private sector plays a leading role in development of the energy sector. Supporting policies to achieve this objective include appropriate distribution of responsibilities within the government institutions for policy formulation, regulation, administration to avoid overlaps and conflicts, policies and regulations that provide appropriate incentives and encourage competition in the private sector, and sustainable pricing regimes that account for cost-of-service and subsidies that are transparent and address the social and environmental concerns.

Implementation Approach and Strategy

To achieve these objectives, the government has adopted an approach based on implementation of integrated energy development plans that take into account crosssectoral economic impacts of energy options and projects through the supply and demand chain. Policies and plans in place target further development of indigenous conventional energy resources including oil and gas, hydel, and coal by providing appropriate incentives and a level playing field to the private sector. Plans for meeting the energy needs of rural areas give special emphasis to exploitation of renewable energy potential, taking into account the economic cost of

delivering energy from alternative sources and benefits associated with decentralized resource development. Finally, longer term strategies focus on meeting the energy deficits by establishment of energy trade corridors to capitalize on the proximity of Pakistan to resource rich countries in the Middle East and Central Asia.

Primary Energy Supply and Demand

Pakistan has a well developed infrastructure for energy. The gas transmission infrastructure connects to 4.26 million households and commercial establishments addition to bulk of the industries and thermal power generating units in the country, and includes 9,060 high pressure transmission pipelines and over 225,000 HP of compression capacity. The power transmission and distribution network serves over 16.3 million residential and commercial and 0.23 million industrial customers, and includes 40,500 km of high voltage transmission lines. In addition, a network of oil pipelines transport crude oil and products to inland refineries and market centers, and the ports at Karachi are well equipped to handle import of crude oil and petroleum products that accounts for a major fraction countries demand, and limited quantities of coal imported into the country.

Figure 1 summarizes the primary energy supply picture for the country. Total energy supplies were 56 MTOE (Million Tons Oil Equivalent) in FY 2005. With an annual production of 3,685 MMscfd (28 MTOE), gas accounts for 51% of energy supply, followed by oil at 29%, hydel at 11%, and coal at 8%. Pakistan currently meets only 19.9% of its oil demand from indigenous resources.

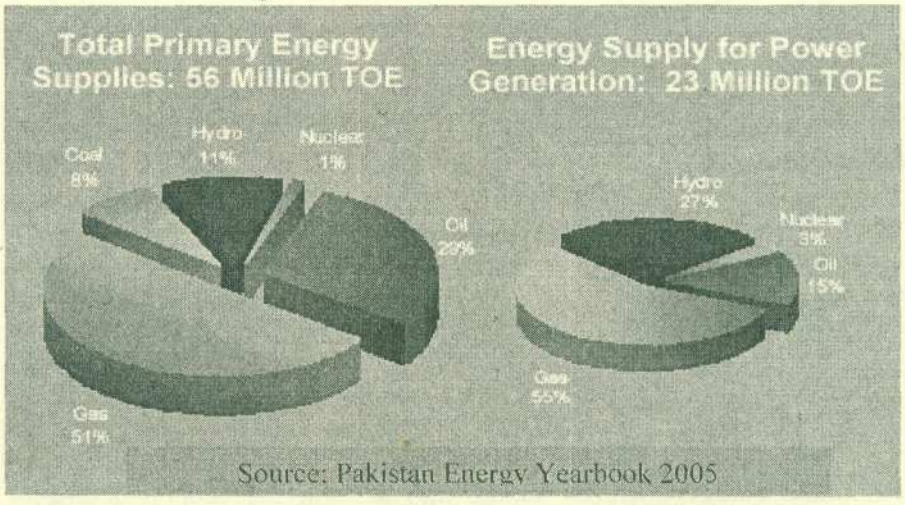


Figure-1

The power sector accounts for 23 MTOE or 41% of energy supply, of which 55% is gas, 27% hydel, and 15% is oil. Nuclear energy accounts for only 3% of power generation. Current installed capacity in the country is 19,160 MW of which 34% is hydel, and bulk of the remaining is thermal. Sector wise energy consumption in FY 2005 is illustrated in Figure 2. Industrial sector dominates the market with 41% of the demand, followed by transport sector at 31% and residential at 21%.

