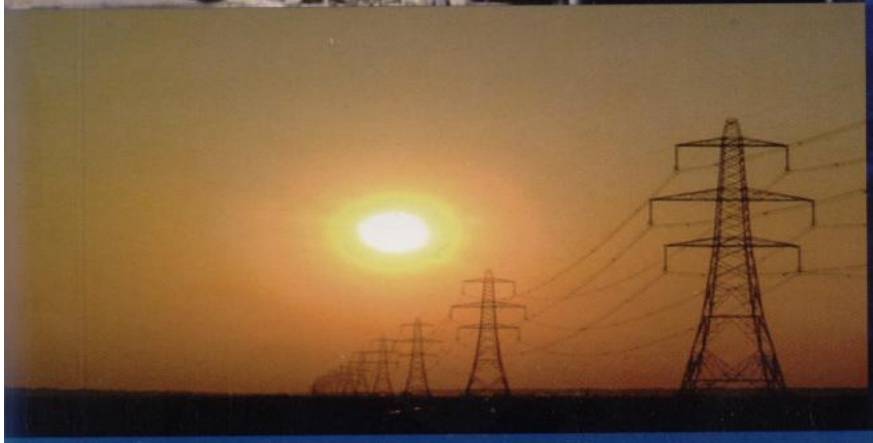
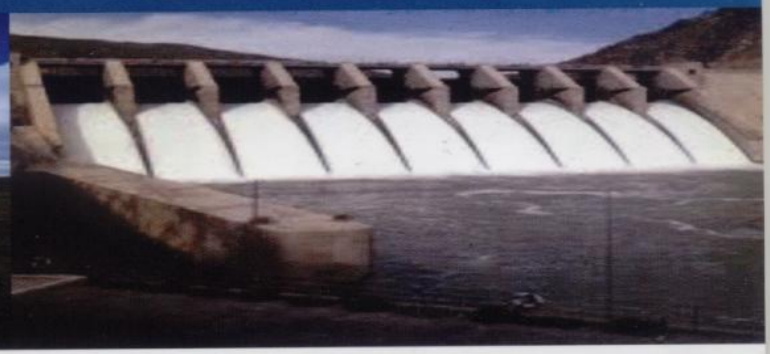


PAKISTAN'S ENERGY CRISIS– RECOMMENDED SOLUTIONS



THE PAKISTAN ACADEMY OF SCIENCES

In Association With

THE CORPORATE ADVISORY COUNCIL (CAC) SECRETARIAT
NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY (NUST)

November 2012

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FOREWORD

Pakistan is faced with a growing energy crisis that has adversely affected industrial growth. It is important to address this important issue with a sense of urgency. The immediate problems that need to be resolved include the operation of existing power plants at optimum capacity (including a solution to the circular debt problem), increasing the transmission and distribution efficiencies, and enforcement of regulations and penalties to prevent revenue losses through thefts. We need to readjust the energy mix so that we rely largely on our own indigenous resources and can reduce our dependence on expensive imported oil. This will involve the use of our coal and hydroelectric resources as the main source of power generation in the future.

The present document is the result of an initiative taken by the Pakistan Academy of Sciences to provide solutions to these problems. It involved extensive discussions with many subject experts, and I am most grateful for their valuable efforts.

It is hoped that the government will give careful consideration to the recommendations and take urgent steps towards their implementation.

Atta-ur-Rahman, FRS, NI, HI, SI, TI

President,
Pakistan Academy of Sciences

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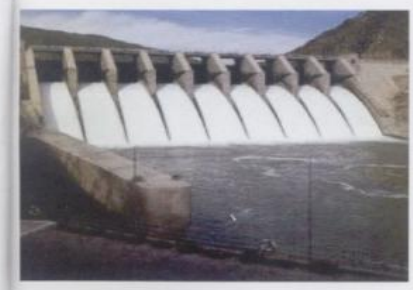

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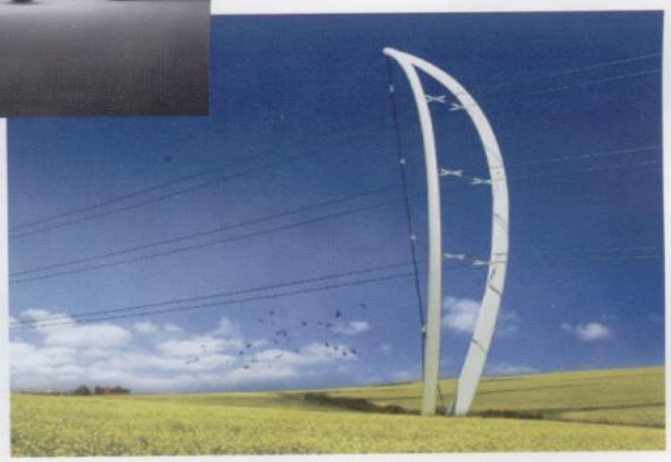

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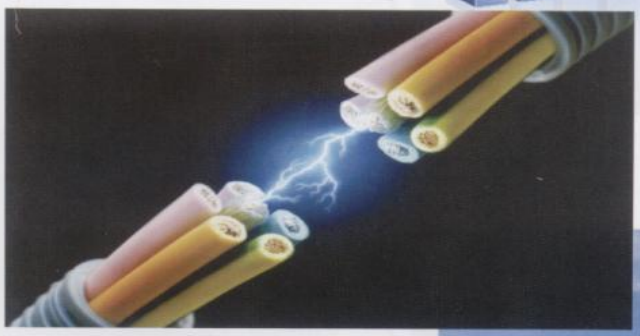

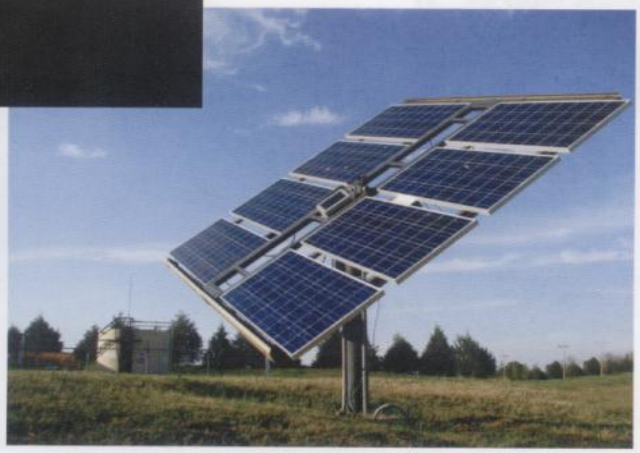

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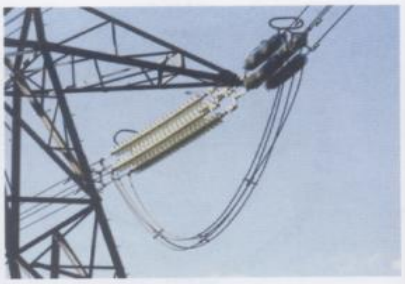

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LIST OF ABBREVIATIONS

Abu Dhabi Petroleum Investment Company L.L.C.	ADPI
Academy of Sciences	PAS
Alternative Energy Development Board	AEDB
Area Electricity Boards	AEBs
Asian Development Bank	ADB
Attock Oil Company	AOC
Attock Refinery Limited	ARL
Balancing, Modernization, Revamping, and Expansion	BMRE
Barrels of Oil Equivalent	BOE
Barrels per day	bbl/d
Bosicor Pakistan Limited	BPL
Byco Busient Incorporated	BBI
Byco Oil Pakistan Limited	BOPL
Byco Petroleum Pakistan Limited	BPPL
Canadian International Development Agency	CIDA
Chashma Nuclear Power Plant-1	CHASNUPP-1
Chashma Nuclear Power Plant-2	CHASNUPP-2
China National Nuclear Corporation	CNNC
Compressed Natural Gas	CNG
Distribution Companies	DISCOs
Energy Conservation	EC
Energy Efficiency	EE
Furnace Oil	FO
Generation Companies	GENCOs
Government of Pakistan	GoP
Government of Sindh	GoS
Gross Domestic Product	GDP
Heavy Mechanical Complex	HMC
High Speed Diesel	HSD
Hub Power Project	HUBCO
Hydrocarbon Development Institute of Pakistan	HDIP
Implementation Agreement	IA
Independent Power Producers	IPPs
Indus Basin Project	IBP
International Atomic Energy Agency	IAEA
International Monetary Fund	IMF
International Petroleum Investment Company	IPIC
Islamic Development Bank	IDB
Karachi Electric Supply Company	KESC
Karachi Nuclear Power Plant	KANUPP
Khyber Pakhtunkhwa	KPK
Kot Addu Power Company Limited	KAPCO
Lakhra Coal Development Company Limited	LCDC
Lakhra Power Generation Company Limited	LPGCL
Liquefied Natural Gas	LNG

Medium Term Development Framework	MTDF
Million Acre-Feet	MAF
Million Standard Cubic Feet per Day	MMSCFD
National Development Finance Corporation	NDFC
National Economic Council	NEC
National Electric Power Regulatory Authority	NEPRA
National Industries Group	NIG
National (Pakistan) Energy Conservation Center	Enercon
National Productivity Organization	NPO
National Refinery Limited	NRL
National Transmission and Dispatch Company	NTDC
National University of Sciences and Technology	NUST
Oil and Gas Development Company	OGDC
Oil and Gas Development Company Limited	OGDCL
Operations & Maintenance	O&M
Pakistan Academy of Sciences	PAS
Pak-Arab Refinery Limited	PARCO
Pakistan Atomic Energy Commission	PAEC
Pakistan Electric Power Company	PEPCO
Pakistan Mineral Development Corporation	PMDC
Pakistan Nuclear Regulatory Authority	PNRA
Pakistan Oilfields Limited	POL
Pakistan Petroleum Limited	PPL
Pakistan Refinery Limited	PRL
Pakistan State Oil	PSO
Planning Commission of Pakistan	PC
Plant, Machinery and Equipment	PME
Pressurized Water Reactor	PWR
Prime Minister	PM
Private Power and Infrastructure Board	PPIB
Private Sector Energy Development Project	PSEDP I
Private Sector Energy Development Project	PSEDP II
Public-Private Partnership	PPP
Public Sector Development Program	PSDP
Renewable Energy	RE
Rental Power Projects	RPPs
Science and Technology	S&T
Sindh Coal Authority	SCA
State Engineering Corporation	SEC
Sui Northern Gas Pipelines Limited	SNGPL
Terms of Reference	TORs
Transfer of Technology	TOT
Underground Coal Gasification	UCG
United States Agency for International Development	USAID
University of Engineering and Technology	UET
Water and Power Development Authority	WAPDA
World Bank	WB

EXECUTIVE SUMMARY

1. Sustainable and affordable energy supply is necessary for the socio-economic development of a country. The severe energy shortage faced by Pakistan in present times has resulted in serious challenges, including power and gas load shedding, price hikes, food shortages, unemployment, and law and order deterioration, resulting in reduced investment in every sector of the economy.

2. This document, "Pakistan's Energy Crisis – Recommended Solutions"prepared by the Pakistan Academy of Sciences (PAS), a non-governmental and non-political prestigious body of distinguished scientists, maps notable events through history and their impact on the energy situation in the country, and outlines short-term and long-term solutions to the energy crisis. This report suggests comprehensive measures for solving the energy crises and for providing adequate energy at affordable cost. The facts and figures given in this report were collected from the relevant organizations by the PAS Secretariat. The PAS sincerely acknowledges the contributions made by the various ministries, public and private sector organizations, and the individuals, who played an important part in putting together this report.

3. Pakistan's current energy mix includes hydel, thermal (coal, gas and furnace oil), nuclear, and, recently, Renewable Energy (RE) for electricity generation; and gasoline, diesel, and Compressed Natural Gas(CNG) for transport applications. The electricity generation capacity of Pakistan was modest (10.7 MW) at the time of independence, but rose significantly during the 1960s due to the **Indus Water Treaty** and the subsequent construction of the Warsak Dam (1960 and then 1980-81), Mangla Dam (1967) and Tarbela Dam (1976); the combined capacity of the three dams is over 4,700 MW. At that time, Pakistan's energy mix was heavily tilted toward hydropower: in 1984 the energy mix was approximately 60% hydel and 40% thermal.

4. During the 1980s, electricity generation rapidly grew to over 7,000 MW, but, as demand overshot supply, load shedding started taking place for the first time. The foundation of private sector participation in power generation was laid during this period.The Government of Pakistan (GoP), with assistance from the World Bank (WB), developed a long-term energy strategy which envisaged the involvement of private investors in power generation. In 1988, the GoP, under pressure from the WB, banned the public sector from putting up thermal power plants, so thermal generation was left exclusively to the private sector. As a result, the first private power project, the oil-based Hub Power Project(HUBCO) began in 1991.

5. Under the **Strategic Plan for Power Sector Privatization** of 1992, the Water and Power Development Authority(WAPDA), up until then the main electric utility in Pakistan, was unbundled into separate generation, transmission and dispatch, and distribution companies. The Pakistan Electric Power Company (PEPCO) was formed in 1992; the thermal power generation facilities of WAPDA were restructured into Generation Companies (GENCOs), the distribution network of WAPDA was divided into nine Distribution Companies (DISCOs) and given in PEPCO's control, and a National Transmission and Dispatch Company (NTDC) was formed under PEPCO. WAPDA was restricted from constructing more dams, and the focus shifted heavily in favor of thermal power generation, which increased power generation costs. Moreover, politicization of and a lack of national consensus on the issue of dam construction brought a complete halt to further construction of major dams.

6. The GoP gave lucrative incentives to foreign private investors in the power sector. Through the Power Policy 1994, the Private Power and Infrastructure Board (PPIB) was established to encourage private investors – Independent Power Producers (IPPs)– toenter the power generation sector in Pakistan. As of June 2010, 27 IPPs are operational, and have an installed capacity of 6,870 MW. In addition, Kot Addu Power Company (1,600 MW) and Karachi Electric Supply Company (KESC) power plants (1,946 MW) are also operating in the private sector. The Power Policy 1994 bound WAPDA and the KESC to buy the power produced by IPPs at a mutually agreed rate. The decision to bring in IPPs was questionable for the power sector for several reasons: the capital cost is very high; the generation costs of IPPs are high, because most of them run on expensive imported Furnace Oil (FO) that became necessary because of gas short ages;IPPs were incentivized with "no-risk" and high profits; commitments were far in excess of demand; and the units operated, and are even now running at far below their installed capacities.

7. In 1995, the State Engineering Corporation (SEC), in association with public and private sector entities, undertook an initiative to start indigenization of power plants. Based on the 1992 policy directive disallowing turn key imports of power plants, the SEC signed General Cooperation Agreements with foreign firms for co-financing and co-manufacturing of complete power plants; the plan was to progressively increase the local component with positive impact on cost reduction. The plan envisaged the best utilization of national resources of engineering, manufacturing and technical services in the public and private sectors of Pakistan. Foreign and local financing was lined up and an offer was made to WAPDA for six power plants of 300-330 MW each (total 2,000 MW). The indigenization plan, if realized, would have helped establish the domestic engineering industry, with substantial foreign exchange savings and employment generation, apart from other socio-economic benefits, particularly attaining much lower cost of power generation, lower capital costs, lower Operations and Maintenance (O&M) costs, and resultantly, lower tariffs. Unfortunately, the GoP did not allow WAPDA to put up the power plants, due to which this important initiative could not succeed. This had an adverse impact not only on the power sector, but also on the growth of engineering goods manufacturing sector.

8. In 1997, the National Electric Power Regulatory Authority (NEPRA) was created to grant licenses for generation and transmission of electric power and to determine tariffs for generation, transmission, and distribution companies.

9. Of the power generated in the country today, around 56% is generated in the public sector (at an average generation cost of less than Pak Rs. 4 per unit) and the remaining by the private sector (minimum generation cost Pak Rs. 15 per unit). For a country with abundant energy resources (hydel, coal, renewable), low-cost power should have been made available to the people. From a 60-40 Hydel-Thermal ratio in 1984, it changed to 45-55 in 1990, and to 33-67 in 2004. This shift of focus from hydel to thermal power generation, and GoP's emphasis on IPPs,has increased electricity generation costs. The shortage of natural gas, a low-cost fuel for power generation, has resulted in an over-dependence on FO, which is an expensive and imported resource. Inclusion of *IPPs* and *Rental Power Projects (RPPs)* to the power generation sector, all running on FO, has further contributed to the electricity price hike.

10. There are currently five major power producers in Pakistan, including WAPDA, PEPCO, KESC, Pakistan Atomic Energy Commission (PAEC), and IPPs. Even with a total electricity generation capacity of 23,412 MW (as of 30th June, 2011), and a peak electricity demand of 14,000-16,000 MW, the power generated is about 5,000-6,000 MW short of demand, resulting in several hours of load shedding per day. The electricity shortfall can be attributed to a host of reasons, including demand fluctuations as well as supply-related factors (water flow, natural gas shortage, FO import and the Circular Debt issue, inefficient running of power plants).

