



BOARD OF INVESTMENT
GOVERNMENT OF PAKISTAN

PAKISTAN

POWER SECTOR



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INVESTOR INFORMATION GUIDE

SECTOR STRUCTURE

INSTALLED POWER CAPACITY

(MW)

TYPE	NUMBER OF STATIONS	Installed Capacity 2002	% Share in Total Capacity
HYDEL (WAPDA)	14	6,494	34 %
THERMAL (WAPDA)	14	4,835	25 %
THERMAL (KESC)	4	1,756	9 %
THERMAL (IPPs)	16	5,832	30 %
NUCLEAR	2	462	2 %
Total Capacity		19,379	100 %

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

POWER POLICY 2002

Income Tax	<ul style="list-style-type: none">• Exemption from income tax including turnover tax and withholding tax on imports for the projects based on indigenous fuel.• No exemption of income tax on oil-fired power plants.
Custom Duties & Sales tax	<ul style="list-style-type: none">• 5% custom duty on the import of plant, machinery & equipment (PME) not manufactured locally for gas, coal & hydel projects.• No levy of sales tax on such plant, machinery and equipment.

FEATURES OF POWER POLICY 2002

- The basis for selection of private power project will be the minimum levelized tariff either through International Competitive Bidding (ICB) for solicited proposals or through negotiations / ICB for proposals on raw sites.
- Without a proper feasibility study for a particular site-specific hydel or indigenous fuel based/ renewable resource based project, it will not be possible to invite competitive bids and receive firm offers.
- Hydel projects will be implemented on Build-Own-Operate-Transfer (BOOT) basis.
- Thermal projects would either be built on BOOT or Build-Own-Operate (BOO) basis.
- Private power companies will be allowed to import plant and equipment (for hydel & thermal projects), not manufactured locally at concessional rates (i.e. 5%) of duty. They are exempt from the payment of income tax, turnover rate tax & withholding tax.

INCENTIVES IN POWER POLICY 2002

- Complete security and guarantee regarding political risk, change in taxes/ duties, transfer of money and contracts with WAPDA, KESC, Provincial and AJK governments.
- Pakistan needs 5,529 Mega Watt (MW) power additional by 2009-2010.
- Policy to discourage thermal power generation and bulk supply tariff is not fixed as was in 1994. Government has learnt lesson from previous policies i.e. no up-front fixed capacity charge for thermal power plants, limitation on front-end loading, and one window operation.
- Special incentives for coal/ gas fired projects and hydel projects. Integrated coal mining and power, secured return on investment made on dedicated coal/gas resource for power generation and investment made in integrated projects to be recovered from tariff under coal and gas projects. Hydrological risk to be borne by WAPDA, priority dispatch with economic load dispatch criteria under hydel projects are the key features.
- Under the pre-qualification criteria, main sponsors to have a 20 percent stake in equity and together with other partners will have direct and relevant experience in development or implementation or ownership or operation in similar projects; demonstrated capability for financing (equity & debt) and main sponsors not to own more than 25 per cent of total generation.

CURRENT & FUTURE POWER POSITION

Base year 2002

(MW)

	THERMAL				HYDEL			COAL			Nuclear	Grand Total	Require-ment
	WAPDA	IPP's	KESC	Total	WAPDA	IPP's	Total	WAPDA	KESC	Total	Public		
Installed	4,835 (25%)	5,832 (30%)	1,756 (9%)	12,423 (64%)	6,494 33%	-	6,494 (33%)				462 (2%)	19,379 100%	20,000
After 5 years	5,000 20%	6,000 24%	2,000 8%	13,000 53%	6,000 24%	3,000 12%	9,000 36%	400 2%	1,200 5%	1,600 7%	1,000 4%	24,600 100%	25,000
After 10 Years	5,000 14%	6,000 17%	2,000 6%	13,000 37%	10,630 30%	5,000 14%	15,630 44%	400 1%	4,600 13%	5,000 14%	1,500 4%	35,130 100%	35,000

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

THERMAL POWER STATIONS (WAPDA)

S. o	Power Stations Installed	Installed Capacity (MW)	Fuel Type	Date of Commissioning
1	SPS Faisalabad	132	Gas / FO	Jun 1967
2	GTPS Faisalabad	244	Gas / HSD Oil	July 1975
3	NGPS Multan	130	Gas / FO	July 1963
4	TPS Muzaffar Garh	1,350	Gas / FO	Sep 1993
5	TPS Guddu (unit 1 – 4)	1,655	Gas / FO	March 1974
6	FBC Lakhra	150	Gas / HSD Oil	Dec 1987
7	GTPS Kotri	174	Gas / HSD Oil	1970
8	TPS Jamshoro	850	Gas / FO	Jan. 1990
9	TPS Pasni	17	HSD Oil	-
10	GTPS Panjpur	39	HSD Oil	-
11	GTPS Shahdra	59		
12	TPS Quetta	35		
	Total Capacity	4835		

SPS: Steam Power Station **TPS:** Thermal Power Station
GTPS: Gas Turbine Power Station **NGPS:** Natural Gas Power Station

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

THERMAL POWER STATIONS (KESC)

