PAPER NO. 222

DEVELOPMENT OF HYDRO-POWER TO MEET ENERGY CRISIS OF THE COUNTRY

BY

ENGR. GHULAM ABBASS
ENGR. FAYYAZ ASGHAR

DEVELOPMENT OF HYDRO-POWER TO MEET ENERGY CRISIS OF THE COUNTRY

BY

Engrs. Ghulam Abbass[1] & Fayyaz Asghar[2]

(ABSTRACT)

ENERGY CRISIS

Pakistan despite being endowed with large indigenous hydro-power resources, has recently suffered a rapid switch over to expensive thermal power development which has caused a significant rise in tariff for consumers. The scenario of power generation was 60:40 hydel thermal in 1960 which has gone to 32:68 in 1997 due to the delay in commencement of ready hydro-power projects (Kalabagh/Basha) and further delay on next projects in the pipeline. The economy of the country had to suffer not only in energy sector but also significantly in agriculture and industrial sector.

The energy demand has an inclining trend and the power shortfall will keep on accumulating causing future energy crisis in the country. It is expected that the peak power demand in 2018 will be 46681 MW. It will result in shortage of 31625 MW required to be met through either hydel or expensive thermal development.

HYDRO-POWER POTENTIAL

Pakistan located in an area blessed with abundant natural resources. The northern parts of Pakistan are the source of enormous runoff draining to number of streams and rivers conducive for hydro-power development. Only the River Indus has an identified hydro-power potential of about 30,000 MW, whereas total identified potential in the country is about 36;000 MW, out of which only 4825 MW has been developed so far.

DEVELOPMENT STRATEGY IN PUBLIC SECTOR

WAPDA since its inception is contributing for identification, preparation of engineering documents and implementation of hydro-power projects to keep abreast with the forecasted demands. The projects privatized for implementation were however delayed in commencement.

Government of Pakistan, presently is giving priority for indigenous resource development including hydro-power to account for the future energy shortfall due to increasing power demand. In this regard two major projects namely Ghazi Barotha and Chashma Hydro-power Projects are already in advanced implementation stages. WAPDA is contributing its part for the identification, planning and design of small, medium and major hydro-power projects in the country. A large number of such projects are planned at different levels of study from identification to detailed engineering and implementation stage. HEPO has prepared a proposal for implementation and their investment to meet the future energy demand up to 2018, end of the 12th five year plan.

HYDEL POWER POLICY

Government of Pakistan has sought investment opportunities from private sector for their role in hydro-power development, mainly due to financial constraint in public sector. Previous Private Power Policy frameworks have predominantly resulted in private investment in oil and gas fired power plants, mainly based on imports fuel). The government now wants to play a proactive role in promoting the indigenous coal and hydroelectric resources in power generation under new power policy 1998.

CONCLUSIONS

The ingress of thermal generation to meet the energy crisis has caused a drastic increase in tariff and resulted in switching of by major consumers to their own energy resources, giving rise to another sort of crisis.

Hydro-power development is the ultimate choice for filling the increasing power demand gap. It may be emphasized that the major hydro-power development should be carried out in public sector, whereas private sector be encouraged to participate in small to medium sized projects.

---

1 Director (Electrical and Mechanical), Hydro-Electric Planning Organization, WAPDA.

2 Deputy Director (Civil), Hydro Electric Planning Organization, WAPDA.

1. ENERGY CRISIS OF PAKISTAN

Pakistan despite being endowed with large indigenous hydro-power resources has recently suffered a rapid switch over to expensive thermal power development due to shorter gestation and low investment. It has caused a significant rise in tariff for consumers. The power generation scenario of 60:40 hydel thermal in 1960 has gone to 32:68 -in 1997 (Table-1, Figures 1&2). It is mainly due to the delay in commencement of ready hydro-power projects (Kalabagh/Basha) and further delay on next projects in the pipeline. The country ~had to suffer in all sectors of economy due to absence of long term policy. Short term/interim solutions are the main cause of energy crisis in Pakistan.

The financial constraints of the country alongwith indecision about Kalabagh Dam Project at Government level has aggravated the energy crisis of the country. These factors ultimately forced the adoption of private sector in the development of power and purchase of power from private power developers at a higher rate than of the existing tariff structure. The strategy evolved to meet the gap demand of energy until now has been thermal development in private sector due to shorter gestation and low base investment. This is a burning issue at national level and known cause for increase in tariff and financial crisis.

2. WAPDA PRESENT AND FUTURE POWER DEMAND

Electricity is, in fact considered as a most reliable development indicator for a country all over the world with the level of its per capita consumption a sure gauge of its stâtus in international line up. Table-2 shows the per capita consumption of different countries in Also and Pacific. For developed / developing countries it is much higher than 5000 kWh whereas the meager figure of 300 kWh for Pakistan shows the poor state of its economic development. As such economics justifies an inclining trend for future energy demand for a~country like Pakistan which has a reasonable margin of economic growth. The power shortfall due to the increasing energy demand will keep up accumulating, causing future energy crisis in the country.

The WAPDA National Power Plan (NPP) has estimated peak power demand forecast for the country by 2018 (Table-3 & Figure-3) which shows a conservative value of 33110 MW and higher value of 46681 MW. Pakistan has up to June 1997 generating capacity of 15056 MW, of which hydel share is 4825 MW (32%). NPP has proposed (Table 9) to add addition of 12546 MW hydel generation, rest to be met through expensive thermal generation. There is still ample hydel potential which can replace the proposed thermal generation. See section 4 of the paper of hydel potential of Pakistan.

3. HYDRO-POWER A SOLUTION TO CRISIS

The variation in peak demand forecast is mainly attributed to on-going energy crisis and uncertainty among the commercial/industrial users to utilize. These consumers are reluctant to use WAPDA sources due to past experience of heavy load shedding and recent un-precedented rise in power tariff. The demand may show a steeper inclining trend if cheaper hydel energy by public sector is inducted into the system. It will help to restore the confidence of consumers to switch to WAPDA energy at a comparatively lower tariff.

The shift in confidence of consumers is apparent from the decrease of industrial and commercial consumption since 1959-60. A visible behaviour of industrial consumption is~ alarming, as the industrial consumers 'are reduced from 64.67% in 1959-60 to 27.12% in 1996-97 (Table-4) of overall consumers. The increase in domestic consumers is unavoidable, as they have no other alternatives like industrial consumers. Even then domestic consumption is also suppressed.

