PAKISTAN

(UPDATED 2011)

1. GENERAL INFORMATION

1.1 COUNTRY OVERVIEW

1.1.1 GOVERNMENTAL SYSTEM

The governmental system of Pakistan is based on the constitution of 1973; a federal parliamentary system with a President as head of state and a Prime Minister as head of government. The parliament consists of the Lower House, which is called National Assembly, and the Upper House called Senate. National Assembly members are directly elected for five-year terms while Senate members are elected by provincial assemblies, with equal representation from each of the four provinces as well as representatives from the Federally Administered Tribal Areas and Islamabad Capital Territory. Both the Senate and National Assembly may initiate and pass legislation.

Executive power lies with the President and the Prime Minister. An electoral college composed of members of the national and provincial legislatures elects the President for a five-year term. The Prime Minister is an elected member of the National Assembly and is the leader of the National Assembly's dominant party or coalition. The Prime Minister is assisted by a cabinet of Ministers who are appointed by the President on the advice of the Prime Minister.

Pakistan has four provinces. Each province has a Governor; appointed by the President, an elected legislative assembly and a Chief Minister who is selected by the party or a coalition majority in legislative assembly. The Chief Minister is assisted by a council of ministers chosen by the Chief Minister and approved by the Governor.

1.1.2 GEOGRAPHY AND CLIMATE

Pakistan is situated in South Asia and it stretches over 1,600 kilometers from south-west to north-east. It lies between 23° and 37° north latitude and 61° and 78° east longitude. The country is a land of diversified physical features, and six major geographical regions can be identified as:

1. Northern Mountains;
2. The Western off-shoots of the Himalayas;

3. Baluchistan Plateau;
4. Potowar Plateau and the Salt Range;
5. Upper and Lower Indus Plains;
6. The Thar Desert.

Pakistan has great diversity in climate. The winter is extremely cold in the northern mountains and western off-shoots of the Himalayas. The mountains remain snow covered throughout the year while the summer is extremely hot in the Baluchistan Plateau and the Lower Indus Plain as temperatures reach up to 53°C at some places in these regions.

Pakistan experiences a general deficiency of rainfall. The country is on the margin of the monsoon climate and most of the rainfall is in the months of July, August and September. Flooding is a regular feature of the Indus plain, and some parts of the Sindh province are dependent on flood irrigated agriculture.

1.1.3 POPULATION

On 1st January 2010, the population of Pakistan was about 173.5 millions with the population density is 218 inhabitants per square kilometer. At present, the population growth rate is about 2.1% per annum (GOP: 2010). The population related information over the last four decades has been given in Table 1.

TABLE 1 POPULATION INFORMATION

							Average annual growth rate
	1970	1980	1990	2000	2005	2010	2000 to 2010
Population (millions)	59.7	80.2	108.2	137.5	152.5	173.5	2.4%
Population density (inhabitants per square km)	75.0	100.8	136.0	172.7	191.6	218.0	2.4%
Urban population as % of total	25.4	28.3	30.2	33.4	34.0	36.3	
Area (square km)	796,095						

Notes:-1) Years in this Table are from 1st January – 31st December
2) Population data is as on 1st January.
Source: (GOP: 2010)

1.1.4 ECONOMIC DATA

Over the last four decades, economy of the country has grown at an average annual rate of 7.5% (in current US$). However, due to high population growth rate, per capita Gross Domestic Product (GDP) has increased at only 5.1% per annum during the same period. The present per capita income in Pakistan is US$ 1,095. The GDP statistics have been reported in Table 2.

TABLE 2 GROSS DOMESTIC PRODUCT (GDP)

							Average annual growth rate
	1970	1980	1990	2000	2005	2010	2000 to 2010
GDP (million of current US$)	9,107	19,114	35,432	68,804	103,147	165,666	9.2%
GDP (million of constant 2000 US$)	15,277	24,442	44,334	68,804	88,722	109,536	4.8%
GDP per capita (current US$/capita)	153	238	327	500	733	1,095	8.1%

Notes:-1) Years in this Table are fiscal (1st July – 30th June).
2) 2010 data is provisional.
Sources: (GOP: 2010)

1.2 ENERGY INFORMATION

1.2.1 ESTIMATED AVAILABLE ENERGY

Pakistan's commercial energy resources consist of coal, gas, oil, hydropower and wind. The energy resources are reported in Table 3. Pakistan does not have adequate oil reserves and has to import large quantities of crude oil and petroleum products to meet its energy requirements.

