APPENDIX A - II

Cost Estimation Sheets of Hydropower Potential Site in Palawan

Cost Estimation

In this annex, the costs of each candidate site are shown in a sequential order. The sites in Core Zones or Restricted Zones are also included for future use. The categories are (i) Run of River Type and (ii) Pondage Type under (a) Map Study from Site, and (b) Map Study from Demand.

(a) Map Study from Site

(i) Run of river type

1) Candidate sites in Multiple Use Zones or Controlled Use Zones

No. 1 Talakaigan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 1 Talakaigan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,725	0	
Dam	m^2	239.00		11,400	2,725	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				545	0	(1.) * 0.2
Subtotal					3,270	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 1 Talakaigan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,349	0	
Sand Flush Gate	ton	547,000		13.43	7,349	0	$0.145*Q_f^{0.692}$
2. Intake					536	0	
Gate	ton	547,000		0.97	530	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.52	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					443	0	
Gate	ton	547,000		0.79	435	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.74	8	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		36.01	17,287	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				5,123	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					30,738	0	

Construction Cost Summary

Site Name: 1 Talakaigan

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	4,276	77,753	9,836	
(1) Access Road	3,270	59,455	7,521	
(2) Camp & Facilities	1,006	18,299	2,315	3. Civil work * 0.05
2. Environmental mitigation cost	201	3,660	463	3. Civil work * 0.01
3. Civil works	20,129	365,973	46,296	
(1) Intake weir	3,325	60,455	7,648	
(2) Intake	794	14,436	1,826	
(3) Settling basin	1,424	25,891	3,275	
(4) Headrace	5,470	99,455	12,581	
(5) Head tank	1,833	33,327	4,216	
(6) Penstock and spillway channel	2,759	50,164	6,346	
(7) Powerhouse	3,150	57,273	7,245	
(8) Tailrace channel	78	1,418	179	
(9) Tailrace	337	6,127	775	
(10) Miscellaneous	959	17,427	2,205	((1) to (9)) *0.05
4. Hydraulic equipment	30,738	558,873	70,697	
(1) Gate and screen	8,328	151,418	19,154	
(2) Penstock	17,287	314,309	39,760	
(3) Others	5,123	93,145	11,783	
5. Electro-mechanical equipment	29,802	541,855	68,545	Turbine and Generator, Transformer, etc
6. Transmission line	13,950	253,636	32,085	1,500,000PhP/km * distance from existing transmission
Direct Cost	99,096	1,801,750	227,921	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	14,864	270,263	34,188	Direct Cost * 0.15
8. Contingency	9,910	180,175	22,792	Direct Cost * 0.1
9. Interest during construction	11,892	216,210	27,351	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	135,762	2,468,398	312,252	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		991		
Development Cost (/kW)	136.962	2,490	315.013	
Annual Generation (kWh/yr)		6,083,534		
Construction Cost per kWh	0.02232	0.40575	0.05133	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.057	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 1 Talakaigan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,325	0	
(1) Excavation (V_e)	m^3	136		1,469	200	0	$8.69*(Dh * CL)^{1.14}$
(2) Masonry Concrete (V_c)	m^3	2,712		789	2,140	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.3
2. Intake					794	0	
(1) Excavation (Ve)	m^3	136		175	24	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		149	469	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	142	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				159	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,424	0	
(1) Excavation (Ve)	m^3	136		728	99	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		229	717	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		12	370	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				238	0	((1) + (2) + (3)) * 0.2
4. Headrace					5,470	0	
(1) Excavation (Ve)	m^3	136		30,933	4,207	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,263	0	((1) + (2)) * 0.3
5. Head Tank					1,833	0	
(1) Excavation (Ve)	m^3	136		1,012	138	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		248	779	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		13	392	0	$0.051*V_c$
(4) Others	L.S.				524	0	((1) + (2) + (3)) * 0.4
6. Penstock					2,759	0	
(1) Excavation (Ve)	m^3	136		2,852	388	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		518	1,623	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		9	288	0	$0.018*V_c$
(4) Others	L.S.				460	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,150	0	
(1) Excavation (Ve)	m^3	136		1,075	147	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		387	1,212	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		24	741	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,050	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					78	0	
(1) Excavation (Ve)	m^3	136		210	29	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	31	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				18	0	((1) + (2)) * 0.3
9. Tailrace outlet					337	0	
(1) Excavation (Ve)	m^3	136		402	55	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		41	130	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	84	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				68	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				959	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					20,129	0	

No. 2 Baraki Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 2 Baraki

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,876	0	
Dam	m^2	239.0		20,400	4,876	0	3.0*Ld
Head tank	m^2	239.0		0	0	0	3.0*Lh
Power house	m^2	239.0		0	0	0	3.0*Lp
2. Others	L.S.				975	0	(1.) * 0.2
Subtotal					5,851	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 2 Baraki

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,198	0	
Sand Flush Gate	ton	547,000		14.99	8,198	0	$0.145*Q_f^{0.692}$
2. Intake					604	0	
Gate	ton	547,000		1.09	598	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.60	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					509	0	
Gate	ton	547,000		0.91	500	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.88	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		20.89	10,029	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,868	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					23,208	0	

Construction Cost Summary

Site Name: 2 Baraki

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	8,645	157,189	19,884	
(1) Access Road	5,851	106,385	13,458	
(2) Camp & Facilities	2,794	50,804	6,427	3. Civil work * 0.05
2. Environmental mitigation cost	559	10,161	1,285	3. Civil work * 0.01
3. Civil works	55,884	1,016,075	128,534	
(1) Intake weir	2,504	45,527	5,759	
(2) Intake	889	16,164	2,045	
(3) Settling basin	1,749	31,800	4,023	
(4) Headrace	40,408	734,691	92,938	
(5) Head tank	2,155	39,182	4,957	
(6) Penstock and spillway channel	1,985	36,091	4,566	
(7) Powerhouse	3,071	55,836	7,063	
(8) Tailrace channel	80	1,455	184	
(9) Tailrace	382	6,945	879	
(10) Miscellaneous	2,661	48,385	6,121	((1) to (9)) *0.05
4. Hydraulic equipment	23,208	421,964	53,378	
(1) Gate and screen	9,311	169,291	21,415	
(2) Penstock	10,029	182,345	23,067	
(3) Others	3,868	70,327	8,896	
5. Electro-mechanical equipment	25,527	464,136	58,713	Turbine and Generator, Transformer, etc
6. Transmission line	13,200	240,000	30,360	1,500,000PhP/km * distance from existing transmission
Direct Cost	127,024	2,309,525	292,155	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	19,054	346,429	43,823	Direct Cost * 0.15
8. Contingency	12,702	230,953	29,215	Direct Cost * 0.1
9. Interest during construction	15,243	277,143	35,059	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	174,023	3,164,050	400,252	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		844		
Development Cost (/kW)	206.173	3,749	474.197	
Annual Generation (kWh/yr)		5,179,986		
Construction Cost per kWh	0.03360	0.61082	0.07727	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.086	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 2 Baraki

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,504	0	
(1) Excavation (V_e)	m^3	136		925	126	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		595	1,614	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				578	0	((1) + (2) + (3)) * 0.3
2. Intake					889	0	
(1) Excavation (Ve)	m^3	136		204	28	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		166	522	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	161	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				178	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,749	0	
(1) Excavation (Ve)	m^3	136		928	127	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		283	887	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	443	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				292	0	((1) + (2) + (3)) * 0.2
4. Headrace					40,408	0	
Tunnel							
(1) Excavation (Ve)	m^3	314		11,334	3,559	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		432	2,156	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	13,622		1,789	24,373	0	(pai*D+D)*0.1*L
Open channel							
(4) Excavation (Ve)	m^3	136		7,312	995	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(5) Concrete(Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(6) Others	L.S.				9,325	0	((1) + (2) + (3) + (4) + (5)) * 0.3
5. Head Tank					2,155	0	
(1) Excavation (Ve)	m^3	136		1,185	162	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		292	916	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		15	461	0	$0.051*V_c$
(4) Others	L.S.				616	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,985	0	
(1) Excavation (Ve)	m^3	136		1,980	270	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		375	1,175	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		7	209	0	$0.018*V_c$
(4) Others	L.S.				331	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,071	0	
(1) Excavation (Ve)	m^3	136		1,051	143	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		377	1,182	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		23	722	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,024	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					80	0	
(1) Excavation (Ve)	m^3	136		229	32	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	34	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					382	0	
(1) Excavation (Ve)	m^3	136		448	61	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		48	152	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	92	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				77	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				2,661	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					55,884	0	

No. 4 Malatgao 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 4 Malatgao1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					7,242	0	
Dam	m^2	239.00		30,300	7,242	0	3.0*Ld
Headtank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,448	0	(1.) * 0.2
Subtotal					8,690	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 4 Malatgao1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					13,177	0	
Sand Flush Gate	ton	547,000		24.09	13,177	0	$0.145*Q_f^{0.692}$
2. Intake					1,536	0	
Gate	ton	547,000		2.78	1,519	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		1.65	17	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					976	0	
Gate	ton	547,000		1.74	955	0	$0.910*Q^{0.613}$
Screen	ton	10,000		2.02	21	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		70.96	34,063	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				9,950	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					59,702	0	

Construction Cost Summary

Site Name: 4 Malatgao1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	11,816	214,836	27,177	
(1) Access Road	8,690	158,007	19,988	
(2) Camp & Facilities	3,126	56,829	7,189	3. Civil work * 0.05
2. Environmental mitigation cost	625	11,366	1,438	3. Civil work * 0.01
3. Civil works	62,512	1,136,577	143,777	
(1) Intake weir	26,700	485,455	61,410	
(2) Intake	2,110	38,364	4,853	
(3) Settling basin	4,554	82,800	10,474	
(4) Headrace	3,473	63,145	7,988	
(5) Head tank	3,922	71,309	9,021	
(6) Penstock and spillway channel	8,669	157,618	19,939	
(7) Powerhouse	8,949	162,709	20,583	
(8) Tailrace channel	116	2,109	267	
(9) Tailrace	1,042	18,945	2,397	
(10) Miscellaneous	2,977	54,123	6,847	((1) to (9)) *0.05
4. Hydroulic equipment	59,702	1,085,498	137,316	
(1) Gate and screen	15,689	285,255	36,085	
(2) Penstock	34,063	619,327	78,345	
(3) Others	9,950	180,916	22,886	
5. Electro-mechanical equipment	64,186	1,167,013	147,627	Turbine and Generator, Transformer, etc
6. Transmission line	13,200	240,000	30,360	1,500,000PhP/km * distance from existing transmission
Direct Cost	212,041	3,855,290	487,694	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	31,806	578,294	73,154	Direct Cost * 0.15
8. Contingency	21,204	385,529	48,769	Direct Cost * 0.1
9. Interest during construction	25,445	462,635	58,523	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	290,496	5,281,747	668,141	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		2,175		
Development Cost (/kW)	133.557	2,428	307.182	
Annual Generation (kWh/yr)		13,335,223		
Construction Cost per kWh	0.02178	0.39607	0.05010	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.056	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 4 Malatgao1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Weir					26,700	0	
(1) Excavation (V_e)	m^3	136		22,858	3,109	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		5,993	16,254	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		38	1,175	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				6,162	0	((1) + (2) + (3)) * 0.3
2. Intake					2,110	0	
(1) Excavation (Ve)	m^3	136		653	89	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		378	1,186	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		13	413	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				422	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					4,554	0	
(1) Excavation (Ve)	m^3	136		2,872	391	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		760	2,382	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		33	1,022	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				759	0	((1) + (2) + (3)) * 0.2
4. Headrace					3,473	0	
(1) Excavation (Ve)	m^3	136		21,276	2,894	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				579	0	((1) + (2)) * 0.2
5. Head Tank					3,922	0	
(1) Excavation (Ve)	m^3	136		2,475	337	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		622	1,950	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		32	981	0	$0.051*V_c$
(4) Others	L.S.				654	0	((1) + (2) + (3)) * 0.2
6. Penstock					8,669	0	
(1) Excavation (Ve)	m^3	136		6,580	895	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		1,435	4,498	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		26	799	0	$0.018*V_c$
(4) Others	L.S.				2,477	0	((1) + (2) + (3)) * 0.4
7. Powerhouse					8,949	0	
(1) Excavation (Ve)	m^3	136		2,763	376	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		1,085	3,402	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		71	2,188	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				2,983	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					116	0	
(1) Excavation (Ve)	m^3	136		340	47	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		15	49	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				20	0	((1) + (2)) * 0.2
9. Tailrace outlet					1,042	0	
(1) Excavation (Ve)	m^3	136		1,035	141	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		160	502	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		6	190	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				209	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				2,977	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					62,512	0	

No. 12 Balsahan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 12 Balsahan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,510	0	
Dam	m^2	239.00		10,500	2,510	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				502	0	(1.) * 0.2
Subtotal					3,012	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 12 Balsahan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					4,926	0	
Sand Flush Gate	ton	547,000		9.00	4,926	0	$0.145*Q_f^{0.692}$
2. Intake					185	0	
Gate	ton	547,000		0.33	183	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.16	2	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					130	0	
Gate	ton	547,000		0.23	128	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.15	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		5.31	2,548	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,558	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					9,347	0	

Construction Cost Summary

Site Name: 12 Balsahan

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,613	65,685	8,309	
(1) Access Road	3,012	54,764	6,928	
(2) Camp & Facilities	601	10,921	1,382	3. Civil work * 0.05
2. Environmental mitigation cost	120	2,184	276	3. Civil work * 0.01
3. Civil works	12,013	218,419	27,630	
(1) Intake weir	6,175	112,273	14,203	
(2) Intake	354	6,436	814	
(3) Settling basin	324	5,891	745	
(4) Headrace	2,717	49,400	6,249	
(5) Head tank	563	10,236	1,295	
(6) Penstock and spillway channel	404	7,345	929	
(7) Powerhouse	728	13,236	1,674	
(8) Tailrace channel	39	709	90	
(9) Tailrace	137	2,491	315	
(10) Miscellaneous	572	10,401	1,316	((1) to (9)) *0.05
4. Hydraulic equipment	9,347	169,942	21,498	
(1) Gate and screen	5,241	95,291	12,054	
(2) Penstock	2,548	46,327	5,860	
(3) Others	1,558	28,324	3,583	
5. Electro-mechanical equipment	5,305	96,450	12,201	Turbine and Generator, Transformer, etc
6. Transmission line	1,950	35,455	4,485	1,500,000PhP/km * distance from existing transmission
Direct Cost	32,347	588,134	74,399	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	4,852	88,220	11,160	Direct Cost * 0.15
8. Contingency	3,235	58,813	7,440	Direct Cost * 0.1
9. Interest during construction	3,882	70,576	8,928	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	44,316	805,743	101,927	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		148		
Development Cost (/kW)	299.851	5,452	689.656	
Annual Generation (kWh/yr)		895,642		
Construction Cost per kWh	0.04948	0.89963	0.11380	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.007	0.127	0.016	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 12 Balsahan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					6,175	0	
(1) Excavation (V_e)	m^3	136		3,858	525	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,421	3,854	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		12	371	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,425	0	((1) + (2) + (3)) * 0.3
2. Intake					354	0	
(1) Excavation (Ve)	m^3	136		58	8	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		69	216	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	59	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				71	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					324	0	
(1) Excavation (Ve)	m^3	136		124	17	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		49	153	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		3	100	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				54	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,717	0	
(1) Excavation (Ve)	m^3	136		15,366	2,090	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				627	0	((1) + (2)) * 0.3
5. Head Tank					563	0	
(1) Excavation (Ve)	m^3	136		319	44	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		76	238	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	120	0	$0.051*V_c$
(4) Others	L.S.				161	0	((1) + (2) + (3)) * 0.4
6. Penstock					404	0	
(1) Excavation (Ve)	m^3	136		506	69	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		72	226	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	41	0	$0.018*V_c$
(4) Others	L.S.				68	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					728	0	
(1) Excavation (Ve)	m^3	136		285	39	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		90	284	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		5	162	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				243	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					39	0	
(1) Excavation (Ve)	m^3	136		109	15	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		5	17	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				7	0	((1) + (2)) * 0.2
9. Tailrace outlet					137	0	
(1) Excavation (Ve)	m^3	136		182	25	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		13	42	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		1	42	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				28	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				572	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					12,013	0	

No. 15 Barongbarong Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 15 Barongbarong

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					789	0	
Dam	m^2	239.00		3,300	789	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				158	0	(1.) * 0.2
Subtotal					947	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 15 Barongbarong

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,048	0	
Sand Flush Gate	ton	547,000		11.06	6,048	0	$0.145*Q_f^{0.692}$
2. Intake					400	0	
Gate	ton	547,000		0.72	396	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.38	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					316	0	
Gate	ton	547,000		0.57	311	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.48	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		6.77	3,250	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,003	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,017	0	

Construction Cost Summary

Site Name: 15 Barongbarong

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,657	30,135	3,812	
(1) Access Road	947	17,215	2,178	
(2) Camp & Facilities	711	12,921	1,634	3. Civil work * 0.05
2. Environmental mitigation cost	142	2,584	327	3. Civil work * 0.01
3. Civil works	14,213	258,415	32,689	
(1) Intake weir	5,159	93,800	11,866	
(2) Intake	712	12,945	1,638	
(3) Settling basin	1,164	21,164	2,677	
(4) Headrace	1,689	30,709	3,885	
(5) Head tank	1,563	28,418	3,595	
(6) Penstock and spillway channel	582	10,582	1,339	
(7) Powerhouse	2,303	41,873	5,297	
(8) Tailrace channel	66	1,200	152	
(9) Tailrace	298	5,418	685	
(10) Miscellaneous	677	12,305	1,557	((1) to (9)) *0.05
4. Hydraulic equipment	12,017	218,487	27,639	
(1) Gate and screen	6,764	122,982	15,557	
(2) Penstock	3,250	59,091	7,475	
(3) Others	2,003	36,415	4,606	
5. Electro-mechanical equipment	18,916	343,928	43,507	Turbine and Generator, Transformer, etc
6. Transmission line	10,500	190,909	24,150	1,500,000PhP/km * distance from existing transmission
Direct Cost	57,445	1,044,459	132,124	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,617	156,669	19,819	Direct Cost * 0.15
8. Contingency	5,745	104,446	13,212	Direct Cost * 0.1
9. Interest during construction	10,340	188,003	23,782	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	82,147	1,493,576	188,937	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		616		
Development Cost (/kW)	133.262	2,423	306.502	
Annual Generation (kWh/yr)		3,772,253		
Construction Cost per kWh	0.02178	0.39594	0.05009	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.056	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 15 Barongbarong

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,159	0	
(1) Excavation (V_e)	m^3	136		2,931	399	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,202	3,260	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		10	309	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,191	0	((1) + (2) + (3)) * 0.3
2. Intake					712	0	
(1) Excavation (Ve)	m^3	136		151	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		135	422	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	126	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				143	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,164	0	
(1) Excavation (Ve)	m^3	136		573	78	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		186	582	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		10	310	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				194	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,689	0	
(1) Excavation (Ve)	m^3	136		9,548	1,299	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	30,900		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				390	0	((1) + (2)) * 0.3
5. Head Tank					1,563	0	
(1) Excavation (Ve)	m^3	136		867	118	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		212	664	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		11	334	0	$0.051*V_c$
(4) Others	L.S.				447	0	((1) + (2) + (3)) * 0.4
6. Penstock					582	0	
(1) Excavation (Ve)	m^3	136		624	85	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		108	339	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.018*V_c$
(4) Others	L.S.				97	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,303	0	
(1) Excavation (Ve)	m^3	136		809	111	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		283	889	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		17	535	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					66	0	
(1) Excavation (Ve)	m^3	136		191	26	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		9	29	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					298	0	
(1) Excavation (Ve)	m^3	136		361	50	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		36	112	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	76	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				60	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				677	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					14,213	0	

No. 27 Aborlan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 27 Aborlan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,865	0	
Dam	m^2	239.00		7,800	1,865	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				373	0	(1.) * 0.2
Subtotal					2,238	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 27 Aborlan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,728	0	
Sand Flush Gate	ton	547,000		15.96	8,728	0	$0.145*Q_f^{0.692}$
2. Intake					649	0	
Gate	ton	547,000		1.17	642	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.64	7	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					552	0	
Gate	ton	547,000		0.99	542	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.98	10	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		15.27	7,332	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,452	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					20,713	0	

Construction Cost Summary

Site Name: 27 Aborlan

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,404	61,889	7,829	
(1) Access Road	2,238	40,691	5,147	
(2) Camp & Facilities	1,166	21,199	2,682	3. Civil work * 0.05
2. Environmental mitigation cost	233	4,240	536	3. Civil work * 0.01
3. Civil works	23,318	423,971	53,632	
(1) Intake weir	6,047	109,945	13,908	
(2) Intake	950	17,273	2,185	
(3) Settling basin	1,976	35,927	4,545	
(4) Headrace	6,252	113,673	14,380	
(5) Head tank	2,373	43,145	5,458	
(6) Penstock and spillway channel	2,276	41,382	5,235	
(7) Powerhouse	1,838	33,418	4,227	
(8) Tailrace channel	83	1,509	191	
(9) Tailrace	413	7,509	950	
(10) Miscellaneous	1,110	20,189	2,554	((1) to (9)) *0.05
4. Hydraulic equipment	20,713	376,604	47,640	
(1) Gate and screen	9,929	180,527	22,837	
(2) Penstock	7,332	133,309	16,864	
(3) Others	3,452	62,767	7,940	
5. Electro-mechanical equipment	9,796	178,110	22,531	Turbine and Generator, Transformer, etc
6. Transmission line	12,750	231,818	29,325	1,500,000PhP/km * distance from existing transmission
Direct Cost	70,215	1,276,632	161,494	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	10,532	191,495	24,224	Direct Cost * 0.15
8. Contingency	7,021	127,663	16,149	Direct Cost * 0.1
9. Interest during construction	8,426	153,196	19,379	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	96,194	1,748,986	221,247	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		302		
Development Cost (/kW)	318.072	5,783	731.565	
Annual Generation (kWh/yr)		1,851,954		
Construction Cost per kWh	0.05194	0.94440	0.11947	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.007	0.133	0.017	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 27 Aborlan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					6,047	0	
(1) Excavation (V_e)	m^3	136		2,830	385	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,436	3,895	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		12	371	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,396	0	((1) + (2) + (3)) * 0.3
2. Intake					950	0	
(1) Excavation (Ve)	m^3	136		223	31	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		177	556	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	173	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				190	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,976	0	
(1) Excavation (Ve)	m^3	136		1,073	146	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		321	1,007	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		16	493	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				330	0	((1) + (2) + (3)) * 0.2
4. Headrace					6,252	0	
(1) Excavation (Ve)	m^3	136		35,355	4,809	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,443	0	((1) + (2)) * 0.3
5. Head Tank					2,373	0	
(1) Excavation (Ve)	m^3	136		1,303	178	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		322	1,009	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		16	508	0	$0.051*V_c$
(4) Others	L.S.				678	0	((1) + (2) + (3)) * 0.4
6. Penstock					2,276	0	
(1) Excavation (Ve)	m^3	136		2,202	300	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		432	1,355	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		8	241	0	$0.018*V_c$
(4) Others	L.S.				380	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,838	0	
(1) Excavation (Ve)	m^3	136		660	90	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		227	712	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		14	423	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				613	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					83	0	
(1) Excavation (Ve)	m^3	136		242	33	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	36	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					413	0	
(1) Excavation (Ve)	m^3	136		478	66	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		53	167	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	97	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				83	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,110	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					23,318	0	

No. 28 Maoyon Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 28 Maoyon

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					574	0	
Dam	m^2	239.00		2,400	574	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				115	0	(1.) * 0.2
Subtotal					689	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 28 Maoyon

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,081	0	
Sand Flush Gate	ton	547,000		11.12	6,081	0	$0.145*Q_f^{0.692}$
2. Intake					307	0	
Gate	ton	547,000		0.55	304	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.28	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					233	0	
Gate	ton	547,000		0.42	229	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.32	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		7.01	3,366	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,997	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					11,984	0	

Construction Cost Summary

Site Name: 28 Maoyon

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,185	21,545	2,725	
(1) Access Road	689	12,524	1,584	
(2) Camp & Facilities	496	9,021	1,141	3. Civil work * 0.05
2. Environmental mitigation cost	99	1,804	228	3. Civil work * 0.01
3. Civil works	9,924	180,428	22,824	
(1) Intake weir	3,730	67,818	8,579	
(2) Intake	604	10,982	1,389	
(3) Settling basin	861	15,655	1,980	
(4) Headrace	869	15,800	1,999	
(5) Head tank	1,231	22,382	2,831	
(6) Penstock and spillway channel	1,139	20,709	2,620	
(7) Powerhouse	710	12,909	1,633	
(8) Tailrace channel	60	1,091	138	
(9) Tailrace	247	4,491	568	
(10) Miscellaneous	473	8,592	1,087	((1) to (9)) *0.05
4. Hydraulic equipment	11,984	217,898	27,564	
(1) Gate and screen	6,621	120,382	15,228	
(2) Penstock	3,366	61,200	7,742	
(3) Others	1,997	36,316	4,594	
5. Electro-mechanical equipment	3,361	61,106	7,730	Turbine and Generator, Transformer, etc
6. Transmission line	1,350	24,545	3,105	1,500,000PhP/km * distance from existing transmission
Direct Cost	27,903	507,327	64,177	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	4,185	76,099	9,627	Direct Cost * 0.15
8. Contingency	2,790	50,733	6,418	Direct Cost * 0.1
9. Interest during construction	3,348	60,879	7,701	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	38,227	695,038	87,922	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		81		
Development Cost (/kW)	472.727	8,595	1,087.273	
Annual Generation (kWh/yr)		494,036		
Construction Cost per kWh	0.07738	1.40686	0.17797	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.011	0.199	0.025	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 28 Maoyon

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,730	0	
(1) Excavation (V_e)	m^3	136		1,751	239	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		878	2,382	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		8	248	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				861	0	((1) + (2) + (3)) * 0.3
2. Intake					604	0	
(1) Excavation (Ve)	m^3	136		121	17	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		115	361	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	105	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				121	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					861	0	
(1) Excavation (Ve)	m^3	136		400	55	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		135	425	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		8	237	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				144	0	((1) + (2) + (3)) * 0.2
4. Headrace					869	0	
(1) Excavation (Ve)	m^3	136		4,909	668	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				201	0	((1) + (2)) * 0.3
5. Head Tank					1,231	0	
(1) Excavation (Ve)	m^3	136		685	94	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		166	522	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		8	263	0	$0.051*V_c$
(4) Others	L.S.				352	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,139	0	
(1) Excavation (Ve)	m^3	136		1,101	150	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		216	678	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		4	121	0	$0.018*V_c$
(4) Others	L.S.				190	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					710	0	
(1) Excavation (Ve)	m^3	136		279	38	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		88	277	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		5	158	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				237	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					60	0	
(1) Excavation (Ve)	m^3	136		172	24	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	26	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.2
9. Tailrace outlet					247	0	
(1) Excavation (Ve)	m^3	136		307	42	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		28	89	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	66	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				50	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				473	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					9,924	0	

No. 33 Filantropa Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 33 Filantropa

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,016	0	
Dam	m^2	239.00		16,800	4,016	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				803	0	(1.) * 0.2
Subtotal					4,819	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 33 Filantropa

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,777	0	
Sand Flush Gate	ton	547,000		14.22	7,777	0	$0.145*Q_f^{0.692}$
2. Intake					268	0	
Gate	ton	547,000		0.48	265	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.24	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					199	0	
Gate	ton	547,000		0.36	196	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.27	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.86	1,852	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,019	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,115	0	

Construction Cost Summary

Site Name: 33 Filantropa

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	6,010	109,267	13,822	
(1) Access Road	4,819	87,622	11,084	
(2) Camp & Facilities	1,190	21,645	2,738	3. Civil work * 0.05
2. Environmental mitigation cost	238	4,329	548	3. Civil work * 0.01
3. Civil works	23,810	432,905	54,763	
(1) Intake weir	17,241	313,473	39,654	
(2) Intake	507	9,218	1,166	
(3) Settling basin	628	11,418	1,444	
(4) Headrace	1,713	31,145	3,940	
(5) Head tank	955	17,364	2,197	
(6) Penstock and spillway channel	396	7,200	911	
(7) Powerhouse	978	17,782	2,249	
(8) Tailrace channel	54	982	124	
(9) Tailrace	204	3,709	469	
(10) Miscellaneous	1,134	20,615	2,608	((1) to (9)) *0.05
4. Hydraulic equipment	12,115	220,276	27,865	
(1) Gate and screen	8,244	149,891	18,961	
(2) Penstock	1,852	33,673	4,260	
(3) Others	2,019	36,713	4,644	
5. Electro-mechanical equipment	6,123	111,325	14,083	Turbine and Generator, Transformer, etc
6. Transmission line	12,300	223,636	28,290	1,500,000PhP/km * distance from existing transmission
Direct Cost	60,596	1,101,740	139,370	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	9,089	165,261	20,906	Direct Cost * 0.15
8. Contingency	6,060	110,174	13,937	Direct Cost * 0.1
9. Interest during construction	7,271	132,209	16,724	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	83,016	1,509,383	190,937	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		176		
Development Cost (/kW)	471.783	8,578	1,085.101	
Annual Generation (kWh/yr)		1,073,187		
Construction Cost per kWh	0.07735	1.40645	0.17792	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.011	0.199	0.025	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 33 Filantropa

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					17,241	0	
(1) Excavation (V_e)	m^3	136		8,503	1,157	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		4,144	11,239	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		28	866	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				3,979	0	((1) + (2) + (3)) * 0.3
2. Intake					507	0	
(1) Excavation (Ve)	m^3	136		95	13	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		97	305	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	87	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				102	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					628	0	
(1) Excavation (Ve)	m^3	136		274	38	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		97	305	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	180	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				105	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,713	0	
(1) Excavation (Ve)	m^3	136		9,677	1,317	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				396	0	((1) + (2)) * 0.3
5. Head Tank					955	0	
(1) Excavation (Ve)	m^3	136		536	73	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		129	405	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	204	0	$0.051*V_c$
(4) Others	L.S.				273	0	((1) + (2) + (3)) * 0.4
6. Penstock					396	0	
(1) Excavation (Ve)	m^3	136		442	61	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		73	228	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	41	0	$0.018*V_c$
(4) Others	L.S.				66	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					978	0	
(1) Excavation (Ve)	m^3	136		373	51	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		121	381	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		7	220	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				326	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					54	0	
(1) Excavation (Ve)	m^3	136		154	21	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	24	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				9	0	((1) + (2)) * 0.2
9. Tailrace outlet					204	0	
(1) Excavation (Ve)	m^3	136		259	36	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		22	70	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	57	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				41	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,134	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					23,810	0	

No. 39 Bakungan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 39 Bakungan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,510	0	
Dam	m^2	239.00		10,500	2,510	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				502	0	(1.) * 0.2
Subtotal					3,012	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 39 Bakungan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,150	0	
Sand Flush Gate	ton	547,000		13.07	7,150	0	$0.145*Q_f^{0.692}$
2. Intake					387	0	
Gate	ton	547,000		0.70	383	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.37	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					305	0	
Gate	ton	547,000		0.55	300	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.46	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.07	512	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,671	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					10,025	0	

Construction Cost Summary

Site Name: 39 Bakungan

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,779	68,714	8,692	
(1) Access Road	3,012	54,764	6,928	
(2) Camp & Facilities	767	13,951	1,765	3. Civil work * 0.05
2. Environmental mitigation cost	153	2,790	353	3. Civil work * 0.01
3. Civil works	15,346	279,014	35,295	
(1) Intake weir	4,120	74,909	9,476	
(2) Intake	692	12,582	1,592	
(3) Settling basin	1,106	20,109	2,544	
(4) Headrace	5,741	104,382	13,204	
(5) Head tank	1,498	27,236	3,445	
(6) Penstock and spillway channel	150	2,727	345	
(7) Powerhouse	954	17,345	2,194	
(8) Tailrace channel	66	1,200	152	
(9) Tailrace	288	5,236	662	
(10) Miscellaneous	731	13,286	1,681	((1) to (9)) *0.05
4. Hydraulic equipment	10,025	182,269	23,057	
(1) Gate and screen	7,842	142,582	18,037	
(2) Penstock	512	9,309	1,178	
(3) Others	1,671	30,378	3,843	
5. Electro-mechanical equipment	4,573	83,147	10,518	Turbine and Generator, Transformer, etc
6. Transmission line	300	5,455	690	1,500,000PhP/km * distance from existing transmission
Direct Cost	34,176	621,388	78,606	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	5,126	93,208	11,791	Direct Cost * 0.15
8. Contingency	3,418	62,139	7,861	Direct Cost * 0.1
9. Interest during construction	6,152	111,850	14,149	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 3
Total Cost	48,872	888,586	112,406	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		123		
Development Cost (/kW)	398.624	7,248	916.836	
Annual Generation (kWh/yr)		750,378		
Construction Cost per kWh	0.06513	1.18418	0.14980	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.009	0.167	0.021	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 39 Bakungan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,120	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		963	2,612	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				951	0	((1) + (2) + (3)) * 0.3
2. Intake					692	0	
(1) Excavation (Ve)	m^3	136		145	20	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		131	411	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	122	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				139	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,106	0	
(1) Excavation (Ve)	m^3	136		538	74	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		176	551	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		10	296	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				185	0	((1) + (2) + (3)) * 0.2
4. Headrace					5,741	0	
(1) Excavation (Ve)	m^3	136		32,464	4,416	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,325	0	((1) + (2)) * 0.3
5. Head Tank					1,498	0	
(1) Excavation (Ve)	m^3	136		832	114	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		203	636	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		10	320	0	$0.051*V_c$
(4) Others	L.S.				428	0	((1) + (2) + (3)) * 0.4
6. Penstock					150	0	
(1) Excavation (Ve)	m^3	136		156	22	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		28	87	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	16	0	$0.018*V_c$
(4) Others	L.S.				25	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					954	0	
(1) Excavation (Ve)	m^3	136		365	50	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		119	372	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		7	214	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				318	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					66	0	
(1) Excavation (Ve)	m^3	136		191	26	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		9	29	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					288	0	
(1) Excavation (Ve)	m^3	136		351	48	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		34	107	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	75	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				58	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				731	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,346	0	

No. N8 Bataraza Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N8 Bataraza

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					789	0	
Dam	m^2	239.00		3,300	789	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				158	0	(1.) * 0.2
Subtotal					947	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N8 Bataraza

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,487	0	
Sand Flush Gate	ton	547,000		15.51	8,487	0	$0.145*Q_f^{0.692}$
2. Intake					571	0	
Gate	ton	547,000		1.03	565	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.56	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					477	0	
Gate	ton	547,000		0.85	468	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.81	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.52	2,169	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,341	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,045	0	

Construction Cost Summary

Site Name: N8 Bataraza

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,023	91,336	11,554	
(1) Access Road	947	17,215	2,178	
(2) Camp & Facilities	4,077	74,121	9,376	3. Civil work * 0.05
2. Environmental mitigation cost	815	14,824	1,875	3. Civil work * 0.01
3. Civil works	81,534	1,482,428	187,527	
(1) Intake weir	66,758	1,213,782	153,543	
(2) Intake	988	17,964	2,272	
(3) Settling basin	2,126	38,655	4,890	
(4) Headrace	1,072	19,491	2,466	
(5) Head tank	2,513	45,691	5,780	
(6) Penstock and spillway channel	770	14,000	1,771	
(7) Powerhouse	2,909	52,891	6,691	
(8) Tailrace channel	83	1,509	191	
(9) Tailrace	432	7,855	994	
(10) Miscellaneous	3,883	70,592	8,930	((1) to (9)) *0.05
4. Hydraulic equipment	14,045	255,360	32,303	
(1) Gate and screen	9,535	173,364	21,931	
(2) Penstock	2,169	39,436	4,989	
(3) Others	2,341	42,560	5,384	
5. Electro-mechanical equipment	20,885	379,723	48,035	Turbine and Generator, Transformer, etc
6. Transmission line	44,550	810,000	102,465	1,500,000PhP/km * distance from existing transmission
Direct Cost	166,852	3,033,672	383,759	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	25,028	455,051	57,564	Direct Cost * 0.15
8. Contingency	16,685	303,367	38,376	Direct Cost * 0.1
9. Interest during construction	30,033	546,061	69,077	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 3
Total Cost	238,598	4,338,150	548,776	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		684		
Development Cost (/kW)	348.718	6,340	802.052	
Annual Generation (kWh/yr)		4,190,317		
Construction Cost per kWh	0.05694	1.03528	0.13096	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.008	0.146	0.019	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N8 Bataraza

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					66,758	0	
(1) Excavation (V_e)	m^3	136		26,540	3,610	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		16,601	45,022	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		88	2,720	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				15,406	0	((1) + (2) + (3)) * 0.3
2. Intake					988	0	
(1) Excavation (Ve)	m^3	136		235	32	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		184	577	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	181	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				198	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,126	0	
(1) Excavation (Ve)	m^3	136		1,169	160	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		346	1,086	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		17	525	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				355	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,072	0	
(1) Excavation (Ve)	m^3	136		6,054	824	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				248	0	((1) + (2)) * 0.3
5. Head Tank					2,513	0	
(1) Excavation (Ve)	m^3	136		1,378	188	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		341	1,069	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		17	538	0	$0.051*V_c$
(4) Others	L.S.				718	0	((1) + (2) + (3)) * 0.4
6. Penstock					770	0	
(1) Excavation (Ve)	m^3	136		794	108	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		144	452	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	81	0	$0.018*V_c$
(4) Others	L.S.				129	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,909	0	
(1) Excavation (Ve)	m^3	136		1,000	137	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		357	1,120	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		22	682	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				970	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					83	0	
(1) Excavation (Ve)	m^3	136		242	33	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	36	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					432	0	
(1) Excavation (Ve)	m^3	136		497	68	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		56	176	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	101	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				87	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				3,883	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					81,534	0	

No. N13 Culasian Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N13 Culasian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					8,820	0	
Dam	m^2	239.00		36,900	8,820	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,764	0	(1.) * 0.2
Subtotal					10,584	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N13 Culasian

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,517	0	
Sand Flush Gate	ton	547,000		15.57	8,517	0	$0.145*Q_f^{0.692}$
2. Intake					579	0	
Gate	ton	547,000		1.05	573	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.57	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					485	0	
Gate	ton	547,000		0.87	476	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.83	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		12.05	5,787	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,074	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					18,442	0	

Construction Cost Summary

Site Name:N13 Culasian

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	11,491	208,926	26,429	
(1) Access Road	10,584	192,436	24,343	
(2) Camp & Facilities	907	16,490	2,086	3. Civil work * 0.05
2. Environmental mitigation cost	181	3,298	417	3. Civil work * 0.01
3. Civil works	18,139	329,795	41,719	
(1) Intake weir	2,504	45,527	5,759	
(2) Intake	1,003	18,236	2,307	
(3) Settling basin	2,180	39,636	5,014	
(4) Headrace	4,184	76,073	9,623	
(5) Head tank	2,565	46,636	5,900	
(6) Penstock and spillway channel	1,388	25,236	3,192	
(7) Powerhouse	2,955	53,727	6,797	
(8) Tailrace channel	57	1,036	131	
(9) Tailrace	439	7,982	1,010	
(10) Miscellaneous	864	15,705	1,987	((1) to (9)) *0.05
4. Hydraulic equipment	18,442	335,302	42,416	
(1) Gate and screen	9,581	174,200	22,036	
(2) Penstock	5,787	105,218	13,310	
(3) Others	3,074	55,884	7,069	
5. Electro-mechanical equipment	21,186	385,200	48,728	Turbine and Generator, Transformer, etc
6. Transmission line	37,500	681,818	86,250	1,500,000PhP/km * distance from existing transmission
Direct Cost	106,939	1,944,339	245,959	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	16,041	291,651	36,894	Direct Cost * 0.15
8. Contingency	10,694	194,434	24,596	Direct Cost * 0.1
9. Interest during construction	12,833	233,321	29,515	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	146,506	2,663,745	336,964	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	695			
Development Cost (/kW)	210.926	3,835	485.129	
Annual Generation (kWh/yr)	4,253,909			
Construction Cost per kWh	0.03444	0.62619	0.07921	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.005	0.088	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N13 Culasian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,504	0	
(1) Excavation (V_e)	m^3	136		925	126	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		595	1,614	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				578	0	((1) + (2) + (3)) * 0.3
2. Intake					1,003	0	
(1) Excavation (Ve)	m^3	136		240	33	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		187	585	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	184	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				201	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,180	0	
(1) Excavation (Ve)	m^3	136		1,205	164	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		356	1,115	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		17	537	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				364	0	((1) + (2) + (3)) * 0.2
4. Headrace					4,184	0	
(1) Excavation (Ve)	m^3	136		23,661	3,218	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				966	0	((1) + (2)) * 0.3
5. Head Tank					2,565	0	
(1) Excavation (Ve)	m^3	136		1,406	192	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		348	1,091	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	549	0	$0.051*V_c$
(4) Others	L.S.				733	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,388	0	
(1) Excavation (Ve)	m^3	136		1,383	189	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		262	821	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		5	146	0	$0.018*V_c$
(4) Others	L.S.				232	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,955	0	
(1) Excavation (Ve)	m^3	136		1,015	139	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		363	1,138	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		22	693	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				985	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					57	0	
(1) Excavation (Ve)	m^3	136		256	35	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		4	12	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.2
9. Tailrace outlet					439	0	
(1) Excavation (Ve)	m^3	136		504	69	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		57	180	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	102	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				88	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				864	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					18,139	0	

No. N15 Ira-Iraan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N15 Ira-Iraan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					10,182	0	
Dam	m^2	239.00		42,600	10,182	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				2,036	0	(1.) * 0.2
Subtotal					12,218	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N15 Ira-Iraan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,514	0	
Sand Flush Gate	ton	547,000		13.74	7,514	0	$0.145*Q_f^{0.692}$
2. Intake					503	0	
Gate	ton	547,000		0.91	498	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.49	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					412	0	
Gate	ton	547,000		0.74	405	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.67	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		48.00	23,043	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				6,294	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					37,766	0	

Construction Cost Summary

Site Name:N15 Ira-Iraan

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	15,696	285,386	36,101	
(1) Access Road	12,218	222,153	28,102	
(2) Camp & Facilities	3,478	63,233	7,999	3. Civil work * 0.05
2. Environmental mitigation cost	696	12,647	1,600	3. Civil work * 0.01
3. Civil works	69,556	1,264,658	159,979	
(1) Intake weir	15,080	274,182	34,684	
(2) Intake	883	16,055	2,031	
(3) Settling basin	1,727	31,400	3,972	
(4) Headrace	38,435	698,818	88,401	
(5) Head tank	2,133	38,782	4,906	
(6) Penstock and spillway channel	2,745	49,909	6,314	
(7) Powerhouse	4,832	87,855	11,114	
(8) Tailrace channel	29	527	67	
(9) Tailrace	380	6,909	874	
(10) Miscellaneous	3,312	60,222	7,618	((1) to (9)) *0.05
4. Hydraulic equipment	37,766	686,662	86,863	
(1) Gate and screen	8,429	153,255	19,387	
(2) Penstock	23,043	418,964	52,999	
(3) Others	6,294	114,444	14,477	
5. Electro-mechanical equipment	58,471	1,063,107	134,483	Turbine and Generator, Transformer, etc
6. Transmission line	37,500	681,818	86,250	1,500,000PhP/km * distance from existing transmission
Direct Cost	219,685	3,994,277	505,276	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	32,953	599,142	75,791	Direct Cost * 0.15
8. Contingency	21,969	399,428	50,528	Direct Cost * 0.1
9. Interest during construction	26,362	479,313	60,633	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	300,969	5,472,160	692,228	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	1,978			
Development Cost (/kW)	152.135	2,766	349.910	
Annual Generation (kWh/yr)	12,102,545			
Construction Cost per kWh	0.02487	0.45215	0.05720	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.004	0.064	0.008	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N15 Ira-Iraan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					15,080	0	
(1) Excavation (V_e)	m^3	3,134		2,629	8,240	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,125	3,051	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		10	309	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				3,480	0	((1) + (2) + (3)) * 0.3
2. Intake					883	0	
(1) Excavation (Ve)	m^3	136		202	28	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		165	518	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	160	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				177	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,727	0	
(1) Excavation (Ve)	m^3	136		915	125	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		279	876	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	438	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				288	0	((1) + (2) + (3)) * 0.2
4. Headrace(Tunnel)					38,435	0	
(1) Excavation (Ve)	m^3	314		11,137	3,497	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		425	2,119	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	13,622		1,758	23,949		(pai*D+D)*0.1*L
(4) Others	L.S.				8,870	0	((1) + (2) + (3)) * 0.3
5. Head Tank					2,133	0	
(1) Excavation (Ve)	m^3	136		1,175	160	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		289	907	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		15	456	0	$0.051*V_c$
(4) Others	L.S.				610	0	((1) + (2) + (3)) * 0.4
6. Penstock					2,745	0	
(1) Excavation (Ve)	m^3	136		2,835	386	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		515	1,614	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		9	287	0	$0.018*V_c$
(4) Others	L.S.				458	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					4,832	0	
(1) Excavation (Ve)	m^3	136		1,583	216	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		590	1,850	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		37	1,155	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,611	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					29	0	
(1) Excavation (Ve)	m^3	136		77	11	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		4	13	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				5	0	((1) + (2)) * 0.2
9. Tailrace outlet					380	0	
(1) Excavation (Ve)	m^3	136		445	61	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		48	151	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	92	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				3,312	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					69,556	0	

No. N17 Culasian Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N17 Culasian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					9,680	0	
Dam	m^2	239.00		40,500	9,680	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,936	0	(1.) * 0.2
Subtotal					11,616	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N17 Culasian

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,109	0	
Sand Flush Gate	ton	547,000		12.99	7,109	0	$0.145*Q_f^{0.692}$
2. Intake					151	0	
Gate	ton	547,000		0.27	149	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.13	2	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					103	0	
Gate	ton	547,000		0.18	101	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.11	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.88	2,341	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,941	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					11,645	0	

Construction Cost Summary

Site Name:N17 Culasian

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	12,115	220,270	27,864	
(1) Access Road	11,616	211,200	26,717	
(2) Camp & Facilities	499	9,070	1,147	3. Civil work * 0.05
2. Environmental mitigation cost	100	1,814	229	3. Civil work * 0.01
3. Civil works	9,977	181,402	22,947	
(1) Intake weir	5,515	100,273	12,685	
(2) Intake	328	5,964	754	
(3) Settling basin	282	5,127	649	
(4) Headrace	1,778	32,327	4,089	
(5) Head tank	503	9,145	1,157	
(6) Penstock and spillway channel	454	8,255	1,044	
(7) Powerhouse	476	8,655	1,095	
(8) Tailrace channel	39	709	90	
(9) Tailrace	127	2,309	292	
(10) Miscellaneous	475	8,638	1,093	((1) to (9)) *0.05
4. Hydraulic equipment	11,645	211,724	26,783	
(1) Gate and screen	7,363	133,873	16,935	
(2) Penstock	2,341	42,564	5,384	
(3) Others	1,941	35,287	4,464	
5. Electro-mechanical equipment	4,263	77,516	9,806	Turbine and Generator, Transformer, etc
6. Transmission line	18,900	343,636	43,470	1,500,000PhP/km * distance from existing transmission
Direct Cost	57,000	1,036,362	131,100	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,550	155,454	19,665	Direct Cost * 0.15
8. Contingency	5,700	103,636	13,110	Direct Cost * 0.1
9. Interest during construction	6,840	124,363	15,732	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	78,090	1,419,816	179,607	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		112		
Development Cost (/kW)	697.604	12,684	1,604.489	
Annual Generation (kWh/yr)		677,983		
Construction Cost per kWh	0.11518	2.09418	0.26491	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.016	0.296	0.037	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N17 Culasian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,515	0	
(1) Excavation (V_e)	m^3	136		3,237	441	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,276	3,461	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		11	340	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,273	0	((1) + (2) + (3)) * 0.3
2. Intake					328	0	
(1) Excavation (Ve)	m^3	136		52	8	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		64	200	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	54	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				66	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					282	0	
(1) Excavation (Ve)	m^3	136		105	15	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		42	132	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		3	88	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				47	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,778	0	
(1) Excavation (Ve)	m^3	136		10,045	1,367	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				411	0	((1) + (2)) * 0.3
5. Head Tank					503	0	
(1) Excavation (Ve)	m^3	136		286	39	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		68	213	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		3	107	0	$0.051*V_c$
(4) Others	L.S.				144	0	((1) + (2) + (3)) * 0.4
6. Penstock					454	0	
(1) Excavation (Ve)	m^3	136		550	75	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		82	257	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	46	0	$0.018*V_c$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					476	0	
(1) Excavation (Ve)	m^3	136		193	27	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		59	186	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	104	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				159	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					39	0	
(1) Excavation (Ve)	m^3	136		109	15	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		5	17	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				7	0	((1) + (2)) * 0.2
9. Tailrace outlet					127	0	
(1) Excavation (Ve)	m^3	136		169	23	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		12	38	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		1	40	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				26	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				475	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					9,977	0	

No. N20 Saraza Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N20 Saraza

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,721	0	
Dam	m^2	239.00		7,200	1,721	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				344	0	(1.) * 0.2
Subtotal					2,065	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N20 Saraza

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,067	0	
Sand Flush Gate	ton	547,000		11.09	6,067	0	$0.145*Q_f^{0.692}$
2. Intake					401	0	
Gate	ton	547,000		0.72	397	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.38	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					317	0	
Gate	ton	547,000		0.57	312	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.48	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		8.32	3,992	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,155	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,932	0	

Construction Cost Summary

Site Name:N20 Saraza

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	3,706	67,373	8,523	
(1) Access Road	2,065	37,549	4,750	
(2) Camp & Facilities	1,640	29,824	3,773	3. Civil work * 0.05
2. Environmental mitigation cost	328	5,965	755	3. Civil work * 0.01
3. Civil works	32,806	596,476	75,454	
(1) Intake weir	13,493	245,327	31,034	
(2) Intake	715	13,000	1,645	
(3) Settling basin	1,173	21,327	2,698	
(4) Headrace	11,010	200,182	25,323	
(5) Head tank	1,571	28,564	3,613	
(6) Penstock and spillway channel	772	14,036	1,776	
(7) Powerhouse	2,145	39,000	4,934	
(8) Tailrace channel	66	1,200	152	
(9) Tailrace	299	5,436	688	
(10) Miscellaneous	1,562	28,404	3,593	((1) to (9)) *0.05
4. Hydraulic equipment	12,932	235,135	29,745	
(1) Gate and screen	6,785	123,364	15,606	
(2) Penstock	3,992	72,582	9,182	
(3) Others	2,155	39,189	4,957	
5. Electro-mechanical equipment	16,660	302,914	38,319	Turbine and Generator, Transformer, etc
6. Transmission line	30,750	559,091	70,725	1,500,000PhP/km * distance from existing transmission
Direct Cost	97,182	1,766,953	223,520	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	14,577	265,043	33,528	Direct Cost * 0.15
8. Contingency	9,718	176,695	22,352	Direct Cost * 0.1
9. Interest during construction	11,662	212,034	26,822	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	133,140	2,420,726	306,222	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		539		
Development Cost (/kW)	247.121	4,493	568.378	
Annual Generation (kWh/yr)		3,295,372		
Construction Cost per kWh	0.04040	0.73458	0.09292	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.006	0.104	0.013	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N20 Saraza

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					13,493	0	
(1) Excavation (V_e)	m^3	136		12,768	1,737	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		2,947	7,993	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		21	649	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				3,114	0	((1) + (2) + (3)) * 0.3
2. Intake					715	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		135	424	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	127	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				143	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,173	0	
(1) Excavation (Ve)	m^3	136		578	79	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		187	586	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		10	312	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				196	0	((1) + (2) + (3)) * 0.2
4. Headrace					11,010	0	
Tunnel							
(1) Excavation (Ve)	m^3	314		6,454	2,027	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		246	1,228	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	4,990		1,019	5,084	0	(pai*D+D)*0.1*L
Open channel							
(4) Excavation (Ve)	m^3	136		955	130	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(5) Concrete(Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(6) Others	L.S.				2,541	0	((1) + (2) + (3) + (4) + (5)) * 0.3
5. Head Tank					1,571	0	
(1) Excavation (Ve)	m^3	136		871	119	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		213	667	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		11	336	0	$0.051*V_c$
(4) Others	L.S.				449	0	((1) + (2) + (3)) * 0.4
6. Penstock					772	0	
(1) Excavation (Ve)	m^3	136		810	111	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		144	451	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	81	0	$0.018*V_c$
(4) Others	L.S.				129	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,145	0	
(1) Excavation (Ve)	m^3	136		760	104	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		264	829	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		16	497	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				715	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					66	0	
(1) Excavation (Ve)	m^3	136		191	26	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		9	29	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					299	0	
(1) Excavation (Ve)	m^3	136		362	50	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		36	112	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	77	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				60	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,562	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					32,806	0	

No. N29 Salongan 4 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N29 Salongon4

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,016	0	
Dam	m^2	239.00		16,800	4,016	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				803	0	(1.) * 0.2
Subtotal					4,819	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N29 Salongon4

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,329	0	
Sand Flush Gate	ton	547,000		13.40	7,329	0	$0.145*Q_f^{0.692}$
2. Intake					490	0	
Gate	ton	547,000		0.89	485	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.47	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					400	0	
Gate	ton	547,000		0.72	393	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.65	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		5.60	2,687	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,181	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,087	0	

Construction Cost Summary

Site Name: N29 Salongon4

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	8,713	158,418	20,040	
(1) Access Road	4,819	87,622	11,084	
(2) Camp & Facilities	3,894	70,796	8,956	3. Civil work * 0.05
2. Environmental mitigation cost	779	14,159	1,791	3. Civil work * 0.01
3. Civil works	77,875	1,415,915	179,113	
(1) Intake weir	62,790	1,141,636	144,417	
(2) Intake	860	15,636	1,978	
(3) Settling basin	1,646	29,927	3,786	
(4) Headrace	2,370	43,091	5,451	
(5) Head tank	2,053	37,327	4,722	
(6) Penstock and spillway channel	880	16,000	2,024	
(7) Powerhouse	3,123	56,782	7,183	
(8) Tailrace channel	77	1,400	177	
(9) Tailrace	368	6,691	846	
(10) Miscellaneous	3,708	67,425	8,529	((1) to (9)) *0.05
4. Hydraulic equipment	13,087	237,949	30,101	
(1) Gate and screen	8,219	149,436	18,904	
(2) Penstock	2,687	48,855	6,180	
(3) Others	2,181	39,658	5,017	
5. Electro-mechanical equipment	27,164	493,890	62,477	Turbine and Generator, Transformer, etc
6. Transmission line	24,900	452,727	57,270	1,500,000PhP/km * distance from existing transmission
Direct Cost	152,518	2,773,058	350,792	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	22,878	415,959	52,619	Direct Cost * 0.15
8. Contingency	15,252	277,306	35,079	Direct Cost * 0.1
9. Interest during construction	18,302	332,767	42,095	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	208,950	3,799,090	480,585	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		900		
Development Cost (/kW)	232.062	4,219	533.742	
Annual Generation (kWh/yr)		5,512,039		
Construction Cost per kWh	0.03791	0.68923	0.08719	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.097	0.012	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N29 Salongon4

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					62,790	0	
(1) Excavation (V_e)	m^3	136		22,858	3,109	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		15,706	42,595	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		84	2,596	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				14,490	0	((1) + (2) + (3)) * 0.3
2. Intake					860	0	
(1) Excavation (Ve)	m^3	136		195	27	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		161	506	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				172	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,646	0	
(1) Excavation (Ve)	m^3	136		864	118	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		266	833	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	420	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				275	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,370	0	
(1) Excavation (Ve)	m^3	136		13,397	1,823	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				547	0	((1) + (2)) * 0.3
5. Head Tank					2,053	0	
(1) Excavation (Ve)	m^3	136		1,132	154	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		278	873	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		14	439	0	$0.051*V_c$
(4) Others	L.S.				587	0	((1) + (2) + (3)) * 0.4
6. Penstock					880	0	
(1) Excavation (Ve)	m^3	136		943	129	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		163	513	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	91	0	$0.018*V_c$
(4) Others	L.S.				147	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,123	0	
(1) Excavation (Ve)	m^3	136		1,067	146	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		383	1,202	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		24	734	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,041	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					77	0	
(1) Excavation (Ve)	m^3	136		223	31	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	33	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.2
9. Tailrace outlet					368	0	
(1) Excavation (Ve)	m^3	136		434	60	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		46	145	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	89	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				74	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				3,708	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					77,875	0	

No. N42 Culandanum 3 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N42 Culandanum 3