S. o	Power Stations Installed	Location	Installed Capacity (MW)	Fuel Type
1	TPS Korangi	Korangi	316	Gas / FO
2	GTPS Korangi Town	Korangi	80	Gas
3	GTPS SITE	Karachi	100	Gas
4	TPS Bin Qasim	Bin Qasim	1260	Gas / FO / Coal
	Total		1,756	

TPS: Thermal Power Station

GTPS: Gas Turbine Power Station

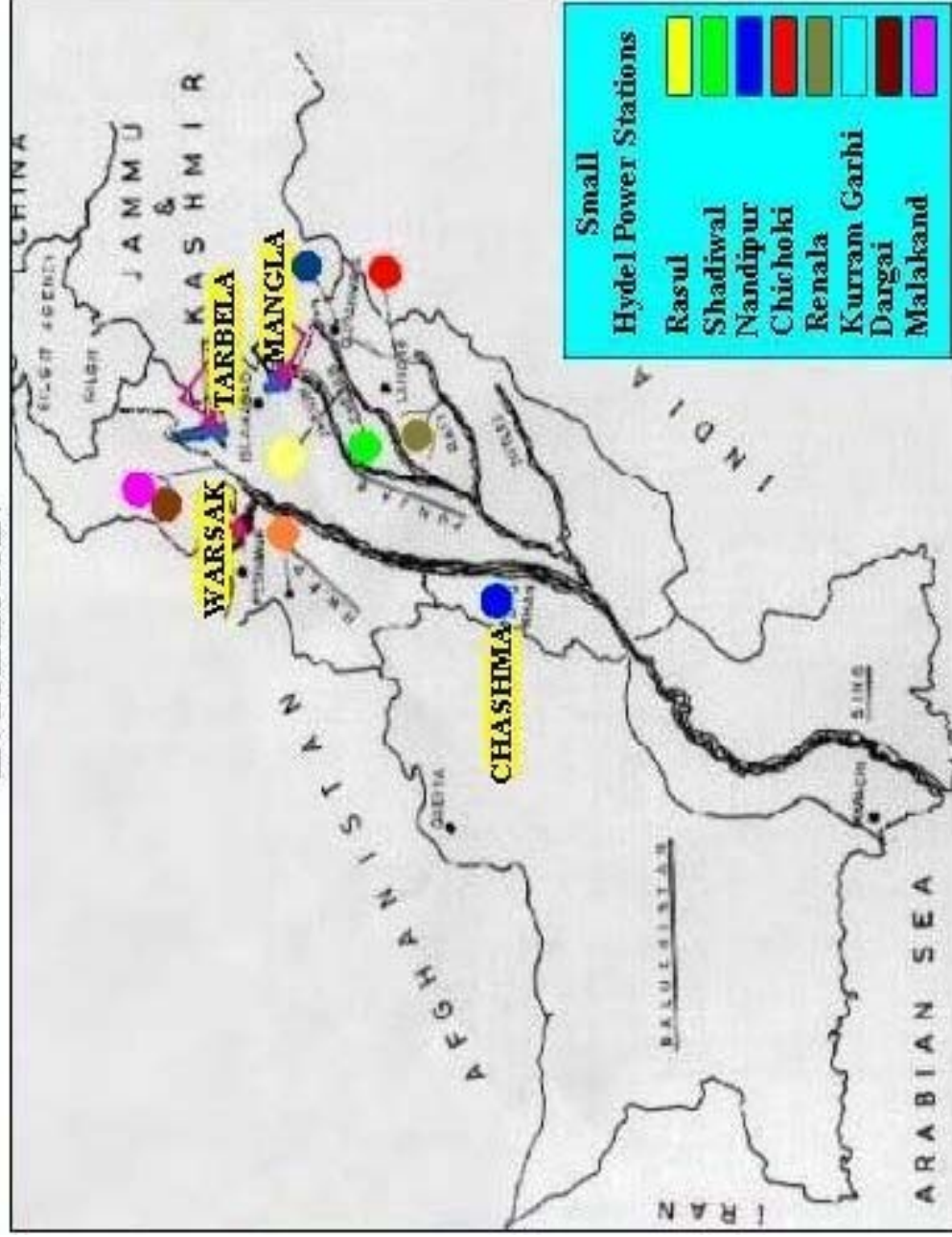
Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

INDEPENDENT POWER PROJECTS (THERMAL)

Sr. No.	NAME OF PROJECT	Capacity (MW)	Commissioning Date	Term of Agreement (Years)
1	AES Lalpir Ltd	362	6/11/1994	30
2	AES Pak Gen Power Co	365	1/2/1998	30
3	Altern EnergyLtd.	10.5	6/6/2001	30
4	Fauji Kabirwala Power Co.	157	21/10/1999	30
5	Gul Ahmed Energy Ltd.	136	3/11/1997	22
6	Habibullah Coastal Power Co.	129	11/9/1999	30
7	Japan power Ltd.	135	14/3/2000	30
8	Kohinoor Energy Ltd.	131	20/6/1997	22
9	Liberty Power Ltd.	235	10/9/2001	25
10	Rouch Power Ltd.	450	11/12/1999	30
11	Saba Power Ltd.	134	31/12/1999	30
12	Southern Electric Power Co.	117	12/7/1999	30
13.	Tapal Energy Ltd.	126	20/6/1997	22
14.	Uch Power Limited	586	18/10/2000	30
15	Hub Power Ltd.	1,292	331/3/1997	30
16	Kapco	1,466	-	-
	Total	5,832		