Pakistan has a considerable potential of wind energy in its coastal areas. Pakistan Metrological Department has conducted a survey of wind power potential of coastal areas of Pakistan and has identified the areas where economically feasible wind farms can be established. The potential areas cover 9,700 square kilometers with average annual wind speed of 7 meters per second at 30 meters height. The gross wind power potential of this area is 50,000 MW and the exploitable wind power potential is estimated to be about 11,000 MW

keeping in view the area utilization constraints. Average capacity factor of wind turbines in this area would be 30-32% (PMD: 2010).

TABLE 3 ESTIMATED ENERGY RESOURCES

	Fossil Fuels			Nuclear	Renewable	
	Solid	Liquid	Gas	Uranium	Hydro	Wind
Total amount in specific units	3,450	41.1	23.2	n.a.	55	11
Total amount in exajoule (EJ)	68.3	1.8	22.1	n.a.	2.5	0.30

n.a. not available

Notes:-1) Specific units for solid & liquid: million tonnes, gas: trillion cubic feet, hydro and wind: GW

2) Solid consists of coal. It has been converted to energy at 19.8 GJ/tonne.
3) Crude oil has been converted to energy at 44.2 GJ/tonne.
4) Natural gas has been converted to energy at 950 GJ/million cubic feet.
5) Hydro power potential has been converted to energy at 50% plant factor and 10,550 GJ/GWh.
6) Wind power potential has been converted to energy at 30.0% capacity factor and 10,550 GJ/GWh.

Sources: (HDIP: 2010), (WAPDA: 2010) and (PMD: 2010).

1.2.2 ENERGY STATISTICS

The energy supply statistics are given in Table 4. For the last ten years, the indigenous oil production has been at the level of about 55,000-70,000 barrels per day (equivalent to about 15-21% of the country's oil consumption). Pakistan's natural gas production in year 2009-10 amounts to 4,063 million cubic feet per day.

TABLE 4: ENERGY STATISTICS (EXAJOULE)

							Average annual growth rate
	1970	**1980**	**1990**	**2000**	**2005**	**2010**	**2000 to 2010**
Energy Consumption							
Total	0.33	0.67	1.24	1.90	2.45	2.78	3.8%
Solid	0.02	0.06	0.09	0.09	0.19	0.20	8.4%
Liquid	0.17	0.20	0.50	0.83	0.73	0.88	0.6%

Gas	0.11	0.25	0.47	0.77	1.23	1.36	5.8%
Nuclear	-	-	-	-	0.03	0.03	21.9%
Hydro	0.03	0.16	0.18	0.20	0.27	0.30	3.8%
Energy production							
Total	0.18	0.46	0.83	1.17	1.78	1.91	5.0%
Solid	0.02	0.03	0.06	0.06	0.09	0.07	0.7%
Liquid	0.02	0.02	0.12	0.13	0.15	0.15	1.9%
Gas	0.11	0.25	0.47	0.77	1.23	1.36	5.8%
Nuclear	-	-	-	-	0.03	0.03	21.9%
Hydro	0.03	0.16	0.18	0.20	0.27	0.30	3.8%
Net import (Import - Export)							
Total	0.15	0.22	0.41	0.73	0.68	0.87	1.7%

- Less than 0.005 exajoule

Notes:-1) Years in this Table are fiscal (1st July – 30th June).

2) Energy consumption = Primary energy production + Net import (import – export).

3) Solid fuel consists of coal.

Sources: (GOP: 1978) and (HDIP: 2010).

Coal Production in 2009-10 was 3.4 million tonnes. Furthermore, 4.7 million tonnes coal was imported to meet the industrial requirement. The sectoral distribution of coal consumption is as follows: Cement and other industry: 56.8%, Brick kilns: 36.2%, as Coke: 5.4% and Power: 1.6%. The development of the coal mining industry in Pakistan, particularly for power generation is hampered by many constraints relating to the quality of coal, mining difficulties and organizational constraints.

During the year 2009-10, hydropower provided 29.8% of electricity in Pakistan. Although, Pakistan has relatively high endowment of hydropower potential, only 6,562 MW (12%) has been exploited. Some small and mini/micro hydro projects are under construction and a number of medium and large size hydroelectric projects have been planned/proposed.

The nuclear power generation contributed 3.0% to the total electricity generation of Pakistan in year 2009-10. At present country has a 137 MW, Pressurized Heavy Water Reactor (PHWR) type nuclear power plant, KANUPP (K-1) and a 325 MW, Pressurized Light Water Reactor (PWR) type plant, CHASNUPP unit-1 (C-1). The construction of another PWR type nuclear unit of 340 MW capacity is in the final stages of construction at Chashma site which is expected to be commissioned in June 2011.