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,442	0	
Dam	m^2	239.00		14,400	3,442	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				688	0	(1.) * 0.2
Subtotal					4,130	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N42 Culandanum 3

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,951	0	
Sand Flush Gate	ton	547,000		20.02	10,951	0	$0.145*Q_f^{0.692}$
2. Intake					503	0	
Gate	ton	547,000		0.91	498	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.49	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					269	0	
Gate	ton	547,000		0.48	265	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.39	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.69	1,772	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,699	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					16,194	0	

Construction Cost Summary

Site Name: N42 Culandanum 3

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	4,720	85,812	10,855	
(1) Access Road	4,130	75,098	9,500	
(2) Camp & Facilities	589	10,714	1,355	3. Civil work * 0.05
2. Environmental mitigation cost	118	2,143	271	3. Civil work * 0.01
3. Civil works	11,785	214,276	27,106	
(1) Intake weir	5,827	105,945	13,402	
(2) Intake	754	13,709	1,734	
(3) Settling basin	693	12,600	1,594	
(4) Headrace	591	10,745	1,359	
(5) Head tank	1,035	18,818	2,381	
(6) Penstock and spillway channel	582	10,582	1,339	
(7) Powerhouse	1,365	24,818	3,140	
(8) Tailrace channel	60	1,091	138	
(9) Tailrace	317	5,764	729	
(10) Miscellaneous	561	10,204	1,291	((1) to (9)) *0.05
4. Hydraulic equipment	16,194	294,436	37,246	
(1) Gate and screen	11,723	213,145	26,963	
(2) Penstock	1,772	32,218	4,076	
(3) Others	2,699	49,073	6,208	
5. Electro-mechanical equipment	10,023	182,241	23,054	Turbine and Generator, Transformer, etc
6. Transmission line	15,900	289,091	36,570	1,500,000PhP/km * distance from existing transmission
Direct Cost	58,740	1,068,000	135,102	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,811	160,200	20,265	Direct Cost * 0.15
8. Contingency	5,874	106,800	13,510	Direct Cost * 0.1
9. Interest during construction	7,049	128,160	16,212	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	80,474	1,463,159	185,090	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		310		
Development Cost (/kW)	259.382	4,716	596.578	
Annual Generation (kWh/yr)		1,894,145		
Construction Cost per kWh	0.04249	0.77246	0.09772	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.006	0.109	0.014	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N42 Culandanum 3

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,827	0	
(1) Excavation (V_e)	m^3	136		3,546	483	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,349	3,659	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		11	340	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,345	0	((1) + (2) + (3)) * 0.3
2. Intake					754	0	
(1) Excavation (Ve)	m^3	136		163	23	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		142	446	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	134	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				151	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					693	0	
(1) Excavation (Ve)	m^3	136		309	42	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		108	339	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	196	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				116	0	((1) + (2) + (3)) * 0.2
4. Headrace					591	0	
(1) Excavation (Ve)	m^3	136		3,336	454	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				137	0	((1) + (2)) * 0.3
5. Head Tank					1,035	0	
(1) Excavation (Ve)	m^3	136		579	79	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		140	439	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	221	0	$0.051*V_c$
(4) Others	L.S.				296	0	((1) + (2) + (3)) * 0.4
6. Penstock					582	0	
(1) Excavation (Ve)	m^3	136		624	85	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		108	339	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.018*V_c$
(4) Others	L.S.				97	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,365	0	
(1) Excavation (Ve)	m^3	136		504	69	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		169	530	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		10	311	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				455	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					60	0	
(1) Excavation (Ve)	m^3	136		159	22	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	24	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.3
9. Tailrace outlet					317	0	
(1) Excavation (Ve)	m^3	136		381	52	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		38	121	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	80	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				561	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					11,785	0	

No. N52 Binduyan 1-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N52 Binduyan1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					717	0	
Dam	m^2	239.00		3,000	717	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				143	0	(1.) * 0.2
Subtotal					860	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N52 Binduyan1-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,846	0	
Sand Flush Gate	ton	547,000		10.69	5,846	0	$0.145*Q_f^{0.692}$
2. Intake					429	0	
Gate	ton	547,000		0.77	424	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.41	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					224	0	
Gate	ton	547,000		0.40	220	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.31	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.20	577	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,415	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					8,491	0	

Construction Cost Summary

Site Name: N52 Binduyan1-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	1,255	22,826	2,887	
(1) Access Road	860	15,644	1,979	
(2) Camp & Facilities	395	7,182	909	3. Civil work * 0.05
2. Environmental mitigation cost	79	1,436	182	3. Civil work * 0.01
3. Civil works	7,900	143,640	18,170	
(1) Intake weir	3,325	60,455	7,648	
(2) Intake	732	13,309	1,684	
(3) Settling basin	658	11,964	1,513	
(4) Headrace	570	10,364	1,311	
(5) Head tank	993	18,055	2,284	
(6) Penstock and spillway channel	191	3,473	439	
(7) Powerhouse	696	12,655	1,601	
(8) Tailrace channel	52	945	120	
(9) Tailrace	307	5,582	706	
(10) Miscellaneous	376	6,840	865	((1) to (9)) *0.05
4. Hydraulic equipment	8,491	154,385	19,530	
(1) Gate and screen	6,499	118,164	14,948	
(2) Penstock	577	10,491	1,327	
(3) Others	1,415	25,731	3,255	
5. Electro-mechanical equipment	3,647	66,300	8,387	Turbine and Generator, Transformer, etc
6. Transmission line	600	10,909	1,380	1,500,000PhP/km * distance from existing transmission
Direct Cost	21,972	399,497	50,536	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	3,296	59,925	7,580	Direct Cost * 0.15
8. Contingency	2,197	39,950	5,054	Direct Cost * 0.1
9. Interest during construction	2,637	47,940	6,064	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	30,102	547,311	69,235	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		91		
Development Cost (/kW)	331.884	6,034	763.333	
Annual Generation (kWh/yr)		553,428		
Construction Cost per kWh	0.05439	0.98895	0.12510	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.008	0.140	0.018	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N52 Binduyan1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,325	0	
(1) Excavation (V_e)	m^3	136		1,469	200	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		789	2,140	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.3
2. Intake					732	0	
(1) Excavation (Ve)	m^3	136		157	22	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		138	433	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	130	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				147	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					658	0	
(1) Excavation (Ve)	m^3	136		290	40	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		102	321	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	187	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				110	0	((1) + (2) + (3)) * 0.2
4. Headrace					570	0	
(1) Excavation (Ve)	m^3	136		3,214	438	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				132	0	((1) + (2)) * 0.3
5. Head Tank					993	0	
(1) Excavation (Ve)	m^3	136		556	76	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		134	421	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	212	0	$0.051*V_c$
(4) Others	L.S.				284	0	((1) + (2) + (3)) * 0.4
6. Penstock					191	0	
(1) Excavation (Ve)	m^3	136		203	28	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		35	111	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	20	0	$0.018*V_c$
(4) Others	L.S.				32	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					696	0	
(1) Excavation (Ve)	m^3	136		274	38	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		87	272	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		5	154	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				232	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					52	0	
(1) Excavation (Ve)	m^3	136		137	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	21	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					307	0	
(1) Excavation (Ve)	m^3	136		371	51	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		37	116	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	78	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				62	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				376	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					7,900	0	

No. N54 Binduyan 2-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N54 Binduyan2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,434	0	
Dam	m^2	239.00		6,000	1,434	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				287	0	(1.) * 0.2
Subtotal					1,721	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N54 Binduyan2-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,703	0	
Sand Flush Gate	ton	547,000		10.43	5,703	0	$0.145*Q_f^{0.692}$
2. Intake					416	0	
Gate	ton	547,000		0.75	412	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.40	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					216	0	
Gate	ton	547,000		0.39	213	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.30	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.87	1,860	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,639	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					9,834	0	

Construction Cost Summary

Site Name: N54 Binduyan2-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,238	40,682	5,146	
(1) Access Road	1,721	31,287	3,958	
(2) Camp & Facilities	517	9,395	1,188	3. Civil work * 0.05
2. Environmental mitigation cost	103	1,879	238	3. Civil work * 0.01
3. Civil works	10,334	187,893	23,768	
(1) Intake weir	3,586	65,200	8,248	
(2) Intake	715	13,000	1,645	
(3) Settling basin	629	11,436	1,447	
(4) Headrace	1,631	29,655	3,751	
(5) Head tank	958	17,418	2,203	
(6) Penstock and spillway channel	558	10,145	1,283	
(7) Powerhouse	1,407	25,582	3,236	
(8) Tailrace channel	59	1,073	136	
(9) Tailrace	299	5,436	688	
(10) Miscellaneous	492	8,947	1,132	((1) to (9)) *0.05
4. Hydraulic equipment	9,834	178,800	22,618	
(1) Gate and screen	6,335	115,182	14,571	
(2) Penstock	1,860	33,818	4,278	
(3) Others	1,639	29,800	3,770	
5. Electro-mechanical equipment	11,067	201,219	25,454	Turbine and Generator, Transformer, etc
6. Transmission line	600	10,909	1,380	1,500,000PhP/km * distance from existing transmission
Direct Cost	34,176	621,382	78,605	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	5,126	93,207	11,791	Direct Cost * 0.15
8. Contingency	3,418	62,138	7,860	Direct Cost * 0.1
9. Interest during construction	4,101	74,566	9,433	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	46,821	851,293	107,689	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		346		
Development Cost (/kW)	135.247	2,459	311.068	
Annual Generation (kWh/yr)		2,113,375		
Construction Cost per kWh	0.02215	0.40281	0.05096	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.057	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N54 Binduyan2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,586	0	
(1) Excavation (V_e)	m^3	136		1,637	223	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		843	2,287	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		8	248	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				828	0	((1) + (2) + (3)) * 0.3
2. Intake					715	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		135	424	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	127	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				143	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					629	0	
(1) Excavation (Ve)	m^3	136		275	38	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		98	306	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	180	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				105	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,631	0	
(1) Excavation (Ve)	m^3	136		9,216	1,254	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				377	0	((1) + (2)) * 0.3
5. Head Tank					958	0	
(1) Excavation (Ve)	m^3	136		537	74	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		129	406	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	204	0	$0.051*V_c$
(4) Others	L.S.				274	0	((1) + (2) + (3)) * 0.4
6. Penstock					558	0	
(1) Excavation (Ve)	m^3	136		624	85	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		103	322	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	58	0	$0.018*V_c$
(4) Others	L.S.				93	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,407	0	
(1) Excavation (Ve)	m^3	136		518	71	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		174	546	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		10	321	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				469	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					59	0	
(1) Excavation (Ve)	m^3	136		154	21	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	24	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.3
9. Tailrace outlet					299	0	
(1) Excavation (Ve)	m^3	136		362	50	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		36	112	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	77	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				60	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				492	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					10,334	0	

No. N56 Binduyan 3-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N56 Binduyan1 3-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,793	0	
Dam	m^2	239.00		7,500	1,793	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				359	0	(1.) * 0.2
Subtotal					2,152	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N56 Binduyan1 3-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,485	0	
Sand Flush Gate	ton	547,000		10.03	5,485	0	$0.145*Q_f^{0.692}$
2. Intake					400	0	
Gate	ton	547,000		0.72	396	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.38	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					207	0	
Gate	ton	547,000		0.37	204	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.28	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		8.37	4,017	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,022	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,131	0	

Construction Cost Summary

Site Name: N56 Binduyan1 3-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,814	51,164	6,472	
(1) Access Road	2,152	39,120	4,949	
(2) Camp & Facilities	662	12,044	1,524	3. Civil work * 0.05
2. Environmental mitigation cost	132	2,409	305	3. Civil work * 0.01
3. Civil works	13,248	240,870	30,470	
(1) Intake weir	4,462	81,127	10,263	
(2) Intake	689	12,527	1,585	
(3) Settling basin	590	10,727	1,357	
(4) Headrace	2,572	46,764	5,916	
(5) Head tank	909	16,527	2,091	
(6) Penstock and spillway channel	1,203	21,873	2,767	
(7) Powerhouse	1,850	33,636	4,255	
(8) Tailrace channel	55	1,000	127	
(9) Tailrace	287	5,218	660	
(10) Miscellaneous	631	11,470	1,451	((1) to (9)) *0.05
4. Hydraulic equipment	12,131	220,560	27,901	
(1) Gate and screen	6,092	110,764	14,012	
(2) Penstock	4,017	73,036	9,239	
(3) Others	2,022	36,760	4,650	
5. Electro-mechanical equipment	18,428	335,058	42,385	Turbine and Generator, Transformer, etc
6. Transmission line	600	10,909	1,380	1,500,000PhP/km * distance from existing transmission
Direct Cost	47,353	860,969	108,913	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	7,103	129,145	16,337	Direct Cost * 0.15
8. Contingency	4,735	86,097	10,891	Direct Cost * 0.1
9. Interest during construction	5,682	103,316	13,070	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	64,874	1,179,528	149,210	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		600		
Development Cost (/kW)	108.189	1,967	248.835	
Annual Generation (kWh/yr)		3,660,669		
Construction Cost per kWh	0.01772	0.32222	0.04076	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.046	0.006	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N56 Binduyan1 3-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,462	0	
(1) Excavation (V_e)	m^3	136		2,332	318	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,045	2,835	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,030	0	((1) + (2) + (3)) * 0.3
2. Intake					689	0	
(1) Excavation (Ve)	m^3	136		144	20	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		130	409	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	122	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				138	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					590	0	
(1) Excavation (Ve)	m^3	136		254	35	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		91	286	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	170	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				99	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,572	0	
(1) Excavation (Ve)	m^3	136		14,541	1,978	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				594	0	((1) + (2)) * 0.3
5. Head Tank					909	0	
(1) Excavation (Ve)	m^3	136		509	70	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		123	385	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	194	0	$0.051*V_c$
(4) Others	L.S.				260	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,203	0	
(1) Excavation (Ve)	m^3	136		1,348	184	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		221	694	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		4	124	0	$0.018*V_c$
(4) Others	L.S.				201	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,850	0	
(1) Excavation (Ve)	m^3	136		664	91	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		228	716	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		14	426	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				617	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					55	0	
(1) Excavation (Ve)	m^3	136		145	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.3
9. Tailrace outlet					287	0	
(1) Excavation (Ve)	m^3	136		349	48	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		34	107	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	74	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				58	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				631	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					13,248	0	

No. N58 Binduyan 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N58 Binduyan2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,865	0	
Dam	m^2	239.00		7,800	1,865	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				373	0	(1.) * 0.2
Subtotal					2,238	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N58 Binduyan2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					4,431	0	
Sand Flush Gate	ton	547,000		8.10	4,431	0	$0.145*Q_f^{0.692}$
2. Intake					324	0	
Gate	ton	547,000		0.58	320	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.30	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					162	0	
Gate	ton	547,000		0.29	159	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.20	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.96	461	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,076	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					6,454	0	

Construction Cost Summary

Site Name: N58 Binduyan2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,731	49,653	6,281	
(1) Access Road	2,238	40,691	5,147	
(2) Camp & Facilities	493	8,962	1,134	3. Civil work * 0.05
2. Environmental mitigation cost	99	1,792	227	3. Civil work * 0.01
3. Civil works	9,858	179,245	22,674	
(1) Intake weir	5,992	108,945	13,782	
(2) Intake	568	10,327	1,306	
(3) Settling basin	413	7,509	950	
(4) Headrace	787	14,309	1,810	
(5) Head tank	685	12,455	1,576	
(6) Penstock and spillway channel	141	2,564	324	
(7) Powerhouse	521	9,473	1,198	
(8) Tailrace channel	50	909	115	
(9) Tailrace	232	4,218	534	
(10) Miscellaneous	469	8,535	1,080	((1) to (9)) *0.05
4. Hydraulic equipment	6,454	117,338	14,843	
(1) Gate and screen	4,917	89,400	11,309	
(2) Penstock	461	8,382	1,060	
(3) Others	1,076	19,556	2,474	
5. Electro-mechanical equipment	2,993	54,424	6,885	Turbine and Generator, Transformer, etc
6. Transmission line	2,850	51,818	6,555	1,500,000PhP/km * distance from existing transmission
Direct Cost	24,985	454,271	57,465	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	3,748	68,141	8,620	Direct Cost * 0.15
8. Contingency	2,498	45,427	5,747	Direct Cost * 0.1
9. Interest during construction	2,998	54,512	6,896	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	34,229	622,351	78,727	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		68		
Development Cost (/kW)	501.810	9,124	1,154.164	
Annual Generation (kWh/yr)		415,435		
Construction Cost per kWh	0.08239	1.49807	0.18951	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.012	0.212	0.027	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N58 Binduyan2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,992	0	
(1) Excavation (V_e)	m^3	136		3,670	500	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,378	3,738	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		12	371	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,383	0	((1) + (2) + (3)) * 0.3
2. Intake					568	0	
(1) Excavation (Ve)	m^3	136		111	16	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		108	340	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	98	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				114	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					413	0	
(1) Excavation (Ve)	m^3	136		166	23	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		63	197	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	124	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				69	0	((1) + (2) + (3)) * 0.2
4. Headrace					787	0	
(1) Excavation (Ve)	m^3	136		4,444	605	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				182	0	((1) + (2)) * 0.3
5. Head Tank					685	0	
(1) Excavation (Ve)	m^3	136		387	53	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		92	290	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	146	0	$0.051*V_c$
(4) Others	L.S.				196	0	((1) + (2) + (3)) * 0.4
6. Penstock					141	0	
(1) Excavation (Ve)	m^3	136		155	22	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		25	80	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	15	0	$0.018*V_c$
(4) Others	L.S.				24	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					521	0	
(1) Excavation (Ve)	m^3	136		210	29	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		65	204	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		4	114	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				174	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					50	0	
(1) Excavation (Ve)	m^3	136		127	18	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	20	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					232	0	
(1) Excavation (Ve)	m^3	136		289	40	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		26	82	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	63	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				47	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				469	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					9,858	0	

No. N60 Binduyan 4-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N60 Binduyan4 1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					9,895	0	
Dam	m^2	239.00		41,400	9,895	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				1,979	0	(1.) * 0.2
Subtotal					11,874	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N60 Binduyan4 1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,316	0	
Sand Flush Gate	ton	547,000		9.72	5,316	0	$0.145*Q_f^{0.692}$
2. Intake					388	0	
Gate	ton	547,000		0.70	384	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.37	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					200	0	
Gate	ton	547,000		0.36	197	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.27	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.48	712	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,323	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					7,939	0	

Construction Cost Summary

Site Name: N60 Binduyan4 1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	12,298	223,593	28,285	
(1) Access Road	11,874	215,891	27,310	
(2) Camp & Facilities	424	7,702	974	3. Civil work * 0.05
2. Environmental mitigation cost	85	1,540	195	3. Civil work * 0.01
3. Civil works	8,472	154,045	19,487	
(1) Intake weir	3,939	71,618	9,060	
(2) Intake	669	12,164	1,539	
(3) Settling basin	560	10,182	1,288	
(4) Headrace	745	13,545	1,714	
(5) Head tank	873	15,873	2,008	
(6) Penstock and spillway channel	237	4,309	545	
(7) Powerhouse	713	12,964	1,640	
(8) Tailrace channel	55	1,000	127	
(9) Tailrace	278	5,055	639	
(10) Miscellaneous	403	7,335	928	((1) to (9)) *0.05
4. Hydraulic equipment	7,939	144,349	18,260	
(1) Gate and screen	5,904	107,345	13,579	
(2) Penstock	712	12,945	1,638	
(3) Others	1,323	24,058	3,043	
5. Electro-mechanical equipment	4,023	73,140	9,252	Turbine and Generator, Transformer, etc
6. Transmission line	23,400	425,455	53,820	1,500,000PhP/km * distance from existing transmission
Direct Cost	56,217	1,022,122	129,298	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,433	153,318	19,395	Direct Cost * 0.15
8. Contingency	5,622	102,212	12,930	Direct Cost * 0.1
9. Interest during construction	6,746	122,655	15,516	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	77,017	1,400,307	177,139	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	104			
Development Cost (/kW)	743.025	13,510	1,708.957	
Annual Generation (kWh/yr)	631,997			
Construction Cost per kWh	0.12186	2.21569	0.28028	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.017	0.313	0.040	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N60 Binduyan4 1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,939	0	
(1) Excavation (V_e)	m^3	136		1,923	262	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		929	2,520	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		8	248	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				909	0	((1) + (2) + (3)) * 0.3
2. Intake					669	0	
(1) Excavation (Ve)	m^3	136		139	19	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		127	398	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	118	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				134	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					560	0	
(1) Excavation (Ve)	m^3	136		239	33	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		86	271	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	162	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				94	0	((1) + (2) + (3)) * 0.2
4. Headrace					745	0	
(1) Excavation (Ve)	m^3	136		4,209	573	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				172	0	((1) + (2)) * 0.3
5. Head Tank					873	0	
(1) Excavation (Ve)	m^3	136		490	67	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		118	370	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.051*V_c$
(4) Others	L.S.				250	0	((1) + (2) + (3)) * 0.4
6. Penstock					237	0	
(1) Excavation (Ve)	m^3	136		251	35	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		43	137	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	25	0	$0.018*V_c$
(4) Others	L.S.				40	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					713	0	
(1) Excavation (Ve)	m^3	136		280	39	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		89	278	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		5	158	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				238	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					55	0	
(1) Excavation (Ve)	m^3	136		140	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.3
9. Tailrace outlet					278	0	
(1) Excavation (Ve)	m^3	136		340	47	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		33	103	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	72	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				56	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				403	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,472	0	

No. N61 Binduyan 4-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N61 Binduyan4 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					11,759	0	
Dam	m^2	239.00		49,200	11,759	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				2,352	0	(1.) * 0.2
Subtotal					14,111	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N61 Binduyan4 2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,033	0	
Sand Flush Gate	ton	547,000		9.20	5,033	0	$0.145*Q_f^{0.692}$
2. Intake					367	0	
Gate	ton	547,000		0.66	363	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.34	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					187	0	
Gate	ton	547,000		0.34	184	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.25	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		21.11	10,133	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,144	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					18,864	0	

Construction Cost Summary

Site Name: N61 Binduyan4 2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	14,696	267,202	33,801	
(1) Access Road	14,111	256,560	32,455	
(2) Camp & Facilities	585	10,642	1,346	3. Civil work * 0.05
2. Environmental mitigation cost	117	2,128	269	3. Civil work * 0.01
3. Civil works	11,706	212,845	26,925	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	637	11,582	1,465	
(3) Settling basin	512	9,309	1,178	
(4) Headrace	887	16,127	2,040	
(5) Head tank	812	14,764	1,868	
(6) Penstock and spillway channel	3,329	60,527	7,657	
(7) Powerhouse	1,722	31,309	3,961	
(8) Tailrace channel	42	764	97	
(9) Tailrace	263	4,782	605	
(10) Miscellaneous	557	10,135	1,282	((1) to (9)) *0.05
4. Hydraulic equipment	18,864	342,982	43,387	
(1) Gate and screen	5,587	101,582	12,850	
(2) Penstock	10,133	184,236	23,306	
(3) Others	3,144	57,164	7,231	
5. Electro-mechanical equipment	17,537	318,857	40,335	Turbine and Generator, Transformer, etc
6. Transmission line	23,850	433,636	54,855	1,500,000PhP/km * distance from existing transmission
Direct Cost	86,771	1,577,650	199,573	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	13,016	236,648	29,936	Direct Cost * 0.15
8. Contingency	8,677	157,765	19,957	Direct Cost * 0.1
9. Interest during construction	10,412	189,318	23,949	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	118,876	2,161,381	273,415	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		569		
Development Cost (/kW)	208.937	3,799	480.556	
Annual Generation (kWh/yr)		3,466,801		
Construction Cost per kWh	0.03429	0.62345	0.07887	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.088	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N61 Binduyan4 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					637	0	
(1) Excavation (Ve)	m^3	136		130	18	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		121	379	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	112	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				128	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					512	0	
(1) Excavation (Ve)	m^3	136		214	30	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		78	246	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	150	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				86	0	((1) + (2) + (3)) * 0.2
4. Headrace					887	0	
(1) Excavation (Ve)	m^3	136		5,012	682	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				205	0	((1) + (2)) * 0.3
5. Head Tank					812	0	
(1) Excavation (Ve)	m^3	136		456	63	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		109	344	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	173	0	$0.051*V_c$
(4) Others	L.S.				232	0	((1) + (2) + (3)) * 0.4
6. Penstock					3,329	0	
(1) Excavation (Ve)	m^3	136		3,575	487	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		619	1,942	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		11	345	0	$0.018*V_c$
(4) Others	L.S.				555	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,722	0	
(1) Excavation (Ve)	m^3	136		623	85	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		213	667	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		13	396	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				574	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					42	0	
(1) Excavation (Ve)	m^3	136		103	15	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		5	17	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.3
9. Tailrace outlet					263	0	
(1) Excavation (Ve)	m^3	136		324	45	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		30	96	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	69	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				53	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				557	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					11,706	0	

2) Candidate sites in Core Zones or Restricted Zones

No.5 Malatgao 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 5 Malatgao2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					10,469	0	
Dam	m^2	239.00		43,800	10,469	0	3.0*Ld
Headtank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				2,094	0	(1.) * 0.2
Subtotal					12,563	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 5 Malatgao2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					12,516	0	
Sand Flush Gate	ton	547,000		22.88	12,516	0	$0.145*Q_f^{0.692}$
2. Intake					1,439	0	
Gate	ton	547,000		2.60	1,423	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		1.53	16	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					905	0	
Gate	ton	547,000		1.62	886	0	$0.910*Q^{0.613}$
Screen	ton	10,000		1.84	19	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		11.70	5,615	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				4,095	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					24,570	0	

Construction Cost Summary

Site Name: 5 Malatgao2

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	14,541	264,378	33,444	
(1) Access Road	12,563	228,415	28,894	
(2) Camp & Facilities	1,978	35,963	4,549	3. Civil work * 0.05
2. Environmental mitigation cost	396	7,193	910	3. Civil work * 0.01
3. Civil works	39,560	719,269	90,988	
(1) Intake weir	14,723	267,691	33,863	
(2) Intake	1,987	36,127	4,570	
(3) Settling basin	4,077	74,127	9,377	
(4) Headrace	4,452	80,945	10,240	
(5) Head tank	3,597	65,400	8,273	
(6) Penstock and spillway channel	3,148	57,236	7,240	
(7) Powerhouse	4,611	83,836	10,605	
(8) Tailrace channel	111	2,018	255	
(9) Tailrace	970	17,636	2,231	
(10) Miscellaneous	1,884	34,251	4,333	((1) to (9)) *0.05
4. Hydroulic equipment	24,570	446,727	56,511	
(1) Gate and screen	14,860	270,182	34,178	
(2) Penstock	5,615	102,091	12,915	
(3) Others	4,095	74,455	9,419	
5. Electro-mechanical equipment	33,824	614,981	77,795	Turbine and Generator, Transformer, etc
6. Transmission line	18,600	338,182	42,780	1,500,000PhP/km * distance from existing transmission
Direct Cost	131,490	2,390,730	302,427	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	19,724	358,609	45,364	Direct Cost * 0.15
8. Contingency	13,149	239,073	30,243	Direct Cost * 0.1
9. Interest during construction	15,779	286,888	36,291	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	180,141	3,275,300	414,325	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	1,130			
Development Cost (/kW)	159.458	2,899	366.753	
Annual Generation (kWh/yr)	6,928,746			
Construction Cost (/kWh)	0.02600	0.47271	0.05980	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor (%)	0.121			i=0.12, n=40
Annual Cost Factor (%)	0.141			
Production Cost (/kWh)	0.004	0.067	0.008	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 5 Malatgao2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Weir					14,723	0	
(1) Excavation (V_e)	m^3	136		9,198	1,251	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		3,441	9,332	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		24	742	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				3,398	0	((1) + (2) + (3)) * 0.3
2. Intake					1,987	0	
(1) Excavation (Ve)	m^3	136		602	82	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		357	1,120	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		13	387	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				398	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					4,077	0	
(1) Excavation (Ve)	m^3	136		2,521	343	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		678	2,126	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		30	928	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.2
4. Headrace					4,452	0	
(1) Excavation (Ve)	m^3	136		27,272	3,710	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				742	0	((1) + (2)) * 0.2
5. Head Tank					3,597	0	
(1) Excavation (Ve)	m^3	136		2,274	310	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		570	1,788	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		29	899	0	$0.051*V_c$
(4) Others	L.S.				600	0	((1) + (2) + (3)) * 0.2
6. Penstock					3,148	0	
(1) Excavation (Ve)	m^3	136		2,388	325	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		521	1,633	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		9	290	0	$0.018*V_c$
(4) Others	L.S.				900	0	((1) + (2) + (3)) * 0.4
7. Powerhouse					4,611	0	
(1) Excavation (Ve)	m^3	136		1,518	207	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		564	1,767	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		36	1,100	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,537	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					111	0	
(1) Excavation (Ve)	m^3	136		327	45	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		15	47	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				19	0	((1) + (2)) * 0.2
9. Tailrace outlet					970	0	
(1) Excavation (Ve)	m^3	136		977	133	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		147	462	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		6	181	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				194	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,884	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					39,560	0	

No.6 Iwahig 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 6 Iwahig1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					9,106	0	
Dam	m^2	239.00		38,100	9,106	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,821	0	(1.) * 0.2
Subtotal					10,927	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 6 Iwahig1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,286	0	
Sand Flush Gate	ton	547,000		13.32	7,286	0	$0.145*Q_f^{0.692}$
2. Intake					279	0	
Gate	ton	547,000		0.50	276	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.25	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					208	0	
Gate	ton	547,000		0.37	205	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.28	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		6.62	3,177	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,190	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,140	0	

Construction Cost Summary

Site Name: 6 Iwahig1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	11,634	211,536	26,759	
(1) Access Road	10,927	198,676	25,133	
(2) Camp & Facilities	707	12,860	1,627	3. Civil work * 0.05
2. Environmental mitigation cost	141	2,572	325	3. Civil work * 0.01
3. Civil works	14,146	257,193	32,535	
(1) Intake weir	4,649	84,527	10,693	
(2) Intake	509	9,255	1,171	
(3) Settling basin	630	11,455	1,449	
(4) Headrace	4,753	86,418	10,932	
(5) Head tank	961	17,473	2,210	
(6) Penstock and spillway channel	641	11,655	1,474	
(7) Powerhouse	1,071	19,473	2,463	
(8) Tailrace channel	54	982	124	
(9) Tailrace	204	3,709	469	
(10) Miscellaneous	674	12,247	1,549	((1) to (9)) *0.05
4. Hydraulic equipment	13,140	238,909	30,222	
(1) Gate and screen	7,773	141,327	17,878	
(2) Penstock	3,177	57,764	7,307	
(3) Others	2,190	39,818	5,037	
5. Electro-mechanical equipment	7,130	129,635	16,399	Turbine and Generator, Transformer, etc
6. Transmission line	19,800	360,000	45,540	1,500,000PhP/km * distance from existing transmission
Direct Cost	65,991	1,199,845	151,780	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	9,899	179,977	22,767	Direct Cost * 0.15
8. Contingency	6,599	119,984	15,178	Direct Cost * 0.1
9. Interest during construction	7,919	143,981	18,214	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	90,408	1,643,787	207,939	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		211		
Development Cost (/kW)	429.219	7,804	987.204	
Annual Generation (kWh/yr)		1,285,235		
Construction Cost per kWh	0.07034	1.27898	0.16179	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.010	0.181	0.023	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 6 Iwahig1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,649	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	3,134		963	3,019	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,073	0	((1) + (2) + (3)) * 0.3
2. Intake					509	0	
(1) Excavation (Ve)	m^3	136		96	14	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		98	306	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	87	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				102	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					630	0	
(1) Excavation (Ve)	m^3	136		276	38	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		98	307	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	180	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				105	0	((1) + (2) + (3)) * 0.2
4. Headrace					4,753	0	
(1) Excavation (Ve)	m^3	136		26,880	3,656	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,097	0	((1) + (2)) * 0.3
5. Head Tank					961	0	
(1) Excavation (Ve)	m^3	136		538	74	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		130	407	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	205	0	$0.051*V_c$
(4) Others	L.S.				275	0	((1) + (2) + (3)) * 0.4
6. Penstock					641	0	
(1) Excavation (Ve)	m^3	136		718	98	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		118	370	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	66	0	$0.018*V_c$
(4) Others	L.S.				107	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,071	0	
(1) Excavation (Ve)	m^3	136		405	56	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		133	417	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		8	241	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				357	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					54	0	
(1) Excavation (Ve)	m^3	136		154	21	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	24	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				9	0	((1) + (2)) * 0.2
9. Tailrace outlet					204	0	
(1) Excavation (Ve)	m^3	136		260	36	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		22	70	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	57	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				41	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				674	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					14,146	0	

No.9 Inagawan 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 9 Inagawan1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					5,880	0	
Dam	m^2	239.00		24,600	5,880	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,176	0	(1.) * 0.2
Subtotal					7,056	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 9 Inagawan1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					12,823	0	
Sand Flush Gate	ton	547,000		23.44	12,823	0	$0.145*Q_f^{0.692}$
2. Intake					538	0	
Gate	ton	547,000		0.97	532	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.52	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					445	0	
Gate	ton	547,000		0.80	437	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.74	8	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		7.52	3,612	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,484	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					20,902	0	

Construction Cost Summary

Site Name: 9 Inagawan1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	8,507	154,665	19,565	
(1) Access Road	7,056	128,291	16,229	
(2) Camp & Facilities	1,451	26,374	3,336	3. Civil work * 0.05
2. Environmental mitigation cost	290	5,275	667	3. Civil work * 0.01
3. Civil works	29,012	527,482	66,726	
(1) Intake weir	4,834	87,891	11,118	
(2) Intake	929	16,891	2,137	
(3) Settling basin	1,895	34,455	4,359	
(4) Headrace	13,402	243,673	30,825	
(5) Head tank	2,296	41,745	5,281	
(6) Penstock and spillway channel	754	13,709	1,734	
(7) Powerhouse	3,035	55,182	6,981	
(8) Tailrace channel	82	1,491	189	
(9) Tailrace	403	7,327	927	
(10) Miscellaneous	1,382	25,118	3,177	((1) to (9)) *0.05
4. Hydraulic equipment	20,902	380,029	48,074	
(1) Gate and screen	13,806	251,018	31,754	
(2) Penstock	3,612	65,673	8,308	
(3) Others	3,484	63,338	8,012	
5. Electro-mechanical equipment	23,921	434,919	55,017	Turbine and Generator, Transformer, etc
6. Transmission line	7,350	133,636	16,905	1,500,000PhP/km * distance from existing transmission
Direct Cost	89,980	1,636,006	206,955	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	13,497	245,401	31,043	Direct Cost * 0.15
8. Contingency	8,998	163,601	20,695	Direct Cost * 0.1
9. Interest during construction	10,798	196,321	24,835	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	123,273	2,241,328	283,528	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		789		
Development Cost (/kW)	156.292	2,842	359.471	
Annual Generation (kWh/yr)		4,830,280		
Construction Cost per kWh	0.02552	0.46402	0.05870	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.004	0.066	0.008	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 9 Inagawan1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,834	0	
(1) Excavation (V_e)	m^3	136		2,629	358	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,125	3,051	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		10	309	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,116	0	((1) + (2) + (3)) * 0.3
2. Intake					929	0	
(1) Excavation (Ve)	m^3	136		216	30	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		173	544	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	169	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				186	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,895	0	
(1) Excavation (Ve)	m^3	136		1,021	139	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		308	965	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		15	475	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				316	0	((1) + (2) + (3)) * 0.2
4. Headrace					13,402	0	
(1) Excavation (Ve)	m^3	136		75,794	10,309	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				3,093	0	((1) + (2)) * 0.3
5. Head Tank					2,296	0	
(1) Excavation (Ve)	m^3	136		1,262	172	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		312	977	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		16	491	0	$0.051*V_c$
(4) Others	L.S.				656	0	((1) + (2) + (3)) * 0.4
6. Penstock					754	0	
(1) Excavation (Ve)	m^3	136		778	106	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		141	443	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	79	0	$0.018*V_c$
(4) Others	L.S.				126	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,035	0	
(1) Excavation (Ve)	m^3	136		1,039	142	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		373	1,168	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		23	713	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,012	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					82	0	
(1) Excavation (Ve)	m^3	136		237	33	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	35	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					403	0	
(1) Excavation (Ve)	m^3	136		468	64	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		51	162	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	96	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				81	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,382	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					29,012	0	

No. 10 Inagawan 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 10 Inagawan2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,940	0	
Dam	m^2	239.00		12,300	2,940	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				588	0	(1.) * 0.2
Subtotal					3,528	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 10 Inagawan2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					13,581	0	
Sand Flush Gate	ton	547,000		24.83	13,581	0	$0.145*Q_f^{0.692}$
2. Intake					576	0	
Gate	ton	547,000		1.04	570	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.56	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					482	0	
Gate	ton	547,000		0.86	473	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.82	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.18	2,006	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,329	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					19,974	0	

Construction Cost Summary

Site Name: 10 Inagawan2

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	4,388	79,784	10,093	
(1) Access Road	3,528	64,145	8,114	
(2) Camp & Facilities	860	15,638	1,978	3. Civil work * 0.05
2. Environmental mitigation cost	172	3,128	396	3. Civil work * 0.01
3. Civil works	17,202	312,766	39,565	
(1) Intake weir	4,120	74,909	9,476	
(2) Intake	994	18,073	2,286	
(3) Settling basin	2,142	38,945	4,927	
(4) Headrace	3,703	67,327	8,517	
(5) Head tank	2,530	46,000	5,819	
(6) Penstock and spillway channel	428	7,782	984	
(7) Powerhouse	1,970	35,818	4,531	
(8) Tailrace channel	63	1,145	145	
(9) Tailrace	433	7,873	996	
(10) Miscellaneous	819	14,894	1,884	((1) to (9)) *0.05
4. Hydraulic equipment	19,974	363,164	45,940	
(1) Gate and screen	14,639	266,164	33,670	
(2) Penstock	2,006	36,473	4,614	
(3) Others	3,329	60,527	7,657	
5. Electro-mechanical equipment	10,570	192,184	24,311	Turbine and Generator, Transformer, etc
6. Transmission line	7,350	133,636	16,905	1,500,000PhP/km * distance from existing transmission
Direct Cost	59,656	1,084,662	137,210	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,948	162,699	20,581	Direct Cost * 0.15
8. Contingency	5,966	108,466	13,721	Direct Cost * 0.1
9. Interest during construction	7,159	130,159	16,465	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	81,729	1,485,987	187,977	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	329			
Development Cost (/kW)	248.356	4,516	571.218	
Annual Generation (kWh/yr)	2,015,391			
Construction Cost per kWh	0.04055	0.73732	0.09327	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.006	0.104	0.013	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 10 Inagawan2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,120	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		963	2,612	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				951	0	((1) + (2) + (3)) * 0.3
2. Intake					994	0	
(1) Excavation (Ve)	m^3	136		237	33	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		185	580	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	182	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				199	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,142	0	
(1) Excavation (Ve)	m^3	136		1,181	161	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		349	1,095	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		17	529	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				357	0	((1) + (2) + (3)) * 0.2
4. Headrace					3,703	0	
(1) Excavation (Ve)	m^3	136		20,940	2,848	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				855	0	((1) + (2)) * 0.3
5. Head Tank					2,530	0	
(1) Excavation (Ve)	m^3	136		1,387	189	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		343	1,076	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	542	0	$0.051*V_c$
(4) Others	L.S.				723	0	((1) + (2) + (3)) * 0.4
6. Penstock					428	0	
(1) Excavation (Ve)	m^3	136		426	58	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		81	253	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	45	0	$0.018*V_c$
(4) Others	L.S.				72	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,970	0	
(1) Excavation (Ve)	m^3	136		703	96	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		243	762	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		15	455	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				657	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					63	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	27	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					433	0	
(1) Excavation (Ve)	m^3	136		499	68	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		56	177	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	101	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				87	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				819	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					17,202	0	

No. 18 Estrella Falls

Preparation Construction Cost (Run-of-River Type)

Site Name: 18 Estrella Falls

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,016	0	
Dam	m^2	239.00		16,800	4,016	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				803	0	(1.) * 0.2
Subtotal					4,819	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 18 Estrella Falls

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					4,758	0	
Sand Flush Gate	ton	547,000		8.70	4,758	0	$0.145*Q_f^{0.692}$
2. Intake					342	0	
Gate	ton	547,000		0.62	338	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.32	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					263	0	
Gate	ton	547,000		0.47	259	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.38	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.66	1,759	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,424	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					8,546	0	

Construction Cost Summary

Site Name: 18 Estrella Falls

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	5,526	100,471	12,710	
(1) Access Road	4,819	87,622	11,084	
(2) Camp & Facilities	707	12,849	1,625	3. Civil work * 0.05
2. Environmental mitigation cost	141	2,570	325	3. Civil work * 0.01
3. Civil works	14,134	256,983	32,508	
(1) Intake weir	9,581	174,200	22,036	
(2) Intake	527	9,582	1,212	
(3) Settling basin	670	12,182	1,541	
(4) Headrace	159	2,891	366	
(5) Head tank	1,007	18,309	2,316	
(6) Penstock and spillway channel	419	7,618	964	
(7) Powerhouse	819	14,891	1,884	
(8) Tailrace channel	66	1,200	152	
(9) Tailrace	213	3,873	490	
(10) Miscellaneous	673	12,237	1,548	((1) to (9)) *0.05
4. Hydraulic equipment	8,546	155,389	19,657	
(1) Gate and screen	5,363	97,509	12,335	
(2) Penstock	1,759	31,982	4,046	
(3) Others	1,424	25,898	3,276	
5. Electro-mechanical equipment	4,534	82,428	10,427	Turbine and Generator, Transformer, etc
6. Transmission line	9,900	180,000	22,770	1,500,000PhP/km * distance from existing transmission
Direct Cost	42,781	777,841	98,397	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	6,417	116,676	14,760	Direct Cost * 0.15
8. Contingency	4,278	77,784	9,840	Direct Cost * 0.1
9. Interest during construction	5,134	93,341	11,808	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	58,610	1,065,642	134,804	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		121		
Development Cost (/kW)	483.418	8,789	1,111.862	
Annual Generation (kWh/yr)		739,675		
Construction Cost per kWh	0.07924	1.44069	0.18225	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.011	0.204	0.026	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 18 Estrella Falls

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					9,581	0	
(1) Excavation (V_e)	m^3	136		4,707	641	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		2,287	6,203	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		17	526	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				2,211	0	((1) + (2) + (3)) * 0.3
2. Intake					527	0	
(1) Excavation (Ve)	m^3	136		100	14	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		101	316	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	91	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				106	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					670	0	
(1) Excavation (Ve)	m^3	136		297	41	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		104	327	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	190	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				112	0	((1) + (2) + (3)) * 0.2
4. Headrace					159	0	
(1) Excavation (Ve)	m^3	47		2,578	122	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,500		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				37	0	((1) + (2)) * 0.3
5. Head Tank					1,007	0	
(1) Excavation (Ve)	m^3	136		564	77	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		136	427	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	215	0	$0.051*V_c$
(4) Others	L.S.				288	0	((1) + (2) + (3)) * 0.4
6. Penstock					419	0	
(1) Excavation (Ve)	m^3	136		470	64	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		77	242	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	43	0	$0.018*V_c$
(4) Others	L.S.				70	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					819	0	
(1) Excavation (Ve)	m^3	136		317	44	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		102	319	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		6	183	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				273	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					66	0	
(1) Excavation (Ve)	m^3	136		191	26	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		9	29	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					213	0	
(1) Excavation (Ve)	m^3	136		269	37	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		23	74	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	59	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				43	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				673	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					14,134	0	

No. 30 Tiga Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 30 Tiga

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,155	0	
Dam	m^2	239.00		13,200	3,155	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				631	0	(1.) * 0.2
Subtotal					3,786	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 30 Tiga

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,388	0	
Sand Flush Gate	ton	547,000		9.85	5,388	0	$0.145*Q_f^{0.692}$
2. Intake					355	0	
Gate	ton	547,000		0.64	351	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.33	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					276	0	
Gate	ton	547,000		0.49	271	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.40	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		28.53	13,696	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,943	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					23,658	0	

Construction Cost Summary

Site Name: 30 Tiga

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	4,557	82,857	10,481	
(1) Access Road	3,786	68,836	8,708	
(2) Camp & Facilities	771	14,020	1,774	3. Civil work * 0.05
2. Environmental mitigation cost	154	2,804	355	3. Civil work * 0.01
3. Civil works	15,422	280,407	35,472	
(1) Intake weir	3,325	60,455	7,648	
(2) Intake	638	11,600	1,467	
(3) Settling basin	953	17,327	2,192	
(4) Headrace	3,640	66,182	8,372	
(5) Head tank	1,332	24,218	3,064	
(6) Penstock and spillway channel	1,642	29,855	3,777	
(7) Powerhouse	2,834	51,527	6,518	
(8) Tailrace channel	60	1,091	138	
(9) Tailrace	264	4,800	607	
(10) Miscellaneous	734	13,353	1,689	((1) to (9)) *0.05
4. Hydraulic equipment	23,658	430,145	54,413	
(1) Gate and screen	6,019	109,436	13,844	
(2) Penstock	13,696	249,018	31,501	
(3) Others	3,943	71,691	9,069	
5. Electro-mechanical equipment	30,581	556,014	70,336	Turbine and Generator, Transformer, etc
6. Transmission line	12,300	223,636	28,290	1,500,000PhP/km * distance from existing transmission
Direct Cost	86,673	1,575,864	199,347	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	13,001	236,380	29,902	Direct Cost * 0.15
8. Contingency	8,667	157,586	19,935	Direct Cost * 0.1
9. Interest during construction	15,601	283,656	35,882	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	123,942	2,253,486	285,066	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		1,018		
Development Cost (/kW)	121.744	2,214	280.012	
Annual Generation (kWh/yr)		6,231,889		
Construction Cost per kWh	0.01989	0.36161	0.04574	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.051	0.006	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 30 Tiga

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,325	0	
(1) Excavation (V_e)	m^3	136		1,469	200	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		789	2,140	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.3
2. Intake					638	0	
(1) Excavation (Ve)	m^3	136		130	18	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		121	380	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	112	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				128	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					953	0	
(1) Excavation (Ve)	m^3	136		451	62	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		150	472	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		8	260	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				159	0	((1) + (2) + (3)) * 0.2
4. Headrace					3,640	0	
(1) Excavation (Ve)	m^3	136		20,585	2,800	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				840	0	((1) + (2)) * 0.3
5. Head Tank					1,332	0	
(1) Excavation (Ve)	m^3	136		741	101	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		180	565	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		9	285	0	$0.051*V_c$
(4) Others	L.S.				381	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,642	0	
(1) Excavation (Ve)	m^3	136		1,764	240	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		306	958	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		6	170	0	$0.018*V_c$
(4) Others	L.S.				274	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,834	0	
(1) Excavation (Ve)	m^3	136		978	133	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		348	1,092	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		21	664	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				945	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					60	0	
(1) Excavation (Ve)	m^3	136		172	24	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	26	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.2
9. Tailrace outlet					264	0	
(1) Excavation (Ve)	m^3	136		324	45	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		30	96	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	70	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				53	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				734	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,422	0	

No. 31 Lara Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 31 Lara

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,080	0	
Dam	m^2	239.00		8,700	2,080	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				416	0	(1.) * 0.2
Subtotal					2,496	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 31 Lara

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,383	0	
Sand Flush Gate	ton	547,000		13.50	7,383	0	$0.145*Q_f^{0.692}$
2. Intake					494	0	
Gate	ton	547,000		0.89	489	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.48	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					404	0	
Gate	ton	547,000		0.72	397	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.66	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		25.27	12,132	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				4,083	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					24,496	0	

Construction Cost Summary

Site Name: 31 Lara

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,633	66,055	8,356	
(1) Access Road	2,496	45,382	5,741	
(2) Camp & Facilities	1,137	20,674	2,615	3. Civil work * 0.05
2. Environmental mitigation cost	227	4,135	523	3. Civil work * 0.01
3. Civil works	22,741	413,471	52,304	
(1) Intake weir	6,175	112,273	14,203	
(2) Intake	867	15,764	1,994	
(3) Settling basin	1,668	30,327	3,836	
(4) Headrace	3,712	67,491	8,538	
(5) Head tank	2,077	37,764	4,777	
(6) Penstock and spillway channel	2,910	52,909	6,693	
(7) Powerhouse	3,800	69,091	8,740	
(8) Tailrace channel	77	1,400	177	
(9) Tailrace	372	6,764	856	
(10) Miscellaneous	1,083	19,689	2,491	((1) to (9)) *0.05
4. Hydraulic equipment	24,496	445,375	56,340	
(1) Gate and screen	8,281	150,564	19,046	
(2) Penstock	12,132	220,582	27,904	
(3) Others	4,083	74,229	9,390	
5. Electro-mechanical equipment	38,438	698,869	88,407	Turbine and Generator, Transformer, etc
6. Transmission line	11,400	207,273	26,220	1,500,000PhP/km * distance from existing transmission
Direct Cost	100,935	1,835,177	232,150	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,140	275,277	34,822	Direct Cost * 0.15
8. Contingency	10,093	183,518	23,215	Direct Cost * 0.1
9. Interest during construction	12,112	220,221	27,858	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	138,281	2,514,193	318,045	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		1,289		
Development Cost (/kW)	107.314	1,951	246.821	
Annual Generation (kWh/yr)		7,888,409		
Construction Cost per kWh	0.01753	0.31872	0.04032	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.002	0.045	0.006	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 31 Lara

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					6,175	0	
(1) Excavation (V_e)	m^3	136		3,858	525	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,421	3,854	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		12	371	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,425	0	((1) + (2) + (3)) * 0.3
2. Intake					867	0	
(1) Excavation (Ve)	m^3	136		197	27	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		162	509	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	157	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				174	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,668	0	
(1) Excavation (Ve)	m^3	136		878	120	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		269	845	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	425	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				278	0	((1) + (2) + (3)) * 0.2
4. Headrace					3,712	0	
(1) Excavation (Ve)	m^3	136		20,989	2,855	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				857	0	((1) + (2)) * 0.3
5. Head Tank					2,077	0	
(1) Excavation (Ve)	m^3	136		1,144	156	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		281	883	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		14	444	0	$0.051*V_c$
(4) Others	L.S.				594	0	((1) + (2) + (3)) * 0.4
6. Penstock					2,910	0	
(1) Excavation (Ve)	m^3	136		3,063	417	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		544	1,705	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		10	303	0	$0.018*V_c$
(4) Others	L.S.				485	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,800	0	
(1) Excavation (Ve)	m^3	136		1,274	174	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		465	1,459	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		29	900	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,267	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					77	0	
(1) Excavation (Ve)	m^3	136		223	31	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	33	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.2
9. Tailrace outlet					372	0	
(1) Excavation (Ve)	m^3	136		437	60	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		47	147	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	90	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				75	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,083	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					22,741	0	

No. 32 Imulnod Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 32 Imulnod

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,510	0	
Dam	m^2	239.00		10,500	2,510	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				502	0	(1.) * 0.2
Subtotal					3,012	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 32 Imulnod

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,142	0	
Sand Flush Gate	ton	547,000		11.23	6,142	0	$0.145*Q_f^{0.692}$
2. Intake					405	0	
Gate	ton	547,000		0.73	401	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.38	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					321	0	
Gate	ton	547,000		0.58	316	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.49	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		9.69	4,652	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,304	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,824	0	

Construction Cost Summary

Site Name: 32 Imulnod

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	5,591	101,646	12,858	
(1) Access Road	3,012	54,764	6,928	
(2) Camp & Facilities	2,579	46,883	5,931	3. Civil work * 0.05
2. Environmental mitigation cost	516	9,377	1,186	3. Civil work * 0.01
3. Civil works	51,571	937,650	118,613	
(1) Intake weir	44,090	801,636	101,407	
(2) Intake	470	8,545	1,081	
(3) Settling basin	548	9,964	1,260	
(4) Headrace	994	18,073	2,286	
(5) Head tank	857	15,582	1,971	
(6) Penstock and spillway channel	942	17,127	2,167	
(7) Powerhouse	975	17,727	2,243	
(8) Tailrace channel	51	927	117	
(9) Tailrace	188	3,418	432	
(10) Miscellaneous	2,456	44,650	5,648	((1) to (9)) *0.05
4. Hydraulic equipment	13,824	251,345	31,795	
(1) Gate and screen	6,868	124,873	15,796	
(2) Penstock	4,652	84,582	10,700	
(3) Others	2,304	41,891	5,299	
5. Electro-mechanical equipment	14,184	257,885	32,622	Turbine and Generator, Transformer, etc
6. Transmission line	14,700	267,273	33,810	1,500,000PhP/km * distance from existing transmission
Direct Cost	100,385	1,825,175	230,885	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,058	273,776	34,633	Direct Cost * 0.15
8. Contingency	10,038	182,518	23,088	Direct Cost * 0.1
9. Interest during construction	18,069	328,532	41,559	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	143,550	2,610,001	330,165	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		453		
Development Cost (/kW)	316.542	5,755	728.046	
Annual Generation (kWh/yr)		2,773,602		
Construction Cost per kWh	0.05176	0.94101	0.11904	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.007	0.133	0.017	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 32 Imulnod

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					44,090	0	
(1) Excavation (V_e)	m^3	136		18,737	2,549	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		10,859	29,450	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		62	1,916	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				10,175	0	((1) + (2) + (3)) * 0.3
2. Intake					470	0	
(1) Excavation (Ve)	m^3	136		86	12	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		91	284	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	80	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				94	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					548	0	
(1) Excavation (Ve)	m^3	136		232	32	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		84	265	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	159	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				92	0	((1) + (2) + (3)) * 0.2
4. Headrace					994	229	
Open channel							
(4) Excavation (Ve)	m^3	136		5,611	764	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(5) Concrete(Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(6) Others	L.S.				230	229	((1) + (2) + (3) + (4) + (5)) * 0.3
5. Head Tank					857	0	
(1) Excavation (Ve)	m^3	136		481	66	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		116	363	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	183	0	$0.051*V_c$
(4) Others	L.S.				245	0	((1) + (2) + (3)) * 0.4
6. Penstock					942	0	
(1) Excavation (Ve)	m^3	136		1,033	141	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		174	547	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	97	0	$0.018*V_c$
(4) Others	L.S.				157	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					975	0	
(1) Excavation (Ve)	m^3	136		372	51	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		121	380	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		7	219	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				325	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					51	0	
(1) Excavation (Ve)	m^3	136		140	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				9	0	((1) + (2)) * 0.2
9. Tailrace outlet					188	0	
(1) Excavation (Ve)	m^3	136		241	33	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		20	63	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	54	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				38	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				2,456	11	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					51,571	241	

No. 34 Bulalakao Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 34 Bulalakao

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					574	0	
Dam	m^2	239.00		2,400	574	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				115	0	(1.) * 0.2
Subtotal					689	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 34 Bulalakao

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,513	0	
Sand Flush Gate	ton	547,000		10.08	5,513	0	$0.145*Q_f^{0.692}$
2. Intake					363	0	
Gate	ton	547,000		0.66	359	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.34	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					283	0	
Gate	ton	547,000		0.51	278	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.42	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		7.38	3,541	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,940	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					11,640	0	

Construction Cost Summary

Site Name: 34 Bulalakao

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,801	32,754	4,143	
(1) Access Road	689	12,524	1,584	
(2) Camp & Facilities	1,113	20,231	2,559	3. Civil work * 0.05
2. Environmental mitigation cost	223	4,046	512	3. Civil work * 0.01
3. Civil works	22,254	404,613	51,184	
(1) Intake weir	10,270	186,727	23,621	
(2) Intake	654	11,891	1,504	
(3) Settling basin	995	18,091	2,289	
(4) Headrace	5,030	91,455	11,569	
(5) Head tank	1,378	25,055	3,169	
(6) Penstock and spillway channel	657	11,945	1,511	
(7) Powerhouse	1,877	34,127	4,317	
(8) Tailrace channel	63	1,145	145	
(9) Tailrace	270	4,909	621	
(10) Miscellaneous	1,060	19,267	2,437	((1) to (9)) *0.05
4. Hydraulic equipment	11,640	211,636	26,772	
(1) Gate and screen	6,159	111,982	14,166	
(2) Penstock	3,541	64,382	8,144	
(3) Others	1,940	35,273	4,462	
5. Electro-mechanical equipment	14,452	262,771	33,241	Turbine and Generator, Transformer, etc
6. Transmission line	55,650	1,011,818	127,995	1,500,000PhP/km * distance from existing transmission
Direct Cost	106,020	1,927,639	243,846	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,903	289,146	36,577	Direct Cost * 0.15
8. Contingency	10,602	192,764	24,385	Direct Cost * 0.1
9. Interest during construction	12,722	231,317	29,262	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	145,248	2,640,865	334,069	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	463			
Development Cost (/kW)	313.880	5,707	721.925	
Annual Generation (kWh/yr)	2,828,827			
Construction Cost per kWh	0.05135	0.93355	0.11809	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.007	0.132	0.017	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 34 Bulalakao

