Appendix A-3

Unit Data of Power Plants with Commissioning Date

(Thermal Power Plants)

Source: Power System Statistics 2013-2014 39th Edition, NTDC Planning

Appendix A-3:
Installed Generation Capacity (Existing Thermal)

(Source: Power System Statistics 2013-2014 39th Edition, NTDC Planning)

GENCO Projects

(Unit: MW)

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity				Derated Capacity	Fuel Type	
						No.	Capacity	Sub Total	Company Total		Primary	Alternate
	Thermal (Public)											
	GENCO-I											
1.	Jamshoro	Jamshoro	Sindh	Steam	Jan.1990	1 x	250	250	850	180	FO	
					Dec.1989	1 x	200	200		180	Gas	FO
					Jun.1990	1 x	200	200		170	Gas	FO
					Jan.1991	1 x	200	200		170	Gas	FO
2	Kotri	Kotri	Sindh	Gas Turb.	Dec.1969	1 x	15*	0	144	10*	Gas	HSD
					Jan.1970	1 x	15*	0		10*	Gas	HSD
					May.1979	2 x	25	50		40	Gas	HSD
					May.1981	2 x	25	50		40	Gas	HSD
				Comb.Cyc.	Dec.1994	1 x	44	44		40	Gas	
					Sub-Total GENCO-I				**994**	**820**		
	GENCO-II											
3	Guddu	Guddu	Sindh	Steam	Mar.1974	1 x	110	110	2402	50	Gas	FO
					Oct.1974	1 x	110	110		75	Gas	FO
					Nov.1980	1 x	210	210		150	Gas	FO
					Dec.1985	1 x	210	210		150	Gas	FO
				Gas Turb.	Dec 1985	1 x	100	100		75	Gas	
					Mar 1986	1 x	100	100		75	Gas	
					Apr 1986	1 x	100	100		80	Gas	
					Apr 1986	1 x	100	100		75	Gas	
				Comb.Cyc	Dec.1987	1 x	100	100		70	Gas	
					Mar.1988	1 x	100	100		65	Gas	
				Gas Turb.	Sep.1992	1 x	136	136		80	Gas	
					Dec.1992	1 x	136	136		115	Gas	
				Comb.Cyc.	May 1994	1 x	143	143		95	Gas	
				Gas Turb.	Mar.2014	1 x	243	243		243	Gas	
					Apr.2014	1 x	243	243		243	Gas	
				Comb.Cyc.	Jun.2014	1 x	261	261		261	Gas	
4	Sukkur *	Sukkur	Sindh				50	0	0			
5	Quetta	Quetta	Baluchistan	Gas Turb.	Nov.1984			35	35	25	Gas	
					Sub-Total GENCO-II				**2437**	1927		
	GENCO-III											
6	Muzaffargarh	Muzaffargarh	Punjab	Steam	Sep 1993	1 x	210	210	1350	185	Gas	FO
					Mar.1994	1 x	210	210		200	Gas	FO
					Feb.1995	1 x	210	210		160	Gas	FO
					Dec.1997	1 x	200	320		245	Gas	FO
					Feb.1995	1 x	200	200		170	Gas	FO
					Jan.1997	1 x	320	200		170	Gas	FO

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity					Derated Capacity	Fuel Type	
						No.		Capacity	Sub Total	Company Total		Primary	Alternate
7	Faisalabad	Faisalabad	Punjab	Steam	Jun 1967	1	x	66	66	376	50	Gas	FO
					Nov 1967	1	x	66	66		50	Gas	FO
				Gas Turb.	May 1975	2	x	25	50		38	Gas	HSD
					May 1975	2	x	25	50		38	Gas	HSD
					Jul 1975	3	x	25	75		69	Gas	HSD
					Nov 1975	1	x	25	25		23	Gas	HSD
				Comb.Cyc.	Dec 1994	1	x	44	44		42	Gas	
8	Multan	Multan	Punjab	Steam	May.1960	1	x	65*	0	0	30*	Gas	FO
					Jul.1963	1	x	65*	0		30*	Gas	FO
						1	x	65*	0		30*	Gas	FO
9	Shahdara	Shahdara	Punjab	Gas Turb.	Sep 1969	3	x	14.75*	0	0	30*	Gas	HSD
					Sub-Total GENCO-III					**1726**	**1440**		
	GENCO-IV												
10	Lakhra Coal 1-3 **	Lakhra	Sindh	Steam	Jun.1995	1	x	50	50	150	30	Coal	
					Oct.1995	1	x	50	50			Coal	
					Jan.1996	1	x	50	50			Coal	
					Sub-Total GENCO-IV					**150**	**30**		
	GENCO-V												
11	Nandipur	Nandipur	Punjab	Gas Turb.	May 2014	1	x	95	95	95	95	FO	HSD
						1	x	0	0			FO	HSD
						1	x	0	0			FO	HSD
				Comb.Cyc.		1	x	0	0				
					Sub-Total GENCO-V					**95**	**95**		
			Sub-Total Thermal w/o Isolated Gen							**5402**	**4312**		
	ISOLATED-GEN												
1	Pasni	Pasni	Baluchistan	Deisel Engine	1991	4	x	4.25	17	17	11	HSD	
2	Panjgoor	Panjgoor	Baluchistan	Gas Turb.	Jan.1975	1	x	25.00	25	39	16	Gas	HSD
					Jan.1974	1	x	14.00	14		8	Gas	HSD
					Sub-Total Isolated Gen					**56**	**35**		
					Total with Isolated Gen					**5458**	**4347**		

* Retired

* G.M Thermal letter dated 17-09-14

a. NEPRA has excluded NGPS Multan from the Gen.Licence being obsolete & inefficient.

b. NEPRA has excluded GTPS Kotri (2x15 MW) from the Gen.Licence being obsolete & inefficient.

c. NEPRA has not granted Licence to GTPS Shahdara

Thermal IPP Projects

(Unit: MW)

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity					Derated Capacity	Fuel Type	
						No.		Capacity	Sub Total	Company Total		Primary	Alternate
	Thermal (IPP)												
1	Kot Addu	Kot Addu, Muzaffargarh	Punjab	Gas Turb.	Feb-1987	2	x	110	220.0	1638.6	1342.0	Gas	FO/HSD
					Mar-1987	1	x	96	96.0				
					May-1987	1	x	96	96.0				
					Nov-1988	1	x	94.4	94.4				
					Dec-1988	1	x	94.4	94.4				
					Jan-1989	1	x	94.4	94.4				
					Feb-1989	1	x	94.4	94.4				
				Comb.Cyc.	Jan-1991	1	x	112	112.0				
					Mar-1991	1	x	112	112.0				
					Oct-1994	2	x	100	200.0				
				Gas Turb.	Apr-1995	2	x	144	288.0				
					Jan-1997	1	x	137	137.0				
2	HUBCO	HUB	Baluchistan	Steam Turb.	Jul-1996	1	x	323	323.0	1292.0	1200.0	RFO	-
					Sep-1996	1	x	323	323.0				
					Nov-1996	1	x	323	323.0				
					Mar-1997	1	x	323	323.0				
3	KOHINOOR (KEL)	Raiwind near Lahore	Punjab	Deisel Engine	June-1997	8	x	15.68	125.4	131.4	124.0	RFO	-
				Steam		1	x	6	6.0				
4	AES Lalpir	Mahmoodkot, Muzaffargarh	Punjab	Steam	Nov-1997	1	x	362	362.0	362.0	350	RFO	-
5	AES Pak Gen.	Mahmoodkot, Muzaffargarh	Punjab	Steam	Feb-1998	1	x	365	365.0	365.0	349	RFO	
6	SEPCOL	Raiwind near Lahore	Punjab	Deisel Engine	Mar-1999	5	x	23.4	117.0	135.9	110.0	Gas	-
						1	x	18.9	18.9				
7	Habibullah Coastal (HCPC)	Quetta	Baluchistan	Gas Turb.	Sep-1999	3	x	37	111.0	140.0	129.0	Gas	HSD
				Comb.Cyc.		1	x	29	29.0				
8	Rousch	Abdul Hakeem-Khanewal	Punjab	Gas Turb.	Dec-1999	2	x	152	304.0	450.0	395.0	Gas	HSD
				Comb.Cyc.		1	x	146	146.0				
9	Saba Power	Farooqabad-Sheikhura	Punjab	Steam	Dec-1999	1	x	134	134.0	134.0	126	RFO	-
10	Fauji Kabirwala	Kabirwala-Khanewal	Punjab	Gas Turb.	Apr-2000	2	x	48.8	97.6	157.0	151.0	Gas	HSD
				Comb.Cyc.		1	x	59.4	59.4				
11	Japan Power	Raiwind Lahore	Punjab	Deisel Engine	Mar-2000	24	x	5.625	135.0	135.0	107	RFO	-
12	Uch Power	Dera Murad Jamali	Baluchistan	Gas Turb.	Oct-2000	3	x	130	390.0	586.0	551.0	Gas	HSD
				Comb.Cyc.		1	x	196	196.0				
13	Altern Energy Ltd.	Fatehjang-Attock	Punjab	Gas Engine	Jun-2001	3	x	10.3	31.0	31.0	27	Gas	-
14	TNB Liberty Power	Dharki	Sindh	Gas Turb.	Sep-2001	1	x	156	156.0	235.0	212.0	Gas	HSD
				Comb.Cyc.		1	x	79	79.0				
15	Attock Gen Ltd(AGL)	Rawalpindi	Punjab	D.G.Sets	Mar-2009	9	x	17.0	153.3	165.3	156.2	RFO	-
				Steam Turb.		1	x	12.0	12.0				
16	Atlas Power	Sheikhupura	Punjab	Reci.Engine	Dec-2009	11	x	18.4	202.7	219.2	213.9	RFO	-
				Steam Turb.		1	x	16.5	16.5				

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity					Derated Capacity	Fuel Type	
						No.		Capacity		Sub Total	Company Total		Primary	Alternate
17	Nishat Power	Multan Rd.,Lahore	Punjab	Reci.Engine	June-2010	11	x	17.1		187.8	202.1	195.3	RFO	-
				Steam Turb.		1	x	14.3		14.3				
18	Orient Power	Baloki	Punjab	Gas Turb.	May-2010	2	x	75.8		151.6	229.1	212.7	Gas	HSD
				Steam Turb.		1	x	77.5		77.5				
19	Engro Energy	Dharki	Sindh	Gas Turb.	Mar-2010	1	x	116.7		116.7	233.4	213.8	Gas	HSD
				Steam Turb.		1	x	116.7		116.7				
20	Saif Power	Sahiwal	Punjab	Gas Turb.	Apr-2010	2	x	75.9		151.8	228.5	205.3	Gas	HSD
				Steam Turb.		1	x	76.7		76.7				
21	Hubco Narowal	Narowal	Punjab	Deisel Engine	Apr-2011	11	x	18.4		202.7	219.2	213.8	RFO	
				Comb.Cyc.		1	x	16.5		16.5				
22	Halmore	Sheikhupura	Punjab	Gas Turb.	Jun-2011	2	x	75.8		151.6	228.6	206.8	Gas	HSD
				Steam Turb.		1	x	77.0		77.0				
23	Saphire	Muridkey	Punjab	Gas Turb.	Oct-2010	2	x	75.8		151.6	228.6	212.1	Gas	HSD
				Steam Turb.		1	x	77.0		77.0				
24	Nishat Chunian	Multan Rd.,Lahore	Punjab	Deisel Engine	Jul-2010	11	x	17.1		187.8	202.1	195.7	RFO	
				Steam Turb.		1	x	14.3		14.3				
25	Liberty PowerTech.	Faisalabad	Punjab	Deisel Engine	Jan-2011	11	x	17.1		187.7	202.0	196.1	RFO	
				Steam Turb.		1	x	14.3		14.3				
26	Foundation Power	Dharki	Sindh	Gas Turb.	May-2011	1	x	114.9		114.9	229.8	178.2	Gas	
				Steam Turb.		1	x	114.9		114.9				
27	Uch Power - II					1	x	386.2		386.2	386.2	380.8	Gas	

Note The rental power plant worked upto October 2011 and thereafter stopped as per Court orders

Appendix A-4

Photographs (Thermal Power Plants)

Power Station Name
Bin Qasim Power Station (K-Electric)

Site Visit Date
06 Nov. 2014

Photo 1-1 Main Building from entrance gate

Photo 1-2 The drum level instrument

Photo 1-3 No.1 Turbine form the top side

Photo 1-4 No.1 Turbine protection switches

Photo 1-5 Intake of cooling water

Photo 1-6 The console desk for Unit No.1

Comment for Bin Qasim power station

Main equipments and protection switches are maintained properly. The up-gradation for life time extension is also carried out by own planning and own budget.

Therefore this power station is reliable to the future.

Power Station Name
Muzaffargah Power Station (GENCO III)

Site Visit Date
10 Nov. 2014

Photo 2-1 Full view of the power station

Photo 2-2 Unit no.1 turbine generator

Photo 2-3 Plant console desk for unit No.4

Photo 2-4 Exhaust gas duct

Photo 2-5 Condenser cooling tower

Photo 2-6 water spread plate made by asbestos

Comment for Muzaffargah power station

Large scale rehabilitation was carried out by USAID. However more main parts are necessary to replace. And It can not be said to be sufficient for maintenance on the whole.

Power Station Name
Guddu Power Station New Plant (GENCO II)

Site Visit Date
25 Nov. 2014

Photo 3-1 Facility of gas turbine and HRST

Photo 3-2 Steam turbine and generator

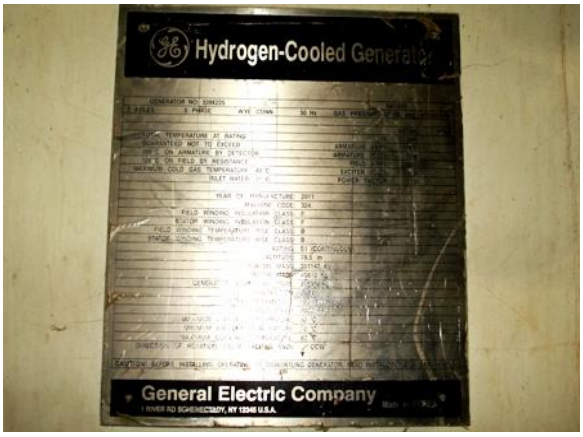

Photo 3-3 Nameplate of Generator

Photo 3-4 Control room for new plant

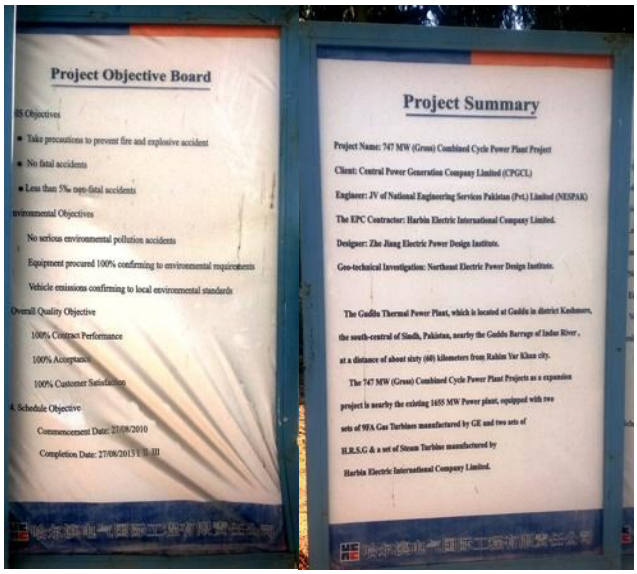

Photo 3-5 Project information board

Comment for Guddu new project

According to the information board, EPC contractor is Harbin Electric international Ltd.. However gas turbine and steam generator is supplied GE in Korea. Harbin Electric International is only supplied HRST and Steam Turbine. It was written with completion date is 27 Aug. 2013. Therefore the project is more than one year.