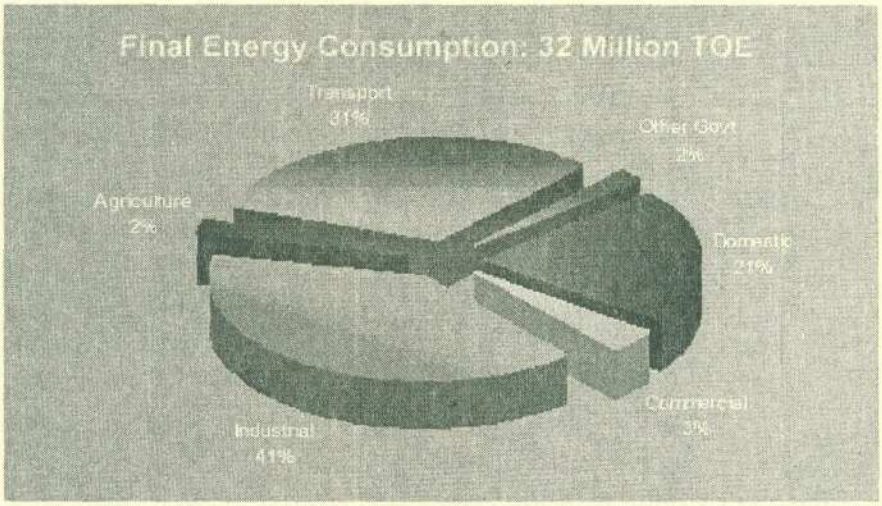


Figure-2

Source: Pakistan Energy Yearbook 2005

Projected Energy Demand and Deficits

Projected energy demand, assuming a GDP growth rate of 6.5% consistent with recent trends, is summarized in Figure 3. Over the next 20 year period, overall demand for energy is expected to increase by a factor of 3.5, from a current level of 56 MTOE to 198 MTOE.

	FY05	FY15	FY25	FY05	FY15	FY25
	Million TOE			% Share		
Oil	16	29	47	30	27	24
Gas	28	56	93	48	50	47
Coal	4	9	17	8	8	8
Hydel	7	13	29	12	12	15
Renewable	-	1	5	0	1	2
Nuclear	1	2	7	1	2	4
Total	56	110	198	100	100	100

Figure-3

Source: Medium-Term Development Framework: 2005-10, Planning Commission

Note: Government of Pakistan adjusted to GDP growth rate of 6.5% and updated for power generation plans

The projections assume current long term plans for power generation with emphasis on development of coal, hydel and nuclear resources, consistent with the policy of the government to develop the indigenous resource base and diversify the energy mix. The share of oil in the energy mix is expected to drop in view of higher oil prices in the international market, and the policy of the government to switch lower cost alternatives for power generation, including an aggressive program for development of nuclear power and renewable energy sources. The sensitivity of demand for energy to the economic growth rate is illustrated in Figure 4. Alternative scenarios for economic growth assuming growth rates of 5.5% and 7.4% were considered to test the impact of GDP growth rate on the demand for energy. The 7.4% scenario corresponds to an 'optimistic' economic growth rate assumed in the MTDF, while the 5.5% scenario represents a 'reasonably conservative outlook' for economic growth, based on a historic average. Over the next 20 year period, the demand for energy under these scenarios varies by about 25%, dropping to 155 MTOE corresponding to an economic growth rate of 5.5%, and increasing to 246 MTOE corresponding to an economic growth rate of 7.4%.