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					10,270	0	
(1) Excavation (V_e)	m^3	136		5,247	714	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		2,444	6,629	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		18	557	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				2,370	0	((1) + (2) + (3)) * 0.3
2. Intake					654	0	
(1) Excavation (Ve)	m^3	136		134	19	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		124	389	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	115	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				131	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					995	0	
(1) Excavation (Ve)	m^3	136		475	65	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		157	494	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		9	270	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				166	0	((1) + (2) + (3)) * 0.2
4. Headrace					5,030	0	
Tunnel							
(1) Excavation (Ve)	m^3	314		1,456	458	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		56	277	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	13,622		230	3,132	0	(pai*D+D)*0.1*L
Open channel							
(4) Excavation (Ve)	m^3	136		10	2	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(5) Concrete(Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(6) Others	L.S.				1,161	0	((1) + (2) + (3) + (4) + (5)) * 0.3
5. Head Tank					1,378	0	
(1) Excavation (Ve)	m^3	136		766	105	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		186	585	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		10	294	0	$0.051*V_c$
(4) Others	L.S.				394	0	((1) + (2) + (3)) * 0.4
6. Penstock					657	0	
(1) Excavation (Ve)	m^3	136		719	98	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		121	381	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	68	0	$0.018*V_c$
(4) Others	L.S.				110	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,877	0	
(1) Excavation (Ve)	m^3	136		673	92	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		232	726	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		14	433	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				626	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					63	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	27	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					270	0	
(1) Excavation (Ve)	m^3	136		332	46	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		31	99	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	71	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				54	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,060	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					22,254	0	

No. 35 Pangbilian Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 35 Pangbilian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,084	0	
Dam	m^2	239.00		12,900	3,084	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				617	0	(1.) * 0.2
Subtotal					3,701	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 35 Pangbilian

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,483	0	
Sand Flush Gate	ton	547,000		15.51	8,483	0	$0.145*Q_f^{0.692}$
2. Intake					577	0	
Gate	ton	547,000		1.04	571	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.57	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					483	0	
Gate	ton	547,000		0.87	474	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.83	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		7.61	3,655	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,640	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					15,838	0	

Construction Cost Summary

Site Name: 35 Pangbilian

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	4,500	81,818	10,350	
(1) Access Road	3,701	67,287	8,512	
(2) Camp & Facilities	799	14,531	1,838	3. Civil work * 0.05
2. Environmental mitigation cost	160	2,906	368	3. Civil work * 0.01
3. Civil works	15,984	290,621	36,764	
(1) Intake weir	2,038	37,055	4,687	
(2) Intake	1,000	18,182	2,300	
(3) Settling basin	2,171	39,473	4,993	
(4) Headrace	2,850	51,818	6,555	
(5) Head tank	2,555	46,455	5,877	
(6) Penstock and spillway channel	808	14,691	1,858	
(7) Powerhouse	3,276	59,564	7,535	
(8) Tailrace channel	87	1,582	200	
(9) Tailrace	438	7,964	1,007	
(10) Miscellaneous	761	13,839	1,751	((1) to (9)) *0.05
4. Hydraulic equipment	15,838	287,956	36,426	
(1) Gate and screen	9,543	173,509	21,949	
(2) Penstock	3,655	66,455	8,407	
(3) Others	2,640	47,993	6,071	
5. Electro-mechanical equipment	25,542	464,401	58,747	Turbine and Generator, Transformer, etc
6. Transmission line	11,850	215,455	27,255	1,500,000PhP/km * distance from existing transmission
Direct Cost	73,874	1,343,157	169,909	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	11,081	201,474	25,486	Direct Cost * 0.15
8. Contingency	7,387	134,316	16,991	Direct Cost * 0.1
9. Interest during construction	17,730	322,358	40,778	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 4
Total Cost	110,072	2,001,304	253,165	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		845		
Development Cost (/kW)	130.329	2,370	299.758	
Annual Generation (kWh/yr)		5,166,435		
Construction Cost per kWh	0.02131	0.38737	0.04900	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.055	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 35 Pangbilian

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,038	0	
(1) Excavation (V_e)	m^3	136		667	91	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		487	1,321	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				471	0	((1) + (2) + (3)) * 0.3
2. Intake					1,000	0	
(1) Excavation (Ve)	m^3	136		239	33	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		186	584	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	183	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				200	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,171	0	
(1) Excavation (Ve)	m^3	136		1,199	164	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		354	1,110	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		17	535	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				362	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,850	0	
(1) Excavation (Ve)	m^3	136		16,115	2,192	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				658	0	((1) + (2)) * 0.3
5. Head Tank					2,555	0	
(1) Excavation (Ve)	m^3	136		1,401	191	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		347	1,087	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	547	0	$0.051*V_c$
(4) Others	L.S.				730	0	((1) + (2) + (3)) * 0.4
6. Penstock					808	0	
(1) Excavation (Ve)	m^3	136		805	110	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		152	478	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	85	0	$0.018*V_c$
(4) Others	L.S.				135	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,276	0	
(1) Excavation (Ve)	m^3	136		1,114	152	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		402	1,260	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		25	772	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,092	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					87	0	
(1) Excavation (Ve)	m^3	136		256	35	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		12	37	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				15	0	((1) + (2)) * 0.2
9. Tailrace outlet					438	0	
(1) Excavation (Ve)	m^3	136		502	69	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		57	179	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	102	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				88	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				761	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,984	0	

No. 40 Nicanor Zabala Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: 40 Nicanor Zabala

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,876	0	
Dam	m^2	239.00		20,400	4,876	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				975	0	(1.) * 0.2
Subtotal					5,851	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: 40 Nicanor Zabala

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,455	0	
Sand Flush Gate	ton	547,000		9.97	5,455	0	$0.145*Q_f^{0.692}$
2. Intake					276	0	
Gate	ton	547,000		0.50	273	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.25	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					206	0	
Gate	ton	547,000		0.37	203	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.28	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		18.37	8,817	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,951	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					17,705	0	

Construction Cost Summary

Site Name: 40 Nicanor Zabala

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	6,408	116,514	14,739	
(1) Access Road	5,851	106,385	13,458	
(2) Camp & Facilities	557	10,129	1,281	3. Civil work * 0.05
2. Environmental mitigation cost	111	2,026	256	3. Civil work * 0.01
3. Civil works	11,142	202,574	25,626	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	488	8,873	1,122	
(3) Settling basin	584	10,618	1,343	
(4) Headrace	2,606	47,382	5,994	
(5) Head tank	902	16,400	2,075	
(6) Penstock and spillway channel	1,158	21,055	2,663	
(7) Powerhouse	1,683	30,600	3,871	
(8) Tailrace channel	51	927	117	
(9) Tailrace	194	3,527	446	
(10) Miscellaneous	531	9,646	1,220	((1) to (9)) *0.05
4. Hydraulic equipment	17,705	321,905	40,721	
(1) Gate and screen	5,937	107,945	13,655	
(2) Penstock	8,817	160,309	20,279	
(3) Others	2,951	53,651	6,787	
5. Electro-mechanical equipment	15,696	285,379	36,100	Turbine and Generator, Transformer, etc
6. Transmission line	6,150	111,818	14,145	1,500,000PhP/km * distance from existing transmission
Direct Cost	57,212	1,040,216	131,587	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,582	156,032	19,738	Direct Cost * 0.15
8. Contingency	5,721	104,022	13,159	Direct Cost * 0.1
9. Interest during construction	13,731	249,652	31,581	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 4
Total Cost	85,246	1,549,922	196,065	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		506		
Development Cost (/kW)	168.616	3,066	387.818	
Annual Generation (kWh/yr)		3,083,471		
Construction Cost per kWh	0.02765	0.50265	0.06359	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.004	0.071	0.009	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: 40 Nicanor Zabala

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					488	0	
(1) Excavation (Ve)	m^3	136		90	13	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		94	294	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	83	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				98	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					584	0	
(1) Excavation (Ve)	m^3	136		251	35	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		90	283	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	168	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				98	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,606	0	
(1) Excavation (Ve)	m^3	136		14,730	2,004	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				602	0	((1) + (2)) * 0.3
5. Head Tank					902	0	
(1) Excavation (Ve)	m^3	136		506	69	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		122	382	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	193	0	$0.051*V_c$
(4) Others	L.S.				258	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,158	0	
(1) Excavation (Ve)	m^3	136		1,298	177	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		213	669	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		4	119	0	$0.018*V_c$
(4) Others	L.S.				193	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,683	0	
(1) Excavation (Ve)	m^3	136		610	83	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		208	652	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		12	387	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				561	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					51	0	
(1) Excavation (Ve)	m^3	136		140	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				9	0	((1) + (2)) * 0.2
9. Tailrace outlet					194	0	
(1) Excavation (Ve)	m^3	136		250	34	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		21	66	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	55	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				39	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				531	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					11,142	0	

No. N2 San Rafael 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N2 San Rafael 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					6,382	0	
Dam	m^2	239.00		26,700	6,382	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				1,276	0	(1.) * 0.2
Subtotal					7,658	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N2 San Rafael 2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,162	0	
Sand Flush Gate	ton	547,000		9.44	5,162	0	$0.145*Q_f^{0.692}$
2. Intake					281	0	
Gate	ton	547,000		0.51	278	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.26	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					138	0	
Gate	ton	547,000		0.25	136	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.17	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.82	394	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,195	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					7,170	0	

Construction Cost Summary

Site Name: N2 San Rafael 2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	8,118	147,605	18,672	
(1) Access Road	7,658	139,244	17,614	
(2) Camp & Facilities	460	8,362	1,058	3. Civil work * 0.05
2. Environmental mitigation cost	92	1,672	212	3. Civil work * 0.01
3. Civil works	9,198	167,236	21,155	
(1) Intake weir	5,766	104,836	13,262	
(2) Intake	517	9,400	1,189	
(3) Settling basin	350	6,364	805	
(4) Headrace	777	14,127	1,787	
(5) Head tank	597	10,855	1,373	
(6) Penstock and spillway channel	94	1,709	216	
(7) Powerhouse	426	7,745	980	
(8) Tailrace channel	25	455	58	
(9) Tailrace	208	3,782	478	
(10) Miscellaneous	438	7,964	1,007	((1) to (9)) *0.05
4. Hydraulic equipment	7,170	130,364	16,491	
(1) Gate and screen	5,581	101,473	12,836	
(2) Penstock	394	7,164	906	
(3) Others	1,195	21,727	2,749	
5. Electro-mechanical equipment	2,506	45,560	5,763	Turbine and Generator, Transformer, etc
6. Transmission line	10,950	199,091	25,185	1,500,000PhP/km * distance from existing transmission
Direct Cost	38,034	691,528	87,478	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	5,705	103,729	13,122	Direct Cost * 0.15
8. Contingency	3,803	69,153	8,748	Direct Cost * 0.1
9. Interest during construction	4,564	82,983	10,497	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	52,107	947,394	119,845	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		51		
Development Cost (/kW)	1,013.252	18,423	2,330.479	
Annual Generation (kWh/yr)		312,306		
Construction Cost per kWh	0.16684	3.03354	0.38374	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.024	0.429	0.054	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N2 San Rafael 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,766	0	
(1) Excavation (V_e)	m^3	136		3,484	474	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,335	3,621	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		11	340	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,331	0	((1) + (2) + (3)) * 0.3
2. Intake					517	0	
(1) Excavation (Ve)	m^3	136		97	14	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		99	310	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	89	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				104	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					350	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		52	165	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		3	107	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				59	0	((1) + (2) + (3)) * 0.2
4. Headrace					777	0	
(1) Excavation (Ve)	m^3	136		4,384	597	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				180	0	((1) + (2)) * 0.3
5. Head Tank					597	0	
(1) Excavation (Ve)	m^3	136		338	46	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		81	253	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	127	0	$0.051*V_c$
(4) Others	L.S.				171	0	((1) + (2) + (3)) * 0.4
6. Penstock					94	0	
(1) Excavation (Ve)	m^3	136		116	16	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		17	52	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	10	0	$0.018*V_c$
(4) Others	L.S.				16	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					426	0	
(1) Excavation (Ve)	m^3	136		175	24	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		53	167	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	93	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				142	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					25	0	
(1) Excavation (Ve)	m^3	136		61	9	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		3	10	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				6	0	((1) + (2)) * 0.3
9. Tailrace outlet					208	0	
(1) Excavation (Ve)	m^3	136		264	36	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		23	72	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	58	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				42	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				438	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					9,198	0	

No. N5 Labog Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N5 Labog

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,940	0	
Dam	m^2	239.00		12,300	2,940	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				588	0	(1.) * 0.2
Subtotal					3,528	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N5 Labog

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,914	0	
Sand Flush Gate	ton	547,000		14.47	7,914	0	$0.145*Q_f^{0.692}$
2. Intake					352	0	
Gate	ton	547,000		0.64	348	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.33	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					272	0	
Gate	ton	547,000		0.49	268	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.40	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.51	2,163	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,140	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,841	0	

Construction Cost Summary

Site Name: N5 Labog

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	5,135	93,370	11,811	
(1) Access Road	3,528	64,145	8,114	
(2) Camp & Facilities	1,607	29,224	3,697	3. Civil work * 0.05
2. Environmental mitigation cost	321	5,845	739	3. Civil work * 0.01
3. Civil works	32,147	584,487	73,938	
(1) Intake weir	23,731	431,473	54,581	
(2) Intake	650	11,818	1,495	
(3) Settling basin	984	17,891	2,263	
(4) Headrace	1,256	22,836	2,889	
(5) Head tank	1,368	24,873	3,146	
(6) Penstock and spillway channel	641	11,655	1,474	
(7) Powerhouse	1,655	30,091	3,807	
(8) Tailrace channel	63	1,145	145	
(9) Tailrace	268	4,873	616	
(10) Miscellaneous	1,531	27,833	3,521	((1) to (9)) *0.05
4. Hydraulic equipment	12,841	233,476	29,535	
(1) Gate and screen	8,538	155,236	19,637	
(2) Penstock	2,163	39,327	4,975	
(3) Others	2,140	38,913	4,922	
5. Electro-mechanical equipment	5,222	94,941	12,010	Turbine and Generator, Transformer, etc
6. Transmission line	2,700	49,091	6,210	1,500,000PhP/km * distance from existing transmission
Direct Cost	58,367	1,061,210	134,243	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,755	159,182	20,136	Direct Cost * 0.15
8. Contingency	5,837	106,121	13,424	Direct Cost * 0.1
9. Interest during construction	10,506	191,018	24,164	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 3
Total Cost	83,464	1,517,530	191,968	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		145		
Development Cost (/kW)	575.869	10,470	1,324.499	
Annual Generation (kWh/yr)		1,142,840		
Construction Cost per kWh	0.07303	1.32786	0.16797	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.010	0.188	0.024	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N5 Labog

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					23,731	0	
(1) Excavation (V_e)	m^3	136		8,966	1,220	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		5,859	15,890	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		37	1,144	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				5,477	0	((1) + (2) + (3)) * 0.3
2. Intake					650	0	
(1) Excavation (Ve)	m^3	136		133	19	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		123	387	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	114	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				130	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					984	0	
(1) Excavation (Ve)	m^3	136		469	64	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		156	489	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		9	267	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				164	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,256	0	
(1) Excavation (Ve)	m^3	136		7,098	966	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				290	0	((1) + (2)) * 0.3
5. Head Tank					1,368	0	
(1) Excavation (Ve)	m^3	136		760	104	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		185	581	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		9	292	0	$0.051*V_c$
(4) Others	L.S.				391	0	((1) + (2) + (3)) * 0.4
6. Penstock					641	0	
(1) Excavation (Ve)	m^3	136		718	98	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		118	370	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	66	0	$0.018*V_c$
(4) Others	L.S.				107	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,655	0	
(1) Excavation (Ve)	m^3	136		600	82	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		204	641	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		12	380	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				552	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					63	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	27	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.2
9. Tailrace outlet					268	0	
(1) Excavation (Ve)	m^3	136		330	45	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		31	98	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	71	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				54	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,531	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					32,147	0	

No. N9 Tinitian 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N9 Tinitian1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,936	0	
Dam	m^2	239.00		8,100	1,936	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				387	0	(1.) * 0.2
Subtotal					2,323	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N9 Tinitian1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					4,747	0	
Sand Flush Gate	ton	547,000		8.68	4,747	0	$0.145*Q_f^{0.692}$
2. Intake					240	0	
Gate	ton	547,000		0.43	237	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.22	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					176	0	
Gate	ton	547,000		0.31	173	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.23	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.05	986	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,230	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					7,379	0	

Construction Cost Summary

Site Name: N9 Tinitian1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,806	51,012	6,453	
(1) Access Road	2,323	42,240	5,343	
(2) Camp & Facilities	482	8,772	1,110	3. Civil work * 0.05
2. Environmental mitigation cost	96	1,754	222	3. Civil work * 0.01
3. Civil works	9,650	175,445	22,194	
(1) Intake weir	4,834	87,891	11,118	
(2) Intake	430	7,818	989	
(3) Settling basin	462	8,400	1,063	
(4) Headrace	1,572	28,582	3,616	
(5) Head tank	751	13,655	1,727	
(6) Penstock and spillway channel	266	4,836	612	
(7) Powerhouse	659	11,982	1,516	
(8) Tailrace channel	46	836	106	
(9) Tailrace	170	3,091	391	
(10) Miscellaneous	460	8,355	1,057	((1) to (9)) *0.05
4. Hydraulic equipment	7,379	134,160	16,971	
(1) Gate and screen	5,163	93,873	11,875	
(2) Penstock	986	17,927	2,268	
(3) Others	1,230	22,360	2,829	
5. Electro-mechanical equipment	3,893	70,779	8,954	Turbine and Generator, Transformer, etc
6. Transmission line	2,250	40,909	5,175	1,500,000PhP/km * distance from existing transmission
Direct Cost	26,073	474,060	59,969	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	3,911	71,109	8,995	Direct Cost * 0.15
8. Contingency	2,607	47,406	5,997	Direct Cost * 0.1
9. Interest during construction	4,693	85,331	10,794	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 3
Total Cost	37,285	677,906	85,755	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	99			
Development Cost (/kW)	375.923	6,835	864.622	
Annual Generation (kWh/yr)	604,170			
Construction Cost per kWh	0.06171	1.12205	0.14194	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.009	0.159	0.020	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N9 Tinitian1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,834	0	
(1) Excavation (V_e)	m^3	136		2,629	358	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,125	3,051	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		10	309	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,116	0	((1) + (2) + (3)) * 0.3
2. Intake					430	0	
(1) Excavation (Ve)	m^3	136		76	11	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		83	260	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	73	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				86	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					462	0	
(1) Excavation (Ve)	m^3	136		190	26	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		71	222	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	137	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				77	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,572	0	
(1) Excavation (Ve)	m^3	136		8,887	1,209	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				363	0	((1) + (2)) * 0.3
5. Head Tank					751	0	
(1) Excavation (Ve)	m^3	136		423	58	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		101	318	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	160	0	$0.051*V_c$
(4) Others	L.S.				215	0	((1) + (2) + (3)) * 0.4
6. Penstock					266	0	
(1) Excavation (Ve)	m^3	136		312	43	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		48	151	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	27	0	$0.018*V_c$
(4) Others	L.S.				45	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					659	0	
(1) Excavation (Ve)	m^3	136		260	36	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		82	257	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		5	146	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				220	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					46	0	
(1) Excavation (Ve)	m^3	136		127	18	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	20	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				8	0	((1) + (2)) * 0.2
9. Tailrace outlet					170	0	
(1) Excavation (Ve)	m^3	136		220	30	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		18	56	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	50	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				34	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				460	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					9,650	0	

No. N10 Tinitian 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N10 Tinitian2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,865	0	
Dam	m^2	239.00		7,800	1,865	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				373	0	(1.) * 0.2
Subtotal					2,238	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N10 Tinitian2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					4,747	0	
Sand Flush Gate	ton	547,000		8.68	4,747	0	$0.145*Q_f^{0.692}$
2. Intake					240	0	
Gate	ton	547,000		0.43	237	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.22	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					176	0	
Gate	ton	547,000		0.31	173	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.23	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.77	370	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,107	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					6,640	0	

Construction Cost Summary

Site Name: N10 Tinitian2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,565	46,629	5,899	
(1) Access Road	2,238	40,691	5,147	
(2) Camp & Facilities	327	5,938	751	3. Civil work * 0.05
2. Environmental mitigation cost	65	1,188	150	3. Civil work * 0.01
3. Civil works	6,532	118,765	15,024	
(1) Intake weir	2,589	47,073	5,955	
(2) Intake	432	7,855	994	
(3) Settling basin	464	8,436	1,067	
(4) Headrace	1,090	19,818	2,507	
(5) Head tank	751	13,655	1,727	
(6) Penstock and spillway channel	101	1,836	232	
(7) Powerhouse	578	10,509	1,329	
(8) Tailrace channel	46	836	106	
(9) Tailrace	170	3,091	391	
(10) Miscellaneous	311	5,655	715	((1) to (9)) *0.05
4. Hydraulic equipment	6,640	120,720	15,271	
(1) Gate and screen	5,163	93,873	11,875	
(2) Penstock	370	6,727	851	
(3) Others	1,107	20,120	2,545	
5. Electro-mechanical equipment	3,261	59,283	7,499	Turbine and Generator, Transformer, etc
6. Transmission line	2,250	40,909	5,175	1,500,000PhP/km * distance from existing transmission
Direct Cost	21,312	387,494	49,018	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	3,197	58,124	7,353	Direct Cost * 0.15
8. Contingency	2,131	38,749	4,902	Direct Cost * 0.1
9. Interest during construction	3,836	69,749	8,823	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 3
Total Cost	30,476	554,116	70,096	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		77		
Development Cost (/kW)	393.684	7,158	905.474	
Annual Generation (kWh/yr)		471,040		
Construction Cost per kWh	0.06470	1.17637	0.14881	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.009	0.166	0.021	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N10 Tinitian2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,589	0	
(1) Excavation (V_e)	m^3	136		978	134	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		616	1,671	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				598	0	((1) + (2) + (3)) * 0.3
2. Intake					432	0	
(1) Excavation (Ve)	m^3	136		76	11	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		83	261	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	73	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				87	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					464	0	
(1) Excavation (Ve)	m^3	136		191	26	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		71	223	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	137	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				78	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,090	0	
(1) Excavation (Ve)	m^3	136		6,158	838	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				252	0	((1) + (2)) * 0.3
5. Head Tank					751	0	
(1) Excavation (Ve)	m^3	136		423	58	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		101	318	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	160	0	$0.051*V_c$
(4) Others	L.S.				215	0	((1) + (2) + (3)) * 0.4
6. Penstock					101	0	
(1) Excavation (Ve)	m^3	136		117	16	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		18	57	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	11	0	$0.018*V_c$
(4) Others	L.S.				17	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					578	0	
(1) Excavation (Ve)	m^3	136		231	32	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		72	226	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		4	127	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				193	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					46	0	
(1) Excavation (Ve)	m^3	136		127	18	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	20	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				8	0	((1) + (2)) * 0.2
9. Tailrace outlet					170	0	
(1) Excavation (Ve)	m^3	136		221	30	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		18	56	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	50	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				34	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				311	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					6,532	0	

No. N11 Talakaigan 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N11 Talakaigan(2)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					2,940	0	
Dam	m^2	239.00		12,300	2,940	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				588	0	(1.) * 0.2
Subtotal					3,528	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N11 Talakaigan(2)

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					7,057	0	
Sand Flush Gate	ton	547,000		12.90	7,057	0	$0.145*Q_f^{0.692}$
2. Intake					512	0	
Gate	ton	547,000		0.93	507	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.50	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					421	0	
Gate	ton	547,000		0.76	414	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.69	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		17.75	8,520	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,302	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					19,812	0	

Construction Cost Summary

Site Name: N11 Talakaigan(2)

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	8,577	155,952	19,728	
(1) Access Road	3,528	64,145	8,114	
(2) Camp & Facilities	5,049	91,806	11,613	3. Civil work * 0.05
2. Environmental mitigation cost	1,010	18,361	2,323	3. Civil work * 0.01
3. Civil works	100,987	1,836,125	232,270	
(1) Intake weir	79,988	1,454,327	183,972	
(2) Intake	763	13,873	1,755	
(3) Settling basin	1,322	24,036	3,041	
(4) Headrace	5,603	101,873	12,887	
(5) Head tank	1,727	31,400	3,972	
(6) Penstock and spillway channel	3,131	56,927	7,201	
(7) Powerhouse	3,276	59,564	7,535	
(8) Tailrace channel	46	836	106	
(9) Tailrace	322	5,855	741	
(10) Miscellaneous	4,809	87,435	11,060	((1) to (9)) *0.05
4. Hydraulic equipment	19,812	360,218	45,568	
(1) Gate and screen	7,990	145,273	18,377	
(2) Penstock	8,520	154,909	19,596	
(3) Others	3,302	60,036	7,595	
5. Electro-mechanical equipment	33,302	605,495	76,595	Turbine and Generator, Transformer, etc
6. Transmission line	13,950	253,636	32,085	1,500,000PhP/km * distance from existing transmission
Direct Cost	177,638	3,229,788	408,568	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	26,646	484,468	61,285	Direct Cost * 0.15
8. Contingency	17,764	322,979	40,857	Direct Cost * 0.1
9. Interest during construction	42,633	775,149	98,056	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 4
Total Cost	264,681	4,812,384	608,767	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		1,112		
Development Cost (/kW)	238.077	4,329	547.576	
Annual Generation (kWh/yr)		6,822,767		
Construction Cost per kWh	0.03879	0.70534	0.08923	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.100	0.013	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N11 Talakaigan(2)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					79,988	0	
(1) Excavation (V_e)	m^3	136		33,544	4,562	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		19,843	53,815	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		102	3,152	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				18,459	0	((1) + (2) + (3)) * 0.3
2. Intake					763	0	
(1) Excavation (Ve)	m^3	136		166	23	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		144	451	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	136	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				153	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,322	0	
(1) Excavation (Ve)	m^3	136		666	91	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		212	664	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		11	346	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				221	0	((1) + (2) + (3)) * 0.2
4. Headrace					5,603	0	
(1) Excavation (Ve)	m^3	136		31,691	4,310	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,293	0	((1) + (2)) * 0.3
5. Head Tank					1,727	0	
(1) Excavation (Ve)	m^3	136		956	130	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		234	734	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		12	369	0	$0.051*V_c$
(4) Others	L.S.				494	0	((1) + (2) + (3)) * 0.4
6. Penstock					3,131	0	
(1) Excavation (Ve)	m^3	136		3,179	433	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		590	1,848	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		11	328	0	$0.018*V_c$
(4) Others	L.S.				522	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,276	0	
(1) Excavation (Ve)	m^3	136		1,114	152	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		402	1,260	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		25	772	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,092	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					46	0	
(1) Excavation (Ve)	m^3	136		204	28	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		3	10	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				8	0	((1) + (2)) * 0.2
9. Tailrace outlet					322	0	
(1) Excavation (Ve)	m^3	136		386	53	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		39	123	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	81	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				65	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				4,809	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					100,987	0	

No. N12 Samanñana

Preparation Construction Cost (Run-of-River Type)

Site Name: N12 Samanñana

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,076	0	
Dam	m^2	239.00		4,500	1,076	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				215	0	(1.) * 0.2
Subtotal					1,291	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N12 Samanñana

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,534	0	
Sand Flush Gate	ton	547,000		15.60	8,534	0	$0.145*Q_f^{0.692}$
2. Intake					582	0	
Gate	ton	547,000		1.05	576	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.57	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					488	0	
Gate	ton	547,000		0.87	479	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.84	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		8.16	3,917	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,704	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					16,225	0	

Construction Cost Summary

Site Name: N12 Samanñana

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	2,295	41,720	5,278	
(1) Access Road	1,291	23,476	2,970	
(2) Camp & Facilities	1,003	18,243	2,308	3. Civil work * 0.05
2. Environmental mitigation cost	201	3,649	462	3. Civil work * 0.01
3. Civil works	20,068	364,865	46,155	
(1) Intake weir	4,120	74,909	9,476	
(2) Intake	1,005	18,273	2,312	
(3) Settling basin	2,192	39,855	5,042	
(4) Headrace	2,870	52,182	6,601	
(5) Head tank	2,576	46,836	5,925	
(6) Penstock and spillway channel	1,492	27,127	3,432	
(7) Powerhouse	4,368	79,418	10,046	
(8) Tailrace channel	50	909	115	
(9) Tailrace	439	7,982	1,010	
(10) Miscellaneous	956	17,375	2,198	((1) to (9)) *0.05
4. Hydraulic equipment	16,225	295,004	37,318	
(1) Gate and screen	9,604	174,618	22,089	
(2) Penstock	3,917	71,218	9,009	
(3) Others	2,704	49,167	6,220	
5. Electro-mechanical equipment	42,733	776,971	98,287	Turbine and Generator, Transformer, etc
6. Transmission line	19,350	351,818	44,505	1,500,000PhP/km * distance from existing transmission
Direct Cost	100,871	1,834,026	232,004	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,131	275,104	34,801	Direct Cost * 0.15
8. Contingency	10,087	183,403	23,200	Direct Cost * 0.1
9. Interest during construction	12,105	220,083	27,841	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	138,194	2,512,616	317,846	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	1,436			
Development Cost (/kW)	96.204	1,749	221.270	
Annual Generation (kWh/yr)	8,791,671			
Construction Cost per kWh	0.01572	0.28580	0.03615	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.002	0.040	0.005	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N12 Samanñana

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,120	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		963	2,612	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				951	0	((1) + (2) + (3)) * 0.3
2. Intake					1,005	0	
(1) Excavation (Ve)	m^3	136		241	33	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		187	587	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	184	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				201	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,192	0	
(1) Excavation (Ve)	m^3	136		1,213	165	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		358	1,121	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		17	540	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				366	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,870	0	
(1) Excavation (Ve)	m^3	136		16,222	2,207	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				663	0	((1) + (2)) * 0.3
5. Head Tank					2,576	0	
(1) Excavation (Ve)	m^3	136		1,412	193	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		350	1,096	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	551	0	$0.051*V_c$
(4) Others	L.S.				736	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,492	0	
(1) Excavation (Ve)	m^3	136		1,488	203	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		281	883	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		5	157	0	$0.018*V_c$
(4) Others	L.S.				249	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					4,368	0	
(1) Excavation (Ve)	m^3	136		1,445	197	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		534	1,675	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		34	1,040	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,456	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					50	0	
(1) Excavation (Ve)	m^3	136		209	29	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		4	12	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				9	0	((1) + (2)) * 0.2
9. Tailrace outlet					439	0	
(1) Excavation (Ve)	m^3	136		505	69	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		57	180	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	102	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				88	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				956	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					20,068	0	

No. N14 Candawaga Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N14 Candawaga

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					7,959	0	
Dam	m^2	239.00		33,300	7,959	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,592	0	(1.) * 0.2
Subtotal					9,551	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N14 Candawaga

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,625	0	
Sand Flush Gate	ton	547,000		15.77	8,625	0	$0.145*Q_f^{0.692}$
2. Intake					587	0	
Gate	ton	547,000		1.06	581	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.58	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					493	0	
Gate	ton	547,000		0.88	484	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.85	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.15	1,995	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,340	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,040	0	

Construction Cost Summary

Site Name:N14 Candawaga

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	11,570	210,369	26,612	
(1) Access Road	9,551	173,651	21,967	
(2) Camp & Facilities	2,020	36,719	4,645	3. Civil work * 0.05
2. Environmental mitigation cost	404	7,344	929	3. Civil work * 0.01
3. Civil works	40,390	734,370	92,898	
(1) Intake weir	4,120	74,909	9,476	
(2) Intake	1,017	18,491	2,339	
(3) Settling basin	2,234	40,618	5,138	
(4) Headrace	24,448	444,509	56,230	
(5) Head tank	2,614	47,527	6,012	
(6) Penstock and spillway channel	476	8,655	1,095	
(7) Powerhouse	3,039	55,255	6,990	
(8) Tailrace channel	74	1,345	170	
(9) Tailrace	445	8,091	1,024	
(10) Miscellaneous	1,923	34,970	4,424	((1) to (9)) *0.05
4. Hydraulic equipment	14,040	255,273	32,292	
(1) Gate and screen	9,705	176,455	22,322	
(2) Penstock	1,995	36,273	4,589	
(3) Others	2,340	42,545	5,382	
5. Electro-mechanical equipment	22,002	400,031	50,604	Turbine and Generator, Transformer, etc
6. Transmission line	33,000	600,000	75,900	1,500,000PhP/km * distance from existing transmission
Direct Cost	121,406	2,207,387	279,234	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	18,211	331,108	41,885	Direct Cost * 0.15
8. Contingency	12,141	220,739	27,923	Direct Cost * 0.1
9. Interest during construction	14,569	264,886	33,508	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	166,327	3,024,121	382,551	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	723			
Development Cost (/kW)	230.155	4,185	529.357	
Annual Generation (kWh/yr)	4,426,086			
Construction Cost per kWh	0.03758	0.68325	0.08643	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.005	0.097	0.012	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N14 Candawaga

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,120	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		963	2,612	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				951	0	((1) + (2) + (3)) * 0.3
2. Intake					1,017	0	
(1) Excavation (Ve)	m^3	136		244	34	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		189	593	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				204	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,234	0	
(1) Excavation (Ve)	m^3	136		1,240	169	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		365	1,143	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		18	549	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				373	0	((1) + (2) + (3)) * 0.2
4. Headrace(Tunnel)					24,448	0	
(1) Excavation (Ve)	m^3	314		7,083	2,225	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		270	1,348	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	13,622		1,118	15,233		(pai*D+D)*0.1*L
(4) Others	L.S.				5,642	0	((1) + (2) + (3)) * 0.3
5. Head Tank					2,614	0	
(1) Excavation (Ve)	m^3	136		1,432	195	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		355	1,112	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	560	0	$0.051*V_c$
(4) Others	L.S.				747	0	((1) + (2) + (3)) * 0.4
6. Penstock					476	0	
(1) Excavation (Ve)	m^3	136		474	65	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		90	281	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	50	0	$0.018*V_c$
(4) Others	L.S.				80	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,039	0	
(1) Excavation (Ve)	m^3	136		1,041	142	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		373	1,170	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		23	714	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,013	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					74	0	
(1) Excavation (Ve)	m^3	136		209	29	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	32	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.2
9. Tailrace outlet					445	0	
(1) Excavation (Ve)	m^3	136		510	70	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		58	183	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	103	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				89	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,923	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					40,390	0	

No. N16 Lamakan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N16 Lamakan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					7,959	0	
Dam	m^2	239.00		33,300	7,959	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,592	0	(1.) * 0.2
Subtotal					9,551	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N16 Lamakan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					9,477	0	
Sand Flush Gate	ton	547,000		17.32	9,477	0	$0.145*Q_f^{0.692}$
2. Intake					206	0	
Gate	ton	547,000		0.37	204	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.18	2	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					147	0	
Gate	ton	547,000		0.26	145	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.18	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.55	744	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,115	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					12,689	0	

Construction Cost Summary

Site Name:N16 Lamakan

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	10,320	187,627	23,735	
(1) Access Road	9,551	173,651	21,967	
(2) Camp & Facilities	769	13,976	1,768	3. Civil work * 0.05
2. Environmental mitigation cost	154	2,795	354	3. Civil work * 0.01
3. Civil works	15,374	279,529	35,360	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	437	7,945	1,005	
(3) Settling basin	474	8,618	1,090	
(4) Headrace	9,082	165,127	20,889	
(5) Head tank	765	13,909	1,760	
(6) Penstock and spillway channel	172	3,127	396	
(7) Powerhouse	546	9,927	1,256	
(8) Tailrace channel	48	873	110	
(9) Tailrace	173	3,145	398	
(10) Miscellaneous	732	13,311	1,684	((1) to (9)) *0.05
4. Hydraulic equipment	12,689	230,705	29,184	
(1) Gate and screen	9,830	178,727	22,609	
(2) Penstock	744	13,527	1,711	
(3) Others	2,115	38,451	4,864	
5. Electro-mechanical equipment	3,026	55,017	6,960	Turbine and Generator, Transformer, etc
6. Transmission line	15,300	278,182	35,190	1,500,000PhP/km * distance from existing transmission
Direct Cost	56,862	1,033,856	130,783	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,529	155,078	19,617	Direct Cost * 0.15
8. Contingency	5,686	103,386	13,078	Direct Cost * 0.1
9. Interest during construction	6,823	124,063	15,694	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	77,901	1,416,382	179,172	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		69		
Development Cost (/kW)	1,123.571	20,429	2,584.212	
Annual Generation (kWh/yr)		421,823		
Construction Cost per kWh	0.18468	3.35777	0.42476	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.026	0.474	0.060	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N16 Lamakan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					437	0	
(1) Excavation (Ve)	m^3	136		78	11	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		84	264	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	74	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				88	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					474	0	
(1) Excavation (Ve)	m^3	136		196	27	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		73	228	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	140	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				79	0	((1) + (2) + (3)) * 0.2
4. Headrace					9,082	0	
Tunnel							
(1) Excavation (Ve)	m^3	314		2,361	742	0	$(0.893*D^2+1.07*D+0.321)*L$
(2) Concrete(Invert)(Vcl)	m^3	4,990		90	450	0	(D*0.1)*L
(3) Concrete(Spray)(Vcy)	m^3	13,622		373	5,078	0	(pai*D+D)*0.1*L
Open channel							
(4) Excavation (Ve)	m^3	136		5,264	716	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(5) Concrete(Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(6) Others	L.S.				2,096	0	((1) + (2) + (3) + (4) + (5)) * 0.3
5. Head Tank					765	0	
(1) Excavation (Ve)	m^3	136		431	59	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		103	324	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	163	0	$0.051*V_c$
(4) Others	L.S.				219	0	((1) + (2) + (3)) * 0.4
6. Penstock					172	0	
(1) Excavation (Ve)	m^3	136		199	28	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		31	97	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	18	0	$0.018*V_c$
(4) Others	L.S.				29	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					546	0	
(1) Excavation (Ve)	m^3	136		220	30	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		68	214	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		4	120	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				182	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					48	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	21	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				8	0	((1) + (2)) * 0.2
9. Tailrace outlet					173	0	
(1) Excavation (Ve)	m^3	136		224	31	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		18	57	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	50	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				35	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				732	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,374	0	

No. N18 Berong Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N18 Berong

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					32,265	0	
Dam	m^2	239.00		135,000	32,265	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				6,453	0	(1.) * 0.2
Subtotal					38,718	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N18 Berong

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,048	0	
Sand Flush Gate	ton	547,000		11.05	6,048	0	$0.145*Q_f^{0.692}$
2. Intake					504	0	
Gate	ton	547,000		0.91	499	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.49	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					413	0	
Gate	ton	547,000		0.74	406	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.68	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		10.43	5,009	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,395	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,369	0	

Construction Cost Summary

Site Name:N18 Berong

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	40,020	727,630	92,045	
(1) Access Road	38,718	703,964	89,051	
(2) Camp & Facilities	1,302	23,666	2,994	3. Civil work * 0.05
2. Environmental mitigation cost	260	4,733	599	3. Civil work * 0.01
3. Civil works	26,033	473,321	59,875	
(1) Intake weir	10,502	190,945	24,155	
(2) Intake	885	16,091	2,036	
(3) Settling basin	1,736	31,564	3,993	
(4) Headrace	5,051	91,836	11,617	
(5) Head tank	2,142	38,945	4,927	
(6) Penstock and spillway channel	982	17,855	2,259	
(7) Powerhouse	3,035	55,182	6,981	
(8) Tailrace channel	80	1,455	184	
(9) Tailrace	380	6,909	874	
(10) Miscellaneous	1,240	22,539	2,851	((1) to (9)) *0.05
4. Hydraulic equipment	14,369	261,251	33,048	
(1) Gate and screen	6,965	126,636	16,020	
(2) Penstock	5,009	91,073	11,521	
(3) Others	2,395	43,542	5,508	
5. Electro-mechanical equipment	25,070	455,818	57,661	Turbine and Generator, Transformer, etc
6. Transmission line	67,500	1,227,273	155,250	1,500,000PhP/km * distance from existing transmission
Direct Cost	173,251	3,150,026	398,478	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	25,988	472,504	59,772	Direct Cost * 0.15
8. Contingency	17,325	315,003	39,848	Direct Cost * 0.1
9. Interest during construction	20,790	378,003	47,817	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	237,354	4,315,535	545,915	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		828		
Development Cost (/kW)	286.552	5,210	659.069	
Annual Generation (kWh/yr)		5,072,871		
Construction Cost per kWh	0.04679	0.85071	0.10761	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.007	0.120	0.015	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N18 Berong

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					10,502	0	
No.1					1,926		
(1) Excavation (V_e)	m^3	136		925	126	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		595	1,614	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
No.2					3,076		
(4) Excavation (Ve)	m^3	136		2,039	278		$8.69*(Dh * CL)^{1.14}$
(5) Concrete (Vc)	m^3	2,712		963	2,612		$16.1*(Dh^2 * CL)^{0.695}$
(6) Reinforcement ba	ton	30,900		6	186		$0.0274*V_c^{0.830}$
(6) Others	L.S.				2,424	0	((1) + (2) + (3) + (4) + (5) + (6)) * 0.3
2. Intake					885	0	
(1) Excavation (Ve)	m^3	136		203	28	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		166	520	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	160	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				177	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,736	0	
(1) Excavation (Ve)	m^3	136		920	126	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		281	880	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	440	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				290	0	((1) + (2) + (3)) * 0.2
4. Headrace (No.1+No.2)					5,051	0	
(1) Excavation (Ve)	m^3	136		28,564	3,885	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				1,166	0	((1) + (2)) * 0.3
5. Head Tank					2,142	0	
(1) Excavation (Ve)	m^3	136		1,179	161	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		290	911	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		15	458	0	$0.051*V_c$
(4) Others	L.S.				612	0	((1) + (2) + (3)) * 0.4
6. Penstock					982	0	
(1) Excavation (Ve)	m^3	136		1,013	138	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		184	577	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	103	0	$0.018*V_c$
(4) Others	L.S.				164	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,035	0	
(1) Excavation (Ve)	m^3	136		1,040	142	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		373	1,168	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		23	713	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,012	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					80	0	
(1) Excavation (Ve)	m^3	136		229	32	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	34	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					380	0	
(1) Excavation (Ve)	m^3	136		446	61	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		48	151	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	92	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				1,240	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					26,033	0	

No. N19 Tagbolante Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N19 Tagbolante

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					32,265	0	
Dam	m^2	239.00		135,000	32,265	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				6,453	0	(1.) * 0.2
Subtotal					38,718	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N19 Tagbolante

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,702	0	
Sand Flush Gate	ton	547,000		12.25	6,702	0	$0.145*Q_f^{0.692}$
2. Intake					508	0	
Gate	ton	547,000		0.92	503	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.49	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					417	0	
Gate	ton	547,000		0.75	410	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.68	7	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.02	1,931	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,912	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					11,470	0	

Construction Cost Summary

Site Name:N19 Tagbolante

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	39,614	720,261	91,113	
(1) Access Road	38,718	703,964	89,051	
(2) Camp & Facilities	896	16,297	2,062	3. Civil work * 0.05
2. Environmental mitigation cost	179	3,259	412	3. Civil work * 0.01
3. Civil works	17,927	325,939	41,231	
(1) Intake weir	4,834	87,891	11,118	
(2) Intake	893	16,236	2,054	
(3) Settling basin	1,763	32,055	4,055	
(4) Headrace	4,041	73,473	9,294	
(5) Head tank	2,170	39,455	4,991	
(6) Penstock and spillway channel	448	8,145	1,030	
(7) Powerhouse	2,460	44,727	5,658	
(8) Tailrace channel	80	1,455	184	
(9) Tailrace	384	6,982	883	
(10) Miscellaneous	854	15,521	1,963	((1) to (9)) *0.05
4. Hydraulic equipment	11,470	208,538	26,380	
(1) Gate and screen	7,627	138,673	17,542	
(2) Penstock	1,931	35,109	4,441	
(3) Others	1,912	34,756	4,397	
5. Electro-mechanical equipment	17,144	311,711	39,431	Turbine and Generator, Transformer, etc
6. Transmission line	67,500	1,227,273	155,250	1,500,000PhP/km * distance from existing transmission
Direct Cost	153,834	2,796,981	353,818	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	23,075	419,547	53,073	Direct Cost * 0.15
8. Contingency	15,383	279,698	35,382	Direct Cost * 0.1
9. Interest during construction	18,460	335,638	42,458	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	210,753	3,831,864	484,731	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		555		
Development Cost (/kW)	379.444	6,899	872.722	
Annual Generation (kWh/yr)		3,400,602		
Construction Cost per kWh	0.06198	1.12682	0.14254	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.009	0.159	0.020	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N19 Tagbolante

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,834	0	
(1) Excavation (V_e)	m^3	136		2,629	358	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		1,125	3,051	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		10	309	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,116	0	((1) + (2) + (3)) * 0.3
2. Intake					893	0	
(1) Excavation (Ve)	m^3	136		205	28	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		167	524	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	162	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				179	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,763	0	
(1) Excavation (Ve)	m^3	136		938	128	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		286	895	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		14	446	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				294	0	((1) + (2) + (3)) * 0.2
4. Headrace					4,041	0	
(1) Excavation (Ve)	m^3	136		22,851	3,108	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				933	0	((1) + (2)) * 0.3
5. Head Tank					2,170	0	
(1) Excavation (Ve)	m^3	136		1,194	163	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		294	923	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		15	464	0	$0.051*V_c$
(4) Others	L.S.				620	0	((1) + (2) + (3)) * 0.4
6. Penstock					448	0	
(1) Excavation (Ve)	m^3	136		462	63	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		84	263	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	47	0	$0.018*V_c$
(4) Others	L.S.				75	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,460	0	
(1) Excavation (Ve)	m^3	136		860	117	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		303	950	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		19	573	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				820	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					80	0	
(1) Excavation (Ve)	m^3	136		229	32	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		11	34	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.2
9. Tailrace outlet					384	0	
(1) Excavation (Ve)	m^3	136		450	62	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		49	153	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	92	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				77	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				854	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					17,927	0	

No. N21 Malatgao 4 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name:N21 Malatgao(4)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					6,453	0	
Dam	m^2	239.00		27,000	6,453	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				1,291	0	(1.) * 0.2
Subtotal					7,744	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name:N21 Malatgao(4)

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,753	0	
Sand Flush Gate	ton	547,000		16.00	8,753	0	$0.145*Q_f^{0.692}$
2. Intake					651	0	
Gate	ton	547,000		1.18	644	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.64	7	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					554	0	
Gate	ton	547,000		0.99	544	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.98	10	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		20.34	9,764	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,944	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					23,666	0	

Construction Cost Summary

Site Name:N21 Malatgao(4)

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	8,734	158,804	20,089	
(1) Access Road	7,744	140,793	17,810	
(2) Camp & Facilities	991	18,011	2,278	3. Civil work * 0.05
2. Environmental mitigation cost	198	3,602	456	3. Civil work * 0.01
3. Civil works	19,812	360,226	45,569	
(1) Intake weir	4,120	74,909	9,476	
(2) Intake	953	17,327	2,192	
(3) Settling basin	1,984	36,073	4,563	
(4) Headrace	3,544	64,436	8,151	
(5) Head tank	2,382	43,309	5,479	
(6) Penstock and spillway channel	1,988	36,145	4,572	
(7) Powerhouse	3,408	61,964	7,838	
(8) Tailrace channel	76	1,382	175	
(9) Tailrace	414	7,527	952	
(10) Miscellaneous	943	17,154	2,170	((1) to (9)) *0.05
4. Hydraulic equipment	23,666	430,298	54,433	
(1) Gate and screen	9,958	181,055	22,903	
(2) Penstock	9,764	177,527	22,457	
(3) Others	3,944	71,716	9,072	
5. Electro-mechanical equipment	28,746	522,651	66,115	Turbine and Generator, Transformer, etc
6. Transmission line	22,800	414,545	52,440	1,500,000PhP/km * distance from existing transmission
Direct Cost	103,957	1,890,127	239,101	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,594	283,519	35,865	Direct Cost * 0.15
8. Contingency	10,396	189,013	23,910	Direct Cost * 0.1
9. Interest during construction	12,475	226,815	28,692	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	142,421	2,589,475	327,569	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		955		
Development Cost (/kW)	149.152	2,712	343.050	
Annual Generation (kWh/yr)		5,852,347		
Construction Cost per kWh	0.02434	0.44247	0.05597	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.003	0.063	0.008	

Civil Engineering Work Cost (Run-of-River Type)

Site Name:N21 Malatgao(4)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,120	0	
(1) Excavation (V_e)	m^3	136		2,039	278	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		963	2,612	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				951	0	((1) + (2) + (3)) * 0.3
2. Intake					953	0	
(1) Excavation (Ve)	m^3	136		224	31	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		178	557	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		6	174	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				191	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,984	0	
(1) Excavation (Ve)	m^3	136		1,078	147	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		323	1,011	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		16	495	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				331	0	((1) + (2) + (3)) * 0.2
4. Headrace					3,544	0	
(1) Excavation (Ve)	m^3	136		20,043	2,726	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				818	0	((1) + (2)) * 0.3
5. Head Tank					2,382	0	
(1) Excavation (Ve)	m^3	136		1,308	178	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		323	1,013	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		16	510	0	$0.051*V_c$
(4) Others	L.S.				681	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,988	0	
(1) Excavation (Ve)	m^3	136		1,896	258	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		379	1,187	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		7	211	0	$0.018*V_c$
(4) Others	L.S.				332	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,408	0	
(1) Excavation (Ve)	m^3	136		1,154	158	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		418	1,310	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		26	804	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,136	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					76	0	
(1) Excavation (Ve)	m^3	136		220	30	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	33	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.2
9. Tailrace outlet					414	0	
(1) Excavation (Ve)	m^3	136		479	66	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		53	167	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	98	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				83	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				943	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					19,812	0	

No. N23 Salogan 1-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N23 Salogan Case1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					574	0	
Dam	m^2	239.00		2,400	574	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				115	0	(1.) * 0.2
Subtotal					689	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N23 Salogan Case1-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,785	0	
Sand Flush Gate	ton	547,000		16.06	8,785	0	$0.145*Q_f^{0.692}$
2. Intake					859	0	
Gate	ton	547,000		1.55	850	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.87	9	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					499	0	
Gate	ton	547,000		0.89	490	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.86	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.03	974	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,223	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,340	0	

Construction Cost Summary

Site Name: N23 Salogan Case1-1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,340	24,372	3,083	
(1) Access Road	689	12,524	1,584	
(2) Camp & Facilities	652	11,849	1,499	3. Civil work * 0.05
2. Environmental mitigation cost	130	2,370	300	3. Civil work * 0.01
3. Civil works	13,034	236,975	29,977	
(1) Intake weir	1,952	35,491	4,490	
(2) Intake	1,442	26,218	3,317	
(3) Settling basin	2,260	41,091	5,198	
(4) Headrace	860	15,636	1,978	
(5) Head tank	2,639	47,982	6,070	
(6) Penstock and spillway channel	395	7,182	909	
(7) Powerhouse	2,151	39,109	4,947	
(8) Tailrace channel	49	891	113	
(9) Tailrace	665	12,091	1,530	
(10) Miscellaneous	621	11,285	1,427	((1) to (9)) *0.05
4. Hydraulic equipment	13,340	242,553	30,683	
(1) Gate and screen	10,143	184,418	23,329	
(2) Penstock	974	17,709	2,240	
(3) Others	2,223	40,425	5,114	
5. Electro-mechanical equipment	11,949	217,253	27,483	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	58,994	1,072,615	135,686	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,849	160,892	20,353	Direct Cost * 0.15
8. Contingency	5,899	107,261	13,569	Direct Cost * 0.1
9. Interest during construction	7,079	128,714	16,282	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	80,822	1,469,482	185,889	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	377			
Development Cost	214.635	3,902	493.660	
Annual Generation (kWh/yr)	2,308,036			
Construction Cost per kWh	0.03502	0.63668	0.08054	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.005	0.090	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N23 Salogan Case1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					1,952	0	
(1) Excavation (V_e)	m^3	136		616	84	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		465	1,262	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				451	0	((1) + (2) + (3)) * 0.3
2. Intake					1,442	0	
(1) Excavation (Ve)	m^3	136		391	54	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		263	826	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		9	273	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				289	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,260	0	
(1) Excavation (Ve)	m^3	136		1,258	172	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		369	1,157	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		18	554	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				377	0	((1) + (2) + (3)) * 0.2
4. Headrace					860	0	
(1) Excavation (Ve)	m^3	136		4,860	661	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				199	0	((1) + (2)) * 0.3
5. Head Tank					2,639	0	
(1) Excavation (Ve)	m^3	136		1,445	197	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		358	1,123	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	565	0	$0.051*V_c$
(4) Others	L.S.				754	0	((1) + (2) + (3)) * 0.4
6. Penstock					395	0	
(1) Excavation (Ve)	m^3	136		382	52	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		75	235	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	42	0	$0.018*V_c$
(4) Others	L.S.				66	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,151	0	
(1) Excavation (Ve)	m^3	136		761	104	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		265	831	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		16	499	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				717	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					49	0	
(1) Excavation (Ve)	m^3	136		128	18	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	19	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					665	0	
(1) Excavation (Ve)	m^3	136		715	98	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		94	296	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				133	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				621	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					13,034	0	

No. N24 Salogan 1-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N24 Salogan Case1-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					574	0	
Dam	m^2	239.00		2,400	574	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				115	0	(1.) * 0.2
Subtotal					689	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N24 Salogan Case1-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,785	0	
Sand Flush Gate	ton	547,000		16.06	8,785	0	$0.145*Q_f^{0.692}$
2. Intake					859	0	
Gate	ton	547,000		1.55	850	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.87	9	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					499	0	
Gate	ton	547,000		0.89	490	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.86	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.03	974	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,223	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,340	0	

Construction Cost Summary

Site Name: N24 Salogan Case1-2

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,343	24,420	3,089	
(1) Access Road	689	12,524	1,584	
(2) Camp & Facilities	654	11,897	1,505	3. Civil work * 0.05
2. Environmental mitigation cost	131	2,379	301	3. Civil work * 0.01
3. Civil works	13,086	237,930	30,098	
(1) Intake weir	1,952	35,491	4,490	
(2) Intake	1,442	26,218	3,317	
(3) Settling basin	2,260	41,091	5,198	
(4) Headrace	865	15,727	1,990	
(5) Head tank	2,639	47,982	6,070	
(6) Penstock and spillway channel	395	7,182	909	
(7) Powerhouse	2,151	39,109	4,947	
(8) Tailrace channel	94	1,709	216	
(9) Tailrace	665	12,091	1,530	
(10) Miscellaneous	623	11,330	1,433	((1) to (9)) *0.05
4. Hydraulic equipment	13,340	242,553	30,683	
(1) Gate and screen	10,143	184,418	23,329	
(2) Penstock	974	17,709	2,240	
(3) Others	2,223	40,425	5,114	
5. Electro-mechanical equipment	11,949	217,253	27,483	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	59,049	1,073,627	135,814	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,857	161,044	20,372	Direct Cost * 0.15
8. Contingency	5,905	107,363	13,581	Direct Cost * 0.1
9. Interest during construction	7,086	128,835	16,298	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	80,898	1,470,868	186,065	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		377		
Development Cost	214.837	3,906	494.126	
Annual Generation (kWh/yr)		2,308,036		
Construction Cost per kWh	0.03505	0.63728	0.08062	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.090	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N24 Salogan Case1-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					1,952	0	
(1) Excavation (V_e)	m^3	136		616	84	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		465	1,262	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				451	0	((1) + (2) + (3)) * 0.3
2. Intake					1,442	0	
(1) Excavation (Ve)	m^3	136		391	54	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		263	826	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		9	273	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				289	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,260	0	
(1) Excavation (Ve)	m^3	136		1,258	172	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		369	1,157	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		18	554	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				377	0	((1) + (2) + (3)) * 0.2
4. Headrace					865	0	
(1) Excavation (Ve)	m^3	136		4,860	661	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		1	4	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				200	0	((1) + (2)) * 0.3
5. Head Tank					2,639	0	
(1) Excavation (Ve)	m^3	136		1,445	197	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		358	1,123	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	565	0	$0.051*V_c$
(4) Others	L.S.				754	0	((1) + (2) + (3)) * 0.4
6. Penstock					395	0	
(1) Excavation (Ve)	m^3	136		382	52	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		75	235	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	42	0	$0.018*V_c$
(4) Others	L.S.				66	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					2,151	0	
(1) Excavation (Ve)	m^3	136		761	104	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		265	831	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		16	499	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				717	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					94	0	
(1) Excavation (Ve)	m^3	136		256	35	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		12	37	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				22	0	((1) + (2)) * 0.3
9. Tailrace outlet					665	0	
(1) Excavation (Ve)	m^3	136		715	98	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		94	296	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				133	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				623	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					13,086	0	

