MATERIAL TESTING SERVICES (PTY) LTD

Head office Laboratory
P.O. BOX 2069
GABORONE
TEL: 3913285
FAX: 3957577
VAT NO. C00762901112

FRANCISTOWN BRANCH
PO BOX 878
FRANCISTOWN
TEL: 2412568
FAX: 24127354
VAT: C00762901112

DPSH AND SPT RECORD SHEET

FIELD DATA

TEST	DEPTH	BLOWS	TEST	DEPTH	BLOWS
CPT	0.3	46	CPT	5.55	
	0.6	29		5.85	
	0.9	12		6.15	
	1.2	10		6.45	
	1.5	9		-	
SPT	75	3	SPT	75	
	75	3		75	
	75	2		75	
	75	3 (N = 13)		75	
	75	3		75	
	75/1.95m	2		75/6.9m	
CPT	2.25	7	CPT	7.2	
	2.55	24		7.5	
	2.85	64		7.8	
	3.15	71		8.1	
SPT	75	50	SPT	75	
	75			75	
	75			75	
	75	(N = Refusal)		75	
	75			75	
	75/3.60m			75/8.55m	
CPT	3.9	100	CPT	8.85	
	4.2	Refusal @ 3.22m		9.15	
	4.5			9.45	
	4.8			9.75	
SPT	75		SPT	75	
	75			75	
	75			75	
	75			75	
	75			75	
	75/5.25m			75/8.55m	

HOLE NO / CHAINAGE: **Test No. 3**

PROJECT: **Morupule A Power Station A – Rehabilitation & Pollution Abatement**

CLIENT: **Bauer Consult (Pty) Ltd**

TECHNICIAN: **Joel** DATE: **14th April 2011**

MATERIAL TESTING SERVICES (PTY) LTD

Head office Laboratory
P.O. BOX 2069
GABORONE
TEL: 3913285
FAX: 3957577
VAT NO. C00762901112

FRANCISTOWN BRANCH
PO BOX 878
FRANCISTOWN
TEL: 2412568
FAX: 24127354
VAT: C00762901112

DPSH AND SPT RECORD SHEET

FIELD DATA

TEST	DEPTH	BLOWS	TEST	DEPTH	BLOWS
CPT	0.3	45	CPT	5.55	
	0.6	61		5.85	
	0.9	26		6.15	
	1.2	14		6.45	
	1.5	12		-	
SPT	75	3	SPT	75	
	75	3		75	
	75	3		75	
	75	3 (N = 15)		75	
	75	3		75	
	75/1.95m	3		75/6.9m	
CPT	2.25	12	CPT	7.2	
	2.55	12		7.5	
	2.85	12		7.8	
	3.15	100		8.1	
SPT	75	Refusal @ 3.03	SPT	75	
	75			75	
	75			75	
	75			75	
	75			75	
	75/3.60m			75/8.55m	
CPT	3.9		CPT	8.85	
	4.2			9.15	
	4.5			9.45	
	4.8			9.75	
SPT	75		SPT	75	
	75			75	
	75			75	
	75			75	
	75			75	
	75/5.25m			75/8.55m	

HOLE NO / CHAINAGE: **Test No. 4**

PROJECT: **Morupule A Power Station A – Rehabilitation & Pollution Abatement**

CLIENT: **Bauer Consult (Pty) Ltd**

TECHNICIAN: **Joel** DATE: **14th April 2011**

MATERIAL TESTING SERVICES (PTY) LTD

Head office Laboratory
P.O. BOX 2069
GABORONE
TEL: 3913285
FAX: 3957577
VAT NO. C00762901112

FRANCISTOWN BRANCH
PO BOX 878
FRANCISTOWN
TEL: 2412568
FAX: 24127354
VAT: C00762901112

DPSH AND SPT RECORD SHEET

FIELD DATA

TEST	DEPTH	BLOWS	TEST	DEPTH	BLOWS
CPT	0.3	51	CPT	5.55	
	0.6	48		5.85	
	0.9	22		6.15	
	1.2	14		6.45	
	1.5	15		-	
SPT	75	3	SPT	75	
	75	2		75	
	75	4		75	
	75	4 (N = 18)		75	
	75	4		75	
	75/1.95m	4		75/6.9m	
CPT	2.25	12	CPT	7.2	
	2.55	8		7.5	
	2.85	8		7.8	
	3.15	11		8.1	
SPT	75	3	SPT	75	
	75	3		75	
	75	2		75	
	75	3 (N = 14)		75	
	75	3		75	
	75/3.60m	3		75/8.55m	
CPT	3.9	12	CPT	8.85	
	4.2	67		9.15	
	4.5	100		9.45	
	4.8	Refusal @ 4.25m		9.75	
SPT	75		SPT	75	
	75			75	
	75			75	
	75			75	
	75			75	
	75/5.25m			75/8.55m	

HOLE NO / CHAINAGE: **Test No. 5**

PROJECT: **Morupule A Power Station A – Rehabilitation & Pollution Abatement**

CLIENT: **Bauer Consult (Ptv) Ltd**

TECHNICIAN: **Joel** DATE: **14th April 2011**

MATERIAL TESTING SERVICES (PTY) LTD

Head office Laboratory
P.O. BOX 2069
GABORONE
TEL: 3913285
FAX: 3957577
VAT NO. C00762901112

FRANCISTOWN BRANCH
PO BOX 878
FRANCISTOWN
TEL: 2412568
FAX: 24127354
VAT: C00762901112

DPSH AND SPT RECORD SHEET

FIELD DATA

TEST	DEPTH	BLOWS	TEST	DEPTH	BLOWS
CPT	0.3	80	CPT	5.55	
	0.6	89		5.85	
	0.9	24		6.15	
	1.2	12		6.45	
	1.5	11		-	
SPT	75	4	SPT	75	
	75	4		75	
	75	3		75	
	75	3 (N = 16)		75	
	75	3		75	
	75/1.95m	3		75/6.9m	
CPT	2.25	11	CPT	7.2	
	2.55	11		7.5	
	2.85	11		7.8	
	3.15	13		8.1	
SPT	75	5	SPT	75	
	75	4		75	
	75	3		75	
	75	3 (N = 17)		75	
	75	3		75	
	75/3.60m	4		75/8.55m	
CPT	3.9	15	CPT	8.85	
	4.2	36		9.15	
	4.5	100		9.45	
	4.8	Refusal @ 4.44m		9.75	
SPT	75		SPT	75	
	75			75	
	75			75	
	75			75	
	75			75	
	75/5.25m			75/8.55m	

HOLE NO / CHAINAGE: **Test No. 6**

PROJECT: **Morupule A Power Station A – Rehabilitation & Pollution Abatement**

CLIENT: **Bauer Consult (Pty) Ltd**

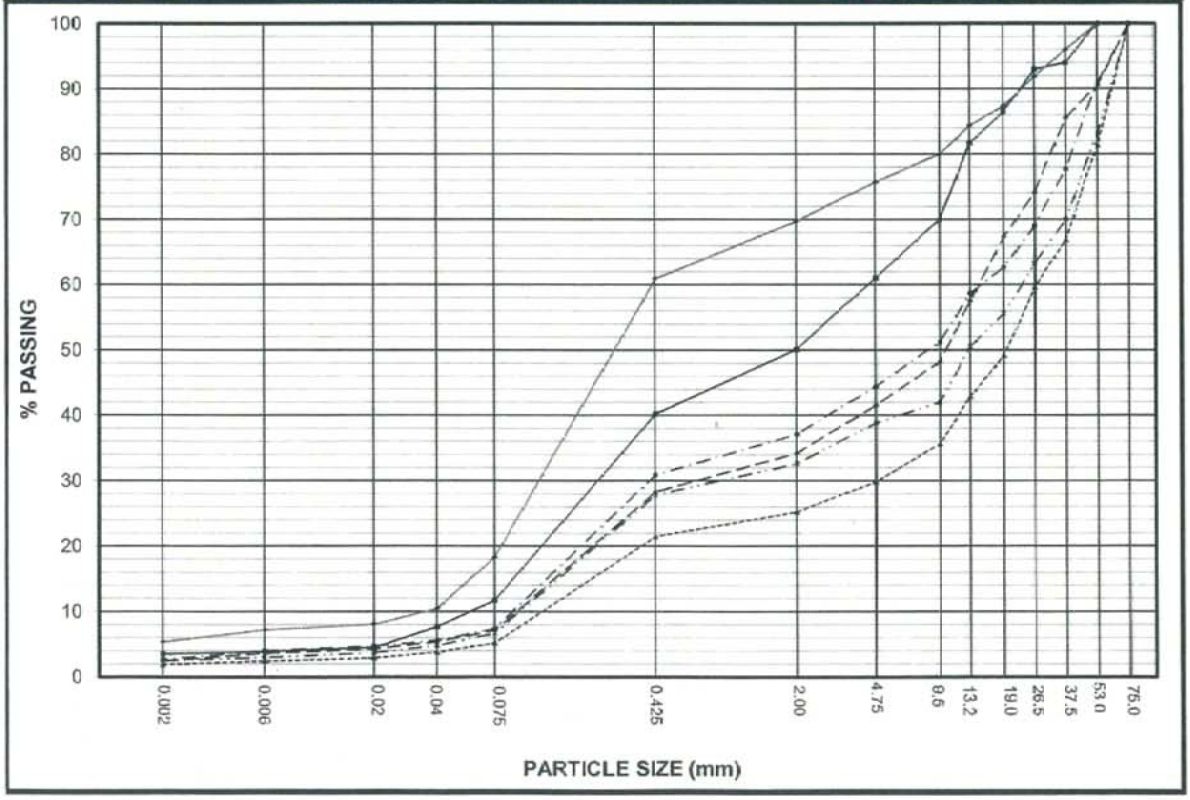
TECHNICIAN: **Joel** DATE: **14th April 2011**

Material Testing Services (Pty) Ltd

PROJECT :- Morupule A Power Station A - Rehabilitation & Ablution Abateman

CLIENT :- *Bauer Consult (Pty) Ltd*

LOCATION		TP 1	TP 1	TP 2	TP 3	TP 3	TP 4
DEPTH (mm)		2250-3700	3900-4300	4700-4900	4000-4200	4200-4500	3100-4700
MAX STONE SIZE (mm)							
SIEVE ANALYSIS (mm)	+75.0						
	75.0		100.0	100.0	100.0	100.0	
	53.0	100.0	90.5	81.4	90.9	83.1	100.0
	37.5	94.0	85.5	66.9	77.7	70.0	96.0
	26.5	93.0	74.1	59.6	69.0	63.2	91.9
	19.0	86.5	67.3	49.2	62.7	55.6	87.4
	13.2	81.7	57.5	42.9	58.7	50.5	84.4
	9.5	70.0	48.2	35.6	51.2	42.0	80.0
	4.75	61.0	41.5	29.8	44.4	38.8	75.7
	2.00	50.1	34.2	25.2	37.1	32.6	69.7
	0.425	40.2	28.3	21.5	30.9	27.8	60.9
	0.075	11.7	7.1	5.2	7.4	6.7	18.3
HYDROMETER ANALYSIS	0.04	7.7	5.4	3.8	5.6	4.8	10.5
	0.02	4.5	4.3	2.9	4.7	3.7	8.1
	0.006	3.9	3.6	2.4	4.0	3.0	7.2
	0.002	3.5	2.5	1.9	2.7	2.5	5.4
GRADING MODULUS		1.98	2.30	2.48	2.25	2.33	1.51
INSITU MOISTURE (%)		11.2	10.4	11.7	9.3	11.2	11.9
SOIL CONSTANTS	LIQUID LIMIT	-	-	-	-	-	-
	PLASTICITY INDEX	NP	NP	NP	NP	NP	NP
	LINEAR SHRINKAGE %	-	-	-	-	-	-
USPRA CLASSIFICATION		A.1.b (0)	A.1.a (0)	A.1.a (0)	A.1.b (0)	A.1.a (0)	A.2.4 (0)
PLOT CODE		———	— — —	- - - -	— · —	— · · —	———



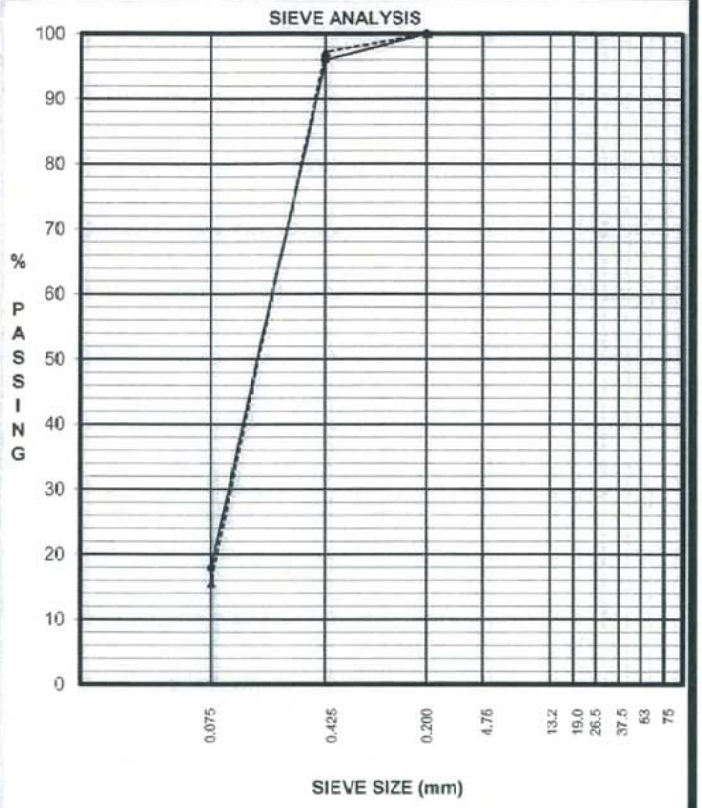
MATERIAL TESTING SERVICES (PTY) LTD

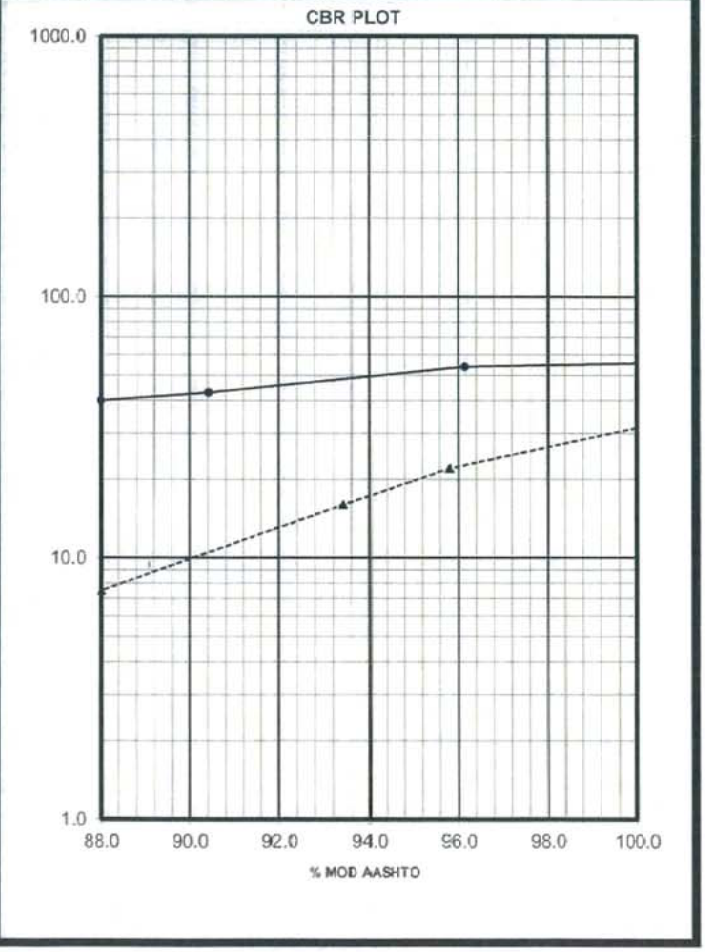
DATE:- 20 April 2011

PROJECT: Morupule A Powers Station A - Rehabilitation & Pollution Abatement

CLIENT: *Bauer Consult (Pty) Ltd*

CHAINAGE / TRIAL PIT		TP 1		TP 3
DEPTH (mm)		0 - 2250		0-2750
DESCRIPTION OF MATERIAL				
MAX STONE SIZE (mm)				
SIEVE ANALYSIS (% PASSING)	+75.0			
	75.0			
	53.0			
	37.5			
	26.5			
	19.0			
	13.2			
	4.75			
	2.00	100.0		100.0
	0.425	96.0		97.2
	0.075	17.9		15.6
GRADING MODULUS		0.86		0.87
CONSTANTS	LIQUID LIMIT	-		-
	PLASTICITY INDEX	NP		NP
	LINEAR SHRINKAGE %	-		-
PLOT CODE		———	-·-·-·-	- - - - - -
USPRA CLASSIFICATION		A.2.4 (0)		A.2.4 (0)
TRH 14 CLASSIFICATION		*G 7*		*G 7*
CBR / UCS CALCS	MOD AASHTO MAX DRY DENSITY	1889		1854
	MOD AASHTO O.M.C %	7.3		6.6
	MOD AASHTO HYGRO%	0.7		1.0
	MOD AASHTO DRY DENSITY (Kg/m³)	1901		1864
	MOD AASHTO % MOD AASHTO	100.6		100.5
	MOD AASHTO VALUE	**56.0**		**33.0**
	MOD AASHTO SWELL %	-		-
	INTER DRY DENSITY (Kg/m³)	1816		1776
	INTER % MOD AASHTO	96.1		95.8
	INTERMEDIATE VALUE	**54.0**		**22.0**
	PROCTOR DRY DENSITY (Kg/m³)	1708		1732
	PROCTOR % MOD AASHTO	90.4		93.4
	PROCTOR VALUE	**43.0**		**16.0**
98% AASHTO		55.0		27.0
95% AASHTO		51.0		20.0
93% AASHTO		48.0		15.0
90% AASHTO		42.0		10.0





MATERIAL TESTING SERVICES (PTY) LTD

P.O. BOX 2069 GABORONE TEL: 313285 FAX: 357577

P.O. BOX 878 FRANCISTOWN TEL: 212568 FAX: 217354

P.O. BOX 61 SELEBI-PHIKWE TEL: 811046 CELL:71603966

Consolidometer Test

Bauer Consult

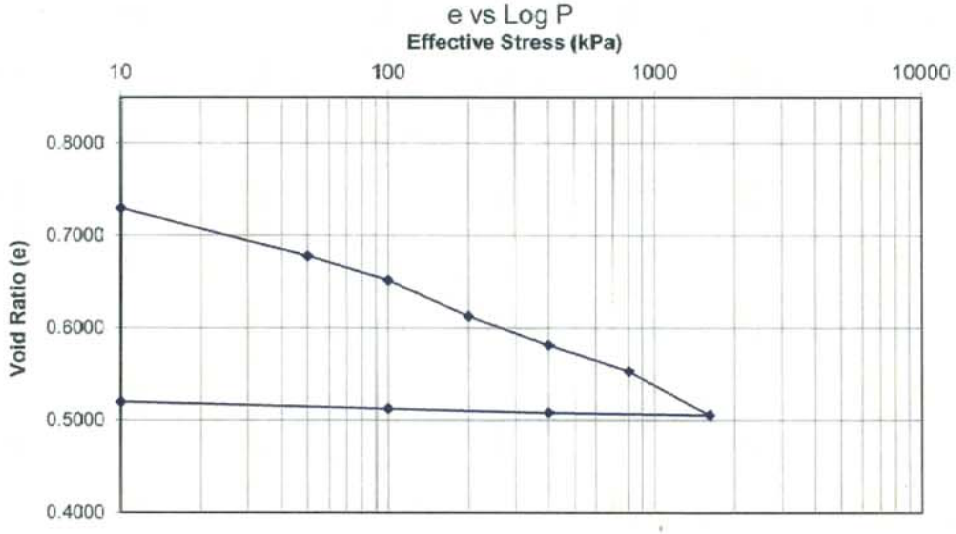
Morupule A Power Station A **Test Pit No. TP 1** **Depth (m) 1.00 - 2.250**

Applied Load (N)	Applied Vertical Stress (kPa)	Correction Factor(μm)	Dial Gauge Reading	Dial Factor	Settlement (mm)	Void Ratio (e)	Strain (%)
0	0	0	1038	0.002	0	0.9014	0.00
4	10	0	1896	0.002	1.716	0.7297	9.03
16	50	1	2158	0.002	2.238	0.6775	11.78
20	100	1	2288	0.002	2.498	0.6514	13.15
40	200	2	2482	0.002	2.884	0.6128	15.18
80	400	13	2650	0.002	3.198	0.5814	16.83
160	800	29	2807	0.002	3.48	0.5532	18.32
320	1600	50	3066	0.002	3.956	0.5055	20.82
80	400	13	3016	0.002	3.93	0.5081	20.68
20	100	1	2982	0.002	3.886	0.5125	20.45
4	10	0	2943	0.002	3.81	0.5202	20.05

Moisture Before Test (%): 13.42 e_0: 0.9014

Moisture After Test (%) : 29.66 **Dry Density (kg/m^3) :** 1393.7

Specific Gravity : 2.65



Material Testing Services (Pty) Ltd
P. O. Box 2069
Gaborone

Consolidometer Test

Bauer Consult

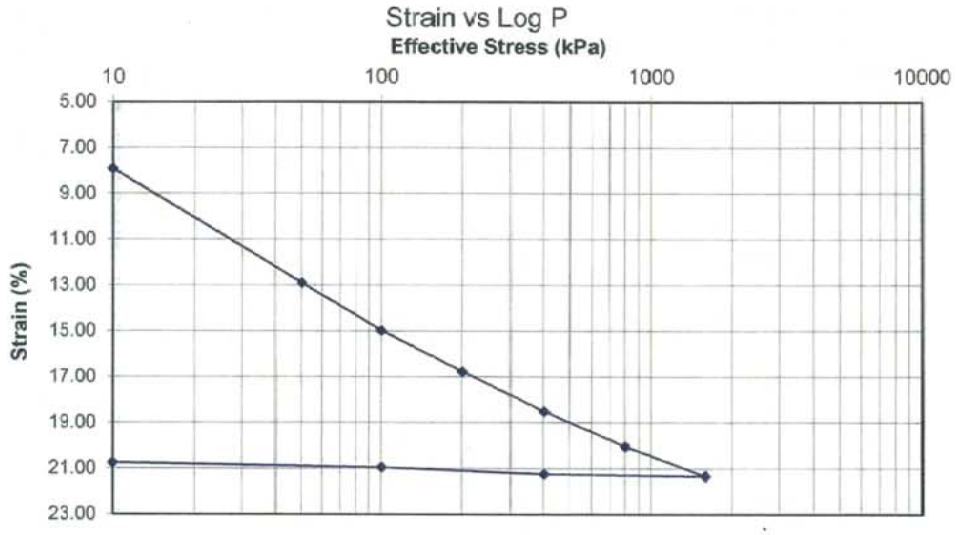
Morupule A Power Station A Test Pit No. TP 3 Depth (m) 0.00 - 0.270

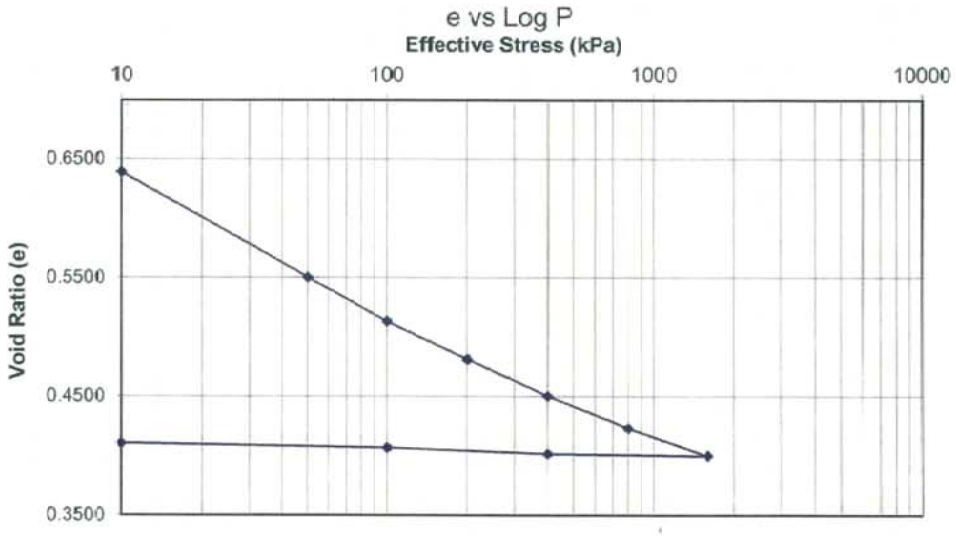
Applied Load (N)	Applied Vertical Stress (kPa)	Correction Factor(μm)	Dial Gauge Reading	Dial Factor	Settlement (mm)	Void Ratio (e)	Strain (%)
0	0	0	1017	0.002	0	0.7797	0.00
4	10	0	1768	0.002	1.502	0.6391	7.91
16	50	1	2243	0.002	2.45	0.5503	12.89
20	100	1	2441	0.002	2.846	0.5132	14.98
40	200	2	2612	0.002	3.186	0.4813	16.77
80	400	13	2788	0.002	3.516	0.4504	18.51
160	800	29	2949	0.002	3.806	0.4232	20.03
320	1600	50	3094	0.002	4.054	0.4000	21.34
80	400	13	3048	0.002	4.036	0.4017	21.24
20	100	1	3008	0.002	3.98	0.4069	20.95
4	10	0	2988	0.002	3.942	0.4105	20.75

Moisture Before Test (%): 8.56 e_0: 0.7797

Moisture After Test (%) : 25.36 Dry Density (kg/m^3) : 1489.0

Specific Gravity : 2.65





Material Testing Services (Pty) Ltd
P. O. Box 2069
Gaborone

SURVEY REPORT

TOPOGRAPHICAL SURVEY FOR MORUPULE POWER STATION A.

Dates: 17 March to 2 April 2011

Purpose: Topographical Survey on the rehabilitation and pollution abatement of Morupule Power Station A.

Approval : the survey was done as per instruction from Bauer Consult.

Calculation Basis : The survey was based on Lo 27, Department of Surveys and Mapping approved survey control.

Method : The survey was carried out using Leica SR530 GPS System and Leica 405 Total Station. The method of survey was real time using Palapyepara as the coordinate system. The base was set up at control point PRM9, on the national grid and two points were established on site BPC 1 and BPC 2.

Six benchmarks PPS1, PPS2, PPS3, PPS4, PPS5 and PPS6 were established on site and surveyed with BPC1 as the base. Adopting Lo 27 coordinates for PPS1 and PPS2 from GPS a traverse was carried out using Leica 405 Total Station from PPS2 orienting to PPS1 to coordinate PPS3 to PPS 6.

A calibration exercise was carried out for the whole site using WGS 84 coordinates obtained for the benchmarks (PPS1 to PPS6) with the base at BPC 1 and Lo 27 coordinates; Y, X from the traverse and Z (Height) from the leveling exercise. The transformation parameters from the calibration exercise were named as BPCPARA (pages 218 to 220). The consistency of the calibration was checked by surveying PRM12 and naming it PRM12CHECK, the discrepancy was found to be within acceptable limits of tolerance.

The benchmarks and other survey points were used to survey points for Topographical survey. BPC 2 was used to survey the ASH PONDS.

Levels : Leveling on benchmarks PPS1, PPS2, PPS3, PPS4, PPS5, BPC 1 and PPSS6 was carried out from PRM12 which on the Botswana national grid using a digital level. A closed loop leveling exercise was done and a misclosure of 2mm was obtained which is within acceptable limits.

Benchmarks: PPS1, PPS2, PPS3, PPS4, PPS5 and PPS6 were constructed using a 0ne meter length of 40mm diameter galvanized pipe set in concrete of dimension 30cm x 30cm x 50cm.

Problems Encountered: A number of manholes could not open and it was not possible to measure their invert **levels and to classify them.**

Ash Volume 2 199 632 m^3

Signed: …….. Date……

T.G.Chembezi

Registered Land Surveyor

TOPOGRAPHICAL SURVEY OF MORUPULE A POWER STATION - CONTROL POINTS

PT NAME	Y COORD	X COORD	ELEVATION (Z)	DESCRIPTION
PRM9	-6636.520	2492971.500	938.405	D.S.M
PRM12	-4487.590	2492576.840	944.355	D.S.M
PRM12CHK	-4487.572	2492576.844	944.349	D.S.M
BPC1	-4030.831	2491067.589	949.017	STN
BPC2	-4400.446	2490713.526	963.329	STN
BPC3	-4021.729	2491049.867	948.915	STN
PPS1	-3447.540	2491317.507	949.720	BM
PPS2	-3444.255	2491081.932	949.924	BM
PPS3	-3550.303	2490937.928	950.073	BM
PPS3A	-3702.575	2490985.556	951.530	BM
PPS4	-3926.190	2490904.959	949.735	BM
PPS5	-3983.646	2491001.497	948.501	BM
PPS6	-3960.002	2491142.983	948.638	BM
PPS7	-3882.726	2491135.681	948.744	STN
PPS8	-3853.034	2491140.75	948.769	STN
PPS9	-3831.139	2491143.227	948.751	STN
PPS10	-3782.014	2491146.720	948.561	STN
PPS11	-3953.519	2491050.038	948.672	STN
PPS12	-3914.788	2491018.911	948.571	STN
PPS13	-3914.918	2490975.056	948.647	STN
PPS14	-3885.111	2490950.928	949.193	STN
PPS15	-3881.670	2490934.190	948.960	STN
PPS16	-3777.502	2491062.076	948.752	STN

PPS17	-3709.388	2491118.113	948.735	STN
PPS19	-3801.984	2490950.529	948.674	STN
PPS20	-3820.074	2490975.653	948.685	STN
PPS21	-3787.025	2490972.521	948.757	STN
PPS22	-3697.159	2490946.229	949.607	STN
PPS23	-3711.050	2490906.011	949.406	STN
PPS24	-3556.030	2491118.070	949.296	STN

Fieldbook Report

04/14/2011 13:19:27

Job Information

Job name:	BPCWATERPONDS
Created:	03/19/2011 08:24:35
Time zone:	2h 00'
Coordinate system name:	BPCPARA
Application software:	LEICA Geo Office 5.0
Firmware version:	5.10

Coordinate System Information

Coordinate system name:	BPCPARA
Created:	03/20/2011 16:49:09

Transformation name:	BPCPARA
Transformation type:	Onestep
Height mode:	Orthometric
Residuals:	1 / distance
Local Ellipsoid:	-
Projection:	-
Geoid model:	-
CSCS model:	-

Transformation details

2D-Helmert transformation

Number of common points:	6	
Rotation origin:	X0:	-0.0017 m
	Y0:	0.0000 m

No.	Parameter	Value
1	dE	2491013.8615 m
2	dN	-3774.0792 m
3	Rotation	-179° 58' 30.99011"
4	Scale	103.9828 ppm

Height transformation

Number of common points:	6		
Mean transformation accuracy:	0.0067 m		
Parameters:	0.00005069	0.00003628	-12.4053 m
Inclination of height in X:	0° 00' 10.45556"		
Inclination of height in Y:	0° 00' 07.48329"		

Residuals

Grid:

System A	System B	Point type	dE [m]	dN [m]	dHgt [m]
PPS1	PPS1	Position + height	-	-	-0.0024 m
PPS2	PPS2	Position + height	0.0011 m	-0.0104 m	-0.0035 m
PPS3	PPS3	Position + height	-0.0009 m	0.0087 m	0.0071 m
PPS4	PPS4	Position + height	0.0148 m	-0.0048 m	-0.0010 m
PPS5	PPS5	Position + height	-0.0090 m	0.0068 m	-0.0100 m
PPS6	PPS6	Position + height	-0.0060 m	-0.0003 m	0.0099 m

List of identical points

System A:

WGS 84 Cartesian:

	X [m]	Y [m]	Z [m]
PPS1	5251353.9468	2679534.3970	-2428281.1428
PPS2	5251436.0035	2679572.5145	-2428063.5836

PPS3	5251437.0867	2679692.0643	-2427930.5875
PPS4	5251277.2420	2680032.4821	-2427899.8309
PPS5	5251217.1430	2680066.3938	-2427988.5246
PPS6	5251177.0030	2680026.1648	-2428119.2919

System B:

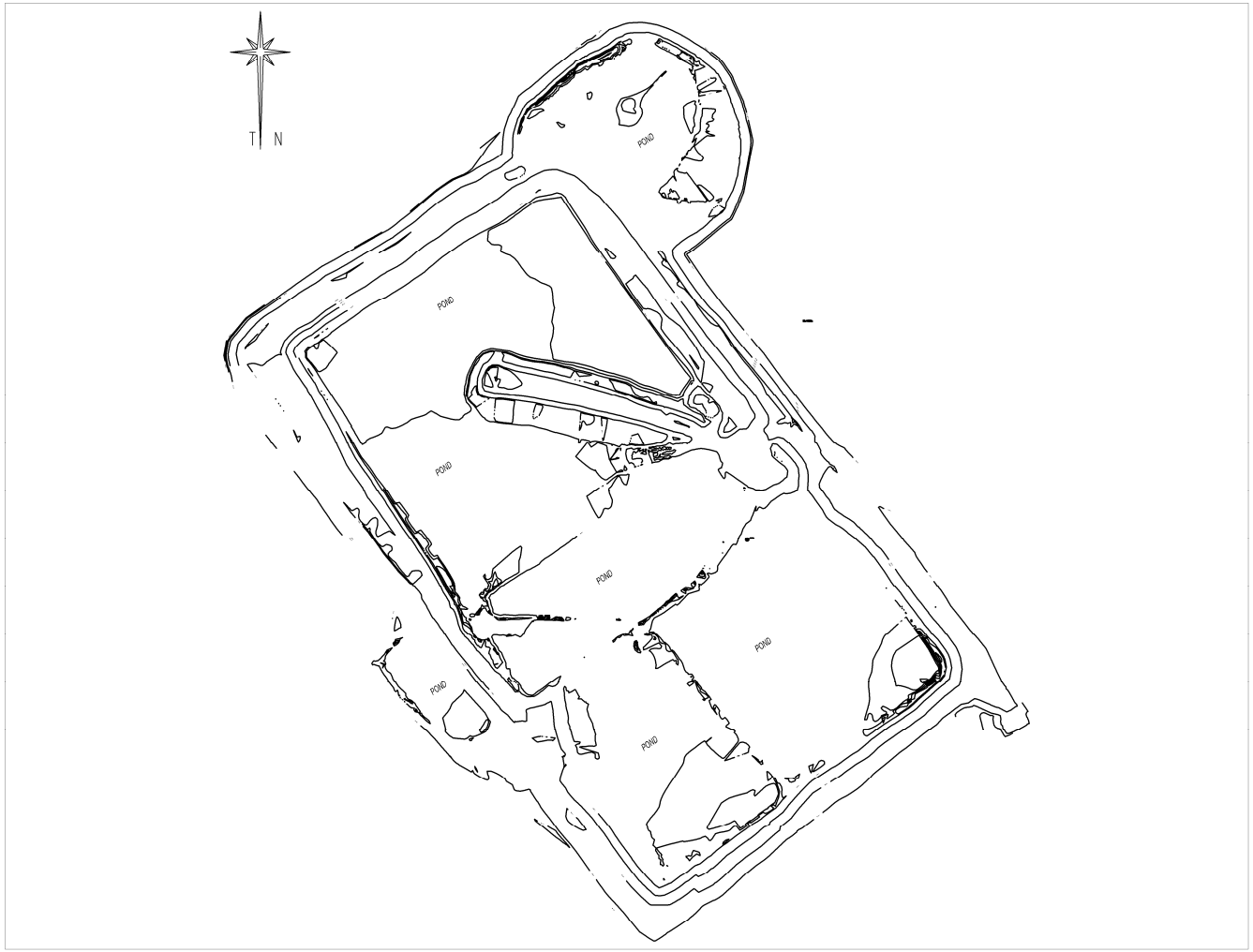
Local Grid:

	Easting [m]	**Northing [m]**	**Hgt [m]**
PPS1	-3447.5400	2491317.5070	949.7200
PPS2	-3444.2550	2491081.9320	949.9240
PPS3	-3550.3030	2490937.9280	950.0730
PPS4	-3926.1900	2490904.9590	949.7350
PPS5	-3983.6460	2491001.4970	948.5010
PPS6	-3966.0020	2491142.9830	948.6380

NOTES

BLD	Building
TOE / BE	Bottom of Embankment
CR	Top of Embankment
BM	Benchmark
STN	Survey Station
CUL	Culvert
BTC	Botswana Telecomms
FE	Fence
GA	Gate
KERB	Kerb stone

EP	Electrical Pole
EL	Electrical Lamp
TRANS	Electrical Transformer
TNK	Tank
COMP	Compressor
POND	Raw water pond
MH	Man Hole
SWD	Storm Water Drain
SLAB	Concrete Slab
FMV	Fire Main Valve
FH	Fire Hydrant
PAV	Pavement
CONC	Concrete
CONV	Conveyor Belt
Edge	Edge of water pond
SH	Spot Height
RD	Road
TAR	Tarred Road
PLI	Plints (concrete foundation)
COL	Column
LC	Live Coal Pile
FEAP	Fire Emergency Assembly Point
EC	Electrical Cable
Pipe	Pipe
SP	Slurry Pipe
PCR	Pipe and Cable Rack
TREN	Trench
DRN	Drain
GAR	Garage
CPK	Car Park


T N
POND
POND
POND
POND
POND
POND
POND

Appendix 5-14 Topographic Survey （9/9）

APPENDICES FOR CHAPTER 6

Appendix 6-1 Environmental Standards (1/4)

(1) Emission Standards

The emission standard shown in the Table 1 is a maximum allowable limit value stipulated by Department of Waste Management and Pollution Control (DWMPC) to the Morupule "A" Power Station as the stack emission certificate in 1987. This is a certified allowable limit effective only for the stack emission of Unit No.1~3 of the Morupule "A" Power Station, not a fixed domestic emission standard for whole region. A domestic emission standard will be established by DWMPC with development of the Morupule B Power Station Project. It will be applicable to the all coal fired power stations in the region once established.

Table 1 Emission Standards

Item	Unit	Standards		
		Botswana[1]	World Bank Guidelines[2]	IFC EHS Guidelines[3] (Solid Fuel 50~600MW)
SO_2	mg/Nm^3	3,293	2,000	900-1,500
NO_x	mg/Nm^3	-	750	510
Dust	mg/Nm^3	154	50	50

[1] Maximum allowable limit value stipulated by the Department of Waste Management and Pollution Control
[2] Thermal Power: Guidelines for New Plants, Pollution Control and Abatement Handbook (1998)
[3] IFC Environmental, Health and Safety (EHS) Guidelines

(Source: JICA Study Team)

(2) Ambient Air Quality Standards

The domestic ambient air quality standard of Botswana will be revised with reference to the WHO standard with the development of the Morpule B Power Station.

Table 2 Ambient Air Quality Standards

	Averaging period	Unit	Standards		
			Botswana[1]	World Bank[2]	WHO[3]
SO_2	24-hour	$\mu g/m^3$	300	150	125(Interim Target-1) 50(IT-2) 20(guideline)
	1-hour	$\mu g/m^3$	-	-	-
	1-year	$\mu g/m^3$	80	80	-
NO_2	24-hour	$\mu g/m^3$	-	150	-
	1-hour	$\mu g/m^3$	-	-	200
	1-year	$\mu g/m^3$	100	100	40
Dust	24-hour	$\mu g/m^3$	300	150	150(IT-1) 100(IT-2) 75(IT-3) 50(guideline)
	1-hour	$\mu g/m^3$	-	-	40
	1-year	$\mu g/m^3$	100	50	70(IT-1) 50(IT-2) 30(IT-3) 20(guideline)

Appendix 6-1 Environmental Standards (2/4)

1 Botswana National Laboratory
2 Thermal Power: Guidelines for New Plants, Pollution Control and Abatement Handbook (1998)
3 WHO Air quality guidelines for particulate matters, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005

(Source: JICA Study Team)

(3) Effluent Standard

Table 3 Ambient Air Quality Standards

item	Standards (mg/l)		
	Botswana standard (upper limited)1	World Bank Guidelines[2]	IFC EHS Guidelines [3]
pH	6-9	6-9	6-9
Dissolved oxygen	60 % sat.	-	-
BOD5	30	-	-
COD (filtered)	75	-	-
COD (unfiltered)	150	-	-
Color	50 TCU	-	-
Turbidity	NTU	-	-
Total Suspended Solid	25	50	50
Total Dissolved Solid	2000	-	-
Faecal coliform	1000/100ml	-	-
Oil and grease	-	10	10
Total residual chlorine	1.0	0.2	0.2
Chromium(total)	0.5	0.5	0.5
Copper	1.0	0.5	0.5
Iron	2.0	1.0	1.0
Zinc	5.0	1.0	1.0
Lead	0.05	-	0.5
Cadmium	0.02	-	0.1
Mercury	0.01	-	0.005
Arsenic	0.1	-	0.5
Chromium VI	0.25	-	-
Cobalt	1.0	-	-
Cyanide	0.1	-	-
Manganese	0.1	-	-
Nickel	0.3	-	-
Selenium	0.02	-	-
Free and saline ammonia	10	-	-
Ortho or soluble phosphate	1.5	-	-
Calcium	500	-	-
Chloride	600	-	-
Fluoride	1.5	-	-
Nitrate	22	-	-
Potassium	100	-	-
Sodium	400	-	-
Sulphate	400	-	-
Boron	0.5	-	-
Temperature at the edge of the mixing zone	35°C upper limit of the effluent	Less than or equal to 3°C	Site specific requirement to be established by the EIA

[1] BOS 93:2004
[2] Thermal Power: Guidelines for New Plants, Pollution Control and Abatement Handbook (1998)
[3] IFC Environmental, Health,and Safety (EHS) Guidelines

(Source: JICA Study Team)

(4) Drinking Water Quality Standard

Drinking Water Quality Standard of Botswana is established by Botswana Bureau of Standard as Table 4.