1.2.3 ENERGY POLICY

The energy sector, to a large extent, has been owned and operated by the Government of Pakistan (GOP). During the last two decades, GOP formulated various policies and programmes to reform the energy sector. Besides improving the efficiency of public sector institutions, policies have been made to increase the private sector participation in the development of the energy sector. The legal and institutional framework has been setup for restructuring of energy sector entities owned by the public sector and to create a market in which private companies can work under the regulatory authorities to provide energy/electricity on competitive basis.

GOP formulated the Medium Term Development Framework (MTDF) 2005-10 (GOP: 2005). The Framework translates the vision of long-term (2005-30) sustainable development into a mix of actions and policies to decide the role of public sector in the development process, and to facilitate the private sector to play its role. The Framework identifies issues in the energy sector to design strategies for development and policies for their implementation. The aim of current energy policy is to ensure sustainable supply of energy to all sectors of economy at a competitive price through development of indigenous energy resources (coal, hydro, nuclear and renewables) and reduction in energy import dependence.

1.3 THE ELECTRICITY SYSTEM

1.3.1 ELECTRICITY POLICY AND DECISION MAKING PROCESS

Pakistan power sector was owned and served by two public utilities; the Pakistan Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC). Over the years it was observed that these institutions were not able to meet the electricity demands of the country that resulted in supply-demand gap. The performance of power sector was continuously deteriorating due to the institutional weaknesses, lack of management in tariff structure and subsidies. To improve the performance of power sector, the Electric Power Act was passed in 1997 and an institutional framework was setup. National Electric Power Regulatory Authority (NEPRA) was established to function as an independent regulator and to ensure a transparent, competitive, commercially-oriented power market in Pakistan.

In the new setup, the Power Wing of WAPDA was unbundled into four Generation Companies (GENCOs), nine Distribution Companies (DISCOs) and one National Transmission and Despatch Company (NTDC). The large hydro power projects remained the responsibility of WAPDA. The KESC has also been privatized. Nuclear power plants remained under Pakistan Atomic Energy Commission (PAEC). Private Power and Infrastructure Board (PPIB) have been established to facilitate private investment in power sector. Alternative Energy Development Board (AEDB) has been set-up for the exploitation of renewable energy resources.

The overall planning of electricity system is under the control of The National Economic Council (NEC) which is the supreme body responsible for ensuring balanced development of the country. It was created in December 1962 under Article 145 of the Constitution of Pakistan. NEC is headed by the Head of the Government. Its members are some of Federal Ministers, the Governors/Chief Ministers of the provinces, and the Deputy Chairman of the Planning Commission.

The Planning Commission is the chief instrument for formulating the national plans. The Energy Wing of the Planning Commission estimates the energy demand on the basis of information obtained from all concerned entities and formulates unified short- and long-term national energy plans. The NEC approves all plans and policies relating to energy/electricity sectors development. The Executive Committee of the National Economic Council (ECNEC) supervises implementation of the energy policy laid down by the Government, and approves any energy sector project to be built by the public sector. The planning and development of nuclear power is the responsibility of PAEC.

1.3.2 STRUCTURE OF THE ELECTRIC POWER SECTOR

The Ministry of Water and Power is responsible for development of water and power resources in the country. It handles all issues related to electricity generation, transmission & distribution, pricing and consumption in the country. The Ministry exercises this function through respective organizations. It also performs certain specific functions such as coordinates power sector plans, formulates policy and specific incentives, and liaisons with provincial governments on all related issues.

The following are the major stakeholders in the electricity sector.

1.3.2.1. Generation Companies (GENCOs)

a) Northern Power Generation Company (NPGC)

It owns and operates five thermal power plants of 1,980 MW capacity; Muzaffargarh (1350 MW), Multan (195 MW), Faisalabad Steam (132 MW), Faisalabad Gas Turbine (244 MW) and Shahdra (59 MW).

b) Central Power Generation Company Ltd (CPGCL)

It owns and operates two thermal power plants of 1,690 MW capacity; Guddu (1655 MW) and Quetta (35 MW).

c) Jamshoro Power Company Ltd (JPCL)

JPCL owns and operates two thermal power plants of 1,024 MW capacity; Jamshoro (850 MW) and Kotri (174 MW).

d) Lakhra Power Generation Company Ltd (LPGCL)

LPGCL owns and operates a coal power plant at Lakhra of 150 MW capacity.

e) Rental Power Plants

GOP is acquiring power plants on rental basis due to acute shortage of electricity in the country. Presently, rental power plants of 172 MW capacity are in operation.