No. N25 Salogan 2-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N25 Salogan Case2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					933	0	
Dam	m^2	239.00		3,900	933	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				187	0	(1.) * 0.2
Subtotal					1,120	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N25 Salogan Case2-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,807	0	
Sand Flush Gate	ton	547,000		16.10	8,807	0	$0.145*Q_f^{0.692}$
2. Intake					855	0	
Gate	ton	547,000		1.55	846	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.87	9	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					496	0	
Gate	ton	547,000		0.89	487	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.85	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.88	1,864	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,404	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,426	0	

Construction Cost Summary

Site Name: N25 Salogan Case2-1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,912	34,759	4,397	
(1) Access Road	1,120	20,356	2,575	
(2) Camp & Facilities	792	14,402	1,822	3. Civil work * 0.05
2. Environmental mitigation cost	158	2,880	364	3. Civil work * 0.01
3. Civil works	15,842	288,044	36,438	
(1) Intake weir	2,129	38,709	4,897	
(2) Intake	1,433	26,055	3,296	
(3) Settling basin	2,240	40,727	5,152	
(4) Headrace	2,019	36,709	4,644	
(5) Head tank	2,621	47,655	6,028	
(6) Penstock and spillway channel	756	13,745	1,739	
(7) Powerhouse	3,134	56,982	7,208	
(8) Tailrace channel	94	1,709	216	
(9) Tailrace	662	12,036	1,523	
(10) Miscellaneous	754	13,716	1,735	((1) to (9)) *0.05
4. Hydraulic equipment	14,426	262,298	33,181	
(1) Gate and screen	10,158	184,691	23,363	
(2) Penstock	1,864	33,891	4,287	
(3) Others	2,404	43,716	5,530	
5. Electro-mechanical equipment	10,389	188,883	23,894	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	61,927	1,125,954	142,433	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	9,289	168,893	21,365	Direct Cost * 0.15
8. Contingency	6,193	112,595	14,243	Direct Cost * 0.1
9. Interest during construction	7,431	135,115	17,092	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	84,841	1,542,558	195,134	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		323		
Development Cost	262.804	4,778	604.448	
Annual Generation (kWh/yr)		2,542,550		
Construction Cost per kWh	0.03337	0.60670	0.07675	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.005	0.086	0.011	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N25 Salogan Case2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,129	0	
(1) Excavation (V_e)	m^3	136		718	98	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		510	1,384	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				492	0	((1) + (2) + (3)) * 0.3
2. Intake					1,433	0	
(1) Excavation (Ve)	m^3	136		388	53	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		262	822	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		9	271	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				287	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,240	0	
(1) Excavation (Ve)	m^3	136		1,244	170	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		366	1,146	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		18	550	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				374	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,019	0	
(1) Excavation (Ve)	m^3	136		11,383	1,549	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		1	4	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				466	0	((1) + (2)) * 0.3
5. Head Tank					2,621	0	
(1) Excavation (Ve)	m^3	136		1,435	196	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		355	1,115	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		18	561	0	$0.051*V_c$
(4) Others	L.S.				749	0	((1) + (2) + (3)) * 0.4
6. Penstock					756	0	
(1) Excavation (Ve)	m^3	136		730	100	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		143	450	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	80	0	$0.018*V_c$
(4) Others	L.S.				126	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,134	0	
(1) Excavation (Ve)	m^3	136		1,071	146	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		385	1,206	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		24	737	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,045	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					94	0	
(1) Excavation (Ve)	m^3	136		256	35	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		12	37	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				22	0	((1) + (2)) * 0.3
9. Tailrace outlet					662	0	
(1) Excavation (Ve)	m^3	136		712	97	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		94	294	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				133	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				754	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,842	0	

No. N26 Salogan 2-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N26 Salogan Case2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					933	0	
Dam	m^2	239.00		3,900	933	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				187	0	(1.) * 0.2
Subtotal					1,120	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N26 Salogan Case2-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					8,807	0	
Sand Flush Gate	ton	547,000		16.10	8,807	0	$0.145*Q_f^{0.692}$
2. Intake					855	0	
Gate	ton	547,000		1.55	846	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.87	9	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					496	0	
Gate	ton	547,000		0.89	487	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.85	9	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		3.88	1,864	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,404	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,426	0	

Construction Cost Summary

Site Name: N26 Salogan Case2-1

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	1,898	34,516	4,366	
(1) Access Road	1,120	20,356	2,575	
(2) Camp & Facilities	779	14,160	1,791	3. Civil work * 0.05
2. Environmental mitigation cost	156	2,832	358	3. Civil work * 0.01
3. Civil works	15,576	283,195	35,824	
(1) Intake weir	2,129	38,709	4,897	
(2) Intake	1,433	26,055	3,296	
(3) Settling basin	2,240	40,727	5,152	
(4) Headrace	2,014	36,618	4,632	
(5) Head tank	2,372	43,127	5,456	
(6) Penstock and spillway channel	756	13,745	1,739	
(7) Powerhouse	3,134	56,982	7,208	
(8) Tailrace channel	94	1,709	216	
(9) Tailrace	662	12,036	1,523	
(10) Miscellaneous	742	13,485	1,706	((1) to (9)) *0.05
4. Hydraulic equipment	14,426	262,298	33,181	
(1) Gate and screen	10,158	184,691	23,363	
(2) Penstock	1,864	33,891	4,287	
(3) Others	2,404	43,716	5,530	
5. Electro-mechanical equipment	23,212	422,027	53,386	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	74,468	1,353,959	171,276	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	11,170	203,094	25,691	Direct Cost * 0.15
8. Contingency	7,447	135,396	17,128	Direct Cost * 0.1
9. Interest during construction	8,936	162,475	20,553	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	102,021	1,854,924	234,648	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	764			
Development Cost	133.478	2,427	307.000	
Annual Generation (kWh/yr)	4,684,833			
Construction Cost per kWh	0.02178	0.39594	0.05009	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.003	0.056	0.007	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N26 Salogan Case2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,129	0	
(1) Excavation (V_e)	m^3	136		718	98	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		510	1,384	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		5	155	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				492	0	((1) + (2) + (3)) * 0.3
2. Intake					1,433	0	
(1) Excavation (Ve)	m^3	136		388	53	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		262	822	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		9	271	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				287	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					2,240	0	
(1) Excavation (Ve)	m^3	136		1,244	170	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		366	1,146	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		18	550	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				374	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,014	0	
(1) Excavation (Ve)	m^3	136		11,383	1,549	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				465	0	((1) + (2)) * 0.3
5. Head Tank					2,372	0	
(1) Excavation (Ve)	m^3	47		1,435	68	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,500		355	1,245	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	21,000		18	381	0	$0.051*V_c$
(4) Others	L.S.				678	0	((1) + (2) + (3)) * 0.4
6. Penstock					756	0	
(1) Excavation (Ve)	m^3	136		730	100	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		143	450	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	80	0	$0.018*V_c$
(4) Others	L.S.				126	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					3,134	0	
(1) Excavation (Ve)	m^3	136		1,071	146	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		385	1,206	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		24	737	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				1,045	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					94	0	
(1) Excavation (Ve)	m^3	136		256	35	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		12	37	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				22	0	((1) + (2)) * 0.3
9. Tailrace outlet					662	0	
(1) Excavation (Ve)	m^3	136		712	97	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		94	294	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				133	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				742	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					15,576	0	

No. N27 Salogan 3-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N27 Salogan Case3-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,589	0	
Dam	m^2	239.00		19,200	4,589	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				918	0	(1.) * 0.2
Subtotal					5,507	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N27 Salogan Case3-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,582	0	
Sand Flush Gate	ton	547,000		19.34	10,582	0	$0.145*Q_f^{0.692}$
2. Intake					517	0	
Gate	ton	547,000		0.93	511	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.50	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					278	0	
Gate	ton	547,000		0.50	273	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.41	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.53	2,176	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,711	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					16,264	0	

Construction Cost Summary

Site Name: N27 Salogan Case3-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	6,048	109,971	13,911	
(1) Access Road	5,507	100,124	12,666	
(2) Camp & Facilities	542	9,847	1,246	3. Civil work * 0.05
2. Environmental mitigation cost	108	1,969	249	3. Civil work * 0.01
3. Civil works	10,832	196,942	24,913	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	904	16,436	2,079	
(3) Settling basin	966	17,564	2,222	
(4) Headrace	990	18,000	2,277	
(5) Head tank	1,347	24,491	3,098	
(6) Penstock and spillway channel	716	13,018	1,647	
(7) Powerhouse	1,991	36,200	4,579	
(8) Tailrace channel	68	1,236	156	
(9) Tailrace	389	7,073	895	
(10) Miscellaneous	516	9,378	1,186	((1) to (9)) *0.05
4. Hydraulic equipment	16,264	295,702	37,406	
(1) Gate and screen	11,377	206,855	26,167	
(2) Penstock	2,176	39,564	5,005	
(3) Others	2,711	49,284	6,234	
5. Electro-mechanical equipment	16,182	294,217	37,218	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	68,634	1,247,892	157,858	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	10,295	187,184	23,679	Direct Cost * 0.15
8. Contingency	6,863	124,789	15,786	Direct Cost * 0.1
9. Interest during construction	8,236	149,747	18,943	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	94,029	1,709,612	216,266	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		522		
Development Cost (/kW)	180.029	3,273	414.068	
Annual Generation (kWh/yr)		3,193,464		
Construction Cost per kWh	0.02944	0.53535	0.06772	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.004	0.076	0.010	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N27 Salogan Case3-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					904	0	
(1) Excavation (Ve)	m^3	136		208	29	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		169	530	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	164	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				181	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					966	0	
(1) Excavation (Ve)	m^3	136		459	63	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		153	479	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		8	263	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				161	0	((1) + (2) + (3)) * 0.2
4. Headrace					990	0	
(1) Excavation (Ve)	m^3	136		5,590	761	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				229	0	((1) + (2)) * 0.3
5. Head Tank					1,347	0	
(1) Excavation (Ve)	m^3	136		749	102	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		182	572	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		9	288	0	$0.051*V_c$
(4) Others	L.S.				385	0	((1) + (2) + (3)) * 0.4
6. Penstock					716	0	
(1) Excavation (Ve)	m^3	136		766	105	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		133	417	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	74	0	$0.018*V_c$
(4) Others	L.S.				120	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,991	0	
(1) Excavation (Ve)	m^3	136		710	97	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		246	770	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		15	460	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				664	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					68	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	27	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				16	0	((1) + (2)) * 0.3
9. Tailrace outlet					389	0	
(1) Excavation (Ve)	m^3	136		455	62	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		50	156	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	93	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				78	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				516	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					10,832	0	

No. N28 Salogan 3-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N28 Salogan Case3-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,589	0	
Dam	m^2	239.00		19,200	4,589	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				918	0	(1.) * 0.2
Subtotal					5,507	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N28 Salogan Case3-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,582	0	
Sand Flush Gate	ton	547,000		19.34	10,582	0	$0.145*Q_f^{0.692}$
2. Intake					517	0	
Gate	ton	547,000		0.93	511	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.50	6	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					278	0	
Gate	ton	547,000		0.50	273	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.41	5	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.53	2,176	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,711	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					16,264	0	

Construction Cost Summary

Site Name: N28 Salogan Case3-2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	6,048	109,971	13,911	
(1) Access Road	5,507	100,124	12,666	
(2) Camp & Facilities	542	9,847	1,246	3. Civil work * 0.05
2. Environmental mitigation cost	108	1,969	249	3. Civil work * 0.01
3. Civil works	10,832	196,942	24,913	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	904	16,436	2,079	
(3) Settling basin	966	17,564	2,222	
(4) Headrace	990	18,000	2,277	
(5) Head tank	1,347	24,491	3,098	
(6) Penstock and spillway channel	716	13,018	1,647	
(7) Powerhouse	1,991	36,200	4,579	
(8) Tailrace channel	68	1,236	156	
(9) Tailrace	389	7,073	895	
(10) Miscellaneous	516	9,378	1,186	((1) to (9)) *0.05
4. Hydraulic equipment	16,264	295,702	37,406	
(1) Gate and screen	11,377	206,855	26,167	
(2) Penstock	2,176	39,564	5,005	
(3) Others	2,711	49,284	6,234	
5. Electro-mechanical equipment	16,182	294,217	37,218	Turbine and Generator, Transformer, etc
6. Transmission line	19,200	349,091	44,160	1,500,000PhP/km * distance from existing transmission
Direct Cost	68,634	1,247,892	157,858	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	10,295	187,184	23,679	Direct Cost * 0.15
8. Contingency	6,863	124,789	15,786	Direct Cost * 0.1
9. Interest during construction	8,236	149,747	18,943	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	94,029	1,709,612	216,266	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		522		
Development Cost (/kW)	180.029	3,273	414.068	
Annual Generation (kWh/yr)		3,193,464		
Construction Cost per kWh	0.02944	0.53535	0.06772	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.004	0.076	0.010	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N28 Salogan Case3-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					904	0	
(1) Excavation (Ve)	m^3	136		208	29	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		169	530	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	164	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				181	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					966	0	
(1) Excavation (Ve)	m^3	136		459	63	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		153	479	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		8	263	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				161	0	((1) + (2) + (3)) * 0.2
4. Headrace					990	0	
(1) Excavation (Ve)	m^3	136		5,590	761	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				229	0	((1) + (2)) * 0.3
5. Head Tank					1,347	0	
(1) Excavation (Ve)	m^3	136		749	102	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		182	572	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		9	288	0	$0.051*V_c$
(4) Others	L.S.				385	0	((1) + (2) + (3)) * 0.4
6. Penstock					716	0	
(1) Excavation (Ve)	m^3	136		766	105	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		133	417	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	74	0	$0.018*V_c$
(4) Others	L.S.				120	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,991	0	
(1) Excavation (Ve)	m^3	136		710	97	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		246	770	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		15	460	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				664	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					68	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		8	27	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				16	0	((1) + (2)) * 0.3
9. Tailrace outlet					389	0	
(1) Excavation (Ve)	m^3	136		455	62	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		50	156	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	93	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				78	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				516	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					10,832	0	

No. N33 Aporawan 3-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N33 Aporawan 3 Case1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					8,461	0	
Dam	m^2	239.00		35,400	8,461	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				1,692	0	(1.) * 0.2
Subtotal					10,153	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N33 Aporawan 3 Case1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					9,561	0	
Sand Flush Gate	ton	547,000		17.48	9,561	0	$0.145*Q_f^{0.692}$
2. Intake					754	0	
Gate	ton	547,000		1.36	746	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.76	8	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					430	0	
Gate	ton	547,000		0.77	422	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.71	8	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.66	799	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,309	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,853	0	

Construction Cost Summary

Site Name: N33 Aporawan 3 Case1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	10,790	196,185	24,817	
(1) Access Road	10,153	184,604	23,352	
(2) Camp & Facilities	637	11,582	1,465	3. Civil work * 0.05
2. Environmental mitigation cost	127	2,316	293	3. Civil work * 0.01
3. Civil works	12,740	231,630	29,301	
(1) Intake weir	3,656	66,473	8,409	
(2) Intake	1,093	19,873	2,514	
(3) Settling basin	1,365	24,818	3,140	
(4) Headrace	2,170	39,455	4,991	
(5) Head tank	1,773	32,236	4,078	
(6) Penstock and spillway channel	305	5,545	702	
(7) Powerhouse	1,211	22,018	2,785	
(8) Tailrace channel	77	1,400	177	
(9) Tailrace	483	8,782	1,111	
(10) Miscellaneous	607	11,030	1,395	((1) to (9)) *0.05
4. Hydraulic equipment	13,853	251,869	31,861	
(1) Gate and screen	10,745	195,364	24,714	
(2) Penstock	799	14,527	1,838	
(3) Others	2,309	41,978	5,310	
5. Electro-mechanical equipment	5,952	108,216	13,689	Turbine and Generator, Transformer, etc
6. Transmission line	27,450	499,091	63,135	1,500,000PhP/km * distance from existing transmission
Direct Cost	70,912	1,289,307	163,097	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	10,637	193,396	24,465	Direct Cost * 0.15
8. Contingency	7,091	128,931	16,310	Direct Cost * 0.1
9. Interest during construction	8,509	154,717	19,572	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	97,149	1,766,351	223,443	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		170		
Development Cost (/kW)	571.216	10,386	1,313.796	
Annual Generation (kWh/yr)		1,040,812		
Construction Cost per kWh	0.09334	1.69709	0.21468	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.013	0.240	0.030	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N33 Aporawan 3 Case1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,656	0	
(1) Excavation (V_e)	m^3	136		1,694	231	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		860	2,333	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		8	248	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				844	0	((1) + (2) + (3)) * 0.3
2. Intake					1,093	0	
(1) Excavation (Ve)	m^3	136		269	37	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		202	635	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		7	202	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				219	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,365	0	
(1) Excavation (Ve)	m^3	136		692	95	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		219	686	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		12	356	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				228	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,170	0	
(1) Excavation (Ve)	m^3	136		12,268	1,669	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				501	0	((1) + (2)) * 0.3
5. Head Tank					1,773	0	
(1) Excavation (Ve)	m^3	136		979	134	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		240	753	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		12	379	0	$0.051*V_c$
(4) Others	L.S.				507	0	((1) + (2) + (3)) * 0.4
6. Penstock					305	0	
(1) Excavation (Ve)	m^3	136		303	42	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		57	180	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	32	0	$0.018*V_c$
(4) Others	L.S.				51	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,211	0	
(1) Excavation (Ve)	m^3	136		452	62	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		150	471	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		9	274	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				404	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					77	0	
(1) Excavation (Ve)	m^3	136		204	28	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	31	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				18	0	((1) + (2)) * 0.3
9. Tailrace outlet					483	0	
(1) Excavation (Ve)	m^3	136		547	75	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		64	202	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	109	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				97	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				607	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					12,740	0	

No. N34 Aporawan 3-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N34 Aporawan 3 Case2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					8,461	0	
Dam	m^2	239.00		35,400	8,461	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				1,692	0	(1.) * 0.2
Subtotal					10,153	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N34 Aporawan 3 Case2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					9,561	0	
Sand Flush Gate	ton	547,000		17.48	9,561	0	$0.145*Q_f^{0.692}$
2. Intake					754	0	
Gate	ton	547,000		1.36	746	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.76	8	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					430	0	
Gate	ton	547,000		0.77	422	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.71	8	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.66	799	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,309	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,853	0	

Construction Cost Summary

Site Name: N34 Aporawan 3 Case2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	10,790	196,185	24,817	
(1) Access Road	10,153	184,604	23,352	
(2) Camp & Facilities	637	11,582	1,465	3. Civil work * 0.05
2. Environmental mitigation cost	127	2,316	293	3. Civil work * 0.01
3. Civil works	12,740	231,630	29,301	
(1) Intake weir	3,656	66,473	8,409	
(2) Intake	1,093	19,873	2,514	
(3) Settling basin	1,365	24,818	3,140	
(4) Headrace	2,170	39,455	4,991	
(5) Head tank	1,773	32,236	4,078	
(6) Penstock and spillway channel	305	5,545	702	
(7) Powerhouse	1,211	22,018	2,785	
(8) Tailrace channel	77	1,400	177	
(9) Tailrace	483	8,782	1,111	
(10) Miscellaneous	607	11,030	1,395	((1) to (9)) *0.05
4. Hydraulic equipment	13,853	251,869	31,861	
(1) Gate and screen	10,745	195,364	24,714	
(2) Penstock	799	14,527	1,838	
(3) Others	2,309	41,978	5,310	
5. Electro-mechanical equipment	3,868	70,327	8,896	Turbine and Generator, Transformer, etc
6. Transmission line	27,450	499,091	63,135	1,500,000PhP/km * distance from existing transmission
Direct Cost	68,828	1,251,418	158,304	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	10,324	187,713	23,746	Direct Cost * 0.15
8. Contingency	6,883	125,142	15,830	Direct Cost * 0.1
9. Interest during construction	8,259	150,170	18,997	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	94,294	1,714,443	216,877	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		98		
Development Cost (/kW)	958.998	17,436	2,205.696	
Annual Generation (kWh/yr)		775,165		
Construction Cost per kWh	0.12164	2.21171	0.27978	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.017	0.313	0.040	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N34 Aporawan 3 Case2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,656	0	
(1) Excavation (V_e)	m^3	136		1,694	231	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		860	2,333	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		8	248	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				844	0	((1) + (2) + (3)) * 0.3
2. Intake					1,093	0	
(1) Excavation (Ve)	m^3	136		269	37	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		202	635	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		7	202	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				219	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					1,365	0	
(1) Excavation (Ve)	m^3	136		692	95	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		219	686	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		12	356	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				228	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,170	0	
(1) Excavation (Ve)	m^3	136		12,268	1,669	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				501	0	((1) + (2)) * 0.3
5. Head Tank					1,773	0	
(1) Excavation (Ve)	m^3	136		979	134	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		240	753	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		12	379	0	$0.051*V_c$
(4) Others	L.S.				507	0	((1) + (2) + (3)) * 0.4
6. Penstock					305	0	
(1) Excavation (Ve)	m^3	136		303	42	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		57	180	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	32	0	$0.018*V_c$
(4) Others	L.S.				51	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,211	0	
(1) Excavation (Ve)	m^3	136		452	62	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		150	471	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		9	274	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				404	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					77	0	
(1) Excavation (Ve)	m^3	136		204	28	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10	31	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				18	0	((1) + (2)) * 0.3
9. Tailrace outlet					483	0	
(1) Excavation (Ve)	m^3	136		547	75	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		64	202	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		4	109	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				97	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				607	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					12,740	0	

No. N35 Baraki 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N35 Baraki-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,514	0	
Dam	m^2	239.00		14,700	3,514	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				703	0	(1.) * 0.2
Subtotal					4,217	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N35 Baraki-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					11,087	0	
Sand Flush Gate	ton	547,000		20.27	11,087	0	$0.145*Q_f^{0.692}$
2. Intake					483	0	
Gate	ton	547,000		0.87	478	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.47	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					257	0	
Gate	ton	547,000		0.46	253	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.37	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.25	1,079	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,581	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					15,487	0	

Construction Cost Summary

Site Name: N35 Baraki-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	4,582	83,315	10,539	
(1) Access Road	4,217	76,669	9,699	
(2) Camp & Facilities	366	6,646	841	3. Civil work * 0.05
2. Environmental mitigation cost	73	1,329	168	3. Civil work * 0.01
3. Civil works	7,310	132,911	16,813	
(1) Intake weir	2,338	42,509	5,377	
(2) Intake	727	13,218	1,672	
(3) Settling basin	646	11,745	1,486	
(4) Headrace	558	10,145	1,283	
(5) Head tank	979	17,800	2,252	
(6) Penstock and spillway channel	356	6,473	819	
(7) Powerhouse	995	18,091	2,289	
(8) Tailrace channel	59	1,073	136	
(9) Tailrace	304	5,527	699	
(10) Miscellaneous	348	6,329	801	((1) to (9)) *0.05
4. Hydraulic equipment	15,487	281,585	35,621	
(1) Gate and screen	11,827	215,036	27,202	
(2) Penstock	1,079	19,618	2,482	
(3) Others	2,581	46,931	5,937	
5. Electro-mechanical equipment	6,199	112,713	14,258	Turbine and Generator, Transformer, etc
6. Transmission line	15,300	278,182	35,190	1,500,000PhP/km * distance from existing transmission
Direct Cost	48,952	890,035	112,589	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	7,343	133,505	16,888	Direct Cost * 0.15
8. Contingency	4,895	89,003	11,259	Direct Cost * 0.1
9. Interest during construction	5,874	106,804	13,511	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	67,064	1,219,347	154,247	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		179		
Development Cost (/kW)	375.521	6,828	863.697	
Annual Generation (kWh/yr)		1,089,918		
Construction Cost per kWh	0.06153	1.11875	0.14152	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.009	0.158	0.020	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N35 Baraki-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,338	0	
(1) Excavation (V_e)	m^3	136		821	112	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		553	1,500	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				540	0	((1) + (2) + (3)) * 0.3
2. Intake					727	0	
(1) Excavation (Ve)	m^3	136		155	22	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		137	430	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	129	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				146	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					646	0	
(1) Excavation (Ve)	m^3	136		284	39	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		100	315	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	184	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				108	0	((1) + (2) + (3)) * 0.2
4. Headrace					558	0	
(1) Excavation (Ve)	m^3	136		3,149	429	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				129	0	((1) + (2)) * 0.3
5. Head Tank					979	0	
(1) Excavation (Ve)	m^3	136		548	75	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		132	415	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	209	0	$0.051*V_c$
(4) Others	L.S.				280	0	((1) + (2) + (3)) * 0.4
6. Penstock					356	0	
(1) Excavation (Ve)	m^3	136		380	52	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		66	207	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	37	0	$0.018*V_c$
(4) Others	L.S.				60	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					995	0	
(1) Excavation (Ve)	m^3	136		379	52	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		123	387	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		7	224	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				332	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					59	0	
(1) Excavation (Ve)	m^3	136		154	21	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	24	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				14	0	((1) + (2)) * 0.3
9. Tailrace outlet					304	0	
(1) Excavation (Ve)	m^3	136		367	50	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		36	115	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	78	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				61	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				348	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					7,310	0	

No. N36 Baraki 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N36 Baraki-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,514	0	
Dam	m^2	239.00		14,700	3,514	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				703	0	(1.) * 0.2
Subtotal					4,217	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N36 Baraki-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					11,087	0	
Sand Flush Gate	ton	547,000		20.27	11,087	0	$0.145*Q_f^{0.692}$
2. Intake					483	0	
Gate	ton	547,000		0.87	478	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.47	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					257	0	
Gate	ton	547,000		0.46	253	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.37	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		5.28	2,535	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,872	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					17,234	0	

Construction Cost Summary

Site Name: N36 Baraki-2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	4,656	84,655	10,709	
(1) Access Road	4,217	76,669	9,699	
(2) Camp & Facilities	439	7,986	1,010	3. Civil work * 0.05
2. Environmental mitigation cost	88	1,597	202	3. Civil work * 0.01
3. Civil works	8,784	159,715	20,204	
(1) Intake weir	2,338	42,509	5,377	
(2) Intake	727	13,218	1,672	
(3) Settling basin	646	11,745	1,486	
(4) Headrace	1,161	21,109	2,670	
(5) Head tank	979	17,800	2,252	
(6) Penstock and spillway channel	836	15,200	1,923	
(7) Powerhouse	1,323	24,055	3,043	
(8) Tailrace channel	52	945	120	
(9) Tailrace	304	5,527	699	
(10) Miscellaneous	418	7,605	962	((1) to (9)) *0.05
4. Hydraulic equipment	17,234	313,353	39,639	
(1) Gate and screen	11,827	215,036	27,202	
(2) Penstock	2,535	46,091	5,831	
(3) Others	2,872	52,225	6,607	
5. Electro-mechanical equipment	9,853	179,146	22,662	Turbine and Generator, Transformer, etc
6. Transmission line	14,400	261,818	33,120	1,500,000PhP/km * distance from existing transmission
Direct Cost	55,016	1,000,283	126,536	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,252	150,042	18,980	Direct Cost * 0.15
8. Contingency	5,502	100,028	12,654	Direct Cost * 0.1
9. Interest during construction	6,602	120,034	15,184	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	75,371	1,370,388	173,354	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		304		
Development Cost (/kW)	247.613	4,502	569.511	
Annual Generation (kWh/yr)		1,857,674		
Construction Cost per kWh	0.04057	0.73769	0.09332	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.006	0.104	0.013	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N36 Baraki-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,338	0	
(1) Excavation (V_e)	m^3	136		821	112	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		553	1,500	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				540	0	((1) + (2) + (3)) * 0.3
2. Intake					727	0	
(1) Excavation (Ve)	m^3	136		155	22	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		137	430	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	129	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				146	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					646	0	
(1) Excavation (Ve)	m^3	136		284	39	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		100	315	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	184	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				108	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,161	0	
(1) Excavation (Ve)	m^3	136		6,565	893	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				268	0	((1) + (2)) * 0.3
5. Head Tank					979	0	
(1) Excavation (Ve)	m^3	136		548	75	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		132	415	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	209	0	$0.051*V_c$
(4) Others	L.S.				280	0	((1) + (2) + (3)) * 0.4
6. Penstock					836	0	
(1) Excavation (Ve)	m^3	136		895	122	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		155	487	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		3	87	0	$0.018*V_c$
(4) Others	L.S.				140	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,323	0	
(1) Excavation (Ve)	m^3	136		490	67	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		164	514	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		10	301	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				441	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					52	0	
(1) Excavation (Ve)	m^3	136		137	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	21	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					304	0	
(1) Excavation (Ve)	m^3	136		367	50	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		36	115	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	78	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				61	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				418	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,784	0	

No. N37 Baraki 3 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N37 Baraki-3

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,087	0	
Dam	m^2	239.00		17,100	4,087	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				817	0	(1.) * 0.2
Subtotal					4,904	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N37 Baraki-3

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					11,186	0	
Sand Flush Gate	ton	547,000		20.45	11,186	0	$0.145*Q_f^{0.692}$
2. Intake					468	0	
Gate	ton	547,000		0.85	463	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.45	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					248	0	
Gate	ton	547,000		0.44	244	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.35	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		4.69	2,253	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,831	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					16,986	0	

Construction Cost Summary

Site Name: N37 Baraki-3

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,408	98,323	12,438	
(1) Access Road	4,904	89,171	11,280	
(2) Camp & Facilities	503	9,152	1,158	3. Civil work * 0.05
2. Environmental mitigation cost	101	1,830	232	3. Civil work * 0.01
3. Civil works	10,067	183,044	23,155	
(1) Intake weir	3,325	60,455	7,648	
(2) Intake	705	12,818	1,622	
(3) Settling basin	614	11,164	1,412	
(4) Headrace	1,544	28,073	3,551	
(5) Head tank	938	17,055	2,157	
(6) Penstock and spillway channel	740	13,455	1,702	
(7) Powerhouse	1,373	24,964	3,158	
(8) Tailrace channel	55	1,000	127	
(9) Tailrace	294	5,345	676	
(10) Miscellaneous	479	8,716	1,103	((1) to (9)) *0.05
4. Hydraulic equipment	16,986	308,836	39,068	
(1) Gate and screen	11,902	216,400	27,375	
(2) Penstock	2,253	40,964	5,182	
(3) Others	2,831	51,473	6,511	
5. Electro-mechanical equipment	10,777	195,954	24,788	Turbine and Generator, Transformer, etc
6. Transmission line	15,300	278,182	35,190	1,500,000PhP/km * distance from existing transmission
Direct Cost	58,639	1,066,170	134,870	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	8,796	159,925	20,231	Direct Cost * 0.15
8. Contingency	5,864	106,617	13,487	Direct Cost * 0.1
9. Interest during construction	7,037	127,940	16,184	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	80,336	1,460,653	184,773	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		336		
Development Cost (/kW)	238.938	4,344	549.557	
Annual Generation (kWh/yr)		2,053,167		
Construction Cost per kWh	0.03913	0.71141	0.08999	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.006	0.101	0.013	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N37 Baraki-3

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,325	0	
(1) Excavation (V_e)	m^3	136		1,469	200	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		789	2,140	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.3
2. Intake					705	0	
(1) Excavation (Ve)	m^3	136		149	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		133	418	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	125	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				141	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					614	0	
(1) Excavation (Ve)	m^3	136		266	37	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		95	298	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	176	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				103	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,544	0	
(1) Excavation (Ve)	m^3	136		8,725	1,187	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				357	0	((1) + (2)) * 0.3
5. Head Tank					938	0	
(1) Excavation (Ve)	m^3	136		526	72	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		127	398	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	200	0	$0.051*V_c$
(4) Others	L.S.				268	0	((1) + (2) + (3)) * 0.4
6. Penstock					740	0	
(1) Excavation (Ve)	m^3	136		794	108	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		138	431	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		2	77	0	$0.018*V_c$
(4) Others	L.S.				124	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,373	0	
(1) Excavation (Ve)	m^3	136		507	69	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		170	533	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		10	313	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				458	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					55	0	
(1) Excavation (Ve)	m^3	136		145	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.3
9. Tailrace outlet					294	0	
(1) Excavation (Ve)	m^3	136		357	49	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		35	110	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	76	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				59	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				479	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					10,067	0	

No. N38 Baraki 4 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N38 Baraki-4

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,087	0	
Dam	m^2	239.00		17,100	4,087	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				817	0	(1.) * 0.2
Subtotal					4,904	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N38 Baraki-4

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					11,186	0	
Sand Flush Gate	ton	547,000		20.45	11,186	0	$0.145*Q_f^{0.692}$
2. Intake					468	0	
Gate	ton	547,000		0.85	463	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.45	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					248	0	
Gate	ton	547,000		0.44	244	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.35	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		8.38	4,024	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				3,185	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					19,111	0	

Construction Cost Summary

Site Name: N38 Baraki-4

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,485	99,720	12,615	
(1) Access Road	4,904	89,171	11,280	
(2) Camp & Facilities	580	10,549	1,334	3. Civil work * 0.05
2. Environmental mitigation cost	116	2,110	267	3. Civil work * 0.01
3. Civil works	11,604	210,974	26,688	
(1) Intake weir	3,325	60,455	7,648	
(2) Intake	705	12,818	1,622	
(3) Settling basin	614	11,164	1,412	
(4) Headrace	2,186	39,745	5,028	
(5) Head tank	938	17,055	2,157	
(6) Penstock and spillway channel	1,320	24,000	3,036	
(7) Powerhouse	1,614	29,345	3,712	
(8) Tailrace channel	55	1,000	127	
(9) Tailrace	294	5,345	676	
(10) Miscellaneous	553	10,046	1,271	((1) to (9)) *0.05
4. Hydraulic equipment	19,111	347,476	43,956	
(1) Gate and screen	11,902	216,400	27,375	
(2) Penstock	4,024	73,164	9,255	
(3) Others	3,185	57,913	7,326	
5. Electro-mechanical equipment	14,212	258,405	32,688	Turbine and Generator, Transformer, etc
6. Transmission line	14,400	261,818	33,120	1,500,000PhP/km * distance from existing transmission
Direct Cost	64,928	1,180,502	149,334	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	9,739	177,075	22,400	Direct Cost * 0.15
8. Contingency	6,493	118,050	14,933	Direct Cost * 0.1
9. Interest during construction	7,791	141,660	17,920	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	88,951	1,617,288	204,587	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	454			
Development Cost (/kW)	195.720	3,559	450.156	
Annual Generation (kWh/yr)	2,775,330			
Construction Cost per kWh	0.03205	0.58274	0.07372	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.005	0.082	0.010	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N38 Baraki-4

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,325	0	
(1) Excavation (V_e)	m^3	136		1,469	200	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		789	2,140	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				768	0	((1) + (2) + (3)) * 0.3
2. Intake					705	0	
(1) Excavation (Ve)	m^3	136		149	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		133	418	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	125	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				141	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					614	0	
(1) Excavation (Ve)	m^3	136		266	37	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		95	298	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	176	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				103	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,186	0	
(1) Excavation (Ve)	m^3	136		12,360	1,681	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				505	0	((1) + (2)) * 0.3
5. Head Tank					938	0	
(1) Excavation (Ve)	m^3	136		526	72	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		127	398	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		6	200	0	$0.051*V_c$
(4) Others	L.S.				268	0	((1) + (2) + (3)) * 0.4
6. Penstock					1,320	0	
(1) Excavation (Ve)	m^3	136		1,418	193	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		246	770	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		4	137	0	$0.018*V_c$
(4) Others	L.S.				220	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,614	0	
(1) Excavation (Ve)	m^3	136		587	80	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		199	626	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		12	370	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				538	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					55	0	
(1) Excavation (Ve)	m^3	136		145	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	22	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				13	0	((1) + (2)) * 0.3
9. Tailrace outlet					294	0	
(1) Excavation (Ve)	m^3	136		357	49	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		35	110	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	76	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				59	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				553	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					11,604	0	

No. N43 Napsan Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N43 Napsan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,302	0	
Dam	m^2	239.00		18,000	4,302	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				860	0	(1.) * 0.2
Subtotal					5,162	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N43 Napsan

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					11,012	0	
Sand Flush Gate	ton	547,000		20.13	11,012	0	$0.145*Q_f^{0.692}$
2. Intake					229	0	
Gate	ton	547,000		0.41	226	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.20	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					109	0	
Gate	ton	547,000		0.19	107	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.12	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.96	460	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,362	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,172	0	

Construction Cost Summary

Site Name: N43 Napsan

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,534	100,616	12,728	
(1) Access Road	5,162	93,862	11,874	
(2) Camp & Facilities	371	6,754	854	3. Civil work * 0.05
2. Environmental mitigation cost	74	1,351	171	3. Civil work * 0.01
3. Civil works	7,430	135,087	17,089	
(1) Intake weir	4,190	76,182	9,637	
(2) Intake	497	9,036	1,143	
(3) Settling basin	324	5,891	745	
(4) Headrace	702	12,764	1,615	
(5) Head tank	566	10,291	1,302	
(6) Penstock and spillway channel	110	2,000	253	
(7) Powerhouse	446	8,109	1,026	
(8) Tailrace channel	42	764	97	
(9) Tailrace	199	3,618	458	
(10) Miscellaneous	354	6,433	814	((1) to (9)) *0.05
4. Hydraulic equipment	14,172	257,673	32,596	
(1) Gate and screen	11,350	206,364	26,105	
(2) Penstock	460	8,364	1,058	
(3) Others	2,362	42,945	5,433	
5. Electro-mechanical equipment	2,712	49,308	6,238	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	104,922	1,907,672	241,320	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,738	286,151	36,198	Direct Cost * 0.15
8. Contingency	10,492	190,767	24,132	Direct Cost * 0.1
9. Interest during construction	12,591	228,921	28,958	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	143,743	2,613,510	330,609	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	59			
Development Cost (/kW)	2,456.142	44,657	5,649.127	
Annual Generation (kWh/yr)	355,221			
Construction Cost per kWh	0.40466	7.35743	0.93071	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.057	1.040	0.132	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N43 Napsan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,190	0	
(1) Excavation (V_e)	m^3	136		2,097	286	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		980	2,658	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				967	0	((1) + (2) + (3)) * 0.3
2. Intake					497	0	
(1) Excavation (Ve)	m^3	136		93	13	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		95	299	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	85	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				100	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					324	0	
(1) Excavation (Ve)	m^3	136		125	17	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		49	153	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		3	100	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				54	0	((1) + (2) + (3)) * 0.2
4. Headrace					702	0	
(1) Excavation (Ve)	m^3	136		3,964	540	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				162	0	((1) + (2)) * 0.3
5. Head Tank					566	0	
(1) Excavation (Ve)	m^3	136		320	44	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		76	239	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	121	0	$0.051*V_c$
(4) Others	L.S.				162	0	((1) + (2) + (3)) * 0.4
6. Penstock					110	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		19	61	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	11	0	$0.018*V_c$
(4) Others	L.S.				19	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					446	0	
(1) Excavation (Ve)	m^3	136		183	25	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		56	175	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	97	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				149	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					42	0	
(1) Excavation (Ve)	m^3	136		109	15	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		5	17	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.3
9. Tailrace outlet					199	0	
(1) Excavation (Ve)	m^3	136		254	35	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		22	68	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	56	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				40	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				354	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					7,430	0	

No. N44 Marufinas 1-1-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N44 Manufinas 1 1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					16,133	0	
Dam	m^2	239.00		67,500	16,133	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				3,227	0	(1.) * 0.2
Subtotal					19,360	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N44 Manufinas 1 1-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,552	0	
Sand Flush Gate	ton	547,000		19.29	10,552	0	$0.145*Q_f^{0.692}$
2. Intake					298	0	
Gate	ton	547,000		0.54	295	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.27	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					147	0	
Gate	ton	547,000		0.26	145	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.18	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.84	405	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,280	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,682	0	

Construction Cost Summary

Site Name: N44 Manufinas 1 1-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	19,710	358,371	45,334	
(1) Access Road	19,360	351,993	44,527	
(2) Camp & Facilities	351	6,378	807	3. Civil work * 0.05
2. Environmental mitigation cost	70	1,276	161	3. Civil work * 0.01
3. Civil works	7,016	127,565	16,137	
(1) Intake weir	4,050	73,636	9,315	
(2) Intake	545	9,909	1,254	
(3) Settling basin	383	6,964	881	
(4) Headrace	216	3,927	497	
(5) Head tank	646	11,745	1,486	
(6) Penstock and spillway channel	98	1,782	225	
(7) Powerhouse	477	8,673	1,097	
(8) Tailrace channel	47	855	108	
(9) Tailrace	220	4,000	506	
(10) Miscellaneous	334	6,075	768	((1) to (9)) *0.05
4. Hydraulic equipment	13,682	248,771	31,470	
(1) Gate and screen	10,997	199,945	25,293	
(2) Penstock	405	7,364	932	
(3) Others	2,280	41,462	5,245	
5. Electro-mechanical equipment	2,761	50,202	6,351	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	118,240	2,149,821	271,952	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	17,736	322,473	40,793	Direct Cost * 0.15
8. Contingency	11,824	214,982	27,195	Direct Cost * 0.1
9. Interest during construction	14,189	257,979	32,634	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	161,989	2,945,255	372,575	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	60			
Development Cost (/kW)	2,690.124	48,911	6,187.286	
Annual Generation (kWh/yr)	366,117			
Construction Cost per kWh	0.44245	8.04457	1.01764	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.063	1.137	0.144	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N44 Manufinas 1 1-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,050	0	
(1) Excavation (V_e)	m^3	136		1,981	270	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		946	2,566	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				935	0	((1) + (2) + (3)) * 0.3
2. Intake					545	0	
(1) Excavation (Ve)	m^3	136		105	15	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		104	327	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	94	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				109	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					383	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		58	182	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	116	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.2
4. Headrace					216	0	
(1) Excavation (Ve)	m^3	136		1,218	166	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				50	0	((1) + (2)) * 0.3
5. Head Tank					646	0	
(1) Excavation (Ve)	m^3	136		365	50	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		87	273	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.051*V_c$
(4) Others	L.S.				185	0	((1) + (2) + (3)) * 0.4
6. Penstock					98	0	
(1) Excavation (Ve)	m^3	136		119	17	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		17	54	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	10	0	$0.018*V_c$
(4) Others	L.S.				17	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					477	0	
(1) Excavation (Ve)	m^3	136		194	27	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		59	187	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	104	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				159	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					47	0	
(1) Excavation (Ve)	m^3	136		122	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	19	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.3
9. Tailrace outlet					220	0	
(1) Excavation (Ve)	m^3	136		278	38	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		24	77	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				44	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				334	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					7,016	0	

No. N45 Marufinas 1-1-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N45 Manufinas 1 1-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					16,133	0	
Dam	m^2	239.00		67,500	16,133	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				3,227	0	(1.) * 0.2
Subtotal					19,360	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N45 Manufinas 1 1-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,552	0	
Sand Flush Gate	ton	547,000		19.29	10,552	0	$0.145*Q_f^{0.692}$
2. Intake					298	0	
Gate	ton	547,000		0.54	295	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.27	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					147	0	
Gate	ton	547,000		0.26	145	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.18	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.84	405	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,280	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,682	0	

Construction Cost Summary

Site Name: N45 Manufinas 1 1-2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	19,709	358,338	45,330	
(1) Access Road	19,360	351,993	44,527	
(2) Camp & Facilities	349	6,345	803	3. Civil work * 0.05
2. Environmental mitigation cost	70	1,269	161	3. Civil work * 0.01
3. Civil works	6,979	126,897	16,053	
(1) Intake weir	4,050	73,636	9,315	
(2) Intake	545	9,909	1,254	
(3) Settling basin	383	6,964	881	
(4) Headrace	216	3,927	497	
(5) Head tank	646	11,745	1,486	
(6) Penstock and spillway channel	98	1,782	225	
(7) Powerhouse	477	8,673	1,097	
(8) Tailrace channel	12	218	28	
(9) Tailrace	220	4,000	506	
(10) Miscellaneous	332	6,043	764	((1) to (9)) *0.05
4. Hydraulic equipment	13,682	248,771	31,470	
(1) Gate and screen	10,997	199,945	25,293	
(2) Penstock	405	7,364	932	
(3) Others	2,280	41,462	5,245	
5. Electro-mechanical equipment	2,761	50,202	6,351	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	118,201	2,149,113	271,863	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	17,730	322,367	40,779	Direct Cost * 0.15
8. Contingency	11,820	214,911	27,186	Direct Cost * 0.1
9. Interest during construction	14,184	257,894	32,624	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	161,936	2,944,285	372,452	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	60			
Development Cost (/kW)	2,689.238	48,895	6,185.247	
Annual Generation (kWh/yr)	366,117			
Construction Cost per kWh	0.44231	8.04192	1.01730	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.062	1.136	0.144	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N45 Manufinas 1 1-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,050	0	
(1) Excavation (V_e)	m^3	136		1,981	270	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		946	2,566	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				935	0	((1) + (2) + (3)) * 0.3
2. Intake					545	0	
(1) Excavation (Ve)	m^3	136		105	15	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		104	327	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	94	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				109	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					383	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		58	182	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	116	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.2
4. Headrace					216	0	
(1) Excavation (Ve)	m^3	136		1,218	166	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				50	0	((1) + (2)) * 0.3
5. Head Tank					646	0	
(1) Excavation (Ve)	m^3	136		365	50	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		87	273	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.051*V_c$
(4) Others	L.S.				185	0	((1) + (2) + (3)) * 0.4
6. Penstock					98	0	
(1) Excavation (Ve)	m^3	136		119	17	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		17	54	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	10	0	$0.018*V_c$
(4) Others	L.S.				17	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					477	0	
(1) Excavation (Ve)	m^3	136		194	27	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		59	187	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	104	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				159	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					12	0	
(1) Excavation (Ve)	m^3	136		61	9	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				3	0	((1) + (2)) * 0.3
9. Tailrace outlet					220	0	
(1) Excavation (Ve)	m^3	136		278	38	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		24	77	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				44	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				332	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					6,979	0	

No. 46 Marufinas 1-2-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N46 Manufinas 1 2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					16,133	0	
Dam	m^2	239.00		67,500	16,133	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				3,227	0	(1.) * 0.2
Subtotal					19,360	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N46 Manufinas 1 2-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,552	0	
Sand Flush Gate	ton	547,000		19.29	10,552	0	$0.145*Q_f^{0.692}$
2. Intake					298	0	
Gate	ton	547,000		0.54	295	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.27	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					147	0	
Gate	ton	547,000		0.26	145	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.18	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.60	1,247	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,449	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,693	0	

Construction Cost Summary

Site Name: N46 Manufenas 1 2-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	19,763	359,335	45,456	
(1) Access Road	19,360	351,993	44,527	
(2) Camp & Facilities	404	7,342	929	3. Civil work * 0.05
2. Environmental mitigation cost	81	1,468	186	3. Civil work * 0.01
3. Civil works	8,077	146,847	18,576	
(1) Intake weir	4,050	73,636	9,315	
(2) Intake	545	9,909	1,254	
(3) Settling basin	383	6,964	881	
(4) Headrace	679	12,345	1,562	
(5) Head tank	646	11,745	1,486	
(6) Penstock and spillway channel	294	5,345	676	
(7) Powerhouse	828	15,055	1,904	
(8) Tailrace channel	47	855	108	
(9) Tailrace	220	4,000	506	
(10) Miscellaneous	385	6,993	885	((1) to (9)) *0.05
4. Hydraulic equipment	14,693	267,142	33,793	
(1) Gate and screen	10,997	199,945	25,293	
(2) Penstock	1,247	22,673	2,868	
(3) Others	2,449	44,524	5,632	
5. Electro-mechanical equipment	5,951	108,196	13,687	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	123,564	2,246,625	284,198	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	18,535	336,994	42,630	Direct Cost * 0.15
8. Contingency	12,356	224,662	28,420	Direct Cost * 0.1
9. Interest during construction	14,828	269,595	34,104	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	169,283	3,077,876	389,351	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		170		
Development Cost (/kW)	995.570	18,101	2,289.810	
Annual Generation (kWh/yr)		1,033,829		
Construction Cost per kWh	0.16374	2.97716	0.37661	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.023	0.421	0.053	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N46 Manufenas 1 2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,050	0	
(1) Excavation (V_e)	m^3	136		1,981	270	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		946	2,566	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				935	0	((1) + (2) + (3)) * 0.3
2. Intake					545	0	
(1) Excavation (Ve)	m^3	136		105	15	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		104	327	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	94	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				109	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					383	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		58	182	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	116	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.2
4. Headrace					679	0	
(1) Excavation (Ve)	m^3	136		3,836	522	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				157	0	((1) + (2)) * 0.3
5. Head Tank					646	0	
(1) Excavation (Ve)	m^3	136		365	50	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		87	273	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.051*V_c$
(4) Others	L.S.				185	0	((1) + (2) + (3)) * 0.4
6. Penstock					294	0	
(1) Excavation (Ve)	m^3	136		367	50	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		52	165	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	30	0	$0.018*V_c$
(4) Others	L.S.				49	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					828	0	
(1) Excavation (Ve)	m^3	136		321	44	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		103	323	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		6	185	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				276	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					47	0	
(1) Excavation (Ve)	m^3	136		122	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	19	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.3
9. Tailrace outlet					220	0	
(1) Excavation (Ve)	m^3	136		278	38	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		24	77	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				44	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				385	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,077	0	

No. N47 Marufinas 1-2-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N47 Manufinas 1 2-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					16,133	0	
Dam	m^2	239.00		67,500	16,133	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				3,227	0	(1.) * 0.2
Subtotal					19,360	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N47 Manufinas 1 2-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,552	0	
Sand Flush Gate	ton	547,000		19.29	10,552	0	$0.145*Q_f^{0.692}$
2. Intake					298	0	
Gate	ton	547,000		0.54	295	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.27	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					147	0	
Gate	ton	547,000		0.26	145	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.18	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.60	1,247	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,449	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,693	0	

Construction Cost Summary

Site Name: N47 Manufinas 1 2-2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	19,763	359,335	45,456	
(1) Access Road	19,360	351,993	44,527	
(2) Camp & Facilities	404	7,342	929	3. Civil work * 0.05
2. Environmental mitigation cost	81	1,468	186	3. Civil work * 0.01
3. Civil works	8,077	146,847	18,576	
(1) Intake weir	4,050	73,636	9,315	
(2) Intake	545	9,909	1,254	
(3) Settling basin	383	6,964	881	
(4) Headrace	679	12,345	1,562	
(5) Head tank	646	11,745	1,486	
(6) Penstock and spillway channel	294	5,345	676	
(7) Powerhouse	828	15,055	1,904	
(8) Tailrace channel	47	855	108	
(9) Tailrace	220	4,000	506	
(10) Miscellaneous	385	6,993	885	((1) to (9)) *0.05
4. Hydraulic equipment	14,693	267,142	33,793	
(1) Gate and screen	10,997	199,945	25,293	
(2) Penstock	1,247	22,673	2,868	
(3) Others	2,449	44,524	5,632	
5. Electro-mechanical equipment	5,951	108,196	13,687	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	123,564	2,246,625	284,198	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	18,535	336,994	42,630	Direct Cost * 0.15
8. Contingency	12,356	224,662	28,420	Direct Cost * 0.1
9. Interest during construction	14,828	269,595	34,104	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	169,283	3,077,876	389,351	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		170		
Development Cost (/kW)	995.570	18,101	2,289.810	
Annual Generation (kWh/yr)		1,033,829		
Construction Cost per kWh	0.16374	2.97716	0.37661	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.023	0.421	0.053	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N47 Manufinas 1 2-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					4,050	0	
(1) Excavation (V_e)	m^3	136		1,981	270	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		946	2,566	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		9	279	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				935	0	((1) + (2) + (3)) * 0.3
2. Intake					545	0	
(1) Excavation (Ve)	m^3	136		105	15	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		104	327	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	94	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				109	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					383	0	
(1) Excavation (Ve)	m^3	136		152	21	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		58	182	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	116	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.2
4. Headrace					679	0	
(1) Excavation (Ve)	m^3	136		3,836	522	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				157	0	((1) + (2)) * 0.3
5. Head Tank					646	0	
(1) Excavation (Ve)	m^3	136		365	50	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		87	273	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		4	138	0	$0.051*V_c$
(4) Others	L.S.				185	0	((1) + (2) + (3)) * 0.4
6. Penstock					294	0	
(1) Excavation (Ve)	m^3	136		367	50	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		52	165	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	30	0	$0.018*V_c$
(4) Others	L.S.				49	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					828	0	
(1) Excavation (Ve)	m^3	136		321	44	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		103	323	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		6	185	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				276	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					47	0	
(1) Excavation (Ve)	m^3	136		122	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	19	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.3
9. Tailrace outlet					220	0	
(1) Excavation (Ve)	m^3	136		278	38	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		24	77	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	61	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				44	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				385	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,077	0	

No. N48 Marufinas 2-1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N48 Manufinas 2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					3,801	0	
Dam	m^2	239.00		15,900	3,801	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				760	0	(1.) * 0.2
Subtotal					4,561	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N48 Manufinas 2-1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,103	0	
Sand Flush Gate	ton	547,000		18.47	10,103	0	$0.145*Q_f^{0.692}$
2. Intake					340	0	
Gate	ton	547,000		0.61	336	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.32	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					171	0	
Gate	ton	547,000		0.31	168	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.22	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		0.68	329	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,189	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					13,132	0	

Construction Cost Summary

Site Name: N48 Manufinas 2-1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	4,889	88,898	11,246	
(1) Access Road	4,561	82,931	10,491	
(2) Camp & Facilities	328	5,967	755	3. Civil work * 0.05
2. Environmental mitigation cost	66	1,193	151	3. Civil work * 0.01
3. Civil works	6,564	119,337	15,096	
(1) Intake weir	2,421	44,018	5,568	
(2) Intake	612	11,127	1,408	
(3) Settling basin	474	8,618	1,090	
(4) Headrace	1,076	19,564	2,475	
(5) Head tank	765	13,909	1,760	
(6) Penstock and spillway channel	80	1,455	184	
(7) Powerhouse	519	9,436	1,194	
(8) Tailrace channel	52	945	120	
(9) Tailrace	252	4,582	580	
(10) Miscellaneous	313	5,683	719	((1) to (9)) *0.05
4. Hydraulic equipment	13,132	238,756	30,203	
(1) Gate and screen	10,614	192,982	24,412	
(2) Penstock	329	5,982	757	
(3) Others	2,189	39,793	5,034	
5. Electro-mechanical equipment	2,832	51,490	6,514	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	102,482	1,863,312	235,709	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	15,372	279,497	35,356	Direct Cost * 0.15
8. Contingency	10,248	186,331	23,571	Direct Cost * 0.1
9. Interest during construction	12,298	223,597	28,285	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	140,401	2,552,737	322,921	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		63		
Development Cost (/kW)	2,240.816	40,742	5,153.876	
Annual Generation (kWh/yr)		381,699		
Construction Cost per kWh	0.36783	6.68782	0.84601	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.052	0.945	0.120	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N48 Manufinas 2-1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,421	0	
(1) Excavation (V_e)	m^3	136		873	119	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		574	1,557	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		6	186	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				559	0	((1) + (2) + (3)) * 0.3
2. Intake					612	0	
(1) Excavation (Ve)	m^3	136		123	17	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		116	365	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	107	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				123	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					474	0	
(1) Excavation (Ve)	m^3	136		196	27	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		73	228	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	140	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				79	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,076	0	
(1) Excavation (Ve)	m^3	136		6,074	827	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				249	0	((1) + (2)) * 0.3
5. Head Tank					765	0	
(1) Excavation (Ve)	m^3	136		431	59	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		103	324	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	163	0	$0.051*V_c$
(4) Others	L.S.				219	0	((1) + (2) + (3)) * 0.4
6. Penstock					80	0	
(1) Excavation (Ve)	m^3	136		97	14	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		14	44	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		0	8	0	$0.018*V_c$
(4) Others	L.S.				14	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					519	0	
(1) Excavation (Ve)	m^3	136		210	29	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		65	203	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		4	114	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				173	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					52	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	21	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					252	0	
(1) Excavation (Ve)	m^3	136		311	43	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		29	91	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	67	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				51	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				313	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					6,564	0	