Table 4 Drinking Water Quality Standards

Parameter	Unit	Botswana		
		Class 1(ideal)	Class 2 (acceptable)	Class 3 (maximum allowable)
Physical and organoleptic requirements				
pH		6.5-8.5	5.5-9.5	5.0-10
Color	TCU	15	20	50
Conductivity	µS/cm	700	1,500	3,100
TDS	mg/l	450	1,500	2,000
Odour	n/a	Not objectionable	Not objectionable	Not objectionable
Turbidity	NTU	0.5	5	10
Chemical Requirements: Inorganic – Macro-determines				
Ammonia (N)	mg/l	0.2	1	2.0
Ca	mg/l	80	150	200
Cl	mg/l	100	200	600
Chlorine residual	mg/l	0.3-0.6	0.6-1.0	1.0
Fluoride (F)	mg/l	0.7	1.0	1.5
Hardness (CaCO3)	mg/l	20	200	500
Mg	mg/l	30	70	100
NO3	mg/l	45	45	45
NO2	mg/l	3.0	3.0	3.0
Na	mg/l	100	200	400
K	mg/l	25	50	100
SO4	mg/l	200	250	400
Zn	mg/l	3.0	5.0	10.0
Chemical Requirements: inorganic – Micro- determines				
Al	mg/l	100	200	200
Sb	mg/l	5.0	5.0	5.0
As	mg/l	10	10	10
Cd	mg/l	3.0	3.0	3.0
Cr	mg/l	50	50	50
Co	mg/l	250	500	1,000
Cu	mg/l	1,000	1,000	1,000
CN (free)	mg/l	70	70	70
CN(recoverable)	mg/l	70	70	70
Fe	mg/l	0.03	0.3	2
Pb	mg/l	10	10	10
Mn	mg/l	50	100	500
Hg	mg/l	1.0	1.0	1.0
Ni	mg/l	20	20	20
Se	mg/l	10	10	10

(Source: BOS 32:2000)

(5) Noise Standard

Botswana does not have a noise standard.

Table 5 Noise Standards

Receptor	Maximum allowable level dB(A)	
	Day Time (7:00-22:00)	Night Time (22:00-7:00)
World Bank Guidelines[1] & IFC[2]		
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

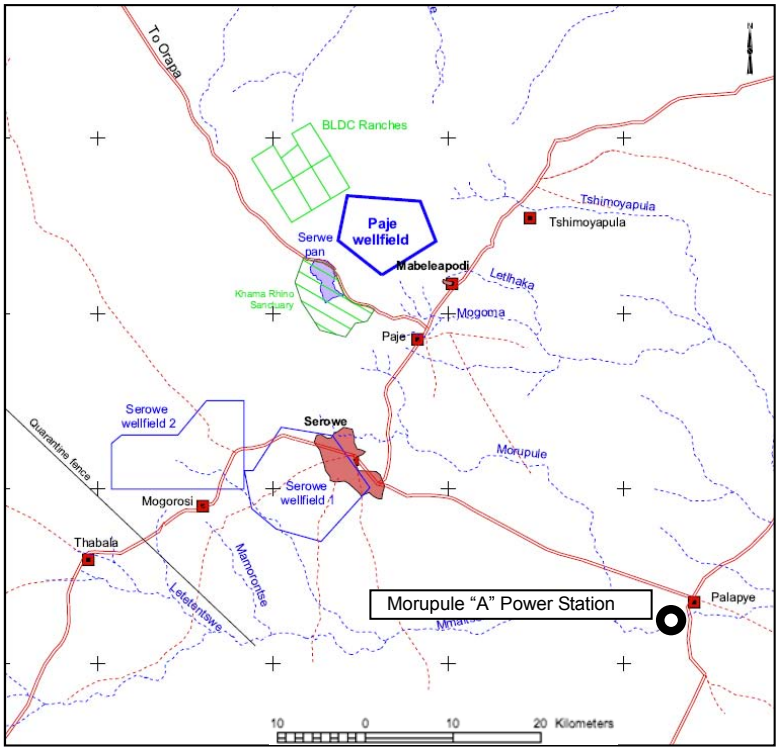
[1] Thermal Power: Guidelines for New Plants, Pollution Control and Abatement Handbook (1998)

[2] IFC Environmental, Health,and Safety (EHS) Guidelines

(Source: JICA Study Team)

(1) Ground Water at Paje Well field

All power station operational water consumed by the Morupule “A” Power Station is ground water and taken from the Paje Well Field which locates about 30 km north east of the Morupule “A” Power Staion as shown in Figure1. A total of 10 production boreholes and 18 observation boreholes are being monitored in the Paje Well Field by BPC. Table 1 compares relevant details of the hydro chemical parameters based on the Botswana Bureau of Standards (BOS 32:2000) with the observations in the Paje well field boreholes.



(Source; Paje Well Field Annual Monitoring Report 2009)

Figure 1 Location of Paje Well Field

Table 1 Comparison of Drinking Water Specification (BOS 32:2000) with Paje Wellfield Boreholes

Determinants	Units	Drinking Water Specifications			Year 2008 and 2009 Range	
		Class I (Ideal)	Class II (Acceptable)	Class III (Max. Allowable)	Production Boreholes 2008 - 2009	
pH at 25°C	-	6.5-8.5	5.5-9.5	5.0-10.0	7.01 - 8.34	7.16 - 7.99
Conductivity, EC at 25 °C	µS/cm	700	1,500	3,100	420 – 1,050	486- 1,078
TDS	mg/l	450	1,000	2,000	260 – 580	315 - 589
Sodium, No	mg/l	100	200	400	15 – 75	16 - 91
Calcium, Ca	mg/l	80	150	200	30 – 90	32 - 105

Magnesium, Mg	mg//	30	70	100	10 – 70	10 - 39
Chloride, Cl	mg//	100	200	600	45 – 205	56 - 225
Sulphate, $S0_4$	mg//	200	250	400	0.1 – 20	4 - 7.5
Fluoride, F	mg//	0.7	1	1.5	0.02 - 0.67	0.02 - 0.45
Nitrate, NO_3	mg//	45	45	45	0.25 – 20	0.5 - 10

(Source; Paje Well Field Annual Monitoring Report 2009, Draft Final, March 2010, BPC)

(2) Ground Water at BPC premise

In order to understand the behavior of groundwater at the Morupule Power Station area and the potential impacts of the disposed fly ash at the ash disposal site (Ash Dam) and the waste effluent treatment/stabilization Evaporation Pond No 2, monitoring of a series of observation boreholes is carried out monthly. Groundwater monitoring carried out by BPC in the area includes the measurement of water levels in the monitoring boreholes together with hydro chemical sampling, and chemical sampling of surface waters. BPC maintains a database of historic groundwater monitoring. The monitoring boreholes at the Morupule “A” Power Station area have been monitored since December 1989 for the assessment of changes in water levels and hydrochemistry. Conductivity, TDS, Sodium, Calcium and Sulphate exceed the standard (Table 2).

Table 2 Comparison of Drinking Water Specification (BOS 32:2000) with Plant Area Samples

Determinants	Units	Drinking Water Specifications			Year 2009 Range		
		Class I Ideal	Class II Acceptable	Class III Max. Allowable	Ash Lagoon Slurry Mixture	Ash Lagoon Boreholes	Evaporation Pond No 2 Boreholes
Physical and Organoleptic Requirements:							
pH at 25°C	-	6.5 - 8.5	5.5 - 9.5	5.0 - 10.0	11.7 - 12.3	6.4 - 8.3	6.9 - 8.9
Conductivity, EC at 25 °C	µS/cm	700	1,500	3,100	4,900 – 10,430	1,280 – 2,910	1,090 – 1,810
TDS	mg/l	450	1,000	2,000	3,260 – 6,940	850 – 1,935	720 – 1,210
Inorganic Macro Concentrations:							
Sodium, Na	mg/l	100	200	400	326 – 1,054	75 - 490	130 - 200
Potassium, K	mg/l	25	50	100	12 - 35	5 - 19	6 - 19
Calcium, Ca	mg/l	80	150	200	90 - 867	19 – 270	9-42
Chloride, Cl	mg/l	100	200	600	216 - 463	180 – 630	120-440
Sulphate, $S0_4$	mg/l	200	250	400	1,780	10 – 800	11 - 12
Ammonia	mg/l	0.5	1	2	0.05 - 6	0 - 14	0.2 - 1.2
Fluoride	mg/l	0.7	1	1.5	0.3 - 1.1	0.01 - 0.3	0.02 - 1
Nitrate, NO_3	mg/l	45	45	45	21 - 26	12 - 24	7 - 24

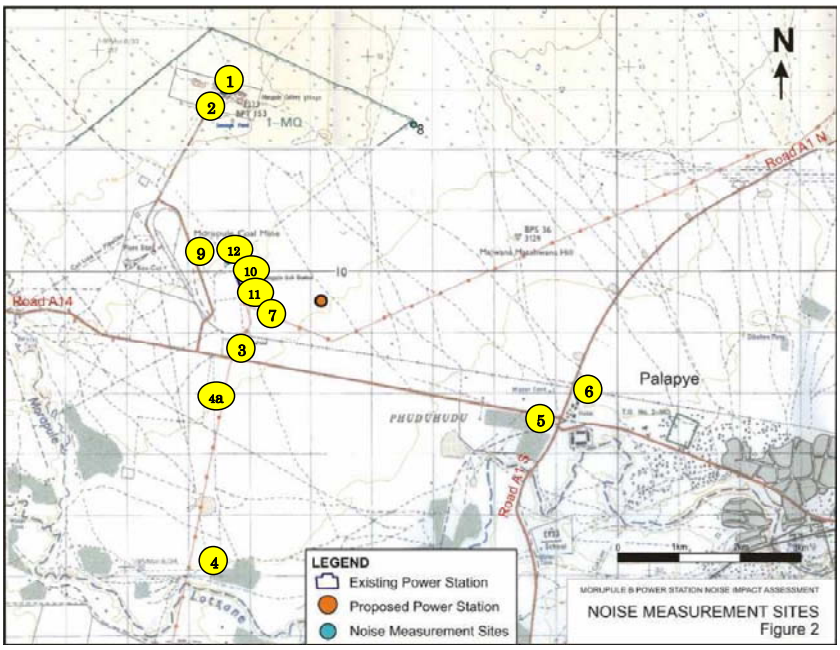
(Source; Annual Ground Water Monitoring Report 2009, Draft Final Report, February 2010, BPC)

Appendix 6-3 Ambient Noise (1/2)

Since noise impact has not monitored out of the power station premise, environmental noise which studied by ESIA for the Morupule B Power Station Project was only available source to referrer as back ground noise.

In the ESIA study, measurements and auditory observations were taken at nine monitoring sites during the noise impact investigation. These were taken at appropriate sites at varying distances from the power station site (Figure 1).

Site 1: In Morupule Mine Village in Mokowe Crescent.
Site2: At entrance gate to Morupule Mine Village on eastern side of access road.
Site3: On the western boundary of Kgaswe Primary School.
Site4: At remote settlement (“Molapu Wapitsi”) just north of the Lotsane River.
Site4a: On road to settlement (Site4) at approximately 1000m south of Road A14.
Site5: On the south side of the road to Serowe(Road A14) just west of Palapye.
Site6: In residential area of Palapye to the east of Road A1and just north of the Desert Sands Motel.
Site7: At the entrance gate to the Morupule Golf Course.
Site8: At the southeast corner of the Morupule Colliery Game Park.



(Source; Morupule B ESIA Report 2007 and revised by JICA study team)

Figure 1 Locations of Noise Measurement Sites

The environmental guidelines of the WHO and World Bank specify 55 dBA during the day (06:00 to22:00) and 45 dBA during the night (22:00 to 06:00) for residential purposes, determined over any hour. Current noise level is as shown in Table 1.

Appendix 6-3 Ambient Noise (2/2)

Table 1 Current Noise Level

Noise Sensitive Site*	Period	Maximum Allowable Noise Level (dBA) WHO&WB	Measured Noise Level (Year 2007) (dBA)
Site 1:Colliery Village (Suburban Residential)	Day	55	47.5
	Night	45	39.2
Site 2:Colliery Village (Suburban Residential)	Day	55	39.8
	Night	45	28.8
Site 3:Kgaswe School(Educational)	Day	55	57.9
	Night	Not Applicable	49.3
Site 4:Settlement (Rural Residential)	Day	55	45.5
	Night	45	30.8
Site 5:Palapye (Urban Residential)	Day	55	62.4
	Night	45	46.2
Site 6:Palapye (Urban Residential)	Day	55	56.8
	Night	45	51.0

*Sites 4a,7 and 8 are omitted as no night-time measurements were taken at these locations

(Source; Morupule B ESIA Report 2007)

Noise levels in Palapye Village are high and are typical of an urban complex. The existing noise climate alongside the main roads in Palapye is degraded with regard to the World Bank residential living standard that is noise exceeds the standards particularly at night. The areas outside Palapye and remote from the main roads and the power station/colliery are very quiet and reflect a rural character.

The existing noise climate alongside Road A14 outside Palapye Village is degraded with regard to the residential living standards.

The impact of the power station on noise sensitive sites in the surrounding area is minor. Noise levels from the existing power station exceed 35 dBA up to a distance of about 2,500 meters from the facility. The power station will be heard late at night when traffic volumes are low.

Noise levels from traffic on Road A14 at the Kgaswe Primary School are slightly higher than desirable for an educational environment. The maximum daytime noise level measured in the vicinity of the school was 76.6 dBA whilst the average daytime noise level was 57.9 dBA. Noise from the power station does not have a significant impact on the activities at the Kgaswe Primary School.

No endangered species designated by the international and domestic regulations are identified within 10 km radius of the site. List of rare and endangered species in Botswana, species found around Palapye area is shown at attachment 6-4-1.

a) Flora

Floral species identified within the Morupule Power Stations area are listed below (Table 1).

Table 1 Plant species identified within the proposed development area

Tree Species	Grasses, Herbs, Flowers
Acacia erioloba (Camel Thorn)	Hibiscus sp.
Acacia mellifera (Hook thorn)	Ipomea sp.
Burkea africana (Wild Syringa)	Tribulus terrestris
Combretum hereroense (Russet Bush Willow)	Ocimum canum
Dichrostachys cinerea (Sickle Bush)	Nicotiana sp.
Grewia sp. (Raisin Bush)	Acrotome inflata
Peltophorum africanum (African Wattle)	Sansevieria sp.
Rhus sp. (Rhus)	Momordica balsamina
Schinus molle (Pepper tree)	Lagenaria seciraria
Terminalia sericea (Silver Cluster leaf)	Cucumis metuliferus
Ziziphus mucronata (Buffalo thorn)	Vernonia sp.
Melia azedarach(Exotic Syringa)	Ricinus communis

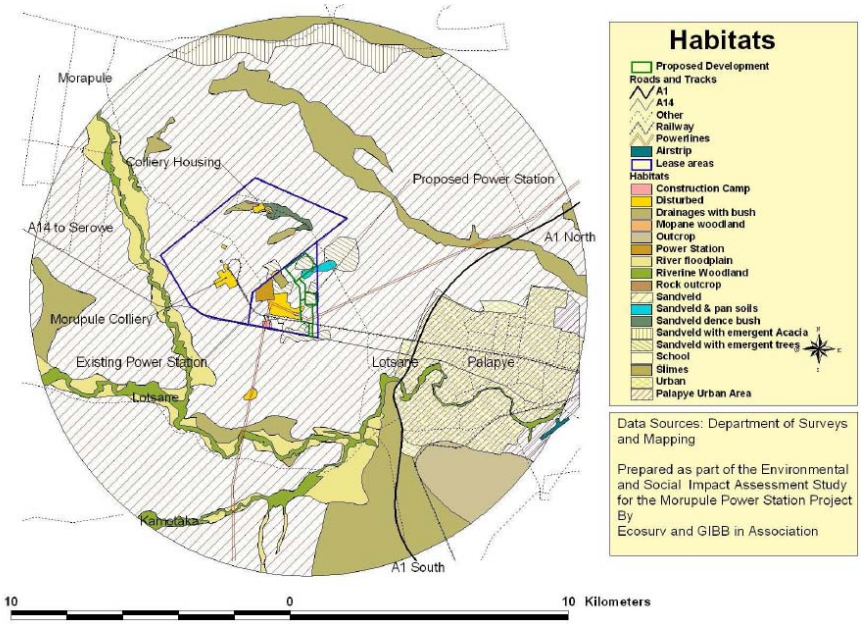
(Source; Morupule B ESIA Report 2007 and revised by JICA study team)

The habitats within the 10 km radius of the Morupule “A” and B Power Station site are dominated by sandveld and riverine habitats (Table2). Riverine habitat has been greatly modified due to the practice of establishing arable agriculture in the river floodplains. At least 20 % of the riverine habitat is severely degraded.

Table 2 Habitats within 10 km of the site

Habitat Type	Area (ha)	%
Disturbed	3,073	9.80
Drainages with bush	3,660	11.67
Mopane woodland	1	0.00
Outcrop	745	2.38
River floodplain	1,473	4.70
Riverine Woodland	873	2.78
Rock outcrop	4	0.01
Sandveld	20,628	65.78
Sandveld & pan soils	32	0.10
Sandveld with emergent Acacia	588	1.87
Sandveld with emergent trees	284	0.91
Total Area (ha)	31,361	

(Source; Morupule B ESIA Report 2007)



(Source; Morupule B ESIA Report 2007)

Figure 1 Major habitats within 10km radius of the project site

Although the site of the Morupule “A” and B Power Station have low plant species diversity, the surrounding areas have been highlighted as being host to important species, namely in the Tswapong hills area. In terms of biological diversity within Botswana the area is seen as being high in species richness, and plant diversity (BSAP Stocktaking Report, Final Draft, 2003). The Royal Botanical Gardens Kew indicates that Botswana currently has 43 species on its national Red Data list. Of these, 13 are confirmed as threatened (critically endangered, endangered or vulnerable) and 22 are of uncertain status. There are an estimated 15 endemic species in Botswana, which are vulnerable due to their limited distribution. None of these species are known to occur at the site.

b) Fauna

Based on the Fauna priority area for the country by the Biodiversity Strategy and Action Plan project the plant site is situated in an area ranked as "Average". This ranking would be based on the level of protection to biodiversity in the area (no formal conservation measures exist i.e. site is not situated in a protected area) against the numbers of species and diversity of species in the area (areas with no protection but high diversity would be ranked as being high priority areas).

Based on the maps produced by the Biodiversity Strategy and Action Plan Project the area is known to hold approximately between 460 -500 bird species. In terms of importance the Tswapong hills have been identified by Bird Life International as being an

Important Bird Area (IBA), which does not have any formal protection, although the site is not situated on these hills it is within 10 km of the western edge of them.

The Tswapong Hills lie in the hardveld of eastern Botswana, east of the town of Palapye. They arise from a sandy plain dominated by mopane woodland. The hills, which extend for 67km in an east west direction, are mainly sandstone and on the steeper slopes the vegetation is dominated by Croton. There are gorges with precipitous cliffs and seasonal streams, and exposed rock faces around the edge of the hills and along some watercourses.

Table 3 Description of Tswapong Hill

Location	Botswana, Central District
Central Coordinates	27°30.00' East 22°40.00' South
Area	75,000 ha
Altitude	1,000 m
Year of IBA assessment	2001

(Source; Birdlife International, website http://www.birdlife.org/index.html)

Table 4 Population of Important Bird Area trigger species

Species	Season	Population estimate	IUCN Category
Southern Pochard *Netta erythrophthalma*	winter	800-1,500 individuals	Least Concern
Cape Vulture *Gyps coprotheres*	resident	300 breeding pairs	Vulnerable
Cape Vulture *Gyps coprotheres*	winter	600 individuals	Vulnerable

(Source; Birdlife International, website http://www.birdlife.org/index.html)

c) Natural Protection Site

Three national parks and three game reserves are designated in Botswana. Location and distance from the proposed project site are summarized as below Table 5. No natural protection site under domestic and international regulations is identified within 10 km radius from the site.

Table 5 Wildlife Management Area

Name	Direction from the Morupule "A" Power Station	Distance from the Morupule "A" Power Station
Chobe National Park	North west	Approx. 660 km
Makgadkgadi Pans National Park/Nxai National Park	North west	Approx. 400 km
Kgalagadi Transfrontier Park	South west	Approx. 860 km
Central Kalahari Game Reserve	West	Approx.260 km
Khutse Game Reserve	South west	Approx. 400 km
Moremi Game Reserve	North west	Approx. 720 km

(Source; JICAStudy Team)

Attachment 6-4-1

14. ANNEXURE 2: RARE AND ENDANGERD PLANT SPECIES OF BOTSWANA (ECOSURV/IUCN, BSAP, 2005)

Note: the species in italics are the only species that may occur in or near the development site

Family	Taxon	IUCN Category	Full IUCN Status
Data Deficient			
Apocynaceae sensu lato	Ceropegia floribunda N.E.Br.	Data Deficient	DD
Asteraceae	Arctotis rogersii S.Moore	Data Deficient	DD
Asteraceae	Arctotis serpens S.Moore	Data Deficient	DD
Asteraceae	Edangea remifolia Wild & G.V.Pope	Data Deficient	DD
Asteraceae	Rennera laxa (Brem. & Oberm.) Kallersio	Data Deficient	DD
Cyperaceae	Eleocharis cubangensis H.E.Hess	Data Deficient	DD
Eriospermaceae	Eriospermum linearifolium Baker	Data Deficient	DD
L riospermacee	Eriospermum seineri Engl. & Krause	Data Deficient	DD
Fabaceae	Acacia hebeclada DC subsp. tristis A.Schreib.	Data Deficient	DD
Mesembryanth emaceae	Nananthus aloides (Haw.) Schwant.	Data Deficient	DD
Mesembryanth emaceae	Nananthus marqaritiferus L.Bolus	Data Deficient	DD
Orchidaceae	Habenaria pasmithii G.Will.	Data Deficient	DD
Orchidaceae	Zeuxine africana Rchb.f.	Data Deficient	DD
Poaceae	Aristida wildii Melderis	Data Deficient	DD
Poaceae	Panicum coloratura L.Mant. var. makarikariense Gooss.	Data Deficient	DD
Poaceae	Panicum gilvum Launert	Data Deficient	DD
Poaceae	Panicum pilgerianum (Schweick.) Clayton	Data Deficient	DD
Poaceae	Sporobolus bechuanicus Gooss.	Data Deficient	DD
Rosaceae	Grielum cuneifolium Schinz	Data Deficient	DD
Santalaceae	Thesium dissitum N.E.Br.	Data Deficient	DD
Scrophulariaceae	Jamesbrittenia concinna (Hiem) Hilliard	Data Deficient	DD
Scrophuladac	Jamesbrittenia	Data Deficient	DD
Lower Risk			
Acanthaceae	Barleriamatopensis	Lower Risk-	LR-Ic
Acanthaceae	Blepharis bainesii S.Moore ex C.B .Clarke	Lower Risk- Least Concern	LR-Ic
Cyperaceae	Pycreus okavangensis Podlech	Lower Risk- Least Concern	LR-Ic
Euphorbiaceae	Jatropha botswanica Radcl: Sm.	Lower Risk- Least Concern	LR-Ic
Capparaceae	Boscia foetida Schinz subsp. minima Toelken	Lower Risk-Near Threatened	LR-nt
Fabaceae	Acacia hebeclada DC subsp. Chobiensis (O.B.Mill.) A.Schreib	Lower Risk- Near Threatened	LR-nt
Pedaliaceae	Harpagophytum procumbens (Burch.) DC. ex Meisn.	Lower Risk Near Threatened	LR-nt
Pedaliaceae	Harpagophytum zeyheri Decne	Lower Risk Near - Threatened	LR-nt
Vulnerable			
Apocynaceae sensu lato	Adenium oleifolium Stapf	Vulnerable	VU B1B2ce
Apocynaceae sensu lato	Hoodia lugardi N.E.Br.	Vulnerable	VU Alde
Apocynaceae sensu lato	Huemia levyi Oberm.	Vulnerable	VU D2
Apocynaceae sensu lato	Orbeopsis knobelfi (EPhfllips) L.C.Leach	Vulnerable	VU D1 D2
Lythraceae	Nesaea minima Immelman	Vulnerable	VU D2
Orchidaceae	Ansellia africana Lindl.	Vulnerable	VU A1ad
Orchidaceae	Eulophia angolensis (Rchb.f.) Summerh.	Vulnerable	VU Mad
Orchidaceae	Eulophia latilabris Summerh,	Vulnerable	VU A1ad
Portulacaceae	Anacampseros rhodesiaca N.E.Br.	Vulnerable	VU A1ad
Sapindaceae	Erythrophysa ransvaalensis I.Verd.	Vulnerable	VU D1 D2
Endangered			
Apocynaceae sensu late	Adenium boehmianum Schinz	Endangered	EN D
Apocynaceae sensu lato	Orbea tapscottii (LVerd.) L.C.Leach	Endangered	EN A1ac
Euphorbiaceae	Euphorbia vented L.C.Leach ex R.Archer & S.Carter	Endangered	EN C2a

REPTILES, AMPHIBIANS AND SMALL MAMALS RECORDED FOR THE PALAPYE AREA

Sources:Reptiles and amphibians (Auerbach. 1987); rodents(De Graaf, 1981); other mammals (Smithers, 1983)

Reptiles and Amphibians

Common Name	Scientific Name
Angolan Shovel-snout	Prosymna angolensis Boulenger
Bushveld Rain Frog, Common Rain Frog Common Blaasop	Breviceps adspersus Peters
Cape Sand Frog, Tremolo Sand Frog Striped Burrowing frog	Tomopterna cryptotis (Boulanger)
Mountain or Leopard Tortoise, Eastern Leopard Tortoise	Geochelone Pardalis babcocki (Loveridge)
Serrated Tortoise, Kalahari Tortoise, Kalahari Geometric Tortoise, Toothed Cape Tortoise, Kuhl's Tortoise	Psammobates oculifer (Kuhl)
Tropical House Gecko, Common or Moreau's Gecko	Hemidactylus mabouia mabouia
Common Cape Gecko, Smith's Cape Gecko, Smith Kaapse geitijie, Kasspse diktoongetiie	Pachydactylus capensis capensis (smith)

Common Name	Scientific Name
Peter's Spotted Gecko, Spotted Thick-toed Gecko	Pachydactylus punctatus punctatus Peter
Bibron's Gecko, Bibron's Thick-toed Gecko	Pachydactylus bibrobii Smith
Lygodactylus Gray	Common or Cape Dwarf Gecko
Wahlberg's or Velvety House Gecko	Homopholis wahlbergii
Wahlberg's Ground Gecko	Colopus wahlbergii wahlbergii Peters
Tree Agama, Black-necked Agama, Black-necked Tree Agama	Agama atricollis Smith
Kalahari Agama, Kalahari Spiny Agama Tropical Spiny Agama	Agama aculeate aculeate Merrem
Peters Spiny Agama, Zambezi Spiny Agama	Agama aculeate armata Peters
Speckled-bellied Skink	Mabuya strata punctatissima (Smith)
Cape Three-striped or Three- striped Skink, House Lizard Three-lined	Mabuya capensis (gray)
Common Variegated Skink, Variable Skink	Mabuya varia (Peters)
Speckled-bellied Skink	Mabuya strata punctatissima (Smith)
Sundeval's Skink, Sundeval's Writhing Skink	Lygosoma sundevallii sundevallii (/Smith)
Yellow-throated. Plated- lizard	Gerrhosaurus flavigularis W iegmann
Jones' Girdled Lizards, Jones' Arboreal Girdled Lizard, Lowveld Girdled Lizard	Gordylus Laurenti
Shoshong Hills Flat Lizard	Platysaurus intermedius nigrescens ;Broadley 1980/1981
Ornate Sandveld or Scrub Lizard	Nucras taeniolata ornate Gray
Black and-yellow Sand lizard	Heliobolus Fitzinger
Ocellated Sand Lizard	Pedioplanis lineoocellata lineoocellata (Dumeril & Bibron)
Rough-scaled Sand Lizard, Mozambique Rough-scaled Sand Lizard	Ichnotropis squamulosa Peter
Western Worm Lizard, Peter's Round-snouted Amphisbaenian, Kalahari Roundsnouted Amphisbaenian	Zygaspis quadrifrons (Peters)
Delalande's Blind Snake, P ink Earth Snake	Typhlops lalandei Schlegel
Peter's Worm-, Thread-, Scaly-fronted or Glossy Worm-Snake	Leptotyphlops scutifrons scutifrons (Peters)
Common or Brown House Snake, Lineated House Snake, African Lined Snake	Lamprophis fuliginosus (Bole)
Cape Wolf Snake, Common Wolf Snake	Lycophidion capense capense (Smith)
Southern Striped-bellied Sand or Grass -Snake. Stripe-Bellied Sun, Grass or Sand Snake, yellow-bellied Sand Snake	Psammophis subtaeniatus subtaeniatus (Peters)
Olive Grass Snake, Hissing Sand- or Grass snake, Short snouted Grass Snake African Beauty Snake, Sun	Psammophis sibilans brevirostris Peters
Cape Centipede-eater or Black-headed Snake. Black headed or Cape Centipede-eater	Aparallactus capensis Smith
Common Purple-glossed Snake	Amblyodipsas polylepis polylepis
Cape Centipede-eater or Black-headed Snake, Black- headed or Cape Centipede-eater	Aparallactus capensis Smith
Angolan Green Snake, Spotted or Variegated Bush Snake, Green Bush Snake, Spotted, Speckled or Variegated Wood Snake	Philothanmnus angclensis Bocage
Spotted or Variegated Bush Snake, Green Spotted Speckled or variegated Wood Snake	Philothamnus,semivariegatus semivariegatus
Eastern Tiger Snake	Telescopus semiannulatus semiannulatus
Southern or Cape Vine, Twig-, or Bird-snake.	Thelotornis capensis capensis (Smith)
Common, Rhombic or African Egg-eating Snake, Scaled Snake, Rough-skinned Snake	Dasypeltis scabra (Linnaeus)
Shield or Shield-nosed Snake	Aspidelaps scutatus scutatus (Smith)
Egyptian, banded, black. Brown, Rock, Bushveld Cobra or South-eastern Egyptoam Cpnra	Naja haje annulifera Peters
Horned Adder, Horned Puff- adder, Side winding Adder, common Single-horned	Bitis caudalis (Smith)

Rodents of the Palapye Area

Common Name	Scientific Name
Cape Ground Squirrel	Xerus inauris (Zimmermann. 1780)
Bush Squirrel, yellow-footed Squirrel, Smith's Bush Squirrel	Paraxerus cepapi (A. Smith, 1836)
Springhare	Pedetes capensis (Forster, 1778)
Cape Porcupine	Hystrix africaeaustralis (Peters, 1852)
Common Molerat, Hottentot Molerat	Cryptomys hottentotus (Lesson, 1826)
Hairy-footed Gerbil, South African Pygmy Gerbil, Lesser Gerbil	Gerbillurus paeba (A Smith 1836)
Bushvek Gerbil, Peters' Gerbil	Tatera leucogaster (Peters, 1852)
Highveld Gerbil, Brants' Gerbil	Tatera brantsii
Short-tailed Gerbil, Namaqua Gerbil	Desmodillus auricularis (a. Smith, 1834)
Pouched Mouse	Saccostomus campestris Peters, 1846
Grey Pygmy Climbing Mouse, Dark-eared Climbing Mouse, Grey Tree Mouse	Dendromus melanotis A. Smith, 1834
Woosnam's Desert Rate	Zelotomys woosnami (Schwann, 1960)
Red Veld Rat	Aethomys (Aethomys) chrysophilus (De Winton 1897)
Namaqua Rock Mouse	Aethomys (Micaelamys) nanaquensis (A. Smith, 1834)
Tree Rat	Thallomys paedulcus
Multimammate	Praomys (Mastomys) natalensis (A Smith, 1834)
Pygmy Mouse	Mus (Leggada) minutoides A. Smith, 1834
Spiny Mouse	Acomys spinosissimus Peters, 1852
Rock Dormouse	Gra(hiurus (Claviglis) Platyops Thomas, 1897
Woodland Dormouse	Graphiurus (Claviglis) murinus (Desmarest, 1822)

Appendix 6-4 Wildlife (6/6)

Mammals (excluding ungulates) (Source: Smithers, 1983)

Common Name	Scientific Name & IUCN Status
Reddish-grey musk shrew	Crocidura cyanea (duvernoy, 1838)
Lesser red musk shrew	Crocidura hirta (peters, 1852)
South African hedgehog	Erinaceus frontalis A. Smith, 1831
Short-snouted elephant- shrew	Elephantulus brachyrhynchus (A. Smith, 1836)
Bushveld elephant-shrew	Elephantulus intufi
Rock elephant-shrew	Elephantulus myurus LC
Egyptian free-tailed bat	Tadarida (Tadarida) aergyptiaca (E. Geoffroy, 1818)
Schreibers' long-fingered bat	Miniopterus schreibersii (Kuhl, 1819)
Rusty bat	Pipistrellus rusticus (Tomes, 1861)
Cape serotine bat	Eptesicus capensis
Yellow house bat	Scotophilus dinganii (A. Smith, 1833)
Common slit-faced bat	Nycteris thebaica
Darling's horseshoe bat	Rhinolophus darlingi k. Andersen, 1905
Lesserbushbaby	Galago senegalensis E Geoffroy, 1796 LC
Chacma babbon	Papio ursinus (Kerr, 1792)
Vervet monkey	Cercopithecus pygerythrus (F. Cuvier, 1821)
Pangolin	Manis temminckii (Smuts, 1832) NT
Scrub hare	Lepus saxatilis
Common mole rat	Cryptomus
Porcupine	Hystrix africaeaustralis Peters 1852
Springhare	Pedetes capensis (Forster, 1778)
Woodland dormouse	Graphiurus (Claviglis) murinus (Desnarestm#, 1822)
Ground squirrel	Xerus inauris
Tree squirrel	Paraxerus cepapi
Woosnam's desert rat	Zelotomys woosnami
Desert pygmy mouse	Mus indutus (Thomas, 1910)
Multimammate mouse	Praomys (Mastomys) natalensis
Tree mouse	Thallomys paedulcus (Sundevall, 1847)
Namaqua rock mouse	Aethomys namaquensis (A. Smith 1934)
Red veld rate	Aethomys chrysophilus (de Winton, 1897
Short-tailed gerbil	Desmodillus auricularis
Hairy footed gerbil	Gerbillurus paeba (A Smith, 1836)
Bushveld gerbil	Tatera leucogaster
Highveld gerbil	Tatera brantsii
Pouched mouse	Saccostomus campestris
Grey climbing mouse	Dendromus melanotis
Aardwolf	Proteles cristatus LC
Brown hyaena	Hyaena brunnea NT
Spotted Hyaena	Crocuta crocuta NT
Cheetah	Acinonyx jubatus VU C2a(i)
Leopard	Panthera pardus LC
Caracal	Fells caracal (Schreber, 1776) LC
African wild cat	Fells silvestris cafra
Bat-eared fox	Otocyon megalotis
Vulpes chama	Cape fox
Black-backed jackal	Canis mesomelas
Honey badger	Mellivara capensis LC
Striped polecat	Ictonyx striatus
African civet	Civettictis civetta LC
Small-spotted genet	Genetta genetta Linnaeus, 1758
Large-spotted genet	Getta tigrina
Suricate	Suricata suricatta LC
Selous' mongoose	Paracynictis selousi LC
Yellow mongoose	Cynictis penicillata
Slender mongoose	Galerella sanguinea
Banded mongoose	Munqos munqo
Dwarf mongoose	Helogale parvula Sundervall, 1846 LC
Rock dassie	Procavia.capensis

Status
EX = Extinct
EW = Extinct in the wild
CR = Critically endangered
EN = Endangered
VU = Vulnerable
NT = Near threatened
LC = Least concern
DD = Data deficient

Appendix 6-5 Environmental Legislatives and Policies of Botswana (1/2)

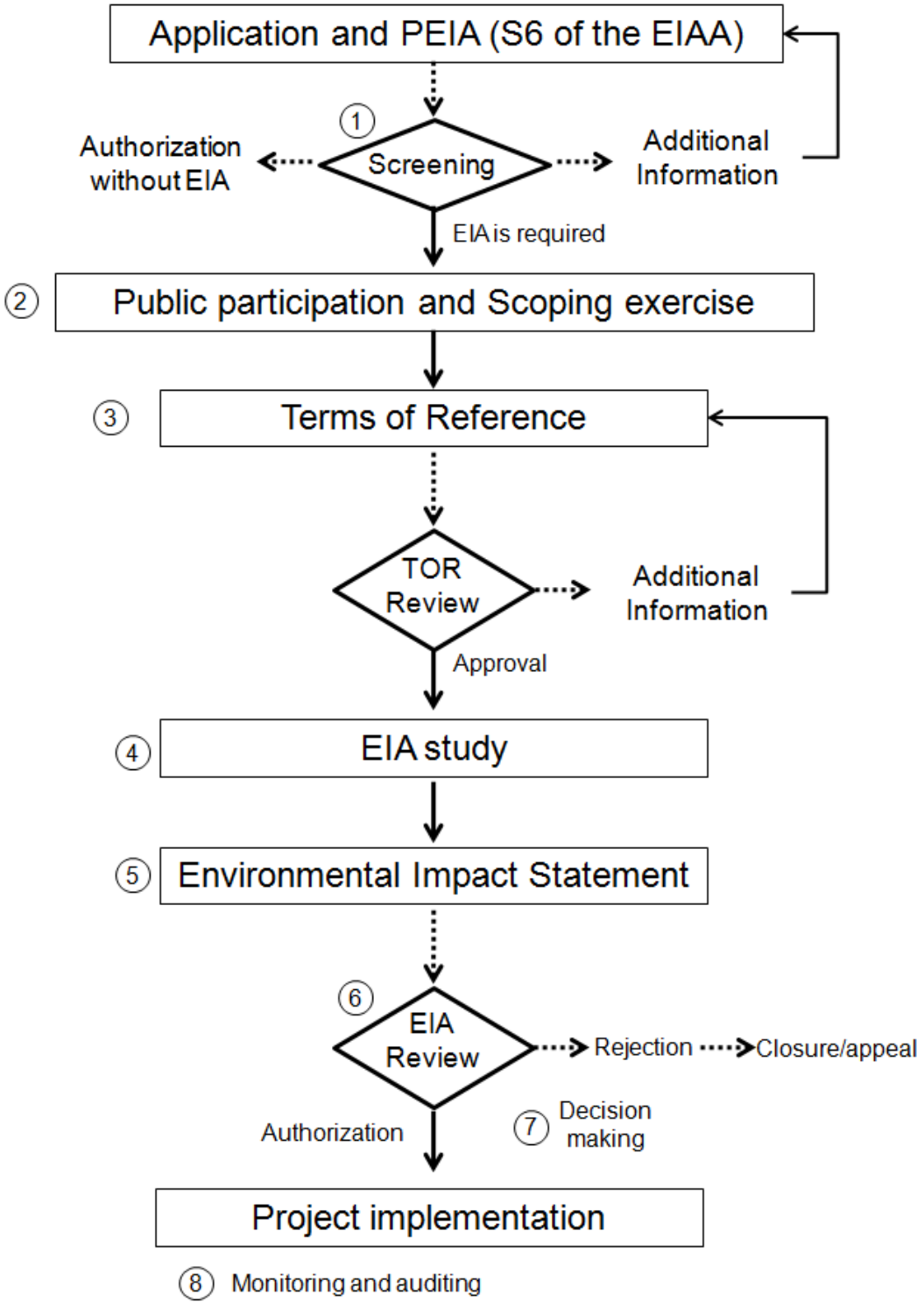
Regulations	Brief summary	Authority
Act		
Environmental Impact Assessment Act 2005	The Act states that environmental impact assessments should be undertaken to assess potentially adverse environmental and socioeconomic effects of planned developmental activities (projects, programs and policies) and to provide mitigation measures and a monitoring and evaluation process where necessary. The Act also provides for retrospective EIAs, i.e. an environmental assessment of existing activities.	Department of Environmental Affairs (DEA)
Atmospheric Pollution (Prevention) Act, 1971	The Act provide for the prevention of the pollution of the atmosphere by enabling the Minister to declare any area as a 'controlled area '(includes all urban areas) and the carrying on of industrial processes in these areas and for matters incidental thereto. The main aim of the Act is to control the emission of 'objectionable matter', i.e. controlling a very wide –range of different forms of atmospheric emissions produced by an extremely wide range of processes.	Department of Waste Management and Pollution Control (DWMPC)
Public Health Act, 1981	The Act addresses diseases and the spread thereof, and provides a range of health measures including regulations on prevention, management and control of diseases as well as cleanliness and sanitation and the control of nuisances. The Act also provides for the welfare of all personnel and addresses working facilities related to sanitation, workshops and offices, stating that these must be cleaned regularly and free of litter, and free of any nuisances that are offensive, injurious to health and possible environmental pollutants.	Ministry of Health
Waste Management Act, 1998	The Act makes provision for the regulation and management of controlled waste (waste defined as household, industrial, and commercial, clinical or hazardous) in order to minimize pollution and prevent harm to human, animal and plant life. It also prescribes that the Basel Convention applies for the regulation of trans-boundary movement of hazardous wastes.	DWMPC
Water Act, 1967	The Act provides for the ownership, protection and rights of use of 'public water'. It imposes duties to return water to its origin where it is reasonable practicable, i.e. to return water to that body of water from which it was taken to a stream or such other body of water. The Water Act specifies that water resources need to be returned of a quality closest to the quality of the abstracted water so that it does not cause injury either directly or indirectly to the biodiversity. There are standards developed by Botswana Bureau of Standards for wastewater discharge into the environment.	Department of Water Affairs
Monument and Relics Act, 2001	The Act (2001, as amended) calls for the protection of the environment, where possible in places where developments are proposed. Section 18 of the Monument and Relics Act prohibits any interference, change of place of origin, alteration, and destruction of monuments, relics of artifacts. Section 19 of the same act however allows for mitigation of the above mentioned in case they appear where proposed developments will affect or have started.	National Museum
Factories Act, 1979	The Act provides for occupational health and safety, safe working practices and the control of employment in factories. Regarding the existing power station, this provision concerns the occupational health and safety of the workers and all personnel present during daily operations. The Act protects the health and safety of employed persons by ensuring that inhalation of dust and fumes are considered and that protective clothing and appliances are used.	

Appendix 6-5 Environmental Legislatives and Policies of Botswana (2/2)

Regulations	Brief summary	Authority
Policy/Strategy		
Botswana Strategy for Waste Management	The strategy states that waste management will be carried out in a manner that protects human health and the environment, and that ensures prudent use of natural resources. It captures the principles of prevention, 'polluter pays' and development and management cooperation.	
Central District Development Plan 6	The plan supports the existence of the current Power Station by indicating a need for the use of coal and increased pressure to use alternative energy sources.	
Plapye Planning Area Development Plan	The plan provides a broad strategy for a 20-year planning period (1995-2015) and covers a surface area of approximately 25 000 hectares. The Morupule Colliery and existing Morupule Power Station are included within the Palapye Planning Area. The Plan succeeds a 1976 Land Use Plan and a 1986 development plan for Palapye. As these previous plans were not statutory, development was largely based on the National Development Plan and the Central District Development Plan.	
National Development Plan	National Development Plan (NDP9) promotes both environmental responsibility and environmental sustainability together with economic diversification and growth. The NDP9 makes recommendations for the appropriate use of natural resources together with responsible development. Economic growth is reliant upon a stable, reliable electrical energy supply.	
National Water Master Plan	The NWMPR documents provide an overarching strategic planning framework for water resources within the country. Planning considerations within the sector range from the sociological and demographical profile of the country, to a review of all surface and ground water resources, water demand management and national resource accounting to water development modeling and the consideration of the economics of urban water. The 2005 NWMPR made key policy, institutional and legislative recommendations that had wide implications on the water sector in terms of suggested law reform, improvement on the effectiveness of waste management, environmental conservation and sustainable development.	
National Energy Policy	The policy aims at providing a least-cost mix of energy supply, which reflects total life cycle costs and externalities, such as environmental damage. The energy policy objectives are mainly that: - Energy users should have access to appropriate and affordable energy services; - Energy should be used efficiently; - The energy supply industry should be economically sustainable and efficient; - All users should have security in their access to energy; - Energy extraction, production, transport and use should not damage the environment or - people's health and safety; and - In the long term sustainable energy usage needs to be implemented.	