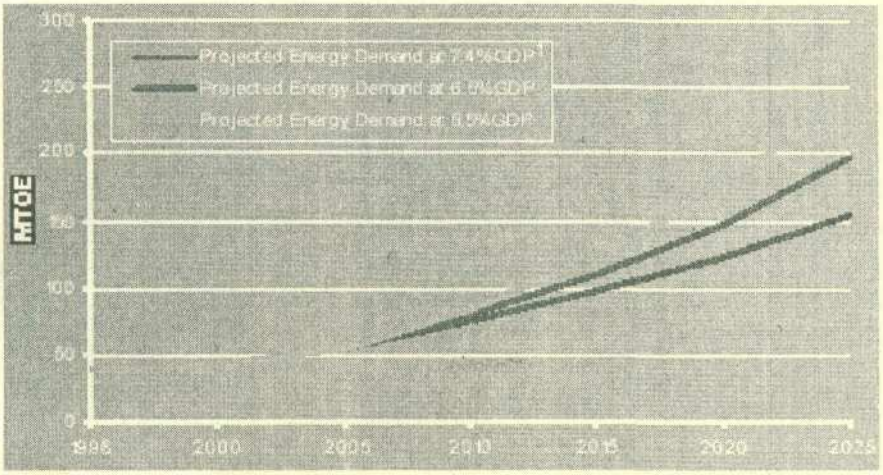


Figure-4
The Medium Term Development Framework, 2005-10. Planning Division assumed a GDP growth rate of 7.4%

Projected indigenous energy supply and deficits corresponding to the 6.5% GDP growth rate are summarized in Figure 5. Production of oil and gas in the country is expected to improve slightly in the near term but decline in the long run, given the current onshore exploration activities and resource outlook, and a low likelihood of a major offshore discovery.

Million TOE

	FY05	FY15	FY25
Oil	3	4	2
Gas	26	34	19
Coal	2	5	13
Hydel	7	13	29
Renewable and Nuclear	1	3	12
Total Indigenous Supply	39	61	75
Total Energy Requirement	54	110	198
Deficit	**15**	**50**	**122**
Deficit as % of Energy Requirement	**28**	**45**	**62**

Figure-5
Source: Medium-Term Development Framework: 2005-10, Planning Commission

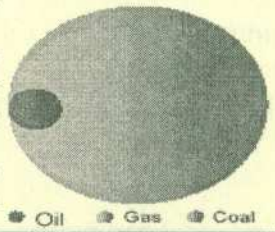
Note: Government of Pakistan adjusted to GDP growth rate of 6.5% and updated for power generation plans

Availability of coal, hydel, nuclear and renewable energy is projected to improve significantly, in line with current resource development plans. The availability of energy form these sources, however, will not be enough to meet the growing demand of the economy. The energy deficit which stands at 15 MTOE or 28% of the energy demand presently will increase to 122 MTOE by 2025, corresponding to 62% of the demand. This outlook clearly indicates a need to place development of the indigenous resource base on a high priority, followed by long-term arrangements to acquire energy from external sources that are affordable and reliable.

Energy Resource Potential and Risks

Energy resource potential for the country is summarized in Figure 6. The reserves to production ratio is currently 13 and 22 for oil and gas respectively, while for coal it is 720, and only 16% of the hydel potential been realized. Major unexploited reserves of coal located in the Thar Desert in the Sindh province.

Oil	41 MTOE	309	Million bbl
Gas	629 MTOE	29	tcf @ 900 btu/scf
Coal Proven	991 MTOE		3,303 MT
Coal Inferred	22,680 MTOE		50,700 MT
Coal Hypothetical	50,410 MTOE		112,700 MT
Installed Hydel	6,600 MW		
Potential Hydel	41,700 MW		



Fuel	*Annual Production*	*Reserves to Production Ratio*
Oil	24.12 Million bbl	13
Gas	1.34 tcf @ 900 btu/scf	22
Coal	4.59 MT	720
Hydel Potential Realized		16%

Figure-6

Development of these reserves, however, presents a major challenge as the coal is of inferior quality, with heating value of 5,700 Btu/lb, sulfur content of over 1%, ash over 6%, and moisture of about 50%. The over burden that will have to be removed to access the coal seams is also soft and has a depth in the range of

175- 230 m, indicating the need for open pit mining that will involve significant upfront investments. Other constraints that increase the costs and commercial risks in development of Thar coal resources include limited road and power infrastructure to support the initial phases of project development, and scarcity of fresh water in the area.