1.3.2.2. Pakistan Water and Power Development Authority (WAPDA)

WAPDA is responsible for planning and execution of hydro power projects. At present, WAPDA is operating 6,444 MW hydro power capacity.

1.3.2.3. Pakistan Atomic Energy Commission (PAEC)

PAEC is responsible for planning, implementation, operation and maintenance of nuclear power plants (NPPs). Presently two NPPs, C-1 (325 MW) and K-1 (137 MW), are in operation and a third NPP, C-2 (340 MW) is under construction.

1.3.2.4. National Transmission and Despatch Company (NTDC)

The NTDC is responsible to construct, operate and maintain electricity transmission system of the country that comprises transmission lines of 220 kV & 500 kV, and grid stations linking all power plants of the country. It also provides services to the distribution companies in designing and construction of 132 kV transmission lines and grid stations.

1.3.2.5. Distribution Companies

Following are nine distribution companies:

(i) Peshawar Electric Supply Company (PESCO)

(ii) Islamabad Electric Supply Company (IESCO)

(iii) Gujranwala Electric Supply Company (GEPCO)

(iv) Lahore Electric Supply Company (LESCO)

(v) Faisalabad Electric Supply Company (FESCO)

(vi) Multan Electric Supply Company (MEPCO)

(vii) Hyderabad Electric Supply Company (HESCO)

(viii) Quetta Electric Supply Company (QESCO)

(ix) Tribal Electric Supply Company (TESCO)

1.3.2.6. Karachi Electric Supply Company (KESC)

KESC is a private company responsible for generation, transmission and distribution of power to the city of Karachi and surrounding area (Uthal and Bela district). KESC owns and operates thermal capacity of 1,955 MW.

1.3.2.7. Private Power Infrastructure Board (PPIB)

PPIB provides support to private sector in implementing conventional power generation projects, including hydro power projects of more than 50 MW capacity. At present, 24 thermal IPPs (Independent Power Producers) with a total installed capacity of 7,301 MW and 3 hydel IPPs with a total of 118 MW installed capacity are operating in the country.

1.3.2.8. Alternative Energy Development Board (AEDB)

The AEDB is responsible for promoting and facilitating exploitation of the renewable energy resources in Pakistan. The first commercial scale wind power plant of 56.4 MW is being constructed by the Zorlu Enerji Group of Turkey at Jhimpir, in Sindh province (AEDB: 2010). The plant is being constructed in two phases; first phase of 6 MW has been commissioned while the capacity will be increased to 56.4 MW in the second phase. Construction of the second phase is expected to complete in 2012.

1.3.2.9. Regulators

a) National Electric Power Regulatory Authority (NEPRA)

NEPRA is responsible for: (i) granting licenses for generation, transmission and distribution of electric power; (ii) determining electric tariffs for the consumers and producers; and (iii) prescribing performance standards for generation, transmission and distribution companies.

b) Pakistan Nuclear Regulatory Authority (PNRA)

PNRA is responsible for granting licenses to all nuclear installations in the country including NPPs. The Authority is formulating and implementing effective regulations to ensure safe operation of NPPs.

1.3.3 MAIN INDICATORS

Table 5 reports the data of electricity production and installed capacity in the country over the last four decades and Table 6 provides energy related ratios.

TABLE 5: ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

							Average annual growth rate (%)
	1970	**1980**	**1990**	**2000**	**2005**	**2010**	**2000 to**
Capacity of electrical plants (GWe)							
Thermal	1.05	1.79	4.83	12.44	12.42	13.32	0.7%
Hydro	0.67	1.57	2.90	4.83	6.50	6.56	3.1%
Nuclear	–	0.14	0.14	0.14	0.46	0.46	12.9%
Total	1.72	3.50	7.86	17.40	19.38	20.34	1.6%
Electricity production (TWh)							
Thermal	3.54	6.17	20.72	46.06	57.16	64.37	3.4%
Hydro	2.92	8.72	16.93	19.29	25.67	28.51	4.0%
Nuclear	–	*	0.29	0.40	2.80	2.89	21.9%
Total	6.46	14.89	37.94	65.75	85.63	95.77	3.8%
Total electricity consumption (TWh)	4.62	10.35	28.77	45.59	61.33	74.35	5.0%

* Less than 0.01 TWh

- Nuclear power was introduced after 1970.

Notes:- 1) Years in this Table are fiscal (1st July – 30th June).

2) Electricity transmission and distribution losses are not deducted.

Source: (HDIP: 2010).