11. The **Power Policy 2002** aimed to encourage enhancement in power generation capacity, whether by public or private sector, or a public-private sector partnership (PPP). The Ghazi Barotha hydropower project, executed by WAPDA and having capacity of 1,450 MW, started operations in 2004. Unfortunately the key aspect of the **Power Policy 2002** was subsequently neglected and power projects in public sector were not permitted even when private sector was not forthcoming. Resultantly, an environment emerged for the crisis.

12. A Task Force was constituted by the Cabinet in 2001, and given the mandate to prepare an **Energy Security Action Plan** to recommend energy security enhancement measures, energy mix, Energy Efficiency (EE) and Energy Conservation (EC) measures, and RE promotion. This Plan was approved by the President and Prime Minister (PM), and subsequently by the National Economic Council (NEC) as part of the **Medium Term Development Framework (MTDF) 2005-10** in May 2005. The Plan adopted an integrated, holistic, consultative and coordinated approach, and called for a huge increase in generating capacity to more than 160,000 MW by 2030, by taking several steps, including utilization of indigenous resources (coal, gas, hydel, nuclear, oil and RE) to meet the growing demand on a sustained and affordable basis thereby providing energy security, enhanced self-reliance and sustainability. Unfortunately the **Energy Security Action Plan 2005**was not implemented sincerely. Lack of achieving a political consensus on the issue of water resources and dam construction was a major reason for non-implementation of this Plan. Had this Plan been implemented in letter and spirit, there would not have been any energy crisis today.

13. From 1992 to 2007, electricity generation capacity more than doubled (approximately 7,540 MW of generation capacity was added). However, the implementing agencies could not deliver on the additional power generation as targeted in the Energy Security Action Plan 2005.

14. Pakistan was hit by its worst power crisis in 2007; production fell by 6,000 MW and massive blackouts followed suit. In 2008, availability of power in Pakistan fell short of the demand by 15%. Load shedding and power blackouts became more and more severe. The 2005 earthquake and the 2010 floods damaged the existing power stations, power distribution and transmission, and other energy infrastructure.

15. The declining availability of electricity to the industry has hit some industries very hard, e.g. the textile sector. In recent times, several textile units have set up their own electricity generation plants, to cater to their individual power needs. This demand suppression, especially in the industry, is extremely unfortunate. Stagnation in industrial growth due to declining energy availability to the industry is having an adverse effect on industrial production and growth, and consequently on revenue collection, exports and employment generation.

16. While summarizing the shortcomings that have led to the present energy crisis, a major factor has been the poor implementation of strategic plans. With the passage of time, the Ministries and concerned organizations have lost their capacity and capability to undertake detailed planning, execution and monitoring of development plans and projects, which is a huge cause for concern for us as a nation. As a result of inadequate implementation capacity in energy sector agencies, the influence of external donors and lenders became more significant. Serious damage was done by the restructuring and unbundling of WAPDA without an in-depth analysis of the problem and the long-term implications, and by disallowing WAPDA to construct more dams and to put up thermal power plants. There was excessive dependence on foreign experts, while ignoring our indigenous professional expertise. Due priority was not given to hydropower generation, despite the fact that Pakistan has an identified hydropower potential of over 46,000 MW **(MTDF 2005-10)**, and given that hydro power is the cheapest source of electricity, and comes with several benefits to Pakistan. Adopting the popular mantra of privatization, liberalization and deregulation, the GoP out sourced power generation to private sector, giving decision-making in the hands of multinationals and foreign investors at the cost of national sovereignty. Excessive involvement of the private sector in power generation, without essential safeguards, is the single biggest reason for the unprecedented rise in generation costs. Running units below their installed capacities, giving high profits to the IPPs and using imported FO as fuel, all contributed to the increased power costs. This was complemented by unaffordable subsidies to keep electricity prices low, nurturing the demon of Circular Debt. Other indigenous resources like coal, natural gas and RE generation were not developed. Likewise, nuclear power generation was not given due importance. The PAEC shifted its focus from developing nuclear power to mainly building strategic assets, with the result that nuclear power production remained minimal. Failure to overhaul / upgrade old and obsolete equipment led to continuous reduction in generation, transmission, and distribution efficiency. Plant capacity in Pakistan is low mainly because of poor O&M reflecting poor management at organizational and national levels. Lack of professionalism, competence, commitment, and merit has contributed to worsening the energy crisis.

17. The outcomes of the improper decisions taken over the years has resulted in announced and unannounced load shedding, increased electricity prices, unavailability of electricity to a substantial portion of the population and the industry, rising unemployment, staggering oil import bills, increasing Circular Debt, and enhanced energy security risk.

18. This document consolidates all the plausible solutions to the energy crisis. To resolve the current crisis, it is essential to take various actions **on war footings.** The Recommended Solutions outline, first, some immediate steps that must be adopted by the GoP to remove the demand-supply gap; second, medium to long-term solutions requiring infrastructure and funding; and, finally some general recommendations. This document also outlines an appropriate mechanism / system to implement the proposed solutions.

19. The general recommendations suggest that instead of looking towards foreign bodies like the WB, International Monetary Fund(IMF), United States Agency for International Development (USAID), or Asian Development Bank(ADB) to present solutions, we must strive to solve our problems ourselves; solutions formulated by our professionals would be more logical and implementable, and would have greater ownership. It is of utmost importance to put honest, competent, and result-oriented professionals at the helm of affairs. A transparent system must be put in place to select **the right person for the right job** Coordination and synergy between all relevant organizations and individuals is important to avoid

unnecessary duplication. Responsibility and accountability must be linked to ensure that the country's scarce resources are used effectively and efficiently. The Government should concentrate on policy formulation and monitoring, and not attempt to micro-manage the institutions. Everyday decision-making and operational management should be left to the concerned organizations. The Government must create an environment that favors investment, productivity, and value-addition, with national interest at the apex. A fundamental change in mindset is required, starting from the elite decision makers, trickling down to the masses. Education and skill development of the people will help speed up this change, and exponentially improve productivity levels. The **Energy Security Action Plan 2005 (MTDF 2005-10)** should be implemented with essential adjustments to current demand, due to lower Gross Domestic Product (GDP) growth as compared to the planned projections. The Plan should be revised and updated, and in combination with this document, should become the basis for solving the energy crisis. Special attention must be given to appropriate development of human capital in this sector from the highest professionals required in Islamabad to man the ministries to the heads of energy organizations and the lowest technicians to operate and maintain installments. Linkages must be established to obtain support from universities and other technical institutes.

20. The immediate solutions (specific recommendations) emphasize operating existing plants at optimum capacity to increase power output, enhancing transmission and distribution efficiency, and increasing efficiency at consumer level. In order to improve output of the existing power plants, the Circular Debt problem must be resolved immediately so that the thermal power plants have the necessary cash flows to pay for imported FO; also, existing power plants (thermal, hydel, coal-fired) must be revamped to work on optimum capacity and efficiency. To improve transmission and distribution efficiency, an overhauling and upgrading of transmission and distribution infrastructure is needed. At the consumer level, regulation for energy-efficient appliances and building designs must be enforced; pilferage, theft and misuse of power, gas and petroleum products must be prevented through enforcement of regulation and tough penalties.

21. There needs to be a focus on increasing efficiency across the full chain and development of indigenous resources, which means much greater development of and dependence on hydropower, coal, and renewable energy resources. Since Pakistan is short of primary energy resources, it will always need to import energy. For this, import of gas from Iran and Turkmenistan (piped gas) as well as Liquefied Natural Gas (LNG) import needs to be fast-tracked.

22. The medium-to-long-term solutions involve altering the energy mix of Pakistan to include more and more indigenous resources, which means development of hydropower, coal, and renewable energy resources, as well as enhancing gas supply.

23. The first and most important medium-to-long-term solution to the energy crisis is development of hydropower. In order to ensure that hydropower reclaims the major share of Pakistan's energy mix, the Government must place emphasis on achieving a national consensuson the construction of large multi-purpose dams; review mechanism of implementing projects to remove delaying factors from the system; prepare local consulting and manufacturing firms to undertake execution of projects by adopting the concepts of co-designing, co-manufacturing, co-financing, co-construction, co-installation and co-commissioning of power plants of all types and teaming up with dependable international partners; arrange funding for the mega- projects; allow WAPDA and the public sector agencies to install thermal power plants; and give due importance to development of small hydel projects.

24. The second step is to increase the share of coal in the energy mix. Coal is a largely unexploited source of energy in Pakistan; power generated from coal is cheaper than that produced from FO, and is ideal for scattered power generation in industries and remote areas. Pakistan's performance in the area of coal-fired power generation has remained dismal till the initiation of an Underground Coal Gasification (UCG) project by the *Planning Commission (PC)*, based on Thar coal. In the short -term, it is important to set up coal-fired power plants based on imported coal, and in the medium -to-long-term, this must be substituted with locally extracted coal.

25. The third step is to enhance gas supply. Pakistan has one of the most elaborate natural gas pipeline transmission systems in the world. To ensure provision of natural gas for industries, domestic use as well as for power generation, we must speed up import of gas in the short-term; the Iran-Pakistan and Turkmenistan-Afghanistan-Pakistan pipeline projects must be given due priority. At the same time, the proven gas resources in the country that have not so far been extracted must be developed on a priority basis. The GoP must extend better incentives to companies to undertake oil and gas exploration in the country. Steps must be taken to improve the law and order situation hampering exploration activities, especially in Balochistan andKhyber Pakhtunkhwa(KPK). At the same time, litigation cases must be resolved as this is one of the biggest impediments to exploration activities.

26. The fourth step is to reduce dependence on expensive, imported oil. Fifthly, we must exploit all available RE resources, as Pakistan is blessed with ample sun, wind, and biomass. Initiatives that must be given priority include solarization of off-grid applications, small-scale windmills for small and medium-sized industries, use of biomass like rice husk, wood chips and corn stalks for scattered power generation, and, in the longer run, on-grid applications of RE resources to optimize mix of power generation.

27. The sixth step, which relates to a very important area, is the indigenization of power plants and other related equipment. Pakistan relies completely on imported plant and machinery for its energy infrastructure, placing a huge burden on the national exchequer, which will grow in coming years as energy infrastructure demands grow. Pakistan must develop indigenous capability for the planning, designing, manufacturing, installation, and commissioning of power plants. Local heavy machinery manufacturers must be given a significant role to play.

28. The implementation mechanism for the above-mentioned solutions constitutes the setting up of a high-level Cabinet approved **National Task Force on Energy** comprising of the Finance Minister, Minister for Water and Power, Minister for Petroleum and Natural Resources, Deputy Chairman *PC,* Secretary Water and Power, Secretary Petroleum, heads of major energy organizations, representatives of provinces, and any other co-opted members. The **National Task Force on Energy** should be headed by the Finance Minister, and report to the PM/Cabinet. Its mandate should be to solve the energy crisis facing Pakistan by implementing the solutions presented in this document. The Task Force should be divided into Implementation Teams (or Committees) pertaining to different areas within Energy, namely EE and EC, Hydropower, Oil and Gas, Coal, and RE. The Task Force as a whole must work towards the goal of operating existing power plants and transmission / distribution infrastructure at optimum capacity, while each Committee looking after its focused area of work.

29. The *PAS*, being a credible Think Tank may be assigned the responsibility of "Third Party Oversight" over the actual implementation of the approved policy, with a mandate to report progress to the Cabinet through the PM. This innovative methodology will strengthen the monitoring mechanism, with high level intellectual input, to keep the top policy makers informed of the state of implementation.

1. INTRODUCTION

1.1. Sustainable and affordable energy supply is necessary for the socio-economic development of a country. The severe energy shortage faced by Pakistan in present times has resulted in serious economic challenges. The society is in the grip of power and gas load shedding, unprecedented price hikes, shortage of food commodities, unemployment, and among others, deterioration in the law and order situation. This has created deterrence for genuine investors in all sectors, including the Energy sector, which has badly affected Pakistan's capacity to mobilize its energy resources. The situation continues to worsen progressively, and the gap between energy supply and demand is widening.

1.2. There are several groups of bureaucrats, politicians, and technocrats, who have been working in isolation, trying to come up with solutions to the energy crisis. First, these efforts are scattered and need to be consolidated to create synergy and amalgamation of multiple points of view. Second, there is need for the so-called problem-solvers to rise above personal preferences and vested interests. Third, the solutions will never work unless we follow the basic principle of putting **the right person for the right job**, and more importantly, putting **competent and result-oriented individuals** to accomplish the task at hand. It is but imperative to find the right "doctors", with technical capabilities to address the fundamental malaise rather than trying to alleviate the symptoms. Fourth, our past track record in implementation of plans has not been satisfactory. It is imperative that the proposed plans are backed up with detailed implementation mechanisms, including monitoring indicators. Last but not the least; we must link responsibility with accountability to ensure that the country's scarce resources are used effectively and efficiently.

1.3. The Pakistan Academy of Sciences (PAS) is a non-governmental and non-political prestigious body of distinguished scientists in different disciplines of Science and Technology (S&T). The Government has given a consultative and advisory status to the Academy *"on all problems relating to the development of scientific efforts in the country"*, and *"generally on such matters of national and international importance in the field of science as may be referred to the Academy."*

1.4. This report has been prepared by the *PAS*, and reviews notable events through history and their impact on the energy situation in the country, and proposes short-term and long-term solutions to the energy crisis in a holistic manner. The report outlines comprehensive measures for solving the energy crises and for providing adequate energy at affordable cost to all including agriculture, residential, commercial and industrial users. The facts and figures given in this report were collected from the relevant organizations by the *PAS* Secretariat. The PAS sincerely acknowledges the contributions made by the various ministries, public and private sector organizations, and the individuals, who played an important part in putting together this report.

2. THE CURRENT SITUATION

2.1. Energy sources in Pakistan's current energy mix include hydel, thermal (coal, gas and furnace oil), and nuclear for electricity generation, and gasoline, diesel, and Compressed Natural Gas (CNG) for transport applications. In addition, on-grid electricity generation using Renewable Energy (RE) resources has just started in the country, mainly through wind. Pakistan's primary energy mix and its energy supplies by source are shown in Tables I and II respectively *(Source: Pakistan Energy Yearbook 2011*).

Table I: PAKISTAN'S PRIMARY ENERGY MIX - 2011

Oil	32.0%
Gas	47.6%
LPG	0.5%
Coal	6.7%
Hydro , Nuclear & Imported Electricity	13.2%

Table II: PRIMARY ENERGY SUPPLIES BY SOURCE

Table: 1.1

PRIMARY ENERGY SUPPLIES BY SOURCE

Source	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	Unit TOE % Share ACGR
Oil*	16,411,834 28.27%	18,188,280 30.0%	19,206,411 30.5%	20,103,060 32.1%	19,806,314 31.4%	20,674,840 32.0%	4.7%
Gas	29,202,951 50.3%	29,324,316 48.4%	29,874,989 47.5%	30,255,885 48.3%	30,808,523 48.8%	30,683,357 47.6%	1.0%
LPG'	400,430 0.7%	470,998 0.8%	418,952 0.7%	401,705 0.6%	395,583 0.6%	339,633 0.5%	-3.2%
Coal	4,049,654 7.0%	4,426,678 7.3%	5,783,844 9.2%	4,732,823 7.6%	4,621,639 7.3%	4,350,868 6.7%	1.4%
Hydro Electricity*	7,366,452 12.6%	7,626,755 12.6%	6,851,955 10.9%	6,631,841 10.6%	6,705,533 10.6%	7,593,074 11.8%	0.6%
Nuclear Electricity*	592,887 1.0%	546,159 0.9%	734,537 1.2%	386,165 0.6%	690,821 1.1%	816,370 1.3%	6.6%
Imported Electricity*	34,775 0.1%	40,781 0.1%	47,550 0.1%	54,266 0.1%	59,537 0.1%	64,093 0.1%	13.0%
TOTAL:	58,058,983 100.0%	60,623,966 100.0%	62,918,268 100.0%	62,565,745 100.0%	63,087,952 100.0%	64,522,234 100.0%	2.1%
Annual growth rate	4.45%	4.42%	3.78%	-0.56%	0.83%	2.27%	

1/ Excluding petroleum products exports and bunkering.
2/ Include imports and production from field plants.
3/ Converted @ 10,000 Btu/KWh to represent primary energy equivalent of hydro nuclear electricity as if this was generated by using fossil fuels.
4/ WAPDA imported electricity from Iran since Oct-2002.