In case of hydel projects, government plans include an aggressive program to develop sites that have been identified, recognizing the economic benefits associated with power generation as well as storage of water for agricultural use. Constraints and risks that can limit the extent to which this potential can be realized in the near term include location of most of the sites in mountainous regions in the north where construction of access roads can involve significant investments, cost of resettlement of affected populations, and longer lead times associated with detailed technical studies required for project design.

In view of the above outlook for exploitation of the domestic resource base and associated risks, Pakistan given high priority to tapping the energy resources in region, and several projects for import of natural gas from the gas rich countries in the Middle East and Central Asia have received serious attention. These include pipelines for import of gas from Turkmenistan, Iran, and Qatar. In addition, import of power from Tajikistan and Kyrgyzstan that are rich in hydel resources is also under active consideration. The development of these options for importing energy has been constrained by the sensitive regional security environment, special technical issues, and complexities associated with commercial and operating arrangements typical of large projects requiring inter-country agreements.

Economic Considerations in Energy Planning

Figure 7 illustrates the comparative economic costs of fuels for the country, assuming a crude oil price of $ 60/bbl and prevailing prices of other fuels in the international market. While delivered cost for local and imported coals is under $ 3/MMBtu, delivered cost of natural gas and LNG is estimated at $ 4 and $ 6/MMBtu respectively, allowing for price differentials associated with liquefaction, transportation, and regasification

for LNG and netback values available to the suppliers. The delivered prices of petroleum products are substantially higher that those for coal and natural gas, and are currently estimated at over $8/MMBtu for high sulfur fuel oil (HSFO) and over $13/MMBtu for transport fuels including diesel and motor gasoline.

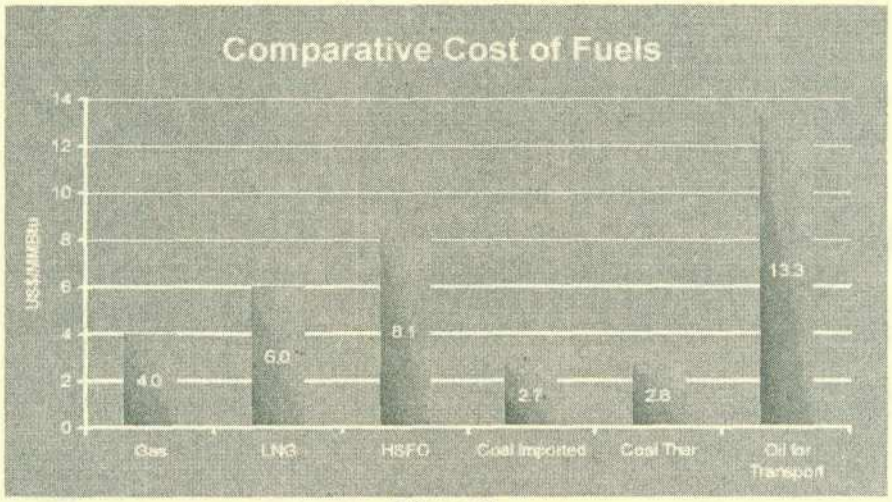


Figure-7

Note: HSFO price corresponding to US$ 60/bbl crude. Delivered price of imported coal assumed at US$ 75/tonne

The economic cost of energy supplied in 2005 (Figure 8) on the basis of these prices is estimated at $15.3 billion, of which 48% is attributable to the oil used in sectors other than power (mainly transport and agriculture), 8% to HSFO used mainly for power generation, 17% to gas used in the industry (inclusive of fertilizer), residential, and commercial sectors, 12% to gas used for power generation, and the remaining 15% shared by hydel, coal, and nuclear energy. In view of this distribution of energy costs, sectors and end-uses that require special attention in energy planning include oil use in transport sector, provision of natural gas for sectors other than power where economics of switching to alternative liquid petroleum and solid fuels such as fuel oil and coal are not favorable, and selection of fuels and technologies for power generation.