The share of hydro power in total electricity generation is about 30%. The availability of hydel power generation is subjected to seasonal variation i.e. it depends upon the reservoir levels, inflow of water and discharge of water from the reservoir. These variations are further deteriorated by the regulation on water outflow from the storage dam for irrigation. As a result, the hydro capacity decreases to about 3,506 MW from installed capacity of 6,480 MW when the water level in the dams becomes low (NTDC: 2010).

TABLE 6: ENERGY RELATED RATIOS

	1970	1980	1990	2000	2005	2010
Energy consumption per capita (GJ/capita)	6	8	11	14	16	16
Electricity consumption per capita (kWh/capita)	77	129	266	332	402	428
Electricity production/Energy production (%)	14	18	31	40	38	39

Nuclear/Total electricity (%)	–	*	0.8	0.6	3.3	3.0
Ratio of external dependency (%)	23	18	24	30	22	25

* less than 0.1%.

Notes:-1) Years in this table are financial years (1st July – 30th June).

2) Energy consumption does not include wood.

3) Self generation is not included in electricity production and consumption.

4) External dependency is the ratio of net import and total energy consumption.

Sources: Based on Tables 1, 4 and 5

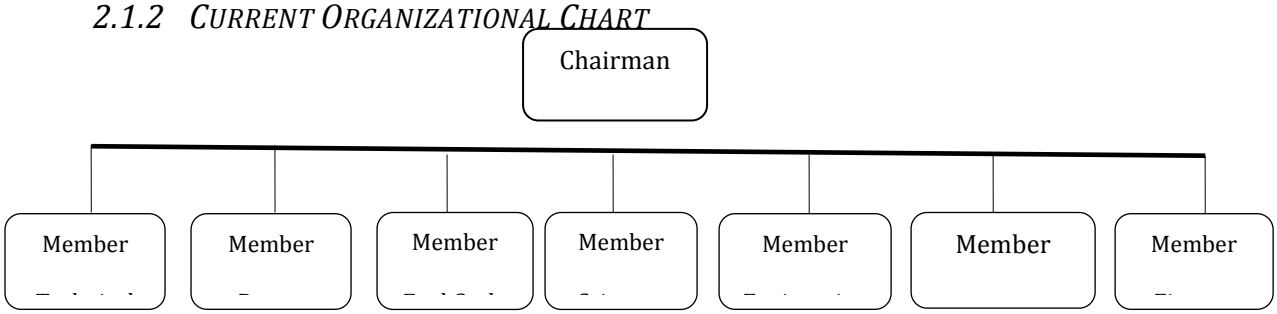
2. NUCLEAR POWER SITUATION

2.1 HISTORICAL DEVELOPMENT AND CURRENT ORGANIZATIONAL STRUCTURE

2.1.1 OVERVIEW

Pakistan Atomic Energy Committee was established in 1955. The Ordinance for Pakistan Atomic Energy Commission (PAEC) was promulgated by the President of Pakistan and later approved by the National Assembly in 1965. The functions of the PAEC includes research work necessary for the promotion of peaceful uses of nuclear energy in the fields of agriculture, medicine & industry and the execution of development projects including nuclear power plants for the generation of electric power. In the performance of its functioning, the Commission is guided by the instructions, if any, given to it by the Government.

2.1.2 CURRENT ORGANIZATIONAL CHART



PAEC has a Chairman and seven full-time Members. The organizational chart of PAEC has been shown in Figure 1.

Figure 1: Organizational Chart of Pakistan Atomic Energy Commission

2.2 NUCLEAR POWER PLANTS: OVERVIEW

Pakistan started construction of its first NPP, K-1, in 1966 at Karachi. The plant was connected to national grid on 18 October 1972. K-1, a PHWR of 137 MW capacity was constructed by the Canadian General Electric (CGE) under a turnkey contract. In 1976, vendor support was withdrawn. Thereafter, PAEC undertook manufacturing of some spares and fuel on an emergency basis and K-1 has been using indigenously manufactured fuel since 1980.

Despite the keen interest of Pakistan in building additional NPPs, it took more than two decades to start construction of the second NPP due to unfavorable international environment coupled with lack of indigenous technological and industrial capabilities for design and construction of NPPs. The construction of Pakistan's second NPP, C-1, a PWR, started in 1992 with the help of China National Nuclear Corporation (CNNC). It has a gross capacity of 325 MW. The plant was connected to the national grid on June 13, 2000. Since then, it is operating well. The third nuclear power plant C-2 of 340 MW capacity, an improved version of C-1, is in final stages of the construction and is expected to be commissioned in June 2011.