The WAPDA system as elaborated above was hydel dominant before 1985, which has now shifted to thermal based. The present cost of generation of different WAPDA generating stations (Table-5) significantly present a remarkable low O&M costs for hydel stations, which after recovery of capital investments are future assets of renewable energy source.

The most recent measures introduced by WAPDA for the improvement distribution system has clearly indicated that the demand has been suppressed due to the higher electricity tariffs which has forced the average consumer to restrict its electricity consumption at a minimum level due to heavy electricity bills. This serious situation needs to be studied in the perspective of private sector involvement in power development. The remedies though available, need very serious attentions on the part of policy markers:

- The future private sector involvement may be thoroughly studied with respect to the terms and condition of power purchase and private sector may be allowed only on competitive tariffs, basis.
- Public sector involvement in development of major multi-purpose hydro-power projects is unavoidable to keep hydel: thermal ratio well within acceptable limits and also to balance and control the electricity tariff.
- Negotiations with existing private power producers to cut down their tariff rates on long term perspective.
- Negotiations for export of power to neighboring countries may be expedited and private power producers may also be allowed to export their energy.

It is best to say that crisis due the shortage of power during recent years may not be continued anymore a crisis for the country in the near future. The-recent few years have witnessed a considerable addition to thermal generation, both in public and private sectors. The generation mix has significantly tilted in favour of expensive thermal with a considerable reduction in cheaper hydel power share. Though, plenty of hydro power is available in the country but it is not explored and not accessible to the people which is main cause of the power crisis in the country.

4. HYDRO-POWER POTENTIAL OF PAKISTAN

The fact is universally accepted and acknowledged that the hydel generation as compared to other sources of power generation in long run is more economical and environment friendly. Hydro-power development has played vital role in economic development of the developed countries. At present the available potential or economic utilization of river systems is not harnessed in underdeveloped countries, due to lack of financial resources and technical capabilities.

Pakistan is located in an area blessed with abundant natural resources. The northern parts of Pakistan are the source of enormous runoff draining down the Himalayan and Karakorum heights from the world's largest glaciers, a free gift of nature, to number of streams and rivers conducive for hydro-power development. Only the Mighty River Indus and its tributaries have an identified hydro-power potential of about 30,000 MW, whereas total identified potential in the country is more than 36,000 MW, out of which only 4825 MW has been developed so far. Some 94 small and micro schemes with accumulated installed capacity of 37 MW is also in operation in northern parts of Pakistan under isolated power system. This is about 13.9% of the identified potential of the country. In addition to the identified potential, substantial power potential on smaller streams/tributaries of major rivers is~still to be identified.

For development of hydro-power in Pakistan, still a long way have to no. With so much cheaper hydel potential, it is really pity that we are opting to pay so much for electricity. The brief of available hydel potential of Pakistan is given in **Table-6,** which is summarized as below :

Sr. No.	Status Projects / Schemes	Potential
1	Developed and in operation	4862.4 MW
2	Under implementation	1689.9 MW
3	Ready for implementation	4698.5 MW
4	Available for development	23,917 MW

WAPDA though had been endeavouring hard to plan and bring the hydel projects in line, ready for implementation, yet on one or other pretext, already described above, the available hydel potential still needs to harnessed to its optimum at accelerated pace. Pakistan and Nepal are two Asian countries where abundant hydel potential is at very initial stage of development. All developed countries of the world have utilized their available renewable hydro-power resources to their maximum.

5. HYDRO-POWER DEVELOPMENT STRATEGY IN PUBLIC SECTOR

WAPDA since its inception is contributing for identification, preparation of engineering documents and implementation of hydro-power projects to keep abreast with the forecasted demands. The projects prioritized for implementation were however delayed in commencement due to different reasons.

Government of Pakistan, presently is giving priority for indigenous resource development including hydro-power to account for the future energy shortfall due to increasing power demand. In this regard two major projects namely Ghazi Barotha Hydro-power Project and Chashma Hydro-power Project are already in advanced implementation stages. Hydro Electric Planning Organization (HEPO)' WAPDA is contributing its part for the identification planning and design of small, medium and major hydro-power projects in the country. A large number of such projects are planned at different levels of study from identification to detailed engineering and implementation stage. HEPO has prepared a proposal for implementation and their investment to meet the future energy demand up to 2017, end of the 12th five-year plan. These projects include 33 projects whose feasibility / pre-feasibility studies have

either already been completed or are in hand (Table-6, Appendix-I). The projects range from small to major multipurpose projects in public as well as private sector. The tentative capital investment of these projects is given in Tables 7 & 8.

It is proposed that these projects may be planned in such a way to cater for 22548 MW of power shortfall up to 2018, through hydel generation, keeping in view the huge investment requirements for hydel projects. Thermal projects may be introduced to meet the interim requirements. In this way the expensive thermal share in National generation will be well within the control and tariffs in the longer run will considerably dampen. It will require accurate long term planning, scheduling and investment strategy probably both in public and private sector.

6. HYDEL POWER POLICY

Despite Government's efforts for implementation of hydro-power projects as per WAPDA's proposed plan, the delays were inevitable due to financial and political reasons. Government of Pakistan has accordingly sought investment from private sector for their role in hydro-power development, mainly due to financial constraint in public sector. Previous Private Power Policy frameworks have predominantly resulted in private investment in oil and gas fired power plants, mainly based on imports (fuel). The 1994/1995 Private Power Policy framework have attracted private investment for over 3000 MW of capacity on "Cost Plus" thermal plants, whereas none of the hydro-power projects offered to private sector have come to financial close-up or implementation stage due to red-tapism and uncertain economic conditions of the country and ongoing tariff conflicts. The Government now intends to play a proactive role in promoting the indigenous coal and hydroelectric resources in power generation under new power policy 1998. It is intended that the initial invitations to bid will only be called for hydel and indigenous coal based projects.

The unpleasant experience with IPP projects and unhealthy negotiations with prospective private investors for hydro-power projects on tariff conflicts has provided healthy environment for private sector involvement in thermal power development. Incentive to private sector shall not be allowed at the cost of WAPDA, who is already in the financial crisis, created due to private sector involvement in power development at high tariff rates.

7. CONSTRAINTS FOR HYDEL DEVELOPMENT

Major constraint at present for development of hydro-power in public sector is lack of financial resources, whereas development of hydro-power projects in private sector are mainly due to red-tapism, uncertain political and economic conditions of the country.