2.2. Estimated cost of electricity generation from various sources is given below.

Table III: APPROXIMATE COST OF ELECTRICITY GENERATION

Electricity source	Cost per unit	
	Pak Rs.	Cents
Hydel	1.18 – 4.00	1.39 – 4.70
Thermal		6.00 – 30.00
PEPCO		8.17
IPPs	11.18	13.00
RPPs		≥ 30.00
Coal	6.00 – 7.00	7.00 8.00
Nuclear		12.20

Note: These are the figures, picked up from various publications. There is a general tendency of relevant organizations not to officially authenticate such figures.

Power Generation by Public Sector: 56%
Power Generation by Private Sector: 44%

Average Generation Cost – Public Sector: Less than Pak Rs. 4 per unit
Generation Cost – Private Sector: Minimum of Pak Rs. 15 per unit

2.3. Electricity generation costs have gone up over the years, since over the last many years, attention was not given to developing ***hydel*** power, which has resulted in shifting the focus to the more expensive thermal power generation. *Rental Power Projects (RPPs)* are even more expensive.

2.4. The growth of ***nuclear*** plants in Pakistan has been stifled due to international agendas and pressures.

2.5. In spite of efforts by the local and foreign oil exploration companies, the locally explored ***oil*** reserves are hardly sufficient to meet about 17-20 % of the country's requirements. The major part of Pakistan's petroleum requirements are met through imports, which consumes the largest portion of our foreign exchange.

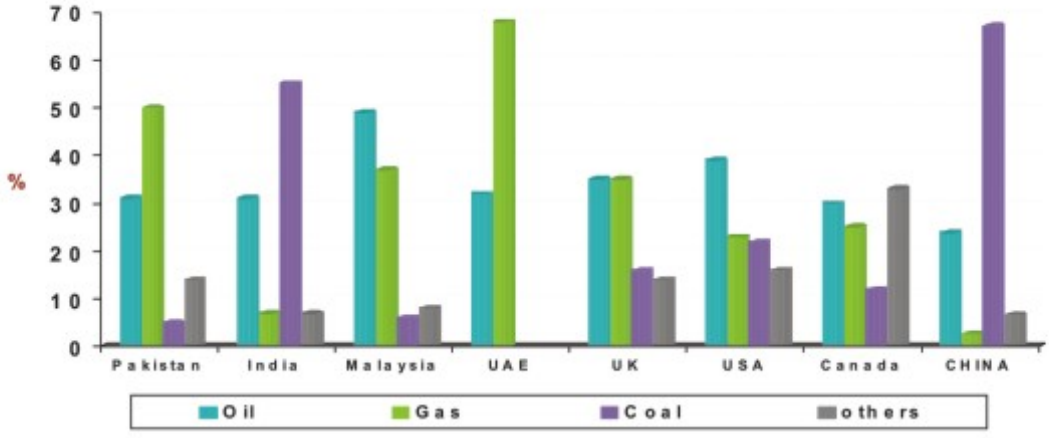
2.6 The highest component in Pakistan's energy mix has been natural ***gas***, the use of which has been expanding at a very high rate while the indigenous usable resources have been depleting. Its usage also suffers from wastages and pilferage. In addition, its diversion to the transport sector without proper analysis has further aggravated the gas shortage being faced by industries, consumers and power generation units. Pakistan is currently the largest consumer of CNG in the world, with over 3,000 operational CNG stations serving around 2 million vehicles (*Source: The Nation, 13th September 2012*). It is also regretfully noted that Pakistan does not assemble or manufacture CNG kits; all CNG kits are imported into Pakistan. While there is need to import gas, it is also imperative to redouble our efforts on the development and exploitation of existing indigenous underground gas resources.

2.7. **Coal** reserves in Pakistan are estimated at 186 Billion tonnes. The measured or drill-proven reserves are estimated at 579 Million tonnes, which are enough to last for 180 years at the present rate of excavation which averages 3.2 Million tonnes annually. Thar coal can generate 50,000 MW of electricity and 100 Million barrels of oil every year for the next 500 years {Source: "Energy Deficit of Pakistan" by Member S&T, Planning Commission (PC), October 2010}. By using only 2% of existing coal reserves, we can generate around 20,000 MW power for almost 40 years (Source: Presentation on "President's Initiative for Trade, Energy, Transport and Industrial Corridor" by PC, July 2006). Besides the major use of Thar coal in power generation, other applications include production of diesel, methanol, low-grade (town) gas, and production of fertilizer through surface gasification; a by-product of coal surface gasification is anhydrous ammonia, which can be used in the fertilizer industry to increase production by 5.14 Million Tonnes per annum (Source: Presentation on "President's Initiative for Trade, Energy, Transport and Industrial Corridor" by PC, July 2006).Given the current gas shortages in the country, substituting gas for power generation with coal would save 832 Million Standard Cubic Feet per Day (MMSCFD) of gas.

2.8. The percentage of coal in Pakistan's primary energy mix is woefully low (6.5% in 2004-05, which increased to 7.3% in 2009-10 and reduced somewhat to 6.7% in 2011) despite our abundant coal reserves. In contrast, India's energy mix in 2004-05 had coal at 55%, and China at 67%, as shown in Figure I on the following page.

Figure I: COUNTRY PRIMARY ENERGY MIX

	Pakistan	India	Malaysia	UAE	UK	USA	Canada	China*
OIL	30	35	42	32	35	40	30	23.8
NATURAL GAS	50	7	51	68	35	23	27	2.6
COAL	6.5	55	4	-	16	23	24	67
OTHERS (HYDEL, NUCLEAR, ETC.)	13.5	3	3	-	14	14	19	6.6



(Source: Energy Security Action Plan 2005)

2.9 Pakistan is rich in renewable sources of energy, such as wind, solar, biofuels, and biomass, but due importance has not been given to build capacity, develop technologies, and formulate policies to utilize these sources to provide affordable power to the country.

2.10. The per capita energy consumption, which is an indicator of the quality of life of a population, is very low in Pakistan. Our per capita energy consumption is the lowest of the six most populous countries in the world (China, India, the U.S., Indonesia, Brazil, and Pakistan). U.S. per capita usage is the highest, with 56.6 Barrels of Oil Equivalent (BOE) per year, while China's is at 9.4 BOE. Pakistan's per capita energy consumption rate is 2.5 BOE (2006).However, our energy consumption growth rate is high, being second only to China's. Between 2000 and 2006, Pakistan's total energy consumption grew at an average yearly rate of 5.5%as against China's 9.8%.

2.11. Pakistan's per capita electricity consumption in 2007 was 469 kWh per capita, less than one-fifth of the world average (2,465 kWh per capita).Pakistan's per capita electricity consumption dropped to 433 kWh in 2008, and then increased to 449 kWh in 2009 {Source: The World Bank (WB)}.

2.12. In 2008, Pakistan's annual Gross Domestic Product (GDP) growth rate was about 6.6%.Since then, GDP growth rate has remained low. Since the GDP growth rate has gone down, power demand has also shrunk. However, a GDP growth rate of about 7% is imperative if we are to improve the standard of living of our population and arrest the growth in unemployment.

2.13. Table IV below shows our installed generation capacities from 2007 to 2011 (Source: State of Industry Report 2011, NEPRA).

Table IV: PAKISTAN'S INSTALLED GENERATION CAPACITY BY TYPE – 2007-2011

As on 30th June		2007	2008	2009	2010	2011
THERMAL						
GENCOs with PEPCO		4,834	4,899	4,900	4,885	4,885
KESC Own		1,756	1,756	1,846	1,946	1,821
IPPs	Connected with PEPCO	5,754	5,773	5,956	7,060	8,325
	Connected with PEPCO	262	262	262	262	262
RPPs	Connected with PEPCO	150	286	286	122	403
	Connected with KESC	0	0	50	50	50
Others (COOs/SPPs)	Connected with KESC	0	239	239	272	324
Sub-Total		12,756	13,215	13,539	14,597	16,070
Percentage share		64.78	65.32	65.86	67.53	68.64
HYDEL						
WAPDA Hydel		6,444	6,444	6,444	6,444	6,444
IPPs Hydel		30	111	111	111	111
Sub-Total		6,474	6,555	6,555	6,555	6,555
Percentage share		32.88	32.40	31.89	30.33	38.00
NUCLEAR						
CHASNUPP (I&II)		325	325	325	325	650
KANUPP		137	137	137	137	137
Sub-Total		462	462	462	462	787
Percentage share		2.35	2.28	2.25	2.14	3.36
Total Installed Generation Capacity of the Country		19,692	20,232	20,556	21,614	23,412

2.14. There are currently five major power producers in Pakistan, including the Water and Power Development Authority(WAPDA), Pakistan Electric Power Company(PEPCO), Karachi Electric Supply Company (KESC), Pakistan Atomic Energy Commission (PAEC), and Independent Power Producers (IPPs).WAPDA is responsible for hydel power generation and operations. PEPCO controls the thermal power generation and distribution companies that were earlier with WAPDA.KESC is the power generation, transmission and distribution company for Karachi and parts of Sindh and Balochistan. The entire power generation of KESC is thermal. PAEC is responsible for all nuclear energy and research applications in the country. IPPs are power generation companies in the private sector, controlled by the Private Power and Infrastructure Board (PPIB). All operational IPPs are based on thermal power generation. The newest player in the energy sector is Rental Power, which is turning out to be by far the most expensive source of electricity for Pakistan.

2.15. Pakistan's peak electricity demand varies from 14,000 MW to 16,000 MW.As such, the total generation capacity is more than the energy demand. However, in practice the electricity generation is much lower and about 5,000-6,000 MW short of demand, resulting in several hours of load shedding per day. The electricity shortfall is because of the following main issues:-

2.15.1. Demand-related factors: difference in demand in different seasons and at different times of the day.

2.15.2. Supply-related factors:

2.15.2.1. Water flow issues – electricity generation is affected by water flows as seasons vary.

2.15.2.2. Shortage of natural gas.

2.15.2.3. Furnace Oil (FO) import and the Circular Debt issue.

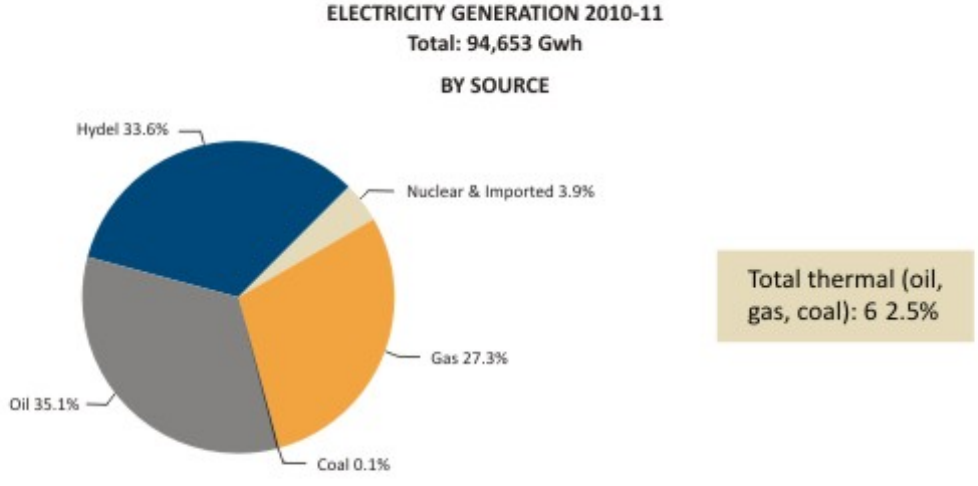
2.15.2.4. Inefficient running of the power generation units.

2.15.2.5. Plants not operating at optimum capacities. Thermal power plants are running at around 52% of their installed capacity.

2.15.2.6. Mismanagement – wastages, leakages, and pilferage.

Electricity generation by source (hydel, thermal, nuclear, and imported)in 2010-11 is shown in Figure II below:

Figure II: ELECTRICITY GENERATION BY SOURCE IN PAKISTAN – 2010-11



3. SITUATION ANALYSIS – 1990 TO DATE

A historical perspective of the development of energy sector in Pakistan from independence to 1990 is provided in Annex I.

In 1990, 45% of the electricity generated in Pakistan was hydel power and the remaining 55% was thermal power. The share of hydropower had already shrunk from 59.3% in 1984, and as the following account will show, it went further down during the two subsequent decades. Annex II covers energy mix figures from 1984 to 2004.

3.1. THE 1990s AND THE DEREGULATION OF THE POWER SECTOR

3.1.1. During the decade of the 1980s, electricity generation capacity in the country rapidly grew to over 7,000 MW. However, electricity load shedding began in the 1980s due to supply falling short of demand. This led subsequent governments to the realization that a serious power crisis was in the offing. It was at this point in time that the foundation of private sector participation in power generation was laid, which later led to unprecedented costs of power generation in Pakistan. In the early 1990s, the power crisis started emerging again.

3.1.2. The Lakhra Coal-Fired Power Plant

3.1.2.1. Lakhra, Sindh, has coal reserves of 1,328 Million Tonnes. The Lakhra Coal Development Company Limited (LCDC) was incorporated as a Public Limited Company in February 1990.The prime objective of the company was to develop Lakhra Coal Mines, under the coal power generation project proposed in 1986, to supply coal to the 150 MW Thermal Plant of the Lakhra Power Generation Company Limited (LPGCL). WAPDA, with Chinese assistance, set up three units of 50 MW each power plant based on Lakhra Coal in 1994. The performance of this unit has, however, remained far from satisfactory. Moreover, no investigation has been carried out to identify solutions required for the success of coal-fired power plants in the region. Two units of the Lakhra Power Plant have been non-operational since 2006, due to non-disbursement of maintenance funds to the power plant due to a leasing dispute (Source: The Express Tribune, 4th January 2012).

3.1.3. HUBCO

3.1.3.1 In 1991, the Hub Power Project (HUBCO) was incorporated in Pakistan as a limited liability company for the purpose of implementing the project. The **Hub Power Station** was the first project to be co-financed by several governments (including those of France, Italy, Japan, UK, and the USA under the **Pakistan Energy Development Fund)** the *WB* as well as international private sector lenders and investors.

3.1.3.2. Rupee debt was provided by a group of local banks led by the *National Development Finance Corporation (NDFC) of Pakistan.* Financial closure was finally achieved in January 1995.

3.1.3.3. The USD 1.6 Billion (high-cost) *HUBCO* was the first private power project in Pakistan. The gross installed capacity of this thermal power plant is 1,292 MW, while its net capacity is 1,200 MW. It is the second largest IPP in Pakistan, *KAPCO* being the largest.

3.1.3.4. This project set the basis for tariff setting of subsequent *IPPs* and had a devastating effect on the financial condition of *WAPDA* and the country.

3.1.4. Huge reserves of coal were discovered in Thar (over 175 Million tonnes), Sindh, in 1992.The *Sindh Coal Authority (SCA)* was established in 1993 to explore, exploit, develop and utilize the vast indigenous coal resources of Sindh. The main objective of *SCA* is to attract potential investors to establish integrated projects of coal-mining and coal-fired power plants in Sindh. The *SCA* provides a one-window facility, and preliminary data required for coal mining and coal-fired power plants.

3.1.5. Performance on the coal front remained unsatisfactory till recently, when the *PC* envisaged a project based on underground coal in Tharparker, Sindh. The Underground Coal Gasification (UCG) Pilot Project of 2x50 MW IGCC power plant in Thar is being implemented and managed by a Governing Body with the current Member S&T, *PC* as the driving force.

3.1.6. Strategic Plan for Power Sector Privatization and The Power Policy 1994

3.1.6.1. In July 1992, the GoP adopted a ***Strategic Plan for Power Sector Privatization***. Under this plan, *WAPDA*, up till then the main electric utility in the country, was to be unbundled into separate generation, transmission and dispatch, and distribution companies, and gradually privatized. The private sector would be invited to construct and operate new thermal generation plants, and an independent regulator would be established. In support of this policy, the *WB* approved two loans: USD 150 Million ***Private Sector Energy Development Project (PSEDP I)*** in June 1988, and USD 250 Million ***Private Sector Energy Development Project (PSEDP II)*** was approved in November 1994.

3.1.6.2. The distribution network of *WAPDA* was divided into nine electricity supply companies (called *Distribution Companies* or *DISCOs*), which are successors of former *Area Electricity Boards (AEBs)*, which were departments within *WAPDA* to administer the supply and distribution, construction, expansion, maintenance and operation of the distribution system. The thermal power generation facilities of *WAPDA* were restructured into *Generation Companies (GENCOs)*.

3.1.6.3. The *Pakistan Electric Power Company (PEPCO)* was formed in 1992 to carry forward reforms in the power sector. As a result:

3.1.6.3.1. *GENCOs* were formed.

3.1.6.3.2. A *National Transmission and Dispatch Company (NTDC)* was formed in August 1998, under *PEPCO*, for the transmission and dispatch functions previously performed by *WAPDA*.

