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PLANNING STRATEGY FOR DEVELOPMENT OF HYDROPOWER IN PAKISTAN

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By

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INTRODUCTION

Per capita energy consumption of 243 kwh per annum of electricity in Pakistan is about 1/48th of United States, 1/9th of the World average and half of the developing countries.

The generation capacity in June 1988 for supply to the national grid was 5967 MW comprising 2888 MW of hydropower (48%), 3079 MW from fossil fuels (50%) and 2% from the lone nuclear reactor KANUPP. In addition there are some generation units serving isolated networks in remote areas, specifically in the Northern areas and Azad Jammu & Kashmir. The installed capacity was barely 37 MW at the time of independence in 1947. It had risen to 119 MW in 1959 when WAPDA came into in to being.

During the past few years demand for electricity has risen tremendously owning largely to pace of industrialization, mechanised farming, rural electrification and above all fast changing pattern of domestic consumption both in rural and urban areas. From fiscal year 1982/83 to 1986/87 energy generated in the WAPDA interconnected system increased from 17500 gwh to 23,700 gwh, an average annual increas of 7.8%. The 23700 gwh produced included 15,300 gwh (65%) hydro and 8400 gwh (35%) thermal.

Table-1 shows all existing generation stations supplying the national grid in 1987/88 with available capacities during various months. There is at present a certain deficit in generating capacity, especially in dry months and load sharing becomes necessary. According to WAPDA's plans this will be gradually improved during the 7th Plan (1987/88 - 1992/93) Table-2.

The short term plan relies largely on thermal generation (65%) which are quicker to install and requires lesser initial capital outlays. This obviously is the only choice in view of the time constraint. However, this cannot be the ultimate solution, since it has the drawback of requiring fossil fuels which are available in limited quantities in the country. Almost 60-65% of the petroleum product requirement is imported which expends major part of our export earnings.

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This will result in increased operating costs affecting correspondingly the industrial and agricultural costs. Development of nuclear power, on the other hand has its own implications in so far as technical and financial assistance is concerned, although it is the ultimate answer to the future energy needs of this country.

OBJECTIVE

Taking the demand increase of about 12% per annum the projected requirement at the turn of the century exceeds 14000 MW. Inspite of our limitations at the present stage, it should be endeavoured to increase the share of hydropower in the energy mix as much as possible or at least keep it at the present level and have the optimum benefit of cheaper hydel generation.

HYDROPOWER POTENTIAL

The country's total identified hydel potential is estimated at around 30,000 MW on the main rivers. Additionally, substantial amount of hydel potential is also available outside the main river valleys in the northern mountaneous regions including AJ&K which has not been investigated so far.

In the past (before 80's) there was no systematic planning and investigation for exploitation of hydel potential, with the exception of:

sporadic project investigation in the 60's and early 70's investigation for big dams.

First effort towards systematic exploitation of hydel potential was made in 1981-83 by scheming an Inventory and Ranking Study of Major Hydels by WAPDA. According to this study after the Kalabagh (3600 MW), other big prospective projects are located in the upper reaches of rivers particularly Indus. Indus river beyond Tarbela was so far considered to be inaccessible but with the construction of Kara Korrum Highway (KKH), new vistas of development have been thrown open. According to the study Basha Dam (3360 MW) located 195 miles upstream of Tarbela has been ranked after Kalabagh. Given the resources, it should reach the take off stage in about a decade and completion in early next century. This should be followed by Dasu (2712 MW) located 43 miles downstream of Basha, Bunji (1290 MW) 70 miles upstream of Basha, Thakot (2415 MW) 68 miles downstream of Dasu and a score of other projects (Table 3)

WAPDA has carried out a Ranking Study of ten (10) identified sites to develop low head hydel potentials at barrages and canal falls in the Indus plains. This has resulted in projects at Chashma barrage (270 MW), Taunsa barrage (108 MW), Jinnah barrage (144 MW) and 6 smaller projects (total another 120 MW) in the first instance, (Table 4).

CONSTRAINTS

Long Construction Period

Large hydel projects are long gestation projects; it takes almost a decade to plan and investigate and antoher decade to fully develop, given the financial and manpower resources.

High Capital Cost

Large hydel projects are high capital intensive. A developing country like Pakistan with limited financial resources cannot possibly conceive of undertaking more than one super project a time with long term investment.