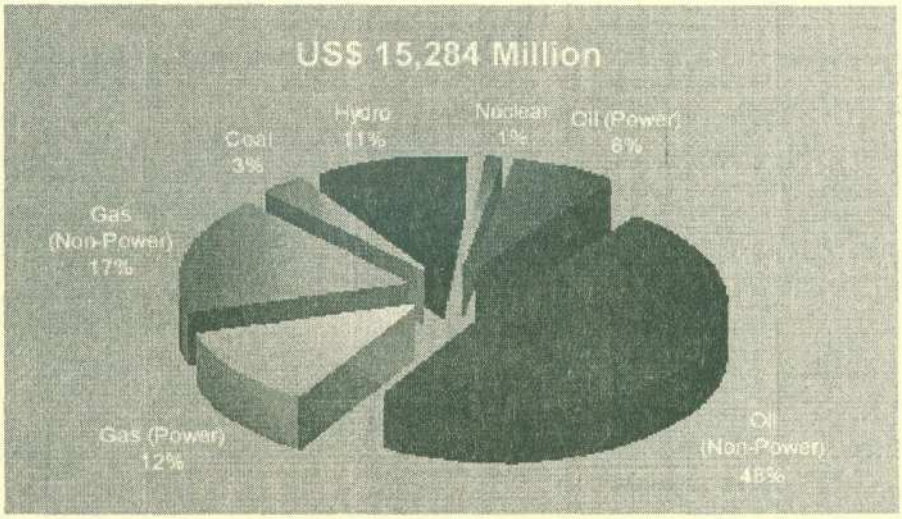


Figure-8

Source: Assumed prices of energy: Oil (power) 8.13 US$/MMBtu, Oil (non power) 13.30 US$/MMBtu, Gas 4.00 US$/MMBtu

Note: Coal 2.70 US$/MMBtu, Hydro and Nuclear 5.73 cents/kWh (equivalent to electricity generated from imported **coal)**

Cost of power generation for alternative technologies and fuels assuming prevailing capital and operating costs and economic cost of energy as indicated in Figure 7 are illustrated in Figure 9. While the economic cost of electricity produced from coal, natural gas, hydel, and nuclear power plants falls in the range of US cents 5-6/kWh, the cost of producing electricity from LNG approaches 7 cents/kWh and that from HSFO exceeds 9 cents/kWh. The country therefore cannot afford to install and operate power generation capacity on imported LNG or HSFO. Priorities for meeting the energy needs of the country in the long-term include import of natural gas, generation of electricity from indigenous and imported coal, and development of hydel and nuclear resources.