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

HYDEL POWER STATIONS IN PAKISTAN



HYDEL STATIONS IN OPERATION

S.No	Power Stations Installed	Water Way (River/ Canal)	Installed Capacity (MW)	Capital Cost Rs. Million	Date of Commissioning
1	Tarbela	Indus	3,478	16,380.0	Jul 1977
2	Mangla	Jehlum	1,000	16,380.0	Jul. 1977
3	Warsak	Kabul	243	1,187.19	Jul. 1960
4	Chashma	Chashma	184	1,7821.77	Jun. 2001
5	Rasul	Upper Jehlum Canal	20	20.33	Jul.1952
6	Dargai	Swat	20	30.86	Dec.1952
7	Malakand	Swat	22	23.21	Jul.1938
8	Nandipur	Upper Chenab	13	50.83	Mar.1963
9	Shadiwal	Canal from River Jehlum	14	42.28	Jan.1961
10	Chihoki	Upper Chenab Canal	14	30.55	Aug.1959
11	Renala	Canal from Balloki	1	N.A	Mar.1925
12	Ghazi Barotha	Indus	1450	-	2004
13	Chitral	Ludko	1	19.49	1975
14	Kuram Garhi	Kachkot Cananl	4	4.07	Feb. 1958
15	Jagran	AJK	30	-	Oct. 2000
	Total		6494		

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.

Nuclear Power Stations

PRIORITY HYDEL PROJECTS

Short Term Plan

Sr. No.	Name of Project	Location	Installed Capacity (MW)	Status	Study		Construction	
					Type	Cost (Rs. M)	Tentative Cost (US\$ Mil)	Period (Years)
1	JINNAH (Mianwali)	PUNJAB	96	F	D	10	162	4
2	MALAKAND -III	NWFP	81	F	D	10	80	3
3	ALLAI KHWAR	NWFP	121	F	D	35	110	4
4	GOLEN GOL	NWFP	106	F	D	15	104	4
5	KHAN KHAWAR	NWFP	72	F	D	25	86	4
6	DUBER KHWAR	NWFP	130	PF	D	35	109	4
7	UPPER JEHLUM CANAL	AJK	74	-	-	-	-	-
8	MATHIN KOT,	PUNJAB	100	-	-	-	-	-
9	PEHUR HIGH LEVEL CANAL	NWFP	12	-	-	-	-	-
	TOTAL:		792	-	-	575	3,783	-

PF - Pre Feasibility Study Completed

D - Detailed Engineering Design & Tender Documents

F - Feasibility Study Completed

Source: Private Power Infrastructure Board.

PRIORITY HYDEL PROJECTS

Medium Term Plan

Sr. No.	Name of Project	Location	Installed Capacity (MW)
1	MATILTAN	NWFP	84
2	SUMMAR GAH	NWFP	28
3	SWAT SCHEME A1	NWFP	105
4	SWAT SCHEME B1	NWFP	429
5	RAJDHANI	AJK	86
6	NEELUM -JHELUM	AJ&K	963
7	KALABAGH	PUNJAB	2,400
8	CHAKOTHI	AJK	139
9	RAISED MANGLA	AJK	180
10	THAL RESERVOIR	PUNJAB	52
11	DOYIAN	NA	425
12	KOHALA (JEHLUM)	AJK	740
13	GULPUR (PUNJAB)	AJK	60
14	GOMAL	NWFP	130
15	KURM TUNGI	NWFP	58
16	ABBASIAN (JEHLUM)	AJK	245
	TOTAL		6,130

Source: Private Power Infrastructure Board.