(Source; Morupule B ESIA Report 2007, and Morupule "A" Environmental Management Plan 2010)

Appendix 6-6 EIA Process (1/6)



source; study team

Stages 1 to 6 are proponent-driven, while 6 to 8 are DEA driven stage.

1. Screening

Screening is the first stage in the EIA process and its purpose is to determine whether or not a proposed development requires an EIA. In line with the Act, the guidelines provide for two levels of screening, the Mandatory list and DEA Discretionary List. All activities listed under the mandatory list would be required to carry out an EIA while the DEA using set criteria, will determine which projects would require an EIA under the Discretionary List.

2. Public Participation and Scoping exercise

In the EIA process, scoping follows a determination by the competent authority that a proposed project or activity requires an EIA, and it follows on from the Preliminary EIA.

The scoping process is used before the preparation of an EIA to reduce the scope and bulk of an EIA, identify only those potentially significant issues relevant to the proposed project, define the form, level of detail, content, alternatives, time table for preparation of the EIA, and to determine the permits for which information will be developed concurrently with the EIA.

Scoping is done by the project proponent or by his consultants in order to identify the main issues of concern in consultation with the regulatory authority and the relevant sectoral authorities as well as the affected and interested persons. It is the responsibility of the project proponent to make sure that all the concerned parties are given adequate opportunity to participate in the scoping exercise. The objective of their inclusion is to determine how their concerns will be addressed in the TOR for the EIA study. The Local Authority, Licensing Authority or Funding institution should make available to the proponent, any relevant environmental information in their possession including advice on the sources of other information relevant to the scoping activity. Communication to the general public is important for a successful scoping exercise. Section 7 (1) of the Act states that an applicant shall take all measures necessary to seek the views of the people or communities which are likely to be affected by the project. An important outcome of the scoping exercise is drawing up of the TOR, which will guide the undertaking of the Environmental Impact Assessment Study. There is a growing consensus that timely and broad-based stakeholder (also referred to as 'interested and affected parties'-IAPs) involvement is a vital ingredient for effective environmental assessment, as it is for project planning, appraisal and development in general.

In accordance with Section 8(2) of the Act, the proponent is obligated to submit the

results of the scoping exercise, along with the TOR, to the competent authority.

The public participation under the scoping requirement is a structured meeting, called in accordance with Section 6(7) of the Act, during which the public who are likely to be affected by the proposed activity are given the opportunity to express their opinions and concerns about the project, it benefits and dis-benefits so they can be empowered to make informed comment.

3. Terms of reference

The TORs are the basis upon which an EIA is prepared and are used by applicants for soliciting proposals from Consultants to carry out the EIA study. TORs are one of the outcomes of the scoping exercise. According to Section 8(1) of the Act, once the Competent Authority has decided on the need for an EIA, the applicant would be requested to prepare TORs, and submit the TORs and results of the scoping exercise to the competent authority.

4. EIA study

EIA is the systematic examination of the environmental consequences of projects so that environmental consequences of proposed initiatives are considered in the planning process and measures taken to ameliorate them. Information required for the EIA is gathered from existing data and information sources, and fieldwork. Topics will include but will not be limited to description of project proposal, existing baseline conditions, potential project impacts, and impact mitigation and management.

5. Environmental Impact Statement

The results of the EIA study are contained in an Environmental Impact Statement, which is submitted to the competent authority for review.

6. EIA review and evaluation

The competent authority shall, within 60 days of receiving a statement from a developer, examine the statement to determine whether such statement complies with the requirements of Section 10 of the Act.

Where the statement complies with the requirements of section 10 of the Act, the competent authority shall -

(a) place a notification in the Gazette and in a newspaper circulating at least once weekly, for four consecutive weeks, inviting comments or objections of those

persons who are most likely to be affected by the proposed activity and other interested persons, stating the -

(i) nature and magnitude of the activity,

(ii) location of the activity,

(iii) anticipated environmental impact of the activity, and

(iv) proposed mitigation measures to respond to the negative environmental impact; and

(b) in its decision making, consider the comments or objections raised by persons who are likely to be affected by the proposed activity and other interested persons.

Public Participation

Public hearings are mandated by the EIA Act Section 7(1) and (2). The public hearing allows the public to make submissions on an Environmental Impact Statement (EIS) before officials make a final decision on its approval, rejection or deferrement. A notice of the public hearing must be published in the mass media using the official languages for a period not less than 10 days prior to the holding of the public hearing.

After the hearing, the information received from the witness must be assembled and minutes prepared. The competent authority will then make its decision taking into account the information from the public hearing. The competent authority should notify all involved parties of the its decision emphasizing that decision is final except that aggrieved persons not satisfied with the decision may appeal with the high court in accordance with the EIA act.

7. Decision making

In assessing applications for an authorization under this Act, and in making a decision as to whether it ought to issue or renew an authorization under this Act, the competent authority shall take into account the contents of the terms of reference, the statement, the recommendations of other government departments, local authorities and the comments and objections of interested persons and the public.

8. Audit

“Audit” refers to:

- the organization and analysis of monitoring data to establish the record of

change associated with a project;

- the comparison of actual versus predicted impacts; and
- the evaluation of the effectiveness of mitigation and enhancement measures designed to optimize anticipated impacts.

An EIA audit can provide an evaluation of compliance with the conditions of approval and can also be used to assess the effectiveness of a particular EIA in predicting at predicting impact type and characteristics. This means that a formal EIA Audit can only be commenced after partial or complete project implementation. Information from such an audit can be used to improve the effectiveness and efficiency of other ElAs in future.

(1) Structure and content of Preliminary EIA

- At the minimum, the contents of the preliminary EIA should include the followings.
- The name and address of the applicant and names of contact person
- A basic description of the project purpose, size, location, preliminary design, including any alternatives, which are under consideration.
- The stage of the project in the project cycle
- A location map of the project site or site alternatives and a site plan
- A discussion of which aspects of the project are likely to cause environmental impacts, and an evaluation of the magnitude and significance of the impacts.
- Proposed environmental management ensures to ameliorate adverse impacts and enhance positive impacts.

(2) Structure and Content of EIA Terms of Reference

The structure and content of EIA TOR should be as follows

- Introduction
- Background information
- Objectives
- Environmental requirements
- Study area
- Scope of work; Tasks for the scope of work should include the following

  Task 1; Description of the proposed project

  Task 2; Description of the environment

  Task 3; Legislatives and Regulatory considerations

  Task 4; Public Consultation

  Task 5; Analysis of alternatives to the proposed project

Task 6; Prediction of the potential impacts for the proposed project

Task 7; Presentation of mitigation measures

Task 8; Development of and Environmental Management Plan

Task 9; Archaeological Impact Assessment

(3) Structure and Content of Environmental Impact Statement

Following should be included in the EIS

- The name of applicant
- Executive summary
- Introduction
- Policy, legal and administrative framework
- Description of the project
- Description of baseline environment
- Public consultation
- Identification and assessment of environmental impacts
- Analysis of alternatives
- Mitigation measures
- Environmental Management Plan
- Conclusion and Recommendations
- References
- Appendices

Appendix 6-7 Major Environmental Impacts and Mitigation Measures during the Rehabilitation Phase (1/3)

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
Inflow of workers	Generation of sewage and waste	– Installation of sewage treatment facilities – Segregation of recyclable waste at generation source and supplied to a third party for reuse – Disposal at a determined sanitary disposal site	Contractor	DWMPC and BPC
	Infectious diseases	– Installation of medical facilities and implementation of periodic health checkups – Education on health management of the workers – Prevention of epidemics among workers (HIV/AID, dengue fever, malaria, hepatitis A, the other infectious diseases)	Contractor	Ministry of Health and BPC
	Traffic and working accidents	– Use of commuter bus for workers – Avoidance of the time when students travel between school and home – Reduction of vehicle speed in residential and school area – Implementation of safety program (traffic sign, speed limit, lighting of track, road restriction, checkup of auto parts (brake, klaxon))	Contractor	BPC
	Employment, income, livelihood, vulnerable groups, uneven distribution of benefit	– Utilization of local human resources and service (cleaning, catering, materials) – Implementation of the preliminary education and training programs with local authority	Contractor	BPC
	Infrastructure	– Installation of medical facilities	Contractor	Ministry of Health and BPC
Installation of construction and	Traffic and working accidents	– Avoidance of the transportation during the school time – Reduction of vehicle speed in residential and school areas	Contractor	BPC

Appendix 6-7 Major Environmental Impacts and Mitigation Measures during the Rehabilitation Phase (2/3)

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
plant equipments		– Implementation of safety program (traffic sign, speed limit, lighting of track, road restriction, checkup of auto parts(brake, klaxon)) – Adaptation of guidance vehicles when abnormal transportation is used.		
	Noise & vibration	– Restraint of night driving – Installation of silencer/muffler to the transportation and construction vehicles – Noise monitoring at residential and school area	Contractor	DWMPC and BPC
	Gas emission from vehicles and dust dispersion	– Periodic inspection and maintenance of vehicle and machineries – Idling stop practice – Installation of a wheel wash at the exit of the construction site – Periodic watering of the surrounding roads	Contractor	DWMPC and BPC
	Disturbance of local traffic	– Adaptation of guidance vehicles when abnormal transportation is used. – Avoidance of transfer during the road congestion time	Contractor	Local Police and BPC
Excavating work and operation of construction equipment and other rehabilitation works	Gas emission from equipment and dust dispersion	– Sufficient maintenance of machineries – Air quality Monitoring at residential area – Periodic watering of unpaved area – Covering of construction soils – Periodic washing of construction vehicles	Contractor	BPC
	Noise and vibration	– Restraint of noisy works during night – Use of low-noise machinery (silencer, muffler) – Installation of a temporary fence around construction site	Contractor	BPC

Appendix 6-7 Major Environmental Impacts and Mitigation Measures during the Rehabilitation Phase (3/3)

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
		– Announce timing of noisy works to the receptors beforehand – Provide noise protective equipment to the workers		
	Construction debris	– Comply with BPC waste management procedure – Disposal at designated sanitary disposal site	Contractor	BPC
	Soil runoff, turbid water, waste water from construction site	– Installation of temporary settling tanks, septic tanks and sediment fencing – Monitoring of effluent quality at the water outlet	Contractor	BPC
	Leakage of harmful substances	– Enclose harmful substances with a band/ in a room – Installation of cleaning facility	Contractor	BPC
	Accidents	– Develop a safety management plan and rules – Swift transport to medical facility – Observation of traffic regulations, installation of traffic signs, and education on driving safety – Reduction of vehicle speed in resident areas and close to schools	Contractor	BPC
	Soil contamination	– Prevention of oil spill from machineries – Immediate removal of contaminated soil – Isolate storage of hazardous substances from other materials	Contractor	BPC
Water intake	Drawdown of underground water level	– Monitoring of underground water level in the surrounding wells – Comply with water right	Contractor	BPC

Appendix 6-8 Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
Power generation	Exhaust gas emission	– Installation of a continuous monitoring system for gas emissions at each stack – Installation of pollution abatement equipments (desulfurization, de-nitrification facilities) – Monitoring of ambient air – Monitoring of human health and floral condition around the power station especially in leeward direction – Appropriate maintenance and management of equipments	BPC	DWMPC and BPC
	PM and Dust	– Rehabilitation of dust collection equipment (such as electrostatic precipitators) – Planting of higher trees around coal yard – Rehabilitation of dust prevention wall of coal conveyors – Watering of coal yard – Installation of dust prevention wall around bottom ash storage area	BPC	DWMPC and BPC
	Waste water discharge	– Sufficient maintenance of water processing unit – Monitoring of effluent quality – Sufficient maintenance of boiler to reduce amount of water consumption for boiler start up – Reuse of wastewater (for planting, ash slurry mixing etc) – Retention of all waste water within power station premise	BPC	DWMPC and BPC
	Noise and Vibration	– Planting higher trees around the power station to reduce noise impact – Installation of low-noise type machinery and soundproofing covers – Installation of low-vibration type machinery and the use of rigid foundations – Periodic maintenance – Monitoring around noise source, boundary and residential area – Distribution of ear protectors/muffs to workers – Periodic hygiene monitoring of workers	BPC	BPC
	Ecosystem and biota	– Periodic monitoring	BPC	Department of Wildlife and BPC

Appendix 6-8 Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
Water pollution	Contamination of the ground water	– Periodic monitoring of ground water near the evaporation pond – Re-route of ash slurry from existing ash dam to new ash dam	BPC	Department of Geological Survey and BPC
Water intake	Lowering of Underground water level Ground subsidence	–Periodic monitoring of underground water level around Paje –Reuse of wastewater –Reduce frequency of boiler trip to reduce water consumption for start up –Comply with water right	BPC	Department of Geological Survey and BPC
Generation of waste	-Generation of waste -Generation of by-product from FGD	General Waste – Comply with BPC Waste Management Procedure – Hazardous Waste – Storage hazardous waste in a secured place where isolated and has impervious floor – Employ contractor holding trans boundary waste transportation permission. – Medical Waste – Incinerate medical waste at designate place and method in accordance with guidance of local council. – General Waste – Recycle extent possible – Dispose at a sanitary landfill – Employ contractor holding waste disposal permission	BPC/Contractor	BPC/ Local council/ DWMPC
	Generation of the ash	– Re-route of ash slurry from existing ash dam to new ash dam which has impervious bottom – Reuse of fly ash at local cement industry extent possible	BPC	BPC
	Soil contamination	– Isolate storage of hazardous waste and used oil – Storage in a secured place which has impervious floor – Remove contaminated soil immediately	Contractor	DWMPC and BPC
Presence of power station, inflow of workers	Employment opportunities for local people and living	– Utilization of local human resources, service and materials – Implementation of the preliminary education and training programs for local unskilled people	Contractor	BPC

Appendix 6-8 Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Proposed EMP	Implementing organization	Responsible organization
Working Condition	livelihood			
	Social foundation Diseases	– Provision of emergency medical facility – Installation of medical facility and periodical health checkup – Education and training on health management of the workers	Contractor	Ministry of Health and BPC
	Deterioration of Working environment	– Strengthen SHE enforcement system and implementation capacity – Awareness improvement of all BPC employees – Periodic cleaning of all working places	Contractor	BPC
	Accidental Fire and disaster	– Installation of fire prevention system at coal yard – Periodic maintenance of fire extinguishers – Periodic implementation of evacuation drill and fire extinguish practice	BPC	BPC
	Occupational accident	– Strengthen SHE enforcement system and implementation capacity – Compliance of SHE Standard – Wear appropriate protections (safety boots, protective wear, helmet, dust musk, ear plug/muff, dust glasses) – Install first aid kits at every working places	BPC	BPC

Appendix 6-9 Existing Environmental Monitoring System of the Morupule "A" Power Station (1/1)

Item	Sampling point	Parameter	Monitoring frequency	Reporting	Reporting frequency	Remarks
Ground water of Paje well field	Paje well field	pH, EC, TDS, Na, Ca, Mg, Cl, SO_4, F, NO_3	Monthly	Water Appointment Board	Annual	-
Ground water of Morupule "A"	14 monitoring boreholes around within the premise	pH, EC, TDS, Na, Ca, Mg, Cl, SO_4, F, NO_3, NH_3, K				-
Water quality of 2 ponds	- Domestic waste water evaporation pond - Storm water evaporation pond	TDS, Na, Ca, Mg, Cl, SO_4, BOD, COD				-
Ash slurry	Ash dam	pH, EC, TDS, Na, Ca, Mg, Cl, SO_4, F, NO_3, NH_3, K				-
Ambient Air quality	North east corner of BPC premise	SO_2, PM_{10}	Continuous Online monitoring	Irregular auditing by DWMPC		Additional stations will be installed at appropriate location.
Noise& vibration	Within the Morupule "A" Power Station	Noise level	Every 2 years	This monitoring is to comply with BPC SHE Standard		Monitoring has been regularly conducted as periodic hygiene inspection for plant workers.
Meteorological data	Top of the boiler building(approx.40m from ground level)	Wind speed, Direction, Temperature	Continuous online monitoring	-	-	-
General Waste	Serowe landfill site	Volume	Every truck	-	-	-
Stack emission						
Unit No.1	At stack, online monitoring	SO_2, PM_{10}	-	Monitoring devices were taken to repair.	Irregular auditing by DWMPC	It has not been working since 2005
Unit No.2		SO_2, PM_{10}				
Unit No.3		SO_2, PM_{10}				
Unit No.4		SO_2, PM_{10}				

Prepared by the; JICA Study Team

Appendix 6-10 Sample of Monitoring Form (Construction) (1/2)

The latest results of the below monitoring items shall be submitted to the lenders as part of Quarterly Progress Report throughout the construction phase.

Construction Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Number	Contents of the comment	Reaction BPC took	Frequency
Formal comments made by the public				Upon receipt of comments/complaints
Number and contents of responses from Government agencies				

2. Pollution

-Water Quality

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Guideline Value	Standards for Contract	Referred International Standards		Measurement Point	Frequency
						World Bank PPHA	IFC		
pH	-			6-9		6-9	6-9	At effluent out let if its discharged to the outer environment of the Power Station premise	Quarterly
Dissolved oxygen	mg/l			60 % sat.					
BOD5	mg/l			30					
COD (filtered)	mg/l			150					
Color	mg/l			50 TCU					
Oil and grease	mg/l					10	10		
Total Suspended Solid	mg/l			25		50	50		

-Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Standards	Standards for Contract	Referred International Standards (WHO)	Measurement Point	Frequency
Dust	µg/m^3			-		50		Quarterly

Appendix 6-10 Sample of Monitoring Form (Construction) (2/2)

-Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Standards	Standards for Contract	Referred International Standards (World Bank)	Measurement Point	Frequency
Noise Level. Leq.	dB(A)			-		Residential 55	- At Site vicinity - At the nearest receptor	Daily

3. Social Environment

-HIV/AIDS and other STDs

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken
HIV/AIDS and other STDs	Incidences per 1000 inhabitants	

The latest results of the below monitoring items shall be submitted to the lenders on biannual basis for the first two years of operation.

Appendix 6-11 Sample of Monitoring Form (Operation) **(1/4)**

Operation Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Number	Contents of the comment	Reaction BPC took	Frequency
Formal comments made by the public				Upon receipt of comments/complaints
Number and contents of responses from Government agencies				

2. Pollution

-Water Quality (Ground water of Power Station)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Effluent Standards	Referred International Standards		Sampling Point	Frequency
					World Bank PPAH	IFC		
pH	-			6-9	6-9	6-9	Monitoring Bore holes around - Existing ash pond - Evaporation pond No.1 - Evaporation pond No.2 - Coal storage yard	Monthly
Dissolved oxygen	mg/l			60 % sat.	-	-		
BOD5	mg/l			30	-	-		
COD (filtered)	mg/l			75	-	-		
COD (unfiltered)	mg/l			150	-	-		
Color				50 TCU	-	-		
Turbidity	mg/l			NTU	-	-		
Total Suspended Solid	mg/l			25	50	50		
Total Dissolved Solid	mg/l			2000	-	-		
Faecal coliform	mg/l			1000/100ml	-	-		
Oil and grease	mg/l			-	10	10		
Total residual chlorine	mg/l			1.0	0.2	0.2		
Chromium(total)	mg/l			0.5	0.5	0.5		
Copper	mg/l			1.0	0.5	0.5		
Iron	mg/l			2.0	1.0	1.0		
Zinc	mg/l			5.0	1.0	1.0		
Lead	mg/l			0.05	-	0.5		
Cadmium	mg/l			0.02	-	0.1		
Mercury	mg/l			0.01	-	0.005		
Arsenic	mg/l			0.1	-	0.5		
Chromium VI	mg/l			0.25				
Cobalt	mg/l			1.0				

Cyanide	mg/l			0.1				
Manganese	mg/l			0.1				
Nickel	mg/l			0.3				
Selenium	mg/l			0.02				
Free and saline ammonia	mg/l			10				
Ortho or soluble phosphate	mg/l			1.5				
Calcium	mg/l			500				
Chloride	mg/l			600				
Fluoride	mg/l			1.5				
Nitrate	mg/l			22				
Potassium	mg/l			100				
Sodium	mg/l			400				
Sulphate	mg/l			400				
Boron	mg/l			0.5				

-Water Quality and water consumption (Ground water of Paje Well Field)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Drinking Water Standards			Sampling Point	Frequency
				Class 1(ideal)	Class 2 (acceptable)	Class 3 (maximum allowable)		
Intake volume	m3	-		Water Right				
pH	-			6.5-8.5	5.5-9.5	5.0-10	Monitoring Bore holes	Monthly
Conductivity	µS/cm			700	1,500	3,100		
TDS	mg/l			450	1,500	2,000		
Na	mg/l			100	200	400		
Ca	mg/l			80	150	200		
Mg	mg/l			30	70	100		
K	mg/l			25	50	100		
Fe	mg/l			0.03	0.3	2		
Cl	mg/l			100	200	600		
SO4	mg/l			200	250	400		
NO3	mg/l			45	45	45		

-Air Quality (Emission)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	DWMPC Standards		Referred International Standards		Measurement Point	Frequency
				Max.	Ave.	World Bank PPAH	IFC		

SO2	mg/Nm3			3,923	2,903	2,000	900-1,500	At stack inlet	Online
NOx				-	-	750	510		
Dust(PM10)				154	137	50	50		
CO				-	-	-	-		
CO2				-	-	-	-		

-Air Quality (Ambient Air Quality)

Item	Averaging time	Unit	Measured Value (Mean)	Measured Value (Max)	Botswana Guideline value	Referred International Standards		Measurement Point	Frequency
						World Bank PPAH	IFC		
SO2	24h	µg/m3			300	150	125(IT-1) 50(IT-2) 20(guideline)	- Palapy - Serowe - And some points at windward and leeward	Online
	1hour				160 (1 month)	-			
	1Year				80	80			
NOx	24h				-	150	-		
	1hour				-	-	200		
	1Year				-	100	40		
Dust	24h				300	150	150(IT-1) 100(IT-2) 75(IT-3) 50(guideline)		
	1hour				200 (1 month)	-	40		
	1Year				100	50	70(IT-1) 50(IT-2) 30(IT-3) 20(guideline)		

-Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Referred International Standards		Measurement Point	Frequency
					World Bank PPAH	IFC		
Noise Level. Leq.	dB(A)			-			- Boundary of the plant area - Primary school - Nearest residential area	Quarterly

3. Natural Environment

Appendix 6-11 Sample of Monitoring Form (Operation) **(4/4)**

-Bird Electrocution and Collision

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Bird Electrocution and Collision	Details of survey results, such as findings		Yearly

-Vegetation

Monitoring Item	Monitoring point	Result	Frequency
Growth condition of Vegetation	Some point within 10 km radius, windward and leeward direction.		Twice a year

3. Social Environment

-HIV/AIDS and other STDs

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
HIV/AIDS and other STDs	Incidences per 1000 inhabitants		Annually

-Accident

Monitoring Item	Location	Date and time	Contents	Coping method
Accident	- Locations of accidents identified			

Appendix 6-12 JBIC Environmental Checklist: "11. Thermal Power Generation" **(1/9)**

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	① Morupule "A" Power Station was constructed in 1986 and the Environmental Impact Assessment Act (Act 6 of 2005, the EIAA) was developed in 2005. EIA was not implemented for the plant construction. Then BPC has developed an Environmental Management Plan (EMP) in August 2010 in accordance with a guidance of the Department of Environmental Affairs (DEA) in November 2008 for the continuous operation of the existing Morupule "A" Power Station. The EMP was already approved by DEA in September 2010 with 6 conditions below. ・ The authorization is for the specified activities outlined in the EMP report and location only as described in the application forms and the subsequent EMP report ・ The authorization cannot apply to another project even at the same location or to the same project at a different location. ・ The authorization is not transferable to another party without the written approval of DEA irrespective of whether that party intends to develop the same project at the same location or not. ・ The mitigation measures and impact management/monitoring recommendations are outlined in the EMP are implemented in totality ・ Self audit reports should be submitted to DEA on a quarterly basis the recommendations on the monitoring aspects should be sent to the relevant authorities on a regular basis as recommended in the EMP. ・ The authorization can be revoke if the conditions outlined above are not complied with ② Ditto ③ Ditto ④ BPC is holding required environmental permits except certificate for stack emission for Unit no.4. The certificate is in the issuance process under DWMPC.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	① BPC voluntary conducted public consultation and stakeholder consultation respectively in 2010 as a part of EMP while requirement from DEA did not include the consultations. ② Comments from attendants were mentioned in the EMP for operation of the existing Morupule "A" Power Station and it was approved by the DEA.
2 Mitigation Measures	(1) Air Quality	① Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by power plant operations comply with the country's emission standards? Is there a possibility that air pollutants emitted from the project will cause areas that do not comply with the country's ambient air quality standards? ② In the case of coal-fired power plants, is there a possibility that fugitive coal dust from coal piles, coal handling facilities, and dust from coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?	① This project intends to reduce the emission concentration of SO2 from the existing Morupule "A" power station by installation of FGD. FGD reduces the SO2 emission to the level that will meet the requirements of not only the air emission standards in Botswana but also the standards of the World Bank. NOx concentration will be within the WB standard by rehabilitation of burners. ② The environmental improvement of the existing coal storage yard, coal transport facilities and others are recommended to BPC.
	(2) Water Quality	① Do effluents including thermal effluents from the power plant comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards or cause a significant temperature rise in the receiving waters? ② In the case of coal-fired power plants, do leachates from coal piles and coal ash disposal sites comply with the country's effluent standards? ③ Are adequate measures taken to prevent contamination of surface water, soil, groundwater, and seawater by the effluents?	① Wastewater from demineralization system, domestic wastewater and storm water are main effluent from the Morupule "A" Power Station. All of this wastewater are stored at evaporation ponds and ash dam and evaporated. Therefore no effluent to outer environment is discharged. ② Leachate from coal piles, ash disposal and evaporation ponds may penetrate to groundwater. Although ground water have been affected, it has not been utilized by surrounding community. Ash slurry will diverted to new ash dam of which will equip seepage control bottom. Ground water contamination will be prevented. ③ Ditto

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(3) Wastes	① Are wastes, (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulfurization generated by the power plant operations properly treated and disposed of in accordance with the country's standards?	① Ash (fly ash and bottom ash), general waste, hazardous waste and gypsums are main waste produced from the power station operation. Waste management are summarized as below. Fly ash; Maximum production is 240 t/d in case of full road operation. The fly ash is mixed with wastewater generated from water demineralization system and boiler blow down and sent to the ash dam by slurry pumps through a delivery pipe. Approximately 46,000 ~ 54,000 tons/y of fly ash were sold to a private cement industry. Bottom ash; The bottom ash is transferred from the plant to the dam by 2 trucks and disposed. General waste; BPC has entrusted solid waste collection and disposal to a private contractor who hold a waste disposal certificate issued by DWMPC. The general waste is disposed at a sanitary landfill in Serowe. Hazardous waste (used/expired chemicals, medical waste); Hazardous waste have been stored in an onsite secured place. Those wastes will be transferred to South Africa when BPC ensures funds to engage a contractor who hold the Trans boundary waste permission which is issued by the DWMPC. Medical waste is collected by the sub district council and incinerated at the Serowe Landfill. Used oils and fluorescent Those wastes are stored in a secured open pit in the power station premise. Those waste are treated by private contractors same as hazardous waste. Gypsum; Gypsum is produced from FGD as a by-product. Although the effective use of the gypsum is included in the plan, the method for processing the unused gypsum should be considered in the FGD design stage.

Appendix 6-12 JBIC Environmental Checklist: "11. Thermal Power Generation" **(4/9)**

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(4) Noise and Vibration	① Do noise and vibrations generated by the power plant operations comply with the country's ambient standards, and occupational health and safety standards? ② In the case of coal-fired power plants, are the facilities for coal unloading, coal storage areas, and facilities for coal handling designed to reduce noise?	① Noise impact of the power station to the sensitive sites in the surrounding area will be minor. Noise levels from the existing power station exceed 35 dBA up to a distance of about 2,500 meters from the facility. Noise from the power station does not have a significant impact on the activities at the Kgaswe Primary School which is the nearest receptor. Plant operation after rehabilitation will not increase noise from present level. ② The existing facilities are not provided with noise-proofing equipment. Planting of higher trees are recommended between power station and receptors to reduce noise impact in addition to the existing shrubs.
	(5) Subsidence	① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	① Currently ground water is taken from Paje well field for the water usage of the plant operation. Ground water intake will increase due to operation of FGDs . The impact should be assessed to prevent subsidence and mitigation measures should be considered.
	(6) Odor	① Are there any odor sources? Are adequate odor control measures taken?	① Evaporation pond No.2 which stores domestic wastewater is a source possibly produce odor. Since the pond is isolated from the residence and secured by locked fence, odor impact is minor.
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	① There is no registered protection area in/around the project site. The nearest area is "Northern Tuli Game Reserve" which locates approx. 270 km east from the project site. Impact from the Morupule "A" Power Station to the area is not expected.
	(2) Ecosystem and biota	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate environmental protection measures taken to reduce the impacts on ecosystem?	① This project relates to rehabilitation of the existing power station and the additional installation of pollution abatement within the premises of the existing power plant, and does not involve development of a new land. Further, such a land is not present within the area to be affected. ② Ditto ③ Ditto

Appendix 6-12 JBIC Environmental Checklist: "11. Thermal Power Generation" **(5/9)**

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	① This Project relates to additional installation of a flue gas desulfurization system within the premises of the existing plant. There is no need for acquisition of a new land or relocation of the local inhabitants. ② through ⑦ ditto

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is sufficient infrastructure (e.g., hospitals, schools, roads) available for the project implementation? If existing infrastructure is insufficient, is a plan developed to construct new infrastructure or improve existing infrastructure? ③ Is there a possibility that large vehicle traffic associated with the project will affect road traffic in the surrounding areas? Are adequate measures considered to reduce the impacts on traffic, if necessary? ④ Is there a possibility that diseases (including communicable diseases, such as HIV) will be introduced due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? ⑤ Is there a possibility that the amount of water used (e.g., surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (especially fishing)?	① This Project is intended to mitigate the impact of the pollutant contained in the exhaust gas, and does not give adverse effect to the lives of the inhabitants. ② The infrastructures required for implementation of this Project are considered to be fully provided by the existing ones. ③ BPC operates commuter buses from residential area to the plant. Therefore no serious impact is predicted. There will be an impact of the traffic volume that will increase during the construction period. The impact on the surrounding traffic should be considered depending on material transported and methods. ④ At the time of additional construction, a safety measure committee (provisional name) composed of the related personnel will be set up to provide safety and sanitary education. ⑤ The impact of water intake should be studied before the selection of pollution abatement equipments. No effluent to the outer environment is predicted.
	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	① There is no heritage or historic spot in the area surrounding this Project.
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① This Project relates to the additional installation of a flue gas desulfurization system within the premises of the existing power plant, and does not raise a new aesthetic problem.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(5) Working conditions	① Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? ② Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? ③ Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public sanitation) for workers etc.? ④ Are appropriate measures being taken to ensure that security guards involved in the project do not violate safety of other individuals involved, or local residents?	① BPC has established a Safety, Health and Environmental standard to comply with the "Factory Act" of Botswana and managed working condition and safety. BPC hires employees and creates working environment in conformance to the domestic law. ② BPC introduces the safety facilities and performs hazard management in conformance in accordance with the standard above and to the domestic law. ③ BPC provides the related personnel with training in accordance with the standard above. ④ BPC provides security guards with an appropriate guidance.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	① BPC administers the safety management organization together with the contractor of the construction work, and studies the measures to reduce the generation of noise, vibration, turbid water, dust, exhaust gas and waste. ② The work is performed within the premises of the existing power plant, and there is no development of new land. Accordingly, adverse effects on natural environment are not assumed. ③ BPC predicts the possible impact of the construction work upon the surrounding community, and studies the mitigation measures.
	(2) Accident Prevention Measures	① Are adequate accident prevention plans and mitigation measures developed to cover both the soft and hard aspects of the project, such as establishment of safety rules, installation of prevention facilities, and equipment, and safety education for workers? Are adequate measures for emergency response to accidental events considered? ② In the case of coal-fired power plants, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g., sprinkler systems)?	① At present, employees are provided with education and training for safety and fire fighting, test and health control. At the time of construction work, a safety management organization will be formed by the related personnel, and education and training for safety and sanitation will be practiced. A close tie-up will be formed with the local police and medical organizations, and safety measures should be worked out in the primary phase of project implementation. ② In an effort to guard against spontaneous ignition at the coal storage yard, water sprinkler and surveillance are performed.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(3) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	① through ④ The items to be monitored, frequency, analysis method and report are stipulated by the relevant authorities. BPC implements a monitoring program through consultation with the competent authorities.
6 Note	Reference to Checklist of Other Sectors	① Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities). ② Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g., projects including construction of port and harbor facilities).	① Since the existing lines are used for power transmission and distribution, additional installation is not performed. ② A port or harbor is not constructed.
	Note on Using Environmental Checklist	① In the case of coal-fired power plants, the following items should be confirmed: • Are coal quality standards established? • Are the electric generation facilities planned by considering coal quality? ② If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	① The currently used coals will be employed, so there is no change in quality. ② BPC will employ a contractor who holds an appropriate certificate of trans-boundary waste disposal issued by the DWMPC to transport hazardous water. Ozone layer destroying substances are not generated in this Project. Since sulfides in the exhaust gas are reduced by the implementation of this Project, impact of the acid fallout is mitigated. The efficiency of power generation will be improved. However total amount of carbon dioxide is not reduced by the rehabilitation.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly general rule, or the International Finance Corporation Performance Standards for private sector limited or non-recourse project finance cases, or other standards established by other international financial institutions, or other rationale for this deviation, and the measures to rectify it if necessary, are to be confirmed. In cases where local environmental regulations are yet to be established in some areas, considerations should be based on comparisons with international standards such as the World Bank Safeguard Policy, and appropriate

standards of other countries(including Japan).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Appendix 6-13 Calculation of CO_2 Emission Reductions **(1/2)**

1. Calculation of Baseline emissions

$$BE_y = EG_y \times EF_{co2,EL,y} \quad (1)$$

BE_y = Baseline emissions in year "y" (tCO_2)

EG_y = Total amount of electricity generated in the project activity power plant in year "y" (transmission end) (MWh)

$EF_{CO2,EL,y}$ = Emission factor used in the calculation of baseline CO_2 emissions per electric generation (tCO_2/MWh)

[Calculation of $EF_{CO2,EL,y}$ in case of Reconstruction of existing plant]

$$EF_{CO2,EL,y} = \frac{COEFi,y}{\eta BL} \times 3.6\ GJ / MWh \quad (2)$$

$COEFi,y$ = CO_2 emission coefficient per calorific value of fuel type "i"

η_{BL} = Actual measured value (principally) or designed value of energy efficiency prior to implementation of the project activity

2. Calculation of Project emissions

$$PE_y = FC_{PJ,y} \times NCV_{i,y} \times COEF_{i,y} \quad (3)$$

PE_y = Project emissions (tCO_2)

$FC_{PJ,y}$ = Total amount of fuel combustion in year "y" (t or kl or m^3)

$NCV_{i,y}$ = Weighted average net calorific value of fuel type "i" in year "y"

$COEF_{i,y}$ = CO_2 emission coefficient per calorific value of fuel type "i" (tCO_2/GJ)

3. Calculation of emission reductions

$$ER_y = BE_y - PE_y \quad (4)$$

ER_y = GHG emission reductions during the year "y" (tCO_2/yr)

BE_y = Baseline emissions during the year "y" (tCO_2/yr)

PE_y = Project emissions during the year "y" (tCO_2/yr)

Appendix 6-13 Calculation of CO_2 Emission Reductions **(2/2)**

Following values were used in this report to calculate CO_2 emission reductions.

Baseline emissions (BE_y)	Value	Remarks
EGy	823,299.84 MWh	
Operational rate in year "y"	86.02%	Actual measured value in 2005
Auxiliary power ratio including installation of FGD	11.64%	11.34% : actual measured value in 2005 0.3% : FGD
$COEF_{i,y}$	0.101 tCO2/GJ	Default value for Lignite
η_{BL}	0.1894	Average value in 2009 and 2010

Project emissions (PE_y)	Value	Remarks
$FC_{PJ,y}$	682,550 t	Designed value
$NCV_{i,y}$	24.04 GJ/t	

Jimmy Hambo Ketlhabanetswe

From: Jacob Raleru
Sent: 21 March 2011 03:23 PM
To: Abraham Joseph
Cc: Jimmy Hambo Ketlhabanetswe
Subject: FW: [BULK] from JICA study Team

Importance: Low

Rre Joseph;

Please **urgently** assist me with a response to Mr Aniku's query.

NJR

From: David Aniku [mailto:daniku@gov.bw]
Sent: 21 March 2011 10:21
To: Jacob Raleru
Subject: FW: [BULK] from JICA study Team
Importance: Low

Sir

See item 2 below from those guys from JICA.

Before I respond, is there any information you have that I am not aware of?.

Our policy on existing projects which are operating is that an EMP is sufficient enough for any upgrading or refurbishment. We had already indicated this to the gentleman. Our understanding is that the EMP covers the following:

- The need to comply to the EIA Act as the power plant was developed prior to the enactment of the Act;
- Address or mitigate any existing concerns, e.g. the current emissions from the stack which are above existing standards;
- Refurbishment/upgrading of the power plant

Thank you

David Aniku
Department of Environmental Affairs
Ministry of Environment, Wildlife and Tourism
Plot 1271, Second Floor- Travaglini House, Old Lobatse Road
Private Bag 0068
Gaborone
Botswana
Tel: 00267 3902050
00267 3644626 (Direct)
00267 3913116 (Direct)
Fax: 00267 3902051
00267 3914 687

APPENDICES FOR CHAPTER 8

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (1/14)

Study on FGD (Flue Gas De-sulferizaiton)

1. Design Condition

(1) Design condition of flue gas

Design conditions of flue gas is shown in Table-A8-1, those are based on the flue gas on Morupule “A” recorded in the Audit report in FY2009 prepared by DWMPC, in which result of source test carried out on 17th to 18th December 2009 by them at Morupule “A” are summarized.

Table-A8-1 Design condition of flue gas

Item	Value	Unit
Flue gas velocity	6	m/sec
Flue gas	130,000	Nm^3/hr
Temperature	120	Degree C
Moisture	10	%
O_2	9.67	%
NO	367.12	ppm
NO_2	0.01	ppm
SO_2	947.65	ppm
CO_2	10.70	%

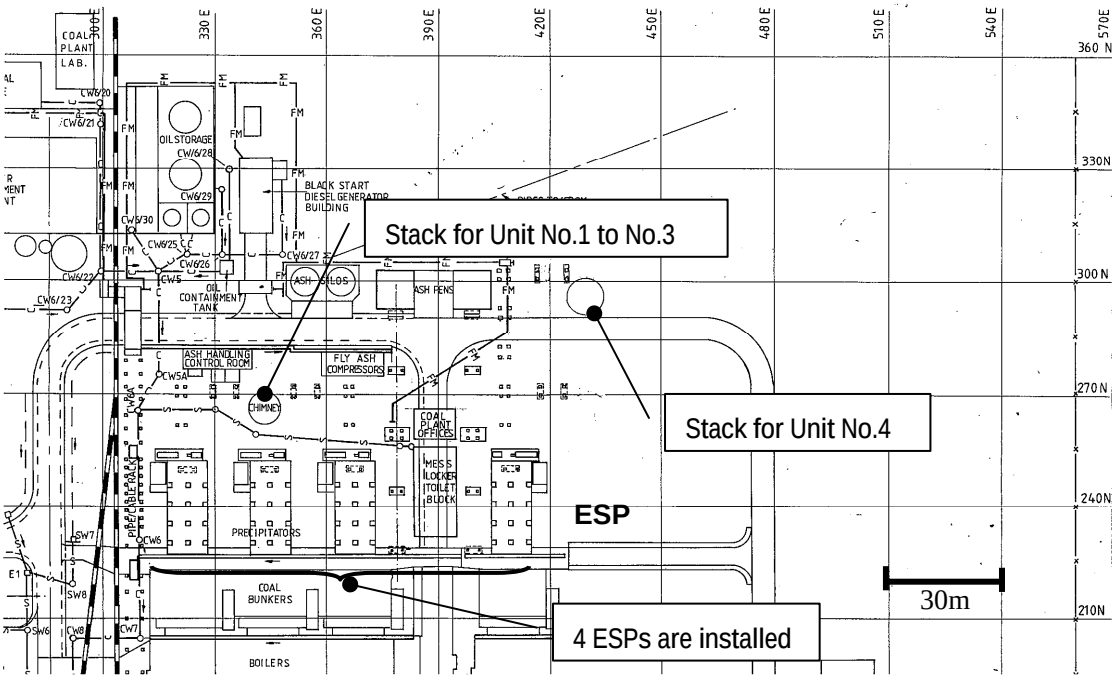
Source: Audit report on FY2009 of flue gas on Morupule power plant by DWMPC

Remark: Gas concentration rate (O_2, NO, NO_2, SO_2, CO_2) is used mean value.

(2) Design condition of space

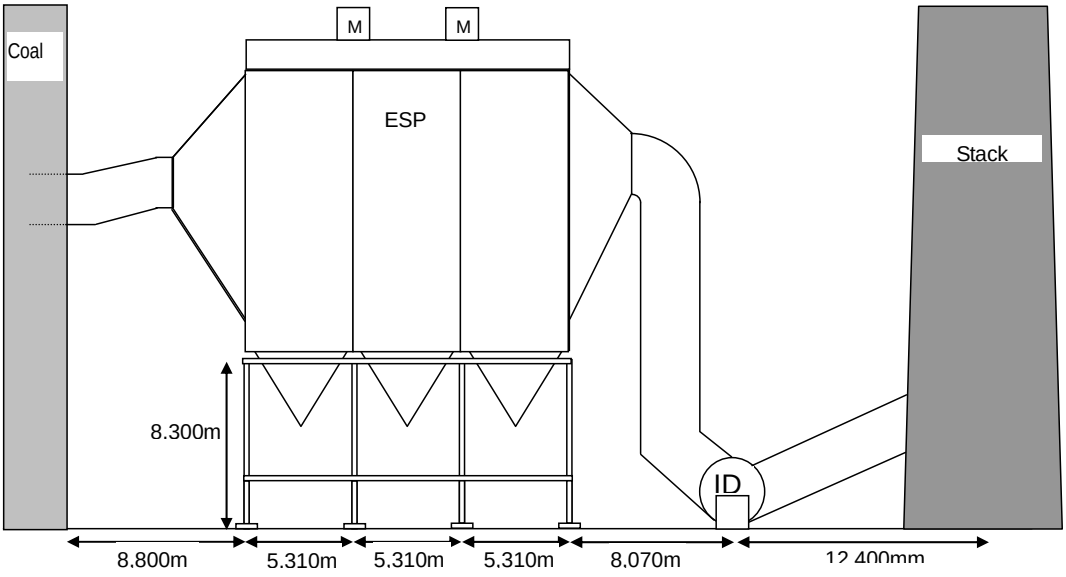
Design condition of installation is shown in Figure A8-2. The clearance between ESPs to stack for Unit No.1 to No.3 is very short. Moreover, various equipments are installed around the stack, therefore there is no enough space for installing new equipment.