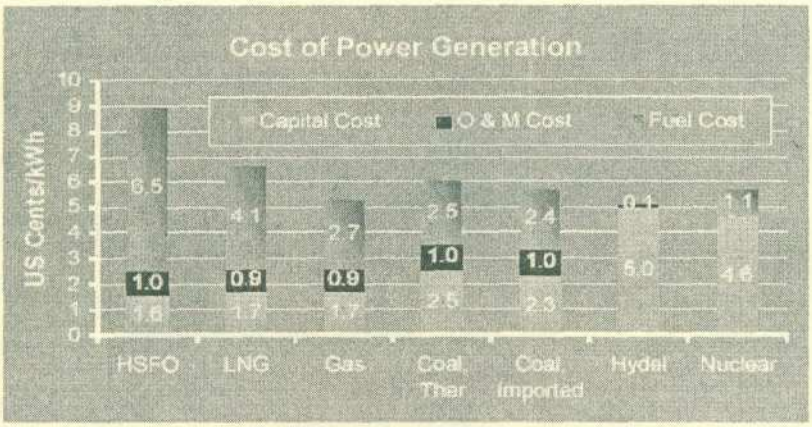


Figure-9

Energy Options and Scenarios

While the cost of meeting the energy requirements of a rapidly expanding economy will be substantial, the country has a range of options available to manage the supply and demand for energy. The choices made will also determine the extent to which the risks associated with variations in energy prices and availability of fuels in the international market can be managed, and the cost of delays or inability to develop indigenous resources can be absorbed. The following cases were analyzed in terms of total energy requirements, energy deficits and imports, and cost of imported energy:

- Base Case: Unconstrained gas import
- Low Gas: Imported gas not available, LNG and imported coal to replace imported gas in Base Case
- High Thar: Thar coal to replace imported coal for power generation in Low Gas Case
- Low Hydel: Hydel capacity additions reduced by 30%, imported coal to replace hydel power generation in Low Gas Case
- High Nuclear: Additions in nuclear capacity increased by 100% in 2015 and 200% in 2025 over the Base Case
- Energy Conservation: Energy conservation applied on Base Case

The Base Case assumes that the country will be able to import natural gas to meet the emerging energy deficits. This is the

least cost option, given the proximity of the country to gas surplus regions, the opportunity of transporting gas through inland pipelines, and the economic advantage offered by gas in end-uses such as fertilizer production, combined cycle gas turbines, cogeneration, and CNG vehicles. This case assumes that the gap in power generation capacity, after accounting for the capacity planned on hydel, nuclear, and renewable sources, will be filled by CCGT units operating on imported natural gas. The Low Gas Case represents the scenario where imported gas is not available, and the deficit has to be made up with the least cost fuel in absence of natural gas. In this case, the country will have to import LNG to meet the established demand for natural gas in the residential, commercial, fertilizer, and industry sectors, and generation capacity in the power sector that can operate only on natural gas.

The gap in power generation capacity, filled by imported gas in the Base Case, was assumed to be filled by capacity based on imported coal which is the least cost option in absence of the CCGT option. The High Thar Case represents the option of enhanced utilization of Thar coal to replace imported coal in the Low Gas Case.

The Low Hydel Case represents the case under which the risks associated with development of hydel capacity such as the negative outcome of feasibility studies and higher than expected resettlement costs come into play. The hydel capacity additions were reduced by 30% for this case, to be replaced by the next economic option which is imported coal. In the High Nuclear Case, installed nuclear capacity was increased from 4,400 MW in the Base Case to 7,200MW, assuming a 100% increase in capacity additions by 2015, and 200% by 2025. Finally, the Energy Conservation scenario assumes a conservative penetration rate for energy efficient technologies and demand side management, resulting in a reduction in demand of about 9% across the economy. Figure 10 summarizes the energy demand and the power generation capacity required in each of the above scenarios.

Scenario	Oil MTOE	Gas MMscfd		LNG MMscfd	Coal MTOE		Hydel MW	Nuclear MW
		Indigenous	Imported		Indigenous	Imported		
Base Case	47	2,290	8,170	750	13	3	20,325	4,400
Low Gas	47	2,290	–	6,060	13	35	20,325	4,400
High Thar	47	2,290	–	6,060	44	3	20,325	4,400
Low Hydel	47	2,290	–	6,060	13	43	14,230	4,400
High Nuclear	47	2,290	–	6,060	13	21	20,325	7,200
Energy Conservation[1]	42	2,060	7,450	675	12	3	18,800	3,740

Figure-10

Energy Conservation Scenario: Technical potential estimated at 15% power, 10% for oil and gas in industry and transport sectors. Achievable by 2025 assumed at 50% of technical potential.

The economic cost of imported fuels under the Base Case is illustrated in. Fuel imports under the base are projected to increase from the Figure 11current level of $ 7.5 billion to $ 38.2 billion in 2025, with oil accounting for 65% of the energy imports, followed by gas at 30%.