Power Station Name
Guddu Power Station Existing Plant (GENCO II)

Site Visit Date
25 Nov. 2014

Photo 3-6 Turbine Generator supplied by Czech

Photo 3-7 Steam boiler (left) and Stack

Photo 3-8 Heat insulation for steam pipe

Photo 3-9 Boiler top and Drum

Photo 3-10 Console desk

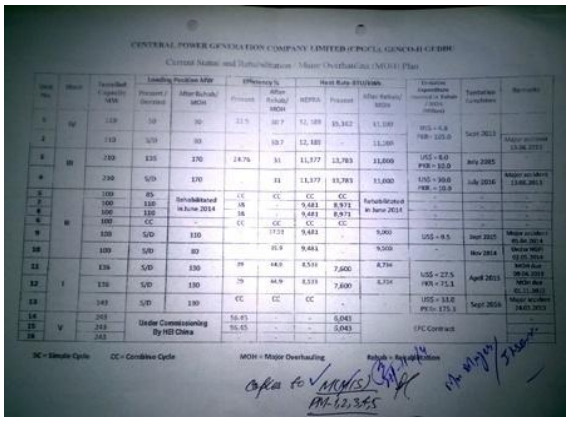

Photo 3-11Current status and Maintenance Plan

Comment for Guddu existing project

It seems all of Units are deteriorate. According to the current status and maintenance plan (refer photo 3-11) , large scale rehabilitation will be carried out till FY 2016 supported by USAID. The heat rate of Unit No.1 to No.4 are more than 20%. However after rehabilitation it will be 11000 BTU/kWh and reduced for NEPRA determination.

Power Station Name
Rousch Power Station (IPP)

Site Visit Date
20 Nov. 2014

Photo 4-1HRSG and stacks

Photo 4-2 Steam turbine generator

Photo 4-3 Gas turbine generator

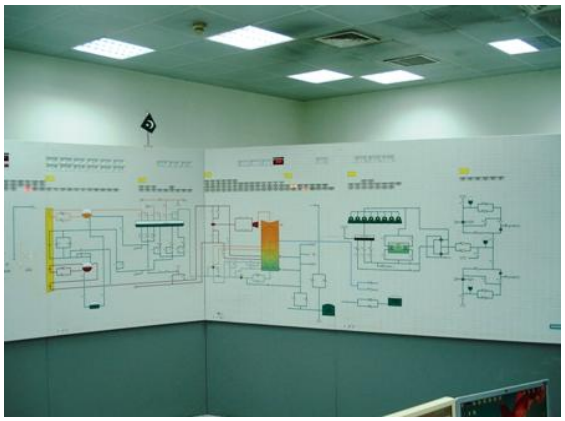

Photo 4-4Monitor board for HRSG

Photo 4-5 Dealing integrating wattmeter

Photo 4-6 Safety notice Board

Comment for Rousch power station

This plant has completed its Life Time Extension (LTE) in June 2012 where whole plant was totally overhauled. Installed capacity is 450 MW at ISO Conditions. Dependable Capacity was 395 MW and this is also contracted capacity as per PPA. Thermal Efficiency normally remains in the range of 47.6% to 47.9% with a maximum of 49%.

Power Station Name
Kot Addu Power Station (IPP)

Site Visit Date
22 Nov. 2014

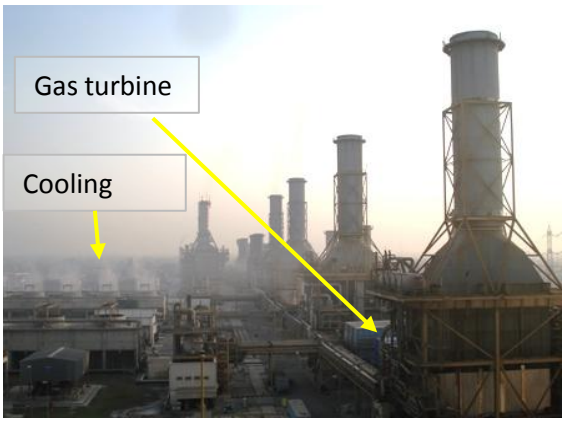

Photo 5-1 Full view of plants

Photo 5-2 Steam turbine building (front)

Photo 5-3 Operator console desk

Photo 5-4 Online operation monitor

Photo 5-5 Cooling towers and oil tanks

Photo 5-6 Gas turbine combustor

Comment for kot addu power station

LSFO is treated for removal of impurity through mechanical process. Only Vanadium is removed through chemical injection. They have 5 LSFO treatment units in operation while 6th unit is under construction. Online monitor for load, heat rate and efficiency. is good management system for generation cost.

Power Station Name
AES Lalpir & Pak Gen Power Station (IPP)

Site Visit Date
21Nov. 2014

Photo 6-1 Full view of the power station

Photo 6-2 Turbine generator

Photo 6-3Generator

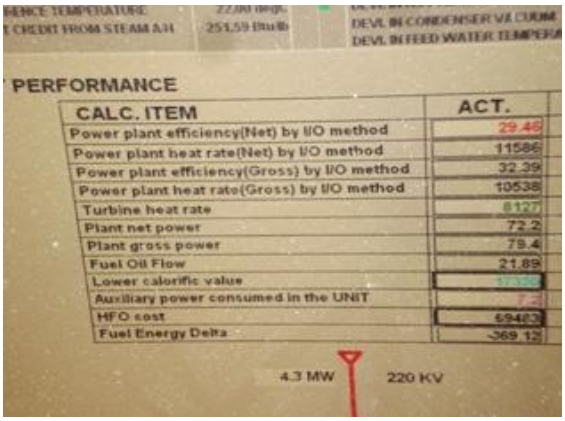

Photo 6-4 Online operation monitor

Photo 6-5 Flue gas de-sulfurization system

Photo 6-6 Drum area

Comment for AES Lalpir & PakGen power station

De-sulfurization Equipment was installed for only PakGen Plant. However Panjab-EPA requirement is to keep the emissions less than 500 tons/day. The emissions are within EPA limits without using the De-sulfurization Equipment. Punjab-EPA visits their plants on regular intervals to ensure the emissions are kept within limits. The plant O&M condition is kept properly.

Power Station Name
Narowal (IPP)

Site Visit Date
28 Nov. 2014

Photo 7-1 Diesel Engine cylinder top

Photo 7-2 Diesel engine generator

Photo 7-3 Operation monitoring system screen 1

Photo 7-4 Operation monitoring system screen 2

Photo 7-5 Water treatment system by RO

RO; Reverse Osmosis membrane

Photo 7-6 DE from side

Comment for Narowal power station

Narowal power station is adapted 11 unit of Reciprocal Engines generator, and one HRST with combine output. All facility and control system are simplified and an average efficiency of 45% in combined cycle mode. The Operations and Maintenance (O&M) of HNPP is contracted out to Tenaga National Berhad Repair and Maintenance Company (TNB REMACO) for a period of 5 years. It seemed the facility were kept good condition however small oil leak trail was found.

Development Plan Project Site

Photo 8-1 Sahiwal Power Plant Project Site1

Photo 8-2 Sahiwal Power Plant Project Site2

Photo 8-3 Port Qasim Power Plant Site

Comment for the development

Both project are set up on fast track and NTDC is listed the commissioning date on Dec. 2017.

The Sabinal Project did not start ground leveling work, and the Port Qasim Project is suspended in the supreme court of judgment.

Therefore these project will be difficult to construct on schedule.

Appendix B-1

Collected Data Sheet (Hydro Power Plants)

Result of Data Collection (Existing Plant)

Sr. No.	Name of Power Station	Type	Installed Capacity (MW)	Result of Data Collection
	WAPDA			
1	Tarbela	Reservoir	3,478	Collected
2	Mangla	Reservoir	1,000	Collected
3	Ghazi Barotha	Small Reservoir	1,450	Collected
4	Warsak	Reservoir	243	Collected
5	Chashma	Run-of-the-River	184	Collected
6	Allai Khwar	Small Reservoir	121	Collected
7	Jinnah	Run-of-the-River	96	Collected
8-18	Small Hydros[1]	Run-of-the-River	128	Nandipur: Collected Others: Not collected
19	Khan Khwar	Small Reservoir	72	Collected
20	Dubair Khwar	Small Reservoir	130	Collected
	IPPs			
21	Jagran Hydro	Run-of-the-river	30	Not collected
22	Malakand-III Hydro	Run-of-the-river	81	Not collected
23	New Bong Escape	Run-of-the-river	84	Not collected

1 11 Stations: Dargai, Malakand, Rasul, Chichoki-Mallian, Shadiwal, Nandipur, Kurram Garhi, Renala, Chitral, Gomal Zam and Jabban

Other Collected Data (Ongoing Project / Development Plan)

Sr. No.	Name of Power Station	Type	Installed Capacity (MW)	Result of Data Collection
	PPIB (Ongoing Project)			
1	Patrind HPP	Small Reservoir	147	Collected
	PPIB (Development Plan)			
9	Kaigah HPP	Small Reservoir	548	Collected

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

WAPDA Hydel

Tarbela

Nippon Koei Co., Ltd.

Data sheet <FORM-2.1> Large Hydro Power Plant Questionnaire (With Reservoir)

Power Plant Name	Total Installed Capacity
Tarbela	3478 (MW)

Pondage Volume ($10^6 m^3$)	
Total	9,178.32
Effective for generation	7,955.95
Effective for other purposes	1,222.38

Construction Cost	Generating Cost
16,417.35 ($10^6$$)	0.772648 (¢/kWh)

Unit No.	Unit size (MW)	F.O.R (%)	Design Flow (m^3/sec)	Commissioning yy	mm
1	175	3	189.61	1977	4
2	175	3	189.61	1977	4
3	175	3	189.61	1977	6
4	175	3	189.61	1977	7
5	175	3	189.61	1982	8
6	175	3	189.61	1982	10
7	175	3	189.61	1982	10
8	175	3	189.61	1982	12
9	175	3	189.61	1985	2
10	175	3	189.61	1985	4
11	432	3	424.5	1992	5
12	432	3	424.5	1992	7
13	432	3	424.5	1992	11
14	432	3	424.5	1993	2

Reservoir water level (m)		Purpose of limitation, limited period
Flood level	472.44	Project Maximum Water Level, Peak Water Season (Jul-Sep)
High Water Level (HWL)	472.44	Project Maximum Water Level, Peak Water Season (Jul-Sep)
limited water level	472.44	Project Maximum Water Level, Peak Water Season (Jul-Sep)
limited water level	420.62	To avoid sediment transport to storage. Lean Water Period (Dec-Mar)
Low Water Level (LWL)	420.62	To avoid sediment transport to storage. Lean Water Period (Dec-Mar)

Rule Curves of the Reservoir	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Water Level	433.73	429.16	424.89	423.67	434.34	459.64	469.39	472.44	472.44	466.34	452.93	441.66
Minimum Water Level	432.51	422.15	420.62	420.62	420.62	428.55	454.15	466.34	461.47	456.9	445.01	433.12

Scheduled Maintenance plan (intervals and their period) :

Shutdown Units (1-10) each for annual maintenance once every 2 years for a period of 30 days. Units (11-14) are shutdown every year for annual maintenance for a epriod of 30 days. Maintenance carried out during lean water period.

Influences to the lower Dam/Reservoir :

Actual records of operation		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2013	Maximum inflow (m3/sec)	557.510	1239.54	1047.1	1066.91	4222.36	9313.53	8311.71	10352.14	5617.55	2142.31	891.45	633.92
	Mean Water Level (reservoir) (m)	443.179	438.772	430.466	429.32	431.597	457.925	466.649	472.44	472.44	465.387	463.39	455.432
	Mean Water Level (outlet of PS) (m)	339.913	340.766	339.547	340.157	340.919	341.163	341.254	341.528	341.193	341.132	340.614	340.523
	Monthly discharge for generation($m^{3/sec}$)	21055.2	29041.46	22866.4	29290.5	46774.24	91785.39	104418.5	102021.5	96132.27	52213.5	40044.5	32177.1
	Spilled water without generation($m^{3/sec}$)	0	0	0	0	588.64	22925.83	65839.95	112535	14817.88	0	0	0
	Maximum Ouput (MW)	1661	2147	1478	1605	2197	3364	3605	3578	3603	3397	2654	2584
	Minimum Output (MW)	630	864	708	680	900	2004	3369	3561	3400	1692	1824	600
	Gross Monthly Generation (MWh)	446981	566439	413990	534726	848618	2013805	2570541	2651123	2482531	1283543	978498	715957
	Auxiliary Consumption (MWh)	1170.6	1189	1133.2	1130.9	1028.656	1343.145	1732.339	1708.163	1650.151	1471.981	1309.48	1178.555
2012	Maximum inflow (m3/sec)	554.68	673.54	1132	1211.24	1791.39	5311.91	7205.18	8037.2	5671.32	1545.18	885.79	633.92
	Mean Water Level (reservoir) (m)	448.91	446.5	425.85	423.38	423.53	428.06	446.3	468.75	472.44	471.26	461.92	449.34
	Mean Water Level (outlet of PS) (m)	339.91	340.71	340.07	339.21	340.4	340.92	341.04	341.04	340.98	341.04	340.95	340.92
	Monthly discharge for generation($m^{3/sec}$)	18253.5	43109.39	22331.53	25962.42	41527.42	77539.17	94748.4	101478.1	87551.71	59033.8	49440.1	31045.1
	Spilled water without generation($m^{3/sec}$)	0	76.41	0	0	0	17647.88	53263.43	30272.51	15522.55	0	0	0
	Maximum Ouput (MW)	2139	2384	1740	1148	1874	2182	2923	3603	3674	3587	2980	2853
	Minimum Output (MW)	495	1680	525	742	900	1868	2119	2949	2426	1984	1992	700
	Gross Monthly Generation (MWh)	413887	870901	362823	435893	695922	1351345	1964569	2418167	2270885	1480827	1181896	647321
	Auxiliary Consumption (MWh)	1057.5	1198	997.6	919.9	1168.3	1645.5	1996.4	2247.8	2228.5	1784.2	1383.1	1205.8
2011	Maximum inflow (m3/sec)	633.92	1007.48	1072.57	1780.07	4513.85	7292.91	7505.16	6616.54	5716.6	1672.53	911.26	732.97
	Mean Water Level (reservoir) (m)	448.95	446.03	434.89	426.35	438.077	439.32	453.5	472.44	472.44	471.5	468.16	458.05
	Mean Water Level (outlet of PS) (m)	339.79	340.52	340.1	340.22	340.55	340.86	340.64	340.67	340.61	340.49	340.4	340.49
	Monthly discharge for generation($m^{3/sec}$)	19753.4	36988.1	34143.95	27134.04	72051.8	89795.9	96868.07	96270.94	88579	45579.98	46581.8	39054
	Spilled water without generation($m^{3/sec}$)	0	0	0	0	2999.8	45769.59	37568.25	20418.45	27020.84	0	0	0
	Maximum Ouput (MW)	1440	2420	2182	2182	2590	2662	3238	3634	3702	3438	3371	3191
	Minimum Output (MW)	650	1373	1470	1470	1794	2350	2632	3057	2656	1607	1920	830
	Gross Monthly Generation (MWh)	445024	742741	627875	471144	1401007	1755905	2061384	2403368	2295829	1159564	1183728	870687
	Auxiliary Consumption (MWh)	1209	1136.9	1150	977.7	1597.6	1964.1	2086.2	2196.4	2037.3	1513.6	1526.2	1324.9
2010	Maximum inflow (m3/sec)	489.59	1986.66	1123.51	1364.06	2917.73	7063.68	20095.83	15765.93	5996.77	1604.61	1047.1	800.89
	Mean Water Level (reservoir) (m)	434.23	432.48	425.24	421.81	424.77	436.37	464.58	472.44	472.44	472.44	468.78	456.92
	Mean Water Level (outlet of PS) (m)	339.09	339.82	340	339.91	340.77	340.8	341.04	341.01	340.55	340.52	340.67	340.55
	Monthly discharge for generation($m^{3/sec}$)	11942.6	27111.4	27736.83	28758.46	61750.6	85078.29	100815.9	102293.2	83071.82	51370.16	54817.1	38006.9
	Spilled water without generation($m^{3/sec}$)	0	0	0	0	0	20166.58	89977.02	190734.4	27221.77	0	0	0
	Maximum Ouput (MW)	1160	2126	2064	1606	2031	2512	3546	3594	3594	3395	3056	2914
	Minimum Output (MW)	399	524	735	820	1288	1874	2540	3552	2808	1710	2344	1031
	Gross Monthly Generation (MWh)	227650	461909	438219	456089	1038890	1439104	2201055	2644653	2159751	1338909	1367466	851061
	Auxiliary Consumption (MWh)	1017	991.2	1018.4	1008.9	1503.3	1711.8	2046.3	2445.7	2115	1568.8	1651	1290.8
2009	Maximum inflow (m3/sec)	679.20	1032.95	1015.97	1525.27	3772.39	5614.72	8260.77	8784.32	4601.58	1952.70	837.68	704.67
	Mean Water Level (reservoir) (m)	434.273	434.456	428.32	430.53	427.69	429.16	462.84	472.44	472.42	457.95	450.57	437.31
	Mean Water Level (outlet of PS) (m)	339.06	339.97	340.1	340.34	340.61	340.43	340.52	340.61	340.46	340.43	340.43	340.22
	Monthly discharge for generation($m^{3/sec}$)	10782.3	25413.4	30283.83	24193.67	67600.21	86598	99593.36	102672.4	97148.24	54791.63	46412	26177.5
	Spilled water without generation($m^{3/sec}$)	0	0	0	0	2413.99	28747.14	20664.66	68740.7	7703.26	0	0	0
	Maximum Ouput (MW)	1455	2080	2044	2272	2160	2234	3552	3623	3642	3348	2738	2425
	Minimum Output (MW)	395	1070	838	714	2000	1796	2296	3582	3370	2376	2198	402
	Gross Monthly Generation (MWh)	201392	475708	479046	431319	1157408	1425086	2098864	2657620	2435023	1214823	965372	470978
	Auxiliary Consumption (MWh)	986	979.9	1050.3	1000.1	1498.4	1764.1	1986.8	2429.3	2300.1	1526.6	1194.1	1048.7
2008	Maximum inflow (m3/sec)	684.86	614.11	789.57	1021.63	3786.54	8518.3	6961.8	8045.69	3294.12	1386.7	863.15	1066.91
	Mean Water Level (reservoir) (m)	434.37	434.15	422.09	421.75	423.37	451.49	460.09	472.44	472.44	452.3	448.28	430.64
	Mean Water Level (outlet of PS) (m)	339.76	340	340.1	339.91	340.4	340.89	340.74	340.64	340.71	340.52	340.61	340.13
	Monthly discharge for generation($m^{3/sec}$)	11150.2	25922.8	22337.19	23658.8	64003.28	92988.14	106594.8	105066.6	98093.46	41385.92	50119.3	20568.44
	Spilled water without generation($m^{3/sec}$)	0	0	0	0	1559.33	33215.71	50484.37	34616.56	9061.66	0	0	0
	Maximum Ouput (MW)	1068	1771	1675	1466	2024	3149	3489	3682	3672	3121	2800	1921
	Minimum Output (MW)	370	1022	605	528	1156	1920	3071	3500	3134	769	1798	360
	Gross Monthly Generation (MWh)	209957	459732	334255	371377	1029346	1805859	2465090	2697299	2400628	869489	1012145	338225
	Auxiliary Consumption (MWh)	1070.1	1045	1028.3	982.1	1498.5	1937.8	2286	2385.2	2181	1249.8	1253.3	1004.9