Dependence on Seasonal Variation in River Flows

Hydel plants are subject to wider seasonal variations. This is a universal phenomenon but is more pronounced in this part of the world. Ratio of maximum and normal high discharge is about 1:30 of our rivers. The large reservoirs at Tarbela and Mangla have mitigated the seasonal variation to some extent but not adequately because primarily these dams are built for irrigation. During the months of December and January, the reservoirs may have some releasable surplus at least with some adjustment in the release pattern, but flows downstream of Mangla and Tarbela are drastically reduced because of limited irrigation demands. This is the period when crop requirement is minimal and the canals are closed for annual maintenance. The hydel power generation in December and January is, therefore, the lowest and has to be supplemented with thermal power if load shedding is to be avoided. Secondly, the river Indus is a late riser. As a result, Tarbela reservoir goes on depleting till as late as June bringing the head pond level to a minimum of 1300 ft. SPD from the normal maximum operating level of 1550 ft. As a consequence, the power production goes down to almost 25% of the rated capacity. In the absence of thermal substitute, this results in a critical power shortage on the system from April to June, with wide load shedding.

PLANNING STRATEGY

To cater for future national demand and needs of isolated areas continuous efforts should be made to plan different categories of hydel projects; super, medium and small and have these schemes ready for implementation according to the availability of resources and socio-environmental considerations at the time.

As for the short comings of hydel power, it would be an ideal arrangement if these could be overcome by planning suitable hydel developments.

Following are some of the possible solutions:

Large hydroelectric projects should be built at regular intervals. With storage power projects are also otherwise necessary to replace the existing reservoirs built primarily for irrigation which are continuously depleting due to sedimentation.

Medium sized projects requiring lower gestation period as well as lower capital cost should be investigated and developed as early as possible to take the place of thermal projects.

Hydel Stations with the peculiar characteristic of generating more power during April to June should be identified and developed.

Balancing or or re-regulation reservoirs should be developed to maximise releases from Tarbela during December and January irrespective of irrigation restriction.

Small hydels should be constructed to serve isolated areas not connected with the national grid.

PLAN OF DEVELOPMENT

WAPDA is conscious of these aspects and has been engaged in planning and investigating of hydel projects with the requisite characteristics. Following are the major cases in point.

TARBELA EXTENSION (UNITS 11-14)

In order to maximise power generation from Tarbela dam it is now planned to install four (4) units of 432 MW capacity each on Tunnel 3 raising the ultimate power potentials of the project from 2100 MW to 3500 MW.

MANGLA EXTENSION (UNITS 9-10)

The extension project envisages installation of power units 9 and 10 of 100 MW each thus raising the total installed capaicty from 800 MW to 1000 MW.

KALABAGH

Kalabagh is vitally important because it will not only be a reservoir for firming up its own power plant capacity but also act as a substitutive reservoir for Tarbela to raise its operating head pond from 1300 to 1390 ft. SPD for the period April to June. Furthermore, it will act as a balancing or regulation reservoir to allow maximum possible releases from Tarbela in December and January (depending on the releaseable surplus of Tarbela Storage) irrespective of irrigation restriction. The usefulness of the proposed development at Tarbela of 4750 MW with 17 Units would be adversely affected, if Kalabagh is delayed, leave alone the direct power benefit of Kalabagh.

BASHA

Basha is important not only as a key reservoir project (7.5 MAF) to supplement water storage and generate power but also to act as substitutive storage for Tarbela raising the minimum drawdown level to 1500 ft. SPD, thereby maximising its power benefits. Similarly, Basha would provide water during December and January commensurate with its releaseable surplus, irrespective of the irrigation restriction to be controlled at Kalabagh. Basha will follow Kalabagh into the early next century.

LOW HYDELS

Chashma (270 MW), Jinnah (144 MW), Taunsa (108 MW) and Guddu Barrage (50 MW), Low Head Hydel Projects are low gestation medium size projects which will take full advantage of the firmed up flow in the Indus at Tarbela and Kalabagh and its contribution especially during April to June would be very useful.