No. N49 Marufinas 2-2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N49 Manufinas 2-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,446	0	
Dam	m^2	239.00		18,600	4,446	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				889	0	(1.) * 0.2
Subtotal					5,335	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N49 Manufinas 2-2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					10,331	0	
Sand Flush Gate	ton	547,000		18.89	10,331	0	$0.145*Q_f^{0.692}$
2. Intake					317	0	
Gate	ton	547,000		0.57	314	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.29	3	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					158	0	
Gate	ton	547,000		0.28	156	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.20	2	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.89	908	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				2,343	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					14,057	0	

Construction Cost Summary

Site Name: N49 Manufinas 2-2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,710	103,815	13,133	
(1) Access Road	5,335	97,004	12,271	
(2) Camp & Facilities	375	6,812	862	3. Civil work * 0.05
2. Environmental mitigation cost	75	1,362	172	3. Civil work * 0.01
3. Civil works	7,493	136,233	17,233	
(1) Intake weir	2,864	52,073	6,587	
(2) Intake	612	11,127	1,408	
(3) Settling basin	474	8,618	1,090	
(4) Headrace	1,039	18,891	2,390	
(5) Head tank	765	13,909	1,760	
(6) Penstock and spillway channel	215	3,909	495	
(7) Powerhouse	863	15,691	1,985	
(8) Tailrace channel	52	945	120	
(9) Tailrace	252	4,582	580	
(10) Miscellaneous	357	6,487	821	((1) to (9)) *0.05
4. Hydraulic equipment	14,057	255,578	32,331	
(1) Gate and screen	10,806	196,473	24,854	
(2) Penstock	908	16,509	2,088	
(3) Others	2,343	42,596	5,388	
5. Electro-mechanical equipment	5,732	104,209	13,182	Turbine and Generator, Transformer, etc
6. Transmission line	75,000	1,363,636	172,500	1,500,000PhP/km * distance from existing transmission
Direct Cost	108,066	1,964,834	248,552	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	16,210	294,725	37,283	Direct Cost * 0.15
8. Contingency	10,807	196,483	24,855	Direct Cost * 0.1
9. Interest during construction	12,968	235,780	29,826	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	148,050	2,691,823	340,516	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	162			
Development Cost (/kW)	911.150	16,566	2,095.644	
Annual Generation (kWh/yr)	876,494			
Construction Cost per kWh	0.16891	3.07112	0.38850	
Planed Life Period (year)	40			
Annual O&M ratio to Construction cost (%)	2			
Capital Recovery Factor	0.121			i=0.12, n=40
Annual Cost Factor	0.141			
Production Cost (/kWh)	0.024	0.434	0.055	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N49 Manufinas 2-2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,864	0	
(1) Excavation (V_e)	m^3	136		1,139	155	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		675	1,831	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				661	0	((1) + (2) + (3)) * 0.3
2. Intake					612	0	
(1) Excavation (Ve)	m^3	136		123	17	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		116	365	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		3	107	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				123	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					474	0	
(1) Excavation (Ve)	m^3	136		196	27	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		73	228	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		5	140	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				79	0	((1) + (2) + (3)) * 0.2
4. Headrace					1,039	0	
(1) Excavation (Ve)	m^3	136		5,872	799	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				240	0	((1) + (2)) * 0.3
5. Head Tank					765	0	
(1) Excavation (Ve)	m^3	136		431	59	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		103	324	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	163	0	$0.051*V_c$
(4) Others	L.S.				219	0	((1) + (2) + (3)) * 0.4
6. Penstock					215	0	
(1) Excavation (Ve)	m^3	136		267	37	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		38	120	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	22	0	$0.018*V_c$
(4) Others	L.S.				36	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					863	0	
(1) Excavation (Ve)	m^3	136		333	46	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		107	336	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		6	193	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				288	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					52	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		7	21	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				12	0	((1) + (2)) * 0.3
9. Tailrace outlet					252	0	
(1) Excavation (Ve)	m^3	136		311	43	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		29	91	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	67	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				51	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				357	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					7,493	0	

No. N50 Conception 1 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N50 Conception 1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					4,159	0	
Dam	m^2	239.00		17,400	4,159	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				832	0	(1.) * 0.2
Subtotal					4,991	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N50 Conception 1

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					6,432	0	
Sand Flush Gate	ton	547,000		11.76	6,432	0	$0.145*Q_f^{0.692}$
2. Intake					473	0	
Gate	ton	547,000		0.85	468	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.45	5	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					251	0	
Gate	ton	547,000		0.45	247	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.36	4	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		1.24	597	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,551	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					9,304	0	

Construction Cost Summary

Site Name: N50 Conception 1

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	5,392	98,029	12,401	
(1) Access Road	4,991	90,742	11,479	
(2) Camp & Facilities	401	7,287	922	3. Civil work * 0.05
2. Environmental mitigation cost	80	1,457	184	3. Civil work * 0.01
3. Civil works	8,016	145,740	18,436	
(1) Intake weir	2,945	53,545	6,774	
(2) Intake	803	14,600	1,847	
(3) Settling basin	777	14,127	1,787	
(4) Headrace	540	9,818	1,242	
(5) Head tank	1,132	20,582	2,604	
(6) Penstock and spillway channel	198	3,600	455	
(7) Powerhouse	852	15,491	1,960	
(8) Tailrace channel	47	855	108	
(9) Tailrace	340	6,182	782	
(10) Miscellaneous	382	6,940	878	((1) to (9)) *0.05
4. Hydraulic equipment	9,304	169,156	21,398	
(1) Gate and screen	7,156	130,109	16,459	
(2) Penstock	597	10,855	1,373	
(3) Others	1,551	28,193	3,566	
5. Electro-mechanical equipment	4,517	82,123	10,389	Turbine and Generator, Transformer, etc
6. Transmission line	14,550	264,545	33,465	1,500,000PhP/km * distance from existing transmission
Direct Cost	41,858	761,051	96,273	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	6,279	114,158	14,441	Direct Cost * 0.15
8. Contingency	4,186	76,105	9,627	Direct Cost * 0.1
9. Interest during construction	5,023	91,326	11,553	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	57,345	1,042,639	131,894	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		121		
Development Cost (/kW)	475.252	8,641	1,093.079	
Annual Generation (kWh/yr)		737,140		
Construction Cost per kWh	0.07779	1.41444	0.17893	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.011	0.200	0.025	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N50 Conception 1

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					2,945	0	
(1) Excavation (V_e)	m^3	136		1,193	163	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		695	1,885	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				680	0	((1) + (2) + (3)) * 0.3
2. Intake					803	0	
(1) Excavation (Ve)	m^3	136		177	25	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		151	473	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		5	144	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				161	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					777	0	
(1) Excavation (Ve)	m^3	136		353	49	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		121	381	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				130	0	((1) + (2) + (3)) * 0.2
4. Headrace					540	0	
(1) Excavation (Ve)	m^3	136		3,045	415	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				125	0	((1) + (2)) * 0.3
5. Head Tank					1,132	0	
(1) Excavation (Ve)	m^3	136		632	86	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		153	480	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		8	242	0	$0.051*V_c$
(4) Others	L.S.				324	0	((1) + (2) + (3)) * 0.4
6. Penstock					198	0	
(1) Excavation (Ve)	m^3	136		210	29	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		36	115	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	21	0	$0.018*V_c$
(4) Others	L.S.				33	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					852	0	
(1) Excavation (Ve)	m^3	136		329	45	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		106	332	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		6	191	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				284	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					47	0	
(1) Excavation (Ve)	m^3	136		122	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		6	19	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				11	0	((1) + (2)) * 0.3
9. Tailrace outlet					340	0	
(1) Excavation (Ve)	m^3	136		405	56	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		42	132	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		3	84	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				68	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				382	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,016	0	

No. N51 Conception 2 Candidate Site

Preparation Construction Cost (Run-of-River Type)

Site Name: N51 Conception 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					5,091	0	
Dam	m^2	239.00		21,300	5,091	0	3*Ld
Head tank	m^2	239.00		0	0	0	3*Lh
Power house	m^2	239.00		0	0	0	3*Lp
2. Others	L.S.				1,018	0	(1.) * 0.2
Subtotal					6,109	0	

Hydraulic Equipment Cost (Run-of-River Type)

Site Name: N51 Conception 2

Item	Unit	Unit Cost	Unit Cost	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					5,646	0	
Sand Flush Gate	ton	547,000		10.32	5,646	0	$0.145*Q_f^{0.692}$
2. Intake					412	0	
Gate	ton	547,000		0.74	408	0	$1.27*(R*Q)^{0.533}$
Screen	ton	10,000		0.39	4	0	$0.701*(R*Q)^{0.582}$
3. Settling basin					214	0	
Gate	ton	547,000		0.38	211	0	$0.910*Q^{0.613}$
Screen	ton	10,000		0.29	3	0	$0.879*Q^{0.785}$
4. Penstock conduit	ton	480,000		2.64	1,268	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
5. Others	L.S.				1,508	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					9,048	0	

Construction Cost Summary

Site Name: N51 Conception 2

Item	Cost (1,000PhP)	Cost (1,000US$)	Cost (1,000JPY)	Note
1. Preparation work	6,534	118,805	15,029	
(1) Access Road	6,109	111,076	14,051	
(2) Camp & Facilities	425	7,729	978	3. Civil work * 0.05
2. Environmental mitigation cost	85	1,546	196	3. Civil work * 0.01
3. Civil works	8,502	154,579	19,554	
(1) Intake weir	3,175	57,727	7,303	
(2) Intake	709	12,891	1,631	
(3) Settling basin	620	11,273	1,426	
(4) Headrace	894	16,255	2,056	
(5) Head tank	947	17,218	2,178	
(6) Penstock and spillway channel	380	6,909	874	
(7) Powerhouse	1,035	18,818	2,381	
(8) Tailrace channel	42	764	97	
(9) Tailrace	295	5,364	679	
(10) Miscellaneous	405	7,361	931	((1) to (9)) *0.05
4. Hydraulic equipment	9,048	164,509	20,810	
(1) Gate and screen	6,272	114,036	14,426	
(2) Penstock	1,268	23,055	2,916	
(3) Others	1,508	27,418	3,468	
5. Electro-mechanical equipment	6,720	122,184	15,456	Turbine and Generator, Transformer, etc
6. Transmission line	16,050	291,818	36,915	1,500,000PhP/km * distance from existing transmission
Direct Cost	46,939	853,441	107,960	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	7,041	128,016	16,194	Direct Cost * 0.15
8. Contingency	4,694	85,344	10,796	Direct Cost * 0.1
9. Interest during construction	5,633	102,413	12,955	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	64,307	1,169,215	147,906	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		197		
Development Cost (/kW)	327.219	5,949	752.604	
Annual Generation (kWh/yr)		1,198,615		
Construction Cost per kWh	0.05365	0.97547	0.12340	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.008	0.138	0.017	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: N51 Conception 2

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					3,175	0	
(1) Excavation (V_e)	m^3	136		1,358	185	0	$8.69*(Dh * CL)^{1.14}$
(2) Concrete (V_c)	m^3	2,712		752	2,040	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		7	217	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				733	0	((1) + (2) + (3)) * 0.3
2. Intake					709	0	
(1) Excavation (Ve)	m^3	136		150	21	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		134	420	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		4	126	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				142	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					620	0	
(1) Excavation (Ve)	m^3	136		270	37	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		96	301	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		6	178	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				104	0	((1) + (2) + (3)) * 0.2
4. Headrace					894	0	
(1) Excavation (Ve)	m^3	136		5,050	687	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				207	0	((1) + (2)) * 0.3
5. Head Tank					947	0	
(1) Excavation (Ve)	m^3	136		530	73	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		128	401	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		7	202	0	$0.051*V_c$
(4) Others	L.S.				271	0	((1) + (2) + (3)) * 0.4
6. Penstock					380	0	
(1) Excavation (Ve)	m^3	136		425	58	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		70	219	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	39	0	$0.018*V_c$
(4) Others	L.S.				64	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					1,035	0	
(1) Excavation (Ve)	m^3	136		392	54	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		128	403	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		8	233	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				345	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					42	0	
(1) Excavation (Ve)	m^3	136		109	15	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		5	17	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				10	0	((1) + (2)) * 0.3
9. Tailrace outlet					295	0	
(1) Excavation (Ve)	m^3	136		359	49	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		35	111	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		2	76	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				59	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				405	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					8,502	0	

(ii) Pondage Type

1) Candidate sites in Multiple Use Zones or Controlled Use Zones

No. P1 Cabigaan

Preparation Construction Cost (Pondage Type)

Site Name: P1 Cabigaan (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					1,793	0	
Dam	m^3	239		7,500	1,793	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				359	0	(1.) * 0.2
Subtotal					2,152	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P1 Cabigaan (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Intake weir					58,766	0	
Gate	ton	547,000		107.43	58,766	0	0.13*Qf
2. Intake					2,141	0	
Gate	ton	547,000		3.87	2,119	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		2.15	22	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		5.79	2,778	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					2,119	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		3.87	2,119	0	Same as Intake gate
5. Others	L.S.				13,161	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					78,965	0	

Construction Cost Summary

Site Name: P1 Cabigaan (H=30m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	4,520	82,174	9,039	
(1) Access Road	2,152	39,120	4,303	
(2) Compensation	0	0	0	
(3) Camp & Facilities	2,368	43,054	4,736	3. Civil work * 0.02
2. Environmental mitigation cost	3,552	64,581	7,104	3. Civil work * 0.03
3. Civil works	118,398	2,152,693	236,796	
(1) Care of River	2,115	38,456	4,230	
(2) Dam	105,754	1,922,800	211,508	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	567	10,309	1,134	
(7) Powerhouse	3,726	67,745	7,452	
(8) Tailrace channel	598	10,873	1,196	
(9) Tailrace	0	0	0	
(10) Miscellaneous	5,638	102,510	11,276	((1) to (9)) *0.05
4. Hydroulic equipment	78,965	1,435,724	157,930	
(1) Gate and screen	60,907	1,107,400	121,814	
(2) Penstock	2,778	50,509	5,556	
(3) Tailrace	2,119	38,527	4,238	
(3) Others	13,161	239,287	26,322	
5. Electro-mechanical equipment	44,497	809,034	88,994	Turbine and Generator, Transformer, etc
6. Transmission line	17,250	313,636	34,500	
Direct Cost	267,181	4,857,842	534,363	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering service	40,077	728,676	80,154	Direct Cost * 0.15
8. Contingency	26,718	485,784	53,436	Direct Cost * 0.1
9. Interest during construction	40,077	728,676	80,154	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	374,054	6,800,979	748,108	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	916			
Development Cost (/kW)	408,356 PHP/kW	7,425 US$/kW	816,711 JPY/kW	
Annual Generation (kWh/yr)	2,963,199			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	748,107,658 PHP	13,601,957 US$	1,496,215,316 JPY	
Production Cost (/kWh)	17.725 PHP/kWh	0.322 US$/kWh	35.450 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P1 Cabigaan (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					107,870	0	
(1) Care of River	L.S.				2,115	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		27,300	3,713	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		26,935	84,415	0	$34.0*(Dh^2 * CL)$^0.59
(4) Others	L.S.				17,626	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					567	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		135	422	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		2	50	0	$0.012*V_c$
(4) Others	L.S.				95	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					3,726	0	
(1) Excavation (Ve)	m^3	136		1,340	183	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		492	1,541	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		25	760	0	$0.05*V_c$
(4) Others	L.S.				1,242	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					598	0	
(1) Excavation (Ve)	m^3	136		156	22	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		22.50	71	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		11.86	367	0	$0.05*V_c$
(4) Others	L.S.				138	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				5,638	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					118,399	0	

No.P3 Dumanguena

Preparation Construction Cost (Pondage Type)

Site Name: P3 Dumanguena (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					180	0	
Dam	m^3	239		750	180	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				36	0	(1.) * 0.2
Subtotal					216	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P3 Dumanguena (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					45,512	0	
Gate	ton	547,000		83.20	45,512	0	0.13*Qf
2. Intake					1,470	0	
Gate	ton	547,000		2.66	1,455	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		1.48	15	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		3.43	1,646	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					1,455	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		2.66	1,455	0	Same as Intake gate
5. Others	L.S.				10,017	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					60,100	0	

Construction Cost Summary

Site Name: P3 Dumanguena (H=25m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	2,548	46,328	5,860	
(1) Access Road	216	3,927	497	
(2) Compensation	0	0	0	
(3) Camp & Facilities	2,332	42,400	5,364	3. Civil work * 0.02
2. Environmental mitigation cost	3,498	63,600	8,045	3. Civil work * 0.03
3. Civil works	116,601	2,120,013	268,182	
(1) Care of River	2,108	38,332	4,849	
(2) Dam	105,414	1,916,618	242,452	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	468	8,509	1,076	
(7) Powerhouse	2,519	45,800	5,794	
(8) Tailrace channel	539	9,800	1,240	
(9) Tailrace	0	0	0	
(10) Miscellaneous	5,552	100,954	12,771	((1) to (9)) *0.05
4. Hydroulic equipment	60,100	1,092,720	138,229	
(1) Gate and screen	46,982	854,218	108,059	
(2) Penstock	1,646	29,927	3,786	
(3) Tailrace	1,455	26,455	3,347	
(3) Others	10,017	182,120	23,038	
5. Electro-mechanical equipment	16,173	294,061	37,199	Turbine and Generator, Transformer, etc
6. Transmission line	15,600	283,636	35,880	
Direct Cost	214,520	3,900,358	493,395	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering service	32,178	585,054	74,009	Direct Cost * 0.15
8. Contingency	21,452	390,036	49,340	Direct Cost * 0.1
9. Interest during construction	32,178	585,054	74,009	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	300,328	5,460,502	690,753	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		522		
Development Cost (/kW)	575,340 PHP/kW	10,461 US$/kW	1,323,282 JPY/kW	
Annual Generation (kWh/yr)		1,688,323		
Planed Life Period (year)		50		
Annual O&M ratio to Construction cost		2%		
Whole Cost	600,655,183 PHP	10,921,003 US$	1,381,506,921 JPY	
Production Cost (/kWh)	24.978 PHP/kWh	0.454 US$/kWh	57.450 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P3 Dumanguena (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					107,523	0	
(1) Care of River	L.S.				2,108	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		27,000	3,672	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		26,858	84,173	0	$38.0*(Dh^2 * CL)$^0.59
(4) Others	L.S.				17,569	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					468	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		111	348	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		1	42	0	$0.012*V_c$
(4) Others	L.S.				78	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					2,519	0	
(1) Excavation (Ve)	m^3	136		934	128	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		331	1,039	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		17	512	0	$0.05*V_c$
(4) Others	L.S.				840	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					539	0	
(1) Excavation (Ve)	m^3	136		137	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		20.10	63	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		10.73	332	0	$0.05*V_c$
(4) Others	L.S.				125	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				5,552	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					116,601	0	

No. P8 Quinlogan

Preparation Construction Cost (Pondage Type)

Site Name: P8 Quinlogan (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					1,506	0	
Dam	m^3	239		6,300	1,506	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				301	0	(1.) * 0.2
Subtotal					1,807	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P8 Quinlogan (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					58,651	0	
Gate	ton	547,000		107.22	58,651	0	0.13*Qf
2. Intake					172	0	
Gate	ton	547,000		0.31	170	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		0.17	2	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		1.85	887	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					170	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		0.31	170	0	Same as Intake gate
5. Others	L.S.				11,976	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					71,856	0	

Construction Cost Summary

Site Name: P8 Quinlogan (H=25m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,456	62,843	6,913	
(1) Access Road	1,807	32,858	3,614	
(2) Compensation	0	0	0	
(3) Camp & Facilities	1,649	29,984	3,298	3. Civil work * 0.02
2. Environmental mitigation cost	2,474	44,976	4,947	3. Civil work * 0.03
3. Civil works	82,457	1,499,217	164,914	
(1) Care of River	1,518	27,607	3,037	
(2) Dam	75,918	1,380,327	151,836	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	322	5,855	644	
(7) Powerhouse	482	8,764	964	
(8) Tailrace channel	290	5,273	580	
(9) Tailrace	0	0	0	
(10) Miscellaneous	3,927	71,392	7,853	((1) to (9)) *0.05
4. Hydroulic equipment	71,856	1,306,473	143,712	
(1) Gate and screen	58,823	1,069,509	117,646	
(2) Penstock	887	16,127	1,774	
(3) Tailrace	170	3,091	340	
(3) Others	11,976	217,745	23,952	
5. Electro-mechanical equipment	2,842	51,672	5,684	Turbine and Generator, Transformer, etc
6. Transmission line	51,000	927,273	102,000	
Direct Cost	214,085	3,892,453	428,170	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering service	32,113	583,868	64,225	Direct Cost * 0.15
8. Contingency	21,408	389,245	42,817	Direct Cost * 0.1
9. Interest during construction	25,690	467,094	51,380	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	293,296	5,332,661	586,593	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	63			
Development Cost (/kW)	4,655,497 PHP/kW	84,645 US$/kW	9,310,995 JPY/kW	
Annual Generation (kWh/yr)	375,687			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	586,592,674 PHP	10,665,321 US$	1,173,185,349 JPY	
Production Cost (/kWh)	109.622 PHP/kWh	1.993 US$/kWh	219.245 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P8 Quinlogan (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					77,437	0	
(1) Care of River	L.S.				1,518	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		17,500	2,380	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		19,427	60,885	0	$35.5*(Dh^2 * CL)^{0.59}$
(4) Others	L.S.				12,653	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					322	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		76	239	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		1	29	0	$0.012*V_c$
(4) Others	L.S.				54	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					482	0	
(1) Excavation (Ve)	m^3	136		202	28	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		62	196	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		3	97	0	$0.05*V_c$
(4) Others	L.S.				161	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					290	0	
(1) Excavation (Ve)	m^3	136		61	9	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10.20	32	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		5.87	182	0	$0.05*V_c$
(4) Others	L.S.				67	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				3,927	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					82,458	0	

2) Candidate sites in Core Zones or Restricted Zones

No. P2 Baraki

Preparation Construction Cost (Pondage Type)

Site Name: P2 Baraki(Case5) (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					1,112	0	
Dam	m^3	239		4,650	1,112	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				222	0	(1.) * 0.2
Subtotal					1,334	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P2 Baraki(Case5) (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					33,265	0	
Gate	ton	547,000		60.81	33,265	0	0.13*Qf
2. Intake					953	0	
Gate	ton	547,000		1.72	943	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		0.96	10	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		5.99	2,876	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					943	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		1.72	943	0	Same as Intake gate
5. Others	L.S.				7,607	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					45,644	0	

Construction Cost Summary

Site Name: P2 Baraki(Case5) (H=35m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	3,077	55,942	6,154	
(1) Access Road	1,334	24,262	2,669	
(2) Compensation	0	0	0	
(3) Camp & Facilities	1,742	31,680	3,485	3. Civil work * 0.02
2. Environmental mitigation cost	2,614	47,520	5,227	3. Civil work * 0.03
3. Civil works	87,120	1,584,001	174,240	
(1) Care of River	1,562	28,409	3,125	
(2) Dam	78,124	1,420,436	156,248	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	629	11,436	1,258	
(7) Powerhouse	2,175	39,545	4,350	
(8) Tailrace channel	481	8,745	962	
(9) Tailrace	0	0	0	
(10) Miscellaneous	4,149	75,429	8,297	((1) to (9)) *0.05
4. Hydroulic equipment	45,644	829,898	91,289	
(1) Gate and screen	34,218	622,145	68,436	
(2) Penstock	2,876	52,291	5,752	
(3) Tailrace	943	17,145	1,886	
(3) Others	7,607	138,316	15,215	
5. Electro-mechanical equipment	18,628	338,694	37,256	Turbine and Generator, Transformer, etc
6. Transmission line	13,050	237,273	26,100	
Direct Cost	170,133	3,093,328	340,266	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering service	25,520	463,999	51,040	Direct Cost * 0.15
8. Contingency	17,013	309,333	34,027	Direct Cost * 0.1
9. Interest during construction	25,520	463,999	51,040	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	238,186	4,330,659	476,372	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	489			
Development Cost (/kW)	487,088 PHP/kW	8,856 US$/kW	974,177 JPY/kW	
Annual Generation (kWh/yr)	1,583,101			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	476,372,474 PHP	8,661,318 US$	952,744,948 JPY	
Production Cost (/kWh)	21.126 PHP/kWh	0.384 US$/kWh	42.253 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P2 Baraki(Case5) (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					79,687	0	
(1) Care of River	L.S.				1,562	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		17,395	2,366	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		20,018	62,737	0	$30.1*(Dh^2 * CL)$^0.59
(4) Others	L.S.				13,021	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					629	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		149	468	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		2	56	0	$0.012*V_c$
(4) Others	L.S.				105	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					2,175	0	
(1) Excavation (Ve)	m^3	136		816	111	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		286	897	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		14	442	0	$0.05*V_c$
(4) Others	L.S.				725	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					481	0	
(1) Excavation (Ve)	m^3	136		118	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		17.70	56	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		9.58	297	0	$0.05*V_c$
(4) Others	L.S.				111	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				4,149	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					87,121	0	

No. P4 Concption

Preparation Construction Cost (Pondage Type)

Site Name: P4 Conception (Case3) (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					180	0	
Dam	m^3	239		750	180	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				36	0	(1.) * 0.2
Subtotal					216	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P4 Conception (Case3) (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					57,753	0	
Gate	ton	547,000		105.58	57,753	0	0.13*Qf
2. Intake					947	0	
Gate	ton	547,000		1.71	937	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		0.95	10	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		5.17	2,484	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					937	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		1.71	937	0	Same as Intake gate
5. Others	L.S.				12,424	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					74,545	0	

Construction Cost Summary

Site Name: P4 Conception (Case3) (H=30m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	2,457	44,669	4,914	
(1) Access Road	216	3,927	432	
(2) Compensation	0	0	0	
(3) Camp & Facilities	2,241	40,742	4,482	3. Civil work * 0.02
2. Environmental mitigation cost	3,361	61,112	6,722	3. Civil work * 0.03
3. Civil works	112,039	2,037,082	224,079	
(1) Care of River	2,032	36,950	4,064	
(2) Dam	101,612	1,847,491	203,224	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	544	9,891	1,088	
(7) Powerhouse	1,983	36,055	3,966	
(8) Tailrace channel	533	9,691	1,066	
(9) Tailrace	0	0	0	
(10) Miscellaneous	5,335	97,005	10,671	((1) to (9)) *0.05
4. Hydroulic equipment	74,545	1,355,367	149,090	
(1) Gate and screen	58,700	1,067,273	117,400	
(2) Penstock	2,484	45,164	4,968	
(3) Tailrace	937	17,036	1,874	
(3) Others	12,424	225,895	24,848	
5. Electro-mechanical equipment	12,978	235,972	25,957	Turbine and Generator, Transformer, etc
6. Transmission line	5,850	106,364	11,700	
Direct Cost	211,231	3,840,566	422,462	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	31,685	576,085	63,369	Direct Cost * 0.15
8. Contingency	21,123	384,057	42,246	Direct Cost * 0.1
9. Interest during construction	31,685	576,085	63,369	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	295,724	5,376,792	591,447	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	412			
Development Cost (/kW)	717,776 PHP/kW	13,050 US$/kW	1,435,551 JPY/kW	
Annual Generation (kWh/yr)	1,989,589			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	591,447,142 PHP	10,753,584 US$	1,182,894,285 JPY	
Production Cost (/kWh)	20.871 PHP/kWh	0.379 US$/kWh	41.742 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P4 Conception (Case3) (H=30m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					103,645	0	
(1) Care of River	L.S.				2,032	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		25,560	3,477	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		25,909	81,199	0	$34.0*(Dh^2 * CL)^{0.59}$
(4) Others	L.S.				16,936	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					544	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		129	405	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		2	48	0	$0.012*V_c$
(4) Others	L.S.				91	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					1,983	0	
(1) Excavation (Ve)	m^3	136		749	102	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		261	817	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		13	403	0	$0.05*V_c$
(4) Others	L.S.				661	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					533	0	
(1) Excavation (Ve)	m^3	136		135	19	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		19.80	63	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		10.58	328	0	$0.05*V_c$
(4) Others	L.S.				123	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				5,335	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					112,040	0	

No. P5 Tanabag

Preparation Construction Cost (Pondage Type)

Site Name: P5 Tanabag (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					216	0	
Dam	m^3	239		900	216	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				43	0	(1.) * 0.2
Subtotal					259	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P5 Tanabag (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					60,638	0	
Gate	ton	547,000		110.85	60,638	0	0.13*Qf
2. Intake					1,016	0	
Gate	ton	547,000		1.84	1,005	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		1.02	11	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		3.17	1,520	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					1,005	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		1.84	1,005	0	Same as Intake gate
5. Others	L.S.				12,836	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					77,015	0	

Construction Cost Summary

Site Name: P5 Tanabag (H=25m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	2,203	40,059	4,406	
(1) Access Road	259	4,713	518	
(2) Compensation	0	0	0	
(3) Camp & Facilities	1,944	35,346	3,888	3. Civil work * 0.02
2. Environmental mitigation cost	2,916	53,019	5,832	3. Civil work * 0.03
3. Civil works	97,202	1,767,302	194,403	
(1) Care of River	1,760	31,999	3,520	
(2) Dam	87,998	1,599,964	175,996	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	444	8,073	888	
(7) Powerhouse	1,890	34,364	3,780	
(8) Tailrace channel	481	8,745	962	
(9) Tailrace	0	0	0	
(10) Miscellaneous	4,629	84,157	9,257	((1) to (9)) *0.05
4. Hydroulic equipment	77,015	1,400,269	154,030	
(1) Gate and screen	61,654	1,120,982	123,308	
(2) Penstock	1,520	27,636	3,040	
(3) Tailrace	1,005	18,273	2,010	
(3) Others	12,836	233,378	25,672	
5. Electro-mechanical equipment	11,526	209,568	23,052	Turbine and Generator, Transformer, etc
6. Transmission line	9,150	166,364	18,300	
Direct Cost	200,012	3,636,581	400,024	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	30,002	545,487	60,004	Direct Cost * 0.15
8. Contingency	20,001	363,658	40,002	Direct Cost * 0.1
9. Interest during construction	30,002	545,487	60,004	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	280,017	5,091,213	560,033	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	362			
Development Cost (/kW)	773,527 PHP/kW	14,064 US$/kW	1,547,054 JPY/kW	
Annual Generation (kWh/yr)	1,795,918			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	560,033,399 PHP	10,182,425 US$	1,120,066,798 JPY	
Production Cost (/kWh)	21.894 PHP/kWh	0.398 US$/kWh	43.787 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P5 Tanabag (H=25m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					89,758	0	
(1) Care of River	L.S.				1,760	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		21,000	2,856	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		22,487	70,475	0	$36.9*(Dh^2 * CL)^{0.59}$
(4) Others	L.S.				14,667	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					444	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		105	330	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		1	40	0	$0.012*V_c$
(4) Others	L.S.				74	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					1,890	0	
(1) Excavation (Ve)	m^3	136		717	98	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		248	778	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		12	384	0	$0.05*V_c$
(4) Others	L.S.				630	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					481	0	
(1) Excavation (Ve)	m^3	136		118	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		17.70	56	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		9.58	297	0	$0.05*V_c$
(4) Others	L.S.				111	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				4,629	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					97,202	0	

No. P6 Inagawan Sub. Colony

Preparation Construction Cost (Pondage Type)

Site Name: P6 Inagawan Sub. Colony (H=40m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					1,148	0	
Dam	m^3	239		4,800	1,148	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				230	0	(1.) * 0.2
Subtotal					1,378	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P6 Inagawan Sub. Colony (H=40m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					120,325	0	
Gate	ton	547,000		219.97	120,325	0	0.13*Qf
2. Intake					1,831	0	
Gate	ton	547,000		3.31	1,812	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		1.84	19	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		7.94	3,812	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					1,812	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		3.31	1,812	0	Same as Intake gate
5. Others	L.S.				25,556	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					153,336	0	

Construction Cost Summary

Site Name: P6 Inagawan Sub. Colony (H=40m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	5,473	99,508	10,946	
(1) Access Road	1,378	25,047	2,755	
(2) Compensation	0	0	0	
(3) Camp & Facilities	4,095	74,461	8,191	3. Civil work * 0.02
2. Environmental mitigation cost	6,143	111,692	12,286	3. Civil work * 0.03
3. Civil works	204,768	3,723,051	409,536	
(1) Care of River	3,721	67,654	7,442	
(2) Dam	186,048	3,382,691	372,096	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	794	14,436	1,588	
(7) Powerhouse	3,887	70,673	7,774	
(8) Tailrace channel	567	10,309	1,134	
(9) Tailrace	0	0	0	
(10) Miscellaneous	9,751	177,288	19,502	((1) to (9)) *0.05
4. Hydroulic equipment	153,336	2,787,927	306,672	
(1) Gate and screen	122,156	2,221,018	244,312	
(2) Penstock	3,812	69,309	7,624	
(3) Tailrace	1,812	32,945	3,624	
(3) Others	25,556	464,655	51,112	
5. Electro-mechanical equipment	53,827	978,665	107,653	Turbine and Generator, Transformer, etc
6. Transmission line	7,350	133,636	14,700	
Direct Cost	430,896	7,834,480	861,793	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering service	64,634	1,175,172	129,269	Direct Cost * 0.15
8. Contingency	43,090	783,448	86,179	Direct Cost * 0.1
9. Interest during construction	51,708	940,138	103,415	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	590,328	10,733,237	1,180,656	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	1,070			
Development Cost (/kW)	551,708 PHP/kW	10,031 US$/kW	1,103,417 JPY/kW	
Annual Generation (kWh/yr)	5,440,297			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	1,180,656,069 PHP	21,466,474 US$	2,361,312,138 JPY	
Production Cost (/kWh)	15.237 PHP/kWh	0.277 US$/kWh	30.473 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P6 Inagawan Sub. Colony (H=40m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					189,769	0	
(1) Care of River	L.S.				3,721	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		56,000	7,616	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		47,040	147,424	0	$0.21*(Dh^2 * CL)$
(4) Others	L.S.				31,008	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					794	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		188	591	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		2	70	0	$0.012*V_c$
(4) Others	L.S.				133	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					3,887	0	
(1) Excavation (Ve)	m^3	136		1,393	190	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		513	1,608	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		26	793	0	$0.05*V_c$
(4) Others	L.S.				1,296	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					567	0	
(1) Excavation (Ve)	m^3	136		147	20	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		21.30	67	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		11.29	349	0	$0.05*V_c$
(4) Others	L.S.				131	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				9,751	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					204,768	0	

No. P7 Ransang

Preparation Construction Cost (Pondage Type)

Site Name: P7 Ransang (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					3,227	0	
Dam	m^3	239		13,500	3,227	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				645	0	(1.) * 0.2
Subtotal					3,872	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P7 Ransang (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					57,695	0	
Gate	ton	547,000		105.47	57,695	0	0.13*Qf
2. Intake					168	0	
Gate	ton	547,000		0.30	166	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		0.17	2	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		2.62	1,258	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					166	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		0.30	166	0	Same as Intake gate
5. Others	L.S.				11,857	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					71,144	0	

Construction Cost Summary

Site Name: P7 Ransang (H=35m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	6,517	118,495	13,034	
(1) Access Road	3,872	70,407	7,745	
(2) Compensation	0	0	0	
(3) Camp & Facilities	2,645	48,088	5,290	3. Civil work * 0.02
2. Environmental mitigation cost	3,967	72,131	7,934	3. Civil work * 0.03
3. Civil works	132,241	2,404,380	264,482	
(1) Care of River	2,444	44,431	4,887	
(2) Dam	122,184	2,221,527	244,368	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	454	8,255	908	
(7) Powerhouse	572	10,400	1,144	
(8) Tailrace channel	290	5,273	580	
(9) Tailrace	0	0	0	
(10) Miscellaneous	6,297	114,495	12,594	((1) to (9)) *0.05
4. Hydroulic equipment	71,144	1,293,535	142,289	
(1) Gate and screen	57,863	1,052,055	115,726	
(2) Penstock	1,258	22,873	2,516	
(3) Tailrace	166	3,018	332	
(3) Others	11,857	215,589	23,715	
5. Electro-mechanical equipment	3,597	65,402	7,194	Turbine and Generator, Transformer, etc
6. Transmission line	33,300	605,455	66,600	
Direct Cost	250,767	4,559,397	501,534	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	37,615	683,910	75,230	Direct Cost * 0.15
8. Contingency	25,077	455,940	50,153	Direct Cost * 0.1
9. Interest during construction	30,092	547,128	60,184	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	343,551	6,246,374	687,101	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		89		
Development Cost (/kW)	3,860,119 PHP/kW	70,184 US$/kW	7,720,238 JPY/kW	
Annual Generation (kWh/yr)		646,267		
Planed Life Period (year)		50		
Annual O&M ratio to Construction cost		2%		
Whole Cost	687,101,143 PHP	12,492,748 US$	1,374,202,286 JPY	
Production Cost (/kWh)	74.644 PHP/kWh	1.357 US$/kWh	149.289 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P7 Ransang (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					124,628	0	
(1) Care of River	L.S.				2,444	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		31,745	4,318	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		31,111	97,502	0	$0.28*(Dh^2 * CL)$
(4) Others	L.S.				20,364	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					454	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		108	338	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		1	40	0	$0.012*V_c$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					572	0	
(1) Excavation (Ve)	m^3	136		237	33	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		74	233	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		4	115	0	$0.05*V_c$
(4) Others	L.S.				191	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					290	0	
(1) Excavation (Ve)	m^3	136		61	9	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		10.20	32	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		5.87	182	0	$0.05*V_c$
(4) Others	L.S.				67	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				6,297	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					132,241	0	

No. P9 San Miguel

Preparation Construction Cost (Pondage Type)

Site Name: P9 San Miguel (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Access roads					4,769	0	
Dam	m^3	239		19,950	4,769	0	1.5*Ld
Headtank	m^3	239		0	0	0	1.5*Lh
Power house	m^3	239		0	0	0	1.5*Lp
2. Others	L.S.				954	0	(1.) * 0.2
Subtotal					5,723	0	

Hydraulic Equipment Cost (Pondage Type)

Site Name: P9 San Miguel (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Intake weir					58,755	0	
Gate	ton	547,000		107.41	58,755	0	0.13*Qf
2. Intake					970	0	
Gate	ton	547,000		1.75	960	0	0.9*(Ha*Dm)^(1/9)*Q
Screen	ton	10,000		0.97	10	0	0.5*(Ha*Dm)^(1/9)*Q
3. Penstock conduit	ton	480,000		5.99	2,876	0	7.85*pai*Dm*tm*1.15*L*n
4. Tailrace					960	0	7.85*pai*Dm*(0.0362*H*Dm+2)*10-3*1.15*L
Gate	ton	547,000		1.75	960	0	Same as Intake gate
5. Others	L.S.				12,712	0	(1 + 2 + 3 + 4) * 0.2
Subtotal					76,273	0	

Construction Cost Summary

Site Name: P9 San Miguel (H=35m)

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	9,001	163,647	18,001	
(1) Access Road	5,723	104,051	11,446	
(2) Compensation	0	0	0	
(3) Camp & Facilities	3,278	59,596	6,556	3. Civil work * 0.02
2. Environmental mitigation cost	4,917	89,394	9,833	3. Civil work * 0.03
3. Civil works	163,890	2,979,813	327,779	
(1) Care of River	2,995	54,463	5,991	
(2) Dam	149,772	2,723,127	299,544	
(3) Intake	0	0	0	
(4) Headrace	0	0	0	
(5) Surge tank	0	0	0	
(6) Penstock	629	11,436	1,258	
(7) Powerhouse	2,208	40,145	4,416	
(8) Tailrace channel	481	8,745	962	
(9) Tailrace	0	0	0	
(10) Miscellaneous	7,804	141,896	15,609	((1) to (9)) *0.05
4. Hydroulic equipment	76,273	1,386,785	152,546	
(1) Gate and screen	59,725	1,085,909	119,450	
(2) Penstock	2,876	52,291	5,752	
(3) Tailrace	960	17,455	1,920	
(3) Others	12,712	231,131	25,424	
5. Electro-mechanical equipment	15,476	281,387	30,953	Turbine and Generator, Transformer, etc
6. Transmission line	15,900	289,091	31,800	
Direct Cost	285,457	5,190,118	570,913	1 + 2 + 3 + 4 + 5 + 6
7. Administration and engineering servic	42,818	778,518	85,637	Direct Cost * 0.15
8. Contingency	28,546	519,012	57,091	Direct Cost * 0.1
9. Interest during construction	34,255	622,814	68,510	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.03 T = 4
Total Cost	391,075	7,110,462	782,151	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)	498			
Development Cost (/kW)	785,292 PHP/kW	14,278 US$/kW	1,570,584 JPY/kW	
Annual Generation (kWh/yr)	2,467,059			
Planed Life Period (year)	50			
Annual O&M ratio to Construction cost	2%			
Whole Cost	782,150,819 PHP	14,220,924 US$	1,564,301,638 JPY	
Production Cost (/kWh)	22.259 PHP/kWh	0.405 US$/kWh	44.517 JPY/kWh	

Civil Engineering Work Cost (Pondage Type)

Site Name: P9 San Miguel (H=35m)

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Caluculation method of Construction Cost
1. Concrete Gravity Dam					152,768	0	
(1) Care of River	L.S.				2,995	0	((2) + (3) + (4))*0.02
(2) Excavation (V_e)	m^3	136		45,080	6,131	0	10*Dh * CL
(3) Concrete (V_c)	m^3	3,134		37,868	118,679	0	0.24*(Dh^2 * CL)
(4) Others	L.S.				24,962	0	((2) + (3)) * 0.2
2. Intake					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
3. Headrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
4. Surge Tank					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
5. Penstock					629	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		149	468	0	PAI/4*((Dm+2*t)^2-Dm^2)*L
(3) Reinforcement bar	ton	30,900		2	56	0	0.012*V_c
(4) Others	L.S.				105	0	((1) + (2) + (3)) * 0.2
6. Powerhouse					2,208	0	
(1) Excavation (Ve)	m^3	136		827	113	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		290	910	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement bar	ton	30,900		15	449	0	0.05*V_c
(4) Others	L.S.				736	0	((1) + (2) + (3)) * 0.5
7. Tailrace channel					481	0	
(1) Excavation (Ve)	m^3	136		118	17	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		17.70	56	0	H*t*2+(B+2*t)*L
(3) Reinforcement bar	ton	30,900		9.58	297	0	0.05*V_c
(4) Others	L.S.				111	0	((1) + (2)) * 0.3
8. Tailrace					0	0	
(1) Excavation (Ve)	m^3	136		0	0	0	
(2) Concrete (Vc)	m^3	3,134		0	0	0	
(3) Reinforcement bar	ton	30,900		0	0	0	
(4) Others	L.S.				0	0	
9. Miscellaneous	L.S.				7,804	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					163,890	0	

(b) Map Study from Demand

In the Map Study from Demand, the hydraulic equipment was not considered because it is cheaper to install a stop-log instead of expensive steel gate and to employ some staff for taking away litters and other garbage.

Preparation Construction Cost (Run-of-River Type)

Site Name: D1 Tarusan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Access roads					1,434	0	
Dam	m^2	239.00		6,000	1,434	0	3.0*Ld
Head tank	m^2	239.00		0	0	0	3.0*Lh
Power house	m^2	239.00		0	0	0	3.0*Lp
2. Others	L.S.				287	0	(1.) * 0.2
Subtotal					1,721	0	

Construction Cost Summary

Site Name: D1 Tarusan

Item	Cost (1,000PhP)	Cost (US$)	Cost (1,000JPY)	Note
1. Preparation work	2,252	40,942	5,179	
(1) Access Road	1,721	31,287	3,958	
(2) Camp & Facilities	531	9,654	1,221	3. Civil work * 0.05
2. Environmental mitigation cost	106	1,931	244	3. Civil work * 0.01
3. Civil works	10,620	193,085	24,425	
(1) Intake weir	5,515	100,273	12,685	
(2) Intake	380	6,909	874	
(3) Settling basin	453	8,236	1,042	
(4) Headrace	2,181	39,655	5,016	
(5) Head tank	737	13,400	1,695	
(6) Penstock and spillway channel	273	4,964	628	
(7) Powerhouse	402	7,309	925	
(8) Tailrace channel	24	436	55	
(9) Tailrace	149	2,709	343	
(10) Miscellaneous	506	9,195	1,163	((1) to (9)) *0.05
4. Electro-mechanical equipment	2,145	38,999	4,719	Turbine and Generator, Transformer, etc
5. Transmission line	899	16,349	2,068	817,473PhP/km * distance from nearest barangay
Direct Cost	16,022	291,306	36,850	1 + 2 + 3 + 4 + 5 + 6
6. Administration and engineering servic	2,403	43,696	5,528	Direct Cost * 0.15
7. Contingency	1,602	29,131	3,685	Direct Cost * 0.1
8. Interest during construction	1,923	34,957	4,422	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8) * 0.4 * i * T i = 0.12 T = 2
Total Cost	21,950	399,090	48,290	1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
Designed Capacity (kW)		39		
Development Cost (/kW)	562.819	10,233	1,238.201	
Annual Generation (kWh/yr)		58,872		
Construction Cost per kWh	0.37284	6.77894	0.82025	
Planed Life Period (year)		40		
Annual O&M ratio to Construction cost (%)		2		
Capital Recovery Factor		0.121		i=0.12, n=40
Annual Cost Factor		0.141		
Production Cost (/kWh)	0.053	0.958	0.116	

Civil Engineering Work Cost (Run-of-River Type)

Site Name: D1 Tarusan

Item	Unit	Unit Cost (PhP)	Unit Cost (US$)	Quantity	Cost (1,000PhP)	Cost (US$)	Calculation method of Construction Cost
1. Weir					5,515	0	
(1) Excavation (V_e)	m^3	136		3,237	441	0	$8.69*(Dh * CL)^{1.14}$
(2) Masonry Concrete (V_c)	m^3	2,712		1,276	3,461	0	$16.1*(Dh^2 * CL)^{0.695}$
(3) Reinforcement ba	ton	30,900		11	340	0	$0.0274*V_c^{0.830}$
(4) Others	L.S.				1,273	0	((1) + (2) + (3)) * 0.3
2. Intake					380	0	
(1) Excavation (Ve)	m^3	136		64	9	0	$171*(R*Q)^{0.666}$
(2) Concrete (Vc)	m^3	3,134		74	232	0	$147*(R*Q)^{0.470}$
(3) Reinforcement ba	ton	30,900		2	63	0	$0.0145*V_c^{1.15}$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.25
3. Settlement Basin					453	0	
(1) Excavation (Ve)	m^3	136		185	26	0	$515*Q^{1.07}$
(2) Concrete (Vc)	m^3	3,134		69	217	0	$169*Q^{0.936}$
(3) Reinforcement ba	ton	30,900		4	134	0	$0.120*V_c^{0.847}$
(4) Others	L.S.				76	0	((1) + (2) + (3)) * 0.2
4. Headrace					2,181	0	
(1) Excavation (Ve)	m^3	136		5,762	784	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		285	893	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				504	0	((1) + (2)) * 0.3
5. Head Tank					737	0	
(1) Excavation (Ve)	m^3	136		415	57	0	$808*Q^{0.697}$
(2) Concrete (Vc)	m^3	3,134		99	312	0	$197*Q^{0.716}$
(3) Reinforcement ba	ton	30,900		5	157	0	$0.051*V_c$
(4) Others	L.S.				211	0	((1) + (2) + (3)) * 0.4
6. Penstock					273	0	
(1) Excavation (Ve)	m^3	136		304	42	0	$10.9*D_m^{1.33}*L$
(2) Concrete (Vc)	m^3	3,134		50	157	0	$2.14*D_m^{1.68}*L$
(3) Reinforcement ba	ton	30,900		1	28	0	$0.018*V_c$
(4) Others	L.S.				46	0	((1) + (2) + (3)) * 0.2
7. Powerhouse					402	0	
(1) Excavation (Ve)	m^3	136		166	23	0	$97.8*(Q*H_e^{2/3}*n^{1/2})^{0.727}$
(2) Concrete (Vc)	m^3	3,134		50	158	0	$28.1*(Q*H_e^{2/3}*n^{1/2})^{0.795}$
(3) Reinforcement ba	ton	30,900		3	87	0	$0.046*V_c^{1.05}$
(4) Others	L.S.				134	0	((1) + (2) + (3)) * 0.5
8. Tailrace channel					24	0	
(1) Excavation (Ve)	m^3	136		129	18	0	$6.22*((B*H)^{1/2})^{1.04}*L$
(2) Concrete (Vc)	m^3	3,134		0	0	0	(H*t*2+(B+2*t)*t)*L
(3) Others	L.S.				6	0	((1) + (2)) * 0.3
9. Tailrace outlet					149	0	
(1) Excavation (Ve)	m^3	136		195	27	0	$395*(R*Q)^{0.479}$
(2) Concrete (Vc)	m^3	3,134		15	47	0	$40.4*(R*Q)^{0.684}$
(3) Reinforcement ba	ton	30,900		1	45	0	$0.278*V_c^{0.610}$
(4) Others	L.S.				30	0	((1) + (2) + (3)) * 0.25
10. Miscellaneous	L.S.				506	0	(1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) * 0.05
Subtotal					10,620	0	

Attachment - B

Renewable Energy Development Plan

B.1 Meteorology of Palawan

The climate of the Philippines is tropical and maritime. It is roughly classified as a tropical monsoon climate with relatively high temperature, high humidity and abundant rainfall. On the other hand, the climate of each region is quite different due to the geographical features and latitude variations of Philippines Archipelago.

In this section meteorological key indicators, such as temperature, humidity and rainfall, which characterize the climate of Palawan, are summarized.

B.1.1 Temperature

Based on the average of all weather stations in the Philippines, excluding Baguio, the mean annual temperature is 26.6 degrees Celsius. In Puerto Princesa, the coolest month is January with a mean temperature of 26.7 degrees Celsius, while the warmest month is May with a mean temperature of 28.6 degrees Celsius. On the other hand, in Cuyo, which is located in a slightly higher latitude area, the coolest month is January with a mean temperature of 27.5 degrees Celsius, while the warmest month is May with a mean temperature of 29.4 degrees Celsius. Therefore, latitude is an insignificant factor in the variation of temperature.

The difference between the maximum monthly temperature and minimum monthly temperature in Puerto Princesa is larger than that in Cuyo, even though both maximum monthly temperatures are almost same level.

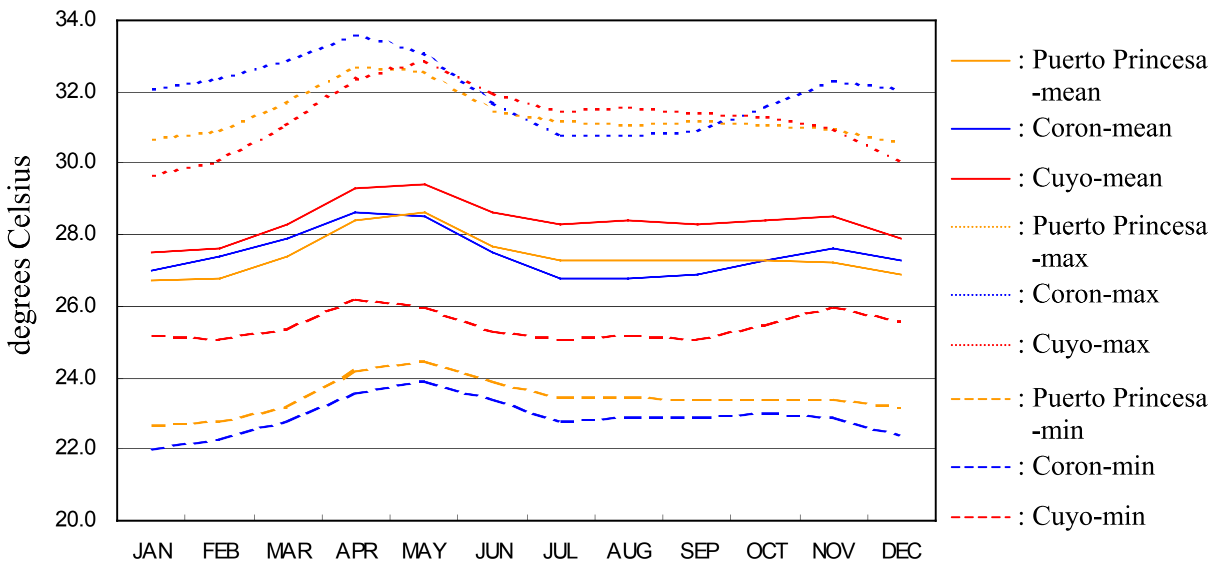


Figure B.1.1 Temperature Changes in Palawan

B.1.2 Humidity

The Philippines has a high relative humidity due to the high temperature and the surrounding bodies of water. The average monthly relative humidity varies between 71 percent in March and 85 percent in September. Figure B.1.2 shows the transition of humidity in Palawan. Annual average monthly humidity is between 82 and 83 percent. The high humidity period is from July to September, and the low humidity period is from March to April.

B.1.3 Rainfall

Rainfall distribution throughout the country varies from one region to another. The average annual rainfall of the Philippines varies from 965 to 4,064 millimeters annually. Based on the average annual rainfall in Palawan, as shown in Figure B.1.3, the high rainfall period is from June to October, while the low rainfall period is from December to April. The average annual rainfall in Coron and Cuyo is between 2300 and 2500 millimeters, while that in Puerto Princesa is about 1500 millimeters.

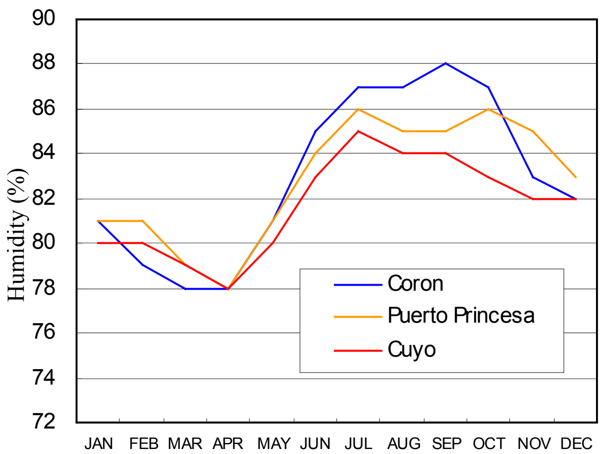


Figure B.1.2 Transition of Humidity in Palawan

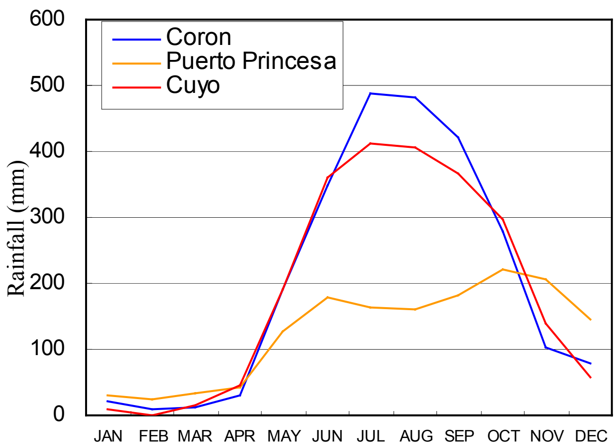


Figure B.1.3 Transition of Rainfall in Palawan

B.1.4 Seasons

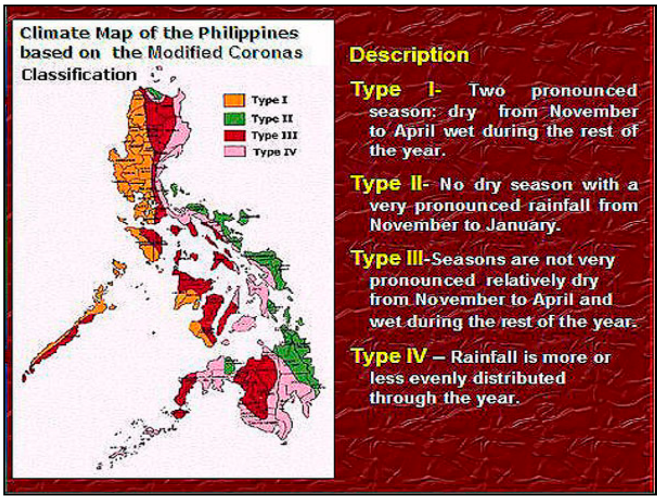
Using temperature and rainfall as bases, the climate of the Philippines can be divided into two major seasons: (1) the rainy season, from June to November; and (2) the dry season, from December to May. The dry season may be subdivided into (a) the cool dry season, from December to February; and (b) the hot dry season, from March to May.

B.1.5 Climate Types

Based on the distribution of rainfall, PAGASA (PAGASA: Philippine Atmospheric, Geophysical, and Astronomical Services Administration) classified four climate types, which are described in Figure B.1.4.