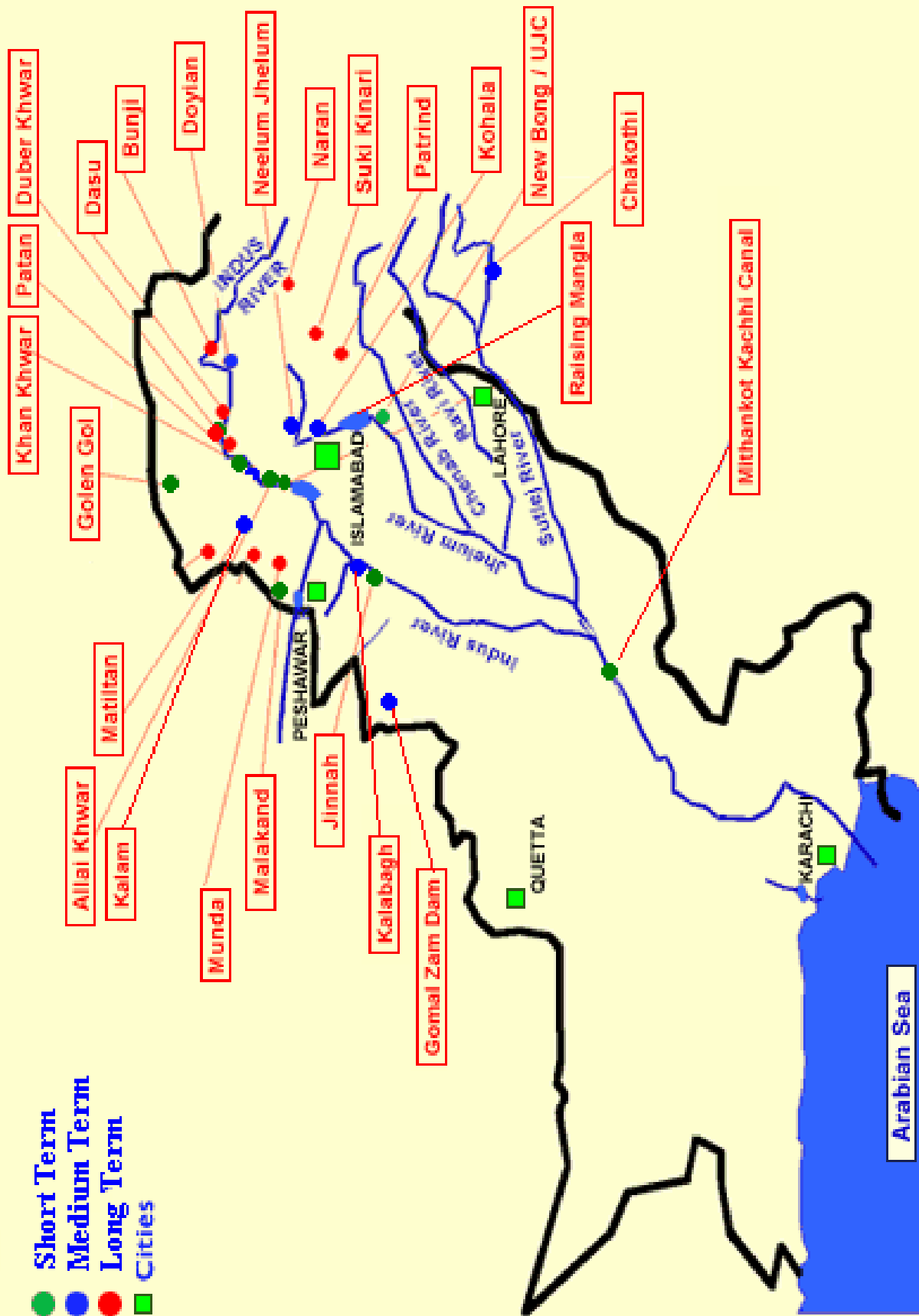
PRIORITY HYDEL PROJECTS

Long Term Plan

Sr. No.	Name of Project	Location	Installed Capacity (MW)	Tentative Commissioning Date
1	HARIGHEL	AJK	53	Dec. 2020
2	KOTLI	AJK	97	Dec. 2020
3	MUNDA DAM	NWFP	600	Dec. 2015
4	SUKI KINARI	NWFP	652	Dec. 2015
5	KARRANG	NWFP	454	Dec. 2020
6	TARBELA 15-16	NWFP	960	Dec. 2008
7	SPATH GAH	NWFP	851	Dec. 2015
8	BASHA	NA	3,600	Dec. 2012
9	PHANDAR	NA	87	Dec. 2015
10	DASU (INDUS)	NA	2,712	Dec. 2015
11	PATAN (INDUS)	NA	1,172	Dec. 2015
12	THAKOT (INDUS)	NWFP	1,043	Dec. 2015
13	BUNGI (INDUS)	NA	1,500	Dec. 2015
14	NARAN (KUNHAR)	NWFP	219	Dec. 2015
15	CHOR NALLAH	-	1,500	Dec. 2020
16	PATRIND (KUNHAR)	NWFP	133	Dec. 2015
	TOTAL		15,633	

Source: Private Power Infrastructure Board.

HYDEL PROJECTS



COAL POWER STATIONS (WAPDA)

S.No	Power Stations Installed	Location	Installed Capacity (MW)	Present Capacity (MW)	Fuel Type	Date of Commissioning
1	FBC Lakhra	Distt. Dadu Sindh	150	120	Coal	1995
	Total		150	120		

Source: Energy Book 2002, Hydrocarbon Development Institute of Pakistan.

PROPOSED COAL POWER PROJECTS MEDIUM TERM PLAN

S.No	Name of Project	Location	Proposed Capacity (MW)
1	Thar Coal 1	SINDH	600
2	Extension of Lakhra Project	SINDH	Ex 150
	TOTAL		750

LONG TERM PLAN

S.No	Name of Project	Location	Proposed Capacity (MW)
1	Thar Coal 2 & 3	SINDH	1,200
2	Thar Coal 4 & 5	SINDH	1,200
3	Thar Coal 5 & 6	SINDH	1,200
	TOTAL		3,600

Source: Private Power Infrastructure Board.

NUCLEAR POWER STATIONS

S.No	Power Stations Installed	Location	Installed Capacity (MW)	Date of Commissioning
1	KANUPP	Karachi	137	1972
2	CHASNUPP	Chashma	325	March 2000
	Total		462	

Source: Energy Book 2005, Hydrocarbon Development Institute of Pakistan.



PROPOSED NUCLEAR POWER PROJECTS

NUCLEAR MEDIUM TERM PLAN

S.No	Name of Project	Location	Proposed Capacity (MW)	Proposed Commissioning Date
1	Chashma II	PUNJAB	600	Dec. 2009
	TOTAL		600	

NUCLEAR LONG TERM PLAN

S.No	Name of Project	Location	Proposed Capacity (MW)
1	Chashma II & KANUPP II	PUNJAB & SINDH	1,200
	TOTAL		1,200

Source: Private Power Infrastructure Board.

