

RENEWABLE ENERGY RESOURCES OF PAKISTAN

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Geographical location of Pakistan

Renewable Energy (RE) Resources in Pakistan

- Energy and water are the prime movers of human life. Though deficient in oil and gas, Pakistan has abundant water and other energy sources like hydropower (hydel) power, coal, wind and solar power.
- Potential of Renewable Energy (RE) resources in Pakistan:
 - Wind Power Potential 350,000 MW
 - Solar Power Potential 600,000 MW
 - Hydro Power Potential 59,000 MW
 - Tidal Power Potential Not Estimated
- **Estimated RE Potential over 1,000,000 MW**

Source: AVM (R) S. J. RAZA, (2010)

Share of Hydropower in Pakistan

- National demand of electricity has been and would keep on growing rapidly.

Sr. No.	Year	Hydel: Thermal Mix	Remarks
1	1960	44:56	
2	1970	50:50	Ideal for Economic Development of the Country
3	1980	58:42	
4	1985	67:33	
5	1990	45:55	
6	2000	33:67	
7	2005	37:63	
8	2008	33:67	
9	2011	31:69	

Based on the present generation capacity, the hydel:thermal mix is 31:69, which is almost the reverse of an ideal hydel:thermal mix, which should be 70:30 for overall economic development of the Pakistan

Renewable Energy (RE) Resources in Pakistan

Forecast of energy supply and demand in Pakistan.

Source: Power Generation from Sugar mills, evolving a business model, 2010.

History of Hydropower in Pakistan

- When Pakistan got independence in 1947, it inherited only **60MW** generation capacity for its 31.5 million people.
- 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 1331MW in 1975, with setting up of a number of hydro and thermal power units.
- In the year 1980, the system capacity touched 3000MW and thereafter it rapidly grew to over 7000MW in 1990-1991.
- During the last decade and a half, the installed capacity has more than doubled, with both thermal and hydropower playing their part. The electricity generation capacity in the country has risen to **19,547MW** now, out of which 7707MW is through Independent Power Producers.
- The addition of 1450MW capacity during 2001-2005 through the Ghazi Brotha hydropower project has resulted in change in the hydro/thermal ratio from 0.40 in 2001 to 0.53 in 2006

Source: Mirza et al., (2008)

History of Hydropower in Pakistan

- Despite all this progress, the per capita electricity consumption stands at 571 kWh per capita, which is less than one-fifth of the world average (2465kWh per capita).
- The electricity demand grown with an annual compound growth rate of 7.9% during the Medium Term Development Framework 2005–2010 of the Government of Pakistan (GoP).

Source: Mirza et al., (2008)

Projections of Demand Installed Capacity in Pakistan

Source: WAPDA, 2011

Electricity Consumption by Various Countries of the World

*Source: World Atlas & Industry Guide 2007
The International Journal on Hydropower & Dams*

Existing Installed Generation Capacity

A comparison of power generation in Pakistan

Source: WAPDA, 2011

Hydropower Potential of Pakistan

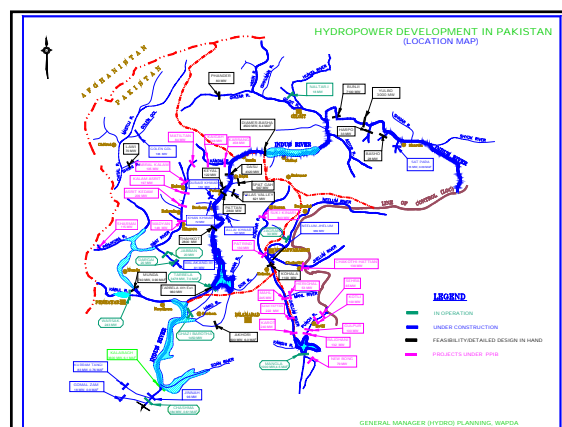
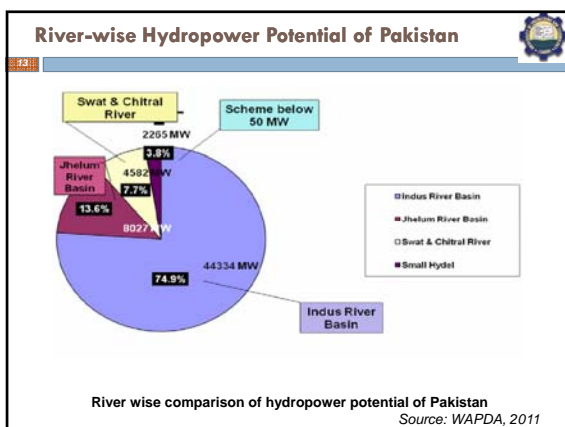
- Pakistan is blessed with over 100,000 MW of hydropower potential with identified sites of 59000 MW.
- Most of these sites lies in KPK, Northern Areas, Azad Jammu & Kashmir and Punjab.
- So far only about 10-15% of this potential has been harnessed and 8–10% is under various stages of development. Thus, around 75-80% of the potential remains un-exploited.