Remarks

The Pondage volume data provided was in Million Acre Feet. It is convereted to Million cubic meter by: 1AFT = 1233.48 m3. 1 ft = 0.3048 meters. 1 CFt = 0.0283 cubic meters.

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	37					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1977					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal//)				($\$/k/$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	2	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	37					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1977					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	3	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	37					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1977					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	4	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	2010					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	4					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	5	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	32					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1982					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	6	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	32					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1982					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	7	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	32					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1982					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal/ℓ)				($/kℓ)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	8	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	32					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1982					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	9	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	29					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1985					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	10	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	29					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1985					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	11	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	22					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1992					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	12	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	22					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1992					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	13	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	22					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1992					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tarbela	14	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	21					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1993					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

WAPDA Hydel

Mangla

Nippon Koei Co., Ltd.

Data sheet <FORM-2.1> Large Hydro Power Plant Questionnaire (With Reservoir)

Power Plant Name	Total Installed Capacity
Mangla	1000 (MW)

Pondage Volume ($10^6 m^3$)	
Total	9238
Effective for generation	9117
Effective for other purposes	121

Construction Cost	Generating Cost
1473 ($10^6$$)	0.3458 (Rs/kWh)

Unit No.	Unit size (MW)	F.O.R (%)	Design Flow (m^3/sec)	Commissioning yy/mm	
1	100	1	127	1967	7
2	100	1	127	1967	7
3	100	1	127	1968	3
4	100	1	127	1969	6
5	100	1	127	1973	12
6	100	1	127	1974	3
7	100	1	127	1981	7
8	100	1	127	1981	7
9	100	1	127	1993	8
10	100	1	127	1994	7

Reservoir water level (m)		Purpose of limitation, limited period
Reservoir water level (Rated)	348	
Flood level	379	
High Water Level (HWL)	378	
limited water level		
limited water level		
Low Water Level (LWL)	317	

Rule Curves of the Reservoir	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Water Level	1156.55	1151.75	1126.45	1146.85	1172.10	1192.85	1223.40	1233.15	1242.00	1241.20	1209.60	1184.60
Minimum Water Level	1152.9	1108.60	1083.80	1128.10	1147.40	1172.20	1193.65	1224.05	1227.25	1230.35	1185.80	1156.70

Scheduled Maintenance plan (intervals and their period) :

Monthly Maintenance of each unit carreid out for 4 hours.Annual Manintenance of each unit carried out for 21 days.
Annual Maintenance carried out during Lean Water Period. Lean Water Period from October 15 to February 28 every year.

Influences to the lower Dam/Reservoir :

Actual records of operation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2013 Maximum inflow (103m3/sec)	0.40	2.05	1.14	1.33	2.45	2.01	2.20	3.09	0.96	0.47	0.37	0.29
Mean Water Level (reservoir) (m)	347.17	343.62	338.08	337.58	339.02	354.10	365.41	372.79	377.22	371.69	365.73	356.06
Mean Water Level (outlet of PS) (m)	255.68	256.68	256.70	256.88	257.55	256.28	256.08	255.38	255.98	257.08	256.98	256.59
Monthly discharge for generation($10^3 m^3$)	226.34	553.67	681.28	682.85	823.61	490.35	315.38	289.83	513.33	245.54	688.27	623.28
Spilled water without generation($10^3 m^3$)	0.00	6.87	22.33	0.68	0.00	0.00	0.00	0.00	87.35	68.38	7.29	0.00
Maximum Ouput (MW)	674	812	730	833	947	1115	1115	1115	1115	1115	1115	1115
Minimum Output (MW)	60	0	160	80	90	170	160	0	180	340	475	120
Gross Monthly Generation (MWh)	179507	395275	442696	446488	543527	384138	280573	270833	543700	671562	642455	524470
Auxiliary Consumption (MWh)	720.6	796.2	879.1	885.3	1026.2	850.5	838.4	751	861.4	1023.1	922.2	878.8
2012 Maximum inflow (103m3/sec)	0.30	0.45	0.85	1.39	1.49	1.55	1.61	1.96	2.77	0.65	0.33	0.34
Mean Water Level (reservoir) (m)	349.36	342.16	350.55	324.40	332.84	336.48	346.93	356.46	364.47	365.07	359.06	350.55
Mean Water Level (outlet of PS) (m)	255.20	256.26	256.62	256.83	257.56	257.47	255.90	255.46	255.48	256.53	256.38	256.16
Monthly discharge for generation($10^3 m^3$)	194.57	638.28	536.17	670.94	890.55	853.01	417.36	293.64	282.82	651.84	570.33	536.27
Spilled water without generation($10^3 m^3$)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Ouput (MW)	711	966	650	726	750	850	1039	1092	1115	1115	1115	1081
Minimum Output (MW)	0	165	0	193	310	0	94	185	185	200	270	155
Gross Monthly Generation (MWh)	153965	448510	264398	347306	529671	534880	294279	242913	270650	600205	519909	393601
Auxiliary Consumption (MWh)	659	751	858.6	944.1	977.4	1016.9	787.1	706.6	702.1	930	887	836.4
2011 Maximum inflow (103m3/sec)	0.22	1.58	1.84	2.65	2.28	1.81	1.20	1.09	2.99	0.52	0.38	0.29
Mean Water Level (reservoir) (m)	343.75	339.27	333.05	335.88	348.70	356.29	362.60	366.09	368.79	366.98	361.77	353.00
Mean Water Level (outlet of PS) (m)	255.81	256.48	257.09	257.40	257.73	256.87	255.84	255.72	256.34	256.30	256.76	256.27
Monthly discharge for generation($10^3 m^3$)	252.85	505.74	712.75	803.95	923.39	654.55	332.38	277.32	509.01	512.50	646.42	555.32
Spilled water without generation($10^3 m^3$)	0.00	0.00	1.82	43.35	74.81	27.90	0.00	0.00	46.42	0.00	0.00	0.00
Maximum Ouput (MW)	754	776	714	889	1060	1097	1035	1060	1120	1115	1115	1111
Minimum Output (MW)	90	170	240	356	450	200	170	190	210	220	290	190
Gross Monthly Generation (MWh)	183857	340981	430257	504976	705665	546814	290780	246118	474328	476184	586730	446376
Auxiliary Consumption (MWh)	700	723.2	876.2	889.6	1017.8	848.7	782.9	699.7	850.5	915.4	879.2	777.3
2010 Maximum inflow (103m3/sec)	0.23	3.42	1.57	1.61	2.82	2.17	7.57	4.40	1.29	0.66	0.39	0.29
Mean Water Level (reservoir) (m)	329.50	327.15	318.88	329.68	343.46	353.03	360.88	367.68	367.61	364.08	357.63	348.77
Mean Water Level (outlet of PS) (m)	254.90	256.26	256.73	256.62	257.44	257.70	256.55	257.93	256.93	256.90	256.84	256.09
Monthly discharge for generation($10^3 m^3$)	83.10	418.62	559.25	572.72	848.97	887.73	508.09	904.54	613.72	660.56	616.79	511.13
Spilled water without generation($10^3 m^3$)	0.00	0.00	0.00	0.00	20.02	59.83	228.21	748.34	3.88	0.00	0.00	0.00
Maximum Ouput (MW)	516	677	606	836	1036	1128	1150	1150	1150	1150	1035	980
Minimum Output (MW)	0	79	109	30	310	340	170	1035	210	280	190	138
Gross Monthly Generation (MWh)	49316	231975	262181	329714	610292	725511	442729	853620	560650	604734	541569	391778
Auxiliary Consumption (MWh)	605.5	686.5	795.4	767	910.7	871.1	843	988.7	928.5	970.2	855.8	795.8
2009 Maximum inflow (103m3/sec)	0.71	1.10	1.12	2.04	2.24	2.04	1.96	1.65	0.90	0.50	0.48	0.32
Mean Water Level (reservoir) (m)	339.65	340.19	330.64	344.01	350.74	355.70	358.70	366.34	364.41	357.09	349.57	334.24
Mean Water Level (outlet of PS) (m)	254.73	257.29	256.36	256.91	257.35	257.18	255.70	256.75	257.59	256.70	256.56	256.02
Monthly discharge for generation($10^3 m^3$)	40.67	704.19	489.53	638.46	740.67	656.67	161.72	532.24	766.63	529.16	610.42	488.01
Spilled water without generation($10^3 m^3$)	0.00	0.00	0.00	26.02	283.67	411.91	438.96	25.43	31.57	2.39	0.00	0.00
Maximum Ouput (MW)	666	878	759	810	1034	1104	1000	1150	1120	1090	1058	942
Minimum Output (MW)	0	110	0	202	548	0	0	180	270	170	280	75
Gross Monthly Generation (MWh)	31232	486791	276935	466319	587187	552167	144603	485131	706492	446043	479256	301882
Auxiliary Consumption (MWh)	624.1	856.5	823.9	904.1	954.1	904.5	951.8	992.3	997.6	960.5	908.9	858.3
2008 Maximum inflow (103m3/sec)	1.08	0.69	0.88	2.03	2.01	2.43	1.51	1.28	0.67	0.50	0.37	1.18
Mean Water Level (reservoir) (m)	338.93	334.42	320.30	327.49	336.44	347.29	360.00	363.65	364.03	357.14	346.90	365.68
Mean Water Level (outlet of PS) (m)	255.16	256.62	256.63	256.98	257.56	257.02	257.18	255.75	257.48	256.52	257.26	255.86
Monthly discharge for generation($10^3 m^3$)	144.81	487.83	529.68	644.76	844.84	611.05	707.97	248.19	676.70	552.59	735.49	420.08
Spilled water without generation($10^3 m^3$)	0.00	0.00	0.00	0.00	0.00	0.00	6.99	0.00	0.00	0.00	0.00	0.00
Maximum Ouput (MW)	609	694	576	732	880	1070	1035	920	1150	1150	1126	850
Minimum Output (MW)	30	190	171	139	300	190	170	160	170	194	160	55
Gross Monthly Generation (MWh)	99249	299310	249439	361753	534159	432586	277015	207336	630372	470335	559373	252363
Auxiliary Consumption (MWh)	617.1	765.2	776.3	828.8	951.2	984.4	792.9	801	1062.5	1038.5	1015.4	854.9

Remarks

The water reservoir is under the control of IRSA and they are the one regulating water discharge. IRSA provides mean daily discharge in CUSEC and then Mangla Power house according to instructions from NPCC regulate discharge in way that
they meet demand of power as well at the end of the day the mean discharge is at the level setforth by IRSA. IRSA stands for Indus River System Authority.
The Rules Curves of Reservoir had not been established after raising of the Mangla Dam so actual data from November 2013 to Octobet 2014 has been used as provided by Mngla Dam Authorities.