3.1.6.3.3. The nine *DISCOs* were also brought under *PEPCO*.

3.1.6.4. From 1992 to 2007, electricity generation more than doubled, with both hydel and

thermal playing a role, but the major role was played by thermal.

3.1.6.5. The Government shifted its focus from hydel power generation to thermal power generation, which increased the power generation cost. *WAPDA* was restricted from constructing more dams. Moreover, a lack of national consensus on the issue of dam construction brought a complete halt to further construction of dams.

3.1.6.6. As part of the GoP's efforts to facilitate private investment and undertake structural changes in development of the power sector, it began providing lucrative incentives to foreign investors through various power policies, the first of which was initiated in 1994. Through the Power Policy 1994, the establishment of IPPs was encouraged to provide Pakistan with investment in the power industry. The PPIB was established in 1994, with the objective of providing a one-window facility to private-sector investors, in setting-up power projects in the private sector. PPIB facilitates investors in establishing private power projects and related infrastructure, executes Implementation Agreements (IAs) with project sponsors, and issues sovereign guarantees on behalf of the Government of Pakistan (GoP).19 IPP projects were initiated with planned capacity of 3,158 MW and investment of USD 4.0 Billion, including the HUBCO, and the Uch Power limited (gross installed capacity of 586 MW and commissioning date of October 2000). By March 2003 the installed capacity was at 2,728 MW. As of June 2010, 27 IPPs are operational, and have an installed capacity of 6,870 MW. In addition, Kot Addu Power Company (1,600 MW) and KESC power plants (1,946 MW) are also operating in the private sector.

3.1.6.7. The Power Policy 1994 bound WAPDA / KESC to buy the power produced by IPPs at a mutually agreed rate. Most of the IPPs established under the Power Policy 1994 and several units of GENCOs were based on oil. Many of them were later converted to natural gas because generation cost is lower. However, this was done without realizing that indigenous gas reserves are not sufficient to supply fuel to all of these units. Moreover, the large scale use of CNG for transport sector further reduced the supply of gas to power generation plants.

3.1.6.8. In 1995, the State Engineering Corporation (SEC), in association with public and private sector entities, took an initiative to start indigenization of power plants. Based on the 1992 policy directive disallowing turnkey imports of power plants, the SEC signed General Cooperation Agreements with foreign firms for co-financing and co-manufacturing of complete power plants, including CMEC (China), GEC Alsthom (France, UK), Babcock (Germany), and General Electric (USA).The plan was to progressively increase local component with positive impact on cost reduction. The plan envisaged the best utilization of national resources of engineering, manufacturing and technical services in the public and private sectors, including the Heavy Mechanical Complex (HMC), Taxila. Foreign and local financing was lined up and an offer was made to WAPDA for six power plants of 300-330 MW each (total 2000 MW).[1]

3.1.6.9. The indigenization plan, if realized, would have helped establish the domestic

engineering industry, with substantial foreign exchange savings and employment generation, apart from other socio-economic benefits, particularly attaining much lower cost of power generation. The capital cost as well as the Operations and Maintenance (O&M) costs of the plants, and resultantly the tariffs, would have been much lower than they are today. Unfortunately, the GoP did not allow WAPDA to put up the power plants, due to which this important initiative could not succeed. This had an adverse impact not only on the power sector, but also on the growth of engineering goods manufacturing sector.

3.1.6.10. In 1997, the GoP enacted the **Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997**. Under this Act, the National Electric Power Regulatory Authority (NEPRA) was created to determine tariffs for the various generation, transmission, and distribution companies, including the IPPs. The main functions of NEPRA are to grant licenses for generation, transmission of electric power, and prescribe and enforce performance standards for generation, transmission and distribution companies and power plants established in the private sector. NEPRA protects the interests of companies providing electric power services as well as those of the consumers of electricity.

3.1.6.11. The decision to bring in IPPs resulted in increased power generation costs because:

3.1.6.11.1. Capital cost of IPPs is very high; the generation cost is also high. Therefore tariffs are unaffordable by the common man. Some people have tried to justify the exorbitant capital costs of IPPs; however, the fact remains that the high capital costs have played a major part in raising the electricity tariffs in Pakistan.

3.1.6.11.2. IPPs were incentivized with "no-risk" and high-profits.

[1]Breakdown of 6 power plants of total capacity 2000 MW:-

- CMEC China: 2 units, 320 MW each
- GEC Alsthom (France, UK), Babcock (Germany): 2 units, 360 MW each
- General Electric (USA) and Cockrill Mechanical Industries (CMI) Belgium: 2 units, 300 MW each

3.1.6.11.3. Commitments were far in excess of demand and the units operated, and are even now running, at below their installed capacities.

3.1.6.11.4. The IPPs being in the private sector, their main objective was to make profits.

3.1.6.11.5. Gradually, more and more IPPs started using FO because of gas shortages. As oil price rose, FO became a very expensive proposition. And hence the cost per unit of power generated became even higher.

3.1.6.11.6. Initially natural gas was used as a fuel in the thermal power plants, since at that time, gas was considered to be in excess of local demand. However, expensive imported FO was also added to the fuel mix, which pushed up the generation cost.

3.1.7. In 1996, a steep deterioration in KESC's financial health began, which promoted suggestions for the utility's transfer into private hands.

3.1.8. The Kot Addu Power Plant

3.1.8.1. The Kot Addu Power Plant was built by WAPDA in five phases between 1985 and 1996.It is a multi-fuel gas turbine power plant, with the capability of using three different fuels to generate electricity, namely Natural Gas, Low Sulphur FO, and High Speed Diesel (HSD) to generate electricity. In April 1996, Kot Addu Power Company Limited (KAPCO) was incorporated as a Public Limited Company under the Companies Ordinance, 1984 with the objective of acquiring the power plant from WAPDA. After privatization, KAPCO became Pakistan's largest IPP with a capacity of 1,600 MW.

3.1.9. In October 1997, OGDC was converted into Oil and Gas Development Company Limited (OGDCL). Currently, OGDCL is the leading oil and gas producing company in Pakistan. In November 1998, the GoP decided to place the National Refinery Limited (NRL) under the administrative control of Ministry Of Petroleum & Natural Resources.

3.2. FROM THE TURN OF THE MILLENNIUM TO DATE

3.2.1. CHASNUPP-1

3.2.1.1. The second nuclear power plant by *PAEC*, *Chashma Nuclear Power Plant-1 (CHASNUPP-1),* with a generation capacity of 325 MW and net output of 300 MW, started operations in September 2000. Its construction was started in 1992 with the help of China. The 2-loop Pressurized Water Reactor (PWR) was supplied by *China National Nuclear Corporation (CNNC)* under safeguards. Its designed lifespan is 40 years.

3.2.2. In 2001, the Cabinet constituted a Task Force with a mandate to prepare an **Energy Security Action Plan**; the plan was meant to include: Energy requirement up to 2010; Energy security enhancement measures; Energy mix, Energy Efficiency (EE) and Energy Conservation (EC); RE promotion measures; and Viability of an additional refinery.

3.2.3. In 2001, *WAPDA* announced an ambitious **Hydropower Development Plan – Vision 2025**, to develop Pakistan's water and hydropower resources. **Vision 2025** suggested a plan to meet the upcoming deficits through additional power generation. The plan was updated and a consolidated list of potential projects to be implemented in the short, medium, and long term was prepared. It was decided that the list would be periodically reviewed and updated, and the choice of implementing projects by the public sector, private sector, or by public-private partnership will depend upon the urgency of meeting demand while keeping in view the resource availability position. The plan,to be implemented in three phases incorporated a total of 23 hydropower projects, to be completed by 2025 under this plan.

3.2.4. Re-privatization of KESC

3.2.4.1.During 2002 and 2003, plans were made to re privatize *KESC*; this was eventually finalized in November 2005, with a 71% transfer of ownership to a consortium of the *Saudi Al-Jomaih Group Of Companies* and Kuwait's *National Industries Group (NIG)*, with the Government still retaining a 26% stake. The privatized consortium was unable to improve the company's financial and operational crisis. In early 2008, *Saudi Al-Jomaih* approached *Abraaj Capital*, a leading private equity firm based in Dubai, for a significant equity stake in *KESC*. In September 2008, full management control of *KESC* was transferred to *Abraaj Capital*, which brought in a professional management team with over 41 senior managers to address the management crisis at *KESC*. *KESC* is listed on all three of Pakistan's stock exchanges.

3.2.5. The Power Policy 2002

3.2.5.1.The *Power Policy 2002* aimed to:

3.2.5.1.1. Provide sufficient capacity for power generation at the least cost, and avoiding capacity shortfalls.

3.2.5.1.2. Encourage and ensure exploitation of indigenous resources, including RE resources like solar and wind, alternate resources like the vast coal deposits in Pakistan, human resources, and participation of local engineering and manufacturing capabilities.

3.2.5.1.3. Ensure a win-win situation for all stakeholders.

3.2.5.1.4. Safeguard the environment.

3.2.5.2. The scope of the policy covered private sector projects, public sector projects, public-private partnership projects, and projects developed by public sector and then divested.

The basic aim of the policy was to encourage enhancement in power generation capacity, whether by public sector or private sector or a partnership of both.

3.2.5.3. Unfortunately this key aspect of the Policy was subsequently neglected and power projects in public sector were not permitted even when private sector was not forthcoming. Resultantly the seeds for the crisis were sown. In order to develop Pakistan's coal resources, the GoP and the Sindh Government signed MOUs and invited EOIs through advertisement for the development of indigenous coal and for setting up coal-based power projects for a total capacity of 2,600 MW. Progress has remained highly unsatisfactory.

3.2.6. Construction of Ghazi Barotha Project

3.2.6.1. *Ghazi Barotha* is a 1,450 MW run-of-the-river hydropower project on the Indus river in the Khyber Pakhtunkhwa(KPK) province. It was executed by *WAPDA*, took around 10 years to complete, and began commercial operations in May 2004.The project accounts for more than 10% of Pakistan's power generation capacity. It made a major contribution to the country's power expansion program. It diverts about 1,600 cubic meters per second of water from the Indus River near the town of Ghazi about 7 km downstream of Tarbela Dam. In the reach from Ghazi to Barotha, the Indus River inclines by 76 meters over a distance of 63 km. After passing through the powerhouse, the water is returned to the Indus. In addition to these main works, transmission lines stretch 340 km. This project, costing USD 2.2 Billion, was financed by *WAPDA* and a consortium of development banks {including *Asian Development Bank(ADB)*, the *European Investment Bank*, the *Islamic Development Bank (IDB)*, *Japan Bank For International Cooperation*, *Kreditanstalt Für Wiederaufbau*, and the *WB}*. Construction work provided skills training and employment for 13,500 local people and many local companies. The *WB* classed it "A" for adequate attention to environmental and social issues. Mangla and Tarbela power stations were the largest contributors to hydropower generation before *Ghazi Barotha* came online in 2004.

3.2.7. Table V below gives Pakistan's hydropower potential (Source: Energy Security Action Plan 2005).

Table V: MINIMUM HYDROPOWER POTENTIAL OF PAKISTAN

S. No	Station/Projects		Capacity (MW)
1.	Hydel Stations in Operation		6,459
2.	Under Implementation		1,275
3.	Feasibility Study Completed:		
	(a) Run-of-the-River	2,038	10,878
	(b) Multipurpose	8,840	
4.	Feasibility Studies in hand		9,072
5.	Projects for which feasibility studies are to be carried out		18,331
	TOTAL		46,015

3.2.8. Out of this, 32,660 MW of hydel power capacity was planned to be completed till 2030 **(Source: Energy Security Action Plan 2005).**

3.2.9. As per the **Medium Term Development Framework (MTDF) 2005-10,** a total electricity generation capacity of 27,420 MW was planned for 2010, against a projected peak load demand of 21,426 MW, as shown in Table VIon the following page.

Table VI: PLANNED VERSUS ACTUAL ELECTRICITY GENERATION CAPACITY – 2010

	Installed as in 2005	Planned for 2010	Existing in 2010
Hydro	6,460	7,720	6,480
Oil and Gas	12,340	17,360	13,204
Coal	160	1,060	150
Nuclear	400	400	400
Renewable	180	880	2
TOTAL CAPACITY	19,360	27,420	20,258
WINTER CAPACITY (ACTUAL)	12,400	19,636	13,832
SUMMER CAPACITY (ACTUAL)	15,600	23,536	17,878
DEMAND (PEAK LOAD)	14,621	21,426	19,257

(Source: "Pakistan Energy Crisis and Solution" – Presentation by Chief Energy Wing, PC, GoP, May 2011)

3.2.10. Had the Energy Security Action Plan 2005 been implemented in letter and spirit, there would not have been any crisis on the energy front today.

3.2.11. The total water storage capacity of all water reservoirs in Pakistan is 13.6 Million Acre-Feet(MAF). Table VIIon the following page shows the average annual flow and storage capacity of dams of the major river basins in the world.

3.2.11.1. Pakistan has water storage of only one month of the annual river flow, which is extremely and disturbingly low.

Table VII: AVERAGE ANNUAL FLOW & STORAGE CAPACITY OF DAMS OF SOME MAJOR RIVER BASINS

River Basin	Catchment Area (1000 Sq. km)	Length (Km)	Average Annual Flow (MAF)	No. of dams	Storage Capacity (MAF)	%age Storage	Power (MW)
Colorado	141	2320	12	4	60+	500	4,167
Nile	3,349	6650	75	1	132	175	2,000
India (Total)	-	-	750	4,636	245	33	-
Yellow River	745,920	5,464	345	7	68.95	20	1,160
Columbia	668	1,950	179	3	34	19	12,602
Indus & Other River	**1,166**	**2,880**	**145**	**3**	**13.64**	**9**	**6,460**
WORLD	**-**	**-**	**20,000**	**-**	**8,000**	**40**	**-**

3.2.12. The GoP decided to include NRL in its privatization program in 2003, and NRL was acquired by the Attock Oil Group in July 2005. The refining capacity of NRL is 52,000 barrels per day (bbl/d).

3.2.13. Energy Security Action Plan 2005

3.2.11.1. Till 2005, the total supply of electricity was surplus to demand by around 450 MW. Since then, demand has been outstripping supply, mainly because while the demand grew, practically little additional power generation was added to the system. The Task Force constituted by the Cabinet in 2001 was reactivated in 2004. The Task Force consulted and associated all stakeholders in private and public sectors (including all relevant ministries), and finalized the Energy Security Action Planing February 2005. This Plan was approved by the President and the Prime Minister (PM) in February 2005 and was subsequently approved by the National Economic Council (NEC) as part of the MTDF 2005-10 in May 2005. This Plan adopted an integrated, holistic, consultative and coordinated approach, and called for a huge increase in generating capacity to more than 160,000 MW by 2030. The MTDF 2005-10 envisages a "developed, industrialized, just, and prosperous Pakistan through rapid and sustainable development in a resource

constrained economy by deploying knowledge inputs."

3.2.13.2. The Plan called for the following steps to be taken:

3.2.13.2.1. Ensure availability of sufficient energy on sustainable basis and at affordable prices to achieve planned GDP growth targets (2005-10 – average 7.4%; 2011-2030 – average 8%).

3.2.13.2.2. Reduce dependence on imported oil, and diversify the energy mix by utilizing indigenous resources (coal, gas, hydel, nuclear, oil and RE) to the maximum to meet the growing demand on a sustained and affordable basis thereby providing energy security, sovereignty and sustainability.

3.2.13.2.3. Promote R&D in emerging areas (e.g. fuel cell), and improve EE and EC and development of energy efficient appliances.

3.2.13.2.4. Improve the quality of consumer services and create a competitive environment to solicit maximum private sector participation.

3.2.13.2.5. Improve oil and gas distribution networks.

3.2.13.2.6. Undertake integrated coal mining and power generation and coal gasification to increase the indigenous coal share in the energy mix i.e. upto 20% in 25 years and lay the foundation for future share to go up to 50%.

3.2.13.2.7. Resort to import of natural gas and Liquefied Natural Gas(LNG) through multiple sources on best possible terms if indigenous resources fall short to maintain GDP growth.

3.2.13.2.8. Maximize indigenization of design and manufacturing of Plant, Machinery, and Equipment(PME) to minimize capital cost and O&M expenses.

3.2.13.2.9. Facilitate establishment of refineries and petrochemical industry based on coal, gas and oil.

3.2.13.2.10. Promote nuclear and renewable/alternate energy sources (wind, solar) to have 10% share in energy mix in 25 years.

3.2.13.2.11. Build up the local power engineering industry for power plant equipment, steam turbines, and generators.

3.2.13.2.12. Promote human resource development to ensure availability of required manpower to achieve Plan objectives.

3.2.13.3 The **Energy Security Action Plan 2005** included enhancing nuclear capacity to 8,800 MW by 2030. PAEC has selected six new sites on the advice of the Pakistan Nuclear Regulatory Authority (PNRA) andthe International Atomic Energy Agency (IAEA). The Plan included planned projections of energy mix and a power generation plan till 2030, shown in Tables VIII and IX on the following two pages.