GHAZI GARIALA

Ghazi Gariala Hydropower Project with a proposed capacity of about 750-1000 MW will be a relatively low gestation project. With a small proposed pondage it will absorb diurnal fluctuations downstream of Tarbela. Secondly, it will have the peculiar feature of providing more power when generation at Tarbela and Kalabagh is the lowest. It will do so by taking full advantage of the additional head with Kalabagh drawdown to 825 SPD from April to June. The contribution of this project is particularly in April to June.

KOHALA

Jhelum, a major river is an early riser and a hydel project thereon of sizeable energy yield could be of great relief. A 500 MW scheme is conceived using a drop of 570 ft by short circuiting of the Domel bend near Muzaffarabad through six miles long tunnels, ultimately the capacity of this station could be doubled on the diversion of Neelum through a tunnel upstream of the Kohala intake.

NEELUM-JHELUM

In order to harness hydro power potential of the Neelum river (a tributary of the Jhelum), two independent/complimentary schemes are envisaged. The first proposal envisages connecting the Neelum with the Jhelum by means of 16 km long tunnels, thus creating a drop of 700 ft which would produce upto 700 MW. The scheme could also double the power generation capacity of hydel station planned downstream at Kohala from 500 MW to 1000 MW.

The second scheme envisages contructing a dam near Dudhnial about 15 miles upstream of Domel to generate hydel power.

ALLAI KHWAR

The Project is located in Kohistan area of NWFP near Besham Qilla. It would divert water of Allai Khwar, a tributary of Indus through a shaft penstock utilizing a head of 2460 ft and generate 120 MW in the 1st phase raising it to 180 MW ultimately.

PARRI

An 18 MW multipurpose hydel scheme has been identified along Sai Nullah near village Parri, about 35 km east of Gilgit town. A drop of 2200 ft is available for generation of power for the use of Gilgit Area. In addition to power generation, the scheme also will irrigate about 12000 acres of virgin land.

GOMAL ZAM

This is multipurpose project which in addition to flood control and irrigation of 100,000 acres of land produces power generation at an installed capacity of 115 MW for four hours. This

scheme consists of construction of 443 ft high concrete dam at Khajuri Kach in south Waziristan and construction of a 4 miles long supply tunnel with a drop of 880 ft to feed a power house having an installed capacity of 115 MW.

COMPREHENSIVE PLANNING IN NORTHERN AREAS INCLUDING AJ&K FOR MEDIUM/SMALL HYDELS

10 percent of the population is residing in far flung areas in the mountaneous north of the country. It is not economical to serve them from the national grid. Through local development of small hydels these areas can be served better.

Comprehensive master planning study should be undertaken in the northern mountaneous regions of Pakistan out side the main Indus valley for development of high head hydels with or without small storage at high altitude. This will result in small and medium size schemes. Small hydels can be developed for the benefits of local population whereas medium size stations nearest to the national grid would be connected to it to meet the national need. Presently development of small hydels is undertaken sporadically to serve different areas.

CONCLUSION

Graphic projection of present and future Peak hydro Power Generation (Fig 1) depicts the proposed hydroelectric power development strategy for the next two decades. Over 8000 MW of hydropower can be added to the system by the turn of the century. It demonstrates adequately the effects of various future proposed or conceptual developments on the monthly generation scenario. On one hand, it incorporates medium sized low gestation schemes into the large development of Kalabagh and Basha, on the other, it overcomes the shortcomings of seasonal variation in river flows to a great extent. The gap between maximum and minimum generation capability will be reduced from 45% to 30%. It will only be then that the requirement of thermal generation for meeting the seasonal deficiency though unavoidable could be minimized and the system will have the optimum benefit of cheaper hydel generation.