8. CONCLUSIONS AND RECOMMENDATIONS

- The ingress of thermal generation to meet the energy crisis has caused a drastic increase in tariff and resulted in switching of by major industrial consumers to their own energy generation, giving rise to another sort of crisis.

- Hydro-power development is the ultimate choice for filling the increasing power demand gap. It may be emphasized that the major hydro-power development should be carried out in public sector as a long term solution, whereas private sector be encouraged to participate in small to medium sized projects.

- Immediate steps may be taken to ensure the implementation of planned and scheduled hydro-power projects and capital investment up to 1 2'h five-year Plan may be earmarked in public sector for investigation and implementation of major hydro-power projects.

- Hydro-power Development had played a significant role in the economic development of all the developed nations who have opted for optimum hydro-power development on the main river systems. Pakistani should also come up with a national consensus to develop the hydro-power potential for small, medium and major projects on ail rivers before it is too late.

- Thermal support cannot be allowed for longer to meet the interim demand gap requirements. However its share in generation should be kept to a minimum for as long as practically possible. In the meanwhile, steps may be taken to harness indigenous coal based thermal generation.

TABLE -2

PER CAPITA CONSUMPTION OF ELECTRICITY IN DIFFERENT COUNTRIES (1992)

Sr. No.	Country	Per Capita Consumption (Kwh)
1	Afghanistan	49 (1990)
2	Australia	7303
3	Bangladesh	52
4	Bhutan	122
5	China	543
6	Fiji	497 (1990)
7	Hong Kong	5370
8	India	283
9	Indonesia	190
10	Iran	947
11	Japan	5334 (1990)
12	Korea, Republic	2639
13	Malaysia	1731
14	Maldives	103 (1988)
15	Nepal	29 (1990)
16	New Zealand	7952
17	Pakistan (WAPDA +KESC)	315 (1996)
18	Pak WAPDA	300 (1996)
19	Pakistan (WAPDA+KESC)	261 (1990)
20	Western Samoa	250 (1988)
21	Singapore	5659
22	Sri Lanka	168
23	Thailand	849

Source: Asia Electric Power Utilities Data Book 1993 and Electric Power in Asia and the Pacific in 1990 and 1992.

TABLE -3
WAPDA SYSTEM LOAD FORECAST

YEAR	NPP PEAK DEMAND	NPP REVISED DEMAND
1999	13454	9185
2000	14373	9618
2001	15511	10141
2002	16722	10694
2003	18009	11280
2004	19375	11809
2005	20836	12636
2006	22381	13520
2007	24010	14467
2008	25741	15480
2009	27367	16563
2010	29073	17888
2011	30877	19319
2012	32793	20865
2013	34818	22534
2014	36940	24337
2015	39179	26284
2016	41541	29386
2017	44039	30657
2018	46681	3310

SOURCES:
1. National Power Plan Pakistan, Generation Plan update 1995-96, WAPDA, October 19961.
2. Latest Demand Supply Projection, General Manager Planning (Power), WAPDA, January 1999.

TABLE -4

SECTOR WISE CONSUMPTION OF AVAILABLE ELECTRICITY IN WAPDA

Year	Domestic	Industrial	Agricultural	Commercial & Others
	Percentage			
1959-60	13.43	64.67	11.11	10.79
1964-65	10.76	49.56	23.27	16.41
1969-70	10.19	45.72	26.56	17.53
1974-75	10.86	43.06	29.37	16.71
1979-80	19.17	38.65	25.20	16.98
1984-85	28.26	36.79	20.22	14.73
1989-90	31.71	34.65	20.75	12.89
1990-91	32.42	34.28	21.05	12.25
1991-92	33.11	34.90	19.90	12.09
1992-93	35.88	34.89	17.89	11.34
1993-94	37.07	32.78	17.87	12.28
1994-95	38.22	30.27	17.75	13.76
1995-96	40.79	28.59	18.42	12.20
1996-97	41.81	27.12	18.82	12.25

SOURCES: WAPDA Annual Report 1996-97.

TABLE 5
COST OF GENERATION (YEAR 1996)
WAPDA POWER PROJECTS

Sr. No.	Power Station	Installed Capacity (MW)	Total Average Cost (Ps/KWh)
A. HYDEL			
1.	Tarbela	3478	14.10
2.	Mangla	1000	2.95
3.	Warsak	240	11.26
4.	Dargai	20	4.09
5.	Malakand	19.6	4.46
6.	Rasul	22	17.15
7.	Shadiwal	13.5	28.70
8.	Nandipur	13.8	42.82
9.	Chichoki Mallian	13.2	26.67
10.	Karram Garhi	4	18.03
11.	Renala	1.1	49.30
12.	Chitral	1	72.27
B. THERMAL			
1.	Multan Steam	260	131.08
2.	Guddu Steam	640	121.18
3.	Guddu Combined Cycle	600	100.23
4.	Shahdara GTPS	85	512.41
5.	Kotri Gas Turbines	174	148.72
6.	Sukkur Steam	50	183.78
7.	Quetta Thermal	83	190.24
8.	Faisalabad GTPS	244	255.74
9.	Faisalabad Steam	132	111.81
10.	Jamshoro	710	189.73
11.	Pasni	17	257.52
12.	Muzaffargarh	1050	82.37
13.	FFB Lakhra Coal	150	120.31
14.	MESCO	20	297.26

Source: WAPDA Power System Statistics, Twenty First Issue, Planning Department. Power Wing WAPDA, March 1997.