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	47					
Salvage Value	%	10					
Capital Cost	$/kW	1473					
Construction	year	1967					
Fixed O&M*	Rs./kW/mo.	82.8947					
Variable O&M*	Rs/MWh	172.022					
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	2	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	47					
Salvage Value	%	10					
Capital Cost	$/kW	1473					
Construction	year	1967					
Fixed O&M	$/kW/mo.	82.89					
Variable O&M	$/MWh	172.022					
Tax & Others	$/MWh	0					
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	3	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	46					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1968					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

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2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	4	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	45					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1969					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	5	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	41					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1973					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	6	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	40					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1974					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	7	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	33					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1981					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	8	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	33					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1981					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	9	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	21					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1993					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Mangla	10	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	20					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1994					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
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Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

WAPDA Hydel

Ghazi Brotha

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Ghazi Brotha	1450 (MW)	1886 ($10^6$$)	1 (¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
25.5 ($10^6 m^3$)	70 (m)	69 (m)	1600 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	Design Flow (m^3/sec)	C.O yy	C.O mm
1	290	0.1	465	2003	7
2	290	0.1	465	2003	8
3	290	0.14	465	2003	10
4	290	0.49	465	2003	12
5	290	0.47	465	2004	4
7					
8					

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	1250	1450	1160	1450	1450	1450	1450	1450	1450	1450	1160	1160
Firm Capacity (MW)												
Minimum output (MW)	250	250	250	250	250	250	250	250	250	250	250	250
Power generation (GWh)												
Gross 2013	346.823	462.464	358.745	469.606	605.677	670.59	735.582	738.316	756.668	709.293	627.742	494.009
Auxiliary Consumption	0.831	0.692	0.684	0.663	0.818	0.897	1.025	0.99	0.897893	0.783	0.671	0.751
Gross 2012	297.916	648.371	348.548	408.597	657.155	725.967	749.953	761.895	746.827	775.161	723.26	450.901
Auxiliary Consumption	0.889834	0.745	0.64	0.621	0.771	0.883	0.654	0.597	0.786322	0.679	0.613	0.747
Gross 2011	319.18	560.92	535.944	428.81	740.09	701.213	745.203	731.301	700.477	631.84	612.408	551.907
Auxiliary Consumption	0.671	0.507	0.547	0.521	0.636	0.619	0.744	0.961	0.844	0.732	0.645	0.731
Gross 2010	187.106	393.290	412.456	432.493	714.626	702.878	715.365	676.6	714.456	727.721	730.134	584.35
Auxiliary Consumption	0.573	0.454067	0.491	0.476	0.596	0.615	0.566	0.473	0.493	0.513	0.557	0.640894
Gross 2009	165.360	390.707	449.931	367.079	725.178	698.209	735.739	737.050	729.060	692.667	669.801	388.789
Auxiliary Consumption	0.650316	0.512192	0.50513	0.469388	0.511746	0.570379	0.554478	0.511596	0.471784	0.581493	0.489909	0.549446
Gross 2008	171.866	401.800	328.508	360.279	694.547	696.366	730.725	734.678	710.536	528.218	686.604	300.512
Auxiliary Consumption	0.693522	0.604492	0.530766	0.513628	0.654401	0.652092	0.589201	0.54634	0.520927	0.524689	0.521645	0.570822
Gross 2007	272.927	443.137	365.667	526.226	737.976	682.004	711.296	704.980	705.349	707.215	703.795	387.698
Auxiliary Consumption	0.498044	0.461238	0.4785	0.488412	0.586562	0.580259	0.62411	0.657159	0.598938	0.556154	0.531542	0.575716
Gross 2006	276.931	402.307	383.934	350.180	723.507	718.438	739.835	710.362	714.515	677.729	711.111	361.318
Auxiliary Consumption	-	-	0.479733	0.468196	0.573952	0.618222	0.678761	0.656406	0.60337	0.570974	0.549182	0.48095
Gross 2005	134.593	290.830	210.740	478.035	660.669	725.950	729.072	755.180	743.534	626.557	761.299	565.901
Auxiliary Consumption	-	-	-	-	-	-	-	-	-	-	-	-
Gross 2004	77.888	195.555	304.114	386.590	680.516	732.957	762.038	771.278	729.309	479.666	728.990	365.881
Auxiliary Consumption	-	-	-	-	-	-	-	-	-	-	-	-
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013												
2012												
2011												
2010												
2009												
2008												
2007												
2006												
2005												
2004												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Ghazi Brotha	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	11					
Salvage Value	%	10					
Capital Cost	$/kW	1300.690					
Construction	year	2003					
Fixed O&M	Rs/kW/mo.	339.7918					
Variable O&M	Rs/MWh	18.456					
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Ghazi Brotha	2	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	11					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	2003					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal/ℓ)				($/kℓ)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
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free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Ghazi Brotha	3	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	11					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	2003					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal/ℓ)				($/kℓ)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
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2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Ghazi Brotha	4	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	11					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	2003					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3$$Nm^3$)
Diesel		(kcal/ℓ)				($/kℓ)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Ghazi Brotha	5	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	10					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	2004					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3Nm^3$)
Diesel		(kcal/ℓ)				($/kℓ)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
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2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

WAPDA Hydel

Warsak

Nippon Koei Co., Ltd.

Data sheet <FORM-2.1> Large Hydro Power Plant Questionnaire (With Reservoir)

Power Plant Name	Total Installed Capacity
Warsak	242.96 (MW)

Unit No.	Unit size (MW)	F.O.R (%)	Design Flow (m^3/sec)	Commissioning yy/mm	
1	40	11	1179.58	1960	5
2	40	10	1179.58	1960	5
3	40	9	1179.58	1960	6
4	40	11	1179.58	1960	7
5	41.48	12	1179.58	1980	12
6	41.48	12	1179.58	1981	3

Pondage Volume (10^6m^3)	1156.91	
Total	1156.91	
Effective for generation	335.28	
Effective for other purposes	0.00017	

Construction Cost	Generating Cost
579.89 ($10^6$$)	1.2342 (¢/kWh)

Reservoir water level (m)	387.1	Purpose of limitation, limited period
Flood level	391.7	
High Water Level (HWL)	387.1	
limited water level	387.1	
limited water level	387.1	
Low Water Level (LWL)	383.743	

Rule Curves of the Reservoir	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Water Level	385.83	385.83	385.83	385.83	385.83	385.83	385.83	385.83	385.83	385.83	385.83	385.83
Minimum Water Level	384.63	384.63	384.63	384.63	384.63	384.63	384.63	384.63	384.63	384.63	384.63	384.63

Scheduled Maintenance plan (intervals and their period) :

Unit No.1 01-01-2015 to 31-01-2015 (Annual Maintenance).
Unit No.2 01-12-2014 to 31-05-2015 (Major overhau
Unit No.3 01-12-2014 to 31-12-2014 (Annual Maintenance)
Unit No.4 20-08-2014 to 31-01-2015 (Major overhaul)
Unit No.5 01-02-2015 to 28-02-2015 (Annual Maintenance).
Unit No.6 01-11-2014 to 30-11-2014 (Annual Maintenance

Influences to the lower Dam/Reservoir :

Actual records of operation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2013 Maximum inflow (103m3/sec)	0.00418	0.00645	0.01203	0.01055	0.02339	0.03169	0.01672	0.03171	0.00723	0.00477	0.00388	0.00536
Mean Water Level (reservoir) (m)	386.56	386.6388	386.6388	386.6388	387.096	387.096	387.096	387.096	386.5778	386.6388	386.6388	386.6388
Mean Water Level (outlet of PS) (m)	342.53	342.5952	343.2658	343.5096	345.0031	345.7346	344.8812	344.8507	343.6925	343.0524	342.6866	342.5038
Monthly discharge for generation(10^3m^3)	0.002	0.00213	0.00359	0.00438	0.00633	0.00584	0.00525	0.00476	0.00469	0.00301	0.00223	0.00093
Spilled water without generation(10^3m^3)	0	0	0.00099	0.00116	0.00845	0.01327	0.01193	0.00714	0.00003	0	0	0
Maximum Ouput (MW)	142	141	177	180	196	192	190	190	190	160	130	130
Minimum Output (MW)	35	35	50	45	30	20	54	20	90	30	50	25
Gross Monthly Generation (MWh)	46379	49542	89681	105937	116651	93048	126983	115777	113454	75655	56731	24389
Auxiliary Consumption (MWh)	108.6	92.2	110.9	135.9	134.6	139.5	147.9	149.5	145.6	137.7	149.9	139.1
2012 Maximum inflow (103m3/sec)	0.00393	0.00393	0.00411	0.01601	0.01639	0.01777	0.02346	0.01313	0.00988	0.00601	0.00424	0.00202
Mean Water Level (reservoir) (m)	386.6388	386.6388	386.6388	387.096	386.6388	387.096	387.096	387.096	386.6388	386.6388	386.6388	386.6388
Mean Water Level (outlet of PS) (m)	342.5038	342.4428	342.4428	344.0278	344.0887	345.2165	345.3079	344.4545	343.9058	342.8695	342.6866	342.5647
Monthly discharge for generation(10^3m^3)	0.00169	0.00173	0.00202	0.00451	0.00476	0.00489	0.00456	0.00554	0.00508	0.00255	0.00196	0.00185
Spilled water without generation(10^3m^3)	0	0	0	0	0.00258	0.00883	0.01011	0.00279	0.00063	0	0	0
Maximum Ouput (MW)	133	133	140	166	190	190	186	203	203	203	144	144
Minimum Output (MW)	25	25	25	25	60	55	40	60	50	35	36	40
Gross Monthly Generation (MWh)	42840	41245	52496	103670	115298	112852	110233	136402	121152	66623	49424	47888
Auxiliary Consumption (MWh)	131.2	116.7	122.5	127.9	144.2	141.1	107.7	154.1	135.8	124.3	121	118.2
2011 Maximum inflow (103m3/sec)	0.00448	0.00441	0.00441	0.00981	0.01421	0.01268	0.01109	0.01785	0.01163	0.00591	0.0049	0.01097
Mean Water Level (reservoir) (m)	386.7607	386.7912	386.7607	386.7455	387.096	387.096	387.096	387.096	386.6388	386.6388	386.6388	384.048
Mean Water Level (outlet of PS) (m)	342.5038	342.6257	342.839	343.5096	344.7898	344.6069	344.5459	344.6069	343.6925	342.8086	342.6562	342.6866
Monthly discharge for generation(10^3m^3)	0.00183	0.00198	0.00259	0.00371	0.00505	0.00541	0.00536	0.00528	0.00445	0.00244	0.00207	0.0015
Spilled water without generation(10^3m^3)	0	0	0	0.00064	0.0048	0.00381	0.00351	0.0036	0.00123	0	0	0.00019
Maximum Ouput (MW)	150	150	150	180	205	205	204	200	200	200	166	133
Minimum Output (MW)	30	40	30	50	50	34	70	20	35	50	35	20
Gross Monthly Generation (MWh)	45981	45508	67088	91208	124537	130196	133760	129748	106710	62621	51604	38250
Auxiliary Consumption (MWh)	135.4	112.6	126.5	122.6	149.9	156.5	160	157.6	156.2	140.8	126.1	129.9
2010 Maximum inflow (103m3/sec)	0.00518	0.0042	0.00523	0.00793	0.01611	0.02042	0.04655	0.03538	0.00918	0.00633	0.00529	0.00441
Mean Water Level (reservoir) (m)	386.5321	386.4864	386.4864	386.5016	387.096	386.9436	386.9436	386.9436	386.5169	386.5626	386.6845	386.7455
Mean Water Level (outlet of PS) (m)	342.3818	342.4428	342.961	343.5706	344.485	345.0031	345.4298	345.7042	343.9363	343.0829	342.7476	342.6257
Monthly discharge for generation(10^3m^3)	0.00188	0.00204	0.00316	0.0046	0.0051	0.00536	0.00475	0.00422	0.00532	0.00299	0.00238	0.00195
Spilled water without generation(10^3m^3)	0	0	0.00005	0.00042	0.00493	0.00738	0.01247	0.01355	0.00054	0	0	0
Maximum Ouput (MW)	176	143	178	178	210	210	205	206	215	215	180	150
Minimum Output (MW)	25	25	35	75	60	30	10	20	90	60	50	42
Gross Monthly Generation (MWh)	47931	46748	81280	111769	124683	127228	116671	102231	128403	78290	59631	50705
Auxiliary Consumption (MWh)	147.4	130.4	141.3	138.7	148.9	138.8	154.5	160.1	160.1	148.7	128.8	129.3
2009 Maximum inflow (103m3/sec)	0.00403	0.005	0.005	0.01172	0.01761	0.02095	0.0222	0.01898	0.01251	0.00625	0.00523	0.00523
Mean Water Level (reservoir) (m)	386.5016	386.4864	386.5474	386.5169	387.096	387.096	387.096	387.096	386.4864	386.4864	386.4864	386.4254
Mean Water Level (outlet of PS) (m)	345.0031	342.4733	342.7476	343.662	344.9117	344.9726	346.1614	344.8202	343.1134	342.6562	342.3209	342.4123
Monthly discharge for generation(10^3m^3)	0.00166	0.00199	0.00266	0.00445	0.00518	0.00502	0.00458	0.00541	0.00421	0.00258	0.00215	0.00213
Spilled water without generation(10^3m^3)	0	0	0	0.00138	0.00634	0.01345	0.01426	0.00634	0.0004	0	0	0
Maximum Ouput (MW)	137	170	170	214	214	200	203	210	213	213	178	178
Minimum Output (MW)	30	20	30	32	53	30	30	45	44	10	25	30
Gross Monthly Generation (MWh)	42485	47568	68448	109725	128509	120727	110085	135829	103769	67008	54220	52718
Auxiliary Consumption (MWh)	107.4	101.3	107.9	112.6	128.5	138.5	149.4	160.5	139.3	141.7	135.7	133.1
2008 Maximum inflow (103m3/sec)	0.00509	0.00509	0.00603	0.00743	0.01471	0.01818	0.01267	0.01629	0.00606	0.00606	0.00403	0.00403
Mean Water Level (reservoir) (m)	386.5321	386.5169	386.5016	386.5321	386.6083	387.096	386.7607	386.5778	386.4864	386.4864	386.4864	386.5016
Mean Water Level (outlet of PS) (m)	342.4428	342.3514	342.199	342.839	344.3021	344.6983	344.3021	343.9363	342.6866	342.3514	342.0161	342.0466
Monthly discharge for generation(10^3m^3)	0.00235	0.00235	0.0022	0.0045	0.00536	0.00505	0.00572	0.00501	0.00322	0.002	0.00169	0.0015
Spilled water without generation(10^3m^3)	0	0	0	0.00004	0.00277	0.00745	0.00324	0.0028	0	0	0	0
Maximum Ouput (MW)	173	173	207	207	207	208	208	206	206	206	137	137
Minimum Output (MW)	20	10	10	35	20	40	30	30	36	25	15	15
Gross Monthly Generation (MWh)	47117	47117	57036	109104	134486	119205	142809	123375	80376	50275	41611	38496
Auxiliary Consumption (MWh)	118.6	118.6	129.9	115.2	135.5	136.6	127.7	129.4	116.6	123.2	108.2	104.8

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	54					
Salvage Value	%						
Capital Cost	$/kW	2386.7715					
Construction	year	1960					
Fixed O&M*	$/kW/mo.						
Variable O&M*	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal//)				($\$/k/$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	2	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	54					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1960					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

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free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	3	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	54					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1960					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

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free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	4	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	54					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1960					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

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free format

2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	5	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	34					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1980					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

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2) Output Data of the latest power sources development plan
free format

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Warsak	6	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year	33					
Salvage Value	%						
Capital Cost	$/kW						
Construction	year	1981					
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/10^3$Nm^3$)
Diesel		(kcal//)				($/k/)
Coal		(kcal/kg)				($/10^{3}kg)
RFO/HSFO		(kcal/kg)				($/10^{3}kg)
Others						

2. WASP Simulation Data

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free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Chashma Hydel Power

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Chashma Hydel Power	184 (MW)	21082 (10^6Rs)	2.03 (Rs/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
(10^6m^3)	8.4 (m)	(m)	2400 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O mm/yy
1	23		May-01
2	23		Apr-01
3	23		Apr-01
4	23		Mar-01
5	23		Mar-01
6	23		Feb-01
7	23		Dec-00
8	23		Dec-00

