

$$P = K Q^e$$

whereas P is price of the service, K is the constant, Q is the quantity of the service consumed and e is the price elasticity.

The convenience of the log-linear demand function is the fact that it enables two point determinations of all the parameters concerned. Therefore the data set involving the two states of pre- and post- electrification suffices for the estimation. In the above function, e is determined in the following formula.

$$e = (\text{Log}(P_1) - \text{Log}(P_0)) / (\text{Log}(Q_1) - \text{Log}(Q_0))$$
 whereas suffixes indicate 1: post electrification state and 0: pre-electrification state.

Subsequently K is calculated by inserting, P, Q, e to the demand function. The consumer benefit to be estimated can be calculated by deriving the integral of the demand function.

$$U = \int P(Q) dQ$$

Incidentally, the integral function is calculated to be;

$$\frac{K}{e+1} Q^{e+1}$$

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-E

OPERATION AND EFFECT INDICATORS

APPENDIX-E OPERATION AND EFFECT INDICATORS

E.1 SAIDI

BPC started to record SAIDI, SAIFI, and CAIDI from January 2005 in all Dzongkhags other than Gasa. **Table-E.1.1** shows dzongkhag-wise SAIDI from January to December 2009 for distribution lines.

Table-E.1.1 SAIDI Data due to the Fault in Distribution Line (Jan-Dec 2009)

(Unit: Min/Customer)

Dzongkhag	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cumulative Total
Bumthang	4.8	0.0	81.8	0.0	0.0	316.6	0.0	0.0	0.0	0.0	0.0	0.0	370.7
Chhukha	3.3	0.0	0.2	23.3	1.0	5.6	19.0	0.6	2.3	3.2	12.1	39.3	107.2
Dagana	0.0	0.0	0.0	5.8	0.0	69.1	0.0	0.0	3,523.2	0.0	26.8	60.7	3,529.3
Haa	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Lhuntse	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Mongar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paro	0.0	0.0	4.1	0.0	52.8	0.0	0.0	0.0	2.7	4.4	0.0	13.5	75.2
Pemagatsel	0.0	0.0	101.5	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	109.6
Punakha	36.6	57.4	273.5	6.8	77.6	8.9	26.9	1,090.8	134.6	102.2	0.0	0.0	1,739.4
Samtse	81.4	0.0	74.9	0.0	106.3	280.1	389.8	348.6	430.3	253.0	33.4	172.9	2,076.3
Sarpang	22.6	0.1	2.3	3.2	0.0	6.2	31.9	0.0	0.0	0.3	0.0	0.0	64.2
Samdrup Jongkhar	2.3	1.7	141.3	57.5	23.7	92.4	61.2	75.7	90.6	0.0	0.0	0.0	524.2
Thimphu	1.0	1.9	6.1	3.1	13.0	8.0	26.9	9.2	12.3	17.2	21.5	0.0	117.5
Trongsa	0.0	0.0	0.0	0.0	0.0	3.2	0.0	3.8	120.9	0.0	5.6	19.0	150.3
Trashigang	0.0	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	64.7	65.0	0.0	141.1
Tashiyangtse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tsirang	0.0	66.7	0.0	0.0	0.0	0.0	91.7	97.2	10.1	0.0	0.0	0.0	230.5
Wangdue	0.0	93.0	26.1	9.4	85.3	126.5	134.3	62.4	0.0	231.7	23.3	0.7	757.6
Zhemgang	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	7.9
All Dzongkhags	0.1	0.1	0.6	0.1	0.4	0.6	0.7	1.3	1.4	0.6	0.2	0.3	365.8

E.2 Bill Collection Rate

The bill collection rate is currently available with total charged bill amount and total collected tariff revenue from energy sold. Dzongkhag-wise bill collection data is summarized in the from Table-E.2.1, E.2.2, E.2.3 for the year 2002-2003, 2004, and 2005.

Table-E.2.1 Bill Collection Rate in 2007

Unit: Nu.