UPCOMING PRIVATIZATION PROGRAMME

S.No	Power Stations	Proposed Dates
1	Jamshoro Power Co. (GFENCO 1)	Dates to be determined, after resolution of technical problems
2	Faislabad Electric Supply Company	
3	Jamshoro Power Co. (GENCO-1)	
4	National Power Construction Corporation (Pvt) Ltd.	
5	Kot Addu Power Company (KAPCO) Secondary Public Offering	4 th Quarter of 2006

Source: Privatization Commission.

List of Recent Fast Track Proposals Received From Sponsors Who Responded To Queries Pertaining to Capacity, COD, Contractual Arrangement, Tariff, & Etc.

Sr.	Proposed By	Capacity (MW)	Location	Proposed COD
<u>New & Unused (Detailed Proposals):</u> ECC on 4th January, 2006 restricted entertaining unsolicited proposals with GOP permission. For seeking GOP permission for the gap in demand/supply position up to year 2008, for FCC consideration is being moved.				
1	Taiyo Hills	150	Lahore	Sep-08
2	Gulf Power	179	Gujranwala	Oct-08
3	Techna	1200	Not Identified	100-120 MW (simple cycle) in May/June gradually increased to 1000-1200 MW (simple cycle) in Dec 2007, CC addition by Dec 2008
Sub-Total		1529		

<u>Used and Refurbished:</u> No provision of Used and Refurbished Plants in Policy 2002				
1	Glimmer (Pvt.) Limited at Sialkot	150	Sialkot	Oct-07
2	Savari Private Limited	500	Not identified	April 2007 (250 MW)+ June 2007 (250 MW) + 250 MW 2 years later
3	Associated Group at Karachi	400	Karachi	Not given
Sub-Total		1050		
Grand Total		2579		

LIST OF PROJECTS BEING PROCESSED BY PPIB

A- THERMAL PROJECTS

Sr. No.	Project	Location	Capacity (MW)	Investment (US \$ Million)
1	Capacity Expansion from Existing IPPs	Near Lahore	405	300
2	Orient Power Project (Phase 1)	Balloki	225	169
3	Sahiwal (Sail) Power Project	Sahiwal	225	169
4	Muridke (Sapphire) Power Project	Muridke	225	169
5	Attock Gen Power Project	Rawalpindi	150	113
6	Nishat Chunian Power Project	Lahore	200	150
7	Sheikhupura (Atlas) Power Project	Sheikhupura	200	150
8	Gujranwala (Gulistan) Project	Gujranwala	200	150
9	Fauji Mari Power Project	Daharki	175	131
10	Star Thermal Power Project	Daharki	134	101
11	Green Power Project (Phase 1)	Zamzama	205	154
12	Engro Power Project	Daharki	150	113
13	Fauji Korangi Power Project	Karachi	150	113
14	Western Electric Power Project	Karachi	150	113
15	Bhikki Pwer Project	Bhikki, Punjab	225	168
16	Uch II ICB Project	Kashmore	450	338
17	Faisalabad ICB Project	Faisalabad	400	300
18	Chichoki Malian ICB Project	Chichoki Mallian	350	263
19	Green Power Project (Phase 2)	Zamzama	200	150
20	KAPCO- Expansion Project	Kot Addu	400	300
21	InterGen Power Project	Kohat NWFP	150	113
22	Warda Power Project	Near Lahore	200	150
23	Khuzdar ICB Project	Khuzdar	100	75
24	Kandra ICB Project	Kandra near Sukkur	60	45
Total (Thermal)			5329	3997

B- HYDEL PROJECTS

25	New Bong Escape Hydel Project	Near Mangla, AJK	79	105
26	Rajdhani Hydro Power Project	Mangla, AJK	132	165
27	Matiltan Hydro Power Project	Dir, NWFP	84	105
28	Kotli Hydel Porject	Kotli, AJK	100	125
29	Gabral-Kalam Hydropower Project	Swat, NWFP	101	125
30	Gulpur Hydro Power Project	Gulpur, AJK	100	125
31	Munda Hydropower Project	NWFP	740	925
32	Sharmi Hydropower Project	NWFP	115	144
33	Patrind Hydro Power Project	NWFP/AJK	130	163
34	Hari-Ghal Hydropower Project	AJK	53	66
35	Suki Kinari Hydropower Project	NWFP	148	185
36	Mahl Hydropower Project	AJK	245	306
37	Karang Hydropower Project	NWFP	458	573
38	Madyan Hydro power Project	NWFP	148	185
39	Kaigah Hydel Project	NWFP	548	685
40	Karot Kydel Proejct	AJK	240	300
41	Azad Patan Hydel Project	AJK	222	278
42	Asrit-Kedam Hydel Project	NWFP	209	261
43	Kalam-Asrit Hydel Project	NWFP	197	246

44	Chakothe-Hattian Project	AJK	139	174
45	Sehra Hydel Project	AJK	65	81
46	Tarbela 4th Extention	NWFP	960	500
Total (Hydel)			5720	6456
C- COAL BASED PROJECTS				
47	AES Thar Coal Project	Thar, Sindh	1000	1000
48	Habibullah Energy Coal Project	Chothi, Sindh	150	150
49	Dadabhoy Coal Project	Jherruk-Sonda, Sindh	200	200
50	Lakhra Coal Project by Fatch Group	Lakhra, Sindh	200	200
51	Imported Coal Based Project	Near Karachi	1000	1000
Total (Coal)			2550	2550
Grand Total (A+B+C)				13003