2.2.1 STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS

Table 7 reports the status and performance of NPPs in Pakistan. K-1 completed its design life of 30 years in 2002. After necessary refurbishments and up-gradations undertaken by PAEC, K-1 is now operating on 15-year extended life at a reduced power level of 90 MW. K-1 has produced 13.20 billion KWh of electricity upto 31st December 2010. C-1 has produced 21.04 billion KWh of electricity upto 31st December 2010. During 2010, capacity factor of C-1 was 80% and of K-1 was 39.2%.

TABLE 7: STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS

Station	Type	Net capacity (MW)	Operator	Status	Reactor supplier	Construction Date	Grid Date	Commercial date	Shutdown date	Capacity factor in 2010
K-1	PHWR	125*	PAEC	Operational	CGE	1st August 1966	18 October 1972	07 December-1972	-	43.1 %
C-1	PWR	300	PAEC	Operational	CNNC	1st August 1993	13 June 2000	15 September-2000	-	80.0 %

C-2	PWR	315	PAEC	Under Construction	CNNC	28th December 2005	March, 2011	June, 2011	-	

* K-1 re-licensed after completing design life of 30 years at 90 MW (Gross).

2.2.2 PLANT UPGRADING, PLANT LIFE MANAGEMENT AND LICENSE RENEWALS

A project "Long Term Safety of KANUPP" (LSFK) is in progress under the auspices of the IAEA. Two projects "Improve Safety Features of KANUPP" (ISFK) and "Safe Operation of KANUPP" (SOK) have been completed. These projects have been undertaken to ensure safe operation by averting plant degradation due to aging, introducing and adopting modern operational practices, and improving the design to some extent. Under Balancing, Modernization and Rehabilitation (BMR) project, KANUPP has upgraded its conventional equipment, such as Building Chillers, Service Air Compressors, Power Cables, Condenser Tubing, Boiler Cleaning and Rehabilitation etc. KANUPP also undertook the replacement of its obsolete regulating computers, control and instrumentation under the Technological Up-gradation project (TUP), under which most of the critical control and instrumentation loops and computers have been replaced.

After rehabilitation, various inspections and reviews of K-1 have been carried out by international experts. On fulfilling the regulatory requirements of PNRA, license has been granted to K-1 at a reduced power level of 90 MW.

2.3 FUTURE DEVELOPMENT OF NUCLEAR POWER

2.3.1 NUCLEAR POWER DEVELOPMENT STRATEGY

The Energy Security Plan of Pakistan envisaged construction of 8,800 MW nuclear power generation capacity by 2030 (GOP: 2005). The PAEC strategy for nuclear power programme is development of indigenous capability in NPP technology to reduce dependence on imported plant and fuel, conserve the foreign exchange component and to reduce total cost, by expanding the level of nation's industrial and technological base.

2.3.2 PROJECT MANAGEMENT

Two existing NPPs of Pakistan, K-1, C-1, and one under construction C-2 were turn-key projects. During construction and installation of K-1, C-1 and C-2, PAEC has been involved in all project management activities. This experience will help PAEC to manage future NPPs. An Engineering Design Organization (EDO) has been established for providing design and

engineering services to the operational and under construction NPPs. It will act as Architect Engineer for future NPPs.

2.3.3 PROJECT FUNDING

K-1, C-1 and C-2 have been funded through Public Sector Development Programme (PSDP) of the Government. The funding for future NPPs will be available from; (i) PSDP allocation for power sector, (ii) income from sale of electricity and, (iii) export credit from the supplier(s).

2.3.4 ELECTRIC GRID DEVELOPMENT

The construction, expansion and upgradation of national electric grid are the responsibility is of National Transmission and Despatch Company (NTDC).

2.3.5 SITE SELECTION

PAEC has conducted in detail studies for sites of existing NPPs; K-1, C-1 and C-2. These sites meet regulatory requirements of PNRA and can accommodate additional nuclear units. However, more sites are also being investigated for expanded nuclear power programme.

2.4 ORGANIZATIONS INVOLVED IN THE CONSTRUCTION OF NPPS

PAEC, CNNC (China) and PNRA are involved in construction of NPPs.

2.5 ORGANIZATIONS INVOLVED IN OPERATION OF NPPS

PAEC, PNRA and NEPRA are involved in the operations of NPPs.

2.6 ORGANIZATIONS INVOLVED IN DECOMMISSIONING OF NPPS

PAEC and PNRA will be involved in decommissioning of NPPs.

2.7 FUEL CYCLE INCLUDING WASTE MANAGEMENT

PAEC initiated nuclear fuel cycle activities with a modest prospecting programme in early 1960s. A number of promising areas were located, some of which are presently being

explored. The first ore processing plant using the indigenous ore is in operation. Essential laboratory facilities have also been set up to support the exploration and ore process development work. Fuel for K-1 is being fabricated by PAEC.