Sl.No	Dzongkhag (ESD Office)	Outstanding as of Dec 2006	Amount Billed	Total Collectable	Total Billed Collection	Bill Collection
1	Bumthang	286,587	4,070,688	4,357,275	4,091,292	93.9%
2	Chukha	712,498	732,343,650	733,056,147	732,103,873	99.9%
3	Dagana	114,933	904,121	1,019,054	936,381	91.9%
4	Gelephu	897,965	12,233,586	13,131,552	12,021,209	91.5%
5	Haa	915,748	9,141,829	10,057,577	8,846,636	88.0%
6	Lhuentse	125,996	2,032,436	2,158,431	1,983,381	91.9%
7	Mongar	300,467	7,220,514	7,520,980	7,178,743	95.4%
8	Paro	2,443,844	28,417,279	30,861,124	29,498,012	95.6%
9	Pema Gatshel	226,789	5,131,774	5,358,564	5,041,977	94.1%
10	Punakha	688,133	9,984,214	10,672,348	9,824,571	92.1%
11	Samdrup Jongkhar	303,509	115,534,872	115,838,380	115,425,169	99.6%
12	Samtse	483,831	107,425,618	107,909,449	107,379,280	99.5%
13	Thimphu	12,769,280	128,743,770	141,513,050	127,321,988	90.0%
14	Trashigang	1,311,553	10,328,238	11,639,791	11,069,901	95.1%
15	Trashiyangtse	118,752	3,253,424	3,372,176	3,276,217	97.2%
16	Trongsa	252,219	1,966,164	2,218,383	1,985,946	89.5%
17	Tsirang	128,971	1,003,573	1,132,544	1,013,227	89.5%
18	Wangdue	851,379	8,412,027	9,263,407	8,441,350	91.1%
19	Zhemgang	94,747	2,828,517	2,923,264	2,782,151	95.2%
	TOTAL	23,027,201	1,190,976,295	1,214,003,496	1,190,221,303	98.0%

Note: Gasa Dzongkhag does not have Electricity Services Division (ESD). The data of Gasa is included in the that of Punakha.

* Total collectable is the sum of the amount billed for the concerned year and the outstanding from the previous year

Source: ESD, BPC

Table-E.2.2 Bill Collection Rate in 2008

Unit: Nu.

Sl.No	Dzongkhag (ESD Office)	Outstanding as of Dec 2007	Amount Billed	Total Collectable	Total Billed Collection	Bill Collection
1	Bumthang	264,530	4,590,681	4,855,211	4,474,316	92.2%
2	Chukha	902,758	978,142,151	979,044,909	936,113,220	95.6%
3	Dagana	83,042	968,457	1,051,499	966,365	91.9%
4	Gelephu	1,130,887	13,856,814	14,987,700	13,780,988	91.9%
5	Haa	1,199,764	11,079,437	12,279,200	11,184,594	91.1%
6	Lhuentse	174,954	2,145,846	2,320,800	2,167,792	93.4%
7	Mongar	334,097	7,432,560	7,766,657	7,433,353	95.7%
8	Paro	1,358,886	36,633,491	37,992,377	36,636,989	96.4%
9	Pema Gatshel	314,835	4,560,762	4,875,597	4,601,740	94.4%
10	Punakha	821,532	11,447,924	12,269,456	11,177,626	91.1%
11	Samdrup Jongkhar	416,871	192,521,090	192,937,961	192,535,429	99.8%
12	Samtse	531,857	116,754,325	117,286,183	116,754,146	99.5%
13	Thimphu	14,206,978	159,332,730	173,539,708	154,367,068	89.0%
14	Trashigang	561,250	11,223,624	11,784,874	11,123,866	94.4%
15	Trashiyangtse	95,368	2,759,616	2,854,984	2,744,916	96.1%
16	Trongsa	228,883	2,093,035	2,321,918	1,938,319	83.5%
17	Tsirang	119,286	944,478	1,063,764	975,862	91.7%
18	Wangdue	820,939	10,621,138	11,442,077	10,695,532	93.5%
19	Zhemgang	140,290	2,637,114	2,777,404	2,694,626	97.0%
	TOTAL	23,707,008	1,569,745,272	1,593,452,280	1,522,366,746	95.5%

Note: Gasa Dzongkhag does not have Electricity Services Division (ESD). The data of Gasa is included in the that of Punakha.

* Total collectable is the sum of the amount billed for the concerned year and the outstanding from the previous year

Source: ESD, BPC

Table-E.2.3 Bill Collection Rate in 2009

Unit: Nu.