The enlarged elevation and plan of No.2 ESP is illustrated in Fig-2 and Figure A8-3, the clearance between No.2 ESP and the stack has is very short as mentioned above.



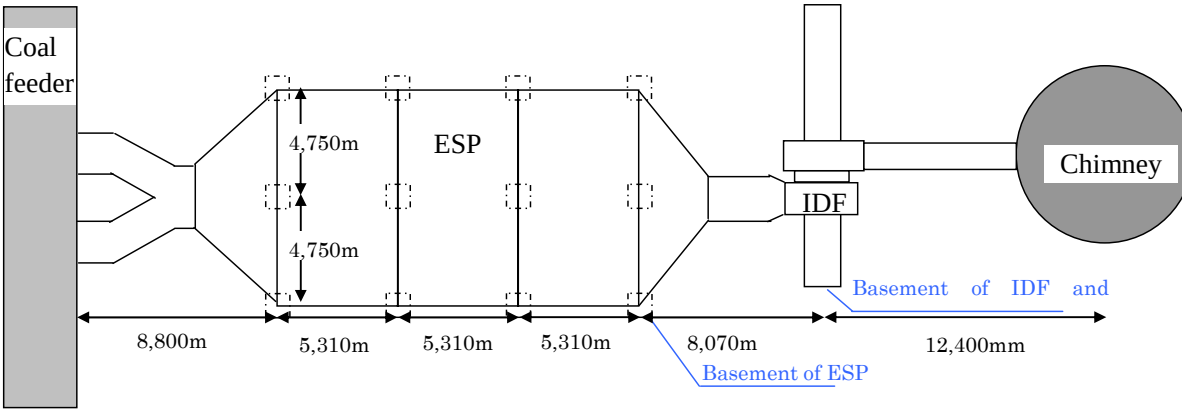
Prepared by JICA Study Team based on MORUPULE POWER STATION SITE PLAN Dated 3/08/89

Figure-A8-1 Existing Equipment between Coal Banker and Stacks



Prepared by JICA Study Team

Figure A8-2 Elevation around ESP for Unit No.2



Prepared by JICA Study Team

Figure A8-3 Plan around ESP for Unit No.2

(3) Design condition of water supply

Since SO2 is removed by a chemical method, some amount of water is needed for the reaction process. Currently the power station has water intake right of 657,000 m^3 per annum only form Paje well field.

Monthly generated powers and corresponding water consumptions in the past are shown in TableA8-1, by which the water consumption per MWh is calculated as minimum at 0.552 to maximum at 0.643 m^3/MWh.

After the rehabilitation project, the plant availability rate is expected to recover 80% or more. The annual water consumption can be calculated to 580,000m^3/year as shown in Table A8-2.

The margin of water between the right 657,000m3 and the average consumption 580,000m3 is calculated at 77,000 m3/year only.

Table A8-1 Generated power and Water Consumption

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
FY2004	Water	35,119	43,924	32,264	40,007	45,118	47,630	51,942	57,254
	MWh	61,646	73,205	69,832	77,706	78,061	88,559	83,819	87,420
FY2005	Water	57,017	48,337	59,510	41,596	37,668	43,167	63,867	49,281
	MWh	89,451	73,076	91,891	92,976	73,815	82,481	88,613	67,609
FY2006	Water	47,585	32,422	36,326	32,596	36,019	26,881	51,474	44,910
	MWh	89,733	80,576	75,929	71,855	70,508	57,843	62,963	67,641
FY2007	Water	22,770	37,778	37,778	28,330	39,771	42,554	39,771	33,869
	MWh	63,655	56,210	66,268	69,030	71,172	59,276	47,513	40,733
FY2008	Water	36,502	26,169	24,378	21,964	38,529	30,903	22,763	31,972
	MWh	55,255	68,484	63,872	61,011	53,041	46,338	48,551	45,923
FY2009	Water	25,388	25,893	26,698	29,486	34,472	34,472	36,756	25,124
	MWh	42,600	57,202	24,229	44,314	55,868	41,858	37,438	32,418

		Dec	Jan	Feb	Mar	SUM	m3/MWh	Load ratio
FY2004	Water	55,296	35,119	43,924	32,264	519,861	0.552	
	MWh	81,587	91,722	71,621	76,487	941,665		81.4%
FY2005	Water	50,576	58,403	46,860	63,242	619,524	0.634	
	MWh	78,206	90,246	65,341	83,396	977,101		84.5%
FY2006	Water	56,612	37,949	37,949	37,778	478,501	0.582	
	MWh	67,668	63,905	47,429	65,476	821,526		71.0%
FY2007	Water	37,014	27,568	21,558	42,137	410,898	0.592	
	MWh	48,482	59,758	54,451	57,504	694,052		60.0%
FY2008	Water	33,235	28,794	22,086	27,555	344,850	0.556	
	MWh	43,627	40,597	41,579	52,276	620,554		53.7%
FY2009	Water	28,605	25,388	25,893	26,698	344,873	0.643	
	MWh	44,119	52,339	45,299	58,892	536,576		46.4%

Source: BPC Month End Report

Table A8-2 Assumed Water Consumption before introducing FGD

Item	formula	Value	Unit
Average water consumption per MWh	A	0.59	m^3/MWh
Operation time per annum	B	8,760	hr
Availability rate (more than 80%)	C	85	%
Number of unit	D	4	Unit
Rated generator output	E	33	MW
Calculated annual water consumption	=A*B*C*D*E Round up	579,894 580,000	m^3/year

Prepared by JICA Study Team

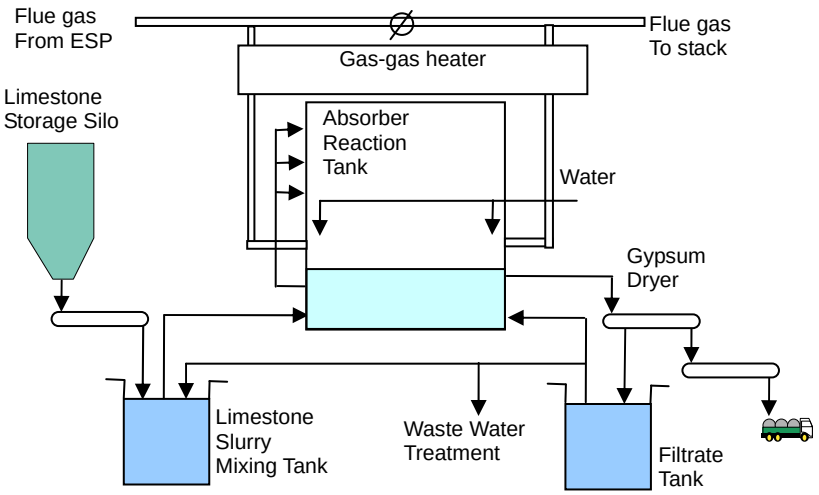
2. Outline of FGD system

Many types of FGD systems are produced worldwide. Outline of typical 5 types of FGD systems are introduced.

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (5/14)

(1) Lime-gypsum system (wet type)

- ✓ Lime-gypsum system is classified into wet type.
- ✓ Typical flow Lime-gypsum system is illustrated in Figure A8-4.
- ✓ The system is installed between ESP outlet and stack. Flue gas from ESP passes through gas-gas heater at first then goes into absorber reaction tank. The gas-gas heater cools the inlet gas for reducing to evaporate the water in the absorber reaction tank. Then the flue gas goes gas-gas heater again to heat the gas again in order to prevent the corrosion inside of the duct or the stack.
- ✓ In the absorber reaction tank, reaction is activated to absorb the SO2 by the chemical reaction formula ”SO2 and CaCO3 react mutually and they change to gypsum, water, and CO2”.
- ✓ Installation of the waste water treatment is also necessary.
- ✓ Where some trouble is occurred in absorber reaction tank, flue gas from ESP can flue directly to stack through bypass vane. During the flue gases go through bypass vane, SO2 is not abated.
- ✓ Where some trouble is occurred in absorber reaction tank, flue gas from ESP can flue directly to stack through bypass valve.



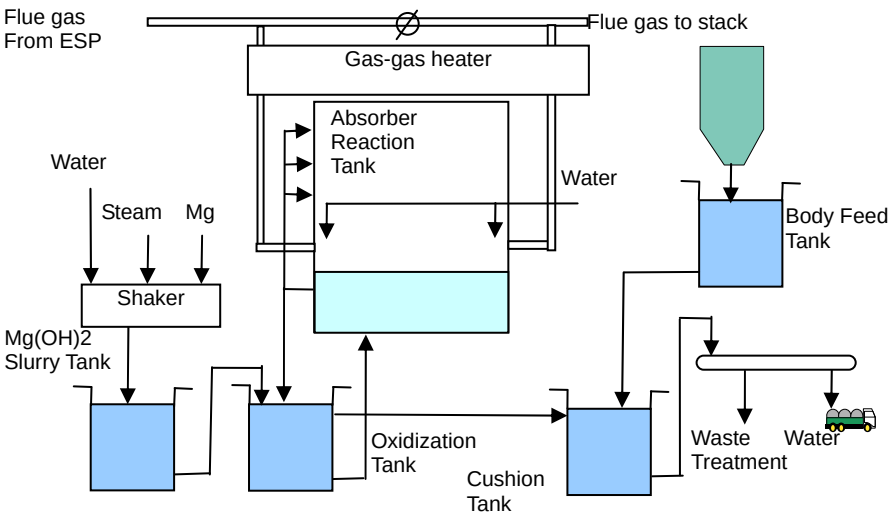
Prepared by JICA Study Team

Figure A8-4 Lime-Gypsum System

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (6/14)

(2) Magnesium Hydroxide System (wet type)

- ✓ Magnesium hydroxide system is classified into wet type.
- ✓ A typical flow of Magnesium hydroxide system is illustrated in Figure A8-5. The system is installed between ESP outlet and stack. Flue gas from ESP passes through gas-gas heater, at first then come into absorber reaction tank. The gas-gas heater cools the inlet gas to reduce to evaporate the water in absorber reaction tank. Then the flue gas goes gas-gas heater to heat the gas in order not to make the corrosion inside of the duct or the stack.
- ✓ In the absorber reaction tank, reaction is activated to absorb the SO2 by the chemical reaction formula “SO2 and magnesium hydroxide react mutually and they change to MgSO4”.
- ✓ Installation of the waste water treatment is also necessary.
- ✓ Where some trouble is occurred in absorber reaction tank, flue gas from ESP can flue directly to stack through bypass valve.



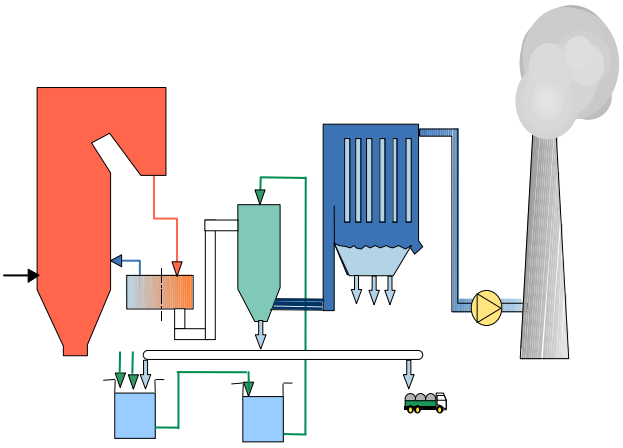
Prepared by JICA Study Team

Figure A8-5 Magnesium Hydroxide System

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (7/14)

(3) Spray-dryer system (Semi dry type)

- ✓ Spray-dryer system is classified into semi dry type.
- ✓ A typical flow of Spray-dryer system is illustrated in Figure-6. Spray-dryer system is installed between air heater AH outlet and ESP.
- ✓ Flue gas goes into spray dryer. In the spray dryer, reaction is activated to absorb the SO2 by chemical reaction formula “SO2 and calcium hydroxide react mutually and they change to gypsum”
- ✓ Installation of waste water treatment is not necessary.
- ✓ Where some trouble occurs in spray dryer, the unit should be outage.



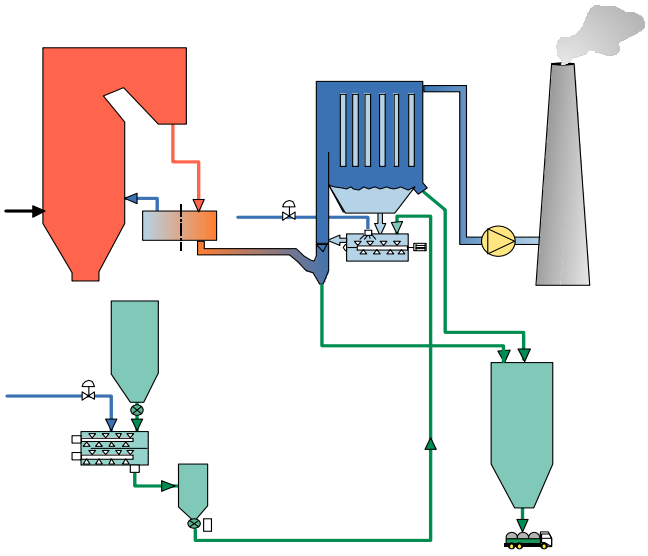
Prepared by JICA Study Team

Figure A8-6 Spray-dryer System

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (8/14)

(4) Circulation System (Semi dry type)

- ✓ Circulation system is classified into semi dry type.
- ✓ A typical flow of circulation system is shown in Figure A8-7. Circulation system is installed between AH outlet and ESP. Flue gas is sprayed in flue duct, then goes into ESP where is also used as reaction tower.
- ✓ In the flue duct and the ESP, reaction is activated to absorb the SO2 by chemical reaction formula “SO2 and calcium hydroxide react mutually and they change to gypsum”.
- ✓ The installation of waste water treatment is not necessary.
- ✓ Where existing ESP is used, the efficiency of ESP down, because reaction is being activated in the ESP.
- ✓ Where some trouble occurs in spray dryer, the unit should be outage.



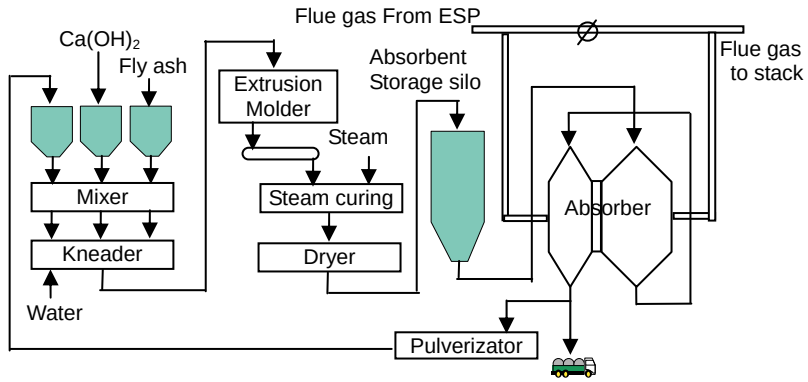
Prepared by JICA Study Team

Figure A8-7 Circulation System

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (9/14)

(5) Utilizing Fly Ash System (Dry type)

- ✓ Utilizing fly ash system is classified into dry type.
- ✓ A typical flow of utilizing fly ash system is illustrated in Figure A8-8.
- ✓ Utilizing fly ash system is installed between the ESP outlet and the stack. Flue gas goes into absorber, in which solid pellet is contained. The pellet is made by mixing the fly ash, quick lime and used pellet supplying less water to kneading.
- ✓ In the absorber, reaction is activated to absorb the SO2 by chemical reaction formula “SO2 and the calcium hydroxide react mutually and they change to gypsum”.
- ✓ Installation of waste water treatment is not necessary.
- ✓ Where some trouble is occurred in absorber reaction tank, flue gas from ESP can flue directly to stack through bypass valve.



Prepared by JICA Study Team

Figure A8-8 Utilizing Fly Ash System

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (10/14)

3. Selection of FGD system

As shown in table A8-3, Lime-gypsum(Wet) Water saving and Circulation (Semi-dry) is selected.

Table A8-3 Comparison for Some Types of FDG for 33MWx 4Unit

Items	Lime-gypsum (Wet) Water Saving Type	Magnesium hydroxide (Wet)	Spray-dryer (Semi dry)	Circulation (Semi dry)	Utilizing fly ash (Dry)
Initial Cost	28 - 32 Mil USD	26 - 33 Mil USD	38 - 46 Mil USD Including Fabric Filter	48 - 52 Mil USD Including Fabric Filter	41-52 Mil USD
Operational Cost (annual)	2.4Mil USD	3.0 Mil USD	3.0 Mil USD	3.0 Mil USD	2.75 Mil USD
Efficiency	> 95% Highest efficiency	> 90%	> 70% Low efficiency	> 90%	> 90%
Necessary Water (annual)	250,000 m3	350,000 m3	250,000 m3	250,000m3	34,000 m3
Kind of Chemicals (Toxicity)	Limestone (Calcium hydroxide invades membrane and the skin, especially eye)	Magnesium hydroxide (No problem)	Quicklime (Calcium hydroxide invades membrane and the skin, especially eye)	Quick lime (Calcium hydroxide invades membrane and the skin, especially eye)	Slaked lime (No problem)
By-products	Gypsum	MgSO4	Gypsum	Gypsum + Ash + Quick lime	Gypsum + Ash+ Slaked Lime
Utilization of By-products	Gypsum can be reused for wall or ceiling materials for building.	MgSO4 can be reused as desulfurization agent.	Gypsum can be reused for wall or ceiling of building materials.	By-product not can be reused, as it becomes cocktail.	By-product not can be reused, as it becomes cocktail.
Environmental and Social Considerations	Present water right 657,000 m3 must increase to 830,000 m3 It is necessary to some ingenuity for the duct working.	Present water right 657,000 m3 must increase to 930,000 m3	Present water right 657,000 m3 must increase to 830,000 m3 Dust collection performance will be decreased from original value.	Present water right 657,000 m3 must increase to 830,000 m3 Dust collection performance will be decreased from original value.	Present water right 657,000 m3 can be kept.
Space for Installation	Large area is needed.	Large area is needed.	Necessary to remove existing ESP	Necessary to remove existing ESP	Large area is needed.
Abating Dust (PM)	Dust is expected to be abated by FGD.	Dust is expected to be abated by FGD	As efficiency of abating PM is decreased, present ESP shall be replaced to Fabric Filter	As efficiency of abating PM is decreased, present ESP shall be replaced to Fabric Filter.	
Conclusion	Wet type is widely used. To apply the water saving type, the usage water can be minimized, same as semi-dry. Existing FGD can be used.	As the water consumption is much, the type cannot be applied.	The efficacy is low, and much augmentation is necessary between boiler and stack. Physically it is impossible to apply.	The cost is high, Conducting the fabric filter, the PM can be reduced to less than 50mg/Nm3. Where WB standards of 50mg /Nm3 is applied, this type can be feasible.	There are few supply records.
Recommendation	Recommend to Apply			Recommend to Apply	

Appendix 8-1 Study on FGD (Flue Gas De-sulferization) (11/14)

4. Basic design calculation

(1) Required Characteristics of FGD

Required characteristics of FGD are shown in Table A8-4.

SO2 concentration in FGD outlet is set 1,500mg/Nm3 as 75% value of WB standard 2,000mg/Nm3.

Since measured maximum SO_2 concentration at FGD inlet is 5,800 mg/Nm^3, required efficiency is more than 75%.

Table A8-4 Required Characteristics of FGD

Item	Value	Unit	Remark
Flue gas volume per hour	130,000	Nm^3/hr	Table A8-1
SO2 concentration at FGD inlet	5,800	mg/Nm^3	Chapter 8
SO2 concentration at FGD outlet	1,500	mg/Nm^3	Set at 75% of WB standard
Required efficiency	75	%	
Temperature	120	Degree C	Table A8-1
Moisture rate	10	%	Table A8-1

(2) Water consumption

Annual water consumption is calculated as 206,000m^3/year to 246,000m^3/year which is shown in Table A8-5.

As previously explained the margin volume against the water right is 77,000m^3/year, modification of water right is needed.

Table A8-5 Annual Water Consumption for FGD

Item	Formula	Value	Unit
Water consumption per MWh	a	0.21~0.25	m^3/MWh
Times per annum	b	8,760	hr
Availability Rate	c	85	%
Number of unit	d	4	Unit
Rated generator output	e	33	MW
Maximum annual water consumption	f=a*b*c*d*e	206,403 ~245,781	m^3/year
Round up		250,000	

Total necessary water is calculated at 830,000m3/year (additional for FGD 250,000m3 + average used at present 580,000m3). As the present water right is

657,000m3, obtaining 173,000m3/year, 26% of original right, additional right is indispensable.

(3) Chemical consumption

Annual chemical consumption is shown in TableA8-6 and A8-7, the former is calculated from the actual SO2 concentration value and targeted value, the latter is calculated from contents of sulfur in coal. Both tables shows approximately same value.

Where the Lime-Gypsum type is applied, 29,000ton of lime stone is calculated to be needed per annum.

Where the Circulation type is applied, 21,400ton of slaked lime is calculated to be needed per annum.

TableA8-6 Annual chemical consumption on FGD (SO2 concentration)

Item	Formula	Value		Unit
System		Lime-Gypsum	Circulation	
Chemical		Lime Stone	Slaked Lime	
Flue gas volume per hour	a	130,000		Nm^3/hr
SO2 concentration in FGD inlet	b	5,800		mg/Nm^3
SO2 concentration in FGD outlet	c	1,500		mg/Nm^3
Density of SO2	d	64.07		g/mol
Density of Chemical	e	100.0	74.1	g/mol
Annual operation time	f	8,760		hr/year
Plant availability rate	g	85		%
Number of unit	h	4		Unit
Reaction efficiency	i	90		%
Chemical consumption Round up	j=a*(b-c)*e/d*f*g*h/i	28,873 ⇒29,000	21,395 ⇒21,400	ton/year

Prepared by JICA Study Team

Table A8-7 Annual chemical consumption on FGD (Sulfur contents in coal)

Item	Formula	Value		Unit
System		Lime-Gypsum	Circulation	
Chemical		Lime Stone	Slaked Lime	
Content of Sulfur in coal	a	1.5		%
Average of coal consumption (*1)	b	535,692		
Average of generated power(*1)	c	913,430		MWh

Constant generation output	d	132		MW
Plant availability rate	e	80		%
Annual operation time	f	8,760		hr/year
Weight ratio between S and Chemical	g	3.125	2.3125	--
Purity of Chemical	h	95		%
Reaction efficiency	i	90		%
Chemical consumption Round up	(b/c*d*e*f) *a*g/h*i	29,742 ⇒30,000	22,009 ⇒22,100	ton/year

Comments: *1 : Average value of 2004 to 2006

Prepared by JICA Study Team

5. Operational Cost

The operational cost, consist of chemicals and raw water, for possible two types FGD is estimated, which is summarized in Table

(1) Operation cost for Lime-Gypsum water saving type

Unit cost of lime stone is set at 482 BWP/ton (69USD/ton), which is assumed cost for Morupule “B”, same for low water is set at 10.4BWP/m3 (1.5US$/tm3), which is current unit cost for Morupule “A”, both are informed by BPC.

Table-A8-8 Operation cost of Lime-Gypsum (water saving type)

Item	Quantity per annum	Unit cost (PWP)	Unit Cost (US$)	Amount (US$)
Chemicals(Lime Stone)	29,000 ton	482	69	2,000,000
Raw water	250,000 m3	10.4	1.5	375,000
Total				2,375,000

Exchange rate 1US$=7BWP

(2) Operation cost for Circulation type

Unit cost of slaked lime is set at 862 BWP/ton (123USD/ton), which is assumed based on the lime stone, same for low water is set at 10.4BWP/m3 (1.5US$/tm3), which is current unit cost for Morupule “A”.

Table A8-9 Operation cost of Circulation (semi-dry type)

Item	Quantity per annum	Unit cost (PWP)	Unit Cost (US$)	Amount (US$)
Chemicals(Slaked Lime)	21,400 ton	862	123	2,632,000
Raw water	250,000 m3	10.4	1.5	375,000
Total				3,007,000

Exchange rate 1US$=7BWP

6. IV. Suggestion of installation and re-installation of measuring instrument

SO2 measuring instruments have been out of order long time, the measuring instruments for NOx and PM have not been installed.

Therefore, newly installation of the instruments of SO2, NOx, and PM is highly recommended.

Although the measuring instrument must consider ambient environment by an electronic device, the present installation atmospheric condition for the instruments are quite bad.

Then, the conditions of the spaces in which the instrument will be installed and the instrumentation system are shown in below.

1) Build the huts for storing measurement instrument at stack side.

2) Install the air conditioner for maintaining at constant temperature in the huts.

3) Conduct the server for recording the measurement value in the hut.

4) Secure the space for installing the telemeter equipment which transmits the measured data to DCS in operator room.

Appendix 8-2 Study on Low NOx Burner (1/2)

Study on Low NOx Burner

1. Outline

NOx concentration, measured as 1709mg/Nm2 by portable analyzer during out Site Works, can be reduced by the replacing the existing burners to low NOx emission type burner to meet Word Bank standard of 750mg/Nm3, which is simple and comparatively less investment.

There is also chemical reaction system for abating the NOx. However, the systems shall be installed between Economizer and AH, where there is no installation space, and initial and operational cost is so high. Therefore, chemical reaction system can be neither physically nor financially applied.

2. Principle of Low NOx Burner

After year of 1990, the unique Low-Nox burner system was developed based on the concept of “In-frame NOx reduction” instead of the conventional slow combustion burner system.

The method of “In-flame NOx reduction” is burnt pulverized coal rapidly and after generated NOx is de-composited N2.

The flame structure and the characteristic of NOx emission are shown in Figure A8-9 and Figure A8-10.

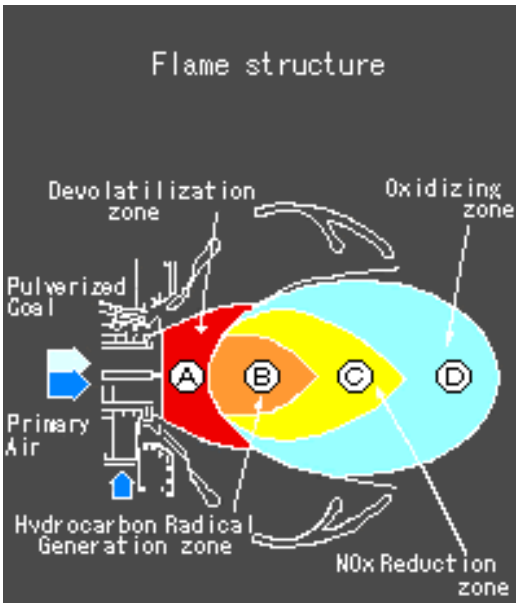


Figure A8-9 Frame Structure (Courtesy: Babcock-Hitachi HP)

Appendix 8-2 Study on Low NOx Burner (2/2)

A: De-volatilization zone: Volatile matter is burnt rapidly. (N→NO)

B: Hydrocarbon radical generation zone. (reducing agent, HC)

C: NOx Reduction zone (NO→Nx→N2)

D: Oxidizing zone (Reduce unburnt matter)

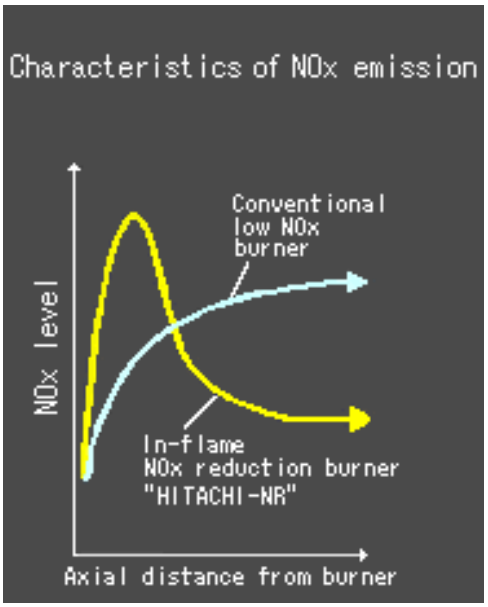


Figure.A8-10 Characteristics of NOx emission (Courtesy: Babcock-Hitachi HP)

Figure A8-10 shows the characteristics of relation between the generated NOx level and the distance from burner.

Compare with NOx level of the conventional, low NOx burner is increase gradually, the NOx level of In-frame NOx reduction burner increase rapidly after reduce.

APPENDICES FOR CHAPTER 9

Appendix 9-1 Project Costs of Each Scenario (1/2)

Project Cost of Scenario 1

Component	Project Cost		
	F.C. (USD)	L..C. (BWP)	TOTAL (USD)
1. Construction Cost (a+b+c)	112,243,637	96,720,951	126,751,782
a. Direct Construction Cost	100,038,892	82,175,830	112,365,269
b. Price Escalation	2,000,778	5,752,308	2,863,624
c. Physical Contingency	10,203,967	8,792,814	11,522,889
2. Consulting Service Cost (d+e+f)	5,081,284	15,687,106	7,434,350
d. Direct Consulting Service Fee	4,528,774	13,328,042	6,527,980
e. Price Escalation	90,575	932,963	230,520
f. Physical Contingency	461,935	1,426,101	675,850
Total Cost of Scenario 1 (1 + 2)			**134,186,132**

Project Cost of Scenario 2a

Component	Project Cost		
	F.C. (USD)	L..C. (BWP)	TOTAL (USD)
1. Construction Cost (a+b+c)	168,369,321	122,272,431	186,710,183
a. Direct Construction Cost	150,061,783	103,884,818	165,644,504
b. Price Escalation	3,001,236	7,271,937	4,092,026
c. Physical Contingency	15,306,302	11,115,676	16,973,653
2. Consulting Service Cost (d+e+f)	7,258,977	22,410,151	10,620,500
d. Direct Consulting Service Fee	6,469,677	19,040,061	9,325,686
e. Price Escalation	129,394	1,332,804	329,314
f. Physical Contingency	659,907	2,037,286	965,500
Total Cost of Scenario 2a (1 + 2)			**197,330,683**

Project Cost of Scenario 2b

Component	Project Cost		
	F.C. (USD)	L..C. (BWP)	TOTAL (USD)
1. Construction Cost (a+b+c)	155,608,285	107,720,128	171,766,306
a. Direct Construction Cost	138,688,311	91,520,924	152,416,451
b. Price Escalation	2,773,766	6,406,465	3,734,736
c. Physical Contingency	14,146,208	9,792,739	15,615,119
2. Consulting Service Cost (d+e+f)	6,708,805	19,742,998	9,670,255
d. Direct Consulting Service Fee	5,979,327	16,774,000	8,495,427
e. Price Escalation	119,587	1,174,180	295,714
f. Physical Contingency	609,891	1,794,818	879,114
Total Cost of Scenario 2b (1 + 2)			**181,436,561**

Appendix 9-1 Project Costs of Each Scenario (2/2)

Project Cost of for Scenario 3

Reference: Morupule B power station (600 MW), is costing 988 million USD (i.e. 1,650 USD / kW). The cost of a 132 MW power plant will be calculated as 217 million USD.
However, the unit cost of a smaller scale power generation plant would become higher.

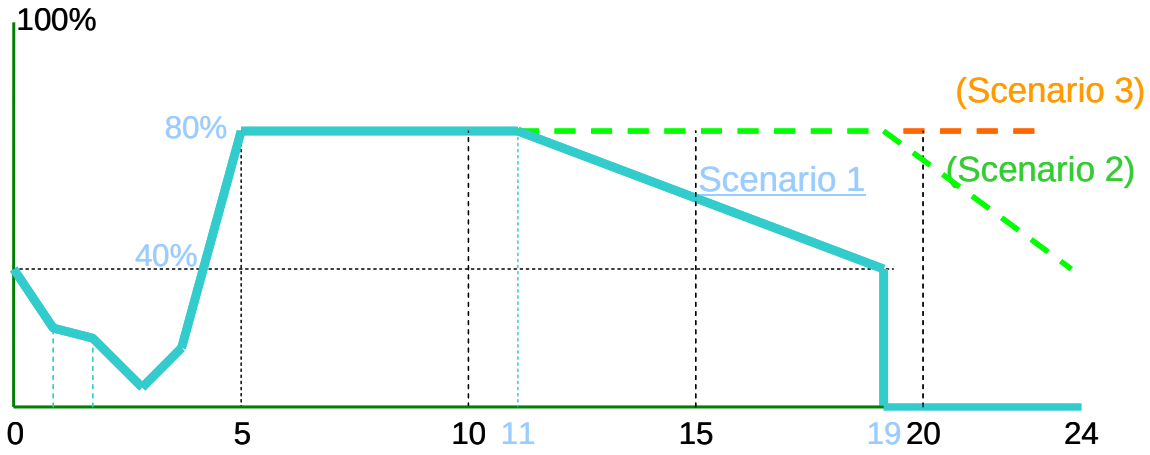
1) A widely established conversion factor formula for smaller-scale power plant is (Capacity A / Capacity B)^0.7. This results in total cost of new 132 MW plant costing **336 million USD.**

2) World Bank report No. 49183-BW "Project Appraisal Document for Morupule B Generation and Transmission Project, Oct 2 2009" states that – "Smaller unit sized Morupule B (150MW) could have been higher than 2,500 USD/kWh if OECD suppliers were to bid." According to this assumption the cost of a 132 MW power plant will be 520 million USD.

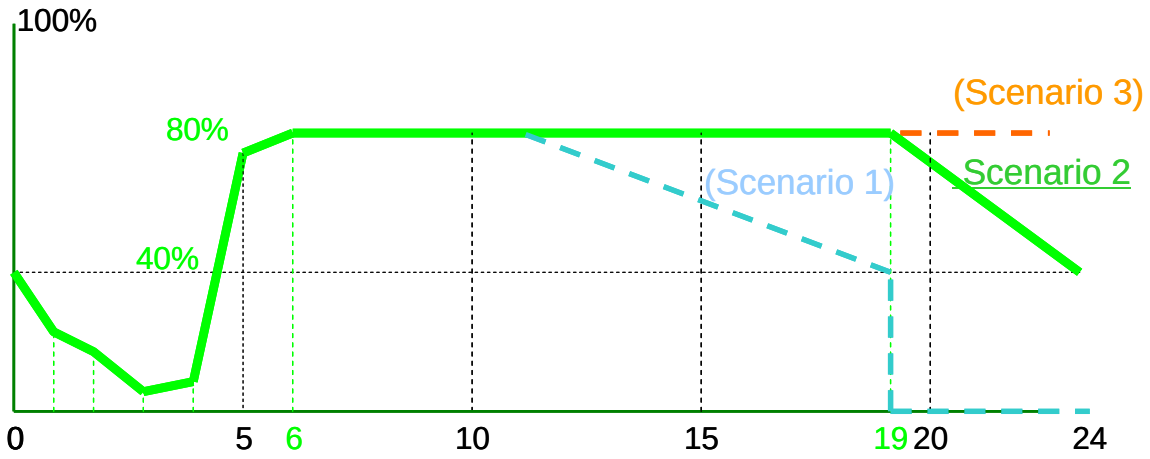
336 million USD is applied to the assumed project cost for Scenario 3.

Appendix-9-2 Availability Rate of Morupule “A” Power Plants (1/2)

Scenario 1: Small-scale rehabilitation

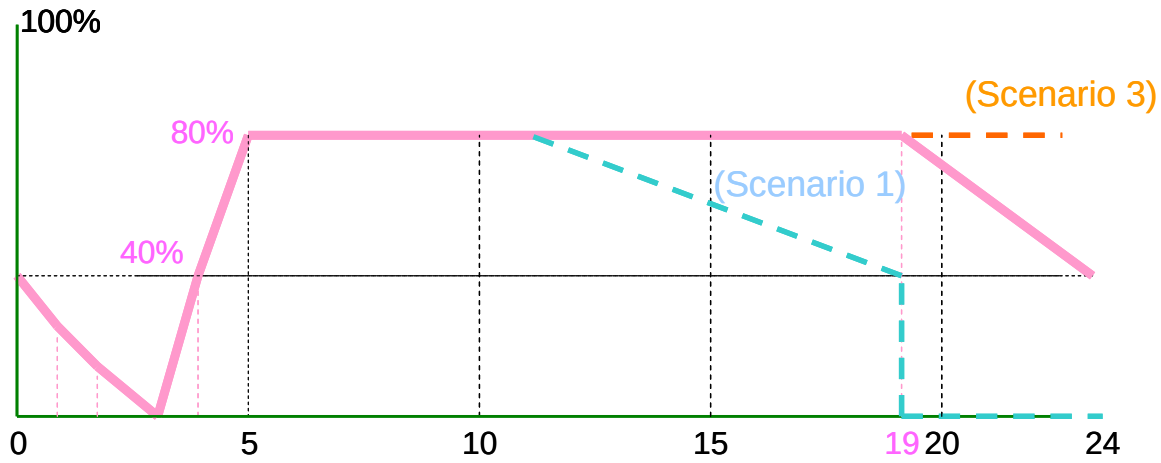


Scenario 2a: Large-scale rehabilitation (2 units in turn)

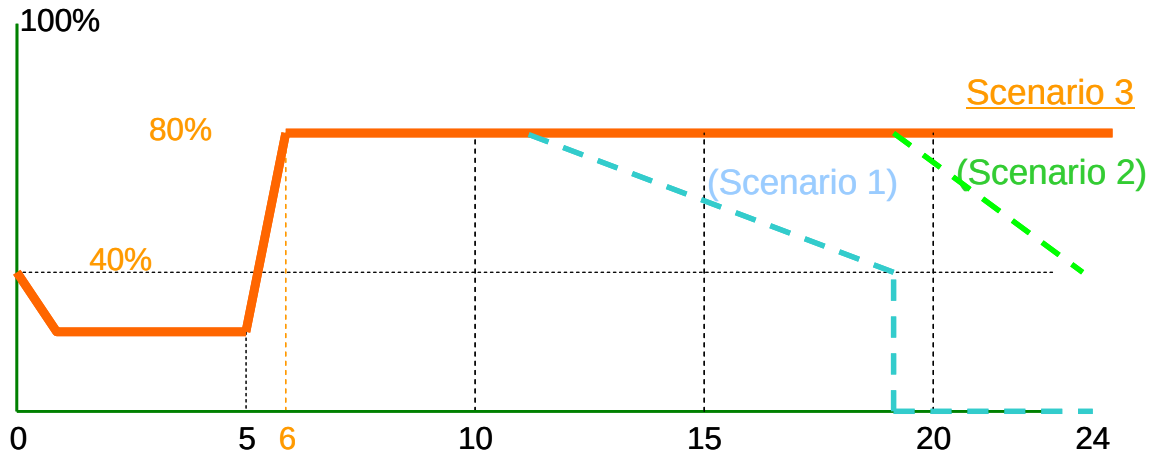


Appendix-9-2 Availability Rate of Morupule “A” Power Plants (2/2)

Scenario 2b: Large-scale rehabilitation (simultaneous)



Scenario 3: New installation



Appendix 9-3 Terms and Conditions of Japanese ODA Loans for Upper-Middle Income Countries (1/1)

(Effective from April 1, 2011)

Category	GNI Per Capita (2009)		Standard/ Option	Interest Rate (%)	Repayment Period (Year)	Grace Period (Year)	Conditions for Procurement
Upper-Middle Income Countries	US$3,946 - US$6,885	General Terms	Standard	1.70	25	7	Untied
			Option1	1.60	20	6	
			Option2	1.50	15	5	
		Preferential Terms	Standard	1.20	25	7	Untied
			Option1	1.00	20	6	
			Option2	0.60	15	5	

Note: The concessional level of optional terms does not exceed that of standard terms.