Table VIII: ENERGY MIX PLAN PROJECTIONS

	Current		Short Term		Medium Term				Long Term			
	2004		2010		2015		2020		2025		2030	
Total MTOE	50.8		79.39		120.18		177.35		255.37		361.31	
Oil	15.20	30%	20.69	26%	32.51	27%	45.47	25.7%	57.93	22.7%	66.84	18.5%
Natural Gas	25.45	50%	38.99	49%	52.98	44%	77.85	44%	114.84	45%	162.58	45%
Coal	3.30	6.5%	7.16	9%	14.45	12%	24.77	14.0%	38.28	15%	68.65	19%
Hydro	6.43	12.7%	11.03	13.9%	16.40	13.6%	21.44	12.1%	30.50	12%	38.93	10.8%
Renewable	0.00	0.0%	0.84	1.1%	1.60	1.3%	3.00	1.7%	5.58	2.2%	9.20	2.5%
Nuclear	0.42	0.8%	0.69	0.9%	2.23	1.9%	4.81	2.7%	8.24	3.2%	15.11	4.2%

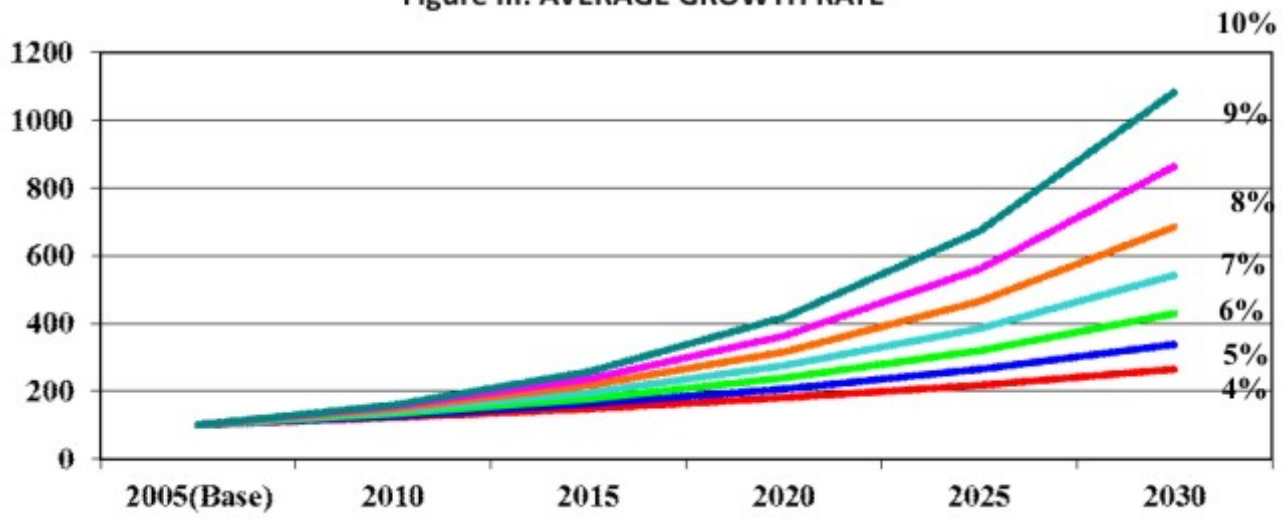
Table IX: POWER GENERATION PLAN

	Nuclear	Hydel	Coal	Renewable	Oil	Gas	Total	Cumulative
Existing 005)	400	6,460	160	180	6,400	5,940	19,540	
Addition	-	-	-	-				
2010	-	1,260	900	700	160	4,860	7,880	27,420
2015	900	7,570	3,000	800	300	7,550	20,120	47,540
2020	1,500	4,700	4,200	1,470	300	12,560	24,730	72,270
2025	2,000	5,600	5,400	2,700	300	22,490	38,490	110,760
2030	4,000	7,070	6,250	3,850	300	30,360	51,830	162,590
Total:	8,800	32,660	19,910	9,700	7,760	83,760	162,590	

Unfortunately, the Energy Security Action Plan 2005 was not implemented sincerely. Lack of achieving a political consensus on the issue of water resources and dam construction was a major reason for non implementation of this Plan.

3.2.13.4 The graph in Figure III on the following page shows the requirement of energy based on different GDP growth rates, keeping 2005 as the base

Figure III: AVERAGE GROWTH RATE



AGR (%)	2005 (Base)	2010	2015	2020	2025	2030
4%	100	121.7	148.0	180.0	219.1	266.6
5%	100	127.6	162.9	207.9	265.3	338.6
6%	100	133.8	179.1	239.7	320.7	429.2
7%	100	140.3	196.7	275.9	387.0	542.7
8%	100	146.9	215.9	317.2	466.1	684.9
9%	100	153.9	236.7	364.3	560.4	862.3
10%	100	161.0	259.4	417.7	672.7	1,083.5

3.2.13.5. It can be seen that if GDP growth rate is assumed at 4%, we need 166.6% of the 2005 base, and so on.

3.2.14. From 1992 to 2007, electricity generation capacity more than doubled (approximately 7,540 MW of generation capacity was added), with both thermal and hydropower playing their role. The increase from 1992 to 1999 was 5,120 MW of gross installed capacity (including the Lakhra Coal Power Plant and KAPCO).The increase from 2000 to 2007 was 2,420 MW (including Ghazi Barotha. During this period, while the implementation of the **Energy Security Action Plan 2005** was regularly monitored but the implementing agencies could not deliver on the planned additional power generation.

3.2.15. With the thermal power generation, transmission, distribution, and billing becoming the responsibility of PEPCO, the responsibilities of WAPDA were limited to hydel power generation and operations.

3.2.16. Pakistan was hit by its worst power crisis in 2007. Production fell by 6,000 MW and massive

blackouts followed suit. In 2008, availability of power in Pakistan fell short of the demand by 15%. Load shedding and power blackouts became more and more severe.

3.2.17. The 2005 earthquake and the 2010 floods damaged the existing power stations, power distribution and transmission, and other energy infrastructures. During the 2010 floods the recently constructed Jinnah Hydroelectric Power Plant was flooded in addition to severe damages to transmission and distribution network and installations while several power plants and refineries were threatened by rising waters and had to be shut down. Natural gas field output had to be reduced as the flood waters approached the wells. There has also been some concern by Pakistani nuclear activists over the effect of natural disasters on nuclear plants, especially over the CHASNUPP-1, since the plant lies over a geological fault.

3.2.18. The first hydel IPP in Pakistan, the 84 MW New Bong Escape Hydropower Project of Laraib Energy Ltd, with major shareholding of HUBCO, achieved financial close in December 2009. This was Pakistan and Azad Jammu & Kashmir's first hydropower project in the private sector. It is located 7.5 km downstream of Mangla Dam, in Azad Jammu & Kashmir and is expected to be commissioned by May 2013.Although this project was hailed by the WB, and termed **"Project Finance Middle East Deal of the Year"** by Euromoney in 2009; the truth is that this project was under discussion and planning for over 15 years. When projects take such a long time to get off the drawing board before moving to implementation, their capital costs rise manifold, and these projects lose much of their anticipated benefits.

3.2.19. The third nuclear power plant, Chashma Nuclear Power Plant-2 (CHASNUPP-2), with a generation capacity of 325 MW, started commercial operations in May 2011. Its construction started in December 2005. The total cost of the plant is Pak Rs. 51.46 Billion (USD 860 Million, with USD 350 Million of this financed by China). A safeguards agreement with IAEA was signed in 2006 and grid connection was made in March 2011. CHASNUPP-2 is the third nuclear power plant in the country. With this addition the total nuclear power generation in the country has increased to 792 MW.

3.2.20. The GoP is planning to install two more units of 300 MW capacity each at Chashma. Additionally, discussions for two coastal units of 1,000 MW each for Karachi are in progress. The GoP has allocated Pak Rs. 32 Billion for the project in the **Public Sector Development Program (PSDP) 2012-13**. The projects are in progress with Chinese assistance.

3.3. ENERGY CONSUMPTION GROWTH PATTERN

3.3.1. The Figure IV on the following page shows a comparison of the sector-wise energy consumption in Pakistan in 2010-11 vis-à-vis the consumption in 2005-06 (Source: Pakistan Energy Yearbook 2011), while the Figure V shows the sector-wise electricity consumption for the two fiscal years 2005-06 and 2010-11 (Source: Pakistan Energy Yearbook 2011).

Figure IV: ENERGY CONSUMPTION BY SECTOR (EXCLUDING FUELS CONSUMED IN THERMAL POWER GENERATION): 2010-11 VIS-À-VIS 2005-06

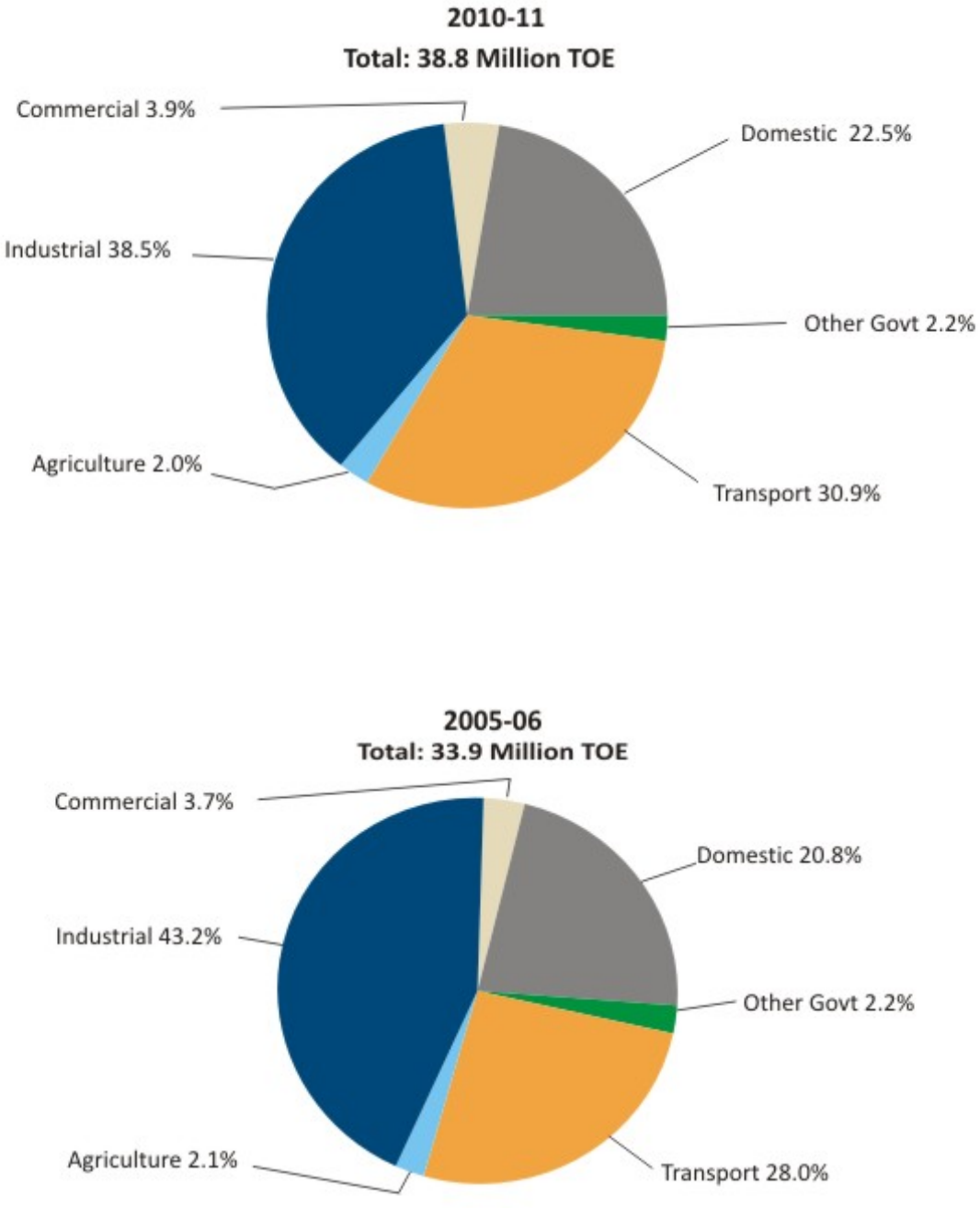
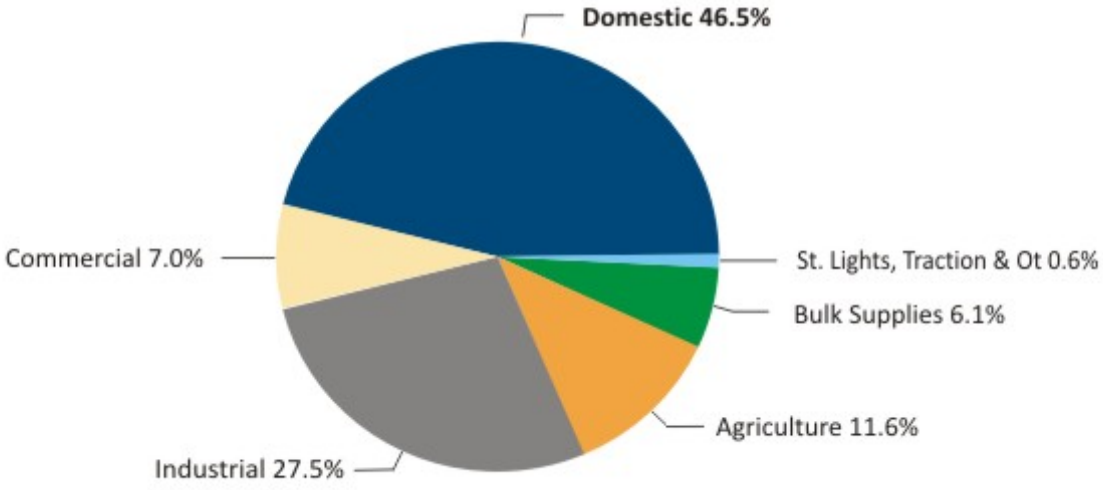


Figure V: ELECTRICITY CONSUMPTION BY SECTOR: 2010-11 VIS-À-VIS 2005-06

ELECTRICITY CONSUMPTION BY SECTOR

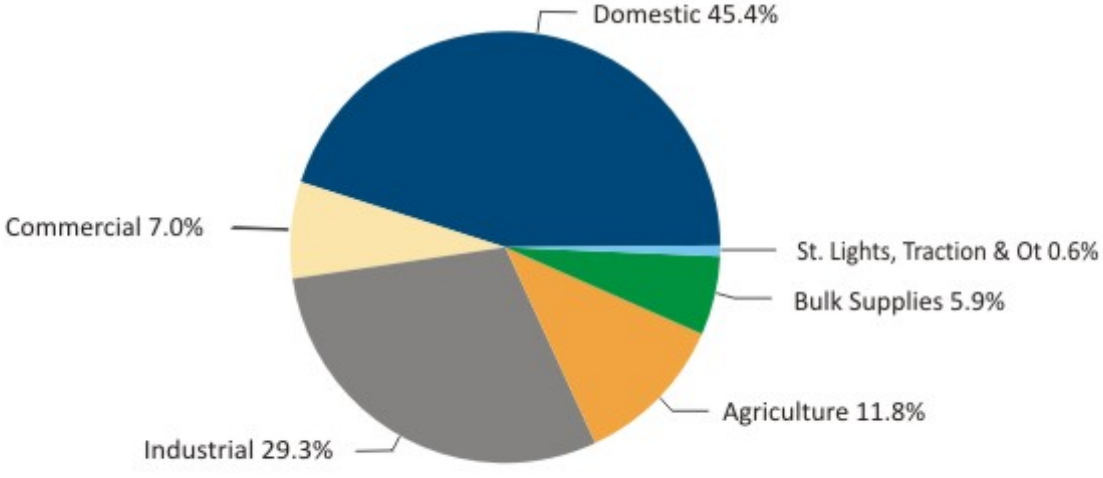
2010-11

Total: 67,099 GWh



2005-06

Total: 67,603 GWh



3.3.2. The declining availability of electricity to the industry has hit some industries very hard, e.g. the textile sector. In recent times, several textile units have set up their own electricity generation plants, to cater to their individual power needs. This demand suppression, especially in the industry, is extremely unfortunate. The shutting down of industries is hampering the growth of our economy, and is creating unemployment, which becomes the root cause of several social evils.