RENEWABLE ENERGY IN PAKISTAN¹

1 (2x50) MW Wind Power Generation Project at Gharo, Sindh

On commercial grid connected electricity generation programme, the Government of Pakistan has decided to install 100 MW Wind Power Farm by June 2006. This programme initiated by the Alternative Energy Development Board (AEDB), involves financing through private sector, land from Government of Sindh and power purchase by NTDC for HESCO. The Government of Pakistan guarantees are backed through NEPRA. The Board has issued LOIs to 30 national and international companies for generation of 1500 MW power through wind energy.

A wind corridor at Gharo-Keti Bandar, Sindh has been identified with an actual potential of 50,000 MW. The pre-feasibility study of the site has been done by AEDB. AEDB drafted the Power Purchase Agreement (PPA) and the Implementation Agreement. 8 companies with financial and technical viability have been short-listed. OEMs / Suppliers like GE, VESTAS and GAMESA have been short-listed for the project. Three companies have submitted applications to NEPRA for obtaining Generation License. NTDC has submitted the request for Power Acquisition Permission to NEPRA for procuring power from the proposed wind plants. HESCO has agreed to purchase the initial 100 MW Wind Power generated through this project. Private investors have entered the PPA negotiations with NTDC / WAPDA. Sindh Government has leased out approximately 5000 Acres of land for the project. AEDB has allocated 1000 acres of land each to five (5) investors, namely M/s New Park Energy Ltd., M/s Green Power, M/s Zephyr Ltd., M/s Win Power Ltd. and M/s Tenaga. Tariff would be determined by NEPRA in consultation with the IPP and the Power Purchaser i.e. NTDC, as per Government of Pakistan's Policy for Power Generation 2002, and under the Section 7(6) of the Regulation Generation, Transmission and Distribution of Electric Power Act (XL of) 1997 (NEPRA Act). New Transmission Network from Mirpur Sakro to Thatta is to be constructed by NTDC in order to sustain the load generated by 100 MW Wind Power. PC-I for the project has been approved by the CDWP.

Once the initial target of generating 100 MW through Wind Energy is achieved, it will be upgraded to 700 MW by the year 2010 and 9700 MW by the year 2030.

2 PSDP Projects undertaken by AEDB

2.1 100 Solar Homes Programme Narian Khorian, Islamabad

The project was successfully executed and implemented by AEDB. It was inaugurated by the Honourable Prime Minister of Pakistan on 19th June, 2005. Each of the 100 households has been provided with 88 Watt Solar Panels, 4 LED lights, a 12 Volt DC fan and a TV socket. In addition, a Solar Geyser and a Solar Cooker have also been provided to each household.

As part of the community welfare, a Solar Water Desalination Plant has also been installed and commissioned at the village ensuring the availability of clean drinking water to the

¹ The Material for this chapter has been provided by Alternative Energy Development Board (AEDB), Prime Minister's Secretariat, Islamabad.

villagers. A Children's Playground with Solar Powered Lights has also been developed at the Village. Two Solar Powered Computers have been provided to the village Mosque / Community Centre which has been air-conditioned using Solar Energy as well. In addition, an electric vehicle has also been developed which will act as the first ever Electric Rickshaw in Pakistan. The batteries of this vehicle are charged with Solar Energy.

2.2 100 Solar Homes Programme per Province:

The project was executed and implemented in the following villages:

1. Allah Baksh Bazar Dandar, District Kech, Balochistan,
2. Bharo Mal, District Thar, Sindh,
3. Janak, District Kohat, N.W.F.P.,
4. Lakhi Bher, District D.G. Khan, Punjab.

Each of the 100 households in each village has been provided with 88 Watt Solar Panels, 4 LED lights, a 12 Volt DC fan and a TV socket. In addition, a Solar Disinfecting Unit and a Solar Cooker have also been provided to each household.

2.3 Pilot Project for Development and Installation of 02 Micro Hydro Kaplan Turbines:

A 40 kW Kaplan type micro hydel Turbine has been imported from China to reverse engineer the technology. An R&D lab is being setup for this purpose.

Another 40 kW Kaplan type micro hydel turbine has been indigenously manufactured and installed at the Khanpur Dam Canal near the village of Mohra Morado, Taxila. This turbine is being used to provide electricity to the village.

2.4 Pilot Project for Installation of Indigenously Developed Micro Wind Turbines:

A total of 140 Micro Wind Turbines have been installed at various sites within Sindh and Balochistan, for providing electricity to the rural households, as well as for water-pumping. Details have been provided in Table 3.

2.5 Pilot Project for Emerging Alternative Energy Technologies Demonstration in Pakistan:

Fuel Cell: The Project clearly emphasizes on the research and development of Fuel Cells in the country and in this regard most of the initial work has already been completed. 03 No Fuel Cells along with accessories were imported from the international market for carrying out research in this field. UET Lahore and NED University Karachi have been contacted for establishment of Fuel Cell Laboratories in their premises so that the youth and intellectual class of students can benefit out of this cutting edge technology to the most. The Laboratories would be established and the equipment would be handed over to the concerned after proper training. Training Workshop by a Foreign Consultant has also been arranged so that the final part of the Project under the present scope could be finalized. The Monitoring and Evaluation team of AEDB would be in continuous operation for the success of the said project, its development and indigenization in the country in near future.