1. Economic Analysis Results

1.1 Scenario 1: Small-Scale Rehabilitation

Appendix 9-4 Calculation Tables: Economic and Financial Analyses (3/31)

Total Cost	134,000	K USD
Maximum Output	132,000	kW
Internal Usage Rate	12%	
System Loss Rate	10%	
O&M Expenditure	301,000	K BWP
Additional Capital Expenditure	20,000	K BWP

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	39%
2015/16	49%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: Not computable

	NPV [mil USD]	CBR
At 12% (=SDR)	628	2.32

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-2,680	-43,500	-46,180	-46,180	30%	274,741,632	2.00	0.60	76,543	76,543	30,363	30,363	30,363
2	2013/14	-13,400	-43,500	-56,900	-50,804	23%	210,635,251	2.00	0.74	59,347	52,988	2,447	2,185	32,548
3	2014/15	-52,260	-44,362	-96,622	-77,027	9%	82,422,490	2.00	0.84	23,408	18,661	-73,214	-58,366	-25,818
4	2015/16	-65,660	-46,665	-112,325	-79,950	15%	137,370,816	2.00	0.84	39,013	27,769	-73,311	-52,181	-78,000
5	2016/17	0	-45,208	-45,208	-28,730	80%	732,644,352	2.00	0.84	208,072	132,233	162,864	103,503	25,503
6	2017/18		-45,150	-45,150	-25,619	80%	732,644,352	2.00	0.84	208,072	118,065	162,922	92,446	117,949
7	2018/19		-45,150	-45,150	-22,874	80%	732,644,352	2.00	0.84	208,072	105,416	162,922	82,541	200,491
8	2019/20		-45,150	-45,150	-20,424	80%	732,644,352	2.00	0.84	208,072	94,121	162,922	73,698	274,188
9	2020/21		-45,150	-45,150	-18,235	80%	732,644,352	2.00	0.84	208,072	84,037	162,922	65,801	339,990
10	2021/22		-45,150	-45,150	-16,282	80%	732,644,352	2.00	0.84	208,072	75,033	162,922	58,751	398,741
11	2022/23		-45,150	-45,150	-14,537	80%	732,644,352	2.00	0.84	208,072	66,994	162,922	52,456	451,197
12	2023/24		-45,150	-45,150	-12,980	75%	686,854,080	2.00	0.84	195,067	56,077	149,917	43,098	494,295
13	2024/25		-45,150	-45,150	-11,589	70%	641,063,808	2.00	0.84	182,063	46,731	136,913	35,142	529,437
14	2025/26		-45,150	-45,150	-10,347	65%	595,273,536	2.00	0.84	169,058	38,744	123,908	28,397	557,834
15	2026/27	-3,000	-45,150	-48,150	-9,852	60%	549,483,264	2.00	0.84	156,054	31,932	107,904	22,079	579,913
16	2027/28	-3,000	-45,150	-48,150	-8,797	55%	503,692,992	2.00	0.84	143,049	26,135	94,899	17,338	597,251
17	2028/29	-3,000	-45,150	-48,150	-7,854	50%	457,902,720	2.00	0.84	130,045	21,213	81,895	13,359	610,609
18	2029/30	-3,000	-45,150	-48,150	-7,013	45%	412,112,448	2.00	0.84	117,040	17,046	68,890	10,033	620,643
19	2030/31	-3,000	-45,150	-48,150	-6,261	40%	366,322,176	2.00	0.84	104,036	13,529	55,886	7,267	627,910
20	2031/32		0	0	0	0%	0	2.00	0.84	0	0			
21	2032/33		0	0	0	0%	0	2.00	0.84	0	0			
22	2033/34		0	0	0	0%	0	2.00	0.84	0	0			
23	2034/35		0	0	0	0%	0	2.00	0.84	0	0			
24	2035/36		0	0	0	0%	0	2.00	0.84	0	0			
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-149,000	-855,335	-1,004,335	-475,356		1.0046E+10			2,851,226	1,103,266	1,846,891	627,910	

1.2 Scenario 2a: Large-Scale Rehabilitation [Phased]

Total Cost	197,000 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	32%
O&M Expenditure	286,000 K BWP	2015/16	39%
Additional Capital Expenditure	20,000 K BWP	2016/17	17%
			100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

	FIRR	
	Not computable	

	NPV	CBR
At 12% (=SDR)	[mil USD] 713	2.34

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,940	-43,500	-47,440	-47,440	30%	274,741,632	2.00	0.60	76,543	76,543	29,103	29,103	29,103
2	2013/14	-19,700	-43,500	-63,200	-56,429	23%	210,635,251	2.00	0.74	59,347	52,988	-3,853	-3,440	25,663
3	2014/15	-63,040	-44,428	-107,468	-85,673	8%	73,264,435	2.00	0.84	20,807	16,587	-86,661	-69,086	-43,423
4	2015/16	-76,830	-45,750	-122,580	-87,250	14%	128,212,762	2.00	0.84	36,413	25,918	-86,168	-61,332	-104,755
5	2016/17	-33,490	-43,016	-76,506	-48,621	75%	686,854,080	2.00	0.84	195,067	123,969	118,562	75,348	-29,407
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00	0.84	208,072	118,065	165,172	93,723	64,316
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00	0.84	208,072	105,416	165,172	83,681	147,997
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00	0.84	208,072	94,121	165,172	74,715	222,712
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00	0.84	208,072	84,037	165,172	66,710	289,422
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00	0.84	208,072	75,033	165,172	59,563	348,985
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00	0.84	208,072	66,994	165,172	53,181	402,166
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00	0.84	208,072	59,816	165,172	47,483	449,649
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00	0.84	208,072	53,407	165,172	42,395	492,044
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00	0.84	208,072	47,685	165,172	37,853	529,897
15	2026/27	-3,000	-42,900	-45,900	-9,392	80%	732,644,352	2.00	0.84	208,072	42,576	162,172	33,184	563,081
16	2027/28	-3,000	-42,900	-45,900	-8,386	80%	732,644,352	2.00	0.84	208,072	38,014	162,172	29,628	592,709
17	2028/29	-3,000	-42,900	-45,900	-7,487	80%	732,644,352	2.00	0.84	208,072	33,941	162,172	26,454	619,163
18	2029/30	-3,000	-42,900	-45,900	-6,685	80%	732,644,352	2.00	0.84	208,072	30,304	162,172	23,619	642,782
19	2030/31	-3,000	-42,900	-45,900	-5,969	80%	732,644,352	2.00	0.84	208,072	27,058	162,172	21,089	663,871
20	2031/32	-3,000	-42,900	-45,900	-5,329	72%	659,379,917	2.00	0.84	187,265	21,743	141,365	16,413	680,284
21	2032/33	-3,000	-42,900	-45,900	-4,758	64%	586,115,482	2.00	0.84	166,457	17,256	120,557	12,498	692,782
22	2033/34	-3,000	-42,900	-45,900	-4,248	56%	512,851,046	2.00	0.84	145,650	13,481	99,750	9,233	702,015
23	2034/35	-3,000	-42,900	-45,900	-3,793	48%	439,586,611	2.00	0.84	124,843	10,317	78,943	6,524	708,539
24	2035/36	-3,000	-42,900	-45,900	-3,387	40%	366,322,176	2.00	0.84	104,036	7,677	58,136	4,290	712,828
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-227,000	-1,035,294	-1,262,294	-530,116		1.4195E+10			4,029,432	1,242,944	2,767,138	712,828	

1.3 Scenario 2b: Large-Scale Rehabilitation [Simultaneous]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: Not computable

	NPV [mil USD]	CBR
At 12% (=SDR)	740	2.41

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	30%	274,741,632	2.00	0.60	76,543	76,543	29,423	29,423	29,423
2	2013/14	-18,100	-43,500	-61,600	-55,000	15%	137,370,816	2.00	0.74	38,704	34,557	-22,896	-20,443	8,981
3	2014/15	-119,460	-44,739	-164,199	-130,899	0%	0	2.00	0.84	0	0	-164,199	-130,899	-121,918
4	2015/16	-39,820	-43,280	-83,100	-59,149	40%	366,322,176	2.00	0.84	104,036	74,051	20,936	14,902	-107,016
5	2016/17	0	-42,958	-42,958	-27,300	80%	732,644,352	2.00	0.84	208,072	132,233	165,114	104,933	-2,083
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00	0.84	208,072	118,065	165,172	93,723	91,640
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00	0.84	208,072	105,416	165,172	83,681	175,321
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00	0.84	208,072	94,121	165,172	74,715	250,036
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00	0.84	208,072	84,037	165,172	66,710	316,747
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00	0.84	208,072	75,033	165,172	59,563	376,309
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00	0.84	208,072	66,994	165,172	53,181	429,490
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00	0.84	208,072	59,816	165,172	47,483	476,973
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00	0.84	208,072	53,407	165,172	42,395	519,368
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00	0.84	208,072	47,685	165,172	37,853	557,221
15	2026/27	-3,000	-42,900	-45,900	-9,392	80%	732,644,352	2.00	0.84	208,072	42,576	162,172	33,184	590,405
16	2027/28	-3,000	-42,900	-45,900	-8,386	80%	732,644,352	2.00	0.84	208,072	38,014	162,172	29,628	620,033
17	2028/29	-3,000	-42,900	-45,900	-7,487	80%	732,644,352	2.00	0.84	208,072	33,941	162,172	26,454	646,487
18	2029/30	-3,000	-42,900	-45,900	-6,685	80%	732,644,352	2.00	0.84	208,072	30,304	162,172	23,619	670,106
19	2030/31	-3,000	-42,900	-45,900	-5,969	80%	732,644,352	2.00	0.84	208,072	27,058	162,172	21,089	691,195
20	2031/32	-3,000	-42,900	-45,900	-5,329	72%	659,379,917	2.00	0.84	187,265	21,743	141,365	16,413	707,608
21	2032/33	-3,000	-42,900	-45,900	-4,758	64%	586,115,482	2.00	0.84	166,457	17,256	120,557	12,498	720,106
22	2033/34	-3,000	-42,900	-45,900	-4,248	56%	512,851,046	2.00	0.84	145,650	13,481	99,750	9,233	729,339
23	2034/35	-3,000	-42,900	-45,900	-3,793	48%	439,586,611	2.00	0.84	124,843	10,317	78,943	6,524	735,863
24	2035/36	-3,000	-42,900	-45,900	-3,387	40%	366,322,176	2.00	0.84	104,036	7,677	58,136	4,290	740,153
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-211,000	-1,033,077	-1,244,077	-524,171		1.4332E+10			4,068,611	1,264,324	2,824,534	740,153	

1.4 Scenario 3: New Installation of a Power Station of Equivalent Capacity

Total Cost	336,000 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	1%
Internal Usage Rate	12%	2013/14	1%
System Loss Rate	10%	2014/15	25%
O&M Expenditure	286,000 K BWP	2015/16	39%
Additional Capital Expenditure	20,000 K BWP	2016/17	34%
			100%

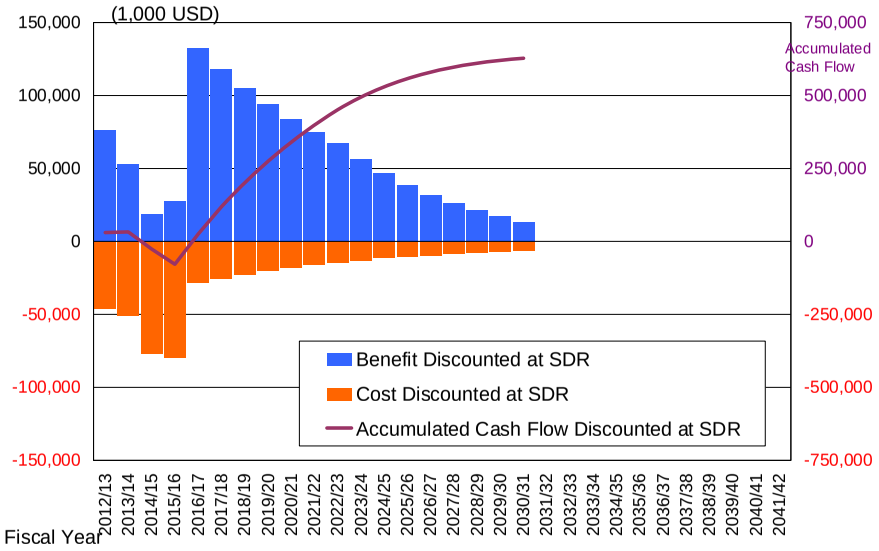
Percentage: Sales to Domestic Market	85%
Percentage: Sales to SAPP Network	15%
Value of Capacity Availability	9,251 K USD
Foreign Exchange	0.15 USD/BWP

Social Discount Rate (SDR)	12%
FIRR	Not computable

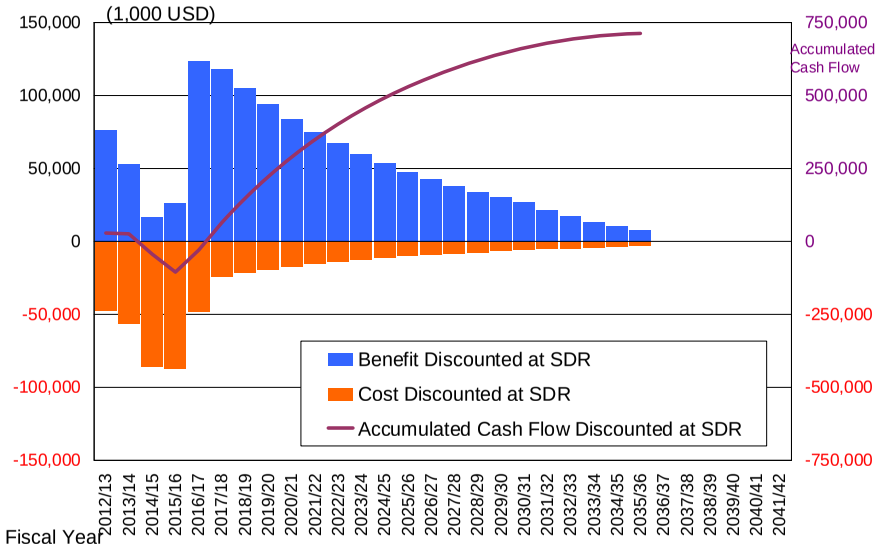
	NPV [mil USD]	CBR
At 12% (=SDR)	**714**	**2.12**

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,360	-43,500	-46,860	-46,860	30%	274,741,632	2.00	0.60	76,543	76,543	29,683	29,683	29,683
2	2013/14	-3,360	-43,500	-46,860	-41,839	30%	274,741,632	2.00	0.74	77,409	69,115	30,549	27,276	56,959
3	2014/15	-84,000	-43,607	-127,607	-101,728	30%	274,741,632	2.00	0.84	78,027	62,203	-49,580	-39,525	17,434
4	2015/16	-131,040	-44,453	-175,493	-124,913	30%	274,741,632	2.00	0.84	78,027	55,538	-97,466	-69,375	-51,941
5	2016/17	-114,240	-47,009	-161,249	-102,476	30%	274,741,632	2.00	0.84	78,027	49,588	-83,222	-52,889	-104,830
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00	0.84	208,072	118,065	165,172	93,723	-11,107
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00	0.84	208,072	105,416	165,172	83,681	72,574
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00	0.84	208,072	94,121	165,172	74,715	147,290
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00	0.84	208,072	84,037	165,172	66,710	214,000
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00	0.84	208,072	75,033	165,172	59,563	273,562
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00	0.84	208,072	66,994	165,172	53,181	326,743
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00	0.84	208,072	59,816	165,172	47,483	374,226
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00	0.84	208,072	53,407	165,172	42,395	416,622
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00	0.84	208,072	47,685	165,172	37,853	454,475
15	2026/27		-42,900	-42,900	-8,778	80%	732,644,352	2.00	0.84	208,072	42,576	165,172	33,797	488,272
16	2027/28	-3,000	-42,900	-45,900	-8,386	80%	732,644,352	2.00	0.84	208,072	38,014	162,172	29,628	517,900
17	2028/29	-3,000	-42,900	-45,900	-7,487	80%	732,644,352	2.00	0.84	208,072	33,941	162,172	26,454	544,354
18	2029/30	-3,000	-42,900	-45,900	-6,685	80%	732,644,352	2.00	0.84	208,072	30,304	162,172	23,619	567,973
19	2030/31	-3,000	-42,900	-45,900	-5,969	80%	732,644,352	2.00	0.84	208,072	27,058	162,172	21,089	589,062
20	2031/32	-3,000	-42,900	-45,900	-5,329	80%	732,644,352	2.00	0.84	208,072	24,159	162,172	18,829	607,891
21	2032/33	-3,000	-42,900	-45,900	-4,758	80%	732,644,352	2.00	0.84	208,072	21,570	162,172	16,812	624,703
22	2033/34	-3,000	-42,900	-45,900	-4,248	80%	732,644,352	2.00	0.84	208,072	19,259	162,172	15,011	639,714
23	2034/35	-3,000	-42,900	-45,900	-3,793	80%	732,644,352	2.00	0.84	208,072	17,196	162,172	13,402	653,116
24	2035/36	-3,000	-42,900	-45,900	-3,387	80%	732,644,352	2.00	0.84	208,072	15,353	162,172	11,966	665,082
25	2036/37	-3,000	-42,900	-45,900	-3,024	80%	732,644,352	2.00	0.84	208,072	13,708	162,172	10,684	675,766
26	2037/38	-3,000	-42,900	-45,900	-2,700	80%	732,644,352	2.00	0.84	208,072	12,239	162,172	9,539	685,306
27	2038/39	-3,000	-42,900	-45,900	-2,411	80%	732,644,352	2.00	0.84	208,072	10,928	162,172	8,517	693,823
28	2039/40	-3,000	-42,900	-45,900	-2,152	80%	732,644,352	2.00	0.84	208,072	9,757	162,172	7,605	701,428
29	2040/41	-3,000	-42,900	-45,900	-1,922	80%	732,644,352	2.00	0.84	208,072	8,712	162,172	6,790	708,218
30	2041/42	-3,000	-42,900	-45,900	-1,716	80%	732644352	2.00	0.84	208,072	7,778	162,172	6,063	714,281
		-381,000	-1,294,569	-1,675,569	-635,830		1.969E+10			5,589,826	1,350,111	3,914,257	714,281	

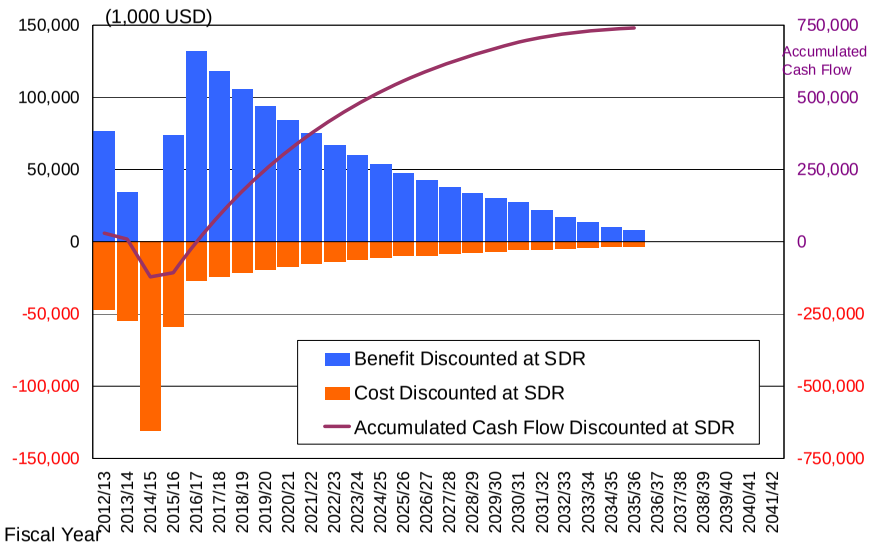
1.5 Discounted Cash Flows



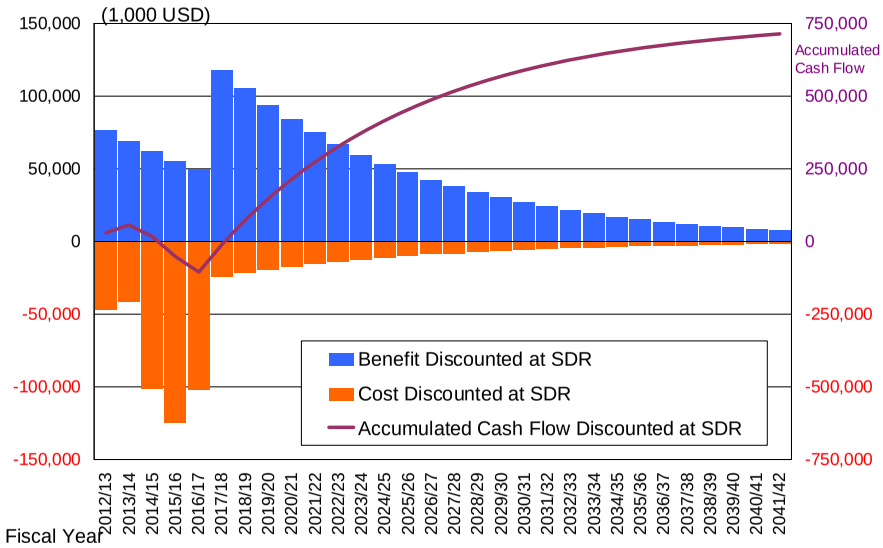
Scenario 1: Small-Scale Rehabilitation



Scenario 2a: Large-Scale Rehabilitation [Phased]



Scenario 2b: Large-Scale Rehabilitation [Simultaneous]



Scenario 3: New Installation of a Power Station of Equivalent Capacity

2. Sensitivity Analysis of Economic Viability

2.1 [20% Increase in O&M Cost]

Total Cost	181,000 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	66%
O&M Expenditure	343,200 K BWP	2015/16	22%
Additional Capital Expenditure	20,000 K BWP	2016/17	0%
			100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: 81%

	NPV [mil USD]	CBR
At 12% (=SDR)	685	2.18

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	30%	274,741,632	2.00	0.60	76,543	76,543	29,423	29,423	29,423
2	2013/14	-18,100	-43,500	-61,600	-55,000	15%	137,370,816	2.00	0.74	38,704	34,557	-22,896	-20,443	8,981
3	2014/15	-119,460	-49,029	-168,489	-134,319	0%	0	2.00	0.84	0	0	-168,489	-134,319	-125,338
4	2015/16	-39,820	-51,860	-91,680	-65,256	40%	366,322,176	2.00	0.84	104,036	74,051	12,356	8,795	-116,543
5	2016/17	0	-51,538	-51,538	-32,753	80%	732,644,352	2.00	0.84	208,072	132,233	156,534	99,480	-17,063
6	2017/18		-51,480	-51,480	-29,211	80%	732,644,352	2.00	0.84	208,072	118,065	156,592	88,854	71,792
7	2018/19		-51,480	-51,480	-26,081	80%	732,644,352	2.00	0.84	208,072	105,416	156,592	79,334	151,126
8	2019/20		-51,480	-51,480	-23,287	80%	732,644,352	2.00	0.84	208,072	94,121	156,592	70,834	221,960
9	2020/21		-51,480	-51,480	-20,792	80%	732,644,352	2.00	0.84	208,072	84,037	156,592	63,245	285,205
10	2021/22		-51,480	-51,480	-18,564	80%	732,644,352	2.00	0.84	208,072	75,033	156,592	56,469	341,673
11	2022/23		-51,480	-51,480	-16,575	80%	732,644,352	2.00	0.84	208,072	66,994	156,592	50,418	392,092
12	2023/24		-51,480	-51,480	-14,799	80%	732,644,352	2.00	0.84	208,072	59,816	156,592	45,016	437,108
13	2024/25		-51,480	-51,480	-13,214	80%	732,644,352	2.00	0.84	208,072	53,407	156,592	40,193	477,301
14	2025/26		-51,480	-51,480	-11,798	80%	732,644,352	2.00	0.84	208,072	47,685	156,592	35,887	513,188
15	2026/27	-3,000	-51,480	-54,480	-11,148	80%	732,644,352	2.00	0.84	208,072	42,576	153,592	31,428	544,616
16	2027/28	-3,000	-51,480	-54,480	-9,953	80%	732,644,352	2.00	0.84	208,072	38,014	153,592	28,061	572,677
17	2028/29	-3,000	-51,480	-54,480	-8,887	80%	732,644,352	2.00	0.84	208,072	33,941	153,592	25,054	597,731
18	2029/30	-3,000	-51,480	-54,480	-7,935	80%	732,644,352	2.00	0.84	208,072	30,304	153,592	22,370	620,101
19	2030/31	-3,000	-51,480	-54,480	-7,085	80%	732,644,352	2.00	0.84	208,072	27,058	153,592	19,973	640,074
20	2031/32	-3,000	-51,480	-54,480	-6,325	72%	659,379,917	2.00	0.84	187,265	21,743	132,785	15,417	655,491
21	2032/33	-3,000	-51,480	-54,480	-5,648	64%	586,115,482	2.00	0.84	166,457	17,256	111,977	11,608	667,099
22	2033/34	-3,000	-51,480	-54,480	-5,043	56%	512,851,046	2.00	0.84	145,650	13,481	91,170	8,439	675,538
23	2034/35	-3,000	-51,480	-54,480	-4,502	48%	439,586,611	2.00	0.84	124,843	10,317	70,363	5,815	681,353
24	2035/36	-3,000	-51,480	-54,480	-4,020	40%	366,322,176	2.00	0.84	104,036	7,677	49,556	3,657	685,009
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-211,000	-1,217,547	-1,428,547	-579,314		1.4332E+10			4,068,611	1,264,324	2,640,064	685,009	

2.2 [20% Increase in Capital Investment Cost]

Total Cost	217,200	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	24,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: **68%**

	NPV [mil USD]	CBR
At 12% (=SDR)	**711**	**2.28**

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	30%	274,741,632	2.00	0.60	76,543	76,543	28,699	28,699	28,699
2	2013/14	-21,720	-43,500	-65,220	-58,232	15%	137,370,816	2.00	0.74	38,704	34,557	-26,516	-23,675	5,025
3	2014/15	-143,352	-44,739	-188,091	-149,945	0%	0	2.00	0.84	0	0	-188,091	-149,945	-144,920
4	2015/16	-47,784	-43,280	-91,064	-64,817	40%	366,322,176	2.00	0.84	104,036	74,051	12,972	9,233	-135,687
5	2016/17	0	-42,958	-42,958	-27,300	80%	732,644,352	2.00	0.84	208,072	132,233	165,114	104,933	-30,754
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00	0.84	208,072	118,065	165,172	93,723	62,969
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00	0.84	208,072	105,416	165,172	83,681	146,650
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00	0.84	208,072	94,121	165,172	74,715	221,365
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00	0.84	208,072	84,037	165,172	66,710	288,075
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00	0.84	208,072	75,033	165,172	59,563	347,638
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00	0.84	208,072	66,994	165,172	53,181	400,819
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00	0.84	208,072	59,816	165,172	47,483	448,302
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00	0.84	208,072	53,407	165,172	42,395	490,697
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00	0.84	208,072	47,685	165,172	37,853	528,550
15	2026/27	-3,600	-42,900	-46,500	-9,515	80%	732,644,352	2.00	0.84	208,072	42,576	161,572	33,061	561,611
16	2027/28	-3,600	-42,900	-46,500	-8,495	80%	732,644,352	2.00	0.84	208,072	38,014	161,572	29,519	591,130
17	2028/29	-3,600	-42,900	-46,500	-7,585	80%	732,644,352	2.00	0.84	208,072	33,941	161,572	26,356	617,485
18	2029/30	-3,600	-42,900	-46,500	-6,772	80%	732,644,352	2.00	0.84	208,072	30,304	161,572	23,532	641,017
19	2030/31	-3,600	-42,900	-46,500	-6,047	80%	732,644,352	2.00	0.84	208,072	27,058	161,572	21,011	662,028
20	2031/32	-3,600	-42,900	-46,500	-5,399	72%	659,379,917	2.00	0.84	187,265	21,743	140,765	16,344	678,372
21	2032/33	-3,600	-42,900	-46,500	-4,821	64%	586,115,482	2.00	0.84	166,457	17,256	119,957	12,436	690,807
22	2033/34	-3,600	-42,900	-46,500	-4,304	56%	512,851,046	2.00	0.84	145,650	13,481	99,150	9,177	699,985
23	2034/35	-3,600	-42,900	-46,500	-3,843	48%	439,586,611	2.00	0.84	124,843	10,317	78,343	6,474	706,459
24	2035/36	-3,600	-42,900	-46,500	-3,431	40%	366,322,176	2.00	0.84	104,036	7,677	57,536	4,245	710,705
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-253,200	-1,033,077	-1,286,277	-553,619		1.4332E+10			4,068,611	1,264,324	2,782,334	711,005	

2.3 [20% Increase in O&M Cost] and [20% Increase in Capital Investment Cost]

Total Cost	217,200	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	343,200	K BWP	
Additional Capital Expenditure	24,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: 61%

	NPV [mil USD]	CBR
At 12% (=SDR)	656	2.08

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	30%	274,741,632	2.00	0.60	76,543	76,543	28,699	28,699	28,699
2	2013/14	-21,720	-43,500	-65,220	-58,232	15%	137,370,816	2.00	0.74	38,704	34,557	-26,516	-23,675	5,025
3	2014/15	-143,352	-49,029	-192,381	-153,365	0%	0	2.00	0.84	0	0	-192,381	-153,365	-148,340
4	2015/16	-47,784	-51,860	-99,644	-70,924	40%	366,322,176	2.00	0.84	104,036	74,051	4,392	3,126	-145,214
5	2016/17	0	-51,538	-51,538	-32,753	80%	732,644,352	2.00	0.84	208,072	132,233	156,534	99,480	-45,734
6	2017/18		-51,480	-51,480	-29,211	80%	732,644,352	2.00	0.84	208,072	118,065	156,592	88,854	43,120
7	2018/19		-51,480	-51,480	-26,081	80%	732,644,352	2.00	0.84	208,072	105,416	156,592	79,334	122,455
8	2019/20		-51,480	-51,480	-23,287	80%	732,644,352	2.00	0.84	208,072	94,121	156,592	70,834	193,289
9	2020/21		-51,480	-51,480	-20,792	80%	732,644,352	2.00	0.84	208,072	84,037	156,592	63,245	256,534
10	2021/22		-51,480	-51,480	-18,564	80%	732,644,352	2.00	0.84	208,072	75,033	156,592	56,469	313,002
11	2022/23		-51,480	-51,480	-16,575	80%	732,644,352	2.00	0.84	208,072	66,994	156,592	50,418	363,420
12	2023/24		-51,480	-51,480	-14,799	80%	732,644,352	2.00	0.84	208,072	59,816	156,592	45,016	408,437
13	2024/25		-51,480	-51,480	-13,214	80%	732,644,352	2.00	0.84	208,072	53,407	156,592	40,193	448,630
14	2025/26		-51,480	-51,480	-11,798	80%	732,644,352	2.00	0.84	208,072	47,685	156,592	35,887	484,517
15	2026/27	-3,600	-51,480	-55,080	-11,270	80%	732,644,352	2.00	0.84	208,072	42,576	152,992	31,305	515,822
16	2027/28	-3,600	-51,480	-55,080	-10,063	80%	732,644,352	2.00	0.84	208,072	38,014	152,992	27,951	543,773
17	2028/29	-3,600	-51,480	-55,080	-8,985	80%	732,644,352	2.00	0.84	208,072	33,941	152,992	24,956	568,729
18	2029/30	-3,600	-51,480	-55,080	-8,022	80%	732,644,352	2.00	0.84	208,072	30,304	152,992	22,282	591,012
19	2030/31	-3,600	-51,480	-55,080	-7,163	80%	732,644,352	2.00	0.84	208,072	27,058	152,992	19,895	610,907
20	2031/32	-3,600	-51,480	-55,080	-6,395	72%	659,379,917	2.00	0.84	187,265	21,743	132,185	15,348	626,254
21	2032/33	-3,600	-51,480	-55,080	-5,710	64%	586,115,482	2.00	0.84	166,457	17,256	111,377	11,546	637,800
22	2033/34	-3,600	-51,480	-55,080	-5,098	56%	512,851,046	2.00	0.84	145,650	13,481	90,570	8,383	646,183
23	2034/35	-3,600	-51,480	-55,080	-4,552	48%	439,586,611	2.00	0.84	124,843	10,317	69,763	5,765	651,949
24	2035/36	-3,600	-51,480	-55,080	-4,064	40%	366,322,176	2.00	0.84	104,036	7,677	48,956	3,612	655,561
25	2036/37		0	0	0	0%	0	2.00	0.84	0	0			
26	2037/38		0	0	0	0%	0	2.00	0.84	0	0			
27	2038/39		0	0	0	0%	0	2.00	0.84	0	0			
28	2039/40		0	0	0	0%	0	2.00	0.84	0	0			
29	2040/41		0	0	0	0%	0	2.00	0.84	0	0			
30	2041/42		0	0	0	0%	0	2.00	0.84	0	0			
		-253,200	-1,217,547	-1,470,747	-608,763		1.4332E+10			4,068,611	1,264,324	2,597,864	655,561	

2.4 [6.7% less Benefit]

Total Cost	181,000	K USD
Maximum Output	132,000	kW
Internal Usage Rate	12%	
System Loss Rate	10%	
O&M Expenditure	286,000	K BWP
Additional Capital Expenditure	20,000	K BWP

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 0%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: 71%

	NPV [mil USD]	CBR
At 12% (=SDR)	658	2.25

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	30%	274,741,632	2.00		72,834	72,834	25,714	25,714	25,714
2	2013/14	-18,100	-43,500	-61,600	-55,000	15%	137,370,816	2.00		36,417	32,515	-25,183	-22,485	3,230
3	2014/15	-119,460	-44,739	-164,199	-130,899	0%	0	2.00		0	0	-164,199	-130,899	-127,669
4	2015/16	-39,820	-43,280	-83,100	-59,149	40%	366,322,176	2.00		97,112	69,123	14,013	9,974	-117,695
5	2016/17	0	-42,958	-42,958	-27,300	80%	732,644,352	2.00		194,225	123,433	151,267	96,133	-21,562
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00		194,225	110,208	151,325	85,866	64,304
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00		194,225	98,400	151,325	76,666	140,969
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00		194,225	87,857	151,325	68,452	209,421
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00		194,225	78,444	151,325	61,118	270,539
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00		194,225	70,039	151,325	54,569	325,108
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00		194,225	62,535	151,325	48,723	373,830
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00		194,225	55,835	151,325	43,502	417,333
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00		194,225	49,853	151,325	38,841	456,174
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00		194,225	44,511	151,325	34,680	490,854
15	2026/27	-3,000	-42,900	-45,900	-9,392	80%	732,644,352	2.00		194,225	39,742	148,325	30,350	521,204
16	2027/28	-3,000	-42,900	-45,900	-8,386	80%	732,644,352	2.00		194,225	35,484	148,325	27,098	548,302
17	2028/29	-3,000	-42,900	-45,900	-7,487	80%	732,644,352	2.00		194,225	31,682	148,325	24,195	572,497
18	2029/30	-3,000	-42,900	-45,900	-6,685	80%	732,644,352	2.00		194,225	28,288	148,325	21,603	594,100
19	2030/31	-3,000	-42,900	-45,900	-5,969	80%	732,644,352	2.00		194,225	25,257	148,325	19,288	613,388
20	2031/32	-3,000	-42,900	-45,900	-5,329	72%	659,379,917	2.00		174,802	20,296	128,902	14,966	628,354
21	2032/33	-3,000	-42,900	-45,900	-4,758	64%	586,115,482	2.00		155,380	16,108	109,480	11,349	639,704
22	2033/34	-3,000	-42,900	-45,900	-4,248	56%	512,851,046	2.00		135,957	12,584	90,057	8,336	648,039
23	2034/35	-3,000	-42,900	-45,900	-3,793	48%	439,586,611	2.00		116,535	9,631	70,635	5,837	653,877
24	2035/36	-3,000	-42,900	-45,900	-3,387	40%	366,322,176	2.00		97,112	7,166	51,212	3,779	657,656
25	2036/37		0	0	0	0%	0	2.00		0	0			
26	2037/38		0	0	0	0%	0	2.00		0	0			
27	2038/39		0	0	0	0%	0	2.00		0	0			
28	2039/40		0	0	0	0%	0	2.00		0	0			
29	2040/41		0	0	0	0%	0	2.00		0	0			
30	2041/42		0	0	0	0%	0	2.00		0	0			
		-211,000	-1,033,077	-1,244,077	-524,171		1.4332E+10			3,799,522	1,181,827	2,555,445	657,656	

2.5 [6.7% less Benefit] and [20% Increase in O&M Cost]

Total Cost	181,000 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	66%
O&M Expenditure	343,200 K BWP	2015/16	22%
Additional Capital Expenditure	20,000 K BWP	2016/17	0%
			100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 0%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: 63%

	NPV [mil USD]	CBR
At 12% (=SDR)	603	2.04

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	30%	274,741,632	2.00		72,834	72,834	25,714	25,714	25,714
2	2013/14	-18,100	-43,500	-61,600	-55,000	15%	137,370,816	2.00		36,417	32,515	-25,183	-22,485	3,230
3	2014/15	-119,460	-49,029	-168,489	-134,319	0%	0	2.00		0	0	-168,489	-134,319	-131,089
4	2015/16	-39,820	-51,860	-91,680	-65,256	40%	366,322,176	2.00		97,112	69,123	5,433	3,867	-127,222
5	2016/17	0	-51,538	-51,538	-32,753	80%	732,644,352	2.00		194,225	123,433	142,687	90,680	-36,542
6	2017/18		-51,480	-51,480	-29,211	80%	732,644,352	2.00		194,225	110,208	142,745	80,997	44,455
7	2018/19		-51,480	-51,480	-26,081	80%	732,644,352	2.00		194,225	98,400	142,745	72,319	116,774
8	2019/20		-51,480	-51,480	-23,287	80%	732,644,352	2.00		194,225	87,857	142,745	64,570	181,345
9	2020/21		-51,480	-51,480	-20,792	80%	732,644,352	2.00		194,225	78,444	142,745	57,652	238,997
10	2021/22		-51,480	-51,480	-18,564	80%	732,644,352	2.00		194,225	70,039	142,745	51,475	290,472
11	2022/23		-51,480	-51,480	-16,575	80%	732,644,352	2.00		194,225	62,535	142,745	45,960	336,432
12	2023/24		-51,480	-51,480	-14,799	80%	732,644,352	2.00		194,225	55,835	142,745	41,036	377,468
13	2024/25		-51,480	-51,480	-13,214	80%	732,644,352	2.00		194,225	49,853	142,745	36,639	414,107
14	2025/26		-51,480	-51,480	-11,798	80%	732,644,352	2.00		194,225	44,511	142,745	32,713	446,820
15	2026/27	-3,000	-51,480	-54,480	-11,148	80%	732,644,352	2.00		194,225	39,742	139,745	28,595	475,415
16	2027/28	-3,000	-51,480	-54,480	-9,953	80%	732,644,352	2.00		194,225	35,484	139,745	25,531	500,946
17	2028/29	-3,000	-51,480	-54,480	-8,887	80%	732,644,352	2.00		194,225	31,682	139,745	22,795	523,741
18	2029/30	-3,000	-51,480	-54,480	-7,935	80%	732,644,352	2.00		194,225	28,288	139,745	20,353	544,094
19	2030/31	-3,000	-51,480	-54,480	-7,085	80%	732,644,352	2.00		194,225	25,257	139,745	18,172	562,266
20	2031/32	-3,000	-51,480	-54,480	-6,325	72%	659,379,917	2.00		174,802	20,296	120,322	13,970	576,237
21	2032/33	-3,000	-51,480	-54,480	-5,648	64%	586,115,482	2.00		155,380	16,108	100,900	10,460	586,697
22	2033/34	-3,000	-51,480	-54,480	-5,043	56%	512,851,046	2.00		135,957	12,584	81,477	7,542	594,238
23	2034/35	-3,000	-51,480	-54,480	-4,502	48%	439,586,611	2.00		116,535	9,631	62,055	5,128	599,367
24	2035/36	-3,000	-51,480	-54,480	-4,020	40%	366,322,176	2.00		97,112	7,166	42,632	3,146	602,512
25	2036/37		0	0	0	0%	0	2.00		0	0			
26	2037/38		0	0	0	0%	0	2.00		0	0			
27	2038/39		0	0	0	0%	0	2.00		0	0			
28	2039/40		0	0	0	0%	0	2.00		0	0			
29	2040/41		0	0	0	0%	0	2.00		0	0			
30	2041/42		0	0	0	0%	0	2.00		0	0			
		-211,000	-1,217,547	-1,428,547	-579,314		1.4332E+10			3,799,522	1,181,827	2,370,975	602,512	

2.6 [6.7% less Benefit] and [20% Increase in Capital Investment Cost]

Total Cost	217,200 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	66%
O&M Expenditure	286,000 K BWP	2015/16	22%
Additional Capital Expenditure	24,000 K BWP	2016/17	0%
			100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 0%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: 57%

	NPV [mil USD]	CBR
At 12% (=SDR)	628	2.13

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	30%	274,741,632	2.00		72,834	72,834	24,990	24,990	24,990
2	2013/14	-21,720	-43,500	-65,220	-58,232	15%	137,370,816	2.00		36,417	32,515	-28,803	-25,717	-727
3	2014/15	-143,352	-44,739	-188,091	-149,945	0%	0	2.00		0	0	-188,091	-149,945	-150,672
4	2015/16	-47,784	-43,280	-91,064	-64,817	40%	366,322,176	2.00		97,112	69,123	6,049	4,305	-146,366
5	2016/17	0	-42,958	-42,958	-27,300	80%	732,644,352	2.00		194,225	123,433	151,267	96,133	-50,233
6	2017/18		-42,900	-42,900	-24,343	80%	732,644,352	2.00		194,225	110,208	151,325	85,866	35,632
7	2018/19		-42,900	-42,900	-21,734	80%	732,644,352	2.00		194,225	98,400	151,325	76,666	112,298
8	2019/20		-42,900	-42,900	-19,406	80%	732,644,352	2.00		194,225	87,857	151,325	68,452	180,750
9	2020/21		-42,900	-42,900	-17,327	80%	732,644,352	2.00		194,225	78,444	151,325	61,118	241,867
10	2021/22		-42,900	-42,900	-15,470	80%	732,644,352	2.00		194,225	70,039	151,325	54,569	296,437
11	2022/23		-42,900	-42,900	-13,813	80%	732,644,352	2.00		194,225	62,535	151,325	48,723	345,159
12	2023/24		-42,900	-42,900	-12,333	80%	732,644,352	2.00		194,225	55,835	151,325	43,502	388,661
13	2024/25		-42,900	-42,900	-11,011	80%	732,644,352	2.00		194,225	49,853	151,325	38,841	427,503
14	2025/26		-42,900	-42,900	-9,832	80%	732,644,352	2.00		194,225	44,511	151,325	34,680	462,182
15	2026/27	-3,600	-42,900	-46,500	-9,515	80%	732,644,352	2.00		194,225	39,742	147,725	30,227	492,410
16	2027/28	-3,600	-42,900	-46,500	-8,495	80%	732,644,352	2.00		194,225	35,484	147,725	26,989	519,399
17	2028/29	-3,600	-42,900	-46,500	-7,585	80%	732,644,352	2.00		194,225	31,682	147,725	24,097	543,496
18	2029/30	-3,600	-42,900	-46,500	-6,772	80%	732,644,352	2.00		194,225	28,288	147,725	21,515	565,011
19	2030/31	-3,600	-42,900	-46,500	-6,047	80%	732,644,352	2.00		194,225	25,257	147,725	19,210	584,221
20	2031/32	-3,600	-42,900	-46,500	-5,399	72%	659,379,917	2.00		174,802	20,296	128,302	14,897	599,118
21	2032/33	-3,600	-42,900	-46,500	-4,821	64%	586,115,482	2.00		155,380	16,108	108,880	11,287	610,405
22	2033/34	-3,600	-42,900	-46,500	-4,304	56%	512,851,046	2.00		135,957	12,584	89,457	8,280	618,685
23	2034/35	-3,600	-42,900	-46,500	-3,843	48%	439,586,611	2.00		116,535	9,631	70,035	5,788	624,473
24	2035/36	-3,600	-42,900	-46,500	-3,431	40%	366,322,176	2.00		97,112	7,166	50,612	3,735	628,208
25	2036/37		0	0	0	0%	0	2.00		0	0			
26	2037/38		0	0	0	0%	0	2.00		0	0			
27	2038/39		0	0	0	0%	0	2.00		0	0			
28	2039/40		0	0	0	0%	0	2.00		0	0			
29	2040/41		0	0	0	0%	0	2.00		0	0			
30	2041/42		0	0	0	0%	0	2.00		0	0			
		-253,200	-1,033,077	-1,286,277	-553,619		1.4332E+10			3,799,522	1,181,827	2,513,245	628,208	

2.7 [6.7% less Benefit] and [20% Increase in O&M Cost] and [20% Increase in Capital Investment Cost]

Total Cost	217,200	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	343,200	K BWP	
Additional Capital Expenditure	24,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 0%