F. O. R : Forced Outage Rate
C. O : Commercial Operation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	161	184	184	184	184	184	184	184	184	184	184	184
Firm Capacit (MW)												
Minimum output (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Power generation (GWh)												
Gross 2013	69.346	88.147	90.461	104.2	105.879	87.05	91.865	64.585	117.768	116.432	91.039	64.689
Auxiliary Consumption	0.3931	0.418	0.4806	0.4971	0.5542	0.5366	0.5625	0.5668	0.547	0.5594	0.486	0.4226
Gross 2012	56.568	86.013	46.161	87.654	105.54	85.074	95.865	97.284	114.038	109.988	90.896	68.956
Auxiliary Consumption	0.3577	0.437	0.3908	0.5208	0.5529	0.5389	0.5555	0.5594	0.5419	0.5322	0.4815	0.4189
Gross 2011	37.501	82.48	81.219	79.254	117.589	117.433	118.009	116.517	127.137	97.042	82.433	66.642
Auxiliary Consumption	0.329	0.4515	0.4618	0.4538	0.5562	0.5434	0.5329	0.5502	0.5363	0.5155	0.4666	0.4531
Gross 2010	45.279	70.19	80.44	78.857	122.989	95.674	97.327	10.897	108.891	105.183	95.845	76.782
Auxiliary Consumption	0.3371	0.4048	0.45622	0.46512	0.5167	0.5257	0.5417	0.45562	0.5228	0.5083	0.44084	0.4303
Gross 2009	51.079	73.615	74.694	99.709	128.937	100.036	106.843	96.907	105.183	97.556	90.981	67.173
Auxiliary Consumption	0.36014	0.4114	0.44662	0.4537	0.52638	0.49672	0.5254	0.5424	0.509	0.5036	0.4454	0.4257
Gross 2008	45.984	29.258	50.433	81.611	96.258	89.91	104.35	117.626	117.21	89.045	85.392	55.217
Auxiliary Consumption	0.28774	0.25694	0.3951	0.394704	0.477336	0.4985	0.5214	0.5199	0.525	0.5211	0.5091	0.3784
Gross 2007	47.685	77.968	94.24	107.668	116.538	103.777	117.537	119.396	118.527	97.175	85.018	56.387
Auxiliary Consumption	0.3547	0.4225	0.4945	0.4705	0.543	0.5333	0.5562	0.5562	0.5382	0.5472	0.5035	0.36324
Gross 2006	38.155	47.583	55.722	61.882	118.479	106.699	116.308	104.722	124.927	98.045	104.866	49.047
Auxiliary Consumption	0.3164	0.3372	0.3659	0.386716	0.537	0.5267	0.541	0.548	0.52338	0.5403	0.5199	0.3628
Gross 2005	51.017	79.353	96.157	105.46	117.618	104.729	28.821	106.677	124.412	108.332	95.733	66.722
Auxiliary Consumption	0.3426	0.42554	0.4753	0.4883	0.5154	0.5164	0.4997	0.5467	0.5254	0.5327	0.5183	0.4409
Gross 2004	39.103	84.661	46.931	63.203	118.81	106.337	105.403	124.909	101.194	84.872	81.66	48.453
Auxiliary Consumption	0.3061	0.4729	0.3727	0.3822	0.5254	0.5395	0.5552	0.55	0.53068	0.48796	0.4792	0.3459
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Existing Run-of-River Hydro Power Plants

Allai Khwar HHP

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Allai Khwar HHP	121 (MW)	($10^6$$)	(¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
0.0113 ($10^6 m^3$)	687 (m)	684 (m)	21 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1	605	0.1	2013/03
2	60.5	0	2013/03
3			
4			
5			
6			

F. O. R : Forced Outage Rate
C. O : Commercial Operation

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)		121	121	121	121	121	121	121	121	80.5	121	121	121
Firm Capacit (MW)													
Minimum output (MW)		0	0	0	0	0	0	0	0	0	10	0	20
Power generation (GWh)													
Gross	2014	9.1547	9.7553	42.3475	70.716	89.9425	69.524	66.8047	50.05	15.555	25.3979	19.7492	
Auxiliary Consumption		0.02963	0.0247	0.0339	0.0821	0.1029	0.10233	0.1103	0.1054	0.0739	0.0669	0.04531	
Gross	2013			19.485	68.2	75.27		51.523	57.9977	28.7847	17.948	13.3599	10.1984
Auxiliary Consumption				0.03002	0.05328	0.06485		0.1253	0.1173	0.9016	0.06671	0.03845	0.02674
Gross	2011												
Auxiliary Consumption													
Gross	2010												
Auxiliary Consumption													
Gross	2009												
Auxiliary Consumption													
Gross	2008												
Auxiliary Consumption													
Gross	2007												
Auxiliary Consumption													
Gross	2006												
Auxiliary Consumption													
Gross	2005												
Auxiliary Consumption													
Gross	2004												
Auxiliary Consumption													
Discharge without Generation													
Estimation (GWh or m^3)													
Result	2013												
	2012												
	2011												
	2010												
	2009												
	2008												
	2007												
	2006												
	2005												
	2004												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

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Questionnaire

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Existing Run-of-River Hydro Power Plants

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Jinnah Hydel Power	96 (MW)	128 ($10^6$$)	0.7 (Rs/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
($10^6 m^3$)	6.2 (m)	4.8 (m)	2800 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O mm/yy
1	12		Mar-12
2	12		Oct-12
3	12		Aug-12
4	12		Jun-13
5	12		May-13
6	12		Oct-13
7	12		Oct-13
8	12		Sep-13

F. O. R : Forced Outage Rate
C. O : Commercial Operation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	24.4	26.7	52.5	59.7	45.5	53.6	39.8	32.1	70.3	72.9	60.5	58.3
Firm Capacit (MW)												
Minimum output (MW)	0	0	7.9	27.3	12.3	6.8	3.6	2.9	8.1	1	21.7	11.6
Power generation (GWh)												
Gross 2013	5.08	8.86	20.59	32.4	19.05	21.71	9.94	9.94	27.97	16.94	35.01	30
Auxiliary Consumption	0.19	0.19	0.33	0.5	0.41	0.52	0.44	0.44	0.64	0.45	0.63	0.49
Gross 2012	0.6	0.84	7.97	6.52	8.04	5.37	6.14	7.09	18.46	18.87	25.14	18.63
Auxiliary Consumption	0.035	0.033	0.13	0.132	0.155	0.184	0.187	0.172	0.326	0.318	0.434	0.301
Gross 2011												
Auxiliary Consumption												
Gross 2010												
Auxiliary Consumption												
Gross 2009												
Auxiliary Consumption												
Gross 2008												
Auxiliary Consumption												
Gross 2007												
Auxiliary Consumption												
Gross 2006												
Auxiliary Consumption												
Gross 2005												
Auxiliary Consumption												
Gross 2004												
Auxiliary Consumption												
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013												
2012												
2011												
2010												
2009												
2008												
2007												
2006												
2005												
2004												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

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Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

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HPS Nandipur

HPS Nandipur

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
HPS Nandipur	13.8 (MW)	56.224 ($10^6$$)	7 (¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
N/A ($10^6 m^3$)	8 (m)	7.3 (m)	9120 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1	4.6		1963/3
2	4.6		1963/3
3	4.6		1963/3
4			
5			
6			

F. O. R : Forced Outage Rate
C. O : Commercial Operation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	7.2	7.7	8.2	8.5	9.2	9.2	9.2	9.2	8.9	9.2	7.4	6.5
Firm Capacit (MW)												
Minimum output (MW)	1.3	0.6	1.4	3.2	1.4	2	0.3	0.2	0.2	0.5	1.8	0.5
Power generation (GWh)												
Gross 2013	1.5008	3.1477	4.822	4.966	5.4038	5.6596	6.0919	4.5077	4.8788	3.5099	1.8629	1.3547
Auxiliary Consumption	0.03419	0.04211	0.04857	0.04988	0.05689	0.05409	0.05792	0.0562	0.0568	0.04814	0.03054	0.03197
Gross 2012	1.4439	3.2643	3.7067	4.0539	3.2549	4.9497	5.976	6.0463	5.3403	4.2776	1.9326	1.3208
Auxiliary Consumption	0.03419	0.04289	0.0402	0.04682	0.04749	0.0581	0.05705	0.05771	0.05901	0.04622	0.03161	0.03373
Gross 2011	1.4669	3.5996	4.2802	3.7275	5.1883	4.4738	5.866	5.5725	3.6187	3.8371	1.7177	0.7403
Auxiliary Consumption	0.03718	0.04635	0.05542	0.04827	0.05689	0.05188	0.05199	0.0613	0.052187	0.04718	0.03177	0.02824
Gross 2010	1.474	2.6622	3.444	4.2856	4.11	4.3022	5.1668	5.1562	5.1238	3.957	1.3538	0.6086
Auxiliary Consumption	0.02907	0.0405	0.04985	0.05596	0.05195	0.05403	0.0503	0.05157	0.05284	0.04638	0.03597	0.02992
Gross 2009	0	2.1312	3.6632	3.7216	3.5273	4.2405	5.0797	5.0469	4.6212	2.3312	2.3557	0.7774
Auxiliary Consumption	0.02941	0.04157	0.04518	0.04879	0.05018	0.04805	0.04826	0.04985	0.04618	0.03354	0.03253	0.02969
Gross 2008	0	0.7257	3.7922	0.0309	2.692	4.3046	5.8412	5.5035	2.6305	2.3369	1.752	1.6261
Auxiliary Consumption	0.02581	0.02515	0.04471	0.01646	0.04085	0.05639	0.06077	0.06298	0.04772	0.03209	0.04017	0.04579
Gross 2007	0	2.2161	2.8384	3.1012	4.2558	4.7168	4.377	4.396	4.1924	2.3736	1.4958	0.6754
Auxiliary Consumption	0.0256	0.0442	0.051	0.0512	0.0657	0.068	0.0572	0.05539	0.04722	0.03528	0.032	0.02951
Gross 2006	0.1053	2.7225	3.6716	4.5826	5.3438	5.4952	5.3316	4.2303	4.3216	4.7837	2.5705	1.7845
Auxiliary Consumption	0.02795	0.04406	0.0526	0.0564	0.0642	0.0608	0.0653	0.0725	0.0592	0.0602	0.0428	0.0392
Gross 2005	0	0.5784	1.3417	2.4494	3.7882	4.0728	3.269	3.7067	3.269	4.2048	1.9481	1.0964
Auxiliary Consumption	0.03109	0.02928	0.03275	0.03619	0.05281	0.059	0.06011	0.0665	0.06011	0.05931	0.0395	0.0368
Gross 2004	0.4017	1.7564	2.0561	0.8254	2.9621	3.7604	5.6253	5.2123	3.3685	0.99	0.5408	0.8511
Auxiliary Consumption	0.03327	0.04037	0.04193	0.02989	0.05133	0.0592	0.06051	0.0608	0.05171	0.02885	0.02836	0.03437
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NL	NIL
2012												
2011												
2010												
2009												
2008												
2007												
2006												
2005												
2004												

Remarks

This is Run-of-Canal type project that is located on a perrinial canal. This canal runs for 11 months every year. It is noted that since year 2010 there is flow and generation during January that mean all 12 months of the year

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
HPS Nandipur		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Khan Khwar HHP

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Khan Khwar HHP	72 (MW)	($10^6$$)	(¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
0.4 ($10^6 m^3$)	257 (m)	247 (m)	35.5 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1	34		
2	34		
3	4		
4			
5			
6			

F.O.R : Forced Outage Rate
C.O : Commercial Operation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	38	68	72	72	72	72	72	72	68	72	68	72
Firm Capacit (MW)												
Minimum output (MW)	4	4	32	34	26	24	10	4	10	0	0	0
Power generation (GWh)												
Gross 2013	0.786019	2.223013	5.034326	2.297544	4.204308	3.491054	26.02129	30.75811	17.79542	8.21561	8.62724	5.71421
Auxiliary Consumption	0.07111	0.08931	0.13176	0.13651	0.14316	0.13238	0.12577	0.16048	0.14791	0.13441	0.12097	0.11589
Gross 2012	5.37588	4.73206	0	20.07535	38.059818	24.2443	20.2104	22.601936	24.44881	9.49617	0.618024	0.721994
Auxiliary Consumption	0.228	0.155945	0.026299	0.057528	0.111427	0.08464	0.19424	0.125685	0.11966	0.07664	0.06131	0.06689
Gross 2011	4.34325	0	0	26.091378	0	27.42378	22.0014	14.42733	13.91	16.50639	14.05045	5.79811
Auxiliary Consumption							0.35	0.244	0.181	0.28989	0.253684	0.19785
Gross 2010											5.00209	
Auxiliary Consumption												
Gross 2009												
Auxiliary Consumption												
Gross 2008												
Auxiliary Consumption												
Gross 2007												
Auxiliary Consumption												
Gross 2006												
Auxiliary Consumption												
Gross 2005												
Auxiliary Consumption												
Gross 2004												
Auxiliary Consumption												
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013												
2012												
2011												
2010												
2009												
2008												
2007												
2006												
2005												
2004												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

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Questionnaire

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in Pakistan

<< DATA SHEETS >>

Duber Khwar HHP

Nippon Koei Co., Ltd.

Data Sheet <FORM-2> Existing power stations (hydro)

Hydro Power Plant Questionnaire (Without Reservoir) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Duber Khwar HHP	130 (MW)	24673.573 (10^6Rs)	(¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
0.37 (10^6m^3)	540 (m)	516 (m)	29 (m^3/sec)

Owner
WAPDA

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1	65		2014/03
2	65		2014/03
3			
4			
5			
6			

F.O.R : Forced Outage Rate
C.O : Commercial Operation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)			65	129	128	120	129	129	129	130	130	
Firm Capacit (MW)												
Minimum output (MW)			0	0	0	0	60	0	0	10	0	
Power generation (GWh)												
Gross 2014			15.0485	57.846	81.025	72.7496	82.1759	90.1879	53.7664	35.38	23.08	
Auxiliary Consumption												
Gross 2013												
Auxiliary Consumption												
Gross 2011												
Auxiliary Consumption												
Gross 2010												
Auxiliary Consumption												
Gross 2009												
Auxiliary Consumption												
Gross 2008												
Auxiliary Consumption												
Gross 2007												
Auxiliary Consumption												
Gross 2006												
Auxiliary Consumption												
Gross 2005												
Auxiliary Consumption												
Gross 2004												
Auxiliary Consumption												
Discharge without Generation												
Estimation (GWh or m^3)												
Result 2013												
2012												
2011												
2010												
2009												
2008												
2007												
2006												
2005												
2004												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	30					
Salvage Value	%	10					
Capital Cost	$/kW						
Construction	year	2014					
Fixed O&M	Rs/kW/mo.	75.89					
Variable O&M	Rs/MWh	77.1878					
Tax & Others	Mil. Rs	357.51					
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Patrind Hydro Power Project

Nippon Koei Co., Ltd.

Data Sheet <FORM-2A> Future power stations (hydro)

Future Hydro Power Plant Questionnaire (more than 50MW plant) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Patrind Hydro Power Project	150 (MW)	362 ($10^6$$)	8.2938 (¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
5.9 ($10^6 m^3$)	115.995 (m)	107.3 (m)	153.66 (m^3/sec)

Owner
Star Hydro Power Limited

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1	50		2017/03
2	50		2017/03
3	50		2017/03
4			
5			
6			

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	36.15	60.1	104.8	146.45	145.72	146.12	146.42	147.5	148.6	148.9	87.44	71.18
Minimum output (MW)	0	0	24.9	49.5	141.11	121.25	95.76	68.53	45.6	32.25	21.09	0
Firm Capacity (MW)												
Gross Monthly Generation (MWh)	12152.9	15571.06	40178.09	86483.5	109405.9	105861.3	107722.2	104025.2	66369.91	37393.11	25040.2	18995.83
Auxiliary Consumption (MWh)	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080	1080
Discharge without Generation (GWh or $m^{3/sec}$)												
Estimation Result												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Patrind Hydro Power Project	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	30					
Salvage Value	%	BOOT					
Capital Cost	$/kW	2415.9500					
Construction	year	2017					
Fixed O&M*	$/kW/mo.	2.3					
Variable O&M*	$/MWh	0.00000021					
Tax & Others	$/MWh	4.15					
Water Use	Rs/kWh	0.15					

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Kaigah Hydro Power Project

Nippon Koei Co., Ltd.

Data Sheet <FORM-2A> Future power stations (hydro)

Future Hydro Power Plant Questionnaire (more than 50MW plant) Hydro No.