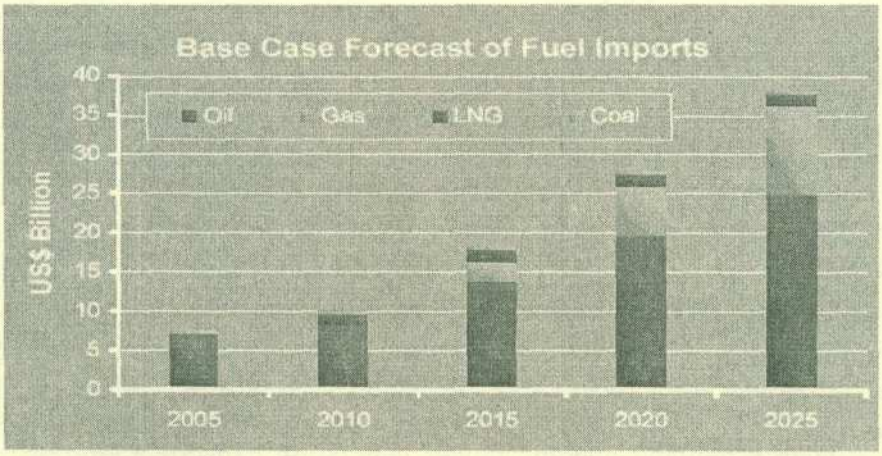


Figure-11

Additional cost of fuel imports under each of the scenarios studied is illustrated in Figure 12. Annual additional cost of imported fuels for the Low Gas Case are estimated at $ 0.8 billion in 2015, increasing to $ 3.2 billion in 2025, and represent the additional cost of energy imports in case the country is unable to import gas through pipelines. Comparable figures for the Low Hydel Case are $ 1.2 billion in 2015 and $ 4.1 billion in 2025, and for the High Nuclear Case are $ 0.6 billion 2015 and $ 1.7 billion in 2025. The High Thar Case yields a saving of $ 0.3 billion in 2025 over the Base Case, on account of lower energy cost of Thar coal.

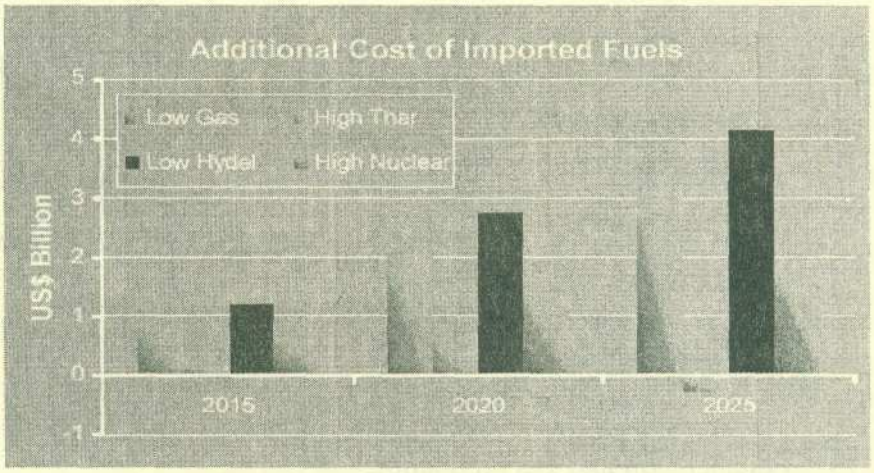


Figure-12

Conclusions and Priority Areas for Action

An assessment of the current and projected energy requirements of the country and additional costs for energy imports under alternative scenarios and options leads to the following conclusions:

- While Pakistan has substantial coal and hydel resources, it is not possible to develop and utilize these resources in the short term in view of inherent constraints
- The dependence of the country on imported energy is therefore expected to increase considerably in the near to medium term