Value of Capacity Availability: 9,251 K USD

Foreign Exchange: 0.15 USD/BWP

Social Discount Rate (SDR): 12%

FIRR: **52%**

	NPV [mil USD]	CBR
At 12% (=SDR)	**573**	**1.94**

FY		Expenditure						Revenue				Cash Flow		
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at SDR (12%)	Availability Rate	Generation	Marginal Benefit to Domestic	SAPP Network Sales	Benefit at Current price	Discounted at SDR (12%)	Current Cash Flow	DCF at SDR (12%)	Cash Accumulation at SDR
		[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	30%	274,741,632	2.00		72,834	72,834	24,990	24,990	24,990
2	2013/14	-21,720	-43,500	-65,220	-58,232	15%	137,370,816	2.00		36,417	32,515	-28,803	-25,717	-727
3	2014/15	-143,352	-49,029	-192,381	-153,365	0%	0	2.00		0	0	-192,381	-153,365	-154,092
4	2015/16	-47,784	-51,860	-99,644	-70,924	40%	366,322,176	2.00		97,112	69,123	-2,531	-1,802	-155,893
5	2016/17	0	-51,538	-51,538	-32,753	80%	732,644,352	2.00		194,225	123,433	142,687	90,680	-65,213
6	2017/18		-51,480	-51,480	-29,211	80%	732,644,352	2.00		194,225	110,208	142,745	80,997	15,784
7	2018/19		-51,480	-51,480	-26,081	80%	732,644,352	2.00		194,225	98,400	142,745	72,319	88,103
8	2019/20		-51,480	-51,480	-23,287	80%	732,644,352	2.00		194,225	87,857	142,745	64,570	152,673
9	2020/21		-51,480	-51,480	-20,792	80%	732,644,352	2.00		194,225	78,444	142,745	57,652	210,326
10	2021/22		-51,480	-51,480	-18,564	80%	732,644,352	2.00		194,225	70,039	142,745	51,475	261,801
11	2022/23		-51,480	-51,480	-16,575	80%	732,644,352	2.00		194,225	62,535	142,745	45,960	307,761
12	2023/24		-51,480	-51,480	-14,799	80%	732,644,352	2.00		194,225	55,835	142,745	41,036	348,797
13	2024/25		-51,480	-51,480	-13,214	80%	732,644,352	2.00		194,225	49,853	142,745	36,639	385,436
14	2025/26		-51,480	-51,480	-11,798	80%	732,644,352	2.00		194,225	44,511	142,745	32,713	418,149
15	2026/27	-3,600	-51,480	-55,080	-11,270	80%	732,644,352	2.00		194,225	39,742	139,145	28,472	446,621
16	2027/28	-3,600	-51,480	-55,080	-10,063	80%	732,644,352	2.00		194,225	35,484	139,145	25,421	472,042
17	2028/29	-3,600	-51,480	-55,080	-8,985	80%	732,644,352	2.00		194,225	31,682	139,145	22,698	494,740
18	2029/30	-3,600	-51,480	-55,080	-8,022	80%	732,644,352	2.00		194,225	28,288	139,145	20,266	515,005
19	2030/31	-3,600	-51,480	-55,080	-7,163	80%	732,644,352	2.00		194,225	25,257	139,145	18,094	533,099
20	2031/32	-3,600	-51,480	-55,080	-6,395	72%	659,379,917	2.00		174,802	20,296	119,722	13,901	547,000
21	2032/33	-3,600	-51,480	-55,080	-5,710	64%	586,115,482	2.00		155,380	16,108	100,300	10,398	557,398
22	2033/34	-3,600	-51,480	-55,080	-5,098	56%	512,851,046	2.00		135,957	12,584	80,877	7,486	564,884
23	2034/35	-3,600	-51,480	-55,080	-4,552	48%	439,586,611	2.00		116,535	9,631	61,455	5,079	569,963
24	2035/36	-3,600	-51,480	-55,080	-4,064	40%	366,322,176	2.00		97,112	7,166	42,032	3,101	573,064
25	2036/37		0	0	0	0%	0	2.00		0	0			
26	2037/38		0	0	0	0%	0	2.00		0	0			
27	2038/39		0	0	0	0%	0	2.00		0	0			
28	2039/40		0	0	0	0%	0	2.00		0	0			
29	2040/41		0	0	0	0%	0	2.00		0	0			
30	2041/42		0	0	0	0%	0	2.00		0	0			
		-253,200	-1,217,547	-1,470,747	-608,763		1.4332E+10			3,799,522	1,181,827	2,328,775	573,064	

3. Financial Analysis Results

3.1 Scenario 1: Small-Scale Rehabilitation

Total Cost	134,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	301,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	39%
2015/16	49%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%
Percentage: Sales to SAPP Network	15%
Foreign Exchange	0.15 USD/BWP
Revenue Attributable to Power Generation	68%

Referential Cost of Capital	12%
WACC	2.3%
FIRR	1.3%

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD]	
	-86	0.82
At 2.3% (=WACC)	[mil USD]	
	-14	0.98

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-2,680	-43,500	-46,180	-46,180	-46,180	-46,180	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-26,155	-26,155	-26,155	-26,155	-26,155
2	2013/14	-13,400	-43,500	-56,900	-50,804	-55,615	-56,193	23%	210,635,251	0.92	0.74	19,024	16,986	18,594	18,788	-37,876	-33,818	-37,021	-37,405	-63,560
3	2014/15	-52,260	-44,362	-96,622	-77,027	-92,309	-94,235	9%	82,422,490	1.05	0.84	8,482	6,762	8,103	8,272	-88,141	-70,265	-84,205	-85,963	-149,523
4	2015/16	-65,660	-46,665	-112,325	-79,950	-104,887	-108,188	15%	137,370,816	1.05	0.84	14,136	10,062	13,200	13,616	-98,188	-69,888	-91,687	-94,572	-244,095
5	2016/17	0	-45,208	-45,208	-28,730	-41,261	-43,001	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	71,715	30,186	19,184	27,551	28,713	-215,382
6	2017/18		-45,150	-45,150	-25,619	-40,278	-42,413	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	70,823	30,244	17,161	26,981	28,411	-186,972
7	2018/19		-45,150	-45,150	-22,874	-39,369	-41,885	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	69,943	30,244	15,323	26,371	28,057	-158,914
8	2019/20		-45,150	-45,150	-20,424	-38,480	-41,365	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	69,073	30,244	13,681	25,776	27,709	-131,206
9	2020/21		-45,150	-45,150	-18,235	-37,611	-40,850	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	68,215	30,244	12,215	25,194	27,364	-103,842
10	2021/22		-45,150	-45,150	-16,282	-36,762	-40,343	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	67,367	30,244	10,906	24,625	27,024	-76,818
11	2022/23		-45,150	-45,150	-14,537	-35,932	-39,841	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	66,529	30,244	9,738	24,069	26,688	-50,130
12	2023/24		-45,150	-45,150	-12,980	-35,120	-39,346	75%	686,854,080	1.05	0.84	70,682	20,319	54,981	61,596	25,532	7,340	19,860	22,250	-27,880
13	2024/25		-45,150	-45,150	-11,589	-34,327	-38,857	70%	641,063,808	1.05	0.84	65,970	16,933	50,157	56,775	20,820	5,344	15,829	17,918	-9,962
14	2025/26		-45,150	-45,150	-10,347	-33,552	-38,374	65%	595,273,536	1.05	0.84	61,258	14,039	45,522	52,064	16,108	3,691	11,970	13,690	3,728
15	2026/27	-3,000	-45,150	-48,150	-9,852	-34,974	-40,415	60%	549,483,264	1.05	0.84	56,546	11,570	41,072	47,462	8,396	1,718	6,098	7,047	10,775
16	2027/28	-3,000	-45,150	-48,150	-8,797	-34,184	-39,912	55%	503,692,992	1.05	0.84	51,833	9,470	36,799	42,966	3,683	673	2,615	3,053	13,829
17	2028/29	-3,000	-45,150	-48,150	-7,854	-33,412	-39,416	50%	457,902,720	1.05	0.84	47,121	7,687	32,699	38,574	-1,029	-168	-714	-842	12,987
18	2029/30	-3,000	-45,150	-48,150	-7,013	-32,658	-38,926	45%	412,112,448	1.05	0.84	42,409	6,177	28,764	34,285	-5,741	-836	-3,894	-4,641	8,346
19	2030/31	-3,000	-45,150	-48,150	-6,261	-31,921	-38,442	40%	366,322,176	1.05	0.84	37,697	4,902	24,991	30,097	-10,453	-1,359	-6,930	-8,345	0
20	2031/32		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
21	2032/33		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
22	2033/34		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
23	2034/35		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
24	2035/36		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-149,000	-855,335	-1,004,335	-475,356	-838,831	-908,182		1.0046E+10			1,022,943	389,840	825,166	908,182	18,608	-85,516	-13,665	0	

3.2 Scenario 2a: Large-Scale Rehabilitation [Phased]

Total Cost	197,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	32%
2015/16	39%
2016/17	17%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	**5.5%**

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	**-90**	**0.83**
At 2.3% (=WACC)	**88**	**1.09**

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,940	-43,500	-47,440	-47,440	-47,440	-47,440	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,415	-27,415	-27,415	-27,415	-27,415
2	2013/14	-19,700	-43,500	-63,200	-56,429	-61,773	-59,925	23%	210,635,251	0.92	0.74	19,024	16,986	18,594	18,038	-44,176	-39,443	-43,179	-41,887	-69,302
3	2014/15	-63,040	-44,428	-107,468	-85,673	-102,670	-96,620	8%	73,264,435	1.05	0.84	7,539	6,010	7,203	6,778	-99,929	-79,663	-95,467	-89,841	-159,144
4	2015/16	-76,830	-45,750	-122,580	-87,250	-114,463	-104,495	14%	128,212,762	1.05	0.84	13,194	9,391	12,320	11,247	-109,386	-77,859	-102,143	-93,248	-252,391
5	2016/17	-33,490	-43,016	-76,506	-48,621	-69,827	-61,839	75%	686,854,080	1.05	0.84	70,682	44,920	64,511	57,132	-5,824	-3,701	-5,315	-4,707	-257,099
6	2017/18		-42,900	-42,900	-24,343	-38,271	-32,879	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	57,783	32,494	18,438	28,988	24,904	-232,195
7	2018/19		-42,900	-42,900	-21,734	-37,407	-31,175	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	54,789	32,494	16,463	28,333	23,613	-208,581
8	2019/20		-42,900	-42,900	-19,406	-36,562	-29,560	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	51,950	32,494	14,699	27,694	22,390	-186,191
9	2020/21		-42,900	-42,900	-17,327	-35,737	-28,028	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	49,258	32,494	13,124	27,068	21,230	-164,962
10	2021/22		-42,900	-42,900	-15,470	-34,930	-26,576	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	46,705	32,494	11,718	26,457	20,130	-144,832
11	2022/23		-42,900	-42,900	-13,813	-34,141	-25,199	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	44,285	32,494	10,462	25,860	19,087	-125,746
12	2023/24		-42,900	-42,900	-12,333	-33,370	-23,893	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	41,991	32,494	9,341	25,276	18,098	-107,648
13	2024/25		-42,900	-42,900	-11,011	-32,617	-22,655	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	39,815	32,494	8,340	24,705	17,160	-90,488
14	2025/26	-3,000	-42,900	-45,900	-10,519	-34,110	-22,983	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	37,752	29,494	6,759	21,918	14,768	-75,720
15	2026/27	-3,000	-42,900	-45,900	-9,392	-33,340	-21,792	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	35,796	29,494	6,035	21,423	14,003	-61,717
16	2027/28	-3,000	-42,900	-45,900	-8,386	-32,587	-20,663	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	33,941	29,494	5,388	20,939	13,278	-48,439
17	2028/29	-3,000	-42,900	-45,900	-7,487	-31,851	-19,592	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	32,182	29,494	4,811	20,467	12,590	-35,849
18	2029/30	-3,000	-42,900	-45,900	-6,685	-31,132	-18,577	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	30,514	29,494	4,296	20,005	11,937	-23,912
19	2030/31	-3,000	-42,900	-45,900	-5,969	-30,429	-17,615	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	28,933	29,494	3,835	19,553	11,319	-12,593
20	2031/32	-3,000	-42,900	-45,900	-5,329	-29,742	-16,702	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	24,691	21,955	2,549	14,226	7,989	-4,605
21	2032/33	-3,000	-42,900	-45,900	-4,758	-29,070	-15,836	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	20,810	14,415	1,494	9,130	4,974	369
22	2033/34	-3,000	-42,900	-45,900	-4,248	-28,414	-15,016	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	17,265	6,876	636	4,256	2,249	2,618
23	2034/35	-3,000	-42,900	-45,900	-3,793	-27,772	-14,238	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	14,032	-663	-55	-401	-206	2,413
24	2035/36	-3,000	-42,900	-45,900	-3,387	-27,145	-13,500	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	11,087	-8,203	-605	-4,851	-2,413	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-230,000	-1,035,294	-1,265,294	-530,803	-1,014,799	-786,799		1.4195E+10			1,449,862	440,452	1,102,325	786,799	184,568	-90,351	87,526	0	

3.3 Scenario 2b: Large-Scale Rehabilitation [Simultaneous]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%	
WACC	2.3%	
FIRR	6.6%	

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	-75	0.86
At 2.3% (=WACC)	118	1.12

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120	-47,120	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,095	-27,095	-27,095	-27,095	-27,095
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209	-57,780	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	11,638	-49,193	-43,922	-48,082	-46,143	-73,238
3	2014/15	-119,460	-44,739	-164,199	-130,899	-156,868	-144,468	0%	0	1.05	0.84	0	0	0	0	-164,199	-130,899	-156,868	-144,468	-217,706
4	2015/16	-39,820	-43,280	-83,100	-59,149	-77,597	-68,580	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	31,110	-45,403	-32,317	-42,396	-37,470	-255,175
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-33,254	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	58,363	32,436	20,614	29,605	25,109	-230,066
6	2017/18		-42,900	-42,900	-24,343	-38,271	-31,150	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	54,744	32,494	18,438	28,988	23,594	-206,472
7	2018/19		-42,900	-42,900	-21,734	-37,407	-29,218	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	51,349	32,494	16,463	28,333	22,131	-184,341
8	2019/20		-42,900	-42,900	-19,406	-36,562	-27,407	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	48,165	32,494	14,699	27,694	20,759	-163,582
9	2020/21		-42,900	-42,900	-17,327	-35,737	-25,707	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	45,179	32,494	13,124	27,068	19,472	-144,110
10	2021/22		-42,900	-42,900	-15,470	-34,930	-24,113	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	42,377	32,494	11,718	26,457	18,264	-125,846
11	2022/23		-42,900	-42,900	-13,813	-34,141	-22,618	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	39,750	32,494	10,462	25,860	17,132	-108,714
12	2023/24		-42,900	-42,900	-12,333	-33,370	-21,216	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	37,285	32,494	9,341	25,276	16,069	-92,645
13	2024/25		-42,900	-42,900	-11,011	-32,617	-19,900	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	34,973	32,494	8,340	24,705	15,073	-77,572
14	2025/26		-42,900	-42,900	-9,832	-31,880	-18,666	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	32,804	32,494	7,447	24,147	14,138	-63,433
15	2026/27	-3,000	-42,900	-45,900	-9,392	-33,340	-18,733	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	30,770	29,494	6,035	21,423	12,037	-51,396
16	2027/28	-3,000	-42,900	-45,900	-8,386	-32,587	-17,571	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	28,862	29,494	5,388	20,939	11,291	-40,105
17	2028/29	-3,000	-42,900	-45,900	-7,487	-31,851	-16,482	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	27,073	29,494	4,811	20,467	10,591	-29,514
18	2029/30	-3,000	-42,900	-45,900	-6,685	-31,132	-15,460	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	25,394	29,494	4,296	20,005	9,934	-19,580
19	2030/31	-3,000	-42,900	-45,900	-5,969	-30,429	-14,501	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	23,819	29,494	3,835	19,553	9,318	-10,262
20	2031/32	-3,000	-42,900	-45,900	-5,329	-29,742	-13,602	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	20,108	21,955	2,549	14,226	6,506	-3,756
21	2032/33	-3,000	-42,900	-45,900	-4,758	-29,070	-12,759	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	16,766	14,415	1,494	9,130	4,007	251
22	2033/34	-3,000	-42,900	-45,900	-4,248	-28,414	-11,968	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	13,760	6,876	636	4,256	1,793	2,044
23	2034/35	-3,000	-42,900	-45,900	-3,793	-27,772	-11,225	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	11,063	-663	-55	-401	-162	1,882
24	2035/36	-3,000	-42,900	-45,900	-3,387	-27,145	-10,529	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	8,648	-8,203	-605	-4,851	-1,882	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-211,000	-1,033,077	-1,244,077	-524,171	-997,398	-714,027		1.4332E+10			1,464,921	448,969	1,115,836	714,027	220,844	-75,202	118,437	0	

3.4 Scenario 3: New Installation of a Power Station of Equivalent Capacity

Total Cost	336,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost	
2012/13	1%
2013/14	1%
2014/15	25%
2015/16	39%
2016/17	34%
	100%

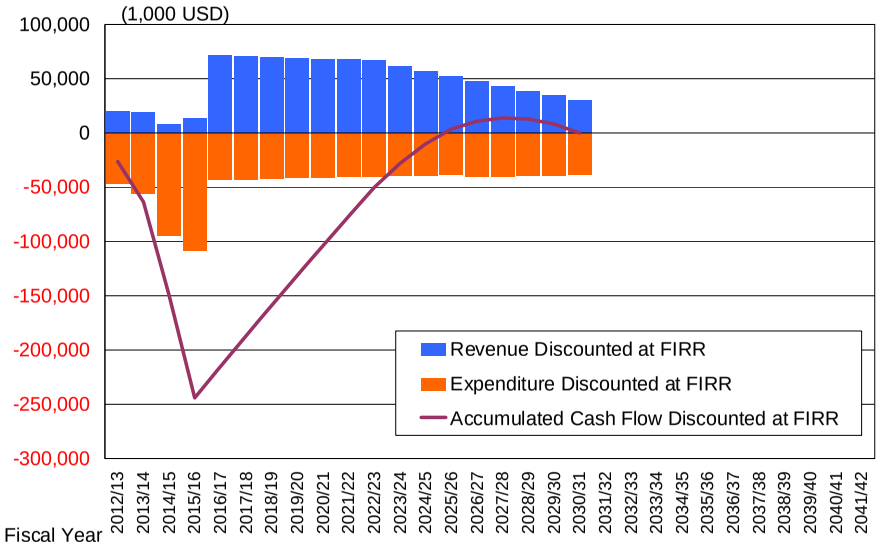
Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	**4.7%**

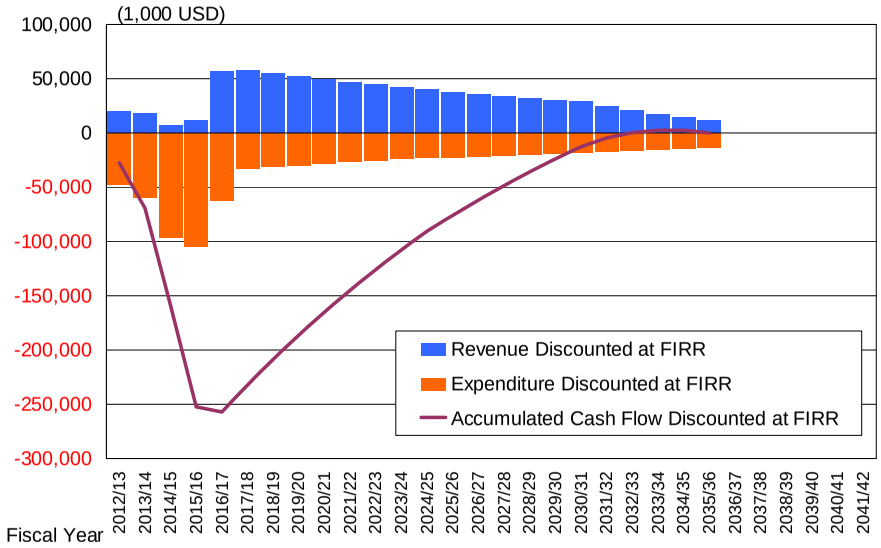
	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	**-157**	**0.75**
At 2.3% (=WACC)	**129**	**1.10**

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,360	-43,500	-46,860	-46,860	-46,860	-46,860	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-26,835	-26,835	-26,835	-26,835	-26,835
2	2013/14	-3,360	-43,500	-46,860	-41,839	-45,802	-44,770	30%	274,741,632	0.92	0.74	24,814	22,155	24,254	23,707	-22,046	-19,684	-21,548	-21,063	-47,898
3	2014/15	-84,000	-43,607	-127,607	-101,728	-121,910	-116,477	30%	274,741,632	1.05	0.84	28,273	22,539	27,011	25,807	-99,334	-79,189	-94,899	-90,670	-138,568
4	2015/16	-131,040	-44,453	-175,493	-124,913	-163,872	-153,041	30%	274,741,632	1.05	0.84	28,273	20,124	26,401	24,656	-147,220	-104,789	-137,472	-128,385	-266,954
5	2016/17	-114,240	-47,009	-161,249	-102,476	-147,172	-134,346	30%	274,741,632	1.05	0.84	28,273	17,968	25,805	23,556	-132,976	-84,509	-121,367	-110,791	-377,744
6	2017/18		-42,900	-42,900	-24,343	-38,271	-34,148	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	60,014	32,494	18,438	28,988	25,865	-351,879
7	2018/19		-42,900	-42,900	-21,734	-37,407	-32,625	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	57,337	32,494	16,463	28,333	24,712	-327,167
8	2019/20		-42,900	-42,900	-19,406	-36,562	-31,170	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	54,779	32,494	14,699	27,694	23,609	-303,558
9	2020/21		-42,900	-42,900	-17,327	-35,737	-29,779	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	52,336	32,494	13,124	27,068	22,556	-281,002
10	2021/22		-42,900	-42,900	-15,470	-34,930	-28,451	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	50,001	32,494	11,718	26,457	21,550	-259,452
11	2022/23		-42,900	-42,900	-13,813	-34,141	-27,182	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	47,771	32,494	10,462	25,860	20,589	-238,863
12	2023/24		-42,900	-42,900	-12,333	-33,370	-25,970	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	45,640	32,494	9,341	25,276	19,670	-219,193
13	2024/25		-42,900	-42,900	-11,011	-32,617	-24,811	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	43,604	32,494	8,340	24,705	18,793	-200,400
14	2025/26		-42,900	-42,900	-9,832	-31,880	-23,704	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	41,659	32,494	7,447	24,147	17,955	-182,445
15	2026/27		-42,900	-42,900	-8,778	-31,160	-22,647	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	39,801	32,494	6,649	23,602	17,154	-165,291
16	2027/28	-3,000	-42,900	-45,900	-8,386	-32,587	-23,150	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	38,026	29,494	5,388	20,939	14,876	-150,416
17	2028/29	-3,000	-42,900	-45,900	-7,487	-31,851	-22,117	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	36,329	29,494	4,811	20,467	14,212	-136,204
18	2029/30	-3,000	-42,900	-45,900	-6,685	-31,132	-21,131	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	34,709	29,494	4,296	20,005	13,578	-122,626
19	2030/31	-3,000	-42,900	-45,900	-5,969	-30,429	-20,188	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	33,161	29,494	3,835	19,553	12,972	-109,653
20	2031/32	-3,000	-42,900	-45,900	-5,329	-29,742	-19,288	80%	732,644,352	1.05	0.84	75,394	8,754	48,853	31,681	29,494	3,424	19,111	12,394	-97,259
21	2032/33	-3,000	-42,900	-45,900	-4,758	-29,070	-18,427	80%	732,644,352	1.05	0.84	75,394	7,816	47,750	30,268	29,494	3,058	18,680	11,841	-85,418
22	2033/34	-3,000	-42,900	-45,900	-4,248	-28,414	-17,605	80%	732,644,352	1.05	0.84	75,394	6,978	46,672	28,918	29,494	2,730	18,258	11,313	-74,106
23	2034/35	-3,000	-42,900	-45,900	-3,793	-27,772	-16,820	80%	732,644,352	1.05	0.84	75,394	6,231	45,618	27,628	29,494	2,437	17,846	10,808	-63,297
24	2035/36	-3,000	-42,900	-45,900	-3,387	-27,145	-16,070	80%	732,644,352	1.05	0.84	75,394	5,563	44,588	26,396	29,494	2,176	17,443	10,326	-52,971
25	2036/37	-3,000	-42,900	-45,900	-3,024	-26,533	-15,353	80%	732,644,352	1.05	0.84	75,394	4,967	43,582	25,218	29,494	1,943	17,049	9,865	-43,106
26	2037/38	-3,000	-42,900	-45,900	-2,700	-25,933	-14,668	80%	732,644,352	1.05	0.84	75,394	4,435	42,598	24,094	29,494	1,735	16,664	9,425	-33,681
27	2038/39	-3,000	-42,900	-45,900	-2,411	-25,348	-14,014	80%	732,644,352	1.05	0.84	75,394	3,960	41,636	23,019	29,494	1,549	16,288	9,005	-24,676
28	2039/40	-3,000	-42,900	-45,900	-2,152	-24,776	-13,389	80%	732,644,352	1.05	0.84	75,394	3,536	40,696	21,992	29,494	1,383	15,920	8,603	-16,072
29	2040/41	-3,000	-42,900	-45,900	-1,922	-24,216	-12,792	80%	732,644,352	1.05	0.84	75,394	3,157	39,777	21,011	29,494	1,235	15,561	8,220	-7,853
30	2041/42	-3,000	-42,900	-45,900	-1,716	-23,669	-12,221	80%	732,644,352	1.05	0.84	75,394	2,818	38,879	20,074	29,494	1,103	15,209	7,853	0
		-381,000	-1,294,569	-1,675,569	-635,830	-1,290,308	-1,033,215		1.969E+10			2,014,511	478,610	1,419,310	1,033,215	338,942	-157,220	129,002	0	

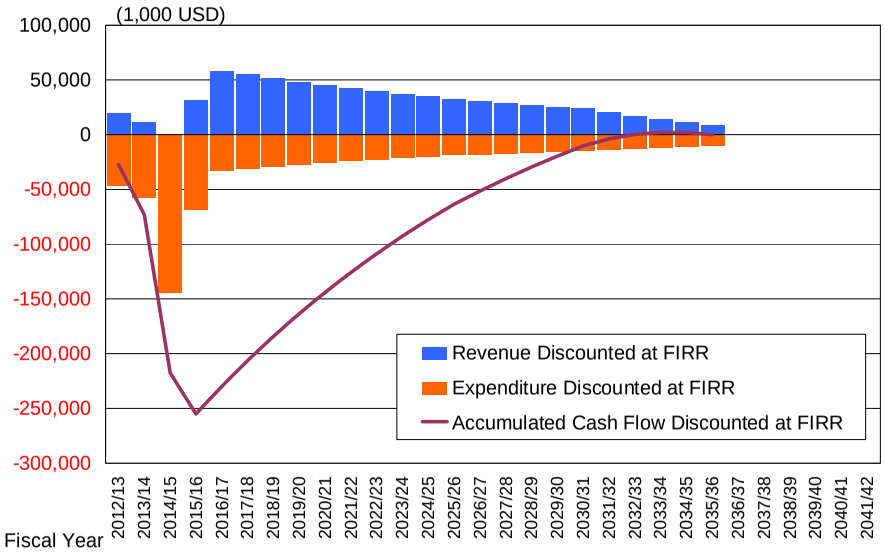
3.5 Discounted Cash Flows



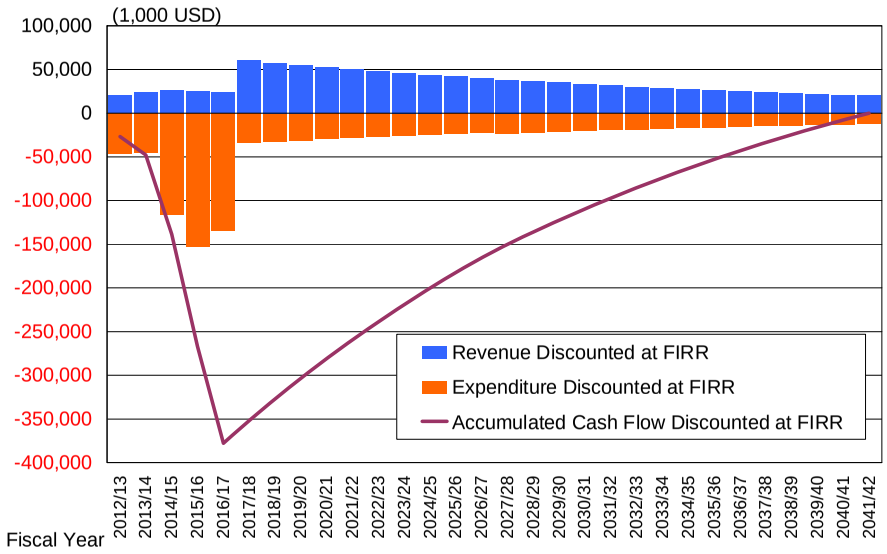
Scenario 1: Small-Scale Rehabilitation



Scenario 2a: Large-Scale Rehabilitation [Phased]



Scenario 2b: Large-Scale Rehabilitation [Simultaneous]



Scenario 3: New Installation of a Power Station of Equivalent Capacity

4. Sensitivity Analysis of Financial Viability

4.1 [10% Increase in O&M Cost]

Total Cost	181,000	K USD
Maximum Output	132,000	kW
Internal Usage Rate	12%	
System Loss Rate	10%	
O&M Expenditure	314,600	K BWP
Additional Capital Expenditure	20,000	K BWP

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market: 85%

Percentage: Sales to SAPP Network: 15%

Foreign Exchange: 0.15 USD/BWP

Revenue Attributable to Power Generation: 68%

Referential Cost of Capital: 12%

WACC: 2.3%

FIRR: **4.2%**

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] **-103**	**0.81**
At 2.3% (=WACC)	[mil USD] **49**	**1.05**

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120	-47,120	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,095	-27,095	-27,095	-27,095	-27,095
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209	-59,095	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	11,902	-49,193	-43,922	-48,082	-47,193	-74,288
3	2014/15	-119,460	-46,884	-166,344	-132,609	-158,917	-153,092	0%	0	1.05	0.84	0	0	0	0	-166,344	-132,609	-158,917	-153,092	-227,380
4	2015/16	-39,820	-47,570	-87,390	-62,202	-81,603	-77,157	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	33,283	-49,693	-35,370	-46,402	-43,874	-271,254
5	2016/17	0	-47,248	-47,248	-30,027	-43,123	-40,019	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	63,860	28,146	17,888	25,689	23,840	-247,414
6	2017/18		-47,190	-47,190	-26,777	-42,098	-38,345	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	61,263	28,204	16,004	25,161	22,918	-224,496
7	2018/19		-47,190	-47,190	-23,908	-41,147	-36,786	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	58,772	28,204	14,289	24,593	21,986	-202,510
8	2019/20		-47,190	-47,190	-21,346	-40,218	-35,290	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	56,383	28,204	12,758	24,037	21,092	-181,418
9	2020/21		-47,190	-47,190	-19,059	-39,310	-33,856	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	54,090	28,204	11,391	23,495	20,235	-161,183
10	2021/22		-47,190	-47,190	-17,017	-38,423	-32,479	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	51,891	28,204	10,171	22,964	19,412	-141,771
11	2022/23		-47,190	-47,190	-15,194	-37,555	-31,158	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	49,781	28,204	9,081	22,446	18,623	-123,149
12	2023/24		-47,190	-47,190	-13,566	-36,707	-29,891	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	47,757	28,204	8,108	21,939	17,865	-105,284
13	2024/25		-47,190	-47,190	-12,112	-35,878	-28,676	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	45,815	28,204	7,239	21,444	17,139	-88,145
14	2025/26		-47,190	-47,190	-10,815	-35,068	-27,510	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	43,952	28,204	6,464	20,959	16,442	-71,703
15	2026/27	-3,000	-47,190	-50,190	-10,270	-36,456	-28,069	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	42,165	25,204	5,157	18,307	14,096	-57,607
16	2027/28	-3,000	-47,190	-50,190	-9,170	-35,632	-26,928	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	40,451	25,204	4,605	17,894	13,523	-44,084
17	2028/29	-3,000	-47,190	-50,190	-8,187	-34,828	-25,833	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	38,806	25,204	4,111	17,490	12,973	-31,112
18	2029/30	-3,000	-47,190	-50,190	-7,310	-34,042	-24,783	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	37,228	25,204	3,671	17,095	12,445	-18,666
19	2030/31	-3,000	-47,190	-50,190	-6,527	-33,273	-23,775	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	35,714	25,204	3,278	16,709	11,939	-6,727
20	2031/32	-3,000	-47,190	-50,190	-5,827	-32,522	-22,808	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	30,836	17,665	2,051	11,446	8,028	1,300
21	2032/33	-3,000	-47,190	-50,190	-5,203	-31,787	-21,881	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	26,295	10,125	1,050	6,413	4,414	5,715
22	2033/34	-3,000	-47,190	-50,190	-4,646	-31,070	-20,991	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	22,073	2,586	239	1,601	1,082	6,796
23	2034/35	-3,000	-47,190	-50,190	-4,148	-30,368	-20,138	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	18,150	-4,953	-409	-2,997	-1,987	4,809
24	2035/36	-3,000	-47,190	-50,190	-3,703	-29,683	-19,319	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	14,510	-12,493	-922	-7,388	-4,809	-0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-211,000	-1,125,312	-1,336,312	-551,743	-1,067,038	-905,002		1.4332E+10			1,464,921	448,969	1,115,836	905,002	128,609	-102,773	48,798	-0	

4.2 [20% Increase in O&M Cost]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	343,200	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	1.4%

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	-130	0.78
At 2.3% (=WACC)	-21	0.98

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120	-47,120	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,095	-27,095	-27,095	-27,095	-27,095
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209	-60,762	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	12,238	-49,193	-43,922	-48,082	-48,524	-75,619
3	2014/15	-119,460	-49,029	-168,489	-134,319	-160,967	-163,937	0%	0	1.05	0.84	0	0	0	0	-168,489	-134,319	-160,967	-163,937	-239,556
4	2015/16	-39,820	-51,860	-91,680	-65,256	-85,609	-87,989	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	36,180	-53,983	-38,424	-50,408	-51,810	-291,366
5	2016/17	0	-51,538	-51,538	-32,753	-47,038	-48,791	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	71,375	23,856	15,161	21,774	22,585	-268,781
6	2017/18		-51,480	-51,480	-29,211	-45,925	-48,073	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	70,404	23,914	13,570	21,334	22,331	-246,450
7	2018/19		-51,480	-51,480	-26,081	-44,888	-47,419	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	69,447	23,914	12,116	20,852	22,028	-224,422
8	2019/20		-51,480	-51,480	-23,287	-43,874	-46,774	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	68,502	23,914	10,818	20,381	21,728	-202,694
9	2020/21		-51,480	-51,480	-20,792	-42,884	-46,138	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	67,571	23,914	9,659	19,921	21,433	-181,261
10	2021/22		-51,480	-51,480	-18,564	-41,916	-45,510	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	66,651	23,914	8,624	19,471	21,141	-160,120
11	2022/23		-51,480	-51,480	-16,575	-40,969	-44,891	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	65,745	23,914	7,700	19,032	20,854	-139,267
12	2023/24		-51,480	-51,480	-14,799	-40,044	-44,281	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	64,851	23,914	6,875	18,602	20,570	-118,697
13	2024/25		-51,480	-51,480	-13,214	-39,140	-43,678	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	63,969	23,914	6,138	18,182	20,290	-98,407
14	2025/26		-51,480	-51,480	-11,798	-38,256	-43,084	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	63,099	23,914	5,481	17,771	20,014	-78,392
15	2026/27	-3,000	-51,480	-54,480	-11,148	-39,572	-44,975	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	62,240	20,914	4,279	15,191	17,265	-61,127
16	2027/28	-3,000	-51,480	-54,480	-9,953	-38,678	-44,363	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	61,394	20,914	3,821	14,848	17,030	-44,097
17	2028/29	-3,000	-51,480	-54,480	-8,887	-37,805	-43,760	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	60,559	20,914	3,412	14,513	16,799	-27,298
18	2029/30	-3,000	-51,480	-54,480	-7,935	-36,951	-43,165	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	59,735	20,914	3,046	14,185	16,570	-10,727
19	2030/31	-3,000	-51,480	-54,480	-7,085	-36,117	-42,578	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	58,923	20,914	2,720	13,865	16,345	5,618
20	2031/32	-3,000	-51,480	-54,480	-6,325	-35,302	-41,998	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	52,309	13,375	1,553	8,666	10,311	15,928
21	2032/33	-3,000	-51,480	-54,480	-5,648	-34,504	-41,427	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	45,864	5,835	605	3,696	4,437	20,365
22	2033/34	-3,000	-51,480	-54,480	-5,043	-33,725	-40,864	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	39,586	-1,704	-158	-1,055	-1,278	19,087
23	2034/35	-3,000	-51,480	-54,480	-4,502	-32,964	-40,308	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	33,469	-9,243	-764	-5,593	-6,839	12,248
24	2035/36	-3,000	-51,480	-54,480	-4,020	-32,220	-39,760	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	27,511	-16,783	-1,238	-9,925	-12,248	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-211,000	-1,217,547	-1,428,547	-579,314	-1,136,678	-1,241,646		1.4332E+10			1,464,921	448,969	1,115,836	1,241,646	36,374	-130,345	-20,842	0	

4.3 [10% Increase in Capital Investment Cost]

Total Cost	199,100	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	22,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	**5.8%**

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	-90	0.83
At 2.3% (=WACC)	99	1.10

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,982	-43,500	-47,482	-47,482	-47,482	-47,482	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,457	-27,457	-27,457	-27,457	-27,457
2	2013/14	-19,910	-43,500	-63,410	-56,616	-61,978	-59,936	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	11,727	-51,003	-45,538	-49,851	-48,209	-75,666
3	2014/15	-131,406	-44,739	-176,145	-140,422	-168,281	-157,374	0%	0	1.05	0.84	0	0	0	0	-176,145	-140,422	-168,281	-157,374	-233,040
4	2015/16	-43,802	-43,280	-87,082	-61,983	-81,315	-73,539	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	31,835	-49,385	-35,151	-46,114	-41,705	-274,745
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-34,290	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	60,181	32,436	20,614	29,605	25,892	-248,853
6	2017/18		-42,900	-42,900	-24,343	-38,271	-32,368	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	56,885	32,494	18,438	28,988	24,517	-224,337
7	2018/19		-42,900	-42,900	-21,734	-37,407	-30,595	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	53,768	32,494	16,463	28,333	23,174	-201,163
8	2019/20		-42,900	-42,900	-19,406	-36,562	-28,919	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	50,823	32,494	14,699	27,694	21,904	-179,259
9	2020/21		-42,900	-42,900	-17,327	-35,737	-27,334	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	48,038	32,494	13,124	27,068	20,704	-158,555
10	2021/22		-42,900	-42,900	-15,470	-34,930	-25,837	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	45,407	32,494	11,718	26,457	19,570	-138,985
11	2022/23		-42,900	-42,900	-13,813	-34,141	-24,421	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	42,919	32,494	10,462	25,860	18,498	-120,488
12	2023/24		-42,900	-42,900	-12,333	-33,370	-23,083	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	40,568	32,494	9,341	25,276	17,484	-103,003
13	2024/25		-42,900	-42,900	-11,011	-32,617	-21,819	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	38,345	32,494	8,340	24,705	16,526	-86,477
14	2025/26		-42,900	-42,900	-9,832	-31,880	-20,624	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	36,245	32,494	7,447	24,147	15,621	-70,856
15	2026/27	-3,300	-42,900	-46,200	-9,453	-33,557	-20,993	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	34,259	29,194	5,974	21,205	13,266	-57,590
16	2027/28	-3,300	-42,900	-46,200	-8,441	-32,800	-19,843	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	32,382	29,194	5,334	20,726	12,539	-45,051
17	2028/29	-3,300	-42,900	-46,200	-7,536	-32,059	-18,756	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	30,608	29,194	4,762	20,258	11,852	-33,199
18	2029/30	-3,300	-42,900	-46,200	-6,729	-31,335	-17,729	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	28,931	29,194	4,252	19,801	11,203	-21,996
19	2030/31	-3,300	-42,900	-46,200	-6,008	-30,628	-16,757	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	27,346	29,194	3,796	19,354	10,589	-11,407
20	2031/32	-3,300	-42,900	-46,200	-5,364	-29,936	-15,839	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	23,263	21,655	2,514	14,032	7,424	-3,983
21	2032/33	-3,300	-42,900	-46,200	-4,789	-29,260	-14,972	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	19,546	14,115	1,463	8,940	4,574	592
22	2033/34	-3,300	-42,900	-46,200	-4,276	-28,600	-14,151	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	16,166	6,576	609	4,071	2,014	2,606
23	2034/35	-3,300	-42,900	-46,200	-3,818	-27,954	-13,376	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	13,097	-963	-80	-583	-279	2,327
24	2035/36	-3,300	-42,900	-46,200	-3,409	-27,323	-12,643	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	10,316	-8,503	-627	-5,029	-2,327	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-232,100	-1,033,077	-1,265,177	-538,895	-1,016,631	-772,681		1.4332E+10			1,464,921	448,969	1,115,836	772,681	199,744	-89,926	99,205	0	

4.4 [20% Increase in Capital Investment Cost]

Total Cost	217,200	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	24,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	**5.0%**

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	**-105**	**0.81**
At 2.3% (=WACC)	**80**	**1.08**