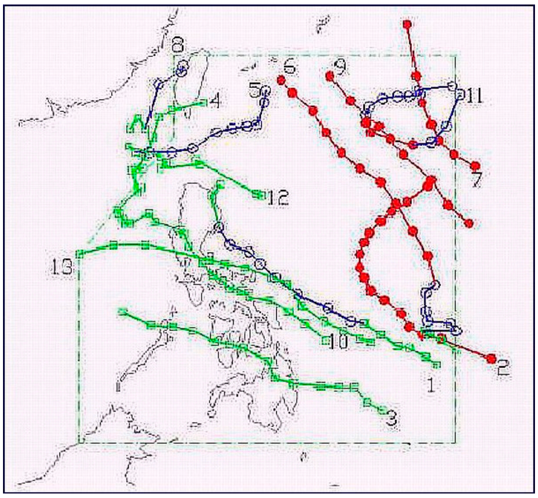
B.1.6 Typhoons

Typhoons that pass over the Philippines generally originate in the region of the Marianas and Caroline Islands of the Pacific Ocean, which have the same latitudinal location as Mindanao. Figure B.1.5 shows the tracks of 13 major tropical cyclones that occurred in 2002. According to this figure, only one typhoon passed over the mainland of Palawan.



Source: PAGASA web site

Figure B.1.4 Climate Classification Map of the Philippines



Source: PAGASA web site

Figure B.1.5 2002 Tropical Cyclone Tracks

B.2 Existing Facilities and On-going Renewable Energy Development Projects

B.2.1 Existing Facilities of Solar Power System

In Palawan a large number of PV systems have been installed. Even though the total amount of installed PV modules and the locations of the PV systems are uncertain, existing PV systems are summarized by the organizations that support the installations of the PV system.

B.2.1.1 SPCP-ANEC

SPCP-ANEC is one NGO that promotes the installation of renewable energy in Palawan such as micro hydropower and solar power. They have already installed 246 SHS in 11 barangays and 14 BCS in 14 barangays as of October 2003. The total installed capacity of these systems is 19kW. Table B.2.1 shows the solar power projects installed by ANEC.

Table B.2.1 SPCP-ANEC Solar Project List

Type	Site	Total Capacity	No. of HH	O&M Organization
SHS	Campung Ulay, Rizal	50Wp	1	SPCP-ANEC
	Poblacion, Araceli	150Wp	2	
	Poblacion, Dumaran	75Wp	1	
	Sibaltan, El Nido	75Wp	1	
	ANEC, Aborlan	75Wp	1	
	Catep, Dumaran	1,600Wp	20	BASPA (Barangay Solar Power Association)
	Magsaysay, Dumaran	1,600Wp	20	
	Busybees, Taytay	1,600Wp	20	
	Calaawag, Taytay	1,600Wp	20	
	Cataban, Taytay	1,600Wp	20	
	Pularaquen, Taytay	1,600Wp	20	
BCS	Bacao, Dumaran	900Wp	20	
	Culasian, Dumaran	900Wp	20	
	Danleg, Dumaran	960Wp	20	
	Banbanan, Taytay	960Wp	20	
	Biton, Taytay	960Wp	20	
	Casian, Taytay	960Wp	20	
	Debangan, Taytay	960Wp	20	
	Berong, Quezon	225Wp	10	
	Bonog, Rizal	450Wp	20	
	Campung Ulay, Rizal	225Wp	10	
	Candawaga, Rizal	225Wp	10	
	Sicud, Candawaga, Rizal	225Wp	10	
	Daan, Apurawan, Aborlan	225Wp	10	
	Bubusawin, Aborlan	450Wp	20	

B.2.1.2 NPC-SPUG

In the franchise area of BISELCO, NPC-SPUG installed 23 BCS. Table B.2.2 shows a list of Barangay where NPC-SPUG has installed BCS.

Table B.2.2 Locations of BCS Installed by NPC-SPUG

Municipality	Barangay
Coron	Banuang Daan, Buenavista, Bulalacao, Cabugao, Decabobo, Lajala, Malawig, Marcilla, San Jose, Tara
Busuanga	Panlaitan, Quezon, San Isidoro
Culion	Galoc, Luac
Linapacan	Barangonan, Cabunlawan, Calibangbangan, Decabaitot, Maroyogroyog, New Culaylayan, Pical, San Nicolas

According to the site survey at Barangay Lajala in Coron, NPC-SPUG installed BCS in 2001 to supply power to 20 households. Pictures B.2.1 and 2.2 show the system and battery used for this BCS. NPC-SPUG donated PV modules with 300W (75W x 4) total capacity, and rented other equipment, such as BOS, batteries and DC lamps to the beneficiaries in the barangay. The monthly payment to NPC-SPUG is PHP 104 per month, and each beneficiary pays PHP 30 per 1 day charging. In return for the monthly payments, beneficiaries can obtain equipment replacement services from NPC-SPUG.

At present, only a few beneficiaries use BCS due to some equipment trouble such as with the battery or light. Considering that almost all batteries had problems within only one year, it would appear that one of causes of battery trouble, other than their low quality, is the lack of know-how on the part of the beneficiaries in terms of proper maintenance and operation. To install the BCS in remote areas, it is important to give the beneficiaries instructions on extending the life span of the battery.

Picture B.2.1 BCS in Barangay Lajala

Picture B.2.2 Battery connected with BCS

B.2.1.3 Shell Solar

In Palawan Shell Solar has five (5) centers in Puerto Princesa, Taytay, Quezon, and Brooke's Point. Shell Solar has continued to market mainly SHS and has established the Shell Solar Supply Center in Palawan. Related direct sale investment costs are basically marketing, servicing and after-sales support costs.

Table B.2.3 shows Shell Solar installations in Palawan. Shell Solar sold different types of SHS to 15 barangays. Among them the highest system is one in El Nido with 72 SHS in various barangays.

Table B.2.3 Shell's Solar Installations in Palawan as of October 2003

Municipality/City	SolarMax 240	SolarMax 200	SolarMax 160	SolarMax 180	SolarMax 300 AC/320Wp
	Module: 60Wp Battery: 100Ah Light: 6W x 3	Module: 50Wp Battery: 100Ah Light: 6W x 3	Module: 50Wp Battery: 100Ah Light: 6W x 3	Module: 45Wp Battery: 70Ah Light: 6W x 3	
	Qty.	Qty.	Qty.	Qty.	Qty.
Aborlan	1				
Balabac	1	18	9	1	1
Bataraza	12	17	3	2	
Brooke's Point	8	17		1	
Coron	1				
Dumaran	5	5			
El Nido	39	26	4	4	
Narra	2	8	2	1	
Puerto Princesa	12	8	2	1	
Quezon	4	9	7	1	
Rizal	2	3	3		
Roxas	7	14		1	
San Vicente	3	4			
Sofronio Espanola	3	3			
Taytay	33	20	4	4	1
Total	133	152	34	16	2

B.2.2 On-going Renewable Energy Development Projects

B.2.2.1 Multi-purpose Pilot PV-Wind Turbine System for Rural Electrification

The primary objective of this project is to install sunlight and wind resource-based hybrid renewable energy. The proposed project is a pilot that centralizes utility-type 5kWp PV/ 10 kW wind turbine hybrid system with a 15 kVA diesel generator as a back-up for the hybrid system. The system will supply power to the 200 farming and fishing households for 24-hours in Sitio Sicud, Barangay Candawaga and Rizal.

Contributions for the project fund and the functions of each stakeholder are as follows.

Table B.2.4 Stakeholders of Multi Purpose Pilot PV-Wind Turbine System Project

Stakeholder	Contribution		Function
	In US$	% Share	
UNDP/Government of Japan	125,000	70.67	The donor and technical assistance /seed capital investment.
GOP-DOE	27,500	15.54	DOE provides the overall supervision and management of the project. SPCP-ANEC implements the project.
Rizal Local Government Unit	12,500	7.07	The Rizal LGU will provide counterpart funds for institutional developments, construction of the multi-purpose building, incentives and allowances of assigned SPCP-ANEC and LGU personnel, and project management coordination/consultation.
Provincial Government of Palawan	8,928	5.05	PGP will provide counterpart funds for the construction of the multi-purpose building
Beneficiaries/village	2,950	1.67	
Total	176,878	100	

B.2.2.2 Palawan New and Renewable Energy and Livelihood Support Project

This project is in line with GEF Operational Program No. 6 – “Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs”, which is aimed at reducing the long-term growth of greenhouse gas (GHG) emissions by removing the barriers to commercial utilization of new and renewable energy (NRE) power systems to substitute for the use of diesel generators in Palawan.

Contributions for the project fund and the functions of each stakeholder are as follows.

Table B.2.5 Stakeholders of Palawan New and Renewable Energy and Livelihood Support Project

Stakeholder	Fund Contribution	Function
UNDP/GEF	US$ 750,000	
UNDP-TRAC	US$ 100,000	
Provincial Government of Palawan	US$ 300,000	Implementation of the technical capability building of internal staff.
CRREE		Will be the executing agency and coordinate with provincial government, private sector and local communities.
University of the Philippines Solar Laboratory		Will provide the key technical support.
Local Government Unit		Will encompass planning, implementation and assessment through a consultative approach
NGO and Local Community		Will provide input in assessing awareness campaign of new & renewable energy and assist in identifying the types of productive use of projects.
Shell Renewables, Inc. and Community Power Corporation	US$ 1,400,000	Will be working in conjunction in establishing a Renewable Energy Service Company (RESCO).
Rural Electric Cooperatives		Will support RESCO installation of renewable energy systems within their franchises.
Department of Energy		Will monitor and document the project, its activities and methodology.
Total	US$ 2,550,000	

B.2.2.3 Renewable Energy Village Power System in Palawan

This project will involve the implementation of a Community-based/Village Power System (a mini grid system powered by solar PV systems). It is intended to demonstrate the viability of a small-scale renewable energy service company (RESCO) as a delivery mechanism to an off-grid area and operated on a “fee for service basis”. The project aims to improve life and livelihood activities in the community by providing a reliable and clean energy at an affordable cost. Based on the PGP tentative plan, a 20kW PV mini grid with a 20kW diesel generator set as back up will be installed in Barangay New Ibajay, El Nido and Palawan. A total cost of US$ 314,255 (Php 16,341,276) is required during the first year of implementation of the project to attain the desired output. These funds will be obtained from various institutions.

B.2.2.4 DOE-WESCOM Electrification Project in Pagasa Island, Kalayaan

The objective of this project is to support the existing diesel units in the military barracks in Pagasa Island, Kalayaan with the installation of SHS and a BCS. In this project, 6 SHS at 75Wp/module and 1 BCS at 300Wp will be installed. The project cost is now estimated at Php326,000 and allocated by DOE and WESCOM (WESCOM: Western Command). The implementation will begin once WESCOM allocates their contribution.

B.3 Solar Energy Potential Survey

B.3.1 Workflow

This section outlines the workflow for the solar energy potential survey.

Normally solar energy is evenly distributed. In Palawan, which will later be described in more detail, solar energy potential can be easily obtained in every barangays. Although there is only 1 observation station in Palawan Province, the existing energy potential data is enough to design the solar power systems by making comparisons with other existing reports.

The following figure shows the workflow for solar power development.

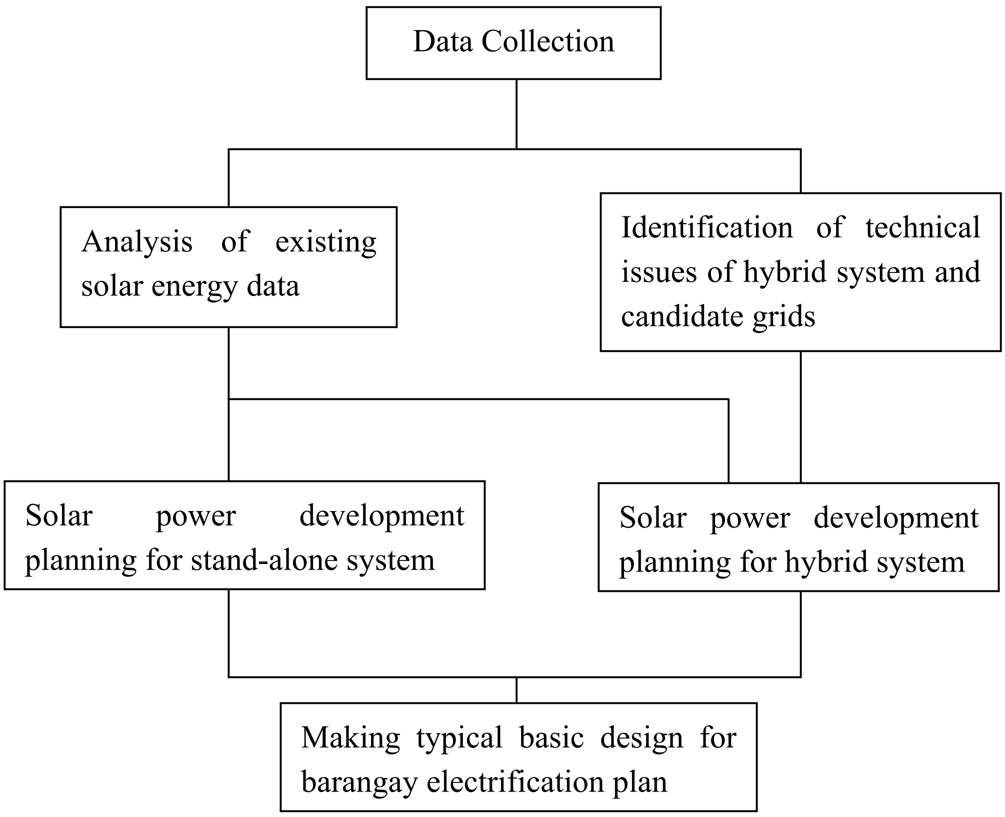


Figure B.3.1 Workflow for Solar Power Development

B.3.2 Data Collection

B.3.2.1 Existing Report and Data

During the Study the Study team collected the following reports and data regarding solar energy potential.

Table B.3.1 Reports and Data Archives (Solar)

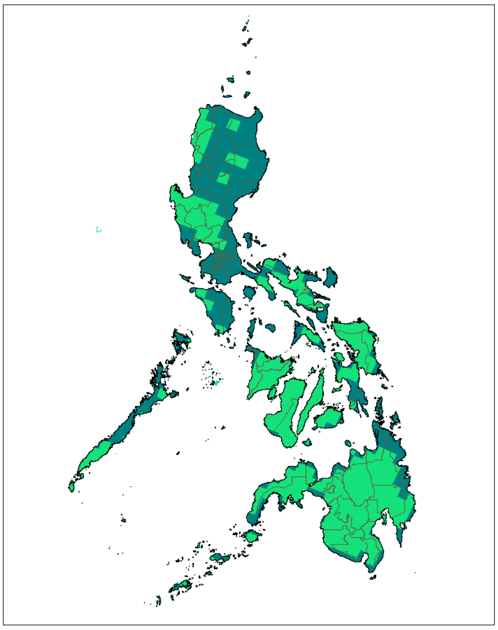
Category	Editor	Site (Latitude, Longitude, Height)	Contents	Data format	Duration
Report	USAID/NREL	Philippines	$kWh/m^2/day$		
	PAGASA	Philippines	Radiation		
			Duration		
Data	PAGASA	Puerto Princesa (9+5N, 118+4E, 10m)	Radiation	Every 1 hour	1994-2002
			Duration		1984-2002

B.3.2.2 Assessment of Solar Resources in the Philippines prepared by USAID/NREL

A report was prepared by NREL (NREL: National Renewable Energy Laboratory) under contract with the USAID. In this report the latest meteorological observation data regarding solar power potential and its distribution was arranged in GIS format as along with wind power potential. Solar power potential is defined in terms of energy-density value ($kWh/m^2/day$) at a 40-km spatial resolution as shown in Figure B.3.2.

Although the resolution is larger than that used for the wind energy potential survey, this GIS system can be useful for estimating amounts of potential energy and finding project sites. As solar energy resources are evenly distributed as opposed to the wind energy potential, solar energy can be obtained as indicated in this system.

This assessment combines existing ground measurement data collected in the Philippines with the output of NREL's CSR (CSR: Climatological Solar Radiation) model. This model converts information on satellite- and surface- derived cloud cover data to estimate the monthly average daily total global horizontal solar resource.

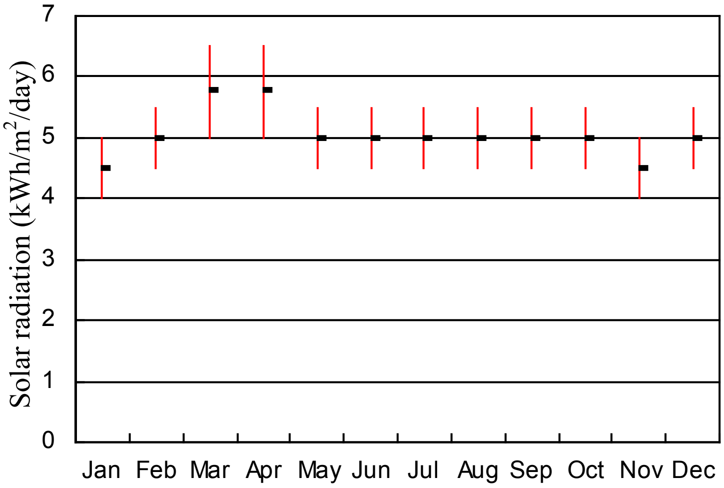


Source: Assessment of Solar Resources in the Philippines

Figure B.3.2 Estimation Result

As NREL reported in this report, the result of this analysis provides results that are comparable to values obtained from surface stations, even though the CSR model is capable of providing higher resolution data than the ground network.

According to this report the annual average global horizontal solar resource for Palawan Province is 4.5 - 5.0 kWh/m^2/day in the northern part of the province, and 5.0 - 5.5 kWh/m^2/day in the southern part of the province. Average global horizontal solar resource of each month in Palawan is shown in Figure B.3.3. The bars in this figure show the range of solar resource in Palawan and the dots show the mean value.



Source: Assessment of Solar Resources in the Philippines

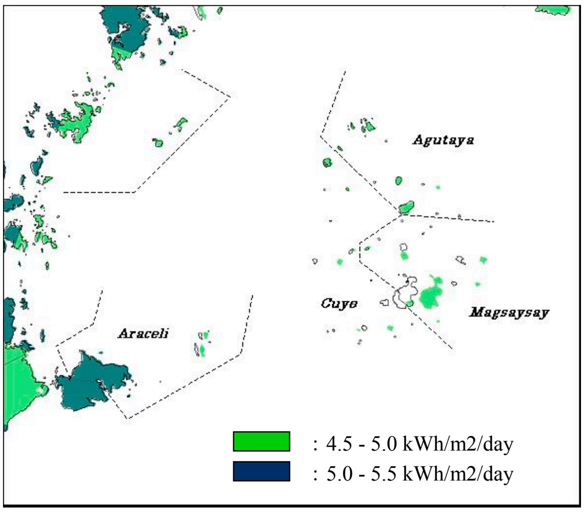
Figure B.3.3 Average global horizontal resource in Palawan

Estimation results of each municipality in Palawan are summarized by annual and twelve monthly average daily total global horizontal solar resource data on a 40 km grid. These data are pointed out in the following section.

(1) Agutaya, Magsaysay, Cuyo, Araceli

Figure B.3.4 shows annual average daily solar radiation in Agutaya, Magsaysay, Cuyo and Araceli.

Daily solar radiation in Agutaya, Magsaysay and Cuyo is 4.5 - 5.0 kWh/m^2/day. Daily solar radiation in the islet parts of Araceli is the same as above. On the other hand, radiation in the main islands of Araceli is 5.0 - 5.5 kWh/m^2/day.



Source: Assessment of Solar Resources in the Philippines

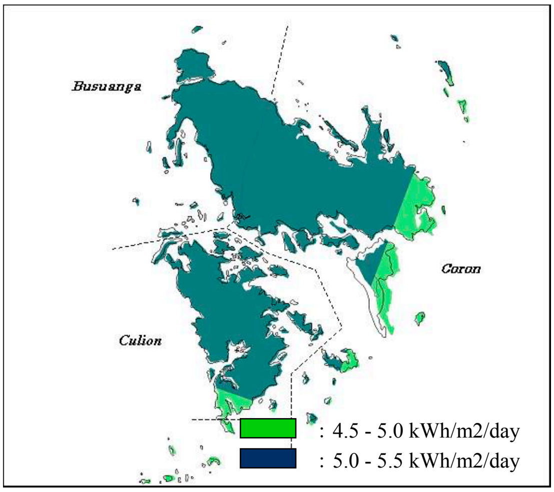
Figure B.3.4 Annual Average Daily Solar Radiation (Agutaya, Magsaysay, Cuyo, Araceli)

(2) Busuanga, Coron, Culion

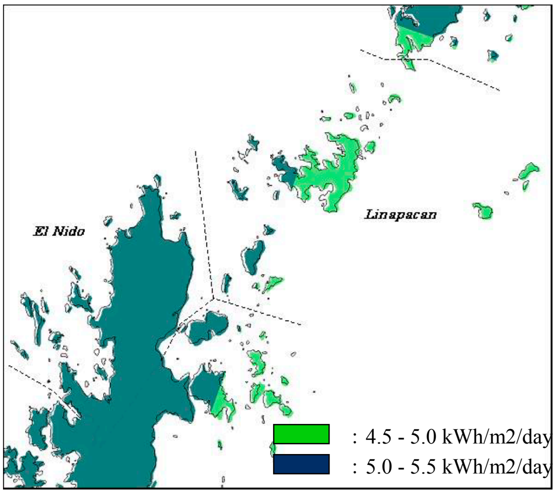
Figure B.3.5 shows annual average daily solar radiation in Busuanga, Coron and Culion. Daily solar radiation in Busuanga is 5.0 - 5.5 kWh/m^2/day. The radiation in almost all parts of Coron and Culion is the same as above. On the other hand, the radiation in the eastern part of Coron and in the southern part of Culion is 4.5 - 5.0 kWh/m^2/day.

(3) Linapacan, El Nido

Figure B.3.6 shows annual average daily solar radiation in Linapacan and El Nido. The radiation in almost all parts of Linapacan is 4.5 – 5.0 kWh/m^2/day. On the other hand, the radiation in El Nido and in the western part of Linapacan is 5.0 – 5.5 kWh/m^2/day.



Source: Assessment of Solar Resources in the Philippines
Figure B.3.5 Annual Average Daily Solar Radiation (Busuanga, Coron, Culion)



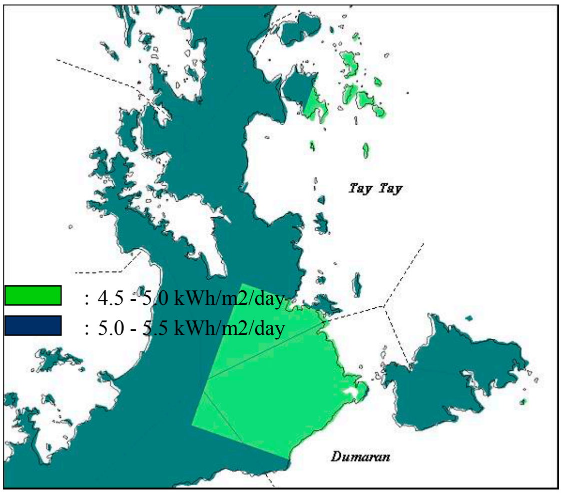
Source: Assessment of Solar Resources in the Philippines
Figure B.3.6 Annual Average Daily Solar Radiation (Linapacan, El Nido)

(4) Tay Tay, Duamran

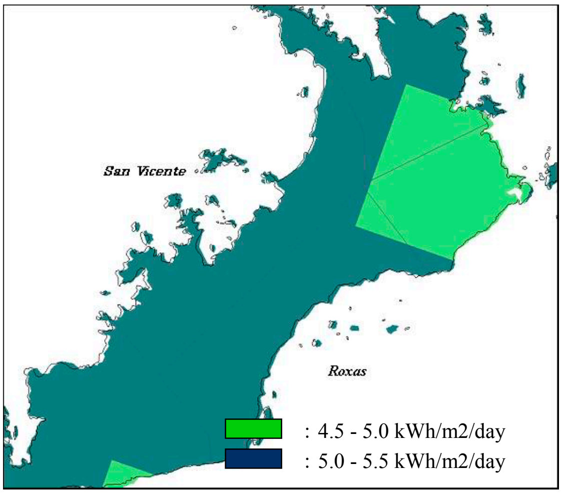
Figure B.3.7 shows annual average daily solar radiation in Tay Tay and Dumaran. The radiation in almost all parts of Tay Tay and in the eastern part of Dumaran is 5.0 – 5.5 kWh/m^2/day. On the other hand, the radiation in the main island of Dumaran, in the southern part and the islet part of Tay Tay is 4.5 – 5.0 kWh/m^2/day.

(5) San Vicente, Roxas

Figure B.3.8 shows annual average daily solar radiation in San Vicente and Roxas. The radiation in San Vicente and in almost all parts of Roxas is 5.0 – 5.5 kWh/m^2/day. On the other hand, the radiation in the northern part of Roxas is 4.5 – 5.0 kWh/m^2/day.



Source: Assessment of Solar Resources in the Philippines
Figure B.3.7 Annual Average Daily Solar Radiation (Tay Tay, Dumaran)



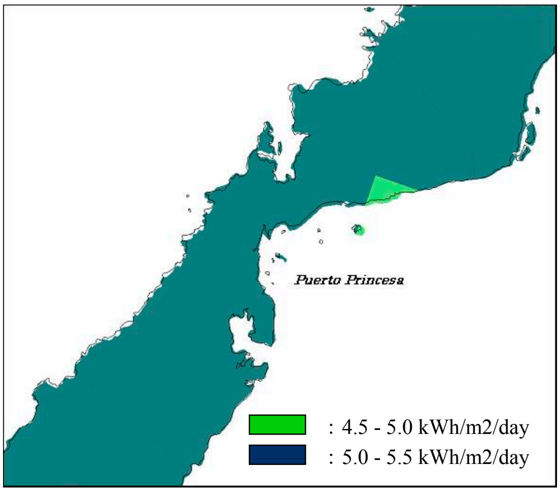
Source: Assessment of Solar Resources in the Philippines
Figure B.3.8 Annual Average Daily Solar Radiation (San Vicente, Roxas)

(6) Puerto Princesa

Figure B.3.9 shows annual average daily solar radiation in Puerto Princesa. The radiation in almost all parts of Puerto Princesa is 5.0 – 5.5 kWh/m^2/day.

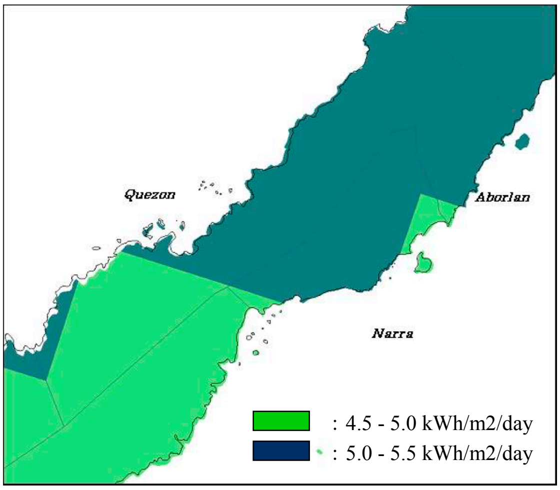
(7) Aborlan, Narra, Quezon

Figure B.3.10 shows annual average daily solar radiation in Aborlan, Narra and Quezon. The radiation in almost all parts of Aborlan and in the northern part of Narra and Quezon is 5.0 – 5.5 kWh/m^2/day. On the other hand, the radiation in the southern part of Narra and Quezon is 4.5 – 5.0 kWh/m^2/day.



Source: Assessment of Solar Resources in the Philippines

Figure B.3.9 Annual Average Daily Solar Radiation (Puerto Princesa)



Source: Assessment of Solar Resources in the Philippines

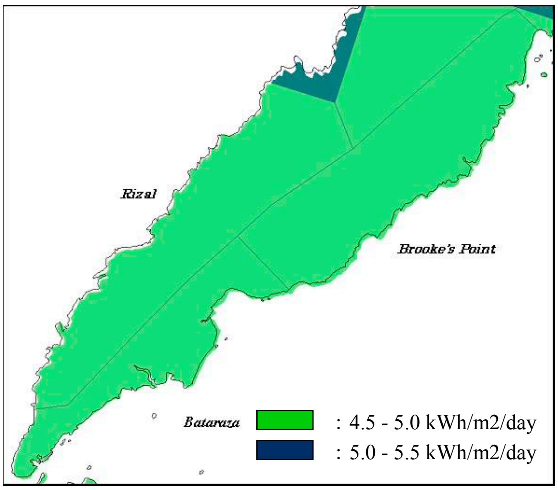
Figure B.3.10 Annual Average Daily Solar Radiation (Aborlan, Narra, Quezon)

(8) Brooke's Point, Rizal

Figure B.3.11 shows annual average daily solar radiation in Brooke's Point and Rizal. The radiation in almost all parts of Brooke's Point and Rizal is 4.5 – 5.0 kWh/m^2/day. On the other hand, the radiation in the northern part of Rizal is 5.0 – 5.5 kWh/m^2/day.

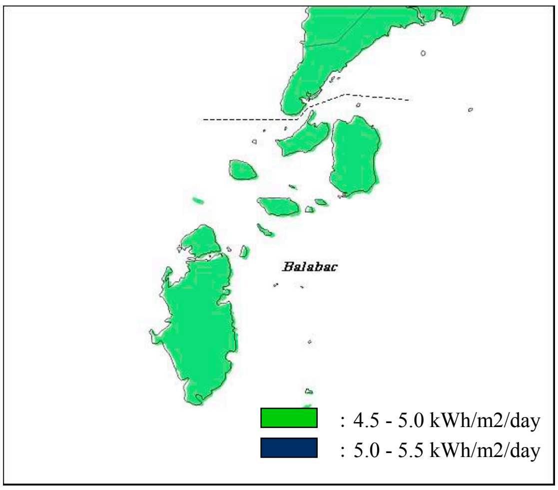
(9) Balabac

Figure B.3.12 shows annual average daily solar radiation in Balabac. The radiation in all parts of Balabac is 4.5 – 5.0 kWh/m^2/day.



Source: Assessment of Solar Resources in the Philippines

Figure B.3.11 Annual Average Daily Solar Radiation (Brooke's Point, Rizal)



Source: Assessment of Solar Resources in the Philippines

Figure B.3.12 Annual Average Daily Solar Radiation (Balabac)

(10) Summary

Based on the above solar radiation maps, the Palawan Province has enough energy potential to utilize solar energy for electric power production. Regarding energy distribution, the energy potential in Busuanga Island and the central part of Palawan Island is more plentiful than in the other areas of Palawan Province.

B.3.2.3 Solar Radiation Map of the Philippines prepared by PAGASA

This report was prepared by PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration) of the Department of Science and Technology. In this report, dataset and figures regarding the solar radiation observed by 12 PAGASA stations are indicated, in addition to explanations on measurements, procedures and terminology used for data making. The report is suitable as an introduction to solar energy distribution in the Philippines.

In Palawan PAGASA has only one station in Puerto Princesa. This station observes hourly/daily totals of the global radiation and the bright sunshine duration. Global radiation measured with the use of a Pyranometer is indicated in terms of joules per square centimeter. Sunshine duration measured with the use of a Campbell-Stokes recorder is indicated in terms of hours.

Based on this data observed between 1984 and 1995, monthly average daily total radiation in Palawan is distributed from 1,423 (J/cm^2) in December to 1,957 (J/cm^2) in April. Maximum daily total radiation of 2,381 (J/cm^2) was recorded in April of 1995. And monthly average daily total sunshine duration is distributed from 4.6 (hours) to 8.0 (hours). Daily total duration between March and May is relatively high, and that between July and October is relatively low.

B.3.2.4 Ground Observation Data prepared by PAGASA

As mentioned before, PAGASA is now observing solar radiation data and sunshine duration in Puerto Princesa. These data can be obtained in electronic format from PAGASA in the Science Garden in Quezon City. Radiation and duration data of Palawan obtained from PAGASA in the Study is shown in Table B.3.2. Results of detailed analysis using these data are indicated in the following section.

Table B.3.2 Acquired Solar Data from PAGASA

Radiation		Duration	
January	1996-1999, 2001, 2002	January	1986-1992, 1994-1998, 2001-2002
February	1996-2002	February	1985-1998, 2000-2002
March	1996-1998, 2000-2002	March	1985-1998, 2000-2002
April	1996-1997, 1999-2002	April	1985, 1987-1997, 2000-2002
May	1996-1997, 1999-2002	May	1985, 1987-1991, 1993-1997, 2002
June	1995-1997, 1999-2002	June	1985-1991, 1993-1997, 2000-2001
July	1995-1997, 2000-2002	July	1985-1991, 1993-1996, 2000-2001
August	1994-2002	August	1985-1991, 1993-1996, 1998-1999, 2001
September	1994-1999, 2001-2002	September	1984-1991, 1993-1996, 2000-2001
October	1994-1997, 1999-2001	October	1984-1996, 1999-2001
November	1995, 1997, 1999, 2000	November	1984-1991, 1993-1996, 1999-2000
December	1995-1997, 2000-2001	December	1985-1991, 1993-1996, 1999-2000

B.3.3 Result of Analysis

In this section, solar data acquired from PAGASA is analyzed and the results of this analysis are compared with results of the USAID report. Based on this comparison, basic data used in the following work is determined.

B.3.3.1 Monthly Average Daily Solar Radiation

Monthly average daily solar radiation in Puerto Princesa is shown in Table B.3.3 and Figure B.3.13. Annual average daily solar radiation is 4.691 (kWh/m^2/day). Solar radiation during the dry season tends to be higher than that during the rainy season because of the effects of cloud cover. The lowest radiation is 3.887 (kWh/m^2/day) in November and the highest radiation is 5.464 (kWh/m^2/day) in March.

Table B.3.3 Monthly Average Daily Solar Radiation in Puerto Princesa

(Unit: kWh/m^2/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AV
4.558	5.200	5.464	5.448	5.016	4.671	4.364	4.536	4.568	4.366	3.887	4.264	4.691

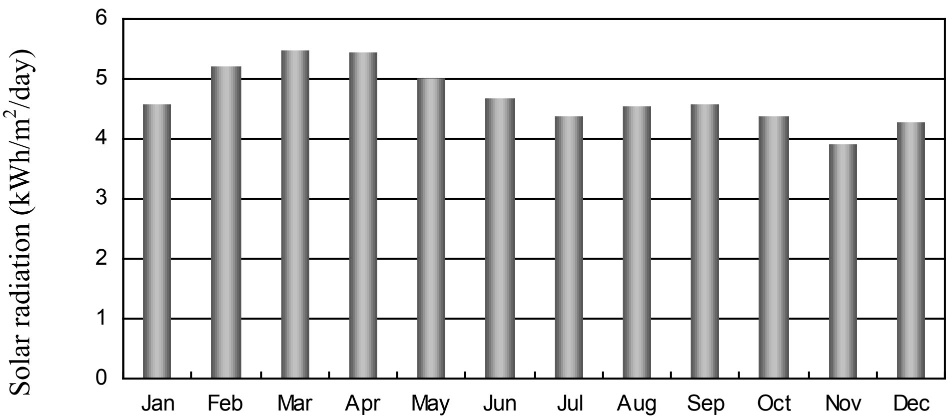


Figure B.3.13 Monthly Average Daily Solar Radiation in Puerto Princesa

B.3.3.2 Monthly Average Hourly Solar Radiation

Monthly average hourly solar radiation in Puerto Princesa is shown in Figures B.3.14 ~ 3.17. As mentioned in the above section, radiation during the dry season is higher than that during the rainy season. Peak radiation occurs between 12 PM and 1 AM. During this peak time the highest hourly radiation is 0.740 (kWh/m^2/h) in March and the lowest radiation is 0.539 (kWh/m^2/h) in November.

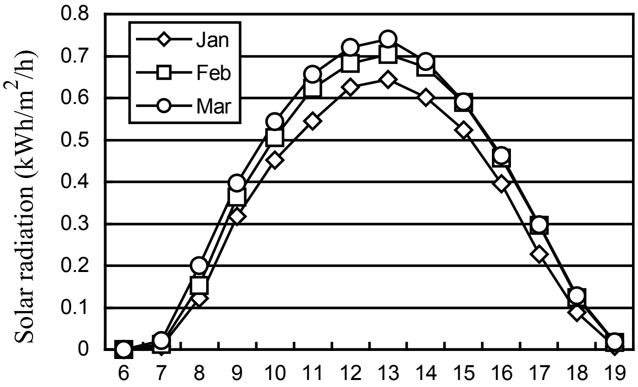


Figure B.3.14 Monthly Average Hourly Radiation (January, February, March)

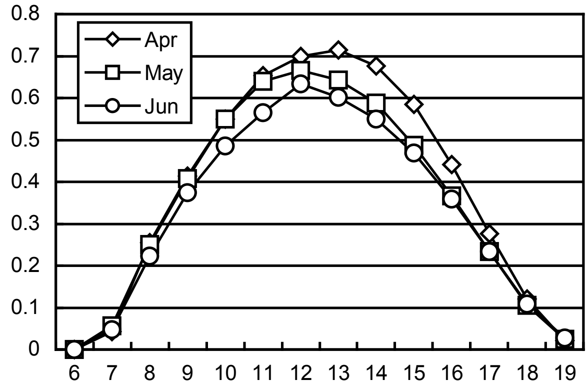


Figure B.3.15 Monthly Average Hourly Radiation (April, May, June)

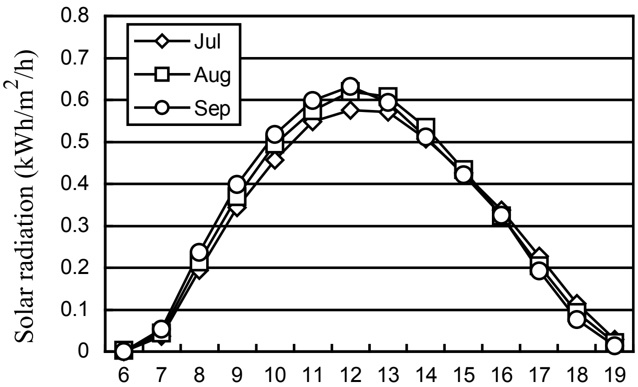


Figure B.3.16 Monthly Average Hourly Radiation (July, August, September)

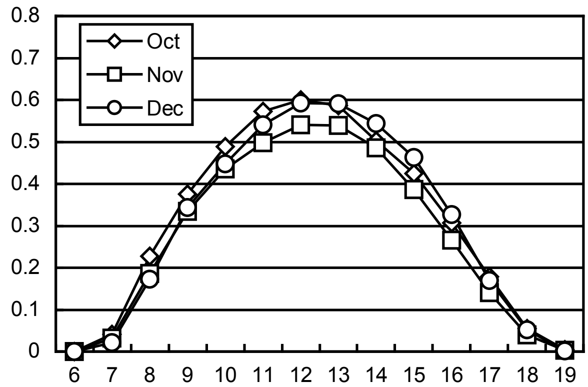


Figure B.3.17 Monthly Average Hourly Radiation (April, May, June)

B.3.3.3 Monthly Average Daily Sunshine Duration

Monthly average daily sunshine duration in Puerto Princesa is shown in Table B.3.4 and Figure B.3.18. Annual average daily sunshine duration is 5.9 (hours). Sunshine duration during the dry season tends to be higher than that during the rainy season, which is also the case for solar radiation. The lowest duration is 4.6 (hours) in July and the highest duration is 7.8 (hours) in April.

Table B.3.4 Monthly Average Daily Sunshine Duration in Puerto Princesa

(Unit: hours)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AV
6.7	7.3	7.6	7.8	6.8	4.9	4.6	4.8	4.7	4.7	5.4	5.6	5.9

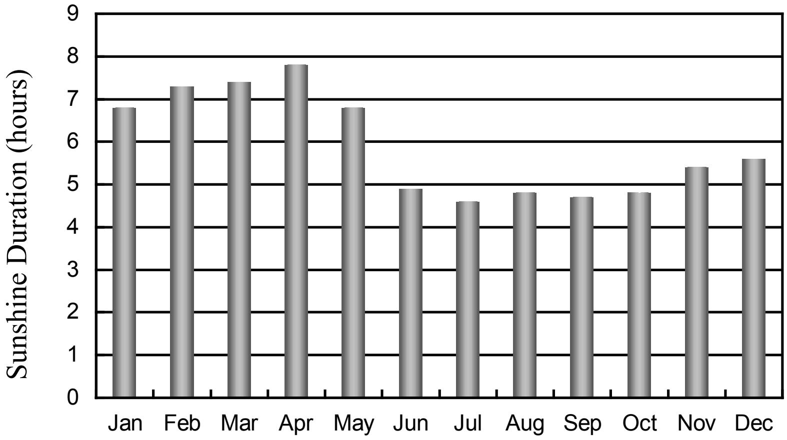


Figure B.3.18 Monthly Average Daily Sunshine Duration in Puerto Princesa

B.3.3.4 Monthly Average Hourly Sunshine Duration

Monthly average hourly sunshine duration in Puerto Princesa is shown in figures B.3.19 ~ 3.22. As mentioned in the above section, duration in the dry season is higher than that during the rainy season.

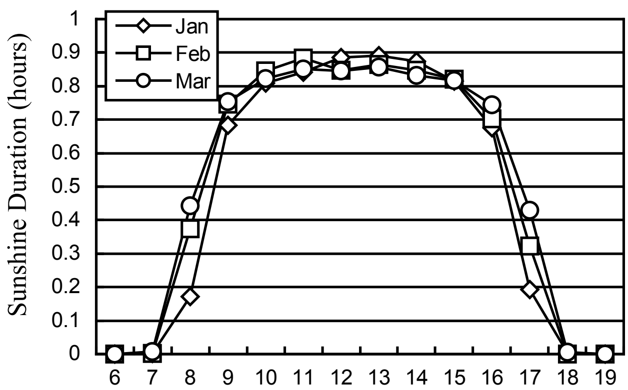


Figure B.3.19 Monthly Average Hourly Radiation (January, February, March)

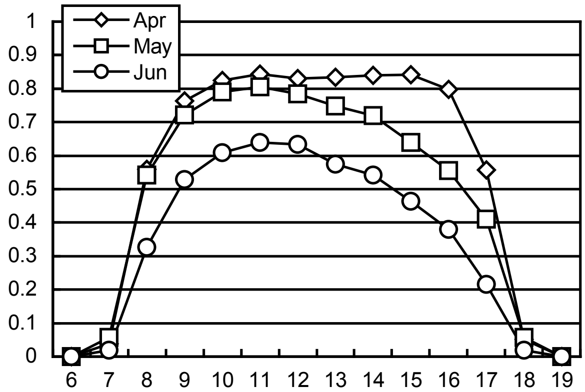


Figure B.3.20 Monthly Average Hourly Radiation (April, May, June)

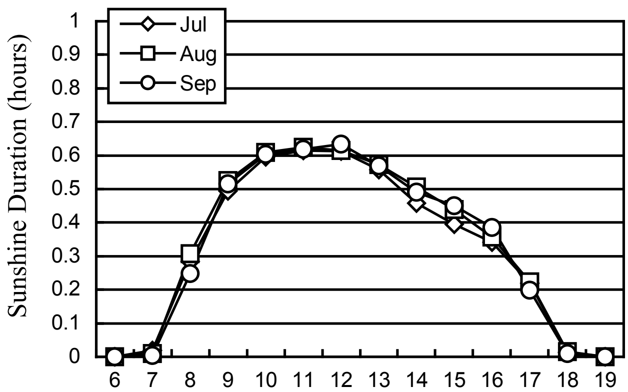


Figure B.3.21 Monthly Average Hourly Radiation (July, August, September)

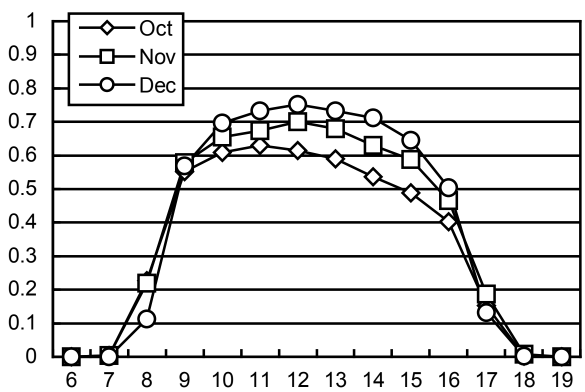


Figure B.3.22 Monthly Average Hourly Radiation (April, May, June)

B.3.3.5 Comparison of Radiation Data

In this section results based on the ground observation data are compared with output from the existing report. According to the comparison with output from the USAID report as shown in Figure B.3.23, the USAID data is higher than the ground data. For both the radiation data in November is the lowest among all the months.

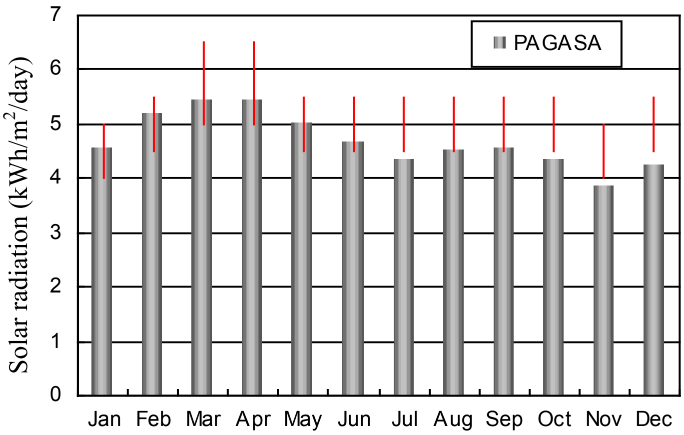


Figure B.3.23 Comparison of Radiation

Even though the ground observation data reflects actual resource conditions, the ground observation data can represent only the average resource of the observation site. When considering solar resource distribution for all of Palawan, the USIAD data may prove to be more useful in the following work.

However, when estimating the construction costs for solar power systems based on this high radiation data, the concern is that the system cost may be underestimated. In addition, considering that it is usual to use the lowest monthly average daily radiation for solar power system design, the PAGASA radiation data may be better, because calibrated PAGASA radiation data according to the tilt angle is lower than radiation of any parts of Palawan in the USAID report. Calibrated radiation data is explained in detail in the following section.

B.4 Solar Energy Development Plan

B.4.1 Method and Condition

B.4.1.1 Adopted Design Method

There are several design methods for solar power systems. Among these methods, the parametric design method was adopted for this Study as this method is simple and easy to understand. The parametric design method has been applied for many solar power projects and has a good track record for generating adequate result in the formulating of a master plan. Other methods, such as the simulation design method, can offer precise results, but this method is more suitable for large-scale projects.

B.4.1.2 Principle of Design Method

The parametric design method is a method to estimate available electric power and/or system capacity that meet the target demand by calculating system loss when converting the solar energy into the electric power.

In this method the basic formula to estimate PV array capacity is as follows;

$$H_A \times A \times \eta_{ps} \times K = E_L \times D \times R \quad (1)$$

$$\eta_{ps} = P_{AS} / (G_S \times A) \quad (2)$$

H_A: solar irradiation during a fixed period (kWh/m^2/day)
A: gross area of PV array (m^2)
η_{ps}: energy convert efficiency of PV cell under the standard test conditions
K: over all design parameters
E_L: total demand during a fixed period (kWh/day)
D: dependency of solar energy of PV system
R: safety factor
P_{AS}: output of PV array under the standard test conditions (kW)
G_S: solar irradiation under the standard test conditions (=1kW/m^2)

Therefore, the formula to calculate system capacity to meet a target demand and the available power supplied by a solar system can be obtained by converting the above formula as follows.

(system capacity calculation)

$$P_{AS} = \frac{E_L \times D \times R}{H_A / G_S \times K} \quad (3)$$

(available power generation)

$$E_P = P_{AS} \times H_A / G_S \times K \quad (4)$$

E_P: available power generation during a fixed period (kWh/day)

B.4.1.3 Design Parameter Assumptions

In the above formula, the design parameter *K* is one of the important factors, which represents the total loss of the solar power system. The *K* value is the total loss when converting the solar energy into electric power, and is indicated by the product of each loss. The value of each loss was determined based on the actual data and typical value. Thus, the *K* value was set at 0.6 for the following examination.

B.4.1.4 Solar Radiation Assumptions

Solar radiation is another important factor that influences available power generation of the system. Before determining the H_A value, the solar radiation data obtained in the previous section needs to be calibrated according to the tilt angle of the PV module. Figure B.4.1 shows monthly average daily solar radiation calibrated by various tilt angles. Theoretically, the highest level of minimum solar radiation can be achieved when the tilt angle is set as the latitude of the site. This theory can be confirmed in this figure.

However, when considering a rain wash effect on a surface of a PV module, it is commonly recognized that the tilt angle should be set to more than 15 degrees. In the case of the tilt angle set at 15 degrees, the minimum solar radiation becomes about 4.0 kWh/m^2/day. When comparing this radiation and the lowest radiation at the tilt angle that is the same as the latitude, the difference is within 3%. Therefore, the minimum solar radiation at tilt angle of 15 degrees is adopted as the H_A value for the Study.

As a reference, another JICA Development Study team also assumed that the solar radiation is 4.0kWh/m^2/day for the PV module sizing in their draft final report.

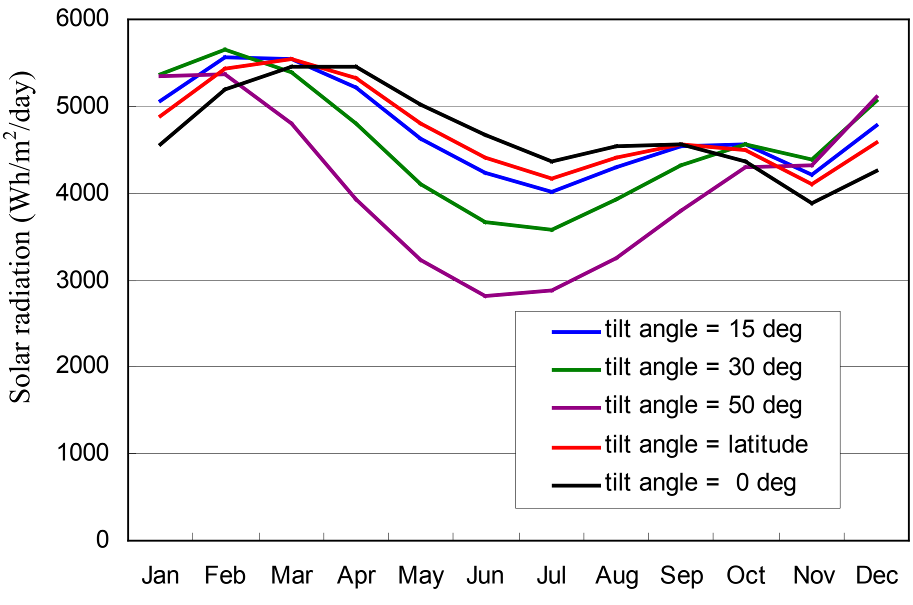


Figure B.4.1 Calibrated Solar Radiation

B.4.2 System Design

B.4.2.1 System Design for SHS

(1) Design parameters

The following parameters are assumed for the design of the solar power system by using the results of the above section and the demand forecast.

Table B.4.1 Assumptions for Design Parameter (SHS)

Parameter	Value	Basis
Inclined solar radiation	4 kWh/m^2/day	Refer to the above section.
System efficiency	60 %	Calculation result based on actual temperature and equipment specifications
Battery voltage	12 V	Availability of batteries in rural areas
Depth of charge	50 %	Performance of batteries in rural areas
Consecutive cloudy days	3 days	Based on the actual solar duration data
Demand of each HH	40 W	Based on result of demand forecast
Daily demand of each HH	120Wh/day	Based on result of demand forecast

(2) System components and cost

Based on the above assumption, a system component is determined to meet household demand in stand-alone generator areas. Cost data is estimated based on the DOE project data and data collected from the website of manufacturers and from hearings with manufacturers. For the charge controller, 10% of duty is considered in the cost estimation. To estimate the total gross project cost of the Barangay Electrification Plan, subsidies from the government and ODA are eliminated in the cost estimation of a PV module.

Table B.4.2 SHS Components

Item	Specification	QTY	Lifetime	Cost (Php)
PV module	50Wp	1	20	19,000
Battery	12VDC, 70Ah	1	3	3,250
Charge controller	12VDC, protection against over charge & discharge	1	10	3,700
DC lamps	20W	2	10	2,260
Frame and accessories		1	20	2,170
Total system cost				30,380

Note: System cost includes VAT (10%), installation cost (3%), transportation cost (3%) and margin (25%).
Exchange rate is set at 1US$=52PHP

(3) Financial analysis

Based on the following assumption, the generation cost and the annual cost are calculated. A battery, charge controller and a DC lamp kit are replaced based on their lifetime during the 20-year life of the system. To impartially evaluate economical features of each power system, common methods such as NPV (NPV: Net Present Value) and CRF (CRF: Cost Recovery Factor) are used to calculate the generation cost and the annual cost.

Table B.4.3 Assumption for Financial Analysis

Parameter	Value	Basis
Discount rate	12%	National Economic Development Authority
Life of system	20years	Based on the lifetime of the PV module
CRF	0.1339	Calculated based on discount rate and lifetime
Inflation ratio	NA	Eliminated to simplify analysis

The following table shows the calculation sheet for financial analysis. In this sheet miscellaneous costs regarding operation and maintenance are set at 1% of the initial cost. Value in the Demand column means the annual demand from each household. NPV factor of each elapsed year can be calculated by the above discount rate. NPV of cost can be calculated by multiplying NPV factor and total cost. Generation cost can be achieved by dividing NPV of cost by NPV of demand.

Table B.4.4 Calculation Sheet for Financial Analysis

Elapsed year	Cost			Demand	NPV		
	Initial	O&M	Total		Factor	Cost	Demand
	(PHP)	(PHP)	(PHP)	(kWh)		(PHP)	(kWh)
0	30,377	0	30,377		1.00	30,377	
1		304	304	43.8	0.89	271	39.1
2		304	304	43.8	0.80	242	34.9
3		304	304	43.8	0.71	216	31.2
4		3,561	3,561	43.8	0.64	2,263	27.8
5		304	304	43.8	0.57	172	24.9
6		304	304	43.8	0.51	154	22.2
7		3,561	3,561	43.8	0.45	1,611	19.8
8		304	304	43.8	0.40	123	17.7
9		304	304	43.8	0.36	110	15.8
10		3,561	3,561	43.8	0.32	1,147	14.1
11		6,272	6,272	43.8	0.29	1,803	12.6
12		304	304	43.8	0.26	78	11.2
13		3,561	3,561	43.8	0.23	816	10.0
14		304	304	43.8	0.20	62	9.0
15		304	304	43.8	0.18	55	8.0
16		3,561	3,561	43.8	0.16	581	7.1
17		304	304	43.8	0.15	44	6.4
18		304	304	43.8	0.13	40	5.7
19		3,561	3,561	43.8	0.12	413	5.1
20		304	304	43.8	0.10	31	4.5
Total	30,377	31,587	61,964	876.0		40,609	327.2

The results of the financial analysis are indicated in the following table. Different assumptions will naturally alter the results. For example, inflation may be taken into account in order to realistically evaluate economical features. To evaluate sensitivity in connection with the inflation ratio and a discount rate, a sensitivity analysis is also conducted.

Table B.4.5 Result of Financial Analysis (SHS)

Index	Formula	Value
System cost	Total cost of SHS	30,380Php
Installation cost	Construction cost / system capacity	607,531Php/kW
Generation cost	NPV of total investment / NPV of total power demand	124Php/kWh
Annual cost	NPV of total investment x CRF	5,437Php/year

Figure B.4.2 shows the generation cost for each discount rate. As the discount rate decreases, the generation cost will also decrease from 124Php/kWh to 74Php/kWh. This indicates that the generation cost of SHS can be decreased according to the economic conditions of the Philippines. As high cost is necessary to install an SHS compared to a fossil power system, the selected discount rate can greatly affect the financial features of SHS.