TABLE 6
HYDEL PROFILE OF THE COUNTRY

	Projects / Schemes	River / Location	Installed Capacity	Remarks
A.	**Projects Operation**			
	1. Tarbela (10x175 + 4x432)	Indus / Terbela	3478 MW	WAPDA
	2. Mangla (10x100)	Jhelum	1000 MW	WAPDA
	3. Warsak (6x40)	Kabul / NWFP	240 MW	WAPDA
	4. Dargai (4x5)	NWFP	20 MW	WAPDA
	5. Malakand (3x32 + 2x5)	NWFP	19.6 MW	WAPDA
	6. Rasul (2x11)	Punjab	22 MW	WAPDA
	7. Chichoki Mallian (3x4.4)	Punjab	13.2 MW	WAPDA
	8. Shadiwal (2x6.75)	Punjab	13.5 MW	WAPDA
	9. Nandipur (3x4.6)	Punjab	13.8 MW	WAPDA
	10. Kurram Garhi (4x1)	NWFP	4 MW	WAPDA
	11. Renala (5x0.22)	Punjab	1.1 MW	WAPDA
	12. Chitral	Lutkoh / NWFP	1 MW	WAPDA
	AJK (3 Projects)	AJK	2.1 MW	AJK HEB
	NA (61 Projects)	Northern Areas	33 MW	NAPWD
	NWFP (7 Projects)	NWFP	1.1 MW	NWFP
	Total		**4862.4 MW**	
B.	**Projects Under Implementation**			
	1. Ghazi Barotha	Indus / Attock	1450 MW	WAPDA
	2. Chashma	Indus / Chashma	184 MW	WAPDA
	3. Jagran-I	Jagran / AJK	30.4 MW	AJK HEB
	4. Kundal Shahi	Jagran / AJK	2 MW	AJK HEB
	5. Leepa	Qazi Nag / AJK	1.6 MW	AJK HEB
	6. Battar	Battar / AJK	4.8 MW	AJK HEB
	7. SHYDO Schemes	NWFP	17.1 MW	SHYDO, NWFP
	Total		**1689.9 MW**	
C.	**Projects Ready for Implementation**			
	1. Sai	Sai / Gilgit, NA	10.5 MW	M/O KANA (PPIB)
	2. Nomal	Nomal / Gilgit, NA	3 MW	M/O KANA (PPIB)
	3. Golen Gol	Golen / Chitral, NWFP	106 MW	WAPDA
	4. Kalabagh	Indus / Kalabagh	3600 MW	WAPDA
	5. Neelum-Jhelum	Neelum / AJK	963 MW	WAPDA
	6. Rohri	Rohri Canal	16 MW	WAPDA
	Total		**4698.5 MW**	
D.	**Identified Projects**			
	1. Feasibility / Pre feasibility Stage		8738* MW	See Appendix 1
	2. WAPDA Projects.		10192* MW	See Appendix 2
	3. SHYDO Projects		4421.5* MW	See Appendix 3
	4. AJK Projects		555* MW	See Appendix 4

* ***The capacities need to be optimized and these figures present index / comparative capacities at identification / ranking level studies.***

Appendix 1

HYDEL PROJECTS AT FEASIBILITY/PRE-FEASIBILITY STAGE

Sr. No.	Project's Name	River/Location	Capacity (MW)	Formation involved	Status
A. FEASIBILITY STUDY COMPLETED					
1.	Gomal Zam	Gomal	17	Wapda	PC-II for Detailed Engineering Design and Project Planning approved by ECNEC on 22.1.1998
2.	3rd Malakand	Upper Swat Canal/Malakand	81	Wapda/Swabi Consultants	Feasibility study completed
3.	Jinnah Barrage	Indus	144	Wapda/Binnie & Partners/GTZ	Feasibility study completed
4.	New Bong Escape	Jhelum	45	M/s Laraib Energy Co.	Feasibility study completed
5.	Rajdhani	Punch	92	M/s Iqbal Power Ltd.	Feasibility study completed
6.	Matiltan	Ushu/Swat	84	M/s Sachal Engg. Works	Feasibility study completed
7.	Diamer Dam	Indus/Chilas	3360	Wapda	Updation of Feasibility
		Total:	**3823**		
B. FEASIBILITY IN HAND					
8.	Munda Dam	Swat	600	Wapda	PC-II approved by ECNEC on 11.7.1998
9.	C.J. Link	C.J. Link Canal Tail	33	Wapda/GTZ	Feasibility study in progress
10.	Taunsa Barrage	Indus/Taunsa	120	Wapda/SOGEX/GTZ	Feasibility study in progress
11.	D.G. Khan Link-III	D.G.Khan Canal	7	Wapda/GTZ	Feasibility study in progress
12.	Kohala	Jhelum	500	AJKHB	Feasibility study in progress
13.	Doyian	Astore river	425	Wapda/GTZ	PC-II approved by CDWP on 25.6.1998.
14.	Phandar	Gilgit river	87	Wapda/GTZ	- do -
15.	Naltar Phase-III	Hunza river	22	Wapda/GTZ	- do -
16.	Basho Phase-II	Indus river	9	Wapda/GTZ	- do -
17.	Harpo Phase-II	Indus river	41	Wapda/GTZ	- do -
18.	Khan Khwar	Khan-Indus	70	SHYDO/GTZ	-
19.	Summar Gah	Summar-Indus	28	SHYDO/GTZ	-
20.	Batal Khwar	Batal-Swat	8	SHYDO/GTZ	-
21.	Daral Khwar	Daral-Swat	36	SHYDO/GTZ	-
22.	Ranolia	Ranolia-Indus	11	SHYDO/GTZ	-
23.	Shishi	Shishi-Swat	2	SHYDO/6TZ	-
24.	Alai Khwar	Alai-Indus	163	SHYDO/GTZ	-
25.	Main Line Lower UCC	UCC/Punjab	7	Punjab	-
26.	Renala	Punjab	4	Punjab	-
		Total:	**2173**		
C. PRE-FEASIBILITY COMPLETED					
18.	Kurarm Tangi Dam	Kurram	40	Wapda	PC-II udated and being submitted to the Govt. of NWFP for feasibility study
19.	Harigehl-Dhalkot	Jhelum	53	Wapda/Statkraft, Norway	PC-II submitted for feasibility study
20.	Chakothi-Hattian	Jhelum	139	-do-	PC-II submitted for feasibility study
21.	Guddu Barrage	Indus/Guddu	34	Wapda/GTZ	Feasibility study in progress
		Total:	**266**		
D. PRE-FEASIBILITY IN HAND					
22.	Bunji	Indus/Near Gilgit	1500	Wapda	Pre-Feasibility study in progress
23.	Hamuchal	Gilgit	16	Wapda	Pre-Feasibility study in progress
		Total:	**1516**		
E. INCEPTION REPORT					
24.	Tarbela Extension	Indus/Tarbela Dam	960	Wapda	Inception
		Total:	**960**		
		GRAND TOTAL	**8738**		