Power Plant Name	Installed Capacity	Construction Cost	Generating Cost
Kaigah Hydro Power Project	545 (MW)	1564.8 ($10^6$$)	9.5 (¢/kWh)

Pondage Volume	Gross Head	Net Head	Design Flow
40.39 ($10^6 m^3$)	527.35 (m)	523.9 (m)	125 (m^3/sec)

Owner
Associated Technologies (Pvt) Ltd.

Unit No.	Unit size (MW)	F.O.R (%)	C.O yy/mm
1			
2			
3			
4			
5			
6			

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Firm Capacity (MW)												
Gross Monthly Generation (MWh)												
Auxiliary Consumption (MWh)												
Discharge without Generation (GWh or $m^{3/sec}$)												
Estimation Result												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Kaigah Hydro Power Project	1	2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%	10					
Life Time	year	30					
Salvage Value	%	10					
Capital Cost	$/kW	2871.1927					
Construction	year						
Fixed O&M*	$/kW/mo.						
Variable O&M*	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price			
			2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/ℓ)				($\$/k\ell$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan

free format

2) Output Data of the latest power sources development plan

free format

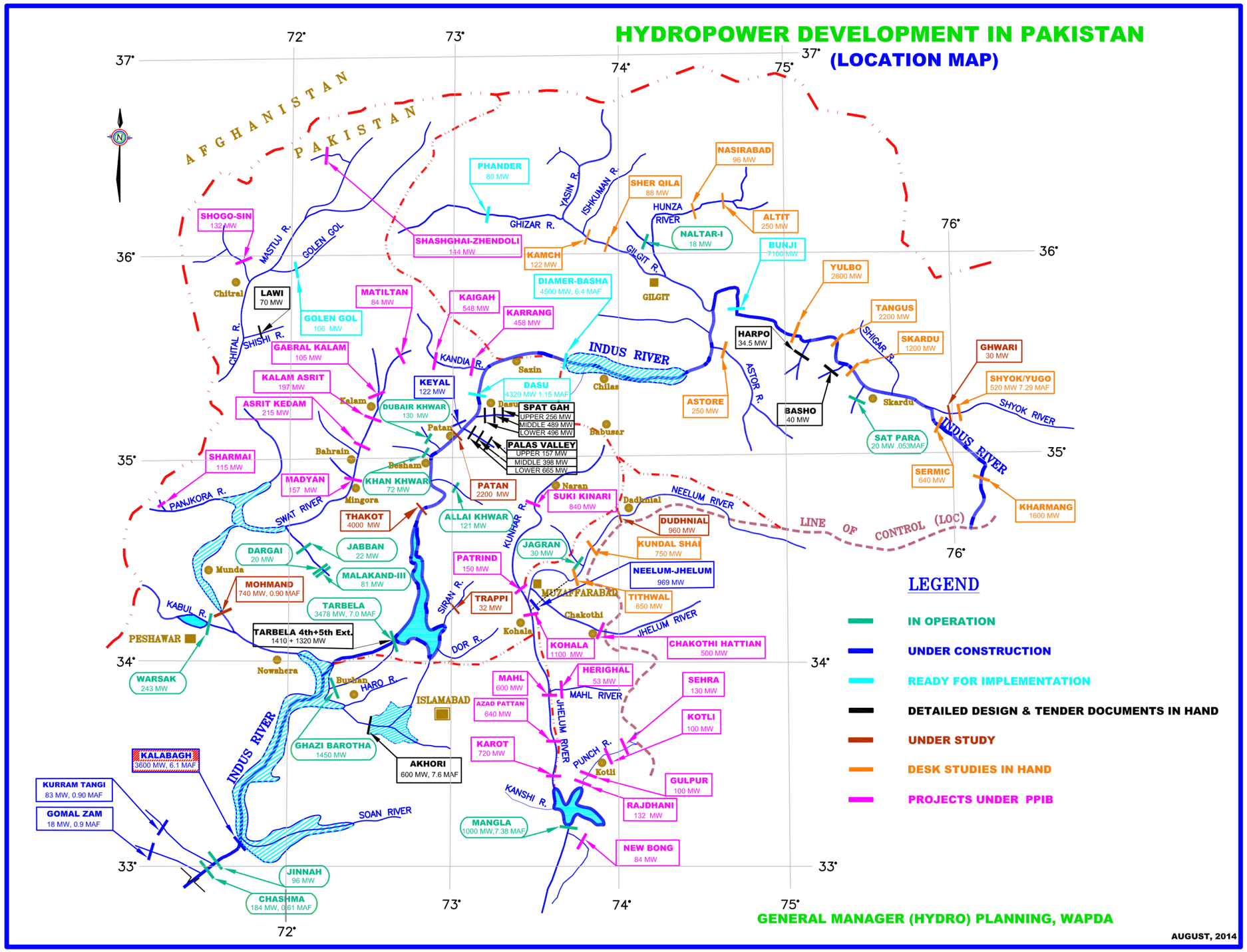
Appendix B-2

Hydropower Development in Pakistan (Location Map)

Issued by General Manager (Hydro) Planning, WAPDA

Appendix B-2:
Hydropower Development in Pakistan (Location Map)

(Issued by General Manager (Hydro) Planning, WAPDA)



Appendix B-3

Unit Data of Power Plants with Commissioning Date

(Hydro Power Plants)

Source: Power System Statistics 2013-2014 39th Edition, NTDC Planning

Appendix B-3-1:
Installed Generation Capacity (Existing Hydro)

(Source: Power System Statistics 2013-2014 39th Edition, NTDC Planning)

WAPDA Projects

(Unit: MW)

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity					Capability	
						No.		Capacity	Sub Total	Station Total	Summer	Winter
	Major Hydro Units											
1	Tarbela	Tarbela	K.P.K	Reservoir	Apr 1977	2	x	175	350	3478	3702	1874
					Jun 1977	1	x	175	175			
					Jul 1977	1	x	175	175			
					Aug 1982	1	x	175	175			
					Oct 1982	2	x	175	350			
					Dec 1982	1	x	175	175			
					Feb 1985	1	x	175	175			
					Apr 1985	1	x	175	175			
					May 1992	1	x	432	432			
					Jul 1992	1	x	432	432			
					Nov 1992	1	x	432	432			
					Feb 1993	1	x	432	432			
2	Mangla	Mangla	A.J.K	Reservoir	Jul 1967	2	x	100	200	1000	1120	450
					Mar 1968	1	x	100	100			
					Jun 1969	1	x	100	100			
					Dec 1973	1	x	100	100			
					Mar 1974	1	x	100	100			
					Jul 1981	2	x	100	200			
					Sep 1993	1	x	100	100			
					Jul 1994	1	x	100	100			
3	Warsak	Warsak	K.P.K	Reservoir	May 1960	2	x	40	80	243	190	20
					Jun 1960	1	x	40	40			
					Jul 1960	1	x	40	40			
					Dec 1980	1	x	41.48	41			
					Mar 1981	1	x	41.48	41			
4	Chashma	Chashma	Punjab	Low Head Power Channel	May 2001	8	x	23	184	184	184	184

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity				Capability	
						No.	Capacity	Sub Total	Station Total	Summer	Winter
5	Ghazi Barotha	Ghazi Barotha	Punjab		July 2003	1 x	290	290	1450	1450	1160
					Aug 2003	1 x	290	290			
					Oct 2003	1 x	290	290			
					Dec 2003	1 x	290	290			
					Apr 2004	1 x	290	290			
6	Khan Khwar	Shangla	K.P.K	Canal	Oct 2010	1 x	34	34	72	68	68
					Nov 2010	1 x	34	34			
						1 x	4	4			
7	Allai Khwar	Shangla	K.P.K	Canal	Mar.2013	2 x	60.5	121	121	68	68
8	Dubair Khwar	Shangla	K.P.K	Canal	Mar.2013	1 x	130.0	130	130	68	68
9	Jinnah	Mianwali	K.P.K	Canal	Mar.2012	1 x	12	12	96	68	68
					Oct.2012	1 x	12	12			
					Aug.2012	1 x	12	12			
					Mar.2013	1 x	12	12			
					Mar.2014	1 x	12	12			
						1 x	12	12			
						1 x	12	12			
						1 x	12	12			
					Sub-Total Major Hydro Units				6774	6918	3960

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity				Capability	
						No.	Capacity	Sub Total	Station Total	Summer	Winter
	Small Hydro Units										
10	Dargai	Dargai	K.P.K	Canal	Dec 1952	4	x 5	20	20		
11	Malakand *	Malakand	K.P.K	Canal	Jul 1938	3	x 3.2	10	0		
					Oct 1952	2	x 5	10			
12	Rasul	Rasul	Punjab	Canal	Jul 1952	2	x 11	22	22		
13	Chichoki-Mallian	Chichoki-Mallian	Punjab	Canal	May 1959	1	x 4.4	4.4	13		
					Jun 1959	1	x 4.4	4.4			
					Aug 1959	1	x 4.4	4.4			
14	Shadiwal	Shadiwal	Punjab	Canal	Jan 1961	2	x 6.75	13.5	13.5		
15	Nandipur	Nandipur	Punjab	Canal	Mar 1963	3	x 4.60	13.80	13.80	128	41
16	Kurram Garhi	Kurram Garhi	K.P.K	Canal	Feb 1958	4	x 1.00	4	4.00		
17	Renala	Renala	Punjab	Canal	Mar 1925	5	x 0.22	1	1.10		
18	Chitral	Chitral	K.P.K	Canal	1975	2	x 0.30	0.6	1		
					1982	2	x 0.20	0.4			
19	Gomal Zam	North Wazirista	K.P.K	Canal	Jun 2013	2	x 8.70	17	17.40		
20	Jabban	Malakand	K.P.K	Canal	Jul 2013	1	x 5.5	5.5	22		
					Oct 2013	1	x 5.5	5.5			
					Nov 2013	1	x 5.5	5.5			
					Dec 2013	1	x 5.5	5.5			
					Sub-Total Small Hydro Units				128	128	41
					Total Hydro Units (WAPDA)				6902	7046	4001

* Malakand power house was burnt totally in Nov-2006 and is now being rebuilt.

PPIB Projects

(Unit: MW)

Sr. No.	Name of Power Station	Location	Province	Type of Power Station	Date of Commissioning	Installed Capacity				Derated Capacity	Fuel Type	
						No.	Capacity	Sub Total	Company Total		Primary	Alternate
	Hydro (IPPs)											
30	Jagran (AJK)	Jagran (AJK)	A.J.K	Hydro	Oct-2000	5	x 6	30.0	30.0	30	HYD	HYD
31	Malakand-III	Malakand-III	K.P.K	Hydro	Nov-2008	3	x 27	81.0	81.0	81	HYD	HYD
32	Laraib/New Bong Esc.		A.J.K	Hydro	Mar-2013	4	x 21	84.0	84.0	84	HYD	HYD
					Sub total (Private)				195	195		

Appendix B-3-2:
Energy Generation from 2009/10-2013/14

(Source: Power System Statistics 2013-2014 39th Edition, NTDC Planning)

WAPDA Projects

(Unit: GWh)

Sr. No.	Power Station	Installed Capacity (MW)	2009/10	2010/11	2011/12	2012/13	2013/14
1	Tarbela	3,478	13,905	15,909	14,057	14,756	15,138
2	Mangla	1,000	4,772	5,969	4,666	4,577	5,725
3	Warsak	243	1,063	1,036	991	1,034	870
4	Ghazi Barotha	1,450	6,796	7,354	6,979	7,083	6,937
5	Chashma low Head	184	1,058	1,001	1,016	1,115	1,024
6	Khan Khwar	72	0	114	179	288	257
7	Allai Khwar	121	0	0	0	0	470
8	Jinnah	96	0	0	0	189	291
9	Rasul	22	91	96	68	48	51
10	Dargai	20.0	111	83	84	94	89
11	Malakand-jabban	22.5	0	0	0	2	73
12	Nandipur	13.8	39	43	42	49	41
13	Chichoki	13.2	30	32	34	40	36
14	Shadiwal	13.5	39	32	33	31	30
15	Kurrum Garhi	4.0	16	10	11	14	19
16	Renala	1.1	3	3	3	3	3
17	Chitral	1.0	4	3	4	4	4
18	Gomal Zam	17.4	0	0	0	0	26
19	Others	***	0	0	40	0	120
	Total		**27,927**	**31,685**	**28,206**	**29,326**	**31,204**

PPIB Projects

(Unit: GWh)

Sr. No.	Power Station	Installed Capacity (MW)	2009/10	2010/11	2011/12	2012/13	2013/14
1	Jagran (AJK)	30	135	0	57	107	105
2	Malakand-III Hydel	81	430	292	337	395	409
3	Pehure	***	0	13	42	45	51
4	Laraib (New Bong Escape)	84	0	0	0	159	470
	Total		**565**	**305**	**436**	**706**	**1,035**

Appendix B-3-3:
Cost of Generation from 2009/10-2013/14

(Source: Power System Statistics 2012-2013 38th Edition, and Power System Statistics 2013-2014 39th Edition, NTDC Planning)

WAPDA Projects

(Unit: Paisa/kWh)

Sr. No.	Power Station	Installed Capacity (MW)	2009/10	2010/11	2011/12	2012/13	2013/14
1	Tarbela	3,478	33.40	76.79	113.00	102.00	96.00
2	Mangla	1,000	76.70		95.00	96.00	64.00
3	Warsak	243	43.80		81.00	126.00	135.00
4	Ghazi Barotha	1,450	107.80		109.00	107.00	103.00
5	Chashma low Head	184	136.60		162.00	170.00	177.00
6	Khan Khwar	72	***		190.00	276.00	236.00
7	Allai Khwar	121	***		***	***	128.00
8	Jinnah	96	***		120.00	190.00	147.00
9	Rasul	22	54.60		104.00	169.00	179.00
10	Dargai	20.0	76.20		112.00	117.00	137.00
11	Malakand-jabban	22.5	***		***	***	***
12	Nandipur	13.8	116.40		140.00	149.00	204.00
13	Chichoki	13.2	119.90		165.00	147.00	175.00
14	Shadiwal	13.5	85.60		137.00	152.00	175.00
15	Kurrum Garhi	4.0	123.50		321.00	252.00	244.00
16	Renala	1.1	334.00		492.00	617.00	917.00
17	Chitral	1.0	533.80		1,161.00	795.00	1,104.00
18	Gomal Zam	17.4	***		***	***	955.00

Appendix B-3-4:
Plant Factor from 2009/10-2013/14

(Source: Power System Statistics 2012-2013 38th Edition, and Power System Statistics 2013-2014 39th Edition, NTDC Planning)

WAPDA Projects

(Unit: %)

Sr. No.	Power Station	Installed Capacity (MW)	2009/10	2010/11	2011/12	2012/13	2013/14
1	Tarbela	3,478	45.64	52.54	46.17	48.41	49.70
2	Mangla	1,000	54.47	69.72	54.64	53.66	66.80
3	Warsak	243	49.95	48.89	46.44	48.41	43.80
4	Ghazi Barotha	1,450	53.50	58.53	55.43	56.25	55.00
5	Chashma low Head	184	65.64	62.69	66.49	68.40	63.80
6	Khan Khwar	72	***	***	28.22	46.91	41.20
7	Allai Khwar	121	***	***	***	***	44.30
8	Jinnah	96	***	***	***	23.96	35.20
9	Rasul	22	47.22	52.40	35.21	25.61	27.20
10	Dargai	20.0	63.36	47.38	48.18	55.04	51.00
11	Malakand-jabban	22.5	***	***	***	***	38.40
12	Nandipur	13.8	33.26	36.48	34.66	41.57	34.70
13	Chichoki	13.2	25.94	39.85	29.74	37.17	31.60
14	Shadiwal	13.5	32.98	27.73	27.55	26.49	25.90
15	Kurrum Garhi	4.0	45.66	34.39	31.50	40.66	54.30
16	Renala	1.1	31.13	29.67	29.85	32.62	30.60
17	Chitral	1.0	45.66	39.36	39.79	42.16	41.90
18	Gomal Zam	17.4	***	***	***	***	17.00