3.4. SUMMARY OF THE ENERGY CRISIS

3.4.1. Mistakes Committed

In the past several mistakes were committed which resulted in the ongoing energy crisis. These included:

3.4.1.1. Inadequate and poor implementation of strategic plans.

3.4.1.2. Inadequate implementation capacity in energy sector agencies, which gave an opportunity for excessive influence of external donors and lenders.

3.4.1.3. Restricting *WAPDA* from constructing more dams and focusing only on thermal power plants.

3.4.1.4. Restructuring and unbundling of *WAPDA* was done without an in-depth analysis of the problem and the long-term implications. Consequently, this move has done serious damage to *WAPDA* and the power generation sector in Pakistan.

3.4.1.5. Excessive, in some cases, exclusive dependence on foreign experts, and lack of confidence in our own professional expertise.

3.4.1.6. Outsourcing power generation to private sector: The GoP adopted the popular mantra of privatization, liberalization and deregulation. This put decision-making in the hands of the multinationals and foreign investors at the cost of national sovereignty. Excessive involvement of the private sector into power generation, without public checks and accountability, was the single biggest reason for the unprecedented increase in generation costs. Running units below their installed capacities, giving high profits to the IPPs and using imported FO as fuel, all contributed to the increased power costs. This was complemented by unaffordable subsidies to keep electricity prices low, nurturing the demon of Circular Debt.

3.4.1.7. Inability to set priorities: Hydropower generation was not given the priority it deserved due to the low cost of power generation. Pakistan has an identified hydropower potential of over 46,000 MW (MTDF 2005-10),out of which only 14% has been exploited so far. It is an indigenous source, with Pakistan having the 5th largest river system in the world. Hydel is the cheapest source of electricity. No fuel is needed, and O&M costs are low. It is clean and environmentally friendly. Hardly any atmospheric pollutants are emitted in hydropower generation. Water reservoirs need to be built in order to save water from being wasted. The agricultural, and hence the economic, future of Pakistan heavily depends on the construction of more dams and water reservoirs. Climate change experts predict that over the next 30 years, global warming will cause glaciers to melt and hence we will experience greater water flows. As this natural water reservoir (glaciers) depletes, the need to replace them with man-made storage will become absolutely essential. Water reservoirs and dams are an instrument for flood control. Hydel power projects are eligible for Carbon

Credits, which can offset the capital cost of the projects. Building more dams and reservoirs would regulate water flow in the rivers throughout the year. This would also provide an opportunity for inland water navigation, the most economical form of transport, which is currently practically non-existent, and would take the burden off our roads and railway networks. To check sea encroachment, it is necessary that water flows into the sea all the year round. This can only be possible if reservoirs can be constructed and water flow controlled.

Given the obvious advantages of investing in hydel power plants, and the strong case for hydel power in Pakistan, exclusive dependence on expensive thermal power based on imported fuel is against national interest.

3.4.1.8. Employing a demand suppression strategy has had an extremely detrimental effect on industrial and commercial activities as well as on the quality of life of people.

3.4.1.9. Escalation in the Circular Debt problem has many negative implications. The most visible subsidy in the budgetary accounts is that on the power sector. Each unit of electricity generated sells at 65% of its cost, and the difference is paid by the Government. Power sector losses in 2010-11 were a staggering Pak Rs. 350 Billion. The GoP provided subsidies worth Pak Rs.342 Billion to the power sector against the total federal development spending of Pak Rs.280 Billion in the fiscal year 2010-2011, and paid Pak Rs. 1 Trillion in energy subsidies in the last four years (Source: Business & Finance section, Daily Times, 4th December, 2011).Against the budget allocation of Pak Rs.84 Billion, PEPCO and WAPDA were given Pak Rs.295 Billion to cover up this differential, while the KESC was provided Pak Rs. 47 Billion compared to the allocated amount of Pak Rs. 3.2 Billion in the 2010-11 budget. If the amount spent by the GoP on subsidies was spent on construction of hydel power projects:

3.4.1.9.1. Today Pakistan would have been self-sufficient in power generation.

3.4.1.9.2. There would have been no energy crisis, no load shedding, and no closure of industries and lack of jobs due to energy unavailability to industries.

3.4.1.9.3. There would have been no Circular Debt.

3.4.1.10. The PAEC's major role was power generation through nuclear resources. However, that was put on the back burner, with the emphasis shifting to building strategic assets. Although indigenous design, manufacturing, and technology base is present within the country, its utilization has remained limited. Instead of developing indigenous capabilities in design, manufacturing, installation, and commissioning of nuclear power plants, we kept looking at China to set them up for us. Had due importance been given to this, today Pakistan could be manufacturing, assembling and installing major parts, components and assembly in our power plants, including nuclear. This concept is required to maintain even a semblance of sovereignty and self-reliance. It is worth mentioning here that indigenization brings technological self-reliance, which is not the same as self-sufficiency. Whereas it is appreciated that no country in the world is

manufacturing entire nuclear power plants by itself, it must also be clearly understood that technological self-reliance is imperative for a nation; it ensures that critical parts and components can be produced locally.

3.4.1.11. Other indigenous resources were not developed, like coal, natural gas and renewables (wind, solar, bio fuels). These resources have the potential to not only meet the energy shortfall of Pakistan, but to help Pakistan become an electricity-exporting nation.

3.4.1.12. Failure to overhaul / upgrade old and obsolete equipment led to continuous reduction in generation, transmission, and distribution efficiency.

3.4.1.13. One of the reasons why privatization was undertaken was that there was a dearth of professionals in the Government organizations. Hence the reliance on outside consultants and professionals was unavoidable.

3.4.1.14. Management issues include the following:

3.4.1.14.1. Plant capacity in Pakistan is low mainly because of poor O&M, reflecting poor management at organizational and national levels.

3.4.1.14.2. Incompetent people have been placed to lead key organizations. Competence and merit should be the key criteria for appointments. If we turn the pages of the history of our country, whenever the right person was put at the right job, the organization flourished, and made significant contributions to the economy. As incompetent persons replaced the worthy ones, successful establishments started to nosedive (This applies not only to energy-related organizations, but to all institutions in the country).Also, when competent professionals at the helm of affairs were allowed freedom to take key decisions, they produced results. When the Government started interfering in their day-to-day running, progress was hampered.

3.4.2. The Outcomes

The mistakes committed (as discussed above) have led to the following outcomes:

3.4.2.1. Long hours of load shedding (both announced and unannounced).

3.4.2.2. Increase in electricity prices.

3.4.2.3. Failure to provide electricity to a substantial portion of the population.

3.4.2.4. Unavailability of sustained and affordable energy for the industry, resulting in suppressed economic growth and declining tendency for industrial investment in Pakistan as well as closure of some industrial units.

3.4.2.5. Rising unemployment.

3.4.2.6. Staggering oil import bills.

3.4.2.7. Increasing Circular Debt.

3.4.2.8. Enhanced energy security risk.

3.4.2.9. Several associated and resultant social problems.

4. RECOMMENDED SOLUTIONS AND IMPLEMENTATION MECHANISM

The *Energy Security Action Plan* clearly out lines strategic plans for the energy sector. From the detailed study of government documents, particularly the **MTDF 2005-2010,** we find that the **Energy Security Action Plan(Chapter 28)** contains a comprehensive and integrated 25-year plan for the energy security of Pakistan. This is a document approved by the *NEC*, the highest economic forum in Pakistan. It has been noted with concern that the implementation of this plan since its approval has not been satisfactory. Had this plan been executed in letter and spirit, we would not be facing the present crisis.

There could possibly be two reasons for this state of affairs: one, which is usually the case in Pakistan, That plans are formulated but implementation is extremely poor. The second, even more disturbing aspect is that with the passage of time, the Ministries and concerned organizations have lost their capacity and capability to undertake detailed planning, execution, and monitoring of development plans and projects, which is a huge cause for concern for us as a nation.

The *PAS* feels that the **Energy Security Action Plan 2005** should be implemented with essential adjustments to current demand, due to lower GDP growth as compared to the planned projections. The plan should be periodically reviewed and updated, and in combination with this document, should become the basis for solving the energy crisis.

To resolve the current crisis, it is essential to take various actions, suggested below, **on war footings,** because the adverse effect on industrial production and growth is hampering the economy including revenue collection, exports and employment generation. The immediate solutions suggested below need to be adopted by the GoP without delay, to fill up as much of the demand-supply gap as possible, and address the severe crisis at hand. At the same time, longer-term solutions requiring large infrastructure and heavy funding must also be sought, which will bear fruit in coming decades.

It is acknowledged that the solutions presented in this document are not novel, but this report has consolidated all the plausible solutions, which were earlier scattered. The energy crisis will not be solved overnight, but we are confident that the recommendations prepared by it, if implemented with commitment and honesty, will bring about improvements in the short term, and put things on the right track in a longer term perspective.

This section covers what needs to be done to tackle the current crisis and put the country on a sustainable energy path, and how to implement the proposed suggestions by putting an appropriate mechanism / system in place.

4.1. RECOMMENDED SOLUTIONS

The recommendations are in the following three categories.

4.1.1. General recommendations.

4.1.2. Immediate steps to be taken to reduce the intensity of the crisis – specific recommendations.

4.1.3. Optimal utilization of available energy resources for meeting short-term and long-term needs.

4.1.1. General Recommendations

These include the following:

4.1.1.1. Pakistan must solve its problems itself, and not look towards foreign bodies like the WB, International Monetary Fund(IMF), United States Agency for International Development(USAID), or ADB to present solutions. The solutions to our problems, when formulated by our own highly qualified professionals, will be far more logical and implement able, and will have greater ownership by all within the country.

4.1.1.2. It is of utmost importance to put honest, competent, and result-oriented professionals at the helm of affairs.

4.1.1.3. A proper and transparent system must be put in place to select the right person for the right job.

4.1.1.4. Improved coordination between all the organizations dealing with or working on energy is very important, in order to avoid unnecessary duplication, and to supplement each other's efforts. The work of individuals or institutes that have been working on solutions to the energy crisis musty be consolidated and synergized.

4.1.1.5. Without accountability, it is impossible to evaluate performance. Responsibility and accountability must be linked to ensure that the country's scarce resources are used effectively and efficiently.

4.1.1.6. The Government's job is policy formulation and monitoring; it should not attempt to micro-manage the institutions. Everyday decision-making and operational management should be left to the concerned organizations and there should be no interference from the Government.

4.1.1.7. It is the responsibility of the Government to create an environment that favors investment, productivity, and value-addition.

4.1.1.8. National interest must be kept above all personal interests and goals. Decisions must be made keeping the benefit of the country in mind. A fundamental change in mindset is required, starting from the top decision makers, trickling down to the

masses. Education and skill development of the people will help speed up this change, and exponentially improve productivity levels.

4.1.1.9. The **Energy Security Action Plan 2005 (MTDF 2005-10)** must be implemented in letter and spirit. The demand projections, of course, need to be reviewed periodically and adjusted suitably keeping in view the actual GDP / energy demand growth and the expected / planned growth figures. However, all efforts should be made to improve implementation plans instead of squandering energy in finding scape goats to blame and justify own failures.

4.1.1.10. Special attention must be given to appropriate development of human capital in this sector from the highest professionals required in Islamabad to man the ministries to the heads of energy organizations and the lowest technicians to operate and maintain installments. Linkages must be established to obtain support from universities and other technical institutes.

4.1.2. Immediate Solutions To The Crisis – Specific Recommendations

These include:

4.1.2.1. Operating existing plants at optimum capacity to increase output.
4.1.2.2. Enhancing transmission & distribution efficiency.
4.1.2.3. Enhancing efficiency at consumer level.

4.1.2.1. Operate Existing Plants At Optimum Capacity – Increase Output:

The following statistics should be noted:

- Installed Capacity (2011): 23,412 MW (against planned capacity of 28,000 + MW)
- Available Capacity: Varies from 14,000 – 18,000 MW (depending upon season)
- Average peak demand: around 15,000 – 20,000 MW (without demand suppression)
- Electricity shortfall in 2011, on an average, has varied between 4,500–6,000 MW and could increase to 7,000 MW in the event of low rainfall.
- Plants are not operating at optimum capacity.

4.1.2.1.1. The Circular Debt problem is a logical outcome of the difference between the generation cost and the sale price, and gets worse with delayed subsidy payments by the GoP to *WAPDA* and *PEPCO*, which in turn delays payments to *IPPs* and to *Pakistan State Oil (PSO)*; consequently, the *IPPs* and *PSO* cannot pay for the imported FO needed to run the thermal power plants. This aggravates the electricity shortage. The GoP must make timely subsidy payments to ensure timely supply of fuel to the thermal power plants so that they can run on optimal capacity.

4.1.2.1.2. **Power Generation Efficiency must be enhanced. Existing power plants, thermal as well as hydel and coal-fired, must be made to work on optimum capacity and efficiency.** Low-efficiency plants must be revamped; new equipment must be installed wherever necessary to ensure that greater output is achieved from the same amount of energy input and there is minimum energy loss and wastage in power generation. Payback period of BMRE such plants will be very low (probably less than 5 years) and there should be no difficulty in arranging loans including suppliers' credit.

4.1.2.2. Enhance Transmission & Distribution Efficiency:

4.1.2.2.1. Infrastructure for transmission and distribution (for gas and electricity) must be revamped or upgraded to reduce wastage and increase efficiency. The benefits accrued from this investment would mean a payback period of less than 5 years.

4.1.2.3 Enhance Efficiency at Consumer Level:

4.1.2.3.1. The Government must develop and enforce regulation for mandatory energy audits of all industrial units, government, commercial, and consumer establishments, and implementation of remedial measures (such as using electrical appliances with low power consumption and energy-efficient building designs) at consumer level are minimized.

4.1.2.3.2. Mechanisms should be devised to integrate the scattered efforts of the organizations currently working in t*his area* **{e.g. National (Pakistan) Energy Conservation Center(Enercon)** and **National Productivity Organization (NPO)}** as well as private sector bodies) with universities like *NUST*, *NED* Karachi, *UET* Lahore and *UET* Peshawar, as well as with consulting companies.

4.1.2.3.3. Pilferage, theft and misuse of power, gas and petroleum products must be prevented through strong monitoring and tough punishments without any discrimination.

4.1.2.3.4. The Energy Efficiency Standards and Labels Regime for energy guzzling inefficient electric and gas appliances must be promoted.

4.1.2.3.5. The Energy Code must be made a part of the Pakistan Building Code.

4.1.2.3.6. The energy losses / wastages due to use of old and inefficient equipment must be cut down. Efficiency of the equipment and machinery used by the industry, commercial hubs, and consumers(e.g. boilers, electric motors, generators and geysers) must be improved.

Appropriate laws must be enacted without delay and proper mechanisms put in place.

4.1.3. Optimal Utilization Of Available Energy Resources For Meeting Short-term And Long-term Energy Needs

The present energy mix (both in primary energy and the power generation) is not in Pakistan's interest. The increasing dependence on imported oil has not only adversely affected the overall economy, but made the life of ordinary citizens miserable. Pakistan must focus on increasing efficiency across the full chain and development of indigenous resources to maximum possible extent which means much greater development of and dependence on hydropower, coal, and renewable energy resources, as well as enhancing gas supply.

4.1.3.1. Developing Hydropower

4.1.3.1.1. There are many benefits of hydropower development. This is the cheapest source of electricity. It is an indigenous resource, available in abundance – generation potential in excess of 46,000 MW. Hydel power generation should, therefore, be given the first priority. Government must do everything in her power to depoliticize the construction of large dams and not permit anyone to play politics against national interest.

4.1.3.1.2. For execution of large, multi-purpose dam projects, the current system / mechanism of implementing projects needs to be reviewed, as the system has resulted in undue delays, cost escalations, and hardly any Transfer of Technology (TOT). To prepare the local consulting and manufacturing firms to undertake execution of these projects on their own, it is proposed that we should consider the concepts of co-designing, co-manufacturing, co-financing, co-construction, co-installation and co-commissioning of power plants of all types. For this, a dependable international partner needs to be selected. China is currently capable of producing power plant equipment of over 100,000 MW annually, and is adding to its system over 70,000 MW every year. These power plants relate to all types, i.e. hydel, thermal (coal, gas, oil), nuclear and alternate (wind and solar).

4.1.3.1.3. Funding for hydropower projects can easily be secured from the **IDB, China Development Bank,** and suppliers' credit from all over the world.

4.1.3.1.4. The **"Multi-purpose Development of Indus River"** program, launched by *WAPDA* many years ago, should be re-initiated and implemented on fast track basis. This, in addition to other benefits, will ease up the prevailing energy crises.

4.1.3.1.5. A national consensus dam construction based on technical considerations must be developed. KPK can use their share of water only with theright bank canal on Kalabagh to meet pressing water requirements of Dera Ismail Khan.