Appendix 2

IDENTIFIED PROJECTS WITH WAPDA

Sr. No.	River/Location		Number of Schemes	Total Capacity (MW)	Remarks
	INDUS				
	I) Major Schemes		8	7142	Inventory and Ranking by WAPDA/MECO in 1984
1	Dasu	2712			PC-II submitted in 1990
2	Thakot	1043			-
3	Pattan	1172			-
4	Rakhiot	670			-
5	Yulbo	710			-
6	Tungas	625			-
7	Kanch	122			-
8	Sher Qila	88			-
	ii) Medium Schemes		16	685	Ranking by WAPDA/GTZ, 1992-97
	iii) Small Schemes		104	453	-do-
	JHELUM				
	I) Major Schemes		6	973	Ranking by WAPDA/GTZ, 1995
9	Abbasian	245			
10	Mahl	245			
11	Azad Pattan	222			
12	Karot	240			
13	Hariyola	12			
14	Nakar	9			
	ii) Small Schemes in Jhelum Basin		17	30	Ranking by WAPDA/GTZ, 1993-96
	PUNCH				
	I) Medium Schemes		4	344	Ranking by WAPDA/GTZ, 1992
15	Sehra	65			
16	Kotli	97			
17	Gulpur	116			
18	Barali	66			
	CANAL FALLS		593	565	Ranking by WAPDA/GTZ, 1993-96
	TOTAL			**10192**	

Appendix 3

SHYDO PROJECTS

Sr. No.	Projects	Tributary/River/Location	Capacity (MW)
	INDUS		
1	Kaigah	Kandiah-Indus	549
2	Karrang	Kandiah-Indus	454
3	Spat Gah Chor Nullah	Spat-Indus	819
4	Dongai Gah	Spat-Indus	32
5	Alai Khwar Scheme IV	Alai-Indus	124
6	Duber Khwar, Pattan	Dubair-Indus	160
7	Jabroi	Siran-Indus	8
8	Karora New	Khan Khwar-Indus	8
9	Ushiri	Ushiri-Indus	6
	SWAT		
10	Mirkhani-Khazana	Panjkura-Swat	110
11	Mirkhani-Kalangai	Swat	256
12	Gabral-Kalam	Swat	105
13	Kalam-Kedam	Swat	429
14	Kedam Madyan	Swat	147
15	Shermai-Darora	Panjkura-Swat	115
16	Kedam Khwar	Kedam Khwar-Swat	7
17	Chokel Khwar	Swat River	10.5
18	Koto	Panjkura River	53
19	Gandegah	Panjkura River	4
	KUNHAR		
20	Patrind	Kunhar	133
21	Naran	Kunhar	219
22	Suki Kinari	Kunhar	652
23	Bhimbal	Bhimbal-Kunhar	8
24	Tangar	Burniali-Kunhar	13
		TOTAL	**4421.5**

Appendix 4

PROJECTS WITH AJK HYDEL BOARD

Sr. No.	Projects	Tributary/River/Location	Capacity (MW)
1	Jari	District Bagh	1
2	Doarian	Mirour	24
3	Gumat Nar	Muzaffarabad	40
4	Shontar	Kotli	20
5	Shardi	Muzaffarabad	10
6	Janowahi	Muzaffarabad	5
7	Taobat	Muzaffarabad	5
8	Jagran-II	Muzaffarabad	30
9	Nagdar	Muzaffarabad	16
10	Luat	Muzaffarabad	10
11	Dhudhnial	Muzaffarabad	300
12	Batdara	Muzaffarabad	4
13	Jagran-III	Muzaffarabad	90
		TOTAL	**555**

TABLE 7
SUMMARY OF INVESTMENT FOR CONSTRUCTION AND GENERATION FOR HYDEL DEVELOPMENT UPTO 2018

Amount in Million US Dollars

Sr. No.	Plan Period	WAPDA Projects				SHYDO Projects		AJK Projects				Punjab Projects		Total	
		Public Sector		Private Sector		Private Sector		Public Sector		Private Sector		Private Sector			
		Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment	Capacity (MW)	Invest-ment
1.	9th Five Year Plan	106	2403	183	685	592	614	90	61	249	2662	31	50	1251	6475
2.	10th Five Year Plan	4218	5087	120	74	1554	2056	10	12	2308	1094	-	-	8210	8323
3.	11th Five Year Plan	2710	6725	-	-	1869	2542	16	25	698	1047	-	-	5293	10339
4.	12th Five Year Plan	6672	2617	-	-	168	241	14	26	971	1732	-	-	7825	4616
	Total Construction	**13706**	**16832**	**303**	**759**	**4183**	**5453**	**130**	**124**	**4226**	**6535**	**31**	**50**	**22548**	**29703**

TABLE-8
INVESTMENT REQUIREMENTS (UPTO 12th FIVE YEAR PLAN)
CONSTRUCTION OF HYDROPOWER PROJECT

Amount in US Million Dollars

Sr.No.	Projects	Capacity MW	Location	Capital Cost	Five Year Plan			
					9th 1999-2003	10th 2003-8	11th 2008-13	12th 2013-18
	WAPDA PROJECTS IN PUBLIC SECTOR							
1.	Golen Gol	106	Chitral	99	99			
2.	Doyian	425	N.A.	346	259	87		
3.	Phandar	86	N.A.	76	57	19		
4.	Harpo	41	N.A.	33	25	8		
5.	Tormic	41	N.A.	32	24	8		
6.	Talu	25	N.A.	23	17	6		
7.	Kalabagh	3600	Punjab	5490	1922	3568		
8.	Altit	250	N.A.	454	-	386	68	
9.	Tarbela-IV	960	NWFP	509	-	432	76	
10.	Basha	3360	N.A.	4234	-	423	2963	848
11.	Bunji	1500*	N.A.	1500	-	150	1350	
12.	Dasu	2712	N.A.	3107	-		2175	932
13.	Munda	600	NWFP	930	-	-	93	837
	Total	**13706**		**16832**	**2403**	**5087**	**6725**	**2617**
	*index capacity							
	WAPDA PROJECTS IN PRIVATE SECTOR							
1.	Jinnah	144	Punjab	387	387			
2.	Taunsa	120	Punjab	296	222	74		
3.	C-J Link	23	Punjab	30	30			
4.	Rohri	16	Sindh	46	46			
	Total	**303**		**759**	**685**	**74**		
	NWFP PROECTS IN PRIVATE SECTOR							
1.	Malakand-III	75		112	112			
2.	Ranolia	11.8		11	11			
3.	Matiltan	84		94	94			
4.	Batal Khwar	8.1		14	14			
5.	Summar Gah	28		21	21			
6.	Shishi	2		4	4			
7.	Daral Khwar	28		31	31			
8.	Khan Khwar	70		87	87			
9.	Duber Khwar	160.6		147	147			
10.	Allai Khwar	125		93	93			
11.	Kalam (A1)	105		113		113		
12.	Kedam	428		401		401		
13.	Madyan	150		212		212		
14.	Naran	219		720		720		
15.	Suki Kinar	652		610		610		
16.	Karang	454		422			422	
17.	Kai	549		1038			1038	
18.	Chor Nalah	850		1064			1064	
19.	Jabori	8		10			10	
20.	Korara New	8		8			8	
21.	Sharmai	115		152				152
22.	Koto	53		89				89
	Total	**4184**		**5453**	**614**	**2056**	**2542**	**241**