Hydropower Potential of Pakistan

Summary: River-wise Hydropower Potential of Pakistan

Sr. No.	River/ Tributary	Power (MW)
A. Hydropower Projects above 50 MW		
1	Indus River	38608
2	Tributaries of Indus in Gilgit-Baltistan	1698
3	Tributaries of Indus in Khyber-Pakhtunkhwa	4028
Sub Total (1-3)		44334
4	Jhelum River	4341
5	Kunhar River	1455
6	Neelum River & its Tributaries	1769
7	Poonch River	462
Sub Total (4-7)		8027
8	Swat River & its Tributaries	2297
9	Chitral River & its Tributaries	2285
Sub Total (8-9)		4582
Total A		56943
B. Hydropower Projects below 50 MW		
1	On Tributaries	1591
2	On Canals	674
Total B		2265
TOTAL (A+B)		59208

Source: WAPDA, 2011



Hydropower Stations (in Operation with WAPDA)

Sr. No.	Project	Installed Capacity (MW)	Energy Generation (GWh)	Commercial Operation Date
1	Tarbela	3478	15801	1977-93
2	Mangla	1000	5443	1967-94
3	Warsak	243	1009	1960-81
4	Ghazi Barotha	1450	7037	2003-04
5	Chashma Low Head	184	959	2001
6	Rasul	22	63	1952
7	Dargai	20	162	1952
8	Jabban*	20	155	1938-52
9	Nandipur	14	32	1963
10	Chichoki Mallian	13.2	23	1959
11	Shadiwal	13.5	38	1961
12	Others	6	29	1925-82
TOTAL		6464	30751	

* Under Rehabilitation

Hydropower Projects (under construction with WAPDA)

Sr. No.	Name of Project	River	Location	Capacity (MW)	Energy Generation (GWh)
1.	Khan Khwar	Khan Khwar	Besham – NWFP	72	275
2.	Allai Khwar	Allai Khwar	Batgram – NWFP	121	450
3.	Duber Khwar	Duber Khwar	Pattan – NWFP	130	590
4.	Satpara	Satpara	Skardu – NWFP	16	105
5.	Gomal Zam	Gomal	Waziristan – NWFP	18	90
6.	Jinnah	Indus	Kalabagh – Punjab	96	688
7.	Neelum Jhelum	Neelum	Muzaffarabad – AJK	969	5150
8.	Kurram Tangi	Kurram	North Waziristan	83	383
9.	Golen Gol	Golen Gol	Chitral	106	436
10.	Diamer Basha	Indus	Chilas Northern Area	4500	16700
TOTAL				6111	24867

Hydropower Projects (Ready for construction)

Sr. No.	Name of Project	River	Location	Capacity (MW)
1.	Kala Bagh	Indus	Kala Bagh	3600
2.	Munda Dam	Swat	Mohmand Agency	740
3.	Akhori	Indus	Attock	600
TOTAL				4940