4.1.3.1.6. Developing Small Hydel:

a. In the north of Pakistan, there are several sites where natural and manageable waterfalls are abundantly available, and should be used for power generation. An estimated 4,500 MW of low-cost electricity can be generated by installing small hydel projects; in Punjab on canal heads, and in KPK and northern areas on the slopes.
b. Remote population can get benefit greatly from micro-hydel power.

4.1.3.2. *WAPDA, PEPCO* and the public sector in general should be given permission to install thermal power plants if they do not ask for sovereign guarantees.

4.1.3.3. Increasing the Share of Coal in the Energy Mix

4.1.3.3.1. There is need for increasing the share of coal in the energy mix. First, coal is available in large quantities in Pakistan. Second, it has remained largely unexploited as a source of energy. Third, power generated from coal is cheaper than that produced from FO. Fourth, it is ideal for scattered power generation in industries and remote areas as well as large-scale power generation for supplying electricity to the grid.

4.1.3.3.2. The huge coal reserves in Pakistan must be exploited to the fullest. It is high time now that all feasible solutions using coal be implemented without further debate. Possible short term, medium term and long term solutions are discussed below. What is important is that all these solutions should be put into practice with immediate effect, to help solve the energy issues of different sections of the economy, whether through public sector initiatives, private sector initiatives, or Public-Private Partnership (PPP) models. In due course of time, the most economically and technically viable solutions will emerge. In the short-term, we should import coal and use that for setting coal-fired power plants for self-generation of steam and electricity by industries. Also, in the short-to-medium term indigenous coal resources must be developed on priority, which can be done in the short-to-medium term. The Federal Government must take initiative in the development of coal mines as huge investment and risks are involved. The Government of Sindh (GoS), in its own interest, needs to welcome the involvement of the

Federal Government. The extracted coal can be used for various purposes, and through various processes, to reduce the energy constraints being faced by the country, including industry, commercial enterprises, and domestic segments. This could cover the following:

a. Steam and power generation for industries.
b. Coal briquetting – this improves energy levels of low-quality coal and is a viable option for Pakistan. The washery waste product (the washing plants, depending on their size reject all coal 6mm or less) can be used for making coal briquettes. Briquettes can be used for steel making, power generation, and for cooking or heating. Briquettes also give extra energy at lower cost per ton, and can be easily transported to far away markets. Coal briquetting plants are easily available and are not expensive to acquire and install. Countries are also producing coal-biomass briquettes by adding agricultural waste and forest residue to coal. The briquettes thus produced are more environmentally friendly than coal briquettes. Another option is co-firing – adding biomass to the coal briquettes to create the heat supplied to the boiler.
c. Surface gasification of extracted coal.
d. UCG, which eliminates the cost of mining, and has the potential to generate low-cost electricity.

4.1.3.3.3. All the earlier studies need to be consolidated and made use of instead of reinventing the wheel most of the time.

4.1.3.4. Enhancing Gas Supply

4.1.3.4.1. Gas is indigenous, in addition to being less polluting and more economical than oil. Therefore, provision of natural gas for industries, domestic use, and power generation should be ensured. Pakistan has one of the most elaborate natural gas pipeline transmission systems in the world. Moreover, as a nation we are dependent on natural gas for domestic, commercial, and industrial usage. In the **Energy Security Action Plan 2005,** it was unambiguously stated that the domestic production of gas would be insufficient for local needs beyond 2009. Since Pakistan is in short of primary energy resources, it will need to import energy. For this, import of piped gas as well as LNG import needs to be fast-tracked. The Iran-Pakistan as well as the Turkmenistan-Afghanistan-Pakistan pipeline projects must be given due priority. At the same time, the proven gas resources in the country that have not so far been extracted must be developed on a priority basis. The gas field at Tal Block near Kohat must be developed at the earliest, as its gas reserves may be as large as Sui, if not larger. The GoP must extend

better incentives to companies to undertake oil and gas exploration in the country. Steps must be taken to improve the law and order situation hampering exploration activities, especially in Balochistan and KPK. At the same time, litigation cases must be resolved as this is one of the biggest impediments to exploration activities. Better terms to the local population should also be offered to create the right environment for exploration and development.

4.1.3.5. Reducing Dependence on Oil

4.1.3.5.1. An over-emphasis on oil as an energy source, particularly as an electricity source, has already caused enough damage to our economy, and therefore should be avoided.

4.1.3.6. Exploiting Available RE Resources

4.1.3.6.1. The use of RE in Pakistan is negligible as compared to the present world averages. With the amount of sun, wind, and biomass-based energy that Pakistan is blessed with, it would be unfair to the nation if these resources are not fully exploited.

a. Solarization for off-grid applications like remote-area telecom towers, billboards and small-industry power generation.
b. Small-scale windmills to generate electricity for small and medium sized industries located in good wind-speed areas.
c. Scattered power generation using biomass such as rice husk, wood chips and corn stalks.
d. On-grid applications of RE resources to optimize mix of power generation.

4.1.3.7. Indigenization of Power Plants

4.1.3.7.1. The increase in energy demand in coming years would also increase demand for power plant machinery and equipment. Pakistan relies completely on imported plant and machinery for its energy infrastructure; the burden on the national exchequer will grow in coming years, which our fragile economy can ill-afford. Following the examples of India and China, countries that reduced their capital and operational costs by indigenizing power generation equipment and machinery, Pakistan must develop indigenous capability for the planning, designing, manufacturing, installation, and commissioning of power plants. Local heavy machinery manufacturers must be given a significant role to play.

4.2. IMPLEMENTATION MECHANISM

4.2.1. It is proposed that the responsibility for the implementation of the recommendations be assigned to a high-level Cabinet approved **National Task Force on Energy**, headed by the Finance Minister, and reporting to the Cabinet. The mandate of the **National Task Force on**

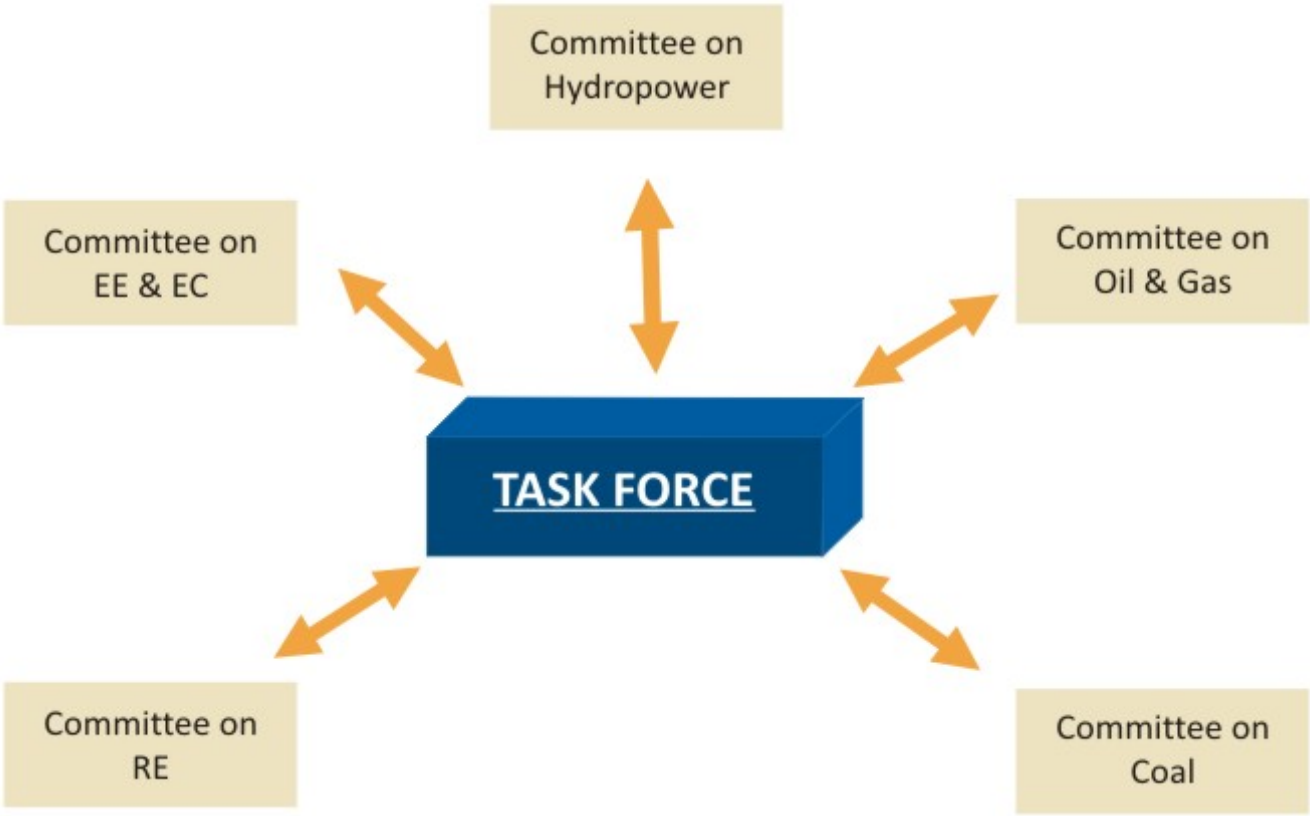
Energy should be to solve the energy crisis facing Pakistan by implementing the solutions presented in this document. The PM could hold one-hour weekly meetings with the Task Force to stay abreast of the actions taken by the Task Force to resolve the crisis. The Cabinet should also be regularly briefed.

4.2.2. **The National Task Force on Energy** should consist of professionals in the field of Energy. The members of the Task Force should include the senior-most and the most experienced personnel in various fields. The membership of the Task Force is proposed as follows:

4.2.2.1. Minister for Finance
4.2.2.2. Minister for Water and Power
4.2.2.3. Minister for Petroleum and Natural Resources
4.2.2.4. Deputy Chairman, *PC*
4.2.2.5. Secretary Water and Power
4.2.2.6. Secretary Petroleum
4.2.2.7. Heads of major energy organizations
4.2.2.8. Representatives of provinces
4.2.2.9. Any other co-opted member

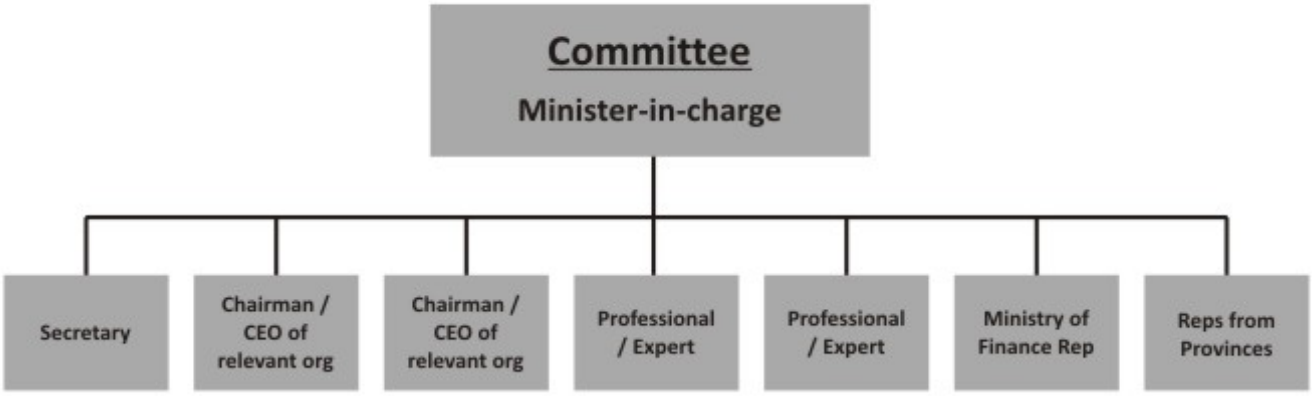
4.2.3. The Task Force should be divided into Implementation Teams (or Committees) pertaining to different areas within Energy, namely Energy Efficiency and Energy Conservation, Hydropower, Oil & Gas, Coal, and Renewable Energy.

Figure VI: NATIONAL TASK FORCE ON ENERGY – RECOMMENDED MECHANISM



4.2.4. Each Committee will be structured on the pattern shown below:

Figure VII: STANDARD STRUCTURE OF TASK FORCE COMMITTEES



4.2.5. This structure applies to all the Committees.

4.2.6. The **National Task Force on Energy** as a whole must work towards the goal of operating existing power plants and transmission / distribution infrastructure at optimum capacity. The proposed Committees will have their specific area of work, and should consist of the experts in the respective fields. The head of the Task Force, i.e. the Finance Minister, must give measure able targets and time frames. The Terms of Reference (TORs) of the Task Force are attached as Annex-III. Since the crisis is severe, the committees must work on war footings. They should meet on a daily basis (even if not physically, but through Audio Video technology), and mobilize all relevant institutions and agencies to ensure that the solutions pertaining to their respective areas are implemented.

4.2.7. The PAS, being a credible Think Tank may be assigned the responsibility of "Third Party Oversight" over the actual implementation of the approved policy with a mandate to report progress to the Cabinet through the PM. This innovative monitoring mechanism would ensure a high level of intellectual input to keep the top policy makers informed of the state of implementation.

ANNEX I: HISTORICAL PERSPECTIVE OF ENERGY SECTOR FROM 1947 TO 1990

A: 1947: INDEPENDENCE FROM BRITISH INDIA

A.1. At independence in 1947, the country inherited only 60 MW generation capacity for its 31.5 million people, and was importing electricity from India.

A.2. Hydel generation capacity of only 10.7 MW existed in Pakistani territory, which comprised the 9.6 MW Malakand Power Station in NWFP, and the 1.1 MW Renala Power Station in Punjab.

A.3. KESC, which was established in 1913 under the Indian Companies Act of 1882,is one of the oldest utilities in the South Asian region.

A.4. Power generation was being done by the respective Electricity and Irrigation department of each province.

A.5. There were hardly any known reserves of oil and gas. TheAttock Oil Company (AOC) is the pioneer in the oil sector in Pakistan, Its oil discovery was made in 1915, much before the creation of Pakistan, in Khaur, district Attock. The refining operations were started in 1922 at Morgah near Rawalpindi.

A.6. Some coal was extracted from coal mines at Lakhra, Mianwali etc, which was mainly used by Pakistan Railwaysand the provincial power generating agencies.

B: THE 1950s

B.1. Pakistan Oilfields Ltd (POL)was founded in 1950, and is one of the oldest Pakistani exploration and production companies.

B.2. In June 1950, Pakistan Petroleum Limited (PPL) was incorporated with the Burmah Oil Company(renamed Burmah Castrol),with the GoP as its principal shareholders. PPL is today one of the pioneer exploration and production companies in Pakistan's oil and gas sector.

B.3. POL, a subsidiary of the AOC, was incorporated in 1950.

B.4. During the 1950s, PPL and POL carried out extensive geological and geophysical surveys and drilled 47 exploratory wells. As a result, some gas fields were discovered.

B.5. In 1952, PPL discovered a giant gas field at Sui in Baluchistan. This discovery generated immense interest in exploration in Pakistan, and five major foreign oil companies entered into concession agreements with the Government.

B.6. In 1952, the GoP acquired a majority shareholding of KESC and it was renamed the Karachi Electric Supply Company Limited. Today, KESC is the only remaining vertically integrated power utility in Pakistan and has exclusive franchise rights to serve Karachi, and its surrounding areas.

B.7. In 1956, the Atomic Energy Research Centre was established under the Science and

Technology Research Division, with an objective to start nuclear power generation in Pakistan.

B.8. **Creation of WAPDA:**

B.8.1. Pakistan's energy generation capacity rose to 115 MW by 1958.

B.8.2. The Water and Power Development Authority (WAPDA) was established in February 1958, as a semi-autonomous body, to coordinate and unify the development of schemes in water and power sectors, which were previously being handled by provincial Electricity and Irrigation departments.WAPDA was entrusted with a massive agenda, which included generation, transmission, and distribution of power along with irrigation, water supply, drainage, flood control, etc.

B.8.3. WAPDA was successful in generating hydel and thermal electricity. WAPDA established an extensive network of power distribution lines throughout the country. It also constructed big dams such as Mangla & Tarbela, as well as barrages on the Indus river.

B.8.4. WAPDA today generates over 6,000 MW of hydel electricity (hydel electricity generated varies between 2,414 MW and 6,761 MW depending upon river flows).

B.9. Oil and gas exploration activity, after having reached its peak in mid-1950s, declined in the late fifties. Private companies, whose main objective was to earn profits, were not interested in developing the gas resources, especially when infrastructure and demand for gas was non-existent.

B.10. With exploration activity at its lowest ebb, several foreign exploration contracting companies terminated their operation and either reduced or relinquished land holdings in 1961.

C: THE 1960s

C.1. This decade witnessed the development of Pakistan into a progressive country; much of the development took place in the industrial sector which is earning handsome exports revenues even today.