Sr.No.	Projects	Capacity MW	Location	Capital Cost	Five Year Plan			
					9th 1999-2003	10th 2003-8	11th 2008-13	12th 2013-18
	AJK PROJECTS IN PRIVATE SECTOR							
1.	Riali	1.6	Saidpur	1.5	1.5			
2.	Abbasian	245	Distt. Bagh Poonch	279.3	202.5	76.8		
3.	New Bong Escape	45	Distt. Mirpur	54	54			
4.	Jari Outlet Works	1	Distt. Mirpur	1.14	1.14			
5.	Rajdhani Project	85	Distt. Kotli	81.7	81.7			
6.	Gulpur Project	116	Distt. Kotli	107.98	107.98			
7.	Neelum-Jhelum	969	Distt. Muzaffarabad	1500	1125	375		
8.	Kohala	1000	Distt. Muzaffarabad	1612.5	1087.5	525		
9.	Doarian	24	Distt. Muzaffarabad	30		30		
10.	Nagdar	16	Distt. Muzaffarabad	20		20		
11.	Harighel	54	Distt. Bagh Poonch	67.5		67.5		
12.	Chakothai Seri	171	Distt. Muzaffarabad	256.5			256.5	
13.	Sehra	65	Distt. Kotli	97.5			97.5	
14.	Azad Pattan	462	Distt. Poonch	693			693	
15.	Mahal	511	Distt. Bagh Poonch	869.72				869.72
16.	Karote	460	Distt. Poonch	862.5				862.5
	Total	**4226**		**6535**	**2661**	**1094**	**1047**	**1732**
	AJK PROJECTS IN PUBLIC SECTOR							
1.	Jagran	30.4		65.09	5.375			
2.	Leepa	1.6		2.39	0.889			
3.	Battar	4.8		5.7	4.96			
4.	Batdara	10.2		9.48	9.48			
5.	Cham fall	3.2		3.04	3.04			
6.	Jagran-II	40		38	36.75			
7.	Sharda	2		2.5		2.5		
8.	Hotreri	1.6		2		2		
9.	Sharian	3.2		4		4		
10.	Kotli Ban	1		1.25		1.25		
11.	Dhanar	1.5		1.875		1.875		
12.	Dudhnial	0.3		0.75			0.75	
13.	Luat	10		15			15	
14.	Rerah	1		1.625			1.625	
15.	Hajira	2.5		4			4	
16.	Dakhan	1.6		2.5			2.5	
17.	Sarsawa	0.825		1.5			1	0.5
18.	Agar	12		22.5				22.5
19.	Sarhota	1		1.875				1.875
20.	Pothi	1		1.875				1.875
	Total	**130**		**187**	**60**	**12**	**25**	**27**

FIGURE 1
WAPDA GENERATION (1960-97)

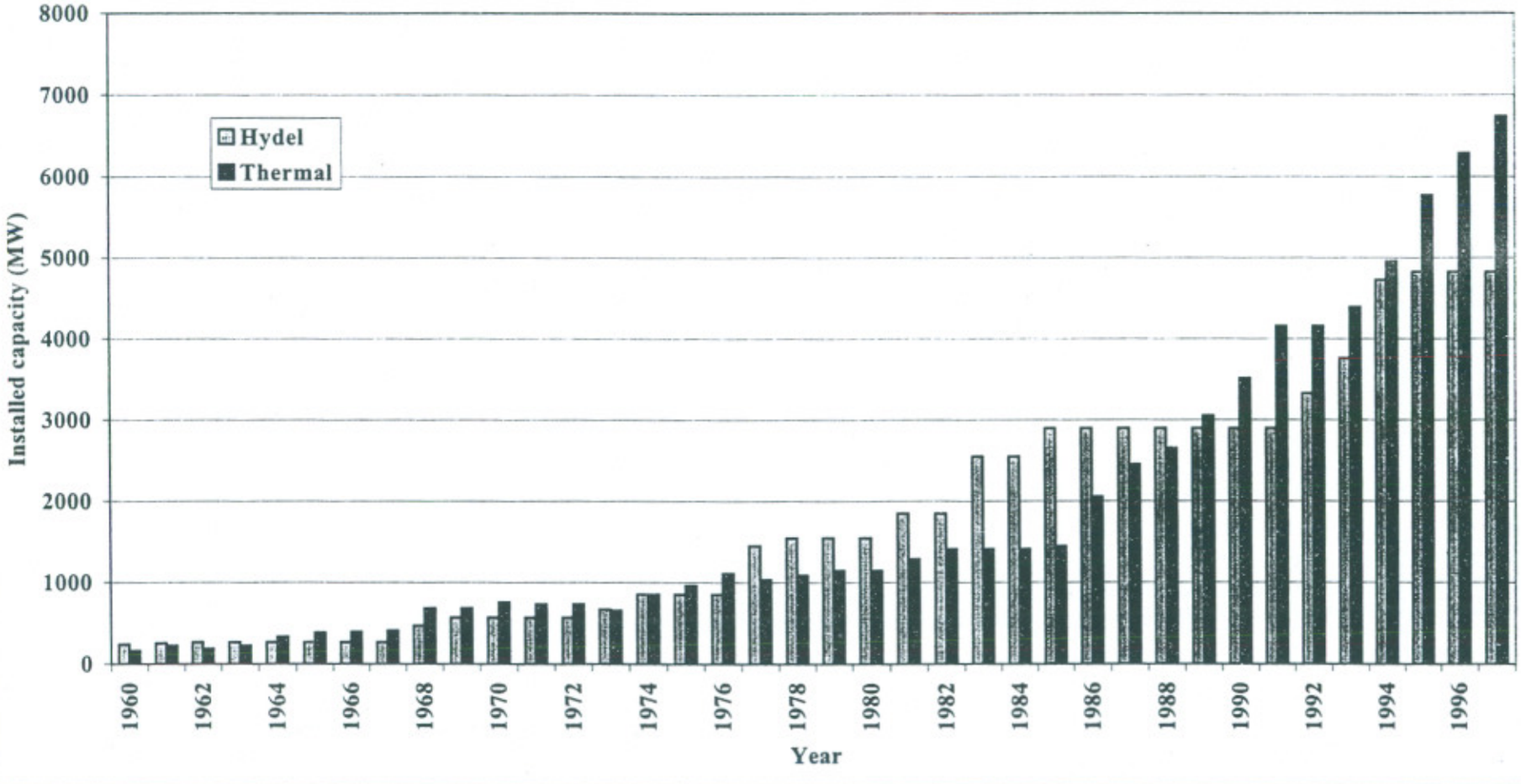


FIGURE 2
WAPDA GENERATION (1960-97)