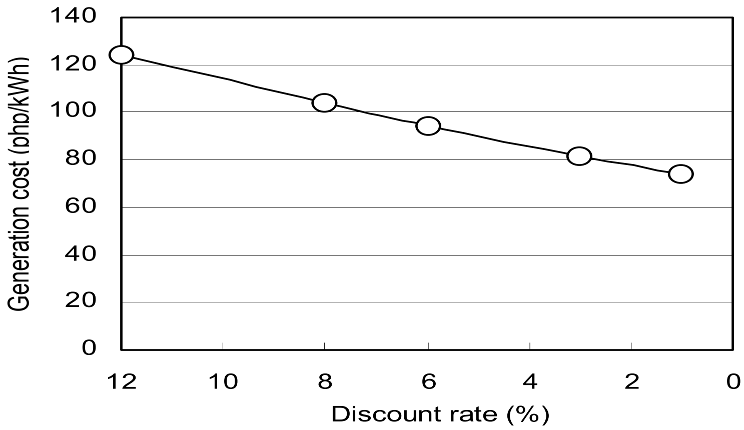


Figure B.4.2 Generation Cost of Each DR

B.4.2.2 System Design for BCS

(1) Design parameter

Most of the parameters for BCS are identical to those of SHS. The following table shows additional parameters required to design BCS. Number of target households is set at 15 households, based on the threshold defined by the comparison of economic features of SHS and POPS (Private Owned Power Sources). The maximum battery capacity is determined based on the availability and the portability of batteries. In the site survey of BCS installed by NPC-SPUG in Busuanga, beneficiaries used small car batteries. Therefore, the maximum battery capacity for BCS is set at 70Ah, which is the maximum capacity of a car battery.

On the other hand, the charging interval is not decided and is treated as a valuable factor, since this variable can be adjusted by the individual households based on their demand preference.

Table B.4.6 Assumption of Design Parameter (BCS)

Parameter	Value	Basis
No. of target HH	15 HH	Economic threshold between SHS and POPS
Maximum battery capacity	70Ah	Availability and portability in rural area

(2) System components and cost

Based on the above assumptions, an example of BCS components is shown in the following table. In this design the charging interval is set at every 3 days. This means that daily power demand for each household becomes 40Wh/day/HH. The cost data are also based on the DOE project data and data obtained from the manufacturers through their websites and direct interviews. Other conditions for cost estimation are the same as SHS.

Table B.4.7 BCS Components

Item	Specifications	QTY	Lifetime	Cost (Php)
PV module	45Wp	6	20	102,790
Battery	12VDC, 70Ah	15	3	48,860
Charge controller	12VDC, protection against over charge & discharge	1	10	18,560
DC lamps	20W	30	10	33,840
Frame and accessories		1	20	10,580
Total system cost				214,630
Total system cost of each HH				14,308

Note: System cost includes VAT (10%), installation cost (3%), transportation cost (3%) and margin (25%).
Exchange rate is set at 1US$=52PHP

(3) Financial analysis

The assumptions and the method used in financial analysis of BCS are the same as those of SHS. Table B.4.8 shows one of the results based on the above system components. To decide appropriate system components for BCS, a detailed social survey should be conducted in the future F/S to identify project site conditions, such as economic conditions, number of target households and the settlement pattern of households.

As mentioned before, a change in power demand can be adjusted by each household by altering their charging intervals. System components also can be changed based on the power demand. The following results show financial features of BCS with various charging intervals.

Table B.4.8 Result of Financial Analysis (BCS)

Index	BCS		SHS
	Every 3rd day	Every 5th day	
Total demand of each HH	40Wh/day/HH	24Wh/day/HH	120Wh/day/HH
System cost	214,624Php	159,259Php	-
System cost of each HH	14,308Php	10,617Php	30,380Php/HH
Installation cost	794,902Php/kW	1,061,725Php/kW	607,531Php/kW
Generation cost	208Php/kWh	283Php/kWh	124Php/kWh
Annual cost	45,444Php/year	37,192Php/year	-
Annual cots of each HH	2,272Php/y/HH	1,860Php/y/HH	5,437Php/y/HH

Generation cost of BCS is higher when compared with SHS, even though system cost and annual cost for each household is lower than those for SHS. Therefore, it seems that BCS is a suitable power sources for barangays where the settlement pattern is high and the income level of beneficiaries is low. In addition, a community-based organization is necessary to operate and maintain BCS and to collect charging fees. SHS seems to be a better option for barangays in which settlement patterns are low and income levels of beneficiaries are relatively high.

Typical characteristics of both systems are summarized in the following table. According to the actual barangay conditions, a combination of SHS and BCS can be considered.

Table B.4.9 Comparison of Typical Characteristics of SHS and BCS

Type	System Characteristic		
	Required initial cost per household	Required annual cost per household	Generation cost
SHS	High	High	Low
BCS	Low	Low	High
Type	Barangay characteristic		
	Settlement pattern	Income level	Organizational condition
SHS	Low density	High	Unnecessary
BCS	High density	Low	Need a community for administration and O&M

B.4.2.3 System Design for PV Hybrid System

(1) Issues for hybrid system

For a PV hybrid system in Palawan it is necessary to evaluate its feasibility from technical and economic points of view, because such a system is not considered as a practical power supply even in the developed countries at this point. From the technical aspect, voltage drops on distribution line should be considered when a hybrid system is connected along the distribution line. In addition, higher harmonic interference and frequency fluctuation can become issues when using a diesel generator.

However, it is unreasonable to connect a hybrid system along the distribution line, even without the technical issues. In addition, considering the fact that a sizable land acquisition is necessary to develop a hybrid system, as well as the fact that existing diesel generators in Palawan are usually located out of the barangay center, a hybrid system should be directly connected to the diesel generator through inverters. Moreover, it is possible to use inverters that address those problems.

Economical issues are much more complicated. Even though the high initial cost is necessary to install hybrid system, the reduction of GHG (GHG: Green House Gas) emission caused by of the reduced fuel consumption of a diesel generator, can be expected.

In the following section, negative impacts in terms of installation cost and positive impacts in terms of environmental issues are compared from the economic aspects.

(2) Assumption for the analysis

For the analysis of a hybrid system, the Study team assumes that a PV system is added to a diesel generator based on the model case in the above section. To evaluate impacts caused by installing a PV system, the PV system is set at a valuable capacity from 0kW to 59kW of the maximum capacity of a diesel generator.

A diesel generator designed based on the model case is shown in Table B.4.10. The following assumption is used to design a PV system added to the diesel generator.

Table B.4.10 Assumption for DG

Item	Assumed value
Demand	59 kW
Annual generation	101,430 kWh
Operation hours	6 hours
Thermal efficiency	30 %
Life time	20 years
Fuel consumption	0.333 litter/kWh
Fuel cost	8.985 Php/kWh
Fuel price	27 Php/litter

Table B.4.11 Assumption for Hybrid System

Item	Assumed Value
PV module capacity	0kW ~ 59kW
Battery capacity	Enough capacity to store power generated in a day
Inverter capacity	Enough capacity to meet AC power demand
Life time of each equipments	Same as SHS and BCS

(3) Financial analysis

Figure B.4.3 shows the production cost and the annual cost per household of a hybrid system. Both of these costs increase in proportion to the capacity increase of an installed PV system. If 59kW capacity of the PV system is added, capital cost increases by about Php 27 million and generation cost also increases from 14 Php/kWh to 48 Php/kWh. The annual fuel reduction caused by the PV capacity is about 17 thousand litters. By using 4 US$/t-CO2 used in the World Bank's Proto type Carbon Fund, its impact can be estimated at about 0.1 Php/kWh, which is negligible. To recover the high initial cost of the PV system, the CO2 price must be more than 1,400 US$/t-CO2, which is unrealistic.

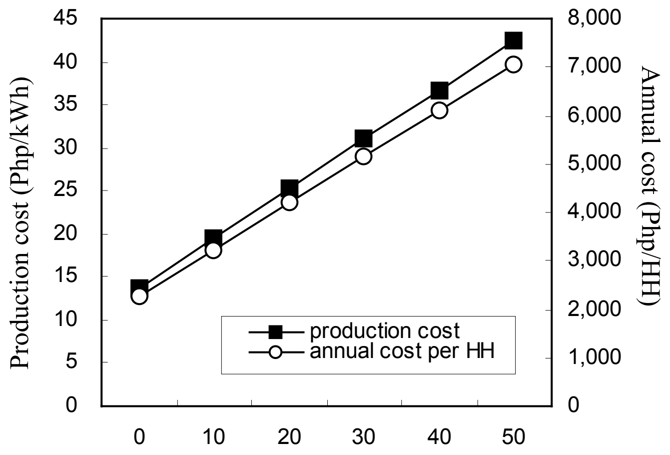


Figure B.4.3 Result of Cost Analysis of Hybrid System

This result means that a hybrid system can't produce enough environmental benefits to compensate for its high initial cost. Even in the environmental scenario, it is obvious that the total required investment for hybrid systems will become unrealistically high. The Study team concludes that a hybrid system is not a reasonable power source for mini-grids, even considering its environmental benefits. Therefore, hybrid system shall not be considered in the barangay electrification planning of this Study.

B.5 Wind Energy Potential Survey

B.5.1 Work Flow

In this section outlines the work flow used in the Study. Considering the uneven distribution of wind energy, actual wind data observed at each candidate site is necessary for making a basic design of the wind power system in the Study.

However, there are significant limitations in terms of the availability and quality of the existing actual wind data, as will be described in detail later. Available existing reports regarding wind energy surveys are not sufficient enough to be utilized for the basic design of the wind power system in the Study. In addition, available ground observation wind data is also insufficient for the basic design of the wind power system. In Palawan Province there are only 3 observation stations and the available actual wind data is not observed every 1 hour.

Thus, it is necessary to formulate the following unusual work flow to fill in the gaps between the available data and the required data. A basic wind system design is examined after selecting candidate barangays and adjusting the wind energy potential by comparing the differences among the available reports and actual wind data.

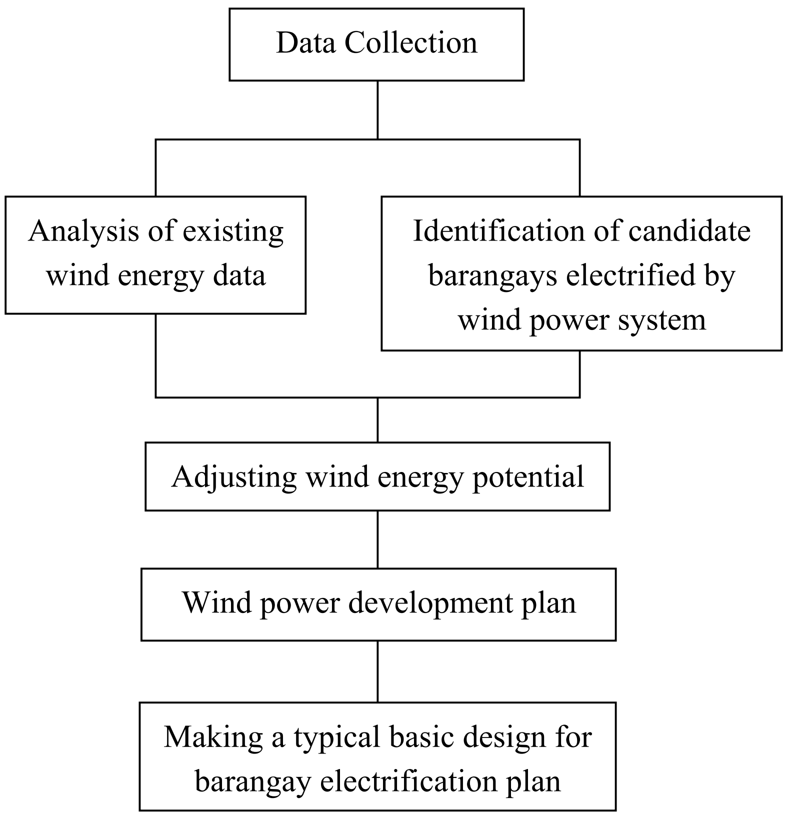


Figure B.5.1 Work Flow for Wind Power Development

B.5.2 Data Collection

B.5.2.1 Existing Report and Data

The Study team collected the following reports and data regarding wind energy potential.

Table B.5.1 Data Archives (Wind)

Category	Editor	Site (LAT, LON, H)	Contents	Data Format	Duration
Report	USAID/NREL	Philippines	Energy Density		
Data	PAGASA	Coron (12+0N, 120+2E, 10m)	Wind Speed	Every 3 hours	1996-2001
			Wind Direction	Monthly	1961-2001
		Cuyo (10+1N, 121+2E, 10m)	Wind Speed	Every 3 hours	2001
			Wind Direction	Monthly	1961-2001
		Puerto Princesa (9+5N, 118+4E, 10m)	Wind Speed	Every 3 hours	2001
			Wind Direction	Monthly	1961-2001
	PAGASA Puerto Princesa	Puerto Princesa (9+5N, 118+4E, 10m)	Wind Speed Wind Direction	Hourly	2002
	NPC-SPUG	Cuyo (10+5N, 121+0E, 20m)	Wind Speed	Hourly	2000
	National Climate Data Center	Coron	Wind Speed	Daily	1994-1999
		Cuyo	Wind Speed	Daily	1994-1999
		Puerto Princesa	Wind Speed	Daily	1994-1999

B.5.2.2 Existing Reports regarding Wind Energy Potential Survey

According to the renewable energy potential survey funded by USAID, the latest meteorological observation data regarding wind power potential and its distribution is arranged in the Geographic Information System (GIS) format. And wind power potential is defined in terms of wind-energy-density value (W/m^2) for each 1km^2 grid cell. This potential data in the report cannot be applied for the detailed examination to analyze whether wind power energy in a specific barangay can be applied for realistic electric power resources or not, such as for the identification of project sites, precise estimation of annual generation of wind power system and verification of financial viability. This is because it is simulated data based on the Weibull Function and cannot completely replicate the actual wind energy conditions.

However, this GIS system is useful for finding potential areas (not sites) and roughly estimating the amount of potential energy. In the following section an outline of this report is introduced to better understand wind energy distribution in each municipality of Palawan. The following maps were created based on the potential map of USAID and the barangay location data provided by PGP.

The following table shows the evaluation index for energy utilization used in the report.

Table B.5.2 Wind Power Classification of USAID Report

Symbol	Utility use	Rural use	Wind energy density at 30m	Wind speed at 30m
			W/m2	m/s
	Marginal	Moderate	100-200	4.4-5.6
	Moderate	Good	200-300	5.6-6.4
	Good	Excellent	300-400	6.4-7.0
	Excellent		400-500	7.0-8.0

In the following section the status of energy potential for each barangay is evaluated by the "rural use" index of this classification.

(1) Agutaya, Magsaysay, Cuyo

- Agutaya

It seems that 6 out of 7 un-electrified barangays can be electrified by wind power systems. All candidate barangays are located in areas with excellent potential.

- Magsaysay

It seems that all un-electrified barangays can be electrified by wind systems. 2 out of 3 candidate barangays are located in areas with excellent potential and the rest are in areas with moderate potential.

- Cuyo

It seems that all un-electrified barangays can be electrified by wind systems. 2 out of 5 candidate barangays are located in areas with excellent potential and the rest are in good potential areas.

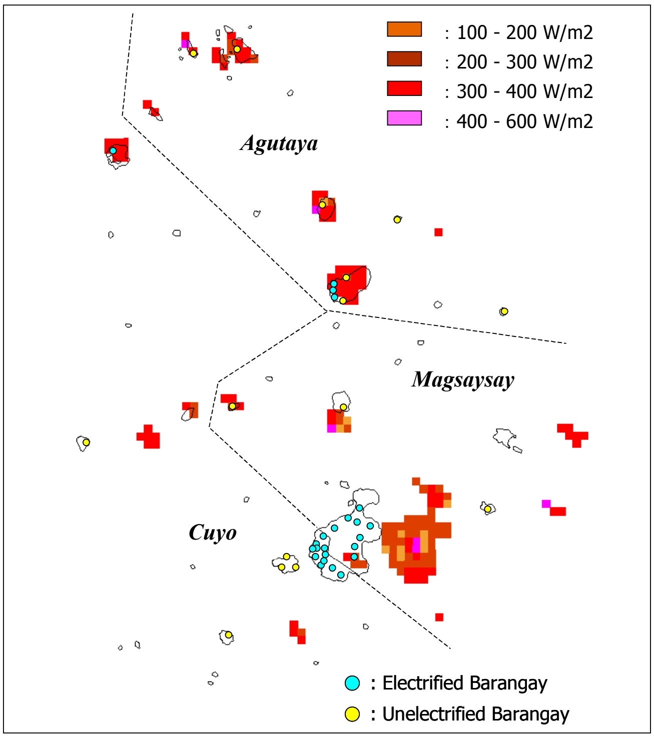


Figure B.5.2 Map of Potential Areas in Agutaya, Magsaysay, Cuyo

(2) Busuanga, Coron, Culion

- Busuanga

It seems that all un-electrified barangays can be electrified by wind systems and are located in areas with moderate potential.

- Coron

It seems that 5 out of 9 un-electrified barangays can be electrified by wind systems. 4 out of 5 candidate barangays are located in areas with moderate potential and the rest are in good potential areas.

- Culion

Location data for the barangay is not available.

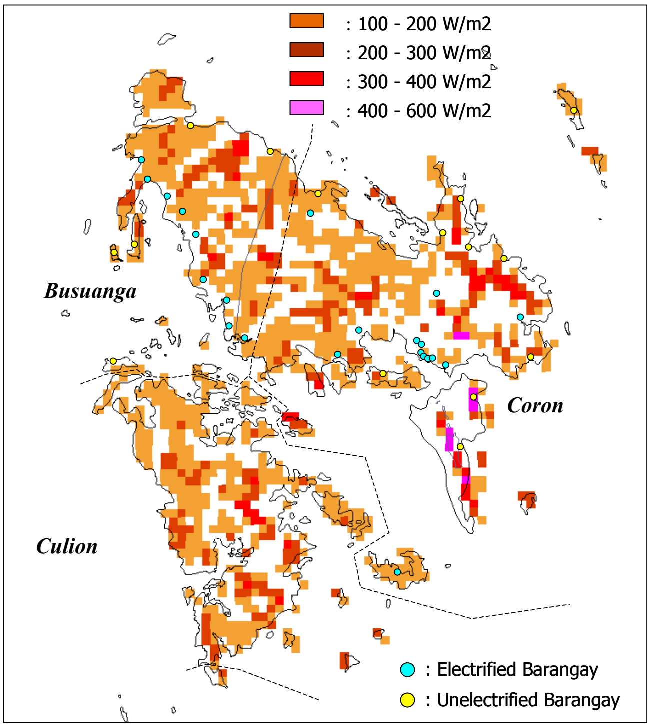


Figure B.5.3 Map of Potential Areas in Busuanga, Coron, Culion

(3) Linapacan, El Nido

- Linapacan

It seems that 6 out of 9 un-electrified barangays can be electrified by wind systems. 5 out of 6 candidate barangays are located in areas with moderate potential and the rest are in areas with excellent potential.

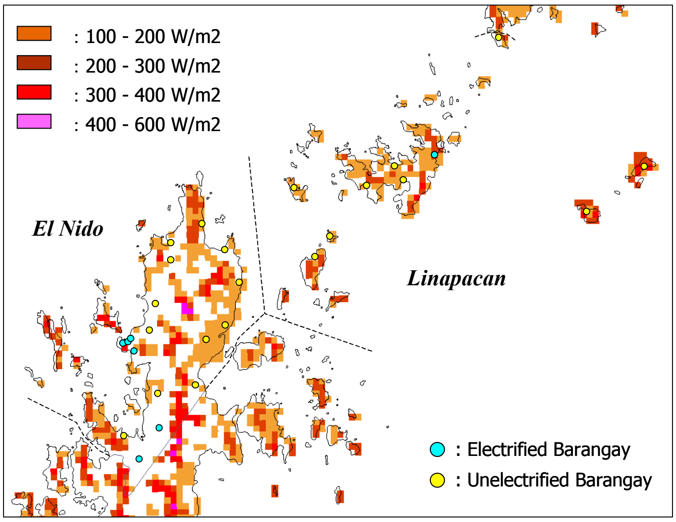


Figure B.5.4 Map of Potential Areas in Linapacan, El Nido

- El Nido

It seems that 4 out of 12 un-electrified barangays can be electrified by wind systems. All candidate barangays are located in areas with moderate potential.

(4) Tay Tay, Araceli, Dumaran

- Tay Tay

It seems that 10 out of 22 un-electrified barangays can be electrified by wind systems. 8 out of 10 candidate barangays are located in areas with moderate potential and the rest are in the good potential areas.

- Araceli

It seems that all un-electrified barangays can be electrified by wind systems. 8 out of 10 candidate barangays are located in areas with moderate potential and the rest are in the good potential areas.

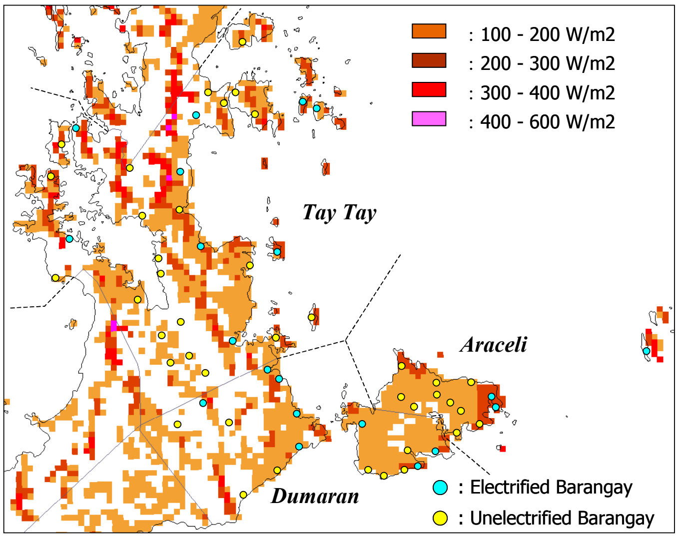


Figure B.5.5 Map of Potential Areas in Tay Tay, Araceli, Dumaran

- Dumaran

It seems that 5 out of 8 un-electrified barangays can be electrified by wind systems. 4 out of 5 candidate barangays are located in areas with moderate potential and the rest are in the good potential areas.

(5) San Vicente, Roxas

- San Vicente

It seems that un-electrified barangays cannot be electrified by wind systems.

- Roxas

It seems that 6 out of 23 un-electrified barangays can be electrified by wind systems. All candidate barangays are located in areas with moderate potential.

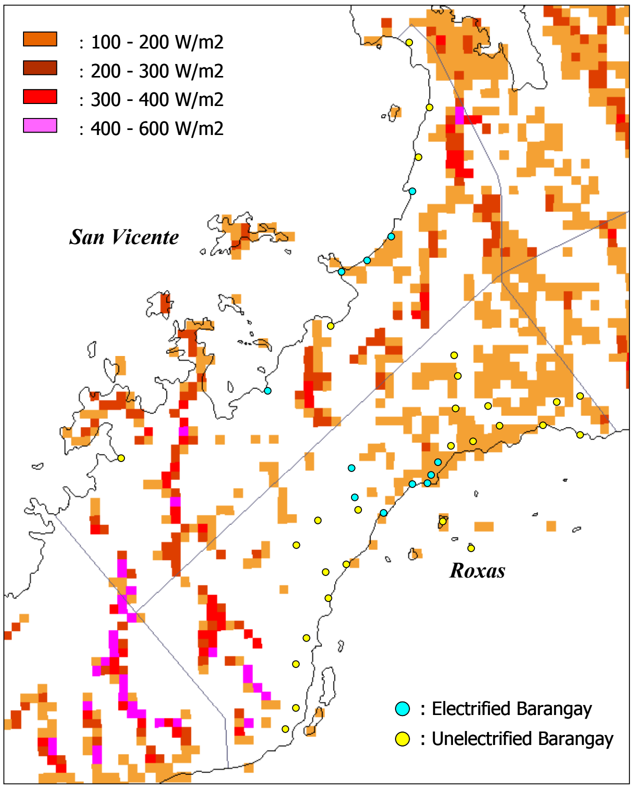


Figure B.5.6 Map of Potential Areas in San Vicente, Roxas

(6) Puerto Princesa

It seems that 5 out of 21 un-electrified barangays can be electrified by wind systems. All candidate barangays are located in areas with moderate potential.

(7) Aborlan, Narra, Quezon, Espanola

- Aborlan

It seems that un-electrified barangays cannot be electrified by wind system.

- Narra

It seems that 1 out of 3 un-electrified barangays can be electrified by wind systems. The candidate barangay is located in an area with moderate potential.

- Quezon

It seems that un-electrified barangays cannot be electrified by wind systems.

- Espanola

It seems that un-electrified barangays cannot be electrified by wind systems.

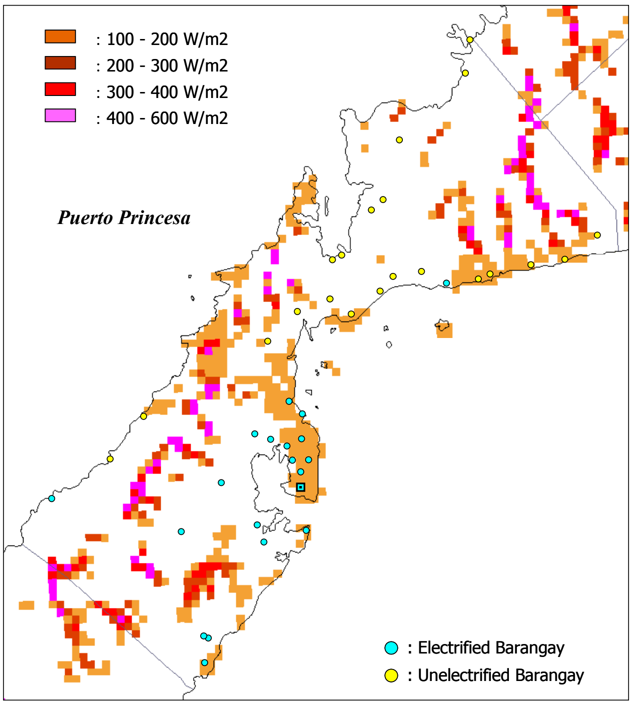


Figure B.5.7 Map of Potential Areas in Puerto Princesa

(8) Brooke's Point, Rizal, Bataraza

- Brooke's Point

It seems that un-electrified barangays cannot be electrified by wind systems.

- Rizal

It seems that 2 out of 9 un-electrified barangays can be electrified by wind systems. All candidate barangays are located in areas with moderate potential.

- Bataraza

It seems that 10 out of 20 un-electrified barangays can be electrified by wind systems. 9 out of 10 candidate barangays are located in areas with moderate potential and the rest are in the good potential areas.

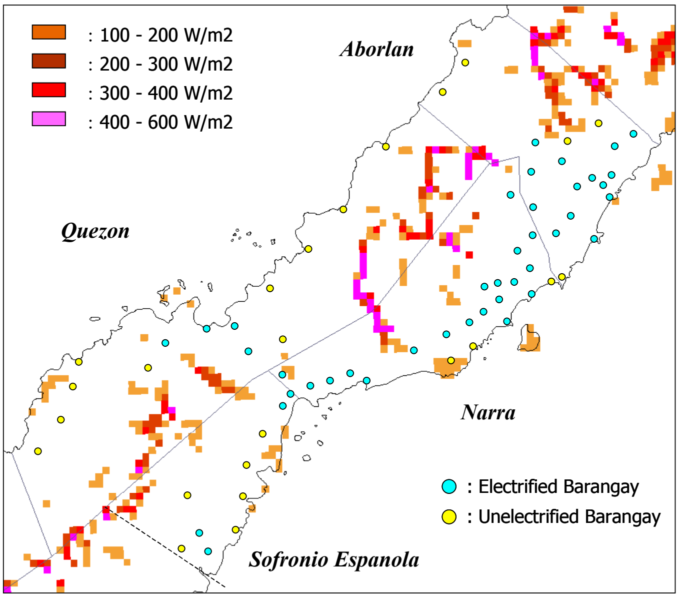


Figure B.5.8 Map of Potential Areas in Aborlan, Narra, Quezon, Espanola

(9) Balabac

It seems that 12 out of 14 un-electrified barangays can be electrified by wind systems. 11 out of 12 candidate barangays are located in areas with moderate potential and the rest are in the good potential areas.

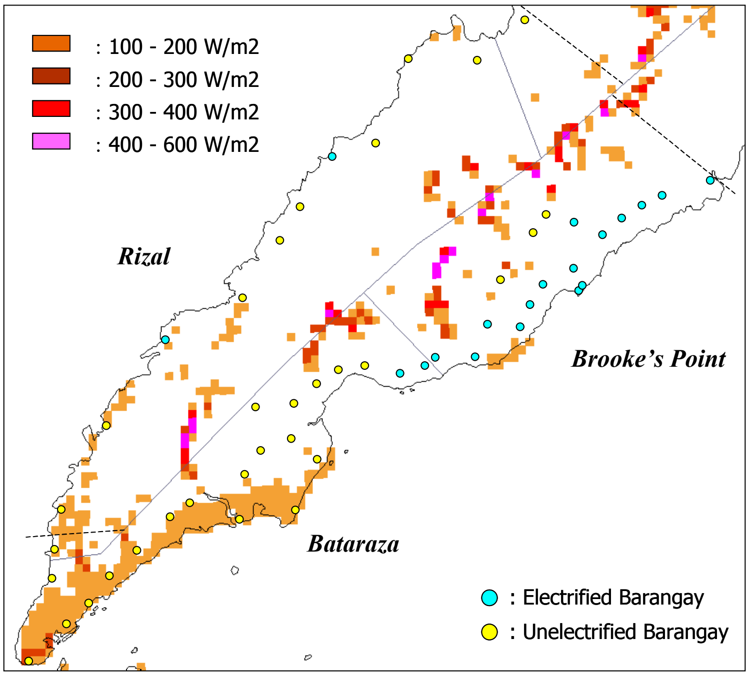


Figure B.5.9 Map of Potential Areas in Aborlan, Narra, Quezon, Espanola

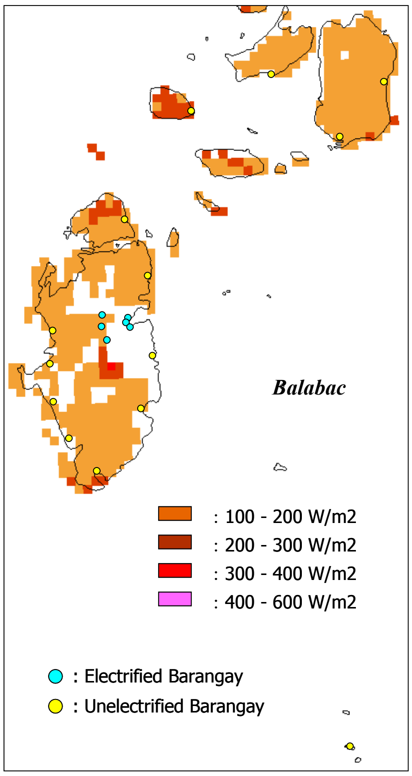


Figure B.5.10 Map of Potential Areas in Balabac

B.5.2.3 Existing Ground Observation Data

Regarding the ground observation data, there are serious limitations in terms of the availability and quality of data. In Palawan, for example, there are only 3 observation stations operated by PAGASA, which are in Puerto Princesa, Cuyo and Coron. Each station observes wind speed / direction every 3 hours, and the available data is quite limited because the PAGASA head office is now processing hourly wind data. NPC-SPUG (NPC-SPUG: National Power Corporation – Small Power Utility Group) also observed wind data every 1 hour for almost 1 year in Cuyo. But they suspended observations due to low wind energy potential at the site.

Results of the USAID wind energy survey indicate that Palawan Province is identified as a relatively higher wind potential area than other regions in the Philippines. Based on the actual data of 3 stations in Palawan, however, it is seems that there are area in Palawan for which the potential is not so high, as will be described in more detail. This difference stems from not only the difference of base data but also the features of wind energy potential, which is unevenly distributed energy between individual sites.

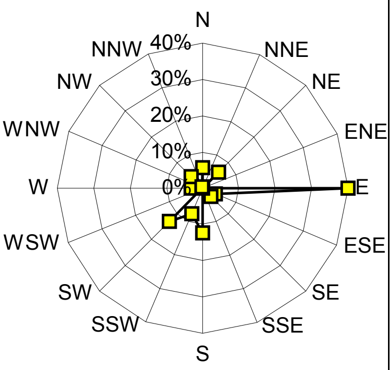
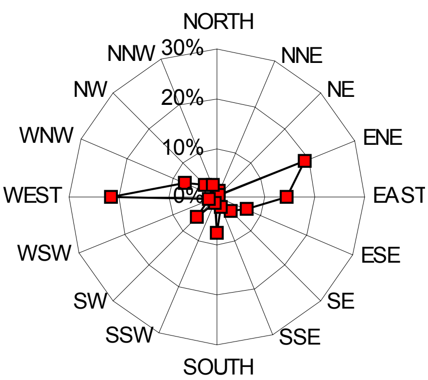
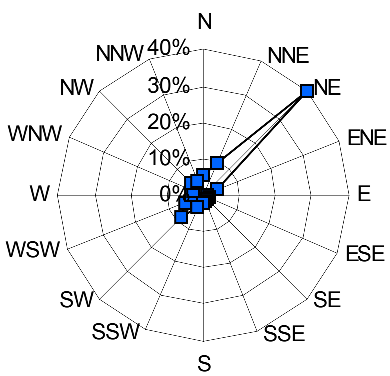
B.5.3 Analysis of Existing Ground Observation Data

B.5.3.1 Wind Direction

Hourly wind data observed in a year by PAGASA, PAGASA Puerto Princesa and NPC-SPUG is analyzed to understand features of wind direction at each site. Wind direction at each observation stations is summarized in Table B.5.3.

When designing the layout of a wind turbine at a specific site, special consideration must be given to the primary wind direction to prevent reduction of generation efficiency caused by the wake influence. Results of this analysis will give useful information for the future F/S.

Table B.5.3 Summary of Wind Direction

<table>
<tr><th>Coron</th><th>Puerto Princesa</th><th>Cuyo</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Primary Direction: EAST</td><td>Primary Direction: WEST</td><td>Primary Direction: NE</td></tr>
<tr><td>Source: PAGASA 2001</td><td>Source: PAGASA-PP 2002</td><td>Source: NPC-SPUG 2000</td></tr>
</table>

B.5.3.2 Wind Direction by Month

(1) Coron

The following figure shows monthly transition of wind directions in Coron. According to these figures, the primary direction is east from October to May, and southwest from June to September. Moreover, as described below, wind speed from December to April is above the annual average wind speed. Therefore, in the case of an examination of a large-scale wind farm, each wind turbine should be separated by the distance of ten times the wind turbine diameter in the east-west direction.

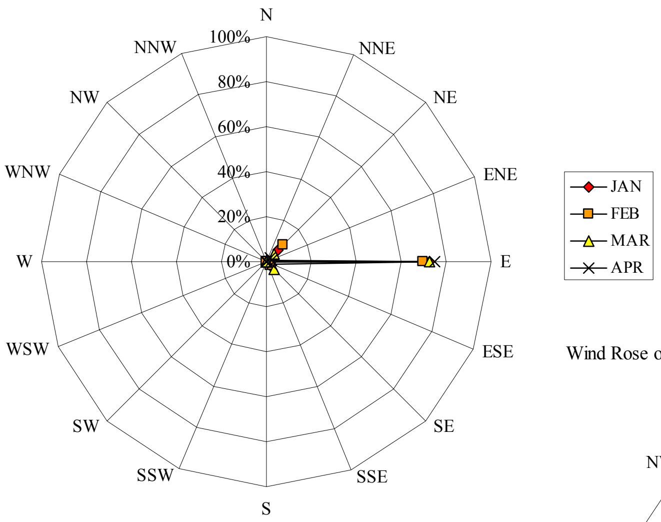


Figure B.5.11 Wind Increase from Jan. to Apr. in Coron

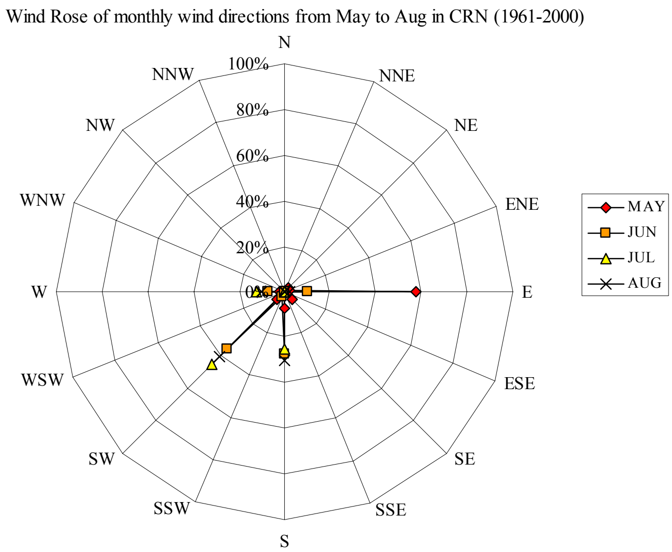
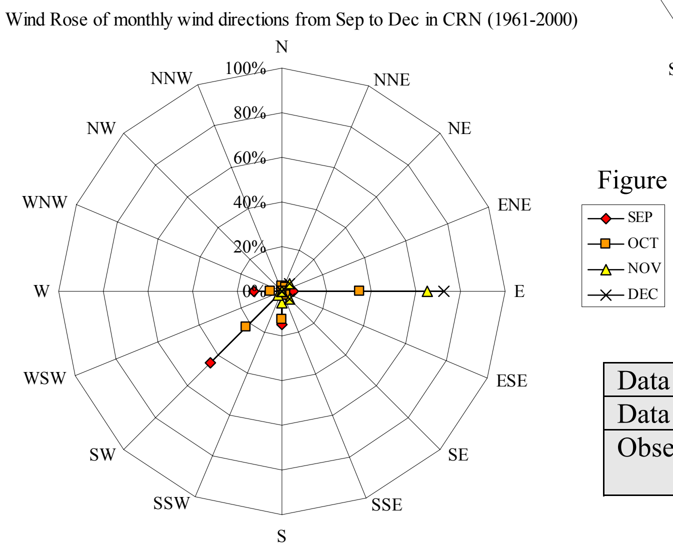


Figure B.5.12 Wind Increase from May to Aug. in Coron



Data Source	PAGASA
Data Format	Monthly
Observation year	1961-1975, 1978-1982, 1984, 1986-1993, 1995, 1997-2000

Figure B.5.13 Wind Increase from Sep. to Dec. in Coron

(2) Puerto Princesa

The following figures show monthly transition of wind directions in Puerto Princesa. According to these figures, the primary direction is east and northeast from December to April, and south and west from June to October. In May and November there is no primary direction. Moreover, as described below, wind speed from December to April is above the annual average wind speed. Therefore, in the case of an examination of a large-scale wind farm, each wind turbine should be separated by the distance of ten times the wind turbine diameter in the east-west direction.

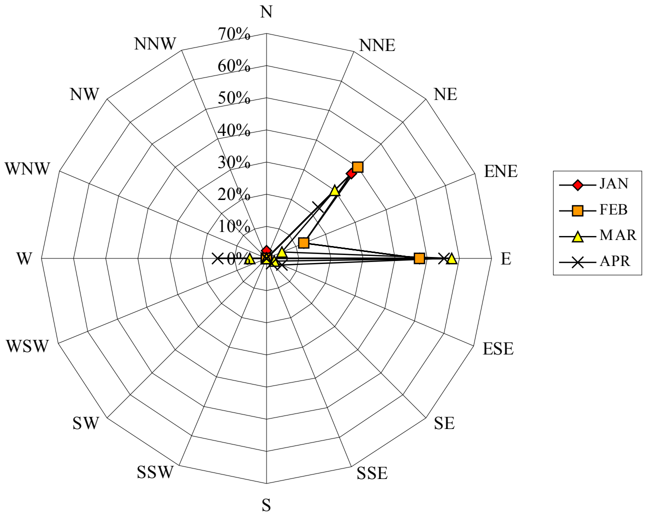


Figure B.5.14　Wind Increase from Jan. to Apr. in PP

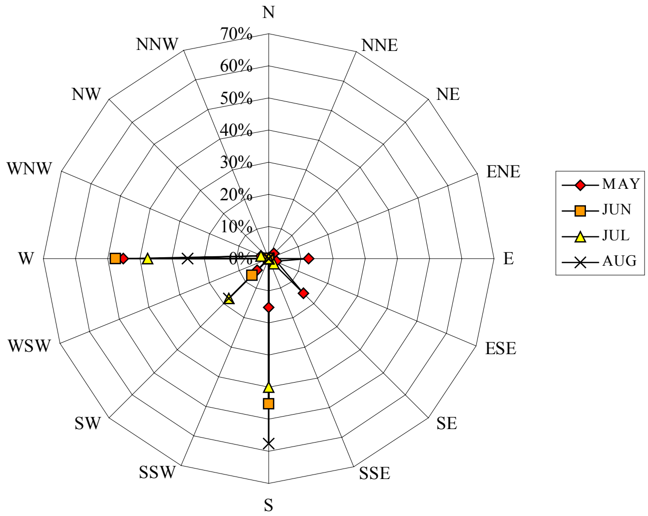


Figure B.5.15　Wind Increase from May to Aug. in PP

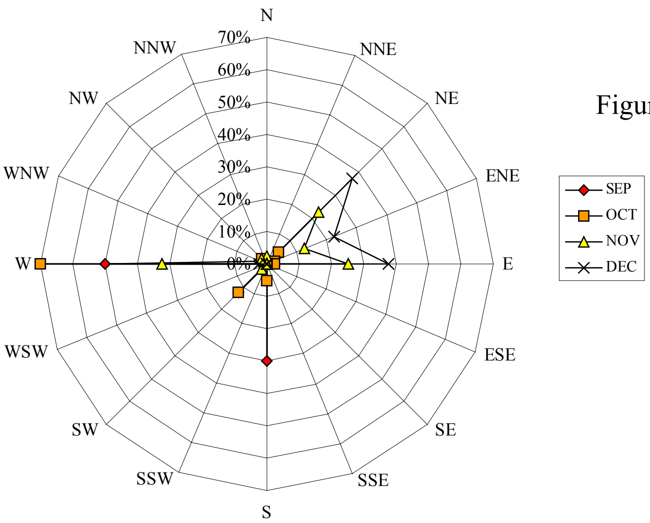


Figure B.5.16　Wind Increase from Sep. to Dec. in PP

Data Source	PAGASA
Data Format	Monthly
Observation year	1962-2001

(3) Cuyo

The following figures show monthly transition of wind directions in Cuyo. According to these figures, the primary direction is northeast from October to May, and southwest from June to September. Moreover, as described below, wind speed from October to April is higher than that of the other months. Therefore, in the case of an examination of a large-scale wind farm, each wind turbine should be separated by the distance of ten times the wind turbine diameter in the northeast-southwest direction.

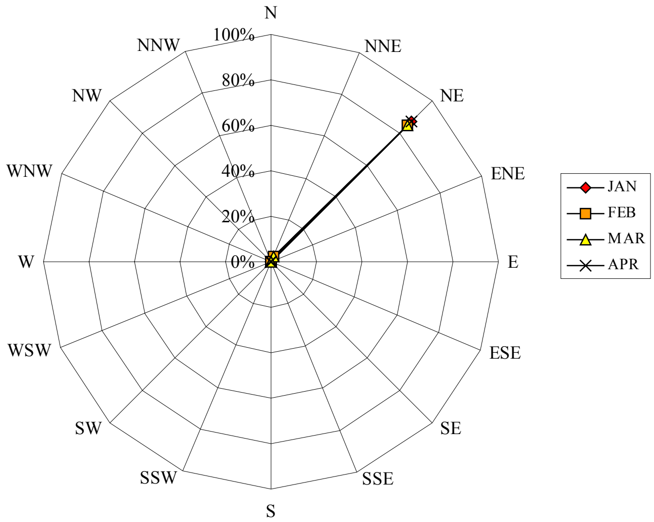


Figure B.5.17 Wind Increase from Jan. to Apr. in Cuyo

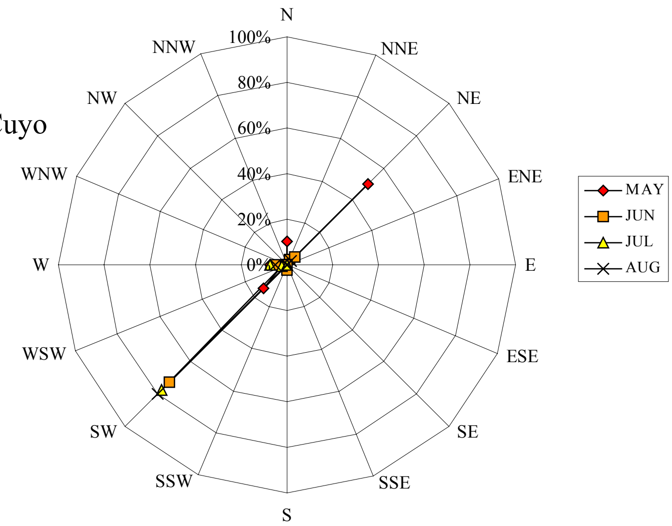


Figure B.5.18 Wind Increase from May to Aug. in Cuyo

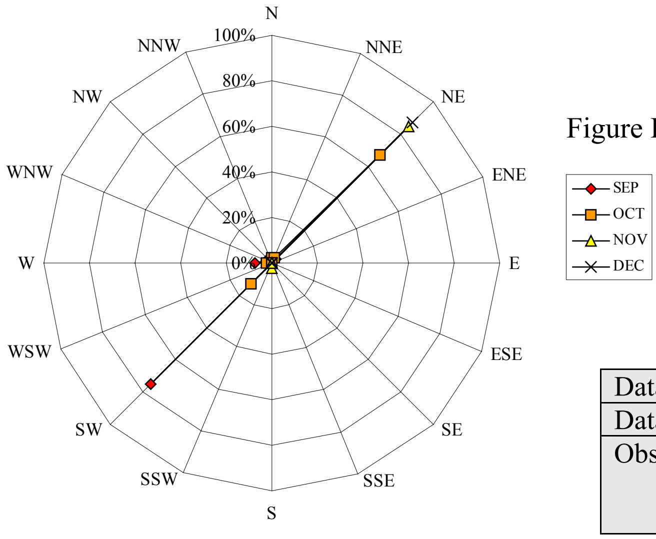


Figure B.5.19 Wind Increase from Sep. to Dec. in Cuyo

Data Source	PAGASA
Data Format	Monthly
Observation year	1961-1974, 1976-1979, 1981-1986, 1988-1989, 1992-2001

B.5.3.3 Wind Speed Distribution

This section summarizes the distribution of wind speed in Coron, Puerto Princesa and Cuyo based on the hourly wind speed data collected from PAGASA and NPC-SPUG.

(1) Coron

No. of records	2,911
Height of anemometer	10m
AV. Speed	1.802 m/s
Source	PAGASA 1998
Data format	Integer
Observation frequency	every 3hours

There are several issues, as listed below, involved in applying this data to the analysis.

- Average wind speed is too slow for wind power system.
- Distribution of calibrated data tends to be slanted due to the integer data format.
  Ex) there is no value in calibrated data of the 30m in 3m/s wind speed class.
- Frequency in the 0m/s wind speed class is largest. There is the high possibility that 0m/s data includes missing data.

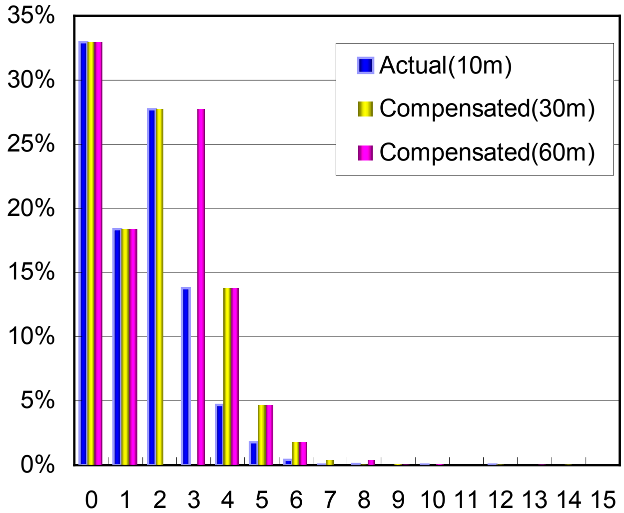


Figure B.5.20 Wind Speed Distribution in Coron

(2) Puerto Princesa

No. of records	5,922
Height of anemometer	10m
AV. Speed	3.010 m/s
Source	PGS-PP 2002
Data format	Integer
Observation frequency	every 1hour

There are several issues, as listed below, involved in applying this data to the analysis.

- Distribution of calibrated data tends to be slanted due to the integer data format.

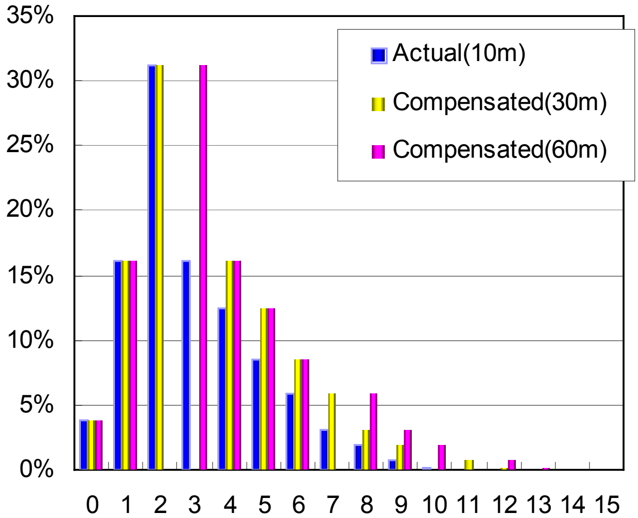


Figure B.5.21 Wind Speed Distribution in PP

(3) Cuyo

No. of records	7333
Height of anemometer	20m
AV. Speed	3.42 m/s
Source	SPUG 2000
Data format	Decimal
Observation frequency	every 1hours

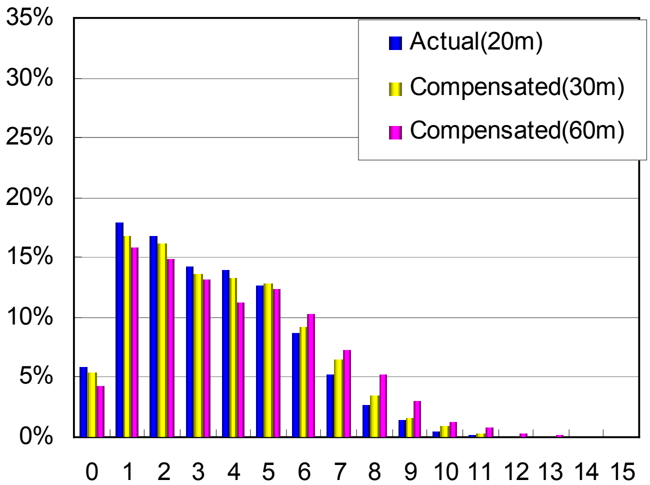


Figure B.5.22 Wind Speed Distribution in Cuyo

(4) Estimated data

It is commonly known that the distribution of wind speed can be approached by using the Weibull distribution function. By using this function, the distribution of wind speed at a 20m-hub height is estimated as follows. To compare with the actual data, wind data in Cuyo, where the amount of data is enough to evaluate, is used for this estimation.

In comparison with the actual data, estimated data cannot completely replicate actual wind distribution.

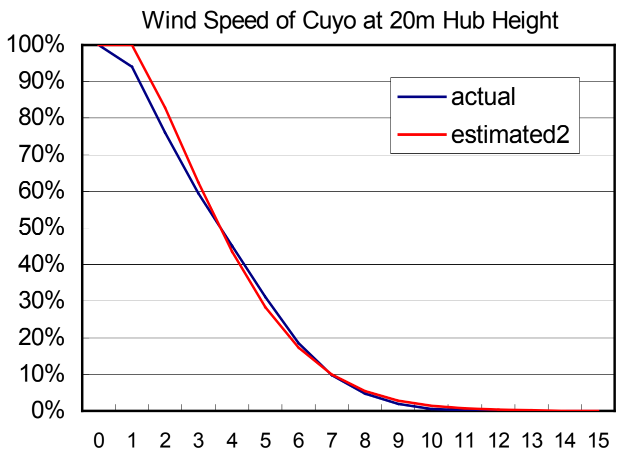


Figure B.5.23 Cumulative Distribution of Estimated Wind Speed in Cuyo

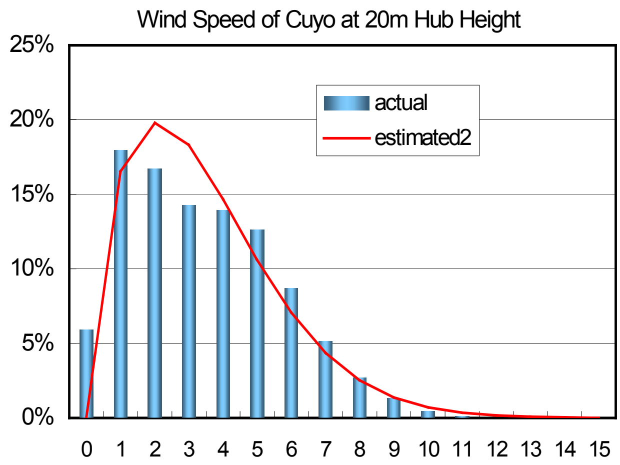


Figure B.5.24 Distribution of Estimated Wind Speed in Cuyo

B.5.3.4 Wind Speed Distribution by Month

This section summarizes the annual transition of wind speed based on monthly wind speed data collected from PAGASA.

(1) Coron

Figure B.5.25 shows the transition of monthly wind speed in Coron. This figure is made from the same data sources as in the examination of wind direction by month.

According to this figure, wind speed from December to April is above the average wind speed by 1.6 m/s. In other words, wind speed is relatively low during the rainy season. As mentioned above, the annual average wind speed in Coron is too slow for the development of a wind power system.

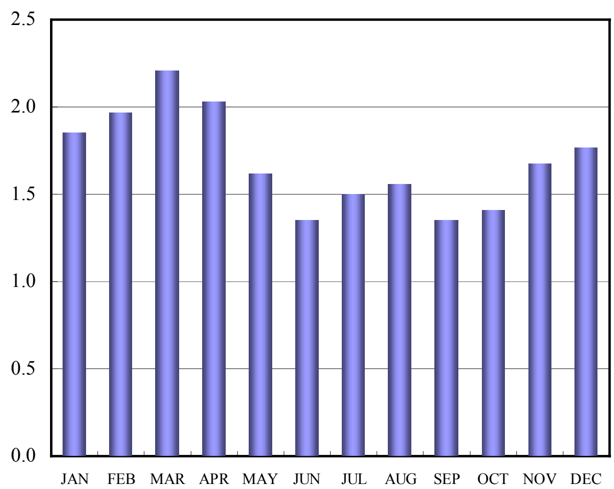


Figure B.5.25 Monthly Wind Speed in Coron

(2) Puerto Princesa

Figure B.5.26 shows transition of the monthly wind speed in Puerto Princesa. According to this figure, the wind speed from December to March is 1.9 m/s above the average wind speed. The wind speed in Puerto Princesa is also relatively slow during the rainy season.

(3) Cuyo

Figure B.5.27 shows transition of the monthly wind speed in Cuyo. According to this figure, the wind speed from November to March is 4.1 m/s above the average wind speed. Wind speed in Cuyo is also relatively slow during the rainy season.

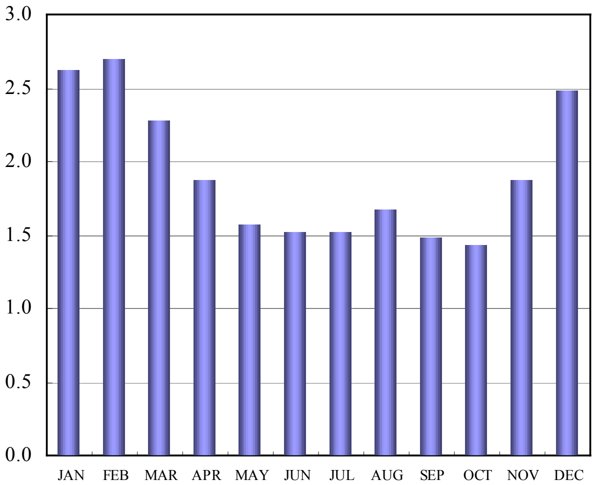


Figure B.5.26 Monthly Wind Speed in PP

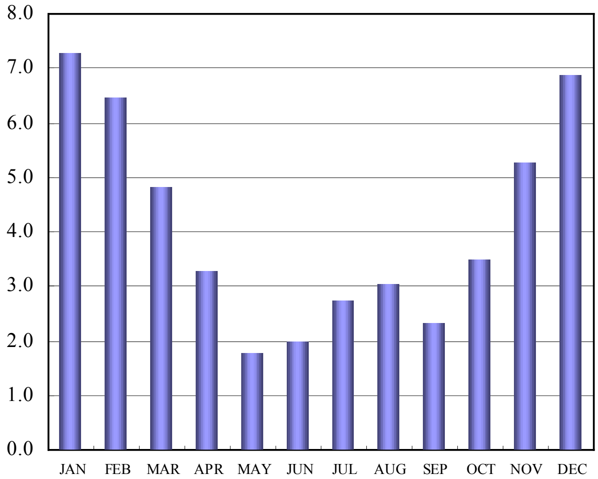


Figure B.5.27 Monthly Wind Speed in Cuyo

B.5.4 Adjusting Wind Energy Potential

B.5.4.1 Adjusting Candidate Barangays

(1) Comparisons between simulation data and actual data

- Coron

Based on the USAID report, Coron is classified into the moderate potential area for rural utilization, even though the observation data analysis shows the opposite result as follows.