Sl.No	Dzongkhag (ESD Office)	Outstanding as of Dec 2008	Amount Billed	Total Collectable	Total Billed Collection	Bill Collection Rate
1	Bumthang	379,191	6,054,871	6,434,062	5,736,632	89.2%
2	Chukha	42,655,385	1,462,638,716	1,505,294,102	1,446,619,685	96.1%
3	Dagana	83,177	1,385,055	1,468,232	1,195,049	81.4%
4	Gelephu	936,542	17,947,020	18,883,562	18,135,250	96.0%
5	Haa	1,049,991	12,934,703	13,984,694	12,613,449	90.2%
6	Lhuentse	152,831	2,687,286	2,840,117	2,673,789	94.1%
7	Mongar	326,895	9,289,111	9,616,006	9,139,994	95.0%
8	Paro	1,386,025	40,650,823	42,036,848	38,195,041	90.9%
9	Pema Gatsel	198,141	5,029,371	5,227,512	4,800,678	91.8%
10	Punakha	1,079,335	11,760,186	12,839,521	11,406,674	88.8%
11	Samdrup Jongkhar	414,731	200,685,865	201,100,595	199,871,416	99.4%
12	Samtse	526,085	126,851,165	127,377,250	127,055,311	99.7%
13	Thimphu	19,121,249	172,572,150	191,693,400	172,417,064	89.9%
14	Trashigang	649,550	12,954,790	13,604,340	12,938,825	95.1%
15	Trashiyangtse	110,648	3,611,979	3,722,626	3,582,191	96.2%
16	Trongsa	383,052	2,828,841	3,211,893	2,812,605	87.6%
17	Tsirang	87,785	2,522,477	2,610,261	2,162,165	82.8%
18	Wangdue	747,244	15,791,766	16,539,010	13,647,378	82.5%
19	Zhemgang	83,065	3,129,040	3,212,105	3,087,684	96.1%
	TOTAL	70,370,921	2,111,325,215	2,181,696,136	2,088,090,880	95.7%

Note: Gasa Dzongkhag does not have Electricity Services Division (ESD). The data of Gasa is included in the that of Punakha.

* Total collectable is the sum of the amount billed for the concerned year and the outstanding from the previous year

Source: ESD, BPC

E.3 Household Energy Consumption

Current household energy consumption is shown in **Table-E.3.1** for annual average, **Table-E.3.2** for January (winter), and **Table-E.3.3** for September (summer) in 2005 by Dzongkhags.

Table-E.3.1 Monthly Household Energy Consumption of Annual Average

	Annual household Electricity consumption (kWh/year)			Number of Household (as of Jun. 2009)			Household Electricity Consumption (kWh/HH/Month)		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Bumthang	1,838,522	403,038	2,241,560	1,603	207	1,810	95.6	162.3	103.2
Chukha	3,323,310	8,976,305	12,299,615	3,221	3,630	6851	86.0	206.1	149.6
Dagana	320,478	302,898	623,376	398	199	597	67.1	126.8	87.0
Gelephu	4,616,404	4,141,653	8,758,057	3,433	1,476	4909	112.1	233.8	148.7
Haa	1,891,409	475,119	2,366,528	1,769	272	2041	89.1	145.6	96.6
Lhuentse	1,438,939	345,175	1,784,114	1,477	188	1665	81.2	153.0	89.3
Mongar	2,769,197	1,777,798	4,546,995	3,255	883	4138	70.9	167.8	91.6
Paro	9,409,510	636,949	10,046,459	4,591	219	4810	170.8	242.4	174.1
Pemagatsel	1,401,722	329,650	1,731,372	2,437	205	2642	47.9	134.0	54.6
Punakha	3,680,508	2,537,355	6,217,863	2,798	1,086	3884	109.6	194.7	133.4
Samtse	3,731,832	1,772,195	5,504,027	3,978	656	4634	78.2	225.1	99.0
Samdrup Jongkhar	1,959,719	3,143,606	5,103,325	1,909	1,498	3407	85.5	174.9	124.8
Thimphu	4,227,163	48,693,287	52,920,450	2,322	12,977	15299	151.7	312.7	288.3
Trongsa	323,048	557,082	880,130	428	340	768	62.9	136.5	95.5
Trashigang	4,763,669	2,093,454	6,857,123	6,185	1,123	7308	64.2	155.3	78.2
Trashiyangtse	1,674,627	709,240	2,383,867	2,335	371	2706	59.8	159.3	73.4
Tsirang	133,089	829,008	962,097	84	411	495	132.0	168.1	162.0
Wangdue	3,311,382	1,155,044	4,466,426	2,915	447	3362	94.7	215.3	110.7
Zhemgang	465,248	535,682	1,000,930	564	342	906	68.7	130.5	92.1
Total	51,279,776	79,414,538	130,694,314	45,702	26,530	72,232	90.9	181.3	118.5