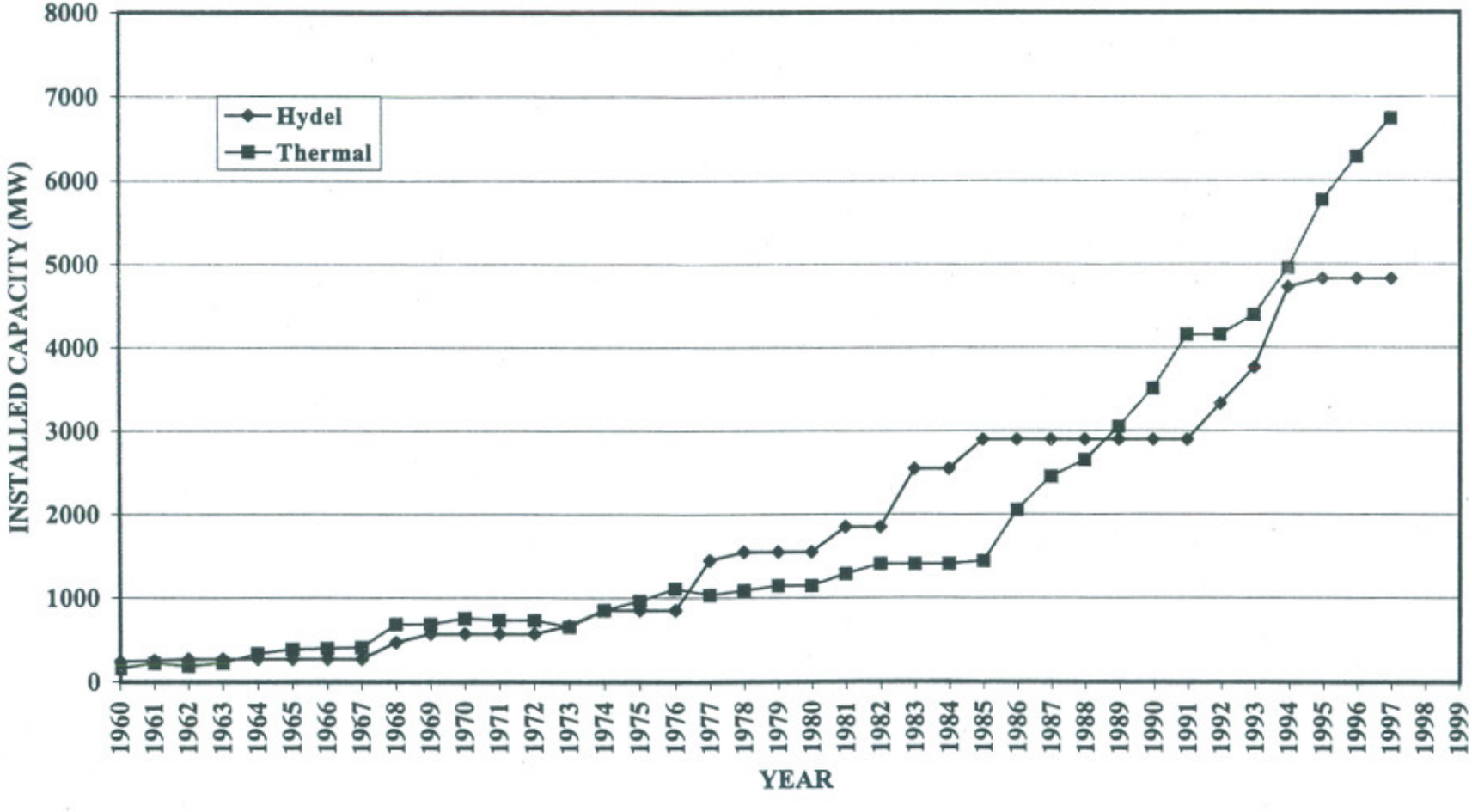


FIGURE 3
WAPDA SYSTEM POWER DEMAND FORECAST

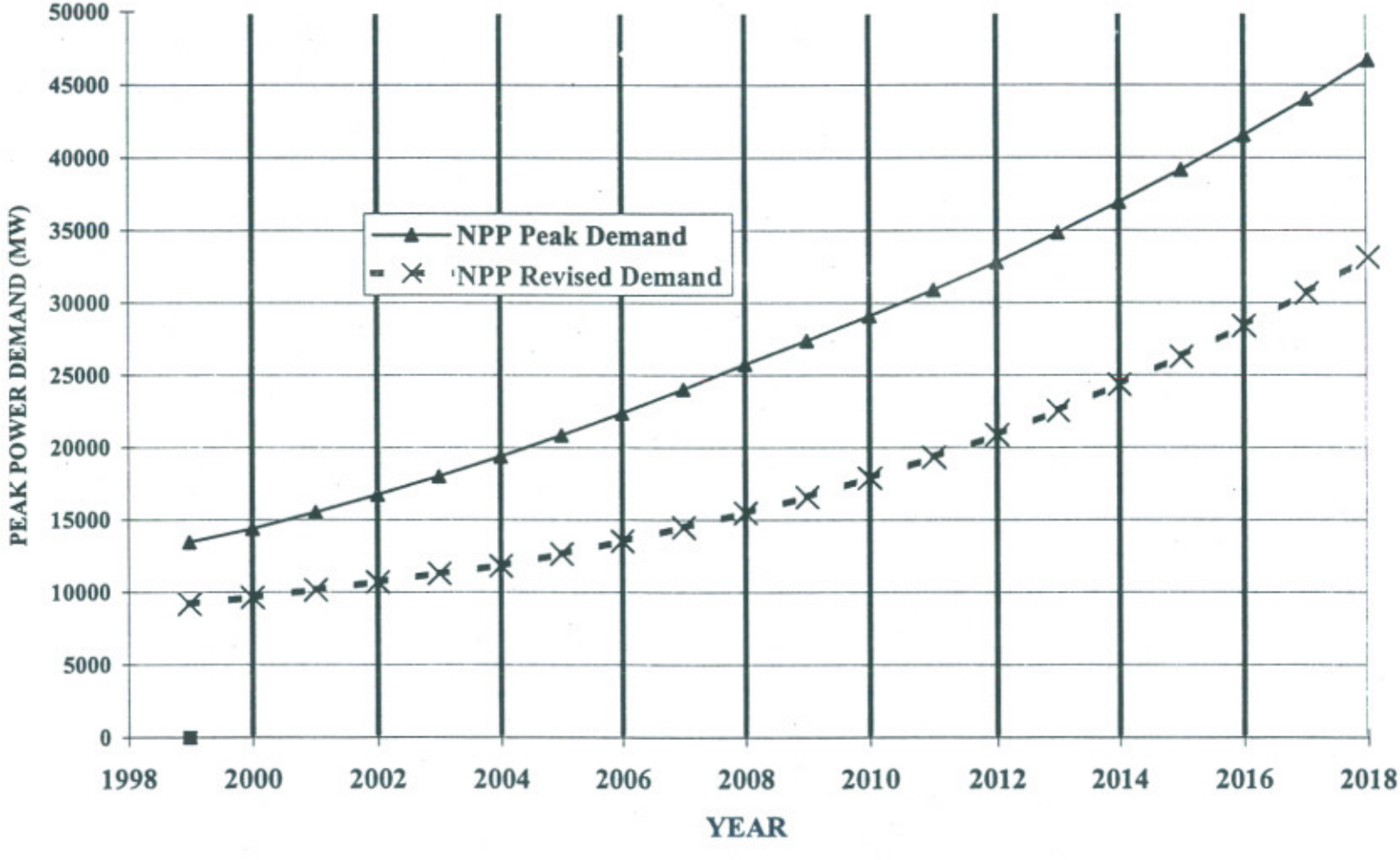


TABLE -9
SEQUENCE OF GENERATION ADDITIONS - BASE CASE (DETAIL SHEET)

Fiscal Year	Existing + Committed - Retirement Capacity		New Projects As Per Base Case Expansion Sequence						Net Capacity Added Per Year	Total Installed Capacity	Peak Demand
	Name	MW	Combustion Turbines (200 MW)	Combined Cycle (630 MW)	Steam Coal (600 MW)	Thermal Capacity (MW)	Hydroelectric Projects Name	(MW)	(MW)	(MW)	(MW)
1995-96	Existing	12784								12784	11005
1996-97	Lakhra FBC #3	50				0			1227	14011	11761
	Bin Qasim # 6	210									
	Kot Addu C.C #15	133									
	Muzaffargarh # 4	320									
	Hub # 1&2	646									
	Korangi ST#1&2(KESC)	-132									
1997-98	Hub # 3&4	646				0			3677	17688	12586
	Uch (Phase-I)	586									
	AES (Phase 1&2)	727									
	Kohinoor Energy Ltd.	131									
	Southern Electric	115									
	Power Gen. System	116									
	Japan Power Gen Ltd.	120									
	Rousch (Pakistan) Power	412									
	Saba Power Company	114									
	Habibullah Energy Ltd.	140									
	Davis Energen	10									
	Gul Ahmed Energy (KESC)	136									
	Tri Star Energy (KESC)	110									
	Tapal Energy Ltd. (KESC)	126									
	Sabah Shipyard (KESC)	288									
	Korangi CT #1-4 (KESC)	-100									
1998-99	Chashma Hydel	184				0			59	17747	13454
	Site CT#1-5 (KESC)	-125									
1999-00	Chashma Nuclear	325				0			1751	19498	14373
	CEPA Power Project	1426									
2000-01	Ghazi Barotha Hydel	1450				0			1180	20678	15511
	MESCO #1&2	-20									
	Korangi ST#3&4 (KESC)	-250									
2001-02	Shahdara CT#1-6	-85				0			-85	20593	16722