- Gas import pipelines can deliver energy at competitive prices in the near term to meet the demand of priority consumer segments such as the residential, industrial and power sectors
- Development of Thar coal and nuclear power in the medium term can secure the country against high energy prices in the global markets and risks associated with large scale development of hydel resources
- Development of indigenous coal can be coupled with inclusion of imported coal for greater diversity in the mix of imported fuels Key elements of an action plan to meet the energy requirements of the country in the long term, to balance the risks associated with rising world energy prices and to protect the economy against uncertainties in development of domestic resource base include:

Import of Energy:

- Implementation of gas pipeline projects, LNG projects and projects for import of electricity from CAS on a fast track basis

Development of Indigenous Energy Resources:

- Enhanced oil and gas production
- Detailed technical and economic assessment of coal mining and coal based-power generation
- Assessment of advanced technology options for gasification and coal bed methane
- Enhanced hydroelectric power generation
- Enhanced nuclear power generation
- Mainstreaming renewable energy

Energy Efficiency and Management:

- Optimization of energy mix
- Demand side management in industrial sector
- Mass transit for major urban centers

Emerging Investment Opportunities in the Energy Sector

The government expects the private sector and foreign direct investment to play a central role in development of the energy sector in the country. Specific investment opportunities in the energy sector where the private sector can participate are summarized below:

- **Oil and Gas Industry**
  - ***LNG Project:*** Consultants have been engaged to provide advice on technical, financial, and commercial issues, and an RFP will be issued to short-listed firms in the near future.
  - ***Gas Import Pipelines:*** Technical parameters have been defined through pre-feasibility studies and technical working groups, and joint working groups have been established to address technical, commercial, project financing, and other issues
  - ***Oil Refining:*** Expressions of interest are being invited for a 200,000 to 300,000 BPD coastal refinery located near Karachi.

- **Electricity and Power Generation**
  - ***Import of Electricity from CAS:*** Further work is being initiated to evaluate the technical and economic aspects of power import.
  - ***Hydroelectric Generation:*** Proposals have been invited from the private sector for 7 projects with a total capacity of 1,620 MW.
  - ***Power Generation from Thar Coal:*** Private sector is currently involved in preparation of feasibility studies for mining and power generation.
  - ***Power Generation from Imported Coal:*** Work has been initiated for involving private sector in setting up power generation units in the coastal areas.
  - ***Power Generation from Renewable Sources:*** Renewable energy policy framework has been drafted and an incentive package has been defined for fast-track capacity additions. In addition to above, the

government plans to divest 51% of its shareholding in the following concerns to give majority ownership and management control to the private sector.

- ***Power Generation and Distribution:*** Jamshoro Power Company, Faisalabad Electric Supply Company, and Peshawar Electric Supply Company
- ***Oil Marketing:*** Pakistan State Oil Co. Ltd., the largest oil marketing company in the country with approximately 70% share of the market
- ***Gas Transmission and Distribution:*** SNGPL and SSGCL, state owned utilities that currently account for over 86% of the gas transmission and distribution business in the country.
- ***Petroleum E&P:*** Pakistan Petroleum Ltd. and Oil & Gas Development Co. Ltd., state owned companies that account for 45% of gas and 53% of oil production respectively in the country. In case of Oil & Gas Development Co. Ltd, divestment of 10% to 15% equity through simultaneous GDR offering and domestic secondary offering will precede the divestment of 51% shares.

Author

Mr. Ahmed is a Chemical Engineer by training (University of Edinburgh, UK) with over 36 years of work experience in the energy sector. Mr. Ahmed has spent about 20 years in the energy industry (mainly downstream oil and gas), with private and public sector entities, in the UK and Pakistan. Mr. Ahmed was the Advisor to the Prime Minister on Energy from May 2005. In this capacity, Mr. Ahmed advised on energy sector policy and planning, assisted with investment promotion, and coordinated the development of major energy infrastructure projects. Mr. Ahmed has represented the Government of Pakistan at a number of professional forums.