Hydropower Projects under Studies by WAPDA

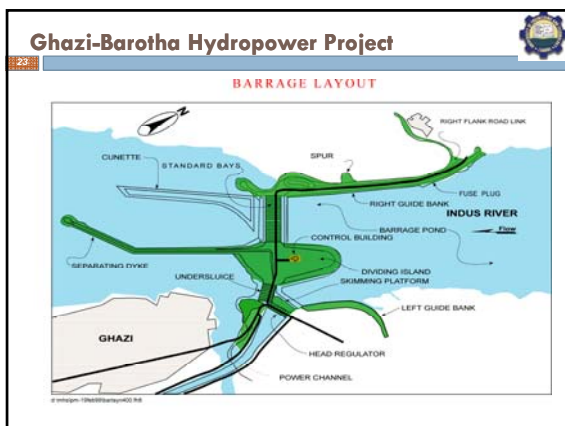
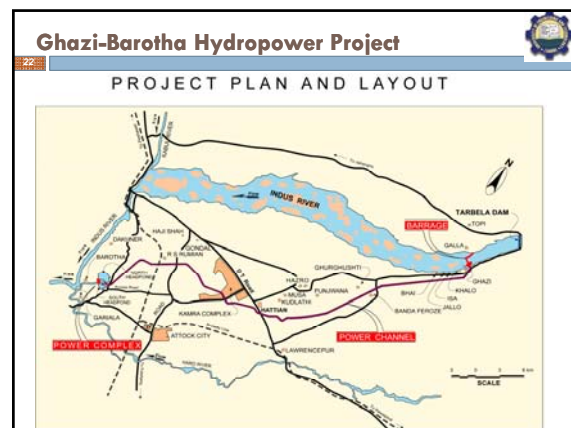
Sr. No.	Project	River	Location	Installed Capacity (MW)	Energy (GWh)	Approx Project Construction Cost (Million US\$)	Status/ Study Completion
1	Tarbela 4 th Ext.	Indus	Tarbela	960	1600	750	World Bank has been requested to fund for design & implementation of the Project.
2	Kohala	Jhelum	Kohala	1100	4800	3032.493	Feasibility study completed. Detailed Design and Tender Documents in progress/ Aug 2009. PPiB has issued LOI to China International Water and Electric Power Company (CWE) on 15.01.2009.
3	Dasu	Indus	Dasu	4320	21300	8486.295	Feasibility study completed. RFP issued to pre-qualified Firms for Detailed Design and Tender Documents for submission by 08.09.2009.
4	Bunji	Indus	Gilgit	7100	24088	12142.118	Detailed Design and Tender Documents in progress/ Aug. 2010
5	Phandar	Ghizar	Gilgit	80	350	70	Feasibility study completed. Evaluation of Technical Proposal by pre-qualified Firms for Detailed Design and Tender Documents in progress.
6	Lower Palas Valley	Chor Nullah	Pattan	621	2448	667	Feasibility study in progress/ Nov. 2009
7	Lower Spat Gah	Spat Gah	Pattan	567	2189	614	Feasibility study in progress/ Oct. 2009

Hydropower Projects under Studies by WAPDA (Conti...)

Sr. No.	Project	River	Location	Installed Capacity (MW)	Energy (GWh)	Approx Project Construct on Cost (Million US\$)	Status/ Study Completion
8	Basho	Basho	Skardu	28	135	49.122	Feasibility study completed. RFP is being issued to pre-qualified Firms for Detailed Design and Tender Documents.
9	Keyal Khwar	Keyal Khwar	Patan	122	426	180	Feasibility study completed. Evaluation of Technical Proposal by pre-qualified Firms for Detailed Design and Tender Documents is under process for approval.
10	Lawi	Shishi	Darosh-Chitral	70	303	120	Feasibility study completed. PC-I for Detailed Design, Tender Documents and project construction is under process for approval.
11	Harpo Lungma	Harpo Lungma	Skardu	33	187	45.403	Feasibility study completed. EOI for pre-qualification of Consultants for Detailed Design & Tender Documents being evaluated.
12	Thakot	Indus	Thakot	2800	14095	6000	PC-II for Feasibility study submitted to MOW&P for approval by the Planning Commission.
13	Patan	Indus	Patan	2800	15230	6000	PC-II for Feasibility study submitted to MOW&P for approval by the Planning Commission.
14	Yulbo	Indus	Skardu	3000	12500	6000	Desk study and field reconnaissance initiated by Hydro Planning Organization, WAPDA
TOTAL				23601	99651		

Hydropower Schemes utilized in Pakistan

- Run-of-river schemes
- Schemes with the powerhouse located at the base of a dam
- Schemes integrated on canal or in a water supply pipe



PRINCIPAL DATA

BARRAGE

Live Storage Volume	62 million cu m (50,000 Acre Feet)
Design Flood Capacity	18,700 cumecs (660,000 cusecs)
Survival Flood Capacity	46,200 cumecs (1,630,000 cusecs)