Appropriate radioactive waste management systems have been designed for KANUPP and CHASNUPP sites to remove radioactive liquid, gaseous and solid wastes arising from the plants. These radioactive waste management systems collect, store, allow sufficient radioactive decay and process the waste through filtration, ion exchange, evaporation, solidification, vitrification and drumming.

2.8 RESEARCH AND DEVELOPMENT

2.8.1 R & D ORGANIZATIONS

- **Research Institutes/Centers**

  PAEC has following research institutes/centers.

  (i) Pakistan Institute of Nuclear Science and Technology (PINSTECH) established for basic/applied research in physics, chemistry, materials, safety, radioisotope applications and radiation protection.

  (ii) Instrumentation, Control and Computers Complex (ICCC) established for Instrumentation and Control of NPPs, simulators, plant computer systems, etc.

  (iii) Engineering Design Organization (EDO) has been established for providing design and engineering services to the operational, under construction and future NPPs.

- **Research Reactor Facilities**

  Pakistan has two research reactors:

  (i) PARR-1, Swimming Pool type, 10 MW.

  (ii) PARR-2, Tank in Pool type, 30 kWe.

2.8.2 DEVELOPMENT OF ADVANCED NUCLEAR TECHNOLOGIES

Pakistan is a member of IAEA project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and is participating in activities of INPRO since its inception.

2.8.3 INTERNATIONAL CO-OPERATION AND INITIATIVES

Pakistan is a member of IAEA, World Association of Nuclear Operators (WANO) and Candu Owners Group (COG) and is getting assistance from their programmes for enhancement of safety and reliability of NPPs. IAEA Operational Safety Review Team (OSART) missions to K-1 were conducted in 1985 and 1989. WANO Peer Reviews of K-1 were conducted in 1994, 2000 and 2010. IAEA OSART mission to C-1 was conducted in January 2004 and follow-up

mission was in January 2006. WANO Peer Review of C-1 was conducted in March 2006. WANO pre-startup Peer Review of C-2 was conducted during 12-22 July 2010 and follow-up mission was from 8-12 November 2010. The recommendations of these missions were very beneficial for improving safety and performance of the NPPs. Both the operating NPPs; K-1, C-1 and the under construction unit C-2 are under the safeguards of IAEA.

2.9 HUMAN RESOURCES DEVELOPMENT (HRD)

PAEC has been making a significant contribution in development of human resources in the field of science and technology in the country, in particular, in application of nuclear science and technology. Every year young scientists and engineers from various disciplines get post-graduate degrees and training in the following PAEC HRD institutes:

(i) Pakistan Institute of Engineering and Applied Sciences (PIEAS) offers Bachelor, Master and Ph.D Programmes in nuclear engineering, system engineering, process engineering, material engineering, mechanical engineering, medical physics, laser, plasma and computational physics, computer science and nuclear medicine. Besides the regular academic programmes, PIEAS also conducts training courses in various specialized topics, i.e., reactor supervision and operation, health physics, laser technology, computer applications and advanced reactor safety, etc. The courses in management are also being conducted in this institute.

(ii) Karachi Institute of Power Engineering (KINPOE) offers Masters Degree in nuclear power engineering and one year diploma in nuclear technology to engineering and science graduates. It also offers a post-diploma programme in nuclear technology for technicians.

(iii) CHASNUPP Centre for Nuclear Training (CHASCENT) provides one year training in nuclear power plant technology to engineers and technicians. It also provides post diploma training programmes to technicians. The retraining of plant operation personnel is being conducted in this centre on regular basis to refresh their knowledge and licensing requirements.

(iv) National Centre for Non-Destructive Testing (NCNDT) provides training in non-destructive testing techniques to engineers and technicians of the PAEC and industry.

(v) The Pakistan Welding Institute (PWI) provides training in industrial welding techniques to professionals of the PAEC and industry.

2.10 STAKEHOLDER COMMUNICATION

PAEC has well established communication with IAEA, PNRA and NEPRA.

3. NATIONAL LAWS AND REGULATIONS

3.1 REGULATORY FRAMEWORK

3.1.1 REGULATORY AUTHORITY

Nuclear regulatory matters are overseen by the PNRA, established through a Presidential Ordinance of 22nd January 2001 (GOP: 2001). PNRA is empowered to devise, adopt, make and enforce regulations and orders for nuclear safety and radiation protection to all types of nuclear installations and nuclear substances.

3.1.2 LICENSING PROCESS

PNRA issues licenses for the nuclear installations and production, storage, disposal, trade and use of nuclear substances and radioactive materials. The license may be issued on application made to the Authority accompanied by prescribed fee, relevant information and documents, as required by regulations.