PPIB Projects

(Unit: %)

Sr. No.	Power Station	Installed Capacity (MW)	2009/10	2010/11	2011/12	2012/13	2013/14
1	Jagran (AJK)	30					39.94
2	Malakand-III Hydel	81					54.51
3	Pehure	***					32.58
4	Laraib (New Bong Escape)	84					63.91

Appendix C-1

Collected Data Sheet (Renewable Energy)

Result of Data Collection (Existing Plant)

Sr. No.	Name of Company	Installed Capacity (MW)	Result of Data Collection
	Wind		
1	Fauji Fertilizer Company Energy Ltd.	49.5	Not collected
2	Zorlu Enerji Pakistan Ltd.	56.4	Collected
3	Three Gorges Wind Farm	50.0	Not collected
	Biomass		
1	JDW-II	26.35	Not collected
2	JDW-III	26.35	Not collected

Other Collected Data (Ongoing Project / Development Plan)

Sr. No.	Name of Company	Installed Capacity (MW)	Result of Data Collection
	Wind (Ongoing Project)		
1	Foundation Wind Energy-I Ltd.	50.0	Collected
2	Foundation Wind Energy-II Ltd.	50.0	Collected
	Wind (Development Plan)		
1	Tenaga Generasi Limited	49.6	Collected
9	Jhimpir Wind Power Limited	49.6	Collected
17	Burj Wind Energy (Pvt) Limited	13.5	Collected

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Wind

Nippon Koei Co., Ltd.

for Wind power stations in commercial operation only

Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
ZORLU WIND POWER PLANT	56.4 (MW)	($10^6$$)	(¢/kWh)

Tower Height	Annual Plant Factor	Location
Vensy: 69 Meters Vestas 80 Meters	33%	Jhimphir, Thatta Sindh, Pakistan

Owner
Zorlu Energy Pakistan limited

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2013/July	1.8 & 1.2	28 +5= 33	56.4

C. O : Commercial Operation

	January-14	Feb.14	Mar.14	Apr.14	May-14	June-14	July-14	August-14	September-14	October-14	November-14	December-14
Maximum output (MW)	52	49.29	51.1	51.2	51.4	51.34	51.42	51.1	50.94	51.21	49.52	
Minimum output (MW)	0	0	0	0	0	0	0	0	0	0	0	
Maximum Wind Speed (m/s)	11.8	9.11	9.4	10.09	12.68	17.23	16.53	13.96	14.98	9.89	10.09	
Minimum Wind Speed (m/s)	2.67	2.67	4.1	4.34	5.3	6.21	4.57	4.19	5.76	2.73	2.48	
Average Wind Speed (m/s)	6.17	5.6	5.92	6.77	8.38	10.63	10.63	8.99	9.11	5.63	5.47	
	January-13	Feb.13	Mar.13	Apr.13	May-13	June-13	July-13	August-13	September-13	October-13	November-13	December-13
Maximum output (MW)							51.66	51.3	50.7	48.88	51.02	47
Minimum output (MW)							3.72	0	0	0	0	0
Maximum Wind Speed (m/s)							10.89	12.18	11.49	8.15	8.98	9.07
Minimum Wind Speed (m/s)							7.41	4.09	4.25	3.19	2.34	3.08
Average Wind Speed (m/s)							9.38	8.9	7.44	5.68	5.19	5.69
Power generation (GWh)												
Gross generation 2014	9.878	6.824	8.086	10.544	17.184	22.836	27.081	20.765	20.246	6.833	6.991	
Sold Electricity to Grid	9.859	6.703	7.921	10.370	16.880	22.448	26.640	20.422	19.952	6.683	6.861	
Gross generation 2013							4.439	20.517	13.722	6.788	6.332	7.670
Sold Electricity to Grid							4.410	21.112	13.477	6.651	6.230	7.533
Gross generation 2012												
Sold Electricity to Grid												
Gross generation 2011												
Sold Electricity to Grid												
Gross generation 2010												
Sold Electricity to Grid												
Gross generation 2009												
Sold Electricity to Grid												
Gross generation 2008												
Sold Electricity to Grid												
Gross generation 2007												
Sold Electricity to Grid												
Gross generation 2006												
Sold Electricity to Grid												
Gross generation 2005												
Sold Electricity to Grid												
Gross generation 2004												
Sold Electricity to Grid												

Existing Plants

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
	(MW)	($10^6$$)	(¢/kWh)

Tower Height	Annual Plant Factor	Location
(m)	(%)	

Owner

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1				
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)												
Gross Monthly Generation (MWh)												
Electricity to be sold to Grid (MWh)												

Remarks

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						
Life Time	year						
Salvage Value	%						
Capital Cost	$/kW						
Construction	year						
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3 Nm^3$)
Diesel		(kcal/*l*)				($/k*l*)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Wind

Nippon Koei Co., Ltd.

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
Foundation Wind Energy-1 Ltd	50 (MW)	125.899 ($10^6$$)	14.1359 (¢/kWh)

Tower Height	Annual Plant Factor	Location
80 (m)	32.99% (%)	Gharo, Thatta Sindh, Pakistan

Owner
Foundation Wind Energy (Pvt) Ltd

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2015/Jan	2.5	20	50
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)												
Gross Monthly Generation (MWh)	5,500.00	5,800.00	7,000.00	12,600.00	20,800.00	23,800.00	19,200.00	22,500.00	15,800.00	3,500.00	2,700.00	5,400.00
Electricity to be sold to Grid (MWh)												

Remarks

Average Annual Wind Speed 7.3m/sec

Ongoing Project

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Foundation Wind Energy-1 Ltd		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						10
Life Time	year						30
Salvage Value	%						
Capital Cost	$/kW						2517.98
Construction	year						2015
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3 Nm^3$)
Diesel		(kcal/*l*)				($/k*l*)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

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Questionnaire

for

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Wind

Nippon Koei Co., Ltd.

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
Foundation Wind Energy-11 Ltd	50 (MW)	124.907 ($10^6$$)	14.1164 (¢/kWh)

Tower Height	Annual Plant Factor	Location
80 (m)	32.99% (%)	Gharo, Thatta Sindh, Pakistan

Owner
Foundation Wind Energy (Pvt) Ltd

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2014/Dec	2.5	20	50
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)												
Gross Monthly Generation (MWh)	5,700.00	6,090.00	7,250.00	12,890.00	19,820.00	22,160.00	18,260.00	21,090.00	15,410.00	3,770.00	2,700.00	5,380.00
Electricity to be sold to Grid (MWh)												

Remarks

Average Annual Wind Speed 7.3m/sec

Ongoing Project

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Foundation Wind Energy-11 Ltd		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						10
Life Time	year						30
Salvage Value	%						
Capital Cost	$/kW						2498.14
Construction	year						2014
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3 Nm^3$)
Diesel		(kcal/*l*)				($/k*l*)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
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2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Wind

Nippon Koei Co., Ltd.

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
Tenaga Generasi Limited	49.6 (MW)	120 ($10^6$$)	14.136 (¢/kWh)

Tower Height	Annual Plant Factor	Location
82.5 (m)	32.00% (%)	Kuttikun, Thatta Sindh, Pakistan

Owner
Tenaga Generasi Limited

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2016/Oct	1.6	31	49.6
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5
Minimum output (MW)	40	40	40	49.5	49.5	49.5	49.5	49.5	49.5	49.5	40	40
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)	5.4	5.7	5.9	7.6	9.8	11.3	9.2	10.3	8.4	4.8	4.4	5.3
Gross Monthly Generation (MWh)	7,996.80	6,281.20	6,965.60	12,253.10	19,715.60	22,387.50	18,759.30	19,903.10	15,018.70	3,553.10	3,271.80	7,050.00
Electricity to be sold to Grid (MWh)	7,597.03	5,967.10	6,617.30	11,640.40	18,729.80	21,268.10	17,821.40	18,907.90	14,267.80	3,375.40	3,108.20	6,697.00

Remarks

Development Plan

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Tenaga Generasi Limited		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						10
Life Time	year						30
Salvage Value	%						
Capital Cost	$/kW						2419.3548
Construction	year						2016
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		($kcal/Nm^3$)				($\$/10^3Nm^3$)
Diesel		(kcal/*l*)				($\$/kl$)
Coal		(kcal/kg)				($\$/10^3kg$)
RFO/HSFO		(kcal/kg)				($\$/10^3kg$)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Wind

Nippon Koei Co., Ltd.

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
Jhimpir Power (Pvt) Ltd	49.6 (MW)	130 ($10^6$$)	13.5 (¢/kWh)

Tower Height	Annual Plant Factor	Location
80 (m)	36.70% (%)	Jhimpir, Thatta Sindh, Pakistan

Owner
Burj Capital (Pvt) Ltd

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2016/Jun	1.6	31	49.6
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)	6.18	7.12	6.66	6.95	10.37	9.53	11.8	9.97	7.18	5.6	5.32	6.77
Gross Monthly Generation (MWh)	8,879.77	10,376.12	10,644.62	10,865.13	21,333.01	18,315.50	26,149.82	20,816.17	11,891.93	6,664.52	5,345.33	11,479.70
Electricity to be sold to Grid (MWh)												

Remarks

Development Plan

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Jhimpir Power (Pvt) Ltd		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						10
Life Time	year						30
Salvage Value	%						
Capital Cost	$/kW						2620.9677
Construction	year						2016
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3 Nm^3$)
Diesel		(kcal/*l*)				($/k*l*)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

Questionnaire

for

Least Cost Generation and Transmission
Expansion Plan (Plant Capacity Analysis)
in Pakistan

<< DATA SHEETS >>

Wind

Nippon Koei Co., Ltd.

Data Sheet <FORM-4A> Future power stations (Wind)

for Wind power stations of which the feasibility study in the official process after Letter of Intent (LOI) being given from the responsible organization has been completed.

Future Wind Power Plant Questionnaire

Wind No.

Power Plant Name	Total Installed Capacity	Construction Cost	Generating Cost
Burj Wind Energy (Pvt) Ltd	13.5 (MW)	40 ($10^6$$)	16 (¢/kWh)

Tower Height	Annual Plant Factor	Location
85 (m)	36.00% (%)	Gujju, Thatta Sindh, Pakistan

Owner
Burj Capital (Pvt) Ltd

Completion Phase	Commence-ment of C.O (yy/mm)	Unit Capacity (MW)	Number of wind mill (nos)	Capacity in Phase (MW)
1	2016/May	1.5	9	13.5
2				

C. O : Commercial Operation

Plan of Generation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum output (MW)												
Minimum output (MW)												
Maximum Wind Speed (m/s)												
Minimum Wind Speed (m/s)												
Average Wind Speed (m/s)	5.39	6.19	6.28	6.76	9.94	9.66	8.82	7.87	7.48	5.52	5.5	6.16
Gross Monthly Generation (MWh)	2,190.00	2,900.00	3,132.00	3,584.00	7,693.00	4,622.00	6,351.00	5,055.00	3,617.00	2,107.00	2,282.00	2,987.00
Electricity to be sold to Grid (MWh)	2,017.00	2,486.00	2,884.00	3,300.00	7,084.00	4,256.00	5,848.00	4,655.00	3,331.00	1,904.00	1,940.00	2,750.00

Remarks

Development Plan

Data Sheet <FORM-3> Simulation data of demand-and-supply operation

1. Assumptions for economic analysis

Power Plant Name	Unit No.	Reporting Year
Burj Wind Energy (Pvt) Ltd		2014

1) Fixed Costs

	unit	Hydro	Gas	Diesel	RFO/HSFO	Coal	Others
Discount Rate	%						10
Life Time	year						30
Salvage Value	%						
Capital Cost	$/kW						2962.9630
Construction	year						2016
Fixed O&M	$/kW/mo.						
Variable O&M	$/MWh						
Tax & Others	$/MWh						
Fuel Use	(%)						

2) Fuel Costs

Type	Heat value (LHV)		Unit Price 2005	2010	2013	
Gas		(kcal/Nm^3)				($/$10^3 Nm^3$)
Diesel		(kcal/*l*)				($/k*l*)
Coal		(kcal/kg)				($/$10^3$kg)
RFO/HSFO		(kcal/kg)				($/$10^3$kg)
Others						

2. WASP Simulation Data

1) Input Data of the latest power sources development plan
free format

2) Output Data of the latest power sources development plan
free format

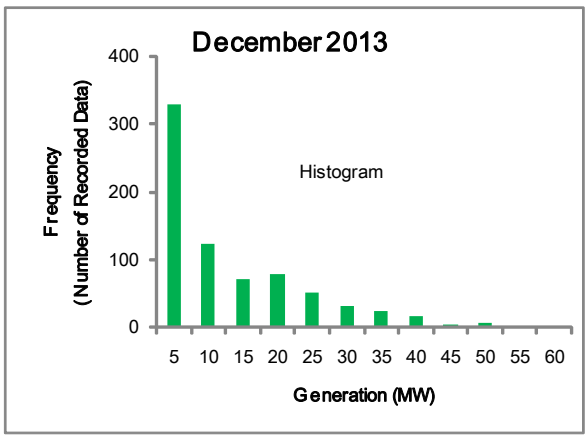
Appendix C-2

Monthly Histogram and Standard Deviation of Generation by Zorlu Wind Farm

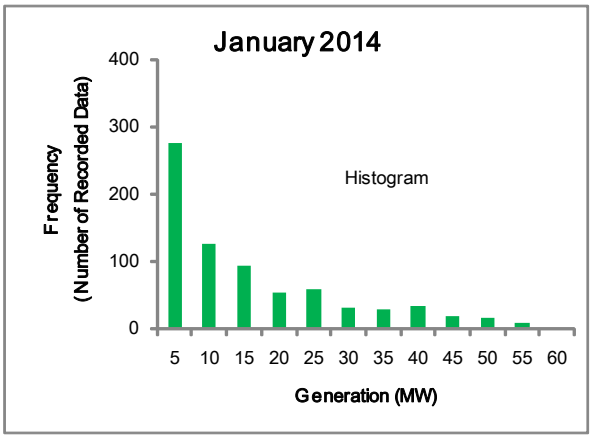
(Source: Prepared by the JICA Study Team based on the data collected at Zorlu Wind Farm)

Appendix C-2:
Monthly Histogram and Standard Deviation of Generation by Zorlu Wind Farm

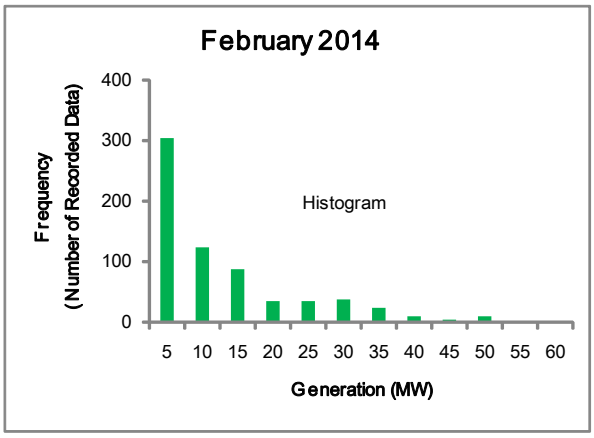
(Source: Prepared by the JICA Study Team based on the data collected at Zorlu Wind Farm)