POWER CHANNEL

Design Flow	1,600 cumecs (56,500 cusecs)
Length	52 Km
Full Supply Depth	9.0 m
Bed Width	58.4 m
Lining Thickness	135 mm
Total Excavation	76 million cu m

Structures

Crossings	48
Superpassages	27
Drainage Inlets	24
Escapes	5
Culvert	1

POWER COMPLEX

Headponds & Forebay Live Volume	25.9 million cu m (21,000 Acre Ft)
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POWER HOUSE

Turbines/Generators	5 x 290 MW
Total Generation Capacity	1,450 MW
Annual Average Energy Output	6,600 GWh

Summary & Recommendations

- Pakistan has considerable Renewable Energy Potential:

Need is there to Harness it.

- Hurdles in Development:
 - Socio-Political Concerns
 - Peace and Security in the region
 - Financial Limitations
 - Environmental Concerns

Way Forward

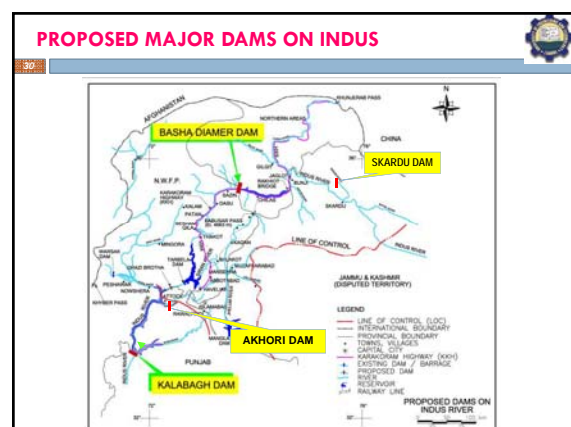
- There is need of:
 - Mutual Cooperation according to true spirit of
 - Indus Basin Treaty (1960), and
 - Water Apportionment Accord (1991)
 - Political Will for DEVELOPMENT Through:
 - Public participation and motivation
 - Resolving provincial and regional issues
 - Policy / Decision making process more effective
 - By Convincing the Funding Institutions for RE Development
 - Peace and Security through: Development
 - Environmental Concerns through: Education and Learning
 - More Investment in this sector can come if **security conditions in the region improve????**

References

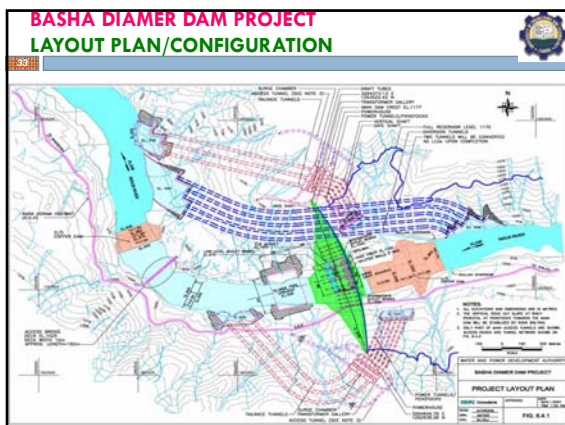
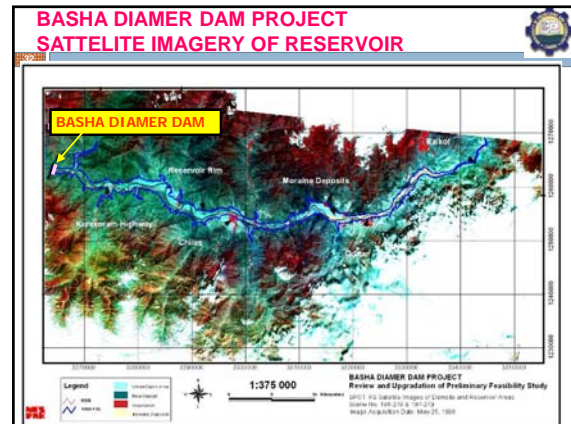
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Thank you for your kind attention.