2002-03	Multan ST#1&2	-130				0	Duber Khwar	170	164	20757	18009
							Allai-IV	124			
2003-04	Multan ST#3&4	-130	4 Gakhar			800	Khan Khwar	73	1116	21873	19375
							Matiltan	84			
							Chakthi	139			
							Kotli	97			
							Harighel	53			
2004-05	Quetta ST#1&2	-15	1 Gakhar	2 Bhikki		1660	Swat Scheme A1	105	1735	23608	20836
	Quetta CT #3-6	-15	1 Sargodha								
2005-06	Sukkur ST#1&2	-25	2 Sargodha	2 Bhikki		1660	Swat Scheme B1	429	1934	25542	22381
	Faisalabad CT#5-8	-100									
	Kotri CT #5&6	-30									
2006-07						0	Kalabagh (1-4)	1200	1917	27459	24010
							Sehra	65			
							Suki Kinari	652			
2007-08	Faisalabad ST #1&2	-132				0	Kalabagh (5-8)	1200	1247	28706	25741
	Sukkur ST # 3&4	-25					Karang	454			
	Korangi ST#3&4 (KESC)	-250									
2008-09				1 Bhikki		630	Neelum-Jhelum	930	1560	30266	27367
2009-10			1 Sargodha	1 D.I.Khan		830	Tarbela 4th Extension	960	2641	32907	29073
							Spath Gah	851			
2010-11			2 Gatti	2 Haveli		1660			1660	34567	30877
2011-12				2 Haveli		1260	Basha (1-3)	840	2100	36667	32793
2012-13			1 Gatti	1 Haveli		1460	Basha (4-6)	840	2300	38967	34818
				1 D.I.Khan							
2013-14	Guddu C.C #1-6	-600	2 Gatti		3 South	2600	Basha (7-9)	840	2630	41597	36940
	Bin Qasim ST#1 (KESC)	-210	2-								
2014-15	Guddu ST # 1&2	-220	2-		3 South	2200	Basha (10-12)	840	2610	44207	39179
	Bin Qasim ST#2 (KESC)	-210									
2015-16	Kot Addu C.C #1-4,9&10	-600	2-		4 South	2800			2200	46407	41541
2016-17	Guddu ST# 3&4	-420	1-		3 South	2000	Kohala	1000	2580	48987	44039
2017-18					4 South	2400	Munda	600	3000	51987	46681
Total		**17481**	**21**	**12**	**17**	**21960**		**12546**	**39203**	**51987**	

Source : WAPDA Power Plan Update, NPP, Planning, Power Wing, WAPDA - October 1996