Bio Diesel: The initial research on bio-diesel resources in Pakistan is complete. As much as 10 oil resources have been subjected to oil extraction, transesterification and chemical analysis. After iterative experiments, a number of potential resources have been identified including Pongamia Pinnata (Sukh Chane), Rape Seed, and Castor Bean.

Out of these, Pongamia Pinnata, being a natural tree and with no other usage of its seed is considered to be the most promising source with an average yield of 40-90 kg seed per tree and 25% oil content in de-shelled seed.

The bio-diesel resources have been subjected to oil production. The practical yields have been found and chemical properties have been compared with those of HSD. The bio-diesel in neat form, as well as B5, B10, B20² has been subjected to road run.

The experiments so far have revealed that performance of bio-diesel, produced through indigenous means, remains same as that of HSD, when used as a blend. One just has to start off the engine and operate. However, for use of neat bio-diesel, production processes require slight iteration to reduce the viscosity of oil. This is achievable but should only be done when use of neat bio-diesel is required.

Basic research on supply chain mechanism is also complete. The infrastructure requirements, the raw material availability and deployment models have been primed.

Still in progress is laboratory set-up for advance research on bio-diesel. This includes installation of seed press in Quaid-i-Azam University to study the productivity and economic aspects vis-à-vis botanical aspect. Secondly, installation of a CL engine test bed at University of Engineering & Technology Taxila, to calculate and compare the performance indicators when operated on HSD and various blends of bio-diesel.

In addition, Pakistan Railways has been involved in plantation of Sukh Chane trees along the railway tracks. Once the performance parameters are finalized and test run of the locomotive's engine is done, the oil extracted from the Sukh Chane seed will be used in the locomotive engine, saving sufficient volumes of imported HSD.

Innovative Lighting Systems: LED Lights, Solar Lanterns, Pedal Generators, Hand Generators and Solar Mobile Phone Chargers have been indigenously developed by the private sector with AEDB's facilitation. These products have also been provided to the rural areas that have been electrified with Solar Energy.

3. Activities of Pakistan Council for Renewable Energy Technologies (PCRET)

² blends of 5%, 10%, 20% bio-diesel, respectively, with HSD.

3.1 Photovoltaic (PV) Technology

- Solar-Wind-Diesel High hybrid system installed to provide electricity to two villages in Balochistan through M/s Empower International, New Zealand.
- Two other villages in Balochistan were electrified using PV system.
- 3000 Laser Detectors were designed and fabricated for incorporating in the laser land leveling system of Pakistan Atomic Energy Commission (PAEC).
- 4000 Solar Cells and 300 Solar Modules of different sizes were fabricated indigenously.

3.2 Solar Thermal Appliances

A number of appliances including solar water heaters, solar fruit and vegetable dryers, solar distillation stills for producing clean water, solar room heating systems and solar cookers have been developed and disseminated for domestic and commercial applications.

3.3 Fuel Saving / Efficient Cooking Stoves

PCRET has developed five different models of efficient cooking stoves for use in different parts of the country. Their efficiency varies from 20% to 25% vis-à-vis 10% efficiency of conventional cooking stoves. So far, 70,000 such cooking stoves have been disseminated, 400 training programmes conducted and 20 cooking stoves manufacturing units/shops established and 200 sale points have been opened by the private sector.

3.4 Biogas Technology

- 1500 family size biogas plants have been installed, which are meeting the domestic needs of 1500 households in the rural area of the country.
- 3 community size biogas plants have been installed in rural areas of Islamabad which are meeting domestic fuel needs of 20 houses.
- A 1000 m³ biogas plant is being designed for installation near Cattle Colony, Karachi. This plant will work under thermophilic conditions.

3.5 Micro Hydro Power (MHP) Plants

- 300 MHP plants (5-50 kW each) installed on cost sharing basis in the hilly terrain of NWFP.
- Under Malakand Rural Development Project, 5 MHP plants have been installed and civil works of another 20 MHP plants have been completed. This project has been funded by the Government of NWFP.

3.6 Electrification through Micro Wind Turbines

- 600 houses have been electrified in the remote coastal areas of Sindh and Balochistan through installation of small wind turbines (stand alone) systems.

- 4 Coast Guard Check Posts at Lasbela have been electrified.
- 5 villages have been provided with battery charging facilities through a wind powered battery charging centre.
- 500 Watts Wind Turbine has been manufactured locally. The second (improved) model is under field test.
- A reverse osmosis unit is being installed near village Mubarak, Kemari Town, Karachi for desalination of brackish water.

Table 6.1
MEDIUM TERM WIND ENERGY DEVELOPMENT PLAN 2011-2020

Year	Capacity Installed (MW)	Cumulative MW of Wind Energy Installed by Year End
	700	<i>Short Term Plan(2005-2010) 700</i>
2011	100	800
2012	100	900
2013	150	1,050
2014	200	1,250
2015	250	1,500
2016	250	1,750
2017	300	2,050
2018	300	2,350
2019	350	2,700
2020	300	3,000

OEMs: GE, VESTAS, GAMESA, MITSUBISHI, GOLD WIND, REPOWER, PERMAPOWER, NEPC, SUZLON.