TABLE 1

EXISTING GENERATION FACILITIES

Figures in MW

Station Name	August	October	December	February	April	June
Tarbela	2000 (10)	1770 (10)	1620 (10)	1250 (10)	670 (10)	630 (10)
Mangla	920 (8)	800 (8)	656 (8)	464 (8)	544 (8)	320 (8)
Warsak	240 (6)	120 (6)	80 (6)	80 (6)	240 (6)	240 (6)
Low Head Hydels	70 (28)	65 (28)	50 (28)	50 (28)	70 (28)	70 (28)
Hydel Totals	3230	2755	2406	1844	1524	1260
Multan	106 (2)	106 (2)	106 (2)	106 (2)	106 (2)	106 (2)
Faisalabad	120 (2)	120 (2)	120 (2)	120 (2)	120 (2)	120 (2)
Guddu Steam	570 (4)	570 (4)	570 (4)	570 (4)	570 (4)	570 (4)
Sukkur	40 (4)	40 (4)	40 (4)	40 (4)	40 (4)	40 (4)
Hyderabad	30 (4)	30 (4)	30 (4)	30 (4)	30 (4)	30 (4)
Quetta	8 (2)	8 (2)	8 (2)	8 (2)	8 (2)	8 (2)
C.C. at Guddu	0 (0)	0 (0)	0 (0)	568 (6)	556 (6)	544 (6)
Repco & Mesco	29 (6)	29 (6)	29 (6)	29 (6)	29 (6)	29 (6)
Kesc Steam	811 (8)	811 (8)	811 (8)	811 (8)	811 (8)	811 (8)
Steam Totals	1714	1714	1714	2282	2270	2258
Shahdara	70 (6)	70 (6)	70 (6)	70 (6)	70 (6)	70 (6)
Faisalabad	192 (8)	192 (8)	192 (8)	192 (8)	192 (8)	192 (8)
Kotri	111 (6)	111 (6)	111 (6)	111 (6)	111 (6)	111 (6)
Quetta	54 (4)	54 (4)	54 (4)	54 (4)	54 (4)	54 (4)
Guddu Gas Turbines	344 (4)	356 (4)	368 (4)	0 (0)	0 (0)	0 (0)
Kotaddu Com. Turb.	344 (4)	356 (4)	368 (4)	368 (4)	356 (4)	344 (4)
Kesc Gas	180 (9)	180 (9)	180 (9)	180 (9)	180 (9)	180 (9)
Gas Totals	1295	1319	1343	975	963	951
Kanupp	70 (1)	70 (1)	70 (1)	70 (1)	70 (1)	70 (1)
Nuclear Totals	70	70	70	70	70	70
Thermal Totals	3079	3103	3127	3327	3303	3279
Total Gen. Capability	6309	5858	5533	5171	4827	5139
Peak Demand	5395	5424	5594	5594	5477	5877
Surplus/Deficit	914	434	-61	-423	-650	-738
Spinning Reserves	400	378	362	325	267	263
Maintenance Reserves	735	735	488	366	202	115
Firm Gen. Capability	5174	4745	4683	4480	4358	4761
Net Surplus/Deficit	-221	-679	-911	-1114	1119	-1116

TABLE 2

PLANNED GENERATION FACILITIES
DURING 7TH PLAN PERIOD (1987-88 TO 1992-93)

Power Plant		Capacity (MW)
Tarbela	11-14	4 x 432
Mangla	9-10	2 x 100
Chashma	1-12	12 x 22.5
Taunsa	1- 3	3 x 20
	Total Hydro	2,258
Jamshoro	1	250
Jamshoro	2-4	3 x 210
Jamshoro	5-7	3 x 350
Multan	5-7	3 x 210
Lacra	1-3	3 x 150
Nanpour	1-2	2 x 100
	Total Steam	2,976
	Gas	600
	Com. Cycle	580
	Total	6,414

TABLE-3

FINAL RANKING OF QUALIFYING SCHEMES (AFTER BASHA)

Rank	Scheme	Index Capacity MW	Primary Energy GWh/a	Secondary Energy GWh/a
1.	Dasu	2712	12181	4600
2.	Bunji	1290	5793	2492
3.	High Thakot	2415	15972	2137
4.	Low Thakot	1043	6897	923
5.	Patan	1172	7577	1119

TABLE - 4

RANKING OF LOW HEAD HYDROPOWER POTENTIAL AT BARRAGE AND CANAL FALLS

Rank	Scheme	River	Index Capacity (MW)	Energy Potential (Gwh)
Barrages				
1.	Chashma	Indus	270	1260
2.	Taunsa	Indus	108	
3.	Jinnah	Indus	14	
4.	Guddu	Indus	51	269
Canal/Links				
1.	C-J Link Tail		40	311
2.	Rohri RD-15 Rohri RD-117		12	
3.	B.S.Link I (RD 106)		9	71
4.	B.S.Link Tail		6	46
		Total:	640	

POSSIBLE HYDRO POWER DEVELOPMENT BY YEAR 2002/3