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	-47,844	-47,844	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-27,819	-27,819	-27,819	-27,819	-27,819
2	2013/14	-21,720	-43,500	-65,220	-58,232	-63,747	-62,094	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	11,812	-52,813	-47,155	-51,621	-50,281	-78,101
3	2014/15	-143,352	-44,739	-188,091	-149,945	-179,693	-170,491	0%	0	1.05	0.84	0	0	0	0	-188,091	-149,945	-179,693	-170,491	-248,592
4	2015/16	-47,784	-43,280	-91,064	-64,817	-85,034	-78,586	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	32,532	-53,367	-37,985	-49,833	-46,054	-294,646
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-35,295	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	61,945	32,436	20,614	29,605	26,650	-267,996
6	2017/18		-42,900	-42,900	-24,343	-38,271	-33,558	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	58,976	32,494	18,438	28,988	25,418	-242,578
7	2018/19		-42,900	-42,900	-21,734	-37,407	-31,949	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	56,149	32,494	16,463	28,333	24,200	-218,379
8	2019/20		-42,900	-42,900	-19,406	-36,562	-30,418	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	53,457	32,494	14,699	27,694	23,040	-195,339
9	2020/21		-42,900	-42,900	-17,327	-35,737	-28,960	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	50,895	32,494	13,124	27,068	21,935	-173,404
10	2021/22		-42,900	-42,900	-15,470	-34,930	-27,571	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	48,455	32,494	11,718	26,457	20,884	-152,520
11	2022/23		-42,900	-42,900	-13,813	-34,141	-26,250	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	46,132	32,494	10,462	25,860	19,883	-132,638
12	2023/24		-42,900	-42,900	-12,333	-33,370	-24,992	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	43,921	32,494	9,341	25,276	18,930	-113,708
13	2024/25		-42,900	-42,900	-11,011	-32,617	-23,794	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	41,816	32,494	8,340	24,705	18,022	-95,686
14	2025/26		-42,900	-42,900	-9,832	-31,880	-22,653	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	39,811	32,494	7,447	24,147	17,158	-78,527
15	2026/27	-3,600	-42,900	-46,500	-9,515	-33,775	-23,377	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	37,903	28,894	5,912	20,987	14,526	-64,001
16	2027/28	-3,600	-42,900	-46,500	-8,495	-33,013	-22,256	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	36,086	28,894	5,279	20,513	13,830	-50,172
17	2028/29	-3,600	-42,900	-46,500	-7,585	-32,267	-21,190	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	34,356	28,894	4,713	20,050	13,167	-37,005
18	2029/30	-3,600	-42,900	-46,500	-6,772	-31,539	-20,174	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	32,710	28,894	4,208	19,598	12,536	-24,469
19	2030/31	-3,600	-42,900	-46,500	-6,047	-30,827	-19,207	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	31,142	28,894	3,757	19,155	11,935	-12,534
20	2031/32	-3,600	-42,900	-46,500	-5,399	-30,131	-18,286	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	26,684	21,355	2,479	13,837	8,398	-4,137
21	2032/33	-3,600	-42,900	-46,500	-4,821	-29,450	-17,410	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	22,582	13,815	1,432	8,750	5,172	1,036
22	2033/34	-3,600	-42,900	-46,500	-4,304	-28,785	-16,575	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	18,812	6,276	581	3,885	2,237	3,273
23	2034/35	-3,600	-42,900	-46,500	-3,843	-28,136	-15,781	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	15,352	-1,263	-104	-764	-429	2,844
24	2035/36	-3,600	-42,900	-46,500	-3,431	-27,500	-15,024	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	12,180	-8,803	-650	-5,206	-2,844	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-253,200	-1,033,077	-1,286,277	-553,619	-1,035,863	-833,733		1.4332E+10			1,464,921	448,969	1,115,836	833,733	178,644	-104,650	79,972	0	

4.5 [12.4% less Revenue]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network		
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	1.4%

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] -131	0.75
At 2.3% (=WACC)	[mil USD] -20	0.98

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120	-47,120	30%	274,741,632	0.74		17,518	17,518	17,518	17,518	-29,602	-29,602	-29,602	-29,602	-29,602
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209	-60,729	15%	137,370,816	0.92		10,861	9,697	10,616	10,708	-50,739	-45,303	-49,593	-50,022	-79,624
3	2014/15	-119,460	-44,739	-164,199	-130,899	-156,868	-159,591	0%	0	1.05		0	0	0	0	-164,199	-130,899	-156,868	-159,591	-239,215
4	2015/16	-39,820	-43,280	-83,100	-59,149	-77,597	-79,626	40%	366,322,176	1.05		33,018	23,501	30,831	31,638	-50,082	-35,647	-46,766	-47,988	-287,204
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-40,581	80%	732,644,352	1.05		66,036	41,967	60,271	62,381	23,078	14,666	21,063	21,801	-265,403
6	2017/18		-42,900	-42,900	-24,343	-38,271	-39,953	80%	732,644,352	1.05		66,036	37,470	58,910	61,500	23,136	13,128	20,639	21,546	-243,856
7	2018/19		-42,900	-42,900	-21,734	-37,407	-39,389	80%	732,644,352	1.05		66,036	33,456	57,580	60,631	23,136	11,721	20,173	21,242	-222,615
8	2019/20		-42,900	-42,900	-19,406	-36,562	-38,832	80%	732,644,352	1.05		66,036	29,871	56,280	59,774	23,136	10,465	19,718	20,942	-201,673
9	2020/21		-42,900	-42,900	-17,327	-35,737	-38,283	80%	732,644,352	1.05		66,036	26,671	55,009	58,929	23,136	9,344	19,272	20,646	-181,027
10	2021/22		-42,900	-42,900	-15,470	-34,930	-37,742	80%	732,644,352	1.05		66,036	23,813	53,767	58,096	23,136	8,343	18,837	20,354	-160,673
11	2022/23		-42,900	-42,900	-13,813	-34,141	-37,209	80%	732,644,352	1.05		66,036	21,262	52,553	57,275	23,136	7,449	18,412	20,066	-140,607
12	2023/24		-42,900	-42,900	-12,333	-33,370	-36,683	80%	732,644,352	1.05		66,036	18,984	51,366	56,466	23,136	6,651	17,996	19,783	-120,824
13	2024/25		-42,900	-42,900	-11,011	-32,617	-36,165	80%	732,644,352	1.05		66,036	16,950	50,207	55,668	23,136	5,938	17,590	19,503	-101,321
14	2025/26		-42,900	-42,900	-9,832	-31,880	-35,654	80%	732,644,352	1.05		66,036	15,134	49,073	54,881	23,136	5,302	17,193	19,228	-82,093
15	2026/27	-3,000	-42,900	-45,900	-9,392	-33,340	-37,608	80%	732,644,352	1.05		66,036	13,512	47,965	54,106	20,136	4,120	14,625	16,498	-65,595
16	2027/28	-3,000	-42,900	-45,900	-8,386	-32,587	-37,076	80%	732,644,352	1.05		66,036	12,064	46,882	53,341	20,136	3,679	14,295	16,265	-49,330
17	2028/29	-3,000	-42,900	-45,900	-7,487	-31,851	-36,552	80%	732,644,352	1.05		66,036	10,772	45,824	52,587	20,136	3,285	13,973	16,035	-33,295
18	2029/30	-3,000	-42,900	-45,900	-6,685	-31,132	-36,036	80%	732,644,352	1.05		66,036	9,618	44,789	51,844	20,136	2,933	13,657	15,808	-17,487
19	2030/31	-3,000	-42,900	-45,900	-5,969	-30,429	-35,527	80%	732,644,352	1.05		66,036	8,587	43,778	51,111	20,136	2,618	13,349	15,585	-1,902
20	2031/32	-3,000	-42,900	-45,900	-5,329	-29,742	-35,025	72%	659,379,917	1.05		59,432	6,900	38,510	45,350	13,532	1,571	8,768	10,326	8,424
21	2032/33	-3,000	-42,900	-45,900	-4,758	-29,070	-34,530	64%	586,115,482	1.05		52,828	5,477	33,458	39,742	6,928	718	4,388	5,212	13,636
22	2033/34	-3,000	-42,900	-45,900	-4,248	-28,414	-34,042	56%	512,851,046	1.05		46,225	4,279	28,615	34,283	325	30	201	241	13,877
23	2034/35	-3,000	-42,900	-45,900	-3,793	-27,772	-33,561	48%	439,586,611	1.05		39,621	3,274	23,973	28,970	-6,279	-519	-3,799	-4,591	9,286
24	2035/36	-3,000	-42,900	-45,900	-3,387	-27,145	-33,086	40%	366,322,176	1.05		33,018	2,436	19,527	23,800	-12,882	-951	-7,619	-9,286	0
25	2036/37		0	0	0	0	0	0%	0	1.05		0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05		0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05		0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05		0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05		0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05		0	0	0	0					
		-211,000	-1,033,077	-1,244,077	-524,171	-997,398	-1,080,598		1.4332E+10			1,283,055	393,213	977,301	1,080,598	38,978	-130,958	-20,097	0	

4.6 [12.4% less Revenue] and [10% Increase in O&M Cost]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	314,600	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network		
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	-2.5%

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] -159	0.71
At 2.3% (=WACC)	[mil USD] -90	0.92

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120	-47,120	30%	274,741,632	0.74		17,518	17,518	17,518	17,518	-29,602	-29,602	-29,602	-29,602	-29,602
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209	-63,148	15%	137,370,816	0.92		10,861	9,697	10,616	11,134	-50,739	-45,303	-49,593	-52,014	-81,616
3	2014/15	-119,460	-46,884	-166,344	-132,609	-158,917	-174,809	0%	0	1.05		0	0	0	0	-166,344	-132,609	-158,917	-174,809	-256,425
4	2015/16	-39,820	-47,570	-87,390	-62,202	-81,603	-94,145	40%	366,322,176	1.05		33,018	23,501	30,831	35,570	-54,372	-38,701	-50,771	-58,575	-315,000
5	2016/17	0	-47,248	-47,248	-30,027	-43,123	-52,179	80%	732,644,352	1.05		66,036	41,967	60,271	72,928	18,788	11,940	17,148	20,749	-294,251
6	2017/18		-47,190	-47,190	-26,777	-42,098	-53,425	80%	732,644,352	1.05		66,036	37,470	58,910	74,760	18,846	10,693	16,812	21,335	-272,916
7	2018/19		-47,190	-47,190	-23,908	-41,147	-54,767	80%	732,644,352	1.05		66,036	33,456	57,580	76,639	18,846	9,548	16,432	21,872	-251,044
8	2019/20		-47,190	-47,190	-21,346	-40,218	-56,144	80%	732,644,352	1.05		66,036	29,871	56,280	78,565	18,846	8,525	16,061	22,421	-228,623
9	2020/21		-47,190	-47,190	-19,059	-39,310	-57,554	80%	732,644,352	1.05		66,036	26,671	55,009	80,539	18,846	7,611	15,699	22,985	-205,638
10	2021/22		-47,190	-47,190	-17,017	-38,423	-59,001	80%	732,644,352	1.05		66,036	23,813	53,767	82,563	18,846	6,796	15,344	23,562	-182,076
11	2022/23		-47,190	-47,190	-15,194	-37,555	-60,483	80%	732,644,352	1.05		66,036	21,262	52,553	84,638	18,846	6,068	14,998	24,154	-157,922
12	2023/24		-47,190	-47,190	-13,566	-36,707	-62,003	80%	732,644,352	1.05		66,036	18,984	51,366	86,765	18,846	5,418	14,659	24,761	-133,161
13	2024/25		-47,190	-47,190	-12,112	-35,878	-63,561	80%	732,644,352	1.05		66,036	16,950	50,207	88,945	18,846	4,837	14,328	25,384	-107,777
14	2025/26		-47,190	-47,190	-10,815	-35,068	-65,159	80%	732,644,352	1.05		66,036	15,134	49,073	91,180	18,846	4,319	14,005	26,021	-81,756
15	2026/27	-3,000	-47,190	-50,190	-10,270	-36,456	-71,042	80%	732,644,352	1.05		66,036	13,512	47,965	93,471	15,846	3,242	11,509	22,429	-59,327
16	2027/28	-3,000	-47,190	-50,190	-9,170	-35,632	-72,828	80%	732,644,352	1.05		66,036	12,064	46,882	95,820	15,846	2,895	11,250	22,992	-36,334
17	2028/29	-3,000	-47,190	-50,190	-8,187	-34,828	-74,658	80%	732,644,352	1.05		66,036	10,772	45,824	98,228	15,846	2,585	10,996	23,570	-12,764
18	2029/30	-3,000	-47,190	-50,190	-7,310	-34,042	-76,534	80%	732,644,352	1.05		66,036	9,618	44,789	100,696	15,846	2,308	10,747	24,163	11,399
19	2030/31	-3,000	-47,190	-50,190	-6,527	-33,273	-78,457	80%	732,644,352	1.05		66,036	8,587	43,778	103,227	15,846	2,061	10,505	24,770	36,168
20	2031/32	-3,000	-47,190	-50,190	-5,827	-32,522	-80,428	72%	659,379,917	1.05		59,432	6,900	38,510	95,239	9,242	1,073	5,989	14,810	50,978
21	2032/33	-3,000	-47,190	-50,190	-5,203	-31,787	-82,450	64%	586,115,482	1.05		52,828	5,477	33,458	86,784	2,638	274	1,671	4,334	55,313
22	2033/34	-3,000	-47,190	-50,190	-4,646	-31,070	-84,521	56%	512,851,046	1.05		46,225	4,279	28,615	77,844	-3,965	-367	-2,455	-6,677	48,635
23	2034/35	-3,000	-47,190	-50,190	-4,148	-30,368	-86,645	48%	439,586,611	1.05		39,621	3,274	23,973	68,400	-10,569	-873	-6,395	-18,245	30,390
24	2035/36	-3,000	-47,190	-50,190	-3,703	-29,683	-88,823	40%	366,322,176	1.05		33,018	2,436	19,527	58,433	-17,172	-1,267	-10,156	-30,390	0
25	2036/37		0	0	0	0	0	0%	0	1.05		0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05		0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05		0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05		0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05		0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05		0	0	0	0					
		-211,000	-1,125,312	-1,336,312	-551,743	-1,067,038	-1,759,884		1.4332E+10			1,283,055	393,213	977,301	1,759,884	-53,257	-158,530	-89,737	0	

4.7 [12.4% less Revenue] and [20% Increase in O&M Cost]

Total Cost	181,000	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	343,200	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost	
2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network		
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	Not computable

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] -186	0.68
At 2.3% (=WACC)	[mil USD] -159	0.86

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,620	-43,500	-47,120	-47,120	-47,120		30%	274,741,632	0.74		17,518	17,518	17,518		-29,602	-29,602	-29,602		
2	2013/14	-18,100	-43,500	-61,600	-55,000	-60,209		15%	137,370,816	0.92		10,861	9,697	10,616		-50,739	-45,303	-49,593		
3	2014/15	-119,460	-49,029	-168,489	-134,319	-160,967		0%	0	1.05		0	0	0		-168,489	-134,319	-160,967		
4	2015/16	-39,820	-51,860	-91,680	-65,256	-85,609		40%	366,322,176	1.05		33,018	23,501	30,831		-58,662	-41,754	-54,777		
5	2016/17	0	-51,538	-51,538	-32,753	-47,038		80%	732,644,352	1.05		66,036	41,967	60,271		14,498	9,214	13,232		
6	2017/18		-51,480	-51,480	-29,211	-45,925		80%	732,644,352	1.05		66,036	37,470	58,910		14,556	8,259	12,985		
7	2018/19		-51,480	-51,480	-26,081	-44,888		80%	732,644,352	1.05		66,036	33,456	57,580		14,556	7,374	12,692		
8	2019/20		-51,480	-51,480	-23,287	-43,874		80%	732,644,352	1.05		66,036	29,871	56,280		14,556	6,584	12,405		
9	2020/21		-51,480	-51,480	-20,792	-42,884		80%	732,644,352	1.05		66,036	26,671	55,009		14,556	5,879	12,125		
10	2021/22		-51,480	-51,480	-18,564	-41,916		80%	732,644,352	1.05		66,036	23,813	53,767		14,556	5,249	11,851		
11	2022/23		-51,480	-51,480	-16,575	-40,969		80%	732,644,352	1.05		66,036	21,262	52,553		14,556	4,687	11,584		
12	2023/24		-51,480	-51,480	-14,799	-40,044		80%	732,644,352	1.05		66,036	18,984	51,366		14,556	4,184	11,322		
13	2024/25		-51,480	-51,480	-13,214	-39,140		80%	732,644,352	1.05		66,036	16,950	50,207		14,556	3,736	11,067		
14	2025/26		-51,480	-51,480	-11,798	-38,256		80%	732,644,352	1.05		66,036	15,134	49,073		14,556	3,336	10,817		
15	2026/27	-3,000	-51,480	-54,480	-11,148	-39,572		80%	732,644,352	1.05		66,036	13,512	47,965		11,556	2,364	8,393		
16	2027/28	-3,000	-51,480	-54,480	-9,953	-38,678		80%	732,644,352	1.05		66,036	12,064	46,882		11,556	2,111	8,204		
17	2028/29	-3,000	-51,480	-54,480	-8,887	-37,805		80%	732,644,352	1.05		66,036	10,772	45,824		11,556	1,885	8,019		
18	2029/30	-3,000	-51,480	-54,480	-7,935	-36,951		80%	732,644,352	1.05		66,036	9,618	44,789		11,556	1,683	7,838		
19	2030/31	-3,000	-51,480	-54,480	-7,085	-36,117		80%	732,644,352	1.05		66,036	8,587	43,778		11,556	1,503	7,661		
20	2031/32	-3,000	-51,480	-54,480	-6,325	-35,302		72%	659,379,917	1.05		59,432	6,900	38,510		4,952	575	3,209		
21	2032/33	-3,000	-51,480	-54,480	-5,648	-34,504		64%	586,115,482	1.05		52,828	5,477	33,458		-1,652	-171	-1,046		
22	2033/34	-3,000	-51,480	-54,480	-5,043	-33,725		56%	512,851,046	1.05		46,225	4,279	28,615		-8,255	-764	-5,110		
23	2034/35	-3,000	-51,480	-54,480	-4,502	-32,964		48%	439,586,611	1.05		39,621	3,274	23,973		-14,859	-1,228	-8,990		
24	2035/36	-3,000	-51,480	-54,480	-4,020	-32,220		40%	366,322,176	1.05		33,018	2,436	19,527		-21,462	-1,584	-12,693		
25	2036/37		0	0	0	0		0%	0	1.05		0	0	0						
26	2037/38		0	0	0	0		0%	0	1.05		0	0	0						
27	2038/39		0	0	0	0		0%	0	1.05		0	0	0						
28	2039/40		0	0	0	0		0%	0	1.05		0	0	0						
29	2040/41		0	0	0	0		0%	0	1.05		0	0	0						
30	2041/42		0	0	0	0		0%	0	1.05		0	0	0						
		-211,000	-1,217,547	-1,428,547	-579,314	-1,136,678			1.4332E+10			1,283,055	393,213	977,301		-145,492	-186,102	-159,377		

4.8 [12.4% less Revenue] and [10% Increase in Capital Investment Cost]

Total Cost	199,100 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	66%
O&M Expenditure	286,000 K BWP	2015/16	22%
Additional Capital Expenditure	22,000 K BWP	2016/17	0%
			100%

Percentage: Sales to Domestic Market	85%
Percentage: Sales to SAPP Network	
Foreign Exchange	0.15 USD/BWP
Revenue Attributable to Power Generation	68%

Referential Cost of Capital	12%
WACC	2.3%
FIRR	0.6%

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] -146	0.73
At 2.3% (=WACC)	[mil USD] -39	0.96

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,982	-43,500	-47,482	-47,482	-47,482	-47,482	30%	274,741,632	0.74		17,518	17,518	17,518	17,518	-29,964	-29,964	-29,964	-29,964	-29,964
2	2013/14	-19,910	-43,500	-63,410	-56,616	-61,978	-63,006	15%	137,370,816	0.92		10,861	9,697	10,616	10,792	-52,549	-46,919	-51,362	-52,214	-82,178
3	2014/15	-131,406	-44,739	-176,145	-140,422	-168,281	-173,908	0%	0	1.05		0	0	0	0	-176,145	-140,422	-168,281	-173,908	-256,086
4	2015/16	-43,802	-43,280	-87,082	-61,983	-81,315	-85,428	40%	366,322,176	1.05		33,018	23,501	30,831	32,391	-54,064	-38,482	-50,484	-53,037	-309,124
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-41,874	80%	732,644,352	1.05		66,036	41,967	60,271	64,369	23,078	14,666	21,063	22,495	-286,628
6	2017/18		-42,900	-42,900	-24,343	-38,271	-41,551	80%	732,644,352	1.05		66,036	37,470	58,910	63,959	23,136	13,128	20,639	22,408	-264,220
7	2018/19		-42,900	-42,900	-21,734	-37,407	-41,286	80%	732,644,352	1.05		66,036	33,456	57,580	63,551	23,136	11,721	20,173	22,265	-241,955
8	2019/20		-42,900	-42,900	-19,406	-36,562	-41,023	80%	732,644,352	1.05		66,036	29,871	56,280	63,147	23,136	10,465	19,718	22,123	-219,832
9	2020/21		-42,900	-42,900	-17,327	-35,737	-40,762	80%	732,644,352	1.05		66,036	26,671	55,009	62,744	23,136	9,344	19,272	21,982	-197,849
10	2021/22		-42,900	-42,900	-15,470	-34,930	-40,502	80%	732,644,352	1.05		66,036	23,813	53,767	62,345	23,136	8,343	18,837	21,842	-176,007
11	2022/23		-42,900	-42,900	-13,813	-34,141	-40,244	80%	732,644,352	1.05		66,036	21,262	52,553	61,947	23,136	7,449	18,412	21,703	-154,303
12	2023/24		-42,900	-42,900	-12,333	-33,370	-39,988	80%	732,644,352	1.05		66,036	18,984	51,366	61,553	23,136	6,651	17,996	21,565	-132,738
13	2024/25		-42,900	-42,900	-11,011	-32,617	-39,733	80%	732,644,352	1.05		66,036	16,950	50,207	61,161	23,136	5,938	17,590	21,428	-111,311
14	2025/26		-42,900	-42,900	-9,832	-31,880	-39,480	80%	732,644,352	1.05		66,036	15,134	49,073	60,771	23,136	5,302	17,193	21,291	-90,020
15	2026/27	-3,300	-42,900	-46,200	-9,453	-33,557	-42,246	80%	732,644,352	1.05		66,036	13,512	47,965	60,384	19,836	4,059	14,408	18,138	-71,882
16	2027/28	-3,300	-42,900	-46,200	-8,441	-32,800	-41,977	80%	732,644,352	1.05		66,036	12,064	46,882	59,999	19,836	3,624	14,082	18,022	-53,859
17	2028/29	-3,300	-42,900	-46,200	-7,536	-32,059	-41,709	80%	732,644,352	1.05		66,036	10,772	45,824	59,617	19,836	3,236	13,764	17,908	-35,952
18	2029/30	-3,300	-42,900	-46,200	-6,729	-31,335	-41,444	80%	732,644,352	1.05		66,036	9,618	44,789	59,237	19,836	2,889	13,454	17,794	-18,158
19	2030/31	-3,300	-42,900	-46,200	-6,008	-30,628	-41,180	80%	732,644,352	1.05		66,036	8,587	43,778	58,860	19,836	2,579	13,150	17,680	-478
20	2031/32	-3,300	-42,900	-46,200	-5,364	-29,936	-40,917	72%	659,379,917	1.05		59,432	6,900	38,510	52,636	13,232	1,536	8,574	11,719	11,241
21	2032/33	-3,300	-42,900	-46,200	-4,789	-29,260	-40,657	64%	586,115,482	1.05		52,828	5,477	33,458	46,490	6,628	687	4,198	5,833	17,074
22	2033/34	-3,300	-42,900	-46,200	-4,276	-28,600	-40,398	56%	512,851,046	1.05		46,225	4,279	28,615	40,420	25	2	15	22	17,096
23	2034/35	-3,300	-42,900	-46,200	-3,818	-27,954	-40,140	48%	439,586,611	1.05		39,621	3,274	23,973	34,425	-6,579	-544	-3,981	-5,716	11,380
24	2035/36	-3,300	-42,900	-46,200	-3,409	-27,323	-39,885	40%	366,322,176	1.05		33,018	2,436	19,527	28,504	-13,182	-973	-7,796	-11,380	-0
25	2036/37		0	0	0	0	0	0%	0	1.05		0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05		0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05		0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05		0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05		0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05		0	0	0	0					
		-232,100	-1,033,077	-1,265,177	-538,895	-1,016,631	-1,186,820		1.4332E+10			1,283,055	393,213	977,301	1,186,820	17,878	-145,682	-39,330	-0	

4.9 [12.4% less Revenue] and [20% Increase in Capital Investment Cost]

Total Cost	217,200 K USD	Distribution of Initial Capital Expenditure Cost	
Maximum Output	132,000 kW	2012/13	2%
Internal Usage Rate	12%	2013/14	10%
System Loss Rate	10%	2014/15	66%
O&M Expenditure	286,000 K BWP	2015/16	22%
Additional Capital Expenditure	24,000 K BWP	2016/17	0%
			100%

Percentage: Sales to Domestic Market	85%
Percentage: Sales to SAPP Network	
Foreign Exchange	0.15 USD/BWP
Revenue Attributable to Power Generation	68%

Referential Cost of Capital	12%
WACC	2.3%
FIRR	-0.1%

	NPV	CBR
At 12% (=Referential cost of capital)	[mil USD] -160	0.71
At 2.3% (=WACC)	[mil USD] -59	0.94

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-4,344	-43,500	-47,844	-47,844	-47,844	-47,844	30%	274,741,632	0.74		17,518	17,518	17,518	17,518	-30,326	-30,326	-30,326	-30,326	-30,326
2	2013/14	-21,720	-43,500	-65,220	-58,232	-63,747	-65,294	15%	137,370,816	0.92		10,861	9,697	10,616	10,873	-54,359	-48,535	-53,132	-54,420	-84,746
3	2014/15	-143,352	-44,739	-188,091	-149,945	-179,693	-188,517	0%	0	1.05		0	0	0	0	-188,091	-149,945	-179,693	-188,517	-273,263
4	2015/16	-47,784	-43,280	-91,064	-64,817	-85,034	-91,373	40%	366,322,176	1.05		33,018	23,501	30,831	33,130	-58,046	-41,316	-54,202	-58,243	-331,506
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-43,152	80%	732,644,352	1.05		66,036	41,967	60,271	66,335	23,078	14,666	21,063	23,182	-308,324
6	2017/18		-42,900	-42,900	-24,343	-38,271	-43,143	80%	732,644,352	1.05		66,036	37,470	58,910	66,410	23,136	13,128	20,639	23,267	-285,057
7	2018/19		-42,900	-42,900	-21,734	-37,407	-43,192	80%	732,644,352	1.05		66,036	33,456	57,580	66,485	23,136	11,721	20,173	23,293	-261,764
8	2019/20		-42,900	-42,900	-19,406	-36,562	-43,241	80%	732,644,352	1.05		66,036	29,871	56,280	66,560	23,136	10,465	19,718	23,319	-238,445
9	2020/21		-42,900	-42,900	-17,327	-35,737	-43,289	80%	732,644,352	1.05		66,036	26,671	55,009	66,635	23,136	9,344	19,272	23,346	-215,099
10	2021/22		-42,900	-42,900	-15,470	-34,930	-43,338	80%	732,644,352	1.05		66,036	23,813	53,767	66,710	23,136	8,343	18,837	23,372	-191,727
11	2022/23		-42,900	-42,900	-13,813	-34,141	-43,387	80%	732,644,352	1.05		66,036	21,262	52,553	66,786	23,136	7,449	18,412	23,398	-168,329
12	2023/24		-42,900	-42,900	-12,333	-33,370	-43,436	80%	732,644,352	1.05		66,036	18,984	51,366	66,861	23,136	6,651	17,996	23,425	-144,904
13	2024/25		-42,900	-42,900	-11,011	-32,617	-43,486	80%	732,644,352	1.05		66,036	16,950	50,207	66,937	23,136	5,938	17,590	23,451	-121,453
14	2025/26		-42,900	-42,900	-9,832	-31,880	-43,535	80%	732,644,352	1.05		66,036	15,134	49,073	67,013	23,136	5,302	17,193	23,478	-97,975
15	2026/27	-3,600	-42,900	-46,500	-9,515	-33,775	-47,241	80%	732,644,352	1.05		66,036	13,512	47,965	67,088	19,536	3,997	14,190	19,847	-78,128
16	2027/28	-3,600	-42,900	-46,500	-8,495	-33,013	-47,295	80%	732,644,352	1.05		66,036	12,064	46,882	67,164	19,536	3,569	13,869	19,869	-58,258
17	2028/29	-3,600	-42,900	-46,500	-7,585	-32,267	-47,348	80%	732,644,352	1.05		66,036	10,772	45,824	67,240	19,536	3,187	13,556	19,892	-38,366
18	2029/30	-3,600	-42,900	-46,500	-6,772	-31,539	-47,402	80%	732,644,352	1.05		66,036	9,618	44,789	67,316	19,536	2,845	13,250	19,914	-18,452
19	2030/31	-3,600	-42,900	-46,500	-6,047	-30,827	-47,455	80%	732,644,352	1.05		66,036	8,587	43,778	67,392	19,536	2,540	12,951	19,937	1,485
20	2031/32	-3,600	-42,900	-46,500	-5,399	-30,131	-47,509	72%	659,379,917	1.05		59,432	6,900	38,510	60,722	12,932	1,501	8,380	13,213	14,698
21	2032/33	-3,600	-42,900	-46,500	-4,821	-29,450	-47,563	64%	586,115,482	1.05		52,828	5,477	33,458	54,036	6,328	656	4,008	6,473	21,171
22	2033/34	-3,600	-42,900	-46,500	-4,304	-28,785	-47,616	56%	512,851,046	1.05		46,225	4,279	28,615	47,335	-275	-25	-170	-282	20,889
23	2034/35	-3,600	-42,900	-46,500	-3,843	-28,136	-47,670	48%	439,586,611	1.05		39,621	3,274	23,973	40,618	-6,879	-568	-4,162	-7,052	13,837
24	2035/36	-3,600	-42,900	-46,500	-3,431	-27,500	-47,724	40%	366,322,176	1.05		33,018	2,436	19,527	33,887	-13,482	-995	-7,973	-13,837	-0
25	2036/37		0	0	0	0	0	0%	0	1.05		0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05		0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05		0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05		0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05		0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05		0	0	0	0					
		-253,200	-1,033,077	-1,286,277	-553,619	-1,035,863	-1,301,051		1.4332E+10			1,283,055	393,213	977,301	1,301,051	-3,222	-160,406	-58,562	-0	

4.10 [Case Utilizing Existing ESP with Wet Type FGD]

Total Cost	166,300	K USD	
Maximum Output	132,000	kW	
Internal Usage Rate	12%		
System Loss Rate	10%		
O&M Expenditure	286,000	K BWP	
Additional Capital Expenditure	20,000	K BWP	

Distribution of Initial Capital Expenditure Cost

2012/13	2%
2013/14	10%
2014/15	66%
2015/16	22%
2016/17	0%
	100%

Percentage: Sales to Domestic Market	85%	
Percentage: Sales to SAPP Network	15%	
Foreign Exchange	0.15	USD/BWP
Revenue Attributable to Power Generation	68%	

Referential Cost of Capital	12%
WACC	2.3%
FIRR	**7.3%**

	NPV [mil USD]	CBR
At 12% (=Referential cost of capital)	**-64**	**0.88**
At 2.3% (=WACC)	**132**	**1.13**

FY		Expenditure								Revenue						Cash Flow				
		Capital Expenditure	O&M Expenditure	Expenditure at Current Price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Availability Rate	Generation	Domestic Market Sales	SAPP Network Sales	Revenue at Current price	Discounted at 12%	Discounted at 2.3%	Discounted at FIRR	Current Cash Flow	DCF at 12%	DCF at 2.3%	DCF at FIRR	Cash Accumulation at FIRR
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[%]	[kWh]	[BWP/kWh]	[BWP/kWh]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,326	-43,500	-46,826	-46,826	-46,826	-46,826	30%	274,741,632	0.74	0.60	20,025	20,025	20,025	20,025	-26,801	-26,801	-26,801	-26,801	-26,801
2	2013/14	-16,630	-43,500	-60,130	-53,688	-58,772	-56,049	15%	137,370,816	0.92	0.74	12,407	11,078	12,127	11,565	-47,723	-42,610	-46,646	-44,484	-71,286
3	2014/15	-109,758	-44,739	-154,497	-123,164	-147,599	-134,239	0%	0	1.05	0.84	0	0	0	0	-154,497	-123,164	-147,599	-134,239	-205,524
4	2015/16	-36,586	-43,280	-79,866	-56,847	-74,577	-64,684	40%	366,322,176	1.05	0.84	37,697	26,832	35,201	30,531	-42,169	-30,015	-39,376	-34,153	-239,677
5	2016/17	0	-42,958	-42,958	-27,300	-39,208	-32,431	80%	732,644,352	1.05	0.84	75,394	47,914	68,812	56,918	32,436	20,614	29,605	24,488	-215,189
6	2017/18		-42,900	-42,900	-24,343	-38,271	-30,189	80%	732,644,352	1.05	0.84	75,394	42,781	67,259	53,056	32,494	18,438	28,988	22,866	-192,323
7	2018/19		-42,900	-42,900	-21,734	-37,407	-28,140	80%	732,644,352	1.05	0.84	75,394	38,197	65,740	49,455	32,494	16,463	28,333	21,315	-171,008
8	2019/20		-42,900	-42,900	-19,406	-36,562	-26,231	80%	732,644,352	1.05	0.84	75,394	34,104	64,256	46,099	32,494	14,699	27,694	19,868	-151,140
9	2020/21		-42,900	-42,900	-17,327	-35,737	-24,451	80%	732,644,352	1.05	0.84	75,394	30,450	62,805	42,970	32,494	13,124	27,068	18,520	-132,620
10	2021/22		-42,900	-42,900	-15,470	-34,930	-22,791	80%	732,644,352	1.05	0.84	75,394	27,188	61,387	40,054	32,494	11,718	26,457	17,263	-115,357
11	2022/23		-42,900	-42,900	-13,813	-34,141	-21,244	80%	732,644,352	1.05	0.84	75,394	24,275	60,001	37,336	32,494	10,462	25,860	16,091	-99,266
12	2023/24		-42,900	-42,900	-12,333	-33,370	-19,803	80%	732,644,352	1.05	0.84	75,394	21,674	58,646	34,802	32,494	9,341	25,276	14,999	-84,267
13	2024/25		-42,900	-42,900	-11,011	-32,617	-18,459	80%	732,644,352	1.05	0.84	75,394	19,352	57,322	32,440	32,494	8,340	24,705	13,981	-70,285
14	2025/26		-42,900	-42,900	-9,832	-31,880	-17,206	80%	732,644,352	1.05	0.84	75,394	17,278	56,028	30,239	32,494	7,447	24,147	13,033	-57,253
15	2026/27	-3,000	-42,900	-45,900	-9,392	-33,340	-17,160	80%	732,644,352	1.05	0.84	75,394	15,427	54,763	28,187	29,494	6,035	21,423	11,027	-46,226
16	2027/28	-3,000	-42,900	-45,900	-8,386	-32,587	-15,995	80%	732,644,352	1.05	0.84	75,394	13,774	53,526	26,274	29,494	5,388	20,939	10,278	-35,948
17	2028/29	-3,000	-42,900	-45,900	-7,487	-31,851	-14,910	80%	732,644,352	1.05	0.84	75,394	12,298	52,318	24,491	29,494	4,811	20,467	9,581	-26,367
18	2029/30	-3,000	-42,900	-45,900	-6,685	-31,132	-13,898	80%	732,644,352	1.05	0.84	75,394	10,981	51,136	22,829	29,494	4,296	20,005	8,931	-17,437
19	2030/31	-3,000	-42,900	-45,900	-5,969	-30,429	-12,955	80%	732,644,352	1.05	0.84	75,394	9,804	49,982	21,279	29,494	3,835	19,553	8,324	-9,112
20	2031/32	-3,000	-42,900	-45,900	-5,329	-29,742	-12,076	72%	659,379,917	1.05	0.84	67,855	7,878	43,968	17,852	21,955	2,549	14,226	5,776	-3,336
21	2032/33	-3,000	-42,900	-45,900	-4,758	-29,070	-11,256	64%	586,115,482	1.05	0.84	60,315	6,253	38,200	14,791	14,415	1,494	9,130	3,535	199
22	2033/34	-3,000	-42,900	-45,900	-4,248	-28,414	-10,492	56%	512,851,046	1.05	0.84	52,776	4,885	32,671	12,064	6,876	636	4,256	1,572	1,771
23	2034/35	-3,000	-42,900	-45,900	-3,793	-27,772	-9,780	48%	439,586,611	1.05	0.84	45,237	3,738	27,371	9,639	-663	-55	-401	-141	1,629
24	2035/36	-3,000	-42,900	-45,900	-3,387	-27,145	-9,116	40%	366,322,176	1.05	0.84	37,697	2,782	22,294	7,487	-8,203	-605	-4,851	-1,629	0
25	2036/37		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
26	2037/38		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
27	2038/39		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
28	2039/40		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
29	2040/41		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
30	2041/42		0	0	0	0	0	0%	0	1.05	0.84	0	0	0	0					
		-196,300	-1,033,077	-1,229,377	-512,528	-983,379	-670,381		1.4332E+10			1,464,921	448,969	1,115,836	670,381	235,544	-63,559	132,457	0	

5. Debt Repayment Simulation

5.1 Scenarios 1 and 2a

Scenario 1 (Small-Scale Rehabilitation)

Financed by ODA Loan

Total Initial Investment	134,000	K USD
ODA Loan Amount	134,000	K USD
ODA Loan Interest rate	0.6%	
ODA Loan Grace Period	5	Years
ODA Loan Repayment Thereafter	10	Years
Debt Commercially Procured (Bond)	0	K USD

Financed by Commercially Procured Debt (Bonds)

Total Initial Investment	134,000	K USD
ODA Loan Amount		K USD
Debt Commercially Procured (Bor	134,000	K USD
Bond Expected Yield / Coupon Ra	12%	
Bond Maturity	15	Years

Scenario 2a (Large-scale rehabilitation [phased])

Financed by ODA Loan

Total Initial Investment	197,000	K USD
ODA Loan Amount	197,000	K USD
ODA Loan Interest rate	0.6%	
ODA Loan Grace Period	5	Years
ODA Loan Repayment Thereafter	10	Years
Debt Commercially Procured (Bond)	0	K USD

Financed by Commercially Procured Debt (Bonds)

Total Initial Investment	197,000	K USD
ODA Loan Amount		K USD
Debt Commercially Procured (Bor	197,000	K USD
Bond Expected Yield / Coupon Ra	12%	
Bond Maturity	15	Years

	FY	Initial Investment	ODA Loan					Debt Commercially Procured (Bond)				
			Balance		Repayment			Balance		Repayment		
			Outstanding	Interest Payable	Total	Principal	Interest	Face value Issued	Interest Payable	Total	Face Value	Interest
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-2,680	2,680	0	0		0	2,680	322	-322		-322
2	2013/14	-13,400	16,080	16	-16		-16	16,080	1,930	-1,930		-1,930
3	2014/15	-52,260	68,340	96	-96		-96	68,340	8,201	-8,201		-8,201
4	2015/16	-65,660	134,000	410	-410		-410	134,000	16,080	-16,080		-16,080
5	2016/17	0	134,000	804	-804		-804	134,000	16,080	-16,080		-16,080
6	2017/18		120,958	804	-13,846	-13,042	-804	134,000	16,080	-16,080		-16,080
7	2018/19		107,837	726	-13,846	-13,120	-726	134,000	16,080	-16,080		-16,080
8	2019/20		94,638	647	-13,846	-13,199	-647	134,000	16,080	-16,080		-16,080
9	2020/21		81,360	568	-13,846	-13,278	-568	134,000	16,080	-16,080		-16,080
10	2021/22		68,002	488	-13,846	-13,358	-488	134,000	16,080	-16,080		-16,080
11	2022/23		54,564	408	-13,846	-13,438	-408	134,000	16,080	-16,080		-16,080
12	2023/24		41,045	327	-13,846	-13,519	-327	134,000	16,080	-16,080		-16,080
13	2024/25		27,445	246	-13,846	-13,600	-246	134,000	16,080	-16,080		-16,080
14	2025/26		13,764	165	-13,846	-13,681	-165	134,000	16,080	-16,080		-16,080
15	2026/27		0	83	-13,846	-13,764	-83	134,000	16,080	-16,080		-16,080
16	2027/28							0	0	-134,000	-134,000	0
17	2028/29											
18	2029/30											
19	2030/31											
20	2031/32											
21	2032/33											
22	2033/34											
23	2034/35											
24	2035/36											
25	2036/37											
26	2037/38											
27	2038/39											
28	2039/40											
29	2040/41											
30	2041/42											
		-134,000		5,788	-139,788	-134,000	-5,788		203,412	-337,412	-134,000	-203,412

	FY	Initial Investment	ODA Loan					Debt Commercially Procured (Bond)				
			Balance		Repayment			Balance		Repayment		
			Outstanding	Interest Payable	Total	Principal	Interest	Face value Issued	Interest Payable	Total	Face Value	Interest
		[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]	[K USD]
1	2012/13	-3,940	3,940	0	0		0	3,940	473	-473		-473
2	2013/14	-19,700	23,640	24	-24		-24	23,640	2,837	-2,837		-2,837
3	2014/15	-63,040	86,680	142	-142		-142	86,680	10,402	-10,402		-10,402
4	2015/16	-76,830	163,510	520	-520		-520	163,510	19,621	-19,621		-19,621
5	2016/17	-33,490	197,000	981	-981		-981	197,000	23,640	-23,640		-23,640
6	2017/18		177,826	1,182	-20,356	-19,174	-1,182	197,000	23,640	-23,640		-23,640
7	2018/19		158,537	1,067	-20,356	-19,289	-1,067	197,000	23,640	-23,640		-23,640
8	2019/20		139,132	951	-20,356	-19,405	-951	197,000	23,640	-23,640		-23,640
9	2020/21		119,611	835	-20,356	-19,521	-835	197,000	23,640	-23,640		-23,640
10	2021/22		99,973	718	-20,356	-19,638	-718	197,000	23,640	-23,640		-23,640
11	2022/23		80,217	600	-20,356	-19,756	-600	197,000	23,640	-23,640		-23,640
12	2023/24		60,342	481	-20,356	-19,875	-481	197,000	23,640	-23,640		-23,640
13	2024/25		40,348	362	-20,356	-19,994	-362	197,000	23,640	-23,640		-23,640
14	2025/26		20,235	242	-20,356	-20,114	-242	197,000	23,640	-23,640		-23,640
15	2026/27		0	121	-20,356	-20,235	-121	197,000	23,640	-23,640		-23,640
16	2027/28							0	0	-197,000	-197,000	0
17	2028/29											
18	2029/30											
19	2030/31											
20	2031/32											
21	2032/33											
22	2033/34											
23	2034/35											
24	2035/36											
25	2036/37											
26	2037/38											
27	2038/39											
28	2039/40											
29	2040/41											
30	2041/42											
		-197,000		8,226	-205,226	-197,000	-8,226		293,372	-490,372	-197,000	-293,372

5.2 Scenarios 2b and 3

Scenario 2b (Large-scale rehabilitation [simultaneous])

Financed by ODA Loan

Total Initial Investment	181,000	K USD
ODA Loan Amount	181,000	K USD
ODA Loan Interest rate	0.6%	
ODA Loan Grace Period	5	Years
ODA Loan Repayment Thereafter	10	Years
Debt Commercially Procured (Bond)	0	K USD

Financed by Commercially Procured Debt (Bonds)

Total Initial Investment	181,000	K USD
ODA Loan Amount		K USD
Debt Commercially Procured (Bor	181,000	K USD
Bond Expected Yield / Coupon Ra	12%	
Bond Maturity	15	Years

Scenario 3 (New Installation of a Power Station of Equivalent Capacity)

Financed by ODA Loan

Total Initial Investment	336,000	K USD
ODA Loan Amount	336,000	K USD
ODA Loan Interest rate	0.6%	
ODA Loan Grace Period	5	Years
ODA Loan Repayment Thereafter	10	Years
Debt Commercially Procured (Bond)	0	K USD