3.2 MAIN NATIONAL LAWS AND REGULATIONS IN NUCLEAR POWER

- Pakistan Nuclear Safety and Radiation Protection Regulations, 1990
- Regulation for Licensing of Nuclear Installations in Pakistan (PAK/909), 2001
- Regulation on the Safety of Nuclear Power Plant-Design (PAK/911), 2002
- Regulation on the Safety of Nuclear Power Plants-Quality Assurance (PAK/912), 2003
- Regulations on Radiation Protection (PAK/904), 2004
- Regulations on the Safety of Nuclear Power Plants Operation (PAK/913), 2004
- Trade Policy 2005-06, Ministry of Commerce, Import and Export Policy and Import and Export Control Act, 2005
- Regulations for the Safe Transport of Radioactive Material, (PAK/916), 2007
- Regulations on the Safety of Nuclear Installations-Site Evaluation (PAK/910), 2008
- Regulations on Management of a Nuclear or Radiological Emergency (PAK/914), 2008
- Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers (PAK/907), 2008
- Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority (PAK/900), 2008.
- Regulations on Radioactive Waste Management (PAK/915).
- Pakistan Nuclear Regularity Authority Enforcement Regulations (PAK/950), 2010.

After the promulgation of the Pakistan Nuclear Safety and Radiation Protection Ordinance in 1984, and the Pakistan Nuclear Safety and Radiation Protection Regulations in 1990, preparation of regulatory documents started in 1990. The first document, prepared in 1990, was the "Procedure for Licensing of Nuclear Power Plants in Pakistan", which provides the basis for the licensing of NPPs in Pakistan. Similarly, "Procedure for Licensing of Research Reactors in Pakistan" was prepared in 1991.

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Appendix 1

INTERNATIONAL (MULTILATERAL AND BILATERAL) AGREEMENTS

Pakistan became a Member State of the International Atomic Energy Agency (IAEA) in 2 May 1957 and has actively participated in the Agency's activities. Pakistan has benefited from the IAEA's Technical Assistance and Co-operation Programme (TACP), and has also provided training to many scientists and engineers from other developing countries through TACP.

AGREEMENTS WITH THE IAEA

Project related safeguard agreements

INFCIRC No.		
• /34	Research reactor	5 March 1962
• /116	Project agreements	17 June 1968
• /135	NPP Project/Canada	17 October 1969
• /239	Reprocessing Plant/France	18 March 1976
• /418	Supply of Nuclear Power Station from PR of China	24 February 1993
• /705	Supply of Nuclear Power Station from PR of China	22 February 2007

Unilateral Safeguard submissions

INFCIRC No.		
• /248	Supply of U-Concentrate	2 March 1977
• /393	Supply of miniature source reactor from PR of China	10 September 1991
• Additional Protocol:	-	Not signed
• Improved procedure for designation of safeguard inspector	Prefers the present system	Letter of 20 December 1988
• Supplementary agreement on provision of technical assistance by the IAEA	-	22 September 1994
• RCA		6 September 1974
• Agreement on privileges and Immunities with IAEA	Party	16 April 1963

Other Relevant International Conventions/Agreements etc.

• Convention on early notification of a nuclear accident	Entry into force	12 October 1989
• Convention on assistance in the case of a	Entry into force	12 October 1989

nuclear accident or radiological emergency		
• Convention on nuclear safety	Entry into force	29 December 1997
• Convention on the physical protection of nuclear material	Entry into force	12 October 2000
• Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management	-	Not signed
• Vienna Convention on Civil liability for nuclear damage	-	Non-party
• Joint protocol relating to the application of the Vienna Convention and the Paris Convention		Non-party
• Protocol to amend the Vienna Convention on civil liability for nuclear damage		Non-party
• Convention on supplementary compensation for nuclear damage		Not signed
• ZANGGER Committee		Non-Member
• Nuclear Suppliers Group (NSG)	-	Non-Member
• Acceptance of NUSS codes	Decision on adoption of IAEA NUSS	May 1981

Appendix 2

MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITY

Pakistan Atomic Energy Commission (PAEC),
P.O. Box 1114,
Islamabad,
Pakistan.

Tel: +92-51-9204276
Fax: +92-51-9204908
http://www.paec.gov.pk

NATIONAL NUCLEAR REGULATORY AUTHORITY

Pakistan Nuclear Regulatory Authority,
P.O.Box 1912,
Islamabad,
Pakistan.

Tel: +92-51-9263001-6
Fax: :+92-51-9263007
http://www.pnra.org