Table B.5.4 Comparison of Wind Speed in Coron

Data	Observation Period	Data Format	Annual Avg. Wind Speed at Anemometer Height	Annual Avg. Wind Speed at 30m Height
PAGASA	1961-2001	Monthly	1 ~ 3 m/s	1 ~ 3 m/s
	1996-2001	3 hours	1.1 ~ 1.8 m/s	1.3 ~ 2.1 m/s
NCDC	1994-1999	Daily	1.30 ~ 1.79 m/s	1.52 ~ 1.89 m/s
USAID	-	-	-	4.4 ~ 5.6 m/s

- Puerto Princesa

Based on the USAID report, Puerto Princesa is classified into the moderate potential area for rural utilization, even though the observation data analysis shows the opposite result as follows.

Table B.5.5 Comparison of Wind Speed in Puerto Princesa

Data	Observation Period	Data Format	Annual Avg. Wind Speed at Anemometer Height	Annual Avg. Wind Speed at 30m Height
PAGASA	1961-2001	Monthly	1 ~ 3 m/s	1 ~ 3 m/s
	2001	3 hours	2.6 m/s	3.1 m/s
PGS – PP*	2002	Hourly	3.0 m/s	3.5 m/s
NCDC	1994-1999	Daily	2.00 ~ 2.47 m/s	2.34 ~ 2.89 m/s
USAID	-	-	-	4.4 ~ 5.6 m/s

* PGS-PP: PAGASA-Puerto Princesa

- Cuyo

Based on the USAID report, Cuyo is classified into the good potential area for rural utilization, even though the observation data analysis shows the opposite result as follows. To solve this contradiction, the observation data is adjusted to the same average wind speed of the USAID report in the following section.

Table B.5.6 Comparison of Wind Speed in Cuyo

Data	Observation Period	Data Format	Annual Avg. Wind Speed at Anemometer Height	Annual Avg. Wind Speed at 30m Height
PAGASA	1961-2001	Monthly	2 ~ 6 m/s	2 ~ 7 m/s
	2001	3 hours	1.6 m/s	1.9 m/s
NPC-SPUG	2000	Hourly	3.42 m/s	3.62 m/s
NCDC	1994-1999	Daily	1.36 ~ 2.18 m/s	1.60 ~ 2.55 m/s
USAID	-	-	-	5.6 ~ 6.4 m/s

According to Figure B.5.28 based on the monthly PAGASA data, only the average wind speed in 1962, 1963, 1964, 1972 and 1976 match the USAID classification. In other words, in spite of the long observation period of 40 years, the average wind speed does not match this classification during most years.

NPC-SPUG data, which was observed to confirm whether or not the wind potential of Cuyo is worth developing, also does not match this classification.

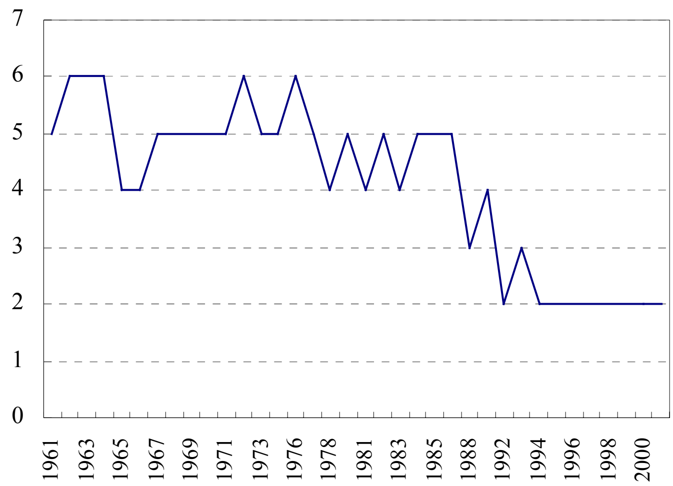


Figure B.5.28 Annual Average Wind Speed based on monthly PAGASA data in Cuyo

(2) Adjusting Candidate Barangays

As mentioned above, the results of the observation data analysis is quite different from those in the USAID report. This does not mean that data in the USAID report does not reflect actual wind energy conditions. If the observation station is placed at a distance a little further away, the ground observation wind speed will match the USAID classification because of the uneven distribution of wind energy resources. In this study, therefore, the USAID report will be applied for finding potential barangays, because this report provides only information on spatial distribution of wind energy resources.

On the other hand, to formulate a realistic master plan we should avoid making a master plan to develop wind power systems in the areas with uncertainty regarding wind energy potential. In the USAID report a moderate wind speed for rural utilization is over 4.4 m/s. It seems that wind speed of over 4.4 m/s can be steadily obtained in the areas with excellent potential classified in this report. By using this criterion, candidate barangays that can be electrified by wind power system are selected as follows.

Table B.5.7 Candidate Barangays for Wind Power Development

No.	Municipality	Candidate Un-electrified Barangay	No. of Households in 2000 Census	Project Schedule in DDP & Fund
1	Agutaya	Villa Fria	119	2003 (KEPCO)
2	Agutaya	Villa Sol	179	2003 (KEPCO)
3	Agutaya	Maracanao	34	2006 (No Fund)
4	Agutaya	Diit	257	2006 (No Fund)
5	Agutaya	Algeciras	694	2005 (No Fund)
6	Agutaya	Conception	505	2006 (No Fund)
7	Magsaysay	Alcoba	69	2006 (No Fund)
8	Magsaysay	Cocoro	166	2006 (No Fund)
9	Cuyo	Lubid	153	2006 (POPS)
10	Cuyo	Caponayan	207	2006 (POPS)
11	Linapacan	Nangalao	214	No Plan

B.5.4.2 Adjusting Wind Speed

(1) Procedure for Adjustment

Based on the above examination almost all candidate barangays are located on the eastern islands and the wind data for Cuyo is sufficient for examination in terms of amount and quality. Therefore, wind data observed at NPC-SPUG station in Cuyo is used for the adjustment of wind speed.

The average wind speed calibrated at the height of 120m is about 4.4m/s and this wind speed is matched with wind speed in the moderate potential classification of the USAID report. Therefore, the Study team assumed that the wind speed distribution in the excellent potential area at the height of 20m, which is the same as height of the anemometer at the NPC-SPUG station, is that of NPC-SPUG calibrated for the height of 120m.

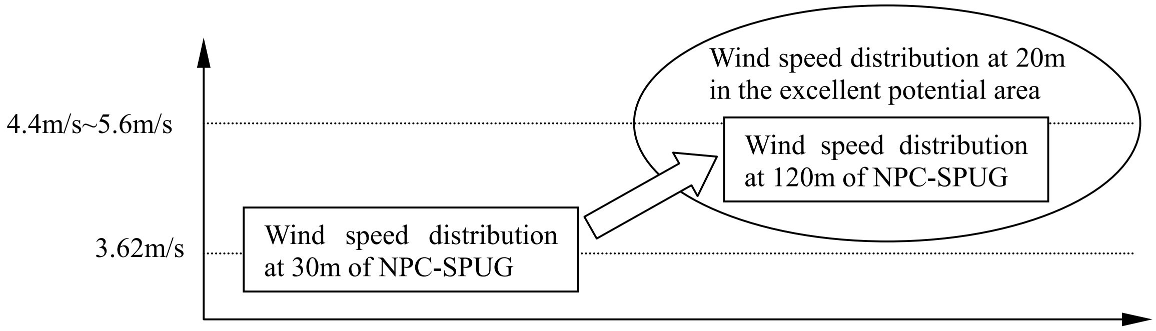


Figure B.5.29 Image of Wind Data Adjustment

(2) Result of Adjustment

The adjusted wind speed distribution for the excellent potential area at the height of 20m is shown in Figure B.5.30. As mentioned before, this distribution is estimated based on distribution of NPC-SPUG calibrated at the height of 120m. Adjusted wind speed distribution of each hub height for the excellent potential area is also shown in Figure B.5.31. Wind power systems will be designed in the following section based on this distribution.

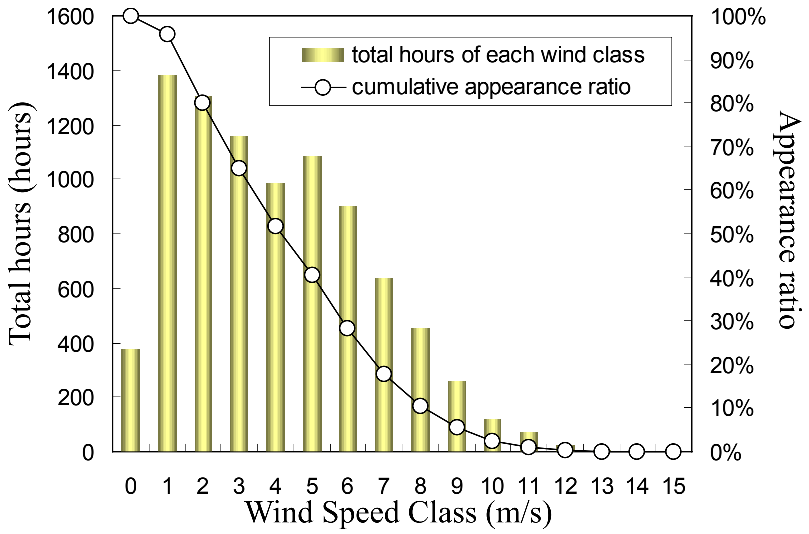
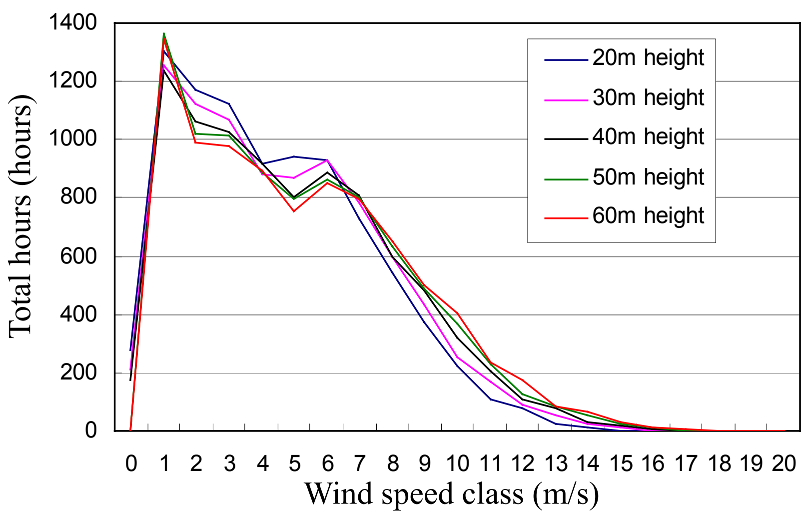


Figure B.5.30 Wind Speed Distribution (at the height of 20m)



Height	Avg. Speed
20m	4.41 m/s
30m	4.68 m/s
40m	4.87 m/s
50m	5.03 m/s
60m	5.17 m/s

Figure B.5.31 Wind Speed Distribution at each Hub Height

B.6 Wind Energy Development Plan

B.6.1 Power Curve

To calculate the amount of generation from the wind power system we must know the wind turbine power curve, as well as the wind speed distribution. In the Study the power curves of the following wind turbines were obtained.

Table B.6.1 Wind Turbine List

Capacity class	Number	No. of Manufacturers
1MW > X	19 units	3 (Germany), 3 (Denmark), 1 (Netherlands), 1 (Japan)
1MW>X>100kW	16 units	3 (Germany), 3 (Denmark), 1 (Netherlands)
100kW > X	10 units	2 (USA), 1 (Australia), 1 (Germany)

The power generation of these wind turbines can be estimated by using the calculation worksheets submitted to PGP. This data can be useful when considering future analysis for wind farms. However, wind turbines above 100kW are too large for rural electrification in the Barangay Electrification Plan for Palawan Province. Therefore, under 100kW wind turbines are mainly examined from the following sections.

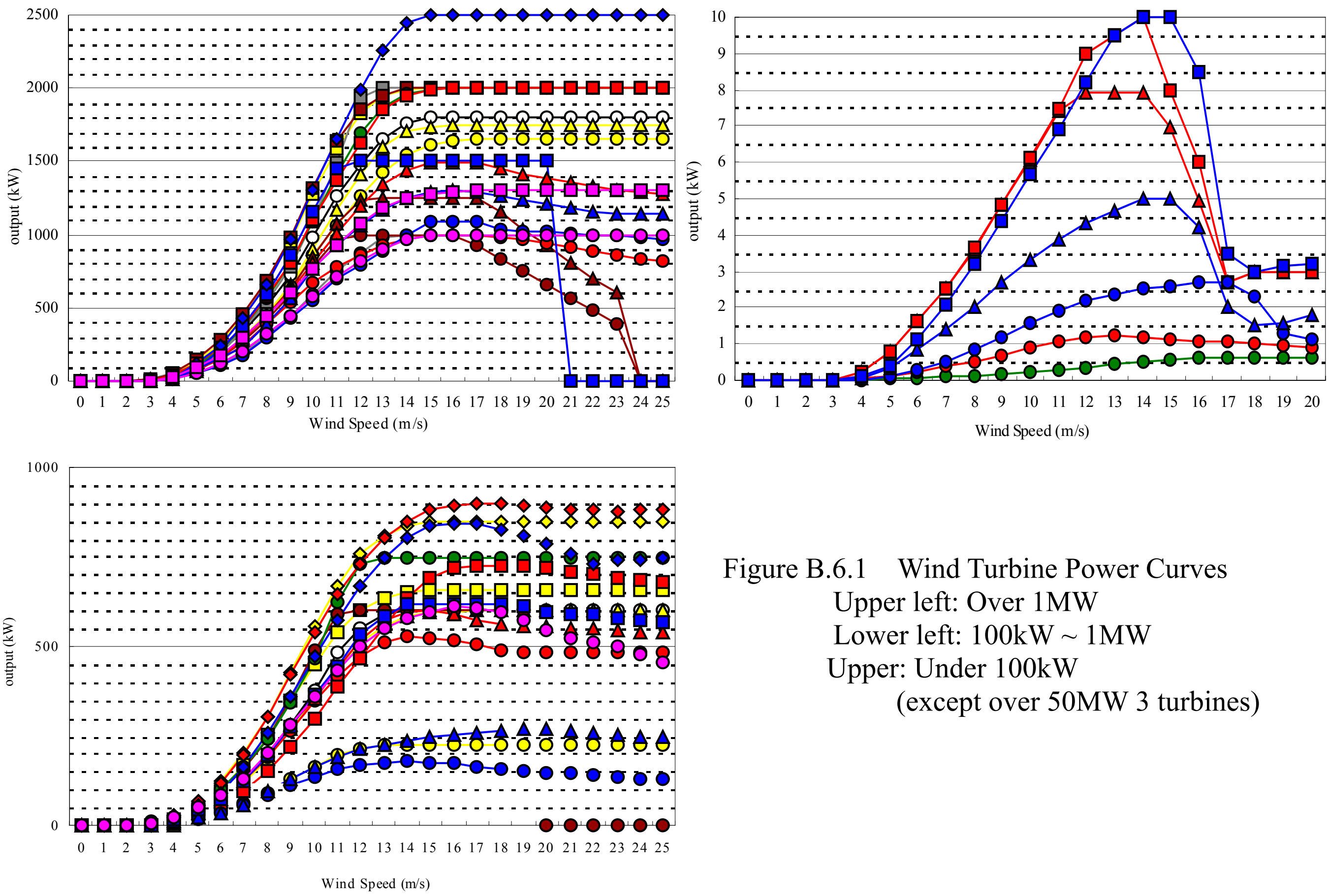


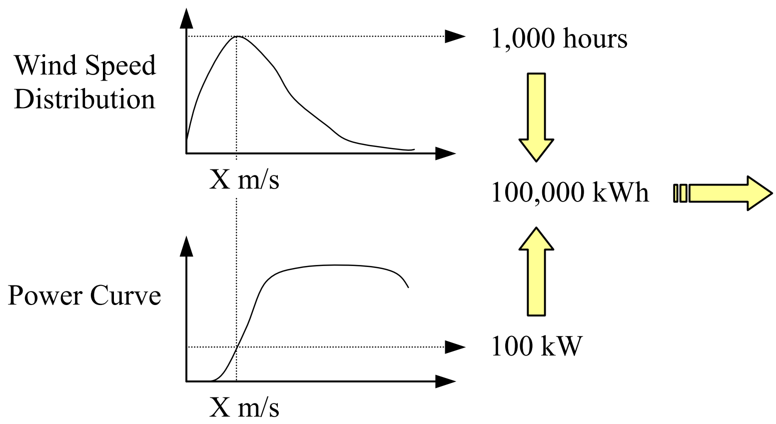
Figure B.6.1 Wind Turbine Power Curves
Upper left: Over 1MW
Lower left: 100kW ~ 1MW
Upper: Under 100kW
(except over 50MW 3 turbines)

B.6.2 Estimation of Available Power Generation

B.6.2.1 Calculation Method

The following method is the established method for estimating the available annual power generation for each wind turbine.

i) Estimation of wind speed distribution
ii) Collection of power curve for each wind turbine
iii) Estimation of power generation for each wind speed class by multiplying the total hours in wind speed distribution by output in the power curve
iv) Estimation of the available annual power generation by building up power generation of each wind speed class



Wind Speed Class	Power Generation
0 m/s	0 kWh
1 m/s	0 kWh
2 m/s	xxx kWh
X m/s	100,000 kWh
25 m/s	yyy kWh
Total	**zz,zzz,zzz kWh**

Figure B.6.2 Image of Calculation Method

B.6.2.2 Estimation Results

As mentioned before, 43 units including wind turbines over 100kW are examined in this section. The wind speed distribution at the height of 60m is applied for calculation of power generation for wind turbines over 100kW and wind speed distribution at the height of 30m is applied for wind turbines under 100kW.

Although over 100kW turbines are too large as the power sources for un-electrified barangays, the estimation results for these turbines were added to this section.

(1) Wind turbines over 1MW

Based on the following table the plant factor for No. 7 and No. 16 is over 20% and the plant factor for all turbines is more than 15%. The plant factor does not definitely correlate with the rated capacity and the annual power generation.

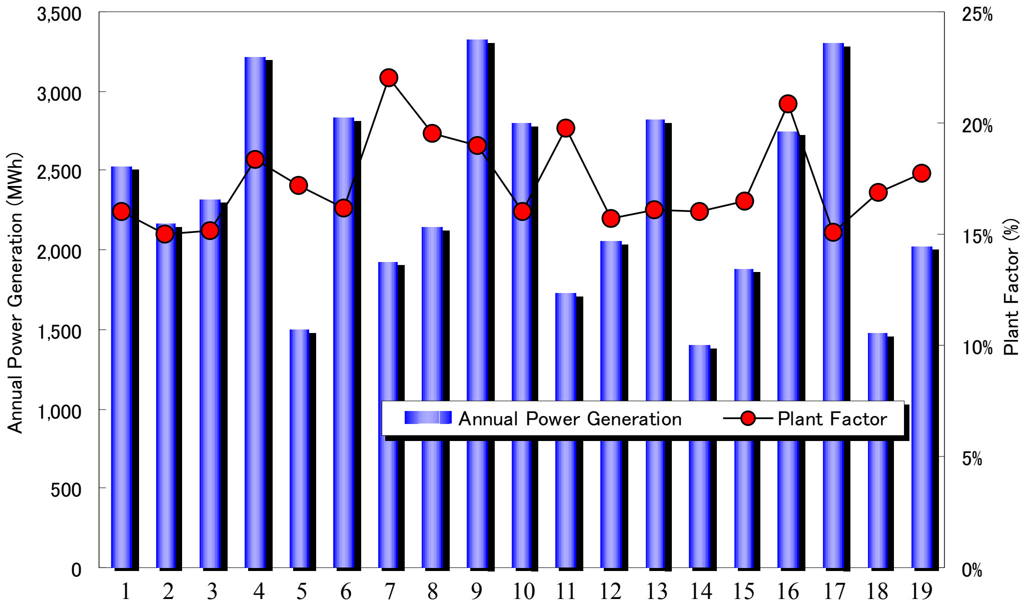


Figure B.6.3 Annual Power Generation and Plant Factor (over 1,000kW)

Table B.6.2 Results of Estimation (over 1,000kW turbines)

No.	Country of Manufacturer	Rated Capacity	Annual Power Generation	Plant Factor
1	Germany	1,800 kW	2,523 MWh	16.0%
2	Denmark	1,650 kW	2,163 MWh	15.0%
3	Denmark	1,750 kW	2,319 MWh	15.1%
4	Denmark	2,000 kW	3,219 MWh	18.4%
5	Japan	1,000 kW	1,504 MWh	17.2%
6	Japan	2,000 kW	2,835 MWh	16.2%
7	Germany	1,000 kW	1,927 MWh	22.0%
8	Germany	1,250 kW	2,141 MWh	19.6%
9	Germany	2,000 kW	3,325 MWh	19.0%
10	Netherlands	2,000 kW	2,799 MWh	16.0%
11	Denmark	1,000 kW	1,728 MWh	19.7%
12	Denmark	1,500 kW	2,060 MWh	15.7%
13	Denmark	2,000 kW	2,821 MWh	16.1%
14	Germany	1,000 kW	1,403 MWh	16.0%
15	Germany	1,300 kW	1,877 MWh	16.5%
16	Germany	1,500 kW	2,746 MWh	20.9%
17	Germany	2,500 kW	3,299 MWh	15.1%
18	Denmark	1,000 kW	1,475 MWh	16.8%
19	Denmark	1,300 kW	2,021 MWh	17.7%

(2) Wind turbines from 100kW to 1MW

Based on the following table the plant factor for No. 21, No. 25, No. 27 and No. 31 is over 20% and the plant factor for almost all turbines is more than 16% except for No. 29. The plant factor does not definitely correlate with the rated capacity and the annual power generation.

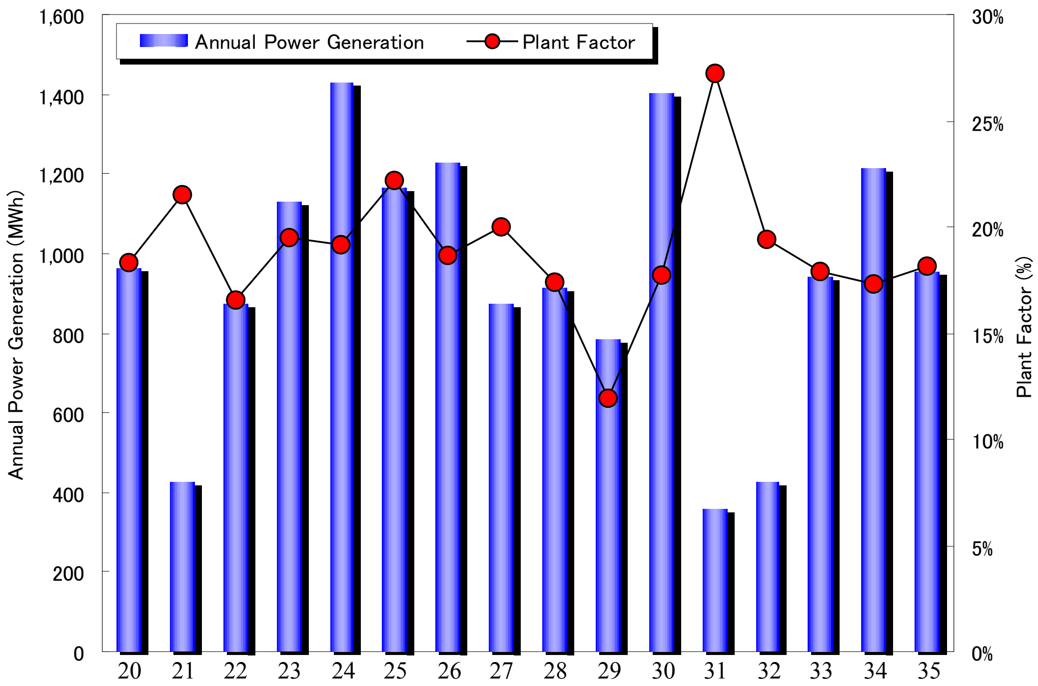


Figure B.6.4 Annual Power Generation and Plant Factor (from 100kW to 1,000kW)

Table B.6.3 Results of Estimation (from 100kW to 1,000kW)

No.	Country of Manufacturer	Rated Capacity	Annual Power Generation	Plant Factor
20	Germany	600 kW	965 MWh	18.4%
21	Denmark	225 kW	424 MWh	21.5%
22	Denmark	600 kW	872 MWh	16.6%
23	Denmark	660 kW	1,128 MWh	19.5%
24	Denmark	850 kW	1,428 MWh	19.2%
25	Germany	600 kW	1,164 MWh	22.1%
26	Netherlands	750 kW	1,227 MWh	18.7%
27	Denmark	500 kW	876 MWh	20.0%
28	Denmark	600 kW	914 MWh	17.4%
29	Denmark	750 kW	784 MWh	11.9%
30	Denmark	900 kW	1,401 MWh	17.8%
31	Germany	150 kW	357 MWh	27.2%
32	Germany	250 kW	425 MWh	19.4%
33	Germany	600 kW	939 MWh	17.9%
34	Germany	800 kW	1,213 MWh	17.3%
35	Denmark	600 kW	953 MWh	18.1%

(3) Wind turbines under 100kW class

Based on the following table the plant factor for the No. 42 and No. 44 wind turbines is over 20% and the plant factor for all turbines is more than 12%. The plant factor does not definitely correlate with the rated capacity and the annual power generation.

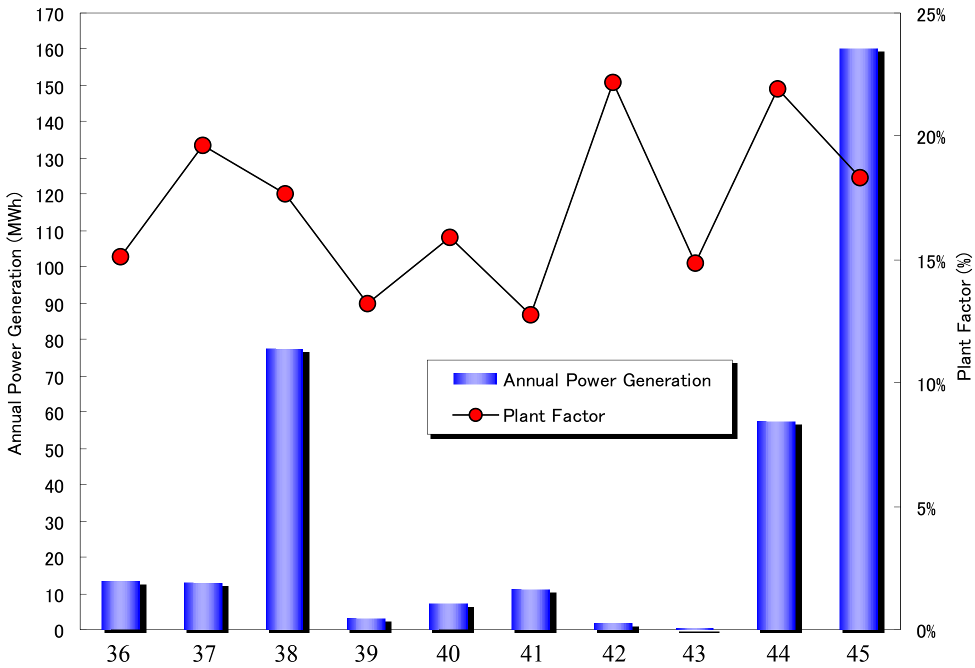


Figure B.6.5 Annual Power Generation and Plant Factor (under 100kW)

Table B.6.4 Results of Estimation (under 100kW)

No.	Country of Manufacturer	Rated Capacity	Annual Power Generation	Plant Factor
36	USA	10.0 kW	13.3 MWh	15.1%
37	USA	7.5 kW	12.9 MWh	19.6%
38	USA	50.0 kW	77.5 MWh	17.7%
39	Australia	2.5 kW	2.9 MWh	13.2%
40	Australia	5.0 kW	7.0 MWh	15.9%
41	Australia	10.0 kW	11.2 MWh	12.7%
42	USA	1.0 kW	1.9 MWh	22.2%
43	-	0.4 kW	0.5 MWh	14.9%
44	Germany	30.0 kW	57.6 MWh	21.9%
45	Germany	100.0 kW	160.3 MWh	18.3%

B.6.3 Selection of Model Turbine and Revision of Power Supply Capacity

B.6.3.1 Selection of Model Turbine

Based on the results of estimation, the model turbines, that is, the wind turbines examined in the following analysis, are selected in this section. As the wind power system is applied as one of the power resources for un-electrified barangay, it is necessary to consider the economic efficiency and its capacity to meet power demand.

- Economic efficiency

The economic efficiency of a wind turbine can be roughly understood by comparing the plant factor of each turbine. Supposing that a wind turbine cost can be strictly defined by the capacity of the turbine, a wind turbine with a high plant factor can generate affordable electric power. The No. 37, No. 42 and No. 44 turbines with a plant factor of around/over 20% can be the more efficient turbines among those in the under 100kW class listed in Table B.6.4.

- Capacity

Based on the assumptions mentioned above, a number of high efficiency small turbines can be constructed according to the power demand. But, the construction cost of a wind power system includes not only the turbine cost, which tends to be defined by capacity, but also the costs for the foundation work and other equipment, which tends to be defined by the number of turbines. Therefore, depending on the power demand, the cost for constructing a single large wind turbine with a low efficiency plant factor is sometimes lower than that for many small turbines with a high efficiency plant factors. In other words, power demand is also one key factor to consider when determining capacity and the number of wind turbines for supplying power efficiently.

- Power Output

In order to apply a wind power system for rural electrification, a battery system is necessary to stably meet the power demand. In order to store power into a battery, power output from the wind turbine should be DC power. This is because an expensive AC-DC converter because is needed in order to store AC power into a DC battery.

- Selection of Model Turbine

Based on the demand forecast, the daily power demand in a stand-alone generator area is 120Wh/day/HH. Considering this unit demand and the above-mentioned factors, the model turbine is selected as follows.

Table B.6.5 Model Turbines

No.	Country	Rated Capacity	Power Generation	Plant Factor
37	USA	7.5 kW	12.9 MWh	19.6%

B.6.3.2 Revision of Power Supply Capacity for Model Turbines

Output from a wind turbine may change according to the wind speed fluctuation. Therefore, output fluctuation of each model turbine should be checked based on the actual wind speed distribution to confirm whether power generation can meet the prescribed power demand. In this section the ability of each model turbine to achieve the maximum power demand was verified.

In the case of stand-alone systems, the maximum power demand depends on the power storage capacity of a battery bank, because a battery bank is necessary to correct the output fluctuation of a wind turbine and to fill gaps between demand and supply.

SMA (SMA: Single Moving Average) is used here in consideration of the above-mentioned limitations on battery banks. SMA means average value, as calculated over a rolling previous period of fixed length. Assuming the battery bank of a stand-alone wind power system has the capacity to storage power demand for 10 days and the power demand is constant, the minimum 10 days SMA means the maximum power demand that can be supplied by the system.

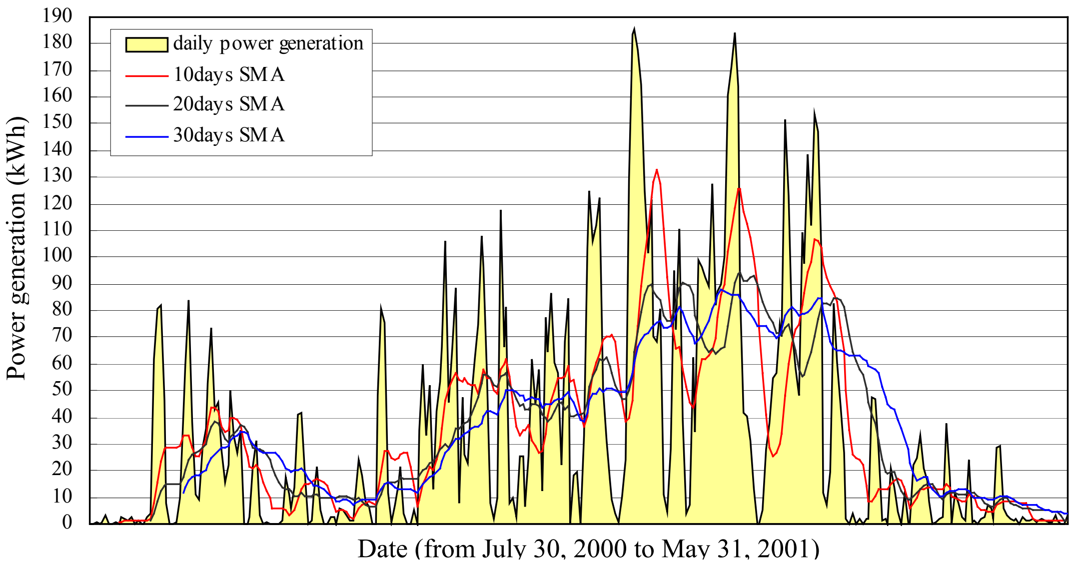


Figure B.6.6 Transition of Power Generation and Single Moving Average (No. 37 turbine)

Figure B.6.6 shows the transition of daily power generation of the No. 37 turbine and its SMA based on NPC-SPUG data observed from July 30, 2000 to May 31, 2001. According to this figure, the minimum 10 days SMA is about 550Wh. This means that the No. 37 turbine and a battery with the capacity worth of 10 days demand has the ability to meet daily power demand of 550Wh.

Table B.6.6 Power Supply Ability of Model Turbines

No.	Rated Capacity	Min. 10 days SMA	Min. 20 days SMA	Min. 30 days SMA
37	7.5 kW	0.6 kWh	1.1 kWh	3.7 kWh

B.6.3.3 Verification of Demand and Supply Balance for No. 37 Turbine

Table B.6.7 shows the results regarding the No. 37 turbine. Annual power generation divided by 365 days is the daily power generation.

Table B.6.8 shows the results for the demand and supply balance for No. 37 turbine. This turbine can supply power to 250 households with the unit demand of 120wh/day according to daily power generation. On the other hand, this turbine and a battery with the capacity worth of 10 days demand can supply 4 households with the same unit demand.

Table B.6.7 Summary of Ability of No. 37 Turbine

No.	Before Revision			After Revision		
	Rated Capacity	Annual Power Generation	Daily Power Generation	Min. 10 days SMA	Min. 20 days SMA	Min. 30 days SMA
37	7.5 kW	12.9 MWh	35.3 kWh	0.6 kWh	1.1 kWh	3.7 kWh

Table B.6.8 Results of Verification for No. 37 Wind Turbine

HH	Daily power demand of each household														
	40	80	120	160	200	240	320	400	480	600	800	1,000	1,200	1,400	1,600
1	40	80	120	160	200	240	320	400	480	600	800	1,000	1,200	1,400	1,600
2	80	160	240	320	400	480	640	800	960	1,200	1,600	2,000	2,400	2,800	3,200
3	120	240	360	480	600	720	960	1,200	1,440	1,800	2,400	3,000	3,600	4,200	4,800
4	160	320	480	640	800	960	1,280	1,600	1,920	2,400	3,200	4,000	4,800	5,600	6,400
5	200	400	600	800	1,000	1,200	1,600	2,000	2,400	3,000	4,000	5,000	6,000	7,000	8,000
6	240	480	720	960	1,200	1,440	1,920	2,400	2,880	3,600	4,800	6,000	7,200	8,400	9,600
7	280	560	840	1,120	1,400	1,680	2,240	2,800	3,360	4,200	5,600	7,000	8,400	9,800	11,200
8	320	640	960	1,280	1,600	1,920	2,560	3,200	3,840	4,800	6,400	8,000	9,600	11,200	12,800
9	360	720	1,080	1,440	1,800	2,160	2,880	3,600	4,320	5,400	7,200	9,000	10,800	12,600	14,400
10	400	800	1,200	1,600	2,000	2,400	3,200	4,000	4,800	6,000	8,000	10,000	12,000	14,000	16,000
20	800	1,600	2,400	3,200	4,000	4,800	6,400	8,000	9,600	12,000	16,000	20,000	24,000	28,000	32,000
40	1,600	3,200	4,800	6,400	8,000	9,600	12,800	16,000	19,200	24,000	32,000	40,000	48,000	56,000	64,000
60	2,400	4,800	7,200	9,600	12,000	14,400	19,200	24,000	28,800	36,000	48,000	60,000	72,000	84,000	96,000
80	3,200	6,400	9,600	12,800	16,000	19,200	25,600	32,000	38,400	48,000	64,000	80,000	96,000	112,000	128,000
100	4,000	8,000	12,000	16,000	20,000	24,000	32,000	40,000	48,000	60,000	80,000	100,000	120,000	140,000	160,000
150	6,000	12,000	18,000	24,000	30,000	36,000	48,000	60,000	72,000	90,000	120,000	150,000	180,000	210,000	240,000
200	8,000	16,000	24,000	32,000	40,000	48,000	64,000	80,000	96,000	120,000	160,000	200,000	240,000	280,000	320,000
250	10,000	20,000	30,000	40,000	50,000	60,000	80,000	100,000	120,000	150,000	200,000	250,000	300,000	350,000	400,000
300	12,000	24,000	36,000	48,000	60,000	72,000	96,000	120,000	144,000	180,000	240,000	300,000	360,000	420,000	480,000
350	14,000	28,000	42,000	56,000	70,000	84,000	112,000	140,000	168,000	210,000	280,000	350,000	420,000	490,000	560,000
400	16,000	32,000	48,000	64,000	80,000	96,000	128,000	160,000	192,000	240,000	320,000	400,000	480,000	560,000	640,000
450	18,000	36,000	54,000	72,000	90,000	108,000	144,000	180,000	216,000	270,000	360,000	450,000	540,000	630,000	720,000
500	20,000	40,000	60,000	80,000	100,000	120,000	160,000	200,000	240,000	300,000	400,000	500,000	600,000	700,000	800,000
550	22,000	44,000	66,000	88,000	110,000	132,000	176,000	220,000	264,000	330,000	440,000	550,000	660,000	770,000	880,000
600	24,000	48,000	72,000	96,000	120,000	144,000	192,000	240,000	288,000	360,000	480,000	600,000	720,000	840,000	960,000
650	26,000	52,000	78,000	104,000	130,000	156,000	208,000	260,000	312,000	390,000	520,000	650,000	780,000	910,000	1,040,000
700	28,000	56,000	84,000	112,000	140,000	168,000	224,000	280,000	336,000	420,000	560,000	700,000	840,000	980,000	1,120,000
750	30,000	60,000	90,000	120,000	150,000	180,000	240,000	300,000	360,000	450,000	600,000	750,000	900,000	1,050,000	1,200,000
800	32,000	64,000	96,000	128,000	160,000	192,000	256,000	320,000	384,000	480,000	640,000	800,000	960,000	1,120,000	1,280,000
850	34,000	68,000	102,000	136,000	170,000	204,000	272,000	340,000	408,000	510,000	680,000	850,000	1,020,000	1,190,000	1,360,000
900	36,000	72,000	108,000	144,000	180,000	216,000	288,000	360,000	432,000	540,000	720,000	900,000	1,080,000	1,260,000	1,440,000
950	38,000	76,000	114,000	152,000	190,000	228,000	304,000	380,000	456,000	570,000	760,000	950,000	1,140,000	1,330,000	1,520,000
1000	40,000	80,000	120,000	160,000	200,000	240,000	320,000	400,000	480,000	600,000	800,000	1,000,000	1,200,000	1,400,000	1,600,000

: Demand model (battery capacity = 10 days demand)
: Demand model (battery capacity = 20 days demand)
: Demand model (battery capacity = 30 days demand)
: Demand model (battery capacity = unlimited)

B.6.4 Wind Power System Design

(1) Design parameters

The following parameters are assumed when designing a wind power system, based on the results of the above section. As daily demand for each household is set at 120 Wh/day/HH in the demand forecast, the number of the target households is set at 4 households based on the above table.

Table B.6.9 Design Parameter Assumptions (Wind)

Parameter	Value	Basis
Capacity of wind turbine	7.5 kW	Refer to the above section
Battery voltage	12 V	Availability of batteries in rural areas
Depth of charge	50 %	Performance of available batteries in rural areas
Battery capacity	10 days demand	Availability of batteries in rural areas
Demand of each HH	40 W	Based on result of demand forecast
Daily demand of each HH	120Wh/day	Based on result of demand forecast
No. of target HH	4 HH	Refer to the above section

(2) System components and cost

Based on the above assumptions, a wind power system component is determined as follows. The cost data for a wind turbine is estimated based on retail costs collected from the manufacturers. Other cost data are the same as those used for solar power systems. The cost of the wind turbine includes a tower, control unit and overseas transportation costs.

Table B.6.10 Wind Power System Components

Item	Specifications	QTY	Lifetime	Cost (10^3Php)
Wind turbine	7.5 kW, tower, control unit	1	20	2,668 (CIF)
Battery	12VDC, 1122Ah	1	3	47
DC lamps	20W	8	10	8
Miscellaneous		1	20	21
			Total system cost	2,744

Note: Wind turbine cost includes VAT (10%), duties (10%), assembling cost (10%), civil cost (15%), electric cost (10%), and domestic transportation cost (3%). Exchange rate is set at 1US$=52PHP

(3) Financial analysis

Assumptions for the economic analysis of a wind power system are the same as those for solar power systems. In this analysis, various battery capacities are also examined, because a battery capacity can significantly affect economic features. Results of the financial analysis are indicated in the following table. By increasing the battery capacity, the number of electrified households increases and the economical features, such as system cost of each household, generation cost and annual cost for each household, all decline remarkably. However, a battery capacity that is too large is unrealistic, since beneficiaries are not able to replace them every 3 years without some financial support.

Table B.6.11 Results of Financial Analysis (Wind)

Index	Value		
	10 days demand	20 days demand	30 days demand
No. of target HH	4HH	9HH	30HH
Battery capacity of each HH	280Ah	460Ah	690Ah
System cost	2,744 $x10^3$Php	2,878 $x10^3$Php	3,613 $x10^3$Php
System cost of each HH	686 $x10^3$Php/HH	320 $x10^3$Php/HH	120 $x10^3$Php/HH
Installation cost	365,846Php/kW	383,785Php/kW	481,735Php/kW
Generation cost	2,324Php/kWh	1,164Php/kWh	566Php/kWh
Annual cost	407,078Php/year	458,785Php/year	743,901Php/year
Annual cost of each HH	101,769Php/y/HH	50,976Php/y/HH	24,797Php/y/HH

(4) Conclusion of wind power development planning

Compared with a solar power system, a wind power system is rather expensive, even when the wind speed is adjusted to the USAID level. This stems from the low wind energy potential and the large fluctuations in wind speed in Palawan. Therefore, based on the available existing information, the Study team must conclude that a wind power system will not be a viable option to be considered in this Master Plan. In order to re-introduce the possibility of wind power, more detailed surveys on wind potential will be required.

B.7 Reference to Facilitate Utilization of Renewable Energy Resources

B.7.1 Experiences from Other Renewable Energy Projects

B.7.1.1 Indonesia

The Presidential Assistance Project (BANPRES), funded by a presidential grant through the Development Budget (DIP), was used to set up a revolving fund. The goal of the project is to test the technical and social viability of photovoltaic energy for large-scale household electrification programs as a means of providing cost-effective electricity services to a portion of the approximately 20 million rural Indonesian households that are unlikely to receive grid electricity for at least ten years. As a result of the positive BANPRES Project experiences, commercially-oriented solar home system initiatives and other programs sponsored by the government have led to nearly 20,000 solar home systems installed to date.

The Government of Indonesia places a high priority on electrification and is committed to supporting geographically balanced development for rural areas by increasing the welfare of the people and stimulating the growth of economic activities. Key agencies involved in such areas as cooperatives, technology development, energy and banking participated in the BANPRES project. With the assistance of the local governments, participating villages are selected based on their desire for electricity, location relative to the administrative area of the qualifying village cooperative, grid electrification plans and capacity of householders to pay down payment and monthly installments.

Once a village is selected as a project site, residents are chosen to receive BANPRES system based on their ability to pay and whether or not they are active KUD members. Users pay a Rp. 50,000 down payment, and Rp. 7500 per month for 10 years for the PV system. The monthly fee for the solar home system was less than the PLN electricity service from the 450-W connection.

In 1993 the fee collection rate in the BANPRES Project was about 60 percent. Village cooperative officials attributed the inadequate fee recovery to seasonal income patterns, short-term financial problems and families realizing they were unable to meet the solar home system financial obligations. In addition, the limited business management capabilities of some village cooperative exacerbated the cost recovery problems. In many cases, the village cooperatives could not force users to comply with their agreements, since many KUD's did not always adhere to their contractual obligations. Despite strict penalties for late payments as specified in the BANPRES guidelines, most village cooperative have been handling disconnections for nonpayment differently. Once users learn that disconnections are not really going to be carried out, the payment rate falls and the financial recovery worsens.

B.7.1.2 Sri Lanka

Approaches used to disseminate solar home systems include sales through the private sector and NGOs, and government-sponsored programs (often with international donor financing). The private sector sells PV systems directly to individual consumers, NGOs, local village cooperatives and government programs. The private firm SPLC is the sole domestic manufacturer of PV modules, importing the PV cells and fabricating them into finished panels. SPLC has a comprehensive after-sales service arrangement. The program consists of regionally-based trained technicians, scheduled household visits and reports, and brochures summarizing proper maintenance techniques and system use. Other solar PV firms, NGOs and government programs purchase these modules at wholesale prices. All the solar PV suppliers offer warranties competitive with solar PV markets in other countries.

NGOs have adopted a more informal approach, relying on village-based technicians who work on commission. The NGOs offer maintenance and support services at the village level and promote the manufacturing of some components at the village level to supplement the income of their technical field staff.

The government-sponsored Pansiyagama solar PV project initially made no provisions for system maintenance. Later due to poor technical performance and fee recovery problems, a private firm was contracted for one year to make monthly service and fee-collection visits to each household. The firm conducted routine system performance tests and educates users on operation and maintenance. The Pansiyagama project also suffered from inadequate communication and coordination with the electric utilities, NGOs, local credit institutions and potential solar home system users. Based on the success of the one-year contract, a five-year system maintenance contract has been issued to provide continued maintenance and support services.

Due to the limited availability of credit, most of the households that obtained PV systems were the rural upper and middle classes. Private sector sales are financed by cash, bank credit or hire-purchase agreements. The more affluent households selected systems themselves based on their ability to pay. NGOs and government programs were designed to reach the poorer classes by offering easier access to credit. Nevertheless, the lowest income households in these rural areas would not be able to purchase PV systems in the absence of large subsidies.

B.7.1.3 Philippines

The Philippines has 20 years of experience with PV technology, yet such applications are still perceived as a means of “pre-electrification” rather than a permanent rural energy solution. Two rural PV electrification programs implemented under a bilateral agreement between the government of the Philippines and the German government have dominated solar home system dissemination.

In 1982 the Philippines-German Solar Energy Project (PGSEP) installed a 13-kWp PV plant, which was later found to be uneconomical due to its high capital investment. The project began to focus on solar home systems and communal battery-charging stations. The SEP procures solar home systems on behalf of the Rural Electric Cooperative (REC) in bulk (50 systems per procurement package) and receives bulk-discounted prices. The cooperative then sells the systems to the users who pay cash for the balance of systems (BOS), except for the battery control unit (BCU), and make monthly payments for the module and controller. The initial payment is considered a connection fee, similar to the fee charged for household grid service connection.

The BAPA staff is responsible for fee collection and system monitoring. The users are trained in routine operation and maintenance practices and in load management. Users receive a manual in a “comic book” style. Service response by the REC technicians was mostly within two days and favorably perceived by the users. Unlike the solar home systems, the communal PV power systems and battery charging stations established under the SEP had limited success due to the unclear delegation of responsibilities.

A typical solar home system has a 53-Wp module, a lead-acid automotive battery, a BCU, switches, a DC/DC voltage converter, a junction box and five lamps. This system generates 130 to 206 Watt-hours (Wh) per day, depending on the location and weather conditions. A solar home system supplied on the average about 140 Wh/day, enough energy to operate one fluorescent light for 3 hours, one compact fluorescent light for 4 hours, and 1 radio for 12 hours.

The average price of a solar home system is approximately P 23,000 (US $900). The solar home system components are exempt from import duties and value added tax. The financing scheme of the SEP includes financing from the National Electrification Administration to the RECs who then finance solar home system sales to users. The SEP also established revolving funds for the RECs to finance additional solar home system installations. The ability and willingness of users to pay for PV electrification is a significant issue in the Philippines. At most 10 percent of the total households could pay cash for solar home systems and an additional 20 to 60 percent could procure them if suitable financing schemes were available (i.e., 20-30 percent down payment and an amortization period of at least three years for the balance of the amount). The remaining households could not afford a solar home system, but could acquire batteries to be recharged at battery-charging stations.

B.7.1.4 Dominican Republic

About 400,000 households in this country lack access to grid electricity as the government was unable to meet the growing demand for electricity.
The institutional framework of the solar PV program in this country consists of ADESOL, local NGOs that manage credit programs for solar PV purchases and the entrepreneurs who sell the systems. Currently, four NGOs are providing credit for solar PV purchases: ADESOL, ADEPE, SSID and ADESJO. Other NGOs that have strong financial support tend to have an urban bias, while the most effective rural developers often lack the financial backing. Only ADEPE has the necessary financing and human resources to handle an expanded program. Businesses involved in the solar PV market face obstacles to their expanding operations, largely due to lack of training, limited contacts that the rest of the educated business community enjoys, inadequate working capital, limited resources for promotion and advertising, and a lack of physical resources such as vehicles, communications equipment, warehouses and workshops. The small businesses generally have not competed with each other for business because their regional markets do not overlap.

The PV module size for a typical solar home system ranges from 25 to 48 Wp. A solar home system consist of a PV module, one lead-acid automotive battery, a battery charge indicator/load center with a PV module disconnect switch, a fuse and light fixtures. The systems are purchased and owned by the user. Monthly installments are about US$30. Prices of SHS have increased substantially in local terms, largely due to the devaluation of the peso. Customs charges, exchange-rate surcharges and domestic industrial protection have also adversely affected the solar PV business.

Access to credit is still a major constraint for solar home system sales. This lack of credit, coupled with solar home system promoters targeting the relatively affluent households, result in about 80% of the purchases being made by cash. Commercial banks do not usually offer credit for solar home systems, which they view as consumer durable goods. NGOs offer loans through a revolving credit fund, which typically require a 25% down payment, 18% interest rate and a 1-2 year payback period. The revolving credit funds are proving effective, but limited, largely due to the dependency on donations for initial funds.

B.7.2 Latest Technology Development Trends

B.7.2.1 PV Module

The main issues confronting PV modules are high cost and low efficiency. To solve these issues, various new types have been developing to better support practical application. For example, the high efficient thin film silicon solar cell has emerged due to its high conversion efficiency and low production cost through the facilitation of the production process. In addition, the dye-sensitized solar cell has also emerged due to low production cost, because this system uses an electrochemical cell unlike with the typical cells. However, the conversion efficiency of this cell is not so high. As both types still have some technical issues, these modules cannot yet be used in the practical application.

B.7.2.2 Batteries

(1) Deep Cycle Batteries

The car battery, which is typically used for SHS and BCS in the developing countries, is designed for the float-use in which the battery is constantly charged by the alternator of the car engine. Therefore, in the case that the car battery is used for the cycle-use of SHS and BCS in which the depth of discharge for a certain fixed time is quite large, the performance and lifetime of the battery tend to be reduced.

On the other hand, the Deep Cycle Battery (DCB) is designed for cycle-use and lifetime is not shortened by the over discharge and performance of the DCB can be kept at the initial level regardless of the cycle of deep charge and discharge. Therefore, the DCB is more suitable as the battery for stand-alone systems using renewable energy than typical car batteries.

Although the DCB can be purchased in the Philippines, it is more expensive than the car battery and its availability in the rural areas is quite limited. Moreover, performance and lifetime equal to the DCB can be expected from the car battery provided that they are handled properly. When also considering that the weight of the DCB is heavier than that of the car battery, it is appropriate to suggest that the DCB should be installed in the stand-alone systems.

(2) Electric Double Layer Capacitors

The lead acid battery commonly used for the stand-alone system stores the electric power through chemical reactions. Therefore, the cycle of deep charge/discharge with large current deteriorates the battery electrolyte and the electrode, which shortens the battery lifetime. In addition, the discarded lead acid battery can become a potential environmental problem due to the lead compound of the battery.

On the other hand, the Electric Double Layer Capacitor (EDLC) is a kind of condenser using an interfacial phenomenon known as the Electric Double Layer. The principle of the EDLC is shown in the following figure.

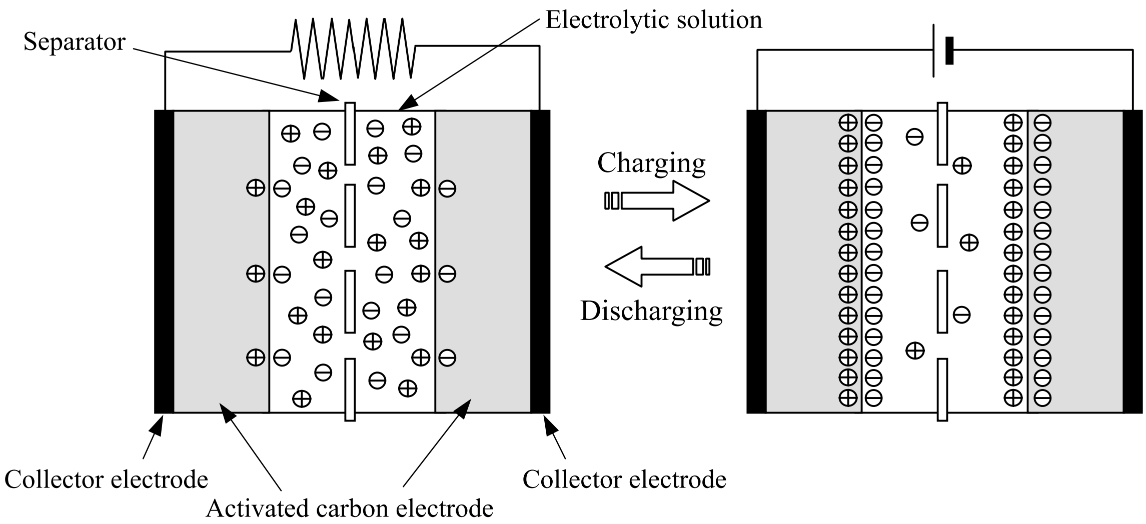


Figure B.7.1 EDLC Principle

When the direct current is impressed to the EDLC, the electric charge is absorbed in the interface between the electrolytic solution and the polarized electrode. When the EDLC discharges, the electric charge is desorbed from the electrode and the electrolytic solution is neutralized. This means that the EDLC stores the electric power through a physical phenomenon, not a chemical reaction. In this sense the EDLC has the following advantages compared with the lead acid battery.

Table B.7.1 Features of the EDLC Compared with the Lead Acid Battery

	EDLC
Advantage	- Low deterioration against frequent charge and discharge - Low deterioration against over charge and over discharge - Rapid charging and discharging is possible - High efficiency for charging and discharging - Environmentally friendly - Easy to maintain
Disadvantage	- Low energy density - Low availability - High cost

Presently the research and development of EDLC mainly focuses on the utilization for fuel cell vehicles, because these advantages are well suited for such applications. To further promote utilization of the EDLC for the stand-alone power systems, it is hoped that energy density and its cost will be improved in the near future.

B.7.2.3 Wind Turbine

In the above section of this report it was concluded that the wind power system is not suitable for the stand-alone system in Palawan Province. Depending on the progress of research and development regarding wind turbines, however, this conclusion could be reversed.

For example, a gyromill wind turbine that is described as a suitable wind turbine for the low and medium wind speed areas has not been popular for the stand-alone wind power systems, because this turbine requires a motor to start moving. But a motor-less gyromill wind turbine with a low cut-in wind speed is now available in the Japanese market, even though its capacity is still small. Although the cost and wind curve of this turbine will become the key factors, a motor-less gyromill turbine that can start moving by the wind from any direction is expected to become one of the stand-alone systems.