Few Proposed Hydel Projects
(if time available)



BASHA DIAMER DAM PROJECT

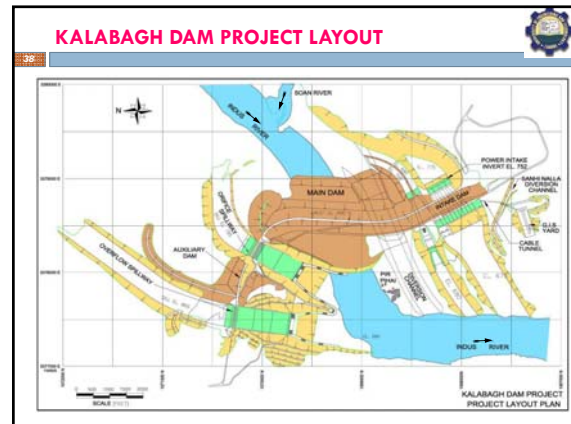
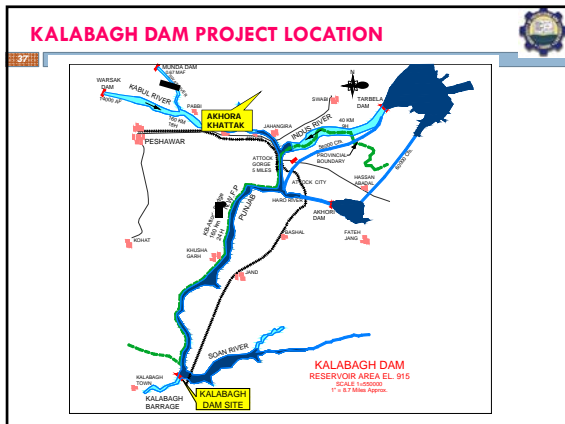


BASHA DIAMER DAM PROJECT SALIENT FEATURES

Sr. No.	DESCRIPTION	CONCRETE GRAVITY DAM AT AXIS-D ROLLER COMPACTED CONCRETE CONSTRUCTION
1.	DIVERSION TUNNELS	5 No. WITH TOTAL LENGTH OF 7.5 Km
2.	COFFER DAMS	55 m HIGH UPSTREAM & 25 m HIGH DOWNSTREAM
3.	MAIN DAM	281 m HIGH, 990 m LONG 12 m, WIDE CREST
4.	RESERVOIR GROSS CAPACITY LIVE CAPACITY FULL RESERVOIR LEVEL	9.04 MAF (11.15 BCM) 7.30 MAF (9.05 BCM) El. 1170 m
5.	MAIN SPILLWAY TYPE DESIGN DISCHARGE	GATE CONTROLLED OGEE CREST 23,700 Cumecs (837,000 Cusecs)
6.	OUTLETS	8 CONDUITS FOR IRRIGATION AND 4 FOR SLUICING
7.	POWERHOUSES LOCATION & TYPE NO. OF UNITS TOTAL INSTALLED CAPACITY	TWO UNDERGROUND, ONE ON EACH BANK 12 UNITS, EACH OF 375 MW (6 ON EACH POWERHOUSE) 4500 MW (16,770 GWh)
8.	ENVIRONMENTAL EFFECT APPROX. POPULATION AFFECTED SUBMERGENCE OF KKH	23,700 (2,850 HOUSEHOLDS) 110 Km

- ### Status of the Diامر Bhasha Dam
- Discussions with Donors going on
 - Detailed investigation at site going on
 - Relocation of KKH is started

KALABAGH DAM PROJECT



KALABAGH DAM PROJECT SALIENT FEATURES

RESERVOIR		
GROSS STORAGE	7.9 MAF	
LIVE STORAGE	6.1 MAF	
RETENTION LEVEL		915 FT
MAIN DAM		
CREST ELEVATION		940 FT.
MAXIMUM HEIGHT		260 FT.
LENGTH		11,000 FT.
SPILLWAYS		
OVERFLOW SPILLWAY	1,070,000 Cusecs	
ORIFICE	980,000 Cusecs	
POWER STATION		
NUMBER OF UNITS	8/12 Nos.	
Initial/Ultimate		
INSTALLED CAPACITY	2,400/3,600 MW	
		(12,400 GWh per year)
ESTIMATED COST (SEPTEMBER 2005)		US \$ 6.1 Billion
NO LOW LEVEL OUTLETS INCLUDED IN PRESENT DESIGN		

Status of Kalabagh Dam

- Held in Abeyance due to disagreement of federation units