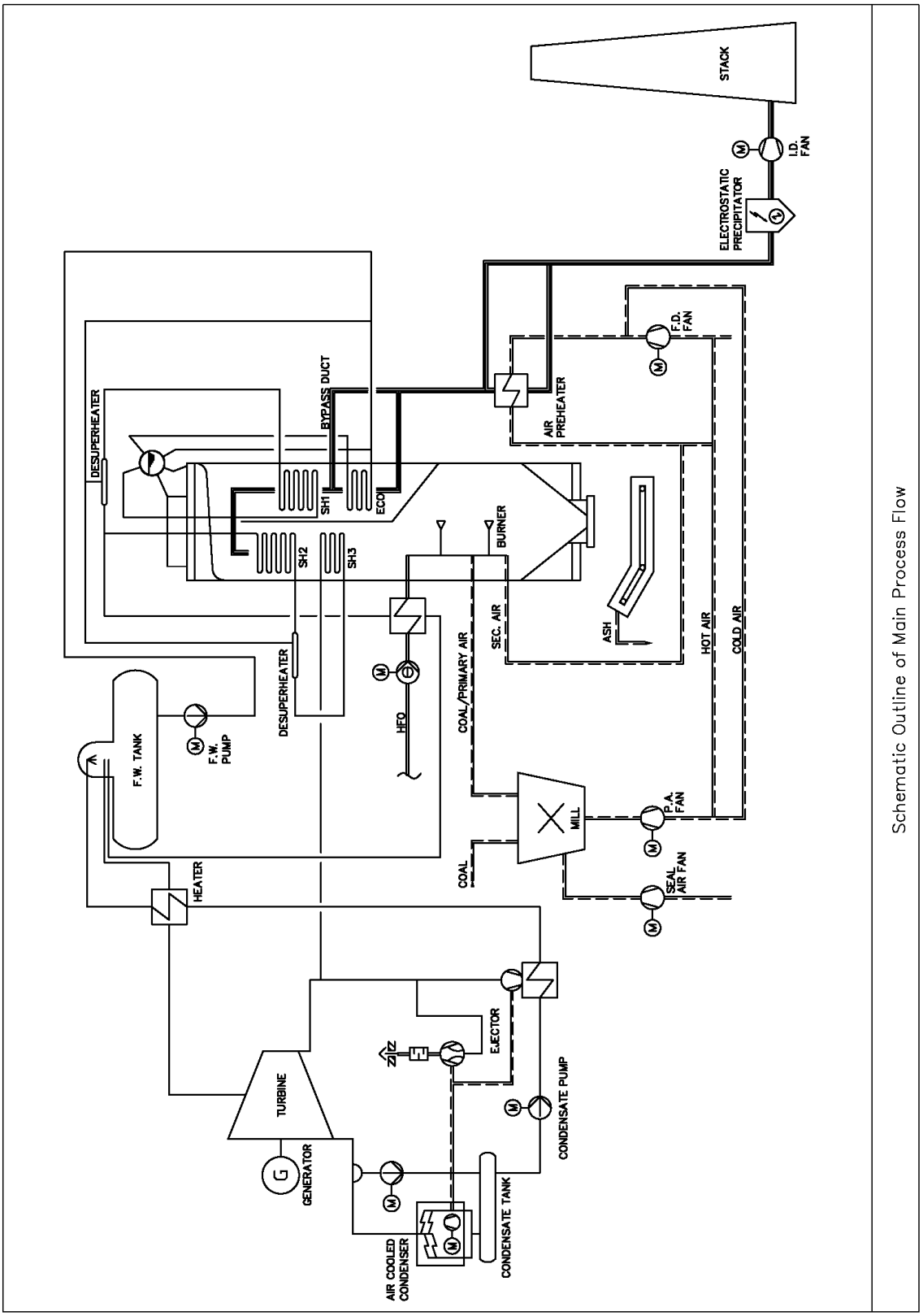
Financed by Commercially Procured Debt (Bonds)

Total Initial Investment	336,000	K USD
ODA Loan Amount		K USD
Debt Commercially Procured (Bor	336,000	K USD
Bond Expected Yield / Coupon Ra	12%	
Bond Maturity	15	Years

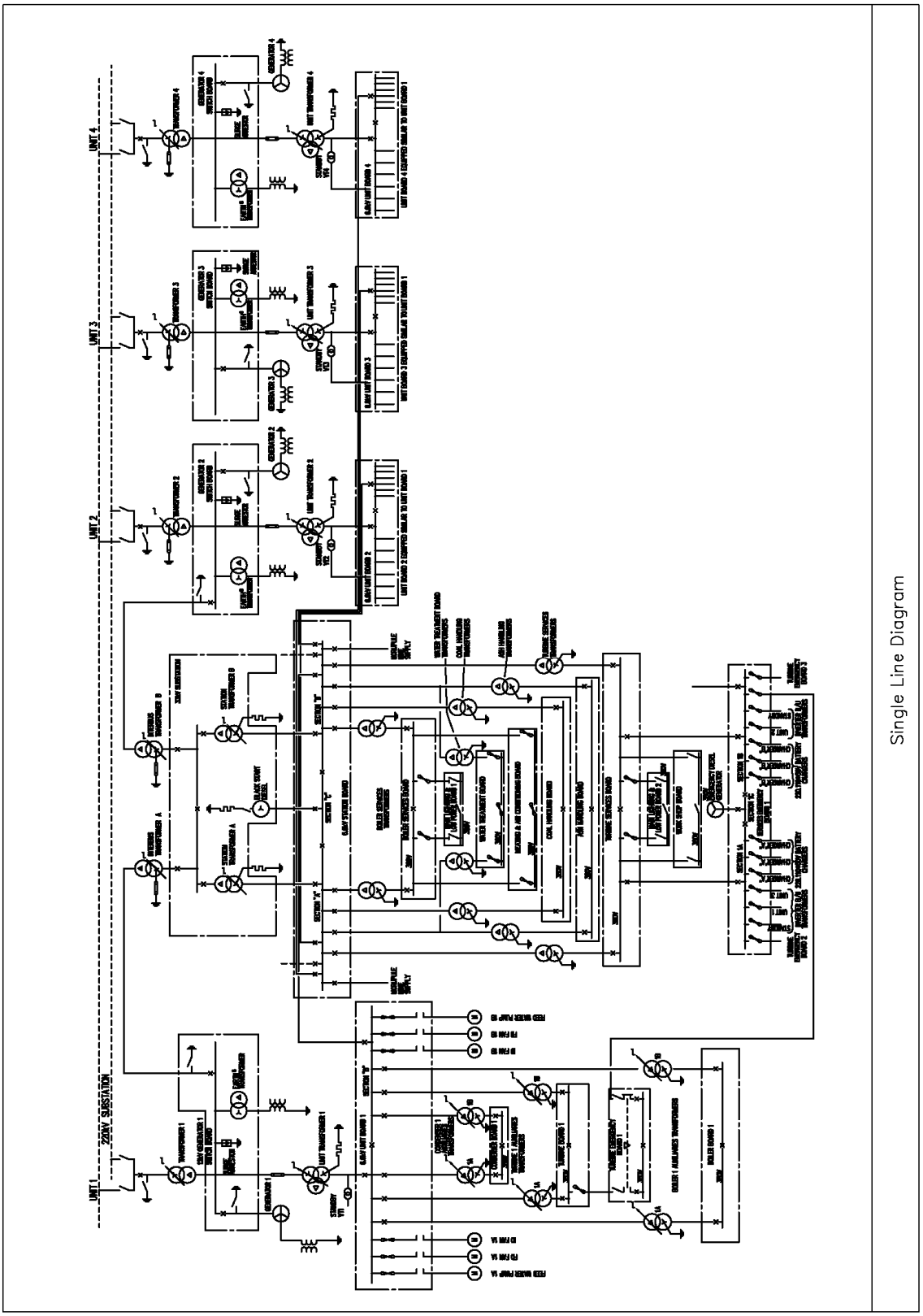
FY		Scenario 2b: ODA Loan Initial Investment [K USD]	ODA Loan Balance Outstanding [K USD]	ODA Loan Balance Interest Payable [K USD]	ODA Loan Repayment Total [K USD]	ODA Loan Repayment Principal [K USD]	ODA Loan Repayment Interest [K USD]	Debt Commercially Procured (Bond) Balance Face value Issued [K USD]	Debt Commercially Procured (Bond) Balance Interest Payable [K USD]	Debt Commercially Procured (Bond) Repayment Total [K USD]	Debt Commercially Procured (Bond) Repayment Face Value [K USD]	Debt Commercially Procured (Bond) Repayment Interest [K USD]	Scenario 3: ODA Loan Initial Investment [K USD]	ODA Loan Balance Outstanding [K USD]	ODA Loan Balance Interest Payable [K USD]	ODA Loan Repayment Total [K USD]	ODA Loan Repayment Principal [K USD]	ODA Loan Repayment Interest [K USD]	Debt Commercially Procured (Bond) Balance Face value Issued [K USD]	Debt Commercially Procured (Bond) Balance Interest Payable [K USD]	Debt Commercially Procured (Bond) Repayment Total [K USD]	Debt Commercially Procured (Bond) Repayment Face Value [K USD]	Debt Commercially Procured (Bond) Repayment Interest [K USD]
1	2012/13	-3,620	3,620	0	0		0	3,620	434	-434		-434	-3,360	3,360	0	0		0	3,360	403	-403		-403
2	2013/14	-18,100	21,720	22	-22		-22	21,720	2,606	-2,606		-2,606	-3,360	6,720	20	-20		-20	6,720	806	-806		-806
3	2014/15	-119,460	141,180	130	-130		-130	141,180	16,942	-16,942		-16,942	-84,000	90,720	40	-40		-40	90,720	10,886	-10,886		-10,886
4	2015/16	-39,820	181,000	847	-847		-847	181,000	21,720	-21,720		-21,720	-131,040	221,760	544	-544		-544	221,760	26,611	-26,611		-26,611
5	2016/17	0	181,000	1,086	-1,086		-1,086	181,000	21,720	-21,720		-21,720	-114,240	336,000	1,331	-1,331		-1,331	336,000	40,320	-40,320		-40,320
6	2017/18		163,383	1,086	-18,703	-17,617	-1,086	181,000	21,720	-21,720		-21,720		303,297	2,016	-34,719	-32,703	-2,016	336,000	40,320	-40,320		-40,320
7	2018/19		145,661	980	-18,703	-17,722	-980	181,000	21,720	-21,720		-21,720		270,398	1,820	-34,719	-32,899	-1,820	336,000	40,320	-40,320		-40,320
8	2019/20		127,832	874	-18,703	-17,829	-874	181,000	21,720	-21,720		-21,720		237,302	1,622	-34,719	-33,096	-1,622	336,000	40,320	-40,320		-40,320
9	2020/21		109,897	767	-18,703	-17,936	-767	181,000	21,720	-21,720		-21,720		204,007	1,424	-34,719	-33,295	-1,424	336,000	40,320	-40,320		-40,320
10	2021/22		91,853	659	-18,703	-18,043	-659	181,000	21,720	-21,720		-21,720		170,512	1,224	-34,719	-33,495	-1,224	336,000	40,320	-40,320		-40,320
11	2022/23		73,702	551	-18,703	-18,152	-551	181,000	21,720	-21,720		-21,720		136,817	1,023	-34,719	-33,696	-1,023	336,000	40,320	-40,320		-40,320
12	2023/24		55,441	442	-18,703	-18,260	-442	181,000	21,720	-21,720		-21,720		102,919	821	-34,719	-33,898	-821	336,000	40,320	-40,320		-40,320
13	2024/25		37,071	333	-18,703	-18,370	-333	181,000	21,720	-21,720		-21,720		68,818	618	-34,719	-34,101	-618	336,000	40,320	-40,320		-40,320
14	2025/26		18,591	222	-18,703	-18,480	-222	181,000	21,720	-21,720		-21,720		34,512	413	-34,719	-34,306	-413	336,000	40,320	-40,320		-40,320
15	2026/27		0	112	-18,703	-18,591	-112	181,000	21,720	-21,720		-21,720		0	207	-34,719	-34,512	-207	336,000	40,320	-40,320		-40,320
16	2027/28							0	0	-181,000	-181,000	0							0	0	-336,000	-336,000	0
17	2028/29																						
18	2029/30																						
19	2030/31																						
20	2031/32																						
21	2032/33																						
22	2033/34																						
23	2034/35																						
24	2035/36																						
25	2036/37																						
26	2037/38																						
27	2038/39																						
28	2039/40																						
29	2040/41																						
30	2041/42																						
		-181,000		8,112	-189,112	-181,000	-8,112		280,622	-461,622	-181,000	-280,622	-336,000		13,123	-349,123	-336,000	-13,123		482,227	-818,227	-336,000	-482,227

APPENDICES FOR CHAPTER 10

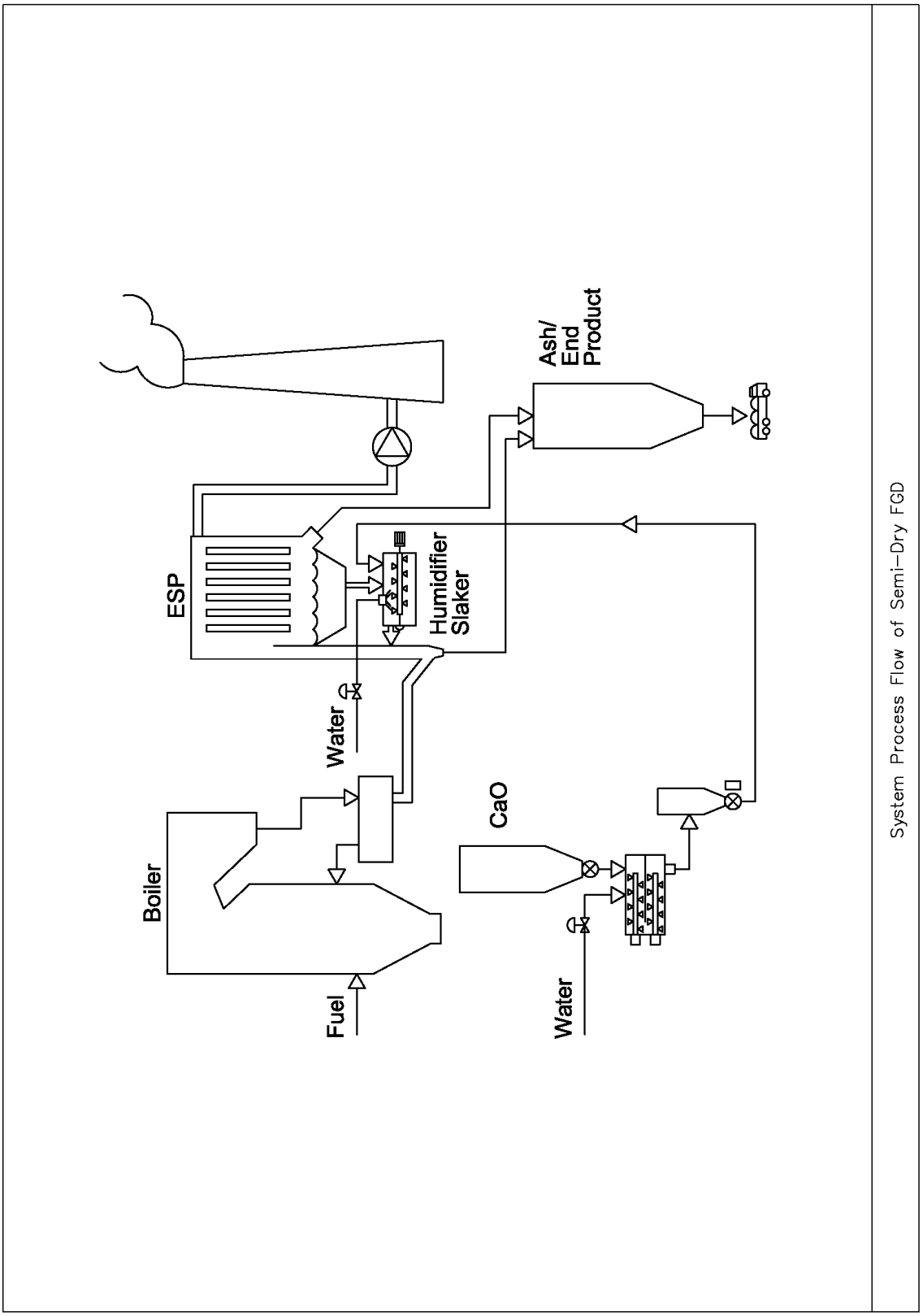
Appendix 10-1



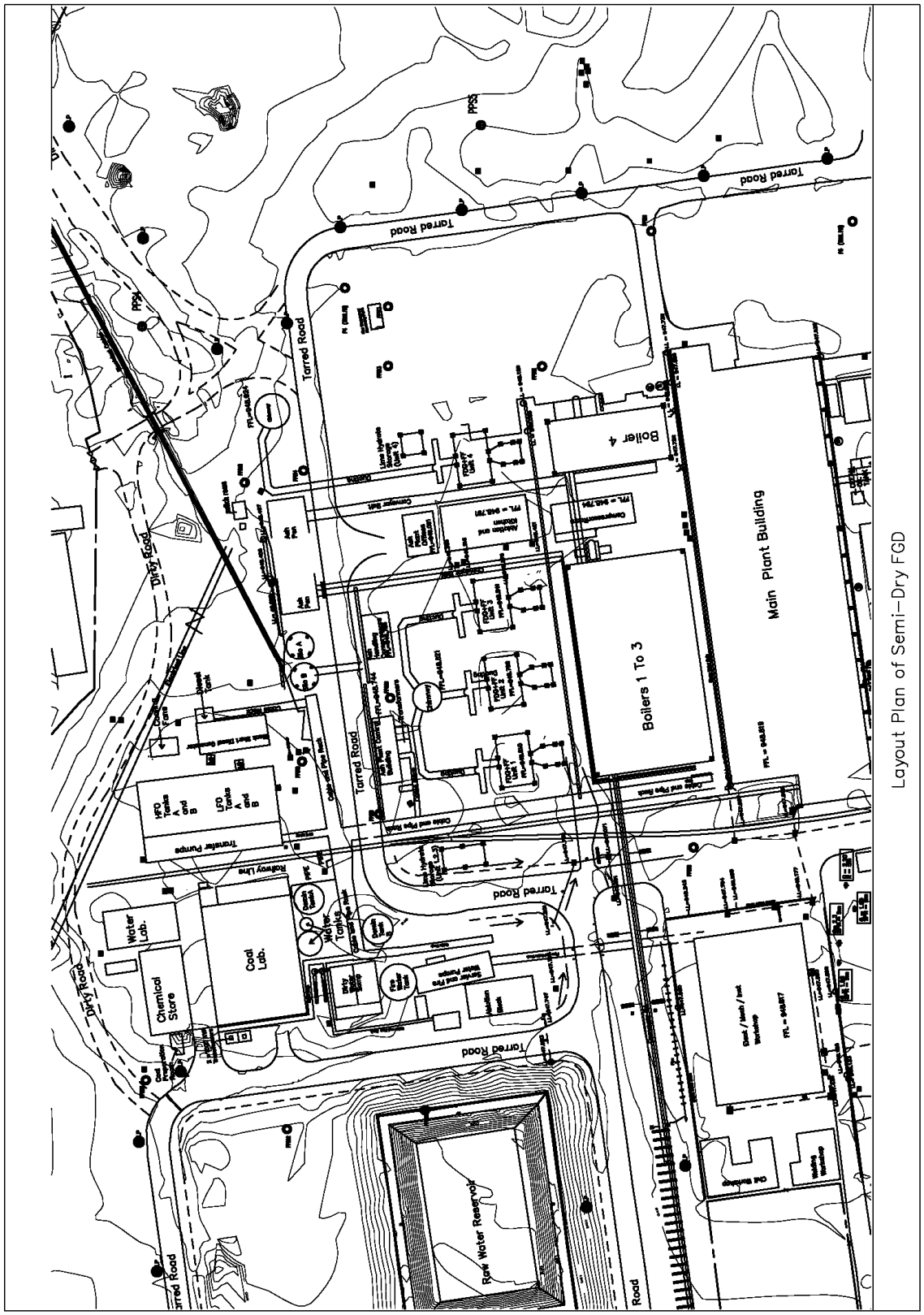
Appendix 10-2



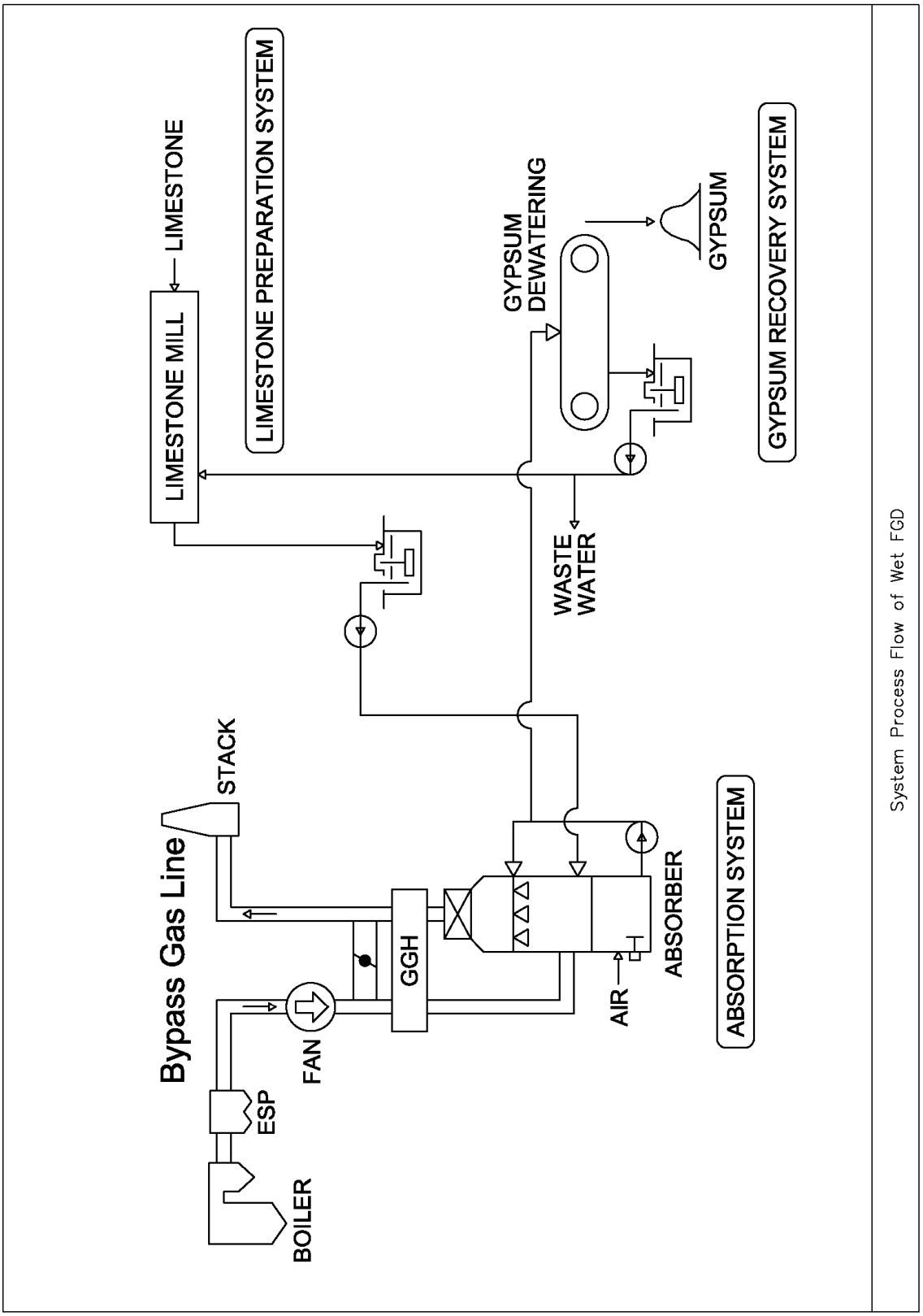
Appendix 10-3



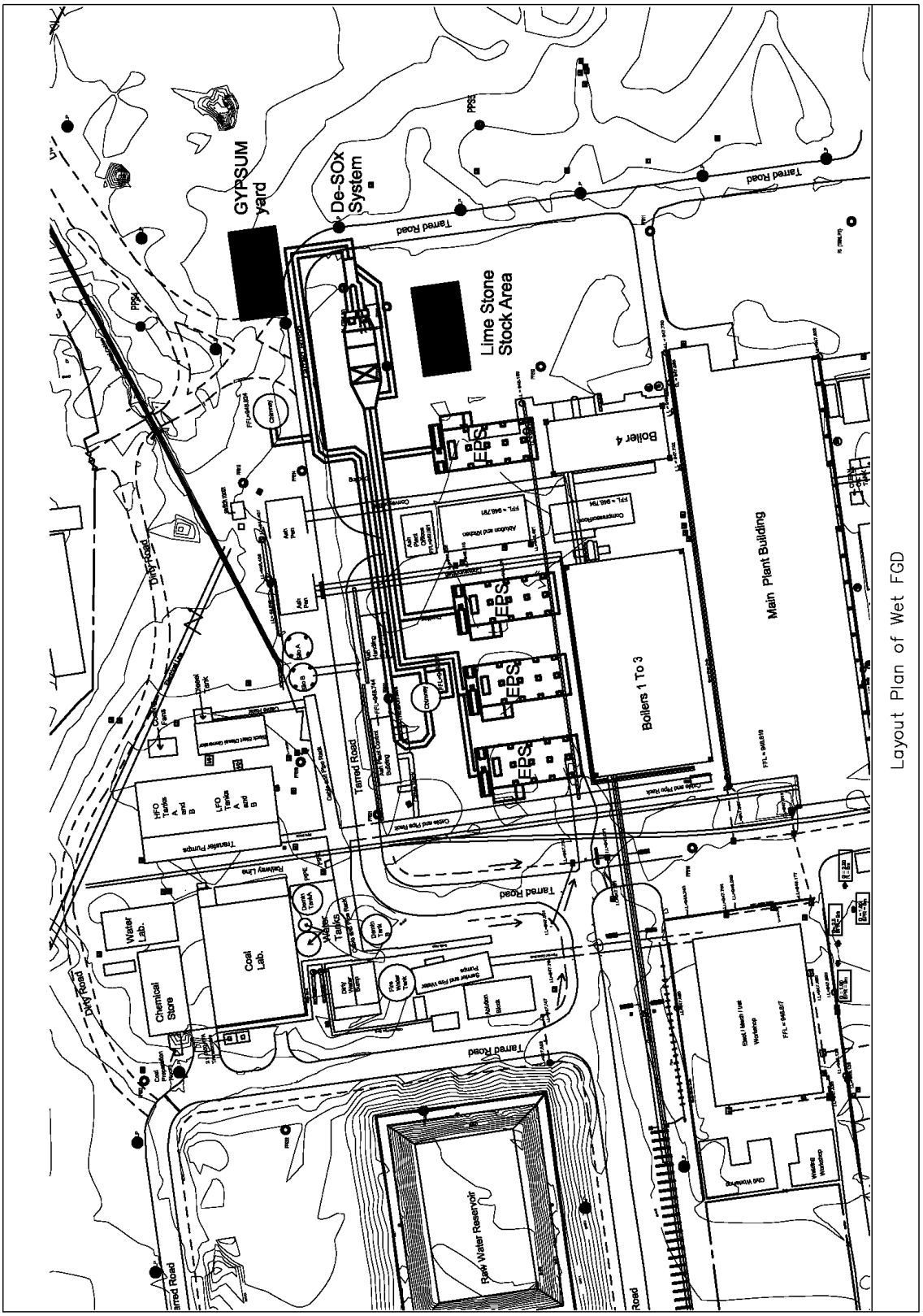
Appendix 10-4



Appendix 10-5



Appendix 10-6



APPENDIX FOR CHAPTER 11

Appendix 11-1 Detail of Direct Construction Cost (1/3)

Scenario 1

1 BWP = 0.150 USD

Item	FC (USD)			LC (BWP)			Total
	Equipment	Transportation	Installation	Equipment	Transportation	Installation	(USD)
1. Boiler and Auxiliaries							
Boiler Pressure Parts, Piping and Casing	5,670,042	289,288	2,082,873	0	1,931,097	1,544,877	8,563,599
Coal Milling System	1,212,074	61,841	333,939	0	412,807	247,684	1,706,928
Fuel Oil Pumping Station and Preparation Systems	755,549	38,548	104,081	0	257,324	77,197	948,356
Coal & HFO Burners and Ignitors Systems	1,835,231	93,634	252,812	0	625,041	187,512	2,303,560
Burner Sealing and Cooling Air Fans	119,837	6,114	33,017	0	40,814	24,489	168,763
Low Nox Buners	10,271,816	524,072	2,829,990	0	3,498,363	2,099,018	14,465,485
Air and Flue Gas Systems	5,552,487	283,290	865,767	0	1,891,060	642,144	7,081,525
Sootblowing System	835,441	42,625	76,724	0	284,534	56,907	1,006,006
Chemical Sampling and Chemical Injection	397,176	20,264	54,713	0	135,270	40,581	498,531
Ash and Slag Extraction System (Bottom Ash)	1,321,640	67,431	242,750	0	450,123	180,049	1,726,347
General	739,570	37,733	169,799	0	251,882	125,941	1,003,775
Subtotal	**28,710,863**	**1,464,840**	**7,046,465**		**9,778,314**	**5,226,399**	**39,472,875**
2. Turbine							
Stator	1,196,096	61,025	274,614	0	407,365	203,682	1,623,392
Valves	547,830	27,951	100,622	0	186,579	74,632	715,585
Glands	337,829	17,236	93,075	0	115,057	69,034	475,754
Auxiliaries	1,181,259	60,268	162,724	0	402,312	120,694	1,482,702
Subtotal	**3,263,014**	**166,480**	**631,035**		**1,111,313**	**468,042**	**4,297,433**
3. Mechanical BOP							
W/S Cycle Systems & Equipment	884,517	45,128	203,078	0	301,248	150,624	1,200,504
Closed Cooling System	342,394	17,469	78,611	0	116,612	58,306	464,712
Air Supply System	542,124	27,659	49,787	0	184,636	36,927	652,804
Demin Water Supply System	102,718	5,241	14,150	0	34,984	10,495	128,931
Black Start Diesel Generator	808,050	41,227	111,313	0	275,205	82,561	1,014,255
Emergency Diesel Generator	349,242	17,818	48,110	0	118,944	35,683	438,364
Fuel Oil Station	148,371	7,570	20,439	0	50,532	15,160	186,234
Subtotal	**3,177,416**	**162,112**	**525,488**		**1,082,160**	**389,757**	**4,085,804**
4. Generator							
Auxiliaries	225,980	11,530	103,766	0	76,964	76,964	364,365
Subtotal	**225,980**	**11,530**	**103,766**		**76,964**	**76,964**	**364,365**
5. Electrical BOP							
Unit Transformer	949,572	48,448	87,206	0	323,404	64,681	1,143,439
Distribution Panel and AUX. Transformer	867,398	44,255	119,488	0	295,417	88,625	1,088,747
Cabling	2,254,093	115,005	828,034	0	767,696	614,157	3,404,410
General	552,395	28,183	101,460	0	188,134	75,254	721,546
Subtotal	**4,623,458**	**235,891**	**1,136,188**		**1,574,652**	**842,717**	**6,358,142**
6. Pollution Abatement							
Desulferization and Fablic Filter System	37,435,063	1,909,952	5,156,871	0	12,749,591	3,824,877	46,988,057
Demolition of Precipitator	1,004,355	51,243	322,829	0	0	239,444	1,414,344
Demolishing & Removal of ESP Foundation	0	0	9,827	81,997	0	262,390	61,485
FGD/ESP Foundation	0	0	419,186	20,986,596	0	11,192,851	5,246,103
Subtotal	**38,439,418**	**1,961,195**	**5,908,713**	**21,068,592**	**12,749,591**	**15,519,561**	**53,709,989**
7. Instrumentation							
Overall Rehabilitation	1,621,866	82,748	397,192	0	552,373	662,848	2,284,089
Subtotal	**1,621,866**	**82,748**	**397,192**		**552,373**	**662,848**	**2,284,089**
8. Civil and Building							
Civil Work	0	0	127,006	6,358,576	0	3,391,241	1,589,479
Reinforcement of Building & Structure	0	0	16,228	812,455	0	433,309	203,093
Subtotal			**143,234**	**7,171,031**		**3,824,550**	**1,792,572**
Grand Total	**80,062,015**	**4,084,796**	**15,892,081**	**28,239,624**	**26,925,368**	**27,010,838**	**112,365,269**

Appendix 11-1 Detail of Direct Construction Cost (2/3)

Scenario 2a

1 BWP = 0.150 USD

Item	FC (USD)			LC (BWP)			Total
	Equipment	Transportation	Installation	Equipment	Transportation	Installation	(USD)
1. Boiler and Auxiliaries							
Boiler Pressure Parts, Piping and Casing	9,450,070	482,146	3,471,455	0	3,218,494	2,574,795	14,272,664
Coal Milling System	4,040,247	206,135	1,113,129	0	1,376,023	825,614	5,689,756
Fuel Oil Pumping Station and Preparation Systems	3,777,745	192,742	520,404	0	1,286,620	385,986	4,741,782
Coal & HFO Burners and Ignitors Systems	3,058,718	156,057	421,354	0	1,041,735	312,520	3,839,267
Burner Sealing and Cooling Air Fans	171,196	8,735	47,167	0	58,306	34,984	241,091
Low Nox Buners	10,167,001	524,072	2,829,990	0	3,498,363	2,099,018	14,360,670
Air and Flue Gas Systems	7,932,124	404,700	1,236,811	0	2,701,514	917,349	10,116,464
Sootblowing System	1,392,401	71,041	127,874	0	474,223	94,845	1,676,676
Chemical Sampling and Chemical Injection	661,961	33,774	91,189	0	225,450	67,635	830,887
Ash and Slag Extraction System (Bottom Ash)	2,202,733	112,384	404,584	0	750,205	300,082	2,877,244
General	1,232,617	62,889	282,999	0	419,804	209,902	1,672,961
Subtotal	**44,086,813**	**2,254,675**	**10,546,956**		**15,050,736**	**7,822,729**	**60,319,462**
2. Turbine							
Rotor	2,784,803	142,082	255,747	0	948,445	189,689	3,353,352
Stator	1,495,120	76,282	343,267	0	509,206	254,603	2,029,240
Bearings	1,529,359	78,029	210,677	0	520,867	156,260	1,919,634
Valves	1,095,660	55,901	201,244	0	373,159	149,264	1,431,168
Glands	844,572	43,090	232,688	0	287,643	172,586	1,189,384
Auxiliaries	3,937,530	200,894	542,415	0	1,341,039	402,312	4,942,342
Subtotal	**11,687,044**	**596,278**	**1,786,038**		**3,980,360**	**1,324,714**	**14,865,120**
3. Mechanical BOP							
W/S Cycle Systems & Equipment	3,538,070	180,514	812,312	0	1,204,992	602,496	4,802,019
Closed Cooling System	570,656	29,115	131,018	0	194,354	97,177	774,519
Air Supply System	1,084,247	55,319	99,574	0	369,272	73,854	1,305,609
Demin Water Supply System	102,718	5,241	14,150	0	34,984	10,495	128,931
Black Start Diesel Generator	1,346,749	68,712	185,522	0	458,674	137,602	1,690,424
Emergency Diesel Generator	582,070	29,697	80,183	0	198,241	59,472	730,607
Fuel Oil Station	148,371	7,570	20,439	0	50,532	15,160	186,234
Subtotal	**7,372,881**	**376,168**	**1,343,198**		**2,511,047**	**996,256**	**9,618,343**
4. Generator							
Auxiliaries	376,633	19,216	172,944	0	128,273	128,273	607,275
Subtotal	**376,633**	**19,216**	**172,944**		**128,273**	**128,273**	**607,275**
5. Electrical BOP							
Unit Transformer	2,373,931	121,119	218,014	0	808,511	161,702	2,858,596
Distribution Panel and AUX. Transformer	4,336,989	221,275	597,442	0	1,477,087	443,126	5,443,738
Cabling	4,508,186	230,009	1,656,068	0	1,535,393	1,228,314	6,808,819
General	1,380,989	70,459	253,651	0	470,336	188,134	1,803,869
Subtotal	**12,600,095**	**642,862**	**2,725,175**		**4,291,326**	**2,021,277**	**16,915,022**
6. Pollution Abatement							
Desulferization and Fablic Filter System	37,435,063	1,909,952	5,156,871	0	12,749,591	3,824,877	46,988,057
Demolition of Precipitator	1,004,355	51,243	322,829	0	0	239,444	1,414,344
Demolishing & Removal of ESP Foundation	0	0	9,827	81,997	0	262,390	61,485
FGD/ESP Foundation	0	0	419,186	20,986,596	0	11,192,851	5,246,103
Subtotal	**38,439,418**	**1,961,195**	**5,908,713**	**21,068,592**	**12,749,591**	**15,519,561**	**53,709,989**
7. Instrumentation							
Overall Rehabilitation	5,406,219	275,828	1,323,972	0	1,841,244	2,209,493	7,613,629
Subtotal	**5,406,219**	**275,828**	**1,323,972**		**1,841,244**	**2,209,493**	**7,613,629**
8. Civil and Building							
Civil Work	0	0	127,006	6,358,576	0	3,391,241	1,589,479
Reinforcement of Building & Structure	0	0	32,456	1,624,910	0	866,619	406,185
Subtotal			**159,462**	**7,983,486**		**4,257,859**	**1,995,664**
Grand Total	**119,969,103**	**6,126,222**	**23,966,458**	**29,052,079**	**40,552,577**	**34,280,162**	**165,644,504**

Appendix 11-1 Detail of Direct Construction Cost (3/3)

Scenario 2b

1 BWP = 0.150 USD

Item	FC (USD)			LC (BWP)			Total
	Equipment	Transportation	Installation	Equipment	Transportation	Installation	(USD)
1. Boiler and Auxiliaries							
Boiler Pressure Parts, Piping and Casing	9,160,783	433,932	2,430,018	0	2,896,645	2,059,836	12,768,205
Coal Milling System	3,916,567	185,522	779,191	0	1,238,421	660,491	5,166,117
Fuel Oil Pumping Station and Preparation Systems	3,662,100	173,468	364,283	0	1,157,958	308,789	4,419,863
Coal & HFO Burners and Ignitors Systems	2,965,084	140,451	294,948	0	937,561	250,016	3,578,620
Burner Sealing and Cooling Air Fans	165,956	7,861	33,017	0	52,475	27,987	218,903
Low Nox Buners	9,957,373	471,665	1,980,993	0	3,148,527	1,679,214	13,134,192
Air and Flue Gas Systems	7,689,305	364,230	865,767	0	2,431,363	733,879	9,394,088
Sootblowing System	1,349,777	63,937	89,512	0	426,800	75,876	1,578,627
Chemical Sampling and Chemical Injection	641,697	30,396	63,832	0	202,905	54,108	774,477
Ash and Slag Extraction System (Bottom Ash)	2,135,303	101,146	283,209	0	675,184	240,065	2,656,945
General	1,194,885	56,600	198,099	0	377,823	167,921	1,531,446
Subtotal	**42,838,830**	**2,029,208**	**7,382,869**		**13,545,663**	**6,258,183**	**55,221,483**
2. Turbine							
Rotor	2,699,554	127,874	179,023	0	853,600	151,751	3,157,254
Stator	1,449,351	68,653	240,287	0	458,285	203,682	1,857,586
Bearings	1,482,542	70,226	147,474	0	468,781	125,008	1,789,310
Valves	1,062,120	50,311	140,871	0	335,843	119,411	1,321,590
Glands	818,717	38,781	162,882	0	258,879	138,069	1,079,922
Auxiliaries	3,816,993	180,805	379,690	0	1,206,935	321,849	4,606,806
Subtotal	**11,329,277**	**536,650**	**1,250,227**		**3,582,323**	**1,059,771**	**13,812,468**
3. Mechanical BOP							
W/S Cycle Systems & Equipment	3,429,762	162,462	568,618	0	1,084,493	481,997	4,395,815
Closed Cooling System	553,187	26,204	91,713	0	174,918	77,741	709,003
Air Supply System	1,051,056	49,787	69,702	0	332,345	59,083	1,229,259
Demin Water Supply System	99,574	4,717	9,905	0	31,485	8,396	120,178
Black Start Diesel Generator	1,305,522	61,841	129,865	0	412,807	110,082	1,575,661
Emergency Diesel Generator	564,251	26,728	56,128	0	178,417	47,578	681,006
Fuel Oil Station	143,829	6,813	14,307	0	45,479	12,128	173,590
Subtotal	**7,147,181**	**338,552**	**940,238**		**2,259,943**	**797,005**	**8,884,512**
4. Generator							
Auxiliaries	365,104	17,294	121,061	0	115,446	102,619	536,169
Subtotal	**365,104**	**17,294**	**121,061**		**115,446**	**102,619**	**536,169**
5. Electrical BOP							
Unit Transformer	2,301,259	109,007	152,610	0	727,660	129,362	2,691,429
Distribution Panel and AUX. Transformer	4,204,224	199,147	418,210	0	1,329,378	354,501	5,074,163
Cabling	4,370,180	207,009	1,159,248	0	1,381,854	982,651	6,091,113
General	1,338,713	63,413	177,556	0	423,302	150,507	1,665,753
Subtotal	**12,214,376**	**578,576**	**1,907,624**		**3,862,193**	**1,617,021**	**15,522,458**
6. Pollution Abatement							
Desulferization and Fablic Filter System	36,289,092	1,718,957	3,609,810	0	11,474,632	3,059,902	43,798,040
Demolition of Precipitator	973,610	46,118	225,980	0	0	191,555	1,274,441
Demolishing & Removal of ESP Foundation	0	0	6,879	77,897	0	209,912	50,050
FGD/ESP Foundation	0	0	293,430	19,937,266	0	8,954,281	4,627,162
Subtotal	**37,262,702**	**1,765,075**	**4,136,099**	**20,015,163**	**11,474,632**	**12,415,649**	**49,749,693**
7. Instrumentation							
Overall Rehabilitation	5,240,723	248,245	926,780	0	1,657,119	1,767,594	6,929,455
Subtotal	**5,240,723**	**248,245**	**926,780**		**1,657,119**	**1,767,594**	**6,929,455**
8. Civil and Building							
Civil Work	0	0	88,904	6,040,647	0	2,712,992	1,401,950
Reinforcement of Building & Structure	0	0	22,719	1,543,664	0	693,295	358,263
Subtotal			**111,623**	**7,584,312**		**3,406,287**	**1,760,213**
Grand Total	**116,398,193**	**5,513,600**	**16,776,521**	**27,599,475**	**36,497,319**	**27,424,130**	**152,416,451**