Investing Companies: NEW PARK ENERGY, MOIZ ENERGY LTD., ACCESS GROUP, FEW INTERNATIONAL, TANAGA MALAYASIA, GREEN POWER, ISMAIL POWER, ME CONSULT, GATELENE INDUSTRIES, WIN POWER LTD., PERMA POWER, AL-KARAM TEXTILE MILLS, HILTON PHARMA, SIGMA ENERGY, MUGHAL STAR, PROVITAL INTERNATIONAL CONSORTIUM, MASTER WIND ENERGY, ZEPHYR POWER LTD, BEACON ENERGY LTD, SKY ENERGY LTD, HOM ENERGY, CHINA INTERNATIONAL WATER & ELECTRIC CORP, SACHAL ENERGY DEVELOPMENT, FAUJI FERTILIZER COMPANY LTD, SAIF POWER LTD, NEW WORLD HUDSON LTD, REPUBLIC ENGINEERING, HABIB ENERGY LTD, AES OASIS LTD.

Table 6.2
DETAILS OF MICRO WIND TURBINES INSTALLED IN SINDH & BALOCHISTAN

SINDH - District Thatta

S.No	Name of Village	Homes Electrified	Turbines Installed
1	Goth Gul Muhammad Khaskheli – Thakani, Mirpur Sakro	16	04
2	Goth Haji Jumo Khaskheli – Thakani, Mirpur Sakro	23	06
3	Goth Ismail Khaskheli 1 – Thakani	15	04
4	Goth Ismail Khaskheli 2 – Thakani	05	01
5	Goth Mohd Hasan Khaskheli – Thakani, Mirpur Sakro	18	05
6	Goth Haji Abdullah Channo – Thakani, Mirpur Sakro	07	02
7	Goth Jamot Hussain Khaskheli – Thakani, Mirpur Sakro	11	03
8	Goth Baboo Pahwar – Thakani, Mirpur Sakro	06	02
9	Goth Sher Muhammad Hamaiti – Gujjo	40	10
10	Goth Daandaari – Ghorabari, U.C. Udaasi	250	40
11	Goth Lukman – Ghorabari, U.C. Udaasi	16	04
12	Goth Sammo – Ghorabari, U.C. Udaasi	14	03
	Total	356	85

13	Daandaari – Ghorabari, U.C. Udaasi	01 (10 kilo Watts) – Water Pumping
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BALOCHISTAN - Kund Malir, District Lasbela

S.No	Name of Village	Homes Electrified	Turbines Installed
1	Goth Meer Isa – Kund Malir, Lasbela	03	01
2	Goth Ramzan – Kund Malir, Lasbela	15	02
3	Goth Haji Sher Muhammad – Kund Malir, Lasbela	35	05
4	Goth Yaaqoob – Kund Malir, Lasbela	18	02
5	Goth Mir Abdullah – Kund Malir, Lasbela	08	01
6	Goth Haji Washi / Daghari – Kund Malir, Lasbela	32	04
	Totals	111	15

BALOCHISTAN - Quetta

S.No	Name of Recipient	Location	Turbines	Current Status
7	Governor Balochistan on behalf of the Government of Balochistan	F.C. Warehouse Quetta	39	To be installed as per the direction and advice of the Irrigation & Power Department Balochistan

Table 6.3
VILLAGES ELECTRIFIED THROUGH SOLAR PHOTOVOLTAIC DURING 2004-05

Village Name	District	Province	No. of Houses
Narian	Rawalpindi	Punjab	53
Khorian	Rawalpindi	Punjab	57
Allah Baksh Bazar Dandar	Turbat	Balochistan	121
Lakhi Bhair	D.G. Khan	Punjab	135
Bharomal	Chachro	Sindh	115
Jhanak	Kohat	N.W.F.P	120
		Total	601

Table 6.4
VILLAGES TO BE ELECTRIFIED THROUGH SOLAR PHOTOVOLTAIC DURING 2005-06

Village name	District	Province	No. of Houses
Khirzaan	Khuzdar	Balochistan	100
Basti Bugha	D.G. Khan	Punjab	100
Pinpario	Chachro	Sindh	100
Shnow Garri	Kohat	N.W.F.P	100
		Total	400

Table 6.5
RENEWABLE ENERGY PROJECTS FOR 2005-06

No.	Project Title
1.	Roshan Pakistan: National Rural Electrification Programme through Alternative / Renewable Energy Technologies
2.	Solar Homes Project in Each Province
3.	Development of Supply Chain Mechanism for Pedal Generators, Hand Generators and LED Lanterns
4.	Pilot Project of Production Plant of Bio-Diesel
5.	Research on Development of 1 kW Fuel Cell Electric Vehicle in Pakistan using Existing Fuel Cell
6.	Solar Water Pumping & Desalination
7.	Solar Thermal Power Plant Technologies (Demonstration Units)
8.	Electrification of Villages through Micro Wind Turbines
9.	Pilot project for Development and Installation of 02 Micro Hydro Kaplan Turbines
10.	Pilot project for Emerging Alternative Energy Technologies Demonstration in Pakistan