C.2. During the 1960s, Pakistan was seen as a model of economic development around the world. Many countries sought to emulate Pakistan's economic planning strategy and one of them, South Korea, copied Karachi's second "Five-Year Plan", and the World Financial Center in Seoul is designed and modeled after Karachi. That was the level of economic development the country had reached.

C.3. The mega projects of special relevance to building the power sector of Pakistan during this decade include the following:

C.3.1. **The Indus Water Treaty**

C.3.1.1. Pakistan, being an agricultural country, needs ample supply of irrigation water. Around 80% of Pakistan's agricultural output comes from the Indus Basin. Pakistan has one of the world's largest canal systems built much before Independence by the British.

C.3.1.2. Rivers flow into Pakistan territory from across India. After Independence, problems between the two countries arose over the distribution of water.

C.3.1.3. In 1947, when Punjab was divided between the two countries, many of the canal head-works remained with India. The division of Punjab thus created major problems for irrigation in Pakistan.

C.3.1.4. On April 1, 1948, India stopped the supply of water to Pakistan from every canal flowing from India to Pakistan. Pakistan protested and India finally agreed on an interim agreement on May 4, 1948.

C.3.1.5. This agreement was not a permanent solution; therefore, Pakistan approached the WB in 1952 to help settle the problem permanently. Negotiations were carried out between the two countries through the offices of the WB.

C.3.1.6. In September 1960, an agreement was signed between India and Pakistan, known as the **Indus Water Treaty**. This treaty divided the use of rivers and canals between the two countries. Pakistan obtained exclusive rights for the three western rivers, namely Indus, Jehlum and Chenab. And India retained rights to the three eastern rivers, namely Ravi, Beas and Sutlej.

C.3.1.7. The **Indus Water Treaty** also guaranteed 10 years of uninterrupted water supply, and provided for construction of replacement works called **Indus Basin Projects (IBPs)** , to compensate for perpetual loss of Eastern rivers' water. During this period Pakistan was to build large dams, financed partly by long-term WB loans and compensation money from India. The works proposed under the Treaty included two multi-purpose dams; Mangla Dam on River Jhelum and Tarbela Dam on River Indus having the provision of power generation. Their capacities were subsequently extended in different phases.

C.3.1.8. Whereas Pakistan had only 10.7 MW of hydropower electricity generation at independence, the implementation of the Indus Water Treaty allowed Pakistan to embark on the construction of two giant earthrock dams at Mangla and Tarbela, with 1,000 MW and 3,478 MW installed capacities, in addition to construction of the Warsak dam, and a system of eight link canals. Remodeling of the existing canals was also carried out. Besides, five barrages and a gated siphon were also constructed under this treaty.

C.3.2. Construction of Warsak Dam

C.3.2.1. Construction of the Warsak Dam was financed by the Canadian Government, and was completed under the Colombo Plan in two phases:

C.3.2.1.1. In 1960, the first phase of the dam was completed, which included construction of the dam, irrigation tunnels, civil works for Phase 2, and four power generating units, each of 40 MW capacity with 132 KV transmission system, at a cost of about Rs.394.98 million.

C.3.2.1.2. In the second phase, two additional generating units of 41.48 MW capacity each were added in 1980-81, at a cost of about Rs. 106.25 million.

C.3.2.2. The dam is built on river Kabul and is situated 30 km north-west of Peshawar.

C.3.2.3. It has a total generating capacity of nearly 243 MW.

C.3.2.4. Warsak Dam has now completely silted up and there is practically no available storage. Power generation is being achieved according to water inflows in River Kabul like a Run-of-the-River project. Lean flow period at Warsak is observed from October to March during which capability reduces to about 100 MW (peak).

C.3.3. Construction of Oil Refineries

C.3.3.1. Pakistan Refinery Limited(PRL) was incorporated in Pakistan as a Public Limited Company in May 1960 and is quoted on the Karachi and Lahore Stock Exchanges. It has a refining capacity of 47,000 bbl/d.

C.3.3.2. National Refinery Limited (NRL) was incorporated in August 1963 as a Public Limited Company, under the Ministry Of Industries.

C.3.4. Establishment of the OGDC

C.3.4.1. To revive exploration in the energy sector, which had gone down in the late 1950s, the GoP signed a long-term loan agreement in March 1961 with the USSR, whereby Pakistan received 27 million Rubles to finance equipment and services of Soviet experts for exploration.

C.3.4.2. Pursuant to the Agreement, the Oil and Gas Development Company(OGDC) was created under an Ordinance in September 1961.

C.3.4.3. The Corporation was given the responsibility to undertake systematic exploration of oil and gas in Pakistan. A number of donor agencies such as the WB, Canadian International Development Agency (CIDA), and the Asian Development Bank (ADB) gave loans and grants, thereby providing the impetus for major development projects.

C.3.4.4. OGDC's concerted efforts were very successful as they resulted in a number of major oil and gas discoveries between 1968 and 1982.

C.3.5. WAPDA 15 MW Quetta Coal Power Plant

C.3.5.1. In 1963, WAPDA, with USAID assistance, set up a coal power plant in Quetta, having two units of 7.5 MW capacity each.

C.3.5.2. This plant used subbituminous coal from the Sore Range mines of Balochistan. The annual coal consumption of the plant was 30,000 tonnes. The plant completed its life and WAPDA closed both the units since they were functioning at de-rated capacity. The plant is now under repair and upgrading to enhance the capacity.

C.3.6. Construction of Mangla Dam

C.3.6.1. Mangla Dam is an earth-filled dam constructed on River Jhelum as a

part of the **Indus Basin Development Plan.** Its construction was started in 1962 and completed in 1967.

C.3.6.2. The dam was built by an international consortium, which besides the WB also included Austria, Canada, West Germany, Newzealand, the UK and USA.

C.3.6.3. It is a multipurpose project primarily meant for affecting part replacement of water supplies of three eastern rivers from Jhelum river. It is also designed to conserve and regulate the floodwater of River Jhelum for irrigation purpose and power generation.

C.3.6.4. MANGLA had an initial storage capacity of 5.88 MAF in 1967, which was reduced to 1.97 MAF in 2005 (34% of the initial). In view of its declining storage, the GoP decided in 2004 to raise the dam by 30 feet from the existing 1,210 feet level at an approximate cost of Rs. 59 billion.

C.3.6.5. Initially its life was estimated as 120 years; now, with the implementation of watershed management practices in catchment area, its expected life is 170 years.

C.3.6.6. Total power generation capacity of Mangla Dam is 1,000 MW.

D: THE 1970s

D.1. In 1972, Enar Petrotech Services Private Limitedwas formed as a division of NRL. In July 1974 the Division was converted into a Private Limited Company. It has a refining capacity of 3,000 bbl/d.

D.2. The pace of electric power infrastructure development gained momentum by the year 1970, and within 5 years the installed capacity rose from 636MW in 1970 to 1,331MW in 1975, with setting up of a number of hydro and thermal power units.

D.3. Nuclear Power Plants

D.3.1. In 1964, 1965, and then 1973, reorganization took place in the Atomic Energy Research Centre, and the Pakistan Atomic Energy Commission (PAEC) was incorporated as a statutory body under the Act of Parliament. In 1972 the commission was transferred from the Science and Technology Research Division to the President's Secretariat.

D.3.2. The first nuclear power plant, Karachi Nuclear Power Plant (KANUPP), with a generation capacity of 137 MW, started in 1971. The pressurized heavy water reactor (PHWR) was supplied by Canada, with safeguards.

D.3.3. An experimental research reactor PARR-I at Nilore, Islamabad was also started, and the emphasis in the early years remained on the peaceful use of nuclear energy. Consequently research centers in agriculture, medicine, biotechnology, and other scientific disciplines were set up all over the country. As the emphasis shifted towards concerns for national security, important projects were also initiated in this area.

D.4. Pak-Arab Refinery Ltd (PARCO), a Joint Venture between the GoP and the Emirate of Abu Dhabi was incorporated as a Public Limited Company in 1974. Government of Pakistan holds 60% of the shareholding while 40% of the shares are held by Emirate of Abu Dhabi through its Abu Dhabi Petroleum Investment Company L.L.C. (ADPI), a subsidiary group of International Petroleum Investment Company (IPIC). PARCO today has a refining capacity of 100,000 bbl/d.

D.5. Construction of Tarbela Dam

D.5.1. The construction of the Tarbela Dam, started in 1968, was completed in 1976, at a total cost of Rs. 18.5 billion. It is located on the river Indus 50 miles northwest of Islamabad, and is the world's largest earth and rock-filled dam, which has greatly enhanced the agriculture and industrial potential in the country.

D.5.2. The power generation capacity of the Tarbela Dam is 3,478 MW. It has a volume of 106 million cubic meters and a reservoir capacity of 11.098 million acre-feet (MAF).

D.5.3. The objective of constructing the dam was to transfer the Indus water to Eastern rivers under the Indus Basin Treaty, to irrigate the land previously fed by Eastern rivers, and to produce power for industrial and domestic uses.

D.5.4. After Tarbela, WAPDA could not construct any big dam, except for the 1,450 MW Ghazi Barotha Hydropower Project in 2004.

D.5.5. The dam's storage capacity, initially at 11.62 MAF (in 1974), reduced to 5.51 MAF in 2005 (i.e. 47% of initial capacity) due to silting.

D.5.6. At its completion in 1976, the useful life of the dam and reservoir was estimated to be around 50 years. However, sedimentation has been much lower than predicted, and it is now estimated that with a useful life span of 85 years, the dam will last to about 2060.

The construction of Tarbela and Mangla Dams made affordable electricity available to the nation; this electricity was being produced from an indigenous source. Pakistan's energy mix at this time was heavily tilted toward hydropower: in 1984 the energy mix was approximately 60% hydel and 40% thermal.

D.6. In 1978, POL took over the exploration and production business of the AOC. Since then, POL has been investing independently and in joint ventures with various exploration and production companies for the search of oil and gas in the country. It is today a leading oil and gas exploration and production company listed on all the three stock exchanges of Pakistan. In addition to exploration and production of oil and gas, POL also operates a network of pipelines for transportation of its own as well as other companies' crude oil to Attock Refinery Limited (ARL).

D.7. ARL was incorporated as a private limited company in November 1978 to take over the

business of the AOC relating to refining of crude oil and supplying of refined petroleum products. It was subsequently converted into a public limited company in June 1979 and is listed on the three Stock Exchanges of the country. It has a refining capacity of 42,000 bbl/d.

E. THE 1980s

E.1. In the year 1980, the electricity generation capacity touched 3,000MW.

E.2. In the 1980s, Pakistan suffered from intense power shortages, mainly due to the inability of WAPDA to install new power projects to cater to the electricity demand. This led to a severe power crisis in the country, resulting in long hours of load-shedding and huge losses to GoP revenues. This power crisis triggered changes in the power policy in Pakistan, as discussed later.

E.3. Start of the Hub Power Project With Involvement of the WB:

E.3.1. In 1985, the GoP, with the help of the WB, developed a long-term energy strategy which envisaged the involvement of private investors in power generation. The objective was to meet the increasing demand for power in the country, in the most efficient and effective way to achieve the levels of growth the Government had set for the economy.

E.3.2. A year later, the development of the oil-based thermal Hub Power Project began. The WB became involved with the sponsors in the development process and set about establishing the support of a number of governments as co-financiers in the Private Sector Energy Development Fund for Pakistan.

E.3.3. An appropriate location was identified in an area near the estuary of the Hub river in district Lasbela, Balochistan, about 40kms north-west of Karachi. The plant was designed to meet the WB's environmental requirements.

E.4. In 1986, a project was proposed to meet the then energy requirement of the country. It included the Lakhra Coal Mine and the Lakhra Power Generation Plant. According to the proposal, the coal mine had to be developed and operated by private sector companies while the power plant had to be operated by WAPDA.

E.5. The Energy Wing was created in 1988 under the Ministry Of Planning & Development, to undertake the technical, financial and economical appraisal of energy resources and power generation projects. The Energy Wing also prepared short and long term energy sector programs including forecasts of the supply and demand of energy resources in the country.

E.6. Beginning in 1987, Pakistan requested assistance from the WB to increase private sector participation in the energy sector. An initial framework of incentives to attract private investment in the energy sector was put in place in 1988.

E.7. In 1988, the GoP, under pressure from the WB, banned the public sector from putting up thermal power plants, so thermal generation was left exclusively to the private sector.

ANNEX-II: ENERGY MIX IN PAKISTAN – 1984-2004

Year	Hydropower		Thermal		*Nuclear		Total
	GWh	%	GWh	%	GWh	%	GWh
1984	12,822	59.3	8,786	40.7			21608
1985	12,245	52.5	11,080	47.5			23325
1986	13,804	53.8	11,833	46.2			25637
1987	15,251	53.7	13,151	46.3			28402
1988	16,689	50.6	16,289	49.4			32978
1989	16,974	49.0	17,645	51.0			34619
1990	16,925	45.0	20,720	55.0			37645
1991	18,298	44.9	22,429	55.1			40727
1992	18,647	41.0	26,838	59.0			45485
1993	21,111	43.4	27,569	56.6			48680
1994	19,436	38.1	31,592	61.9			51028
1995	22,858	41.6	32,028	58.4			54886
1996	23,206	39.8	35,039	60.2			58245
1997	20,858	34.7	39,251	65.3			60109
1998	22,060	36.4	38,517	63.6			60577
1999	22,448	34.8	41,855	64.8	284	0.4	64587
2000	19,288	28.5	48,021	70.9	399	0.6	67708
2001	17,259	24.5	51,308	72.7	1997	2.8	70564
2002	19,056	25.9	52,257	71.0	2291	3.1	73604
2003	22,350	29.0	52,920	68.7	1740	2.3	77010
2004	27,477	33.2	53,450	64.6	1760	2.1	82687

Source: WAPDA-Power System Statistics Twenty Ninth Issue

*Source: HDIP

ANNEX III:
PROPOSED TERMS OF REFERENCE FOR THE NATIONAL TASK FORCE ON ENERGY

A. ESTABLISHMENT

A.1. The **National Task Force on Energy** should be set up with the approval of the Cabinet.

A.2. The Task Force should evaluate the performance of the organizations working in the energy sector, as well as their key personnel, and regularly report performance thereof to the Cabinet.

A.3. For evaluating performance, the Task Force should develop a framework for performance indicators.

A.4. The Task Force should be empowered to take decisions on appropriate appointments in energy organizations, and will have complete authority to incentivize, reward, penalize, remove, and / or replace the key personnel.

B. MANDATE / TERMS OF REFERENCE

B.1. To put an end to load shedding in Pakistan and thereby provide uninterrupted supply of power to all sectors of the economy.

B.2. To provide affordable electricity to all sectors of the economy.

B.3. To operate existing plants at optimum capacity in order to increase output, thereby immediately eliminating a good portion of the load-shedding.

B.4. To resolve the Circular Debt issue and put in place a mechanism that ensures timely payments of subsidies.

B.5. To enhance efficiency across the value chain, from power generation to transmission/distribution to consumption. To ensure education and skill development of the masses to understand and practice Energy Conservation (EC) and Energy Efficiency (EE).

B.6. To enact appropriate laws enacted without delay and proper mechanisms put in place.

B.7. To reduce Pakistan's dependence on imported oil for both primary energy requirement and power generation, and thus ease the burden on the national exchequer, and at the same time, enhance energy security.

B.8. To ensure the optimal energy mix (hydel, micro-hydel, coal, natural gas, oil, Renewable Energy) in Pakistan, focusing on development and enhancement of indigenous resources

that can provide affordable energy to the country (like hydel and coal), and importing only those energy resources that are essential but not indigenously available in sufficient quantity.

B.9. To develop indigenous resources, like Renewable Energy (RE) resources, which are unable to provide inexpensive electricity at the moment, with a longer-term objective of indigenous and reasonably priced energy provision.

B.10. To revamp the current mechanism of implementing projects that has caused undue delays, cost escalations, and very little transfer of technology.

B.11. To develop collaboration with international partners that fit into our strategic framework for executing large-scale projects related to hydropower (and others like coal and RE), and to work on the principles of co-designing, co-manufacturing, co-financing, and co-construction, that will eventually lead to indigenous production of energy-related equipment, machinery, and infrastructure, as well development of related manpower.

B.12. To secure funding for mega energy projects from reliable and tested investors.

B.13. To ensure that honest, competent and result-oriented professionals are put at key positions in energy-related organizations and ministries, and to put in place a proper and transparent system for selection of the right personnel for the right job.

B.14. To improve coordination and synergy between all organizations working in energy.

B.15. To ensure that an environment is created that favors investment, productivity, and value-addition in the energy industry.

B.16. To ensure implementation of the **Energy Security Action Plan 2005 (Medium Term Development Framework 2005-10)**.