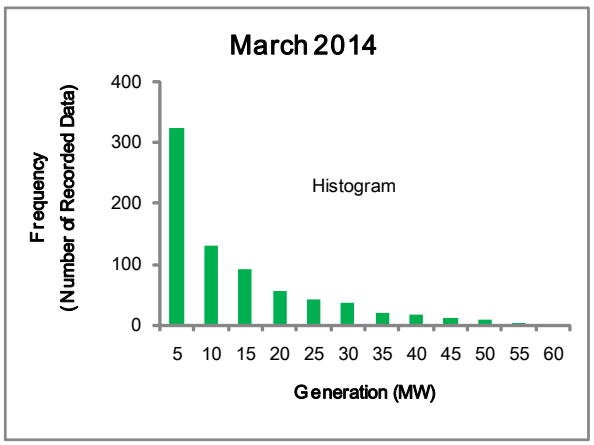
Number of Data:	744	
Data Record Interval:	1 hour	
Average:	10.13	MW
Standard Deviation:	10.93	MW



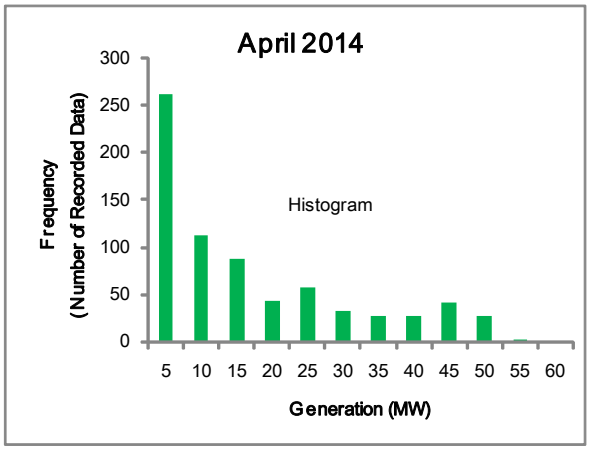
Number of Data:	744	
Data Record Interval:	1 hour	
Average:	13.25	MW
Standard Deviation:	13.38	MW



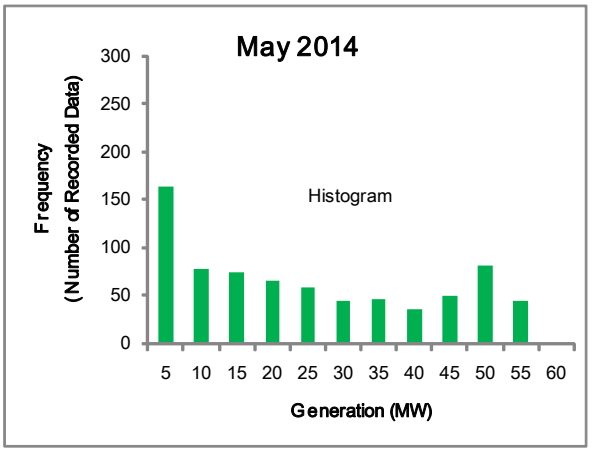
Number of Data:	672	
Data Record Interval:	1 hour	
Average:	9.97	MW
Standard Deviation:	11.17	MW



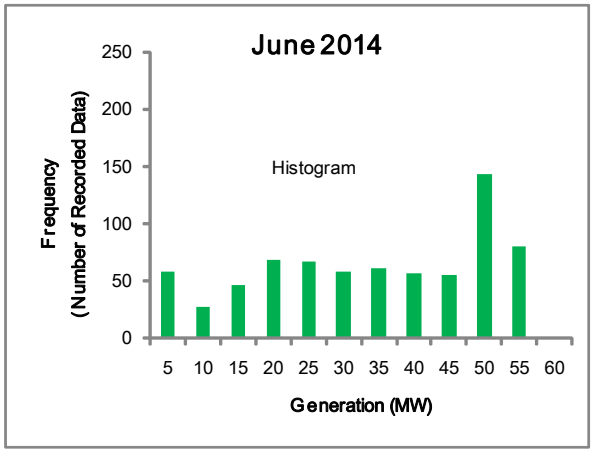
Number of Data:	744	
Data Record Interval:	1 hour	
Average:	10.64	MW
Standard Deviation:	11.66	MW



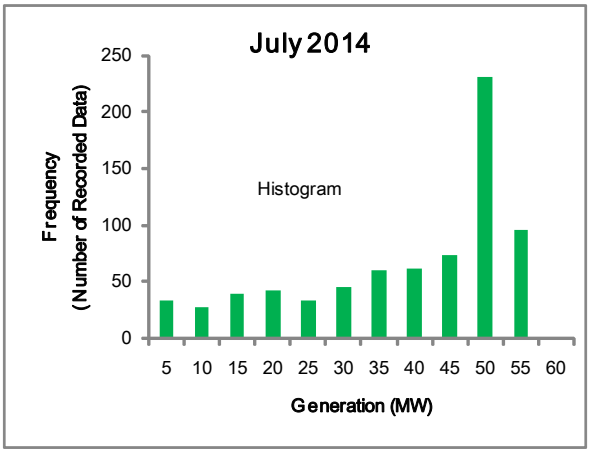
Number of Data:	720	
Data Record Interval:	1 hour	
Average:	14.22	MW
Standard Deviation:	14.36	MW



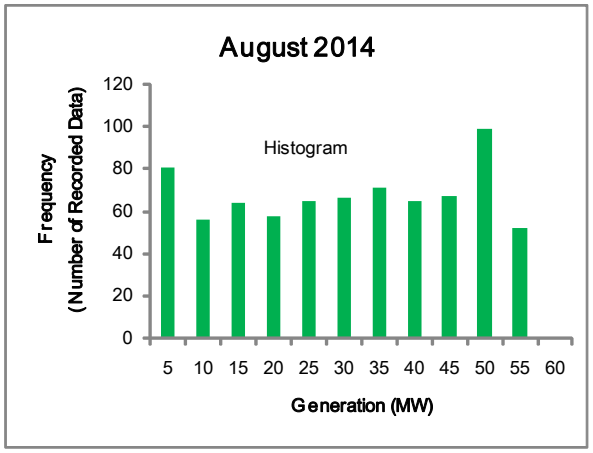
Number of Data:	744	
Data Record Interval:	1 hour	
Average:	22.25	MW
Standard Deviation:	17.39	MW



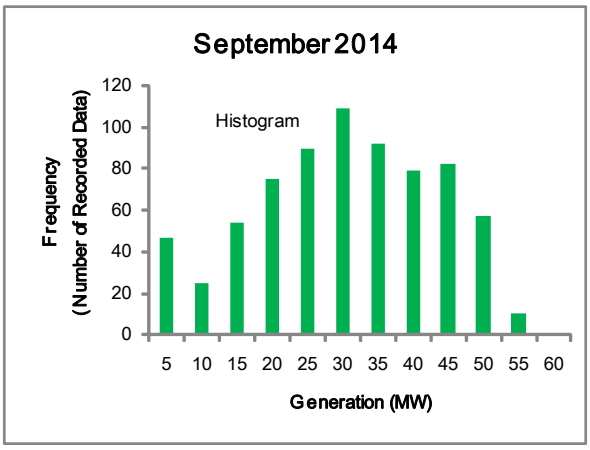
Number of Data:	720
Data Record Interval:	1 hour
Average:	31.34 MW
Standard Deviation:	15.93 MW



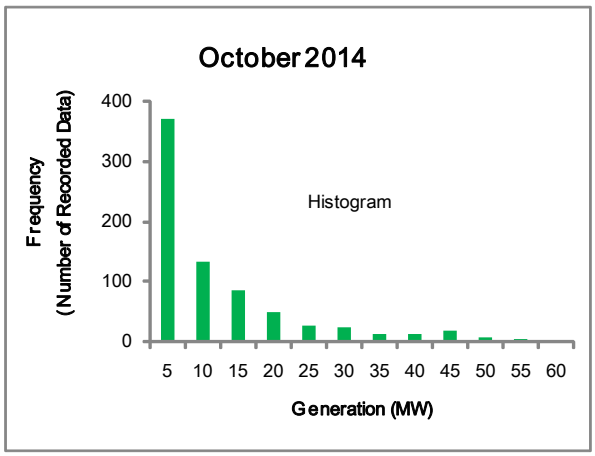
Number of Data:	744
Data Record Interval:	1 hour
Average:	36.06 MW
Standard Deviation:	15.07 MW



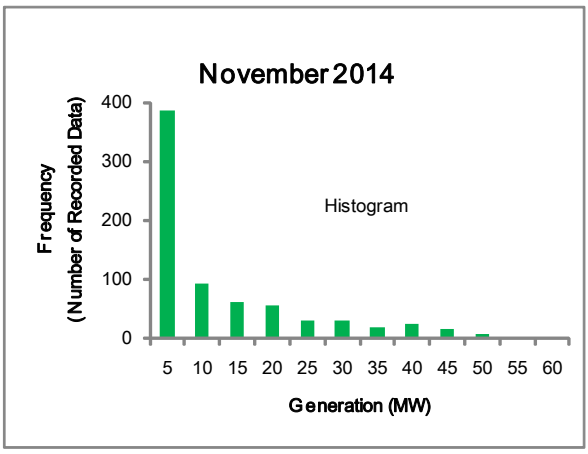
Number of Data:	744
Data Record Interval:	1 hour
Average:	27.67 MW
Standard Deviation:	16.01 MW



Number of Data:	720
Data Record Interval:	1 hour
Average:	27.70 MW
Standard Deviation:	12.96 MW



Number of Data:	744
Data Record Interval:	1 hour
Average:	9.04 MW
Standard Deviation:	11.14 MW



Number of Data:	720
Data Record Interval:	1 hour
Average:	9.50 MW
Standard Deviation:	11.97 MW

Appendix D

Energy Infrastructure Map - 2012

Issued by DG PC Ministry of Petroleum & Natural Resources)

Directorate General of Petroleum Concessions

PPIS Pakistan Petroleum Information Service

Energy Infrastructure Map - 2012

PRIMARY ENERGY SUPPLIES AND FINAL CONSUMPTION BALANCES (2010-2011) (Unit - Million TOE)**

Indigenous Supplies	
Crude Oil	3.23
Gas	30.67
LPG	0.27
Coal	1.54
Hydro Electricity	7.59
Nuclear Electricity	0.82
Total	**44.12**
Imports	
Crude Oil	6.88
Pet. Products	12.50
LPG	0.07
Coal	2.81
Electricity	0.06
Total	**22.32**

Gross Energy Supply 66.44

Less Exports, Bunkers & Stock Changes -1.92

Net Primary Energy Supply 64.52

Less Transformations, Distribution Losses & Non-Energy Uses -25.68

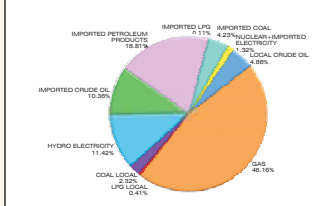
Net Energy Supply 38.84

Energy Consumed By Sector	
Domestic	8.72
Commercial	1.52
Industrial	14.96
Agriculture	0.77
Transport	12.02
Other Govt.	0.85
Net Consumption	**38.84**
By Source*	
Oil	11.25
Gas	16.78
LPG	0.50
Coal	4.03
Electricity	6.28
Net Consumption	**38.84**

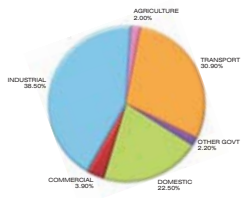
*Excluding Consumption for Power Generation and Feed Stock

Net Energy Consumed 38.84

GROSS ENERGY SUPPLIES
Total : 66.44 Million TOE

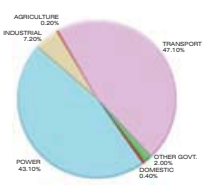


SECTORAL ENERGY CONSUMPTION
(Excluding fuels consumed in thermal power generation)
Total : 38.84 Million TOE

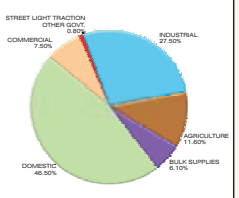


SECTORAL ENERGY CONSUMPTION BY SOURCE

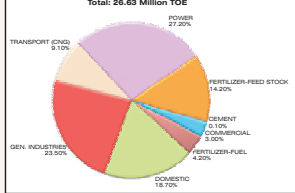
OIL CONSUMPTION
Total: 18.89 Million TOE



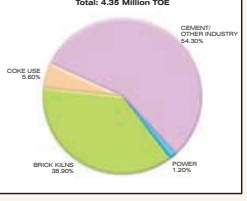
ELECTRICITY CONSUMPTION
Total: 6.28 Million TOE



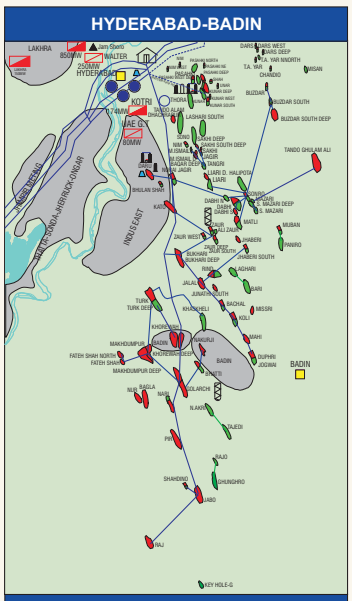
GAS CONSUMPTION
Total: 26.63 Million TOE



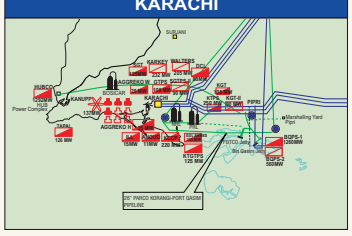
COAL CONSUMPTION
Total: 4.35 Million TOE



HYDERABAD-BADIN



KARACHI



INSTALLED CAPACITY OF ELECTRICITY GENERATION BY SOURCE
2010-2011 (Unit- Mw)

WAPDA (Hydel)	6,481
PEPCO (Thermal)	4,900
IPP's (Thermal)	8,363
Nuclear	787
KESC (Thermal)	1946
Total	**22,477**

ENERGY RESERVES & PRODUCTION
2010-2011

PRODUCT	RESERVES	PRODUCTION
OIL (MBBLS)	264.012	24.041
GAS (BCF)	27500.486	1471.590
COAL (Million Tonnes)	3450.000	3.45

LEGEND

- SNGPL GAS PIPELINE EXISTING
- SNGPL GAS PIPELINE PLANNED
- SSGCL GAS PIPELINE EXISTING
- SSGCL GAS PIPELINE PLANNED
- HEAD QUARTER (HQ) / TERMINAL
- REPEATER / TERMINAL STATION
- PURIFICATION PLANT
- PURIFICATION PLANT UNDER CONST.
- COMPRESSOR STATION
- COMPRESSOR STATION UNDER CONST.
- CRUDE OIL PIPELINE EXISTING
- REFINED OIL PIPELINE EXISTING
- OIL PIPELINE UNDER CONST./PLANNED
- OIL REFINERY EXISTING
- OIL REFINERY UNDER CONSTRUCTION
- CONDENSATE PLANT
- CONDENSATE PLANT UNDER CONST.
- LPG PLANT
- LPG / NGL PLANT
- LPG PLANT PLANNED/UNDER CONST.
- AVIATION FUELING FACILITY
- OIL STORAGE EXISTING
- OIL STORAGE PLANNED

POWER STATIONS EXISTING
- HYDEL
- THERMAL
- NUCLEAR
- WIND
- OTHER FUELS

POWER STATIONS PROPOSED/UNDER CONSTRUCTION
- HYDEL
- THERMAL
- NUCLEAR
- WIND
- OTHER FUELS

- OIL FIELDS
- GAS FIELDS
- CONDENSATE FIELDS
- EXISTING COAL FIELDS
- COAL OCCURANCES
- CITIES
- TOWN

ABBREVIATIONS

MMBBLS	Million US Barrels
BCF	Billion Cubic Feet
Mw	Megawatt
TOE	Tonnes of Oil Equivalent

**Source: Pakistan Energy Year Book 2011

JAMMU&KASHMIR (Disputed Territory)

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