Prepared by JBIC SAPROF Study Team with BPC CSD Data

Table-E.3.2 Monthly Household Energy Consumption in Winter (January 2005)

	Monthly Household Electricity consumption (kWh/month)			Number of Household (as of Jan. 2009)			Household Electricity Consumption (kWh/HH/Month)		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Bumthang	157,090	39,365	196,455	1,439	207	1,646	109.2	190.2	119.4
Chhukha	274,698	731,860	1,006,558	3,061	3,515	6,576	89.7	208.2	153.1
Dagana	23,204	24,700	47,904	387	180	567	60.0	137.2	84.5
Gelephu	304,908	227,050	531,958	3,267	1,375	4,642	93.3	165.1	114.6
Haa	145,628	35,398	181,026	1,745	265	2,010	83.5	133.6	90.1
Lhuntse	128,889	38,173	167,062	1,425	187	1,612	90.4	204.1	103.6
Mongar	227,667	159,648	387,315	3,199	833	4,032	71.2	191.7	96.1
Paro	966,874	68,745	1,035,619	4,513	216	4,729	214.2	318.3	219.0
Pemagatsel	107,440	23,419	130,859	2,421	204	2,625	44.4	114.8	49.9
Punakha	358,607	241,116	599,723	2,688	1,039	3,727	133.4	232.1	160.9
Samtse	310,080	135,898	445,978	3,930	628	4,558	78.9	216.4	97.8
Samdrup Jongkhar	130,354	189,586	319,940	1,887	1,394	3,281	69.1	136.0	97.5
Thimphu	381,264	5,770,473	6,151,737	2,157	12,765	14,922	176.8	452.1	412.3
Trongsa	22,444	53,109	75,553	372	326	698	60.3	162.9	108.2
Trashigang	471,563	215,505	687,068	5,946	1,053	6,999	79.3	204.7	98.2
Trashy Yangtse	119,786	50,147	169,933	2,297	368	2,665	52.1	136.3	63.8
Tsirang	2,959	75,198	78,157	48	384	432	61.6	195.8	180.9
Wangdue	287,760	104,203	391,963	2,846	414	3,260	101.1	251.7	120.2
Zhemgang	38,306	38,411	76,717	557	295	852	68.8	130.2	90.0
Total	4,459,521	8,222,004	12,681,525	44,185	25,648	69,833	91.4	199.0	129.5

Prepared by JBIC SAPROF Study Team with BPC CSD Data

Table-E.3.3 Monthly Household Energy Consumption in Summer (September 2005)

	Monthly Household Electricity consumption in Sep. 2009 (kWh/month)			Number of Household as of Sep. 2009			Household Electricity Consumption in Sep. 2009 (kWh/HH/Month)		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Bumthang	154,223	34,946	189,169	1,663	208	1,871	92.7	168.0	101.1
Chhukha	296,467	781,920	1,078,387	3,432	3,685	7,117	86.4	212.2	151.5
Dagana	22,179	21,091	43,270	493	229	722	45.0	92.1	59.9
Gelephu	387,224	352,549	739,773	3,515	1,518	5,033	110.2	232.2	147.0
Haa	177,810	36,687	214,497	1,796	274	2,070	99.0	133.9	103.6
Lhuntse	184,782	38,606	223,388	1,486	189	1,675	124.3	204.3	133.4
Mongar	386,532	212,963	599,495	3,311	877	4,188	116.7	242.8	143.1
Paro	733,640	42,561	776,201	4,716	219	4,935	155.6	194.3	157.3
Pemagatsel	158,783	29,364	188,147	2,434	205	2,639	65.2	143.2	71.3
Punakha	291,315	221,256	512,571	2,860	1,119	3,979	101.9	197.7	128.8
Samtse	303,649	165,202	468,851	4,058	682	4,740	74.8	242.2	98.9
Samdrup Jongkhar	143,767	278,406	422,173	1,915	1,527	3,442	75.1	182.3	122.7
Thimphu	324,843	2,881,756	3,206,599	2,382	13,123	15,505	136.4	219.6	206.8
Trongsa	30,220	41,987	72,207	453	344	797	66.7	122.1	90.6
Trashigang	422,465	146,957	569,422	6,273	1,128	7,401	67.3	130.3	76.9
Trashy Yangtse	273,993	100,825	374,818	2,577	381	2,958	106.3	264.6	126.7
Tsirang	10,356	67,541	77,897	184	433	617	56.3	156.0	126.3
Wangdue	266,678	88,822	355,500	2,925	454	3,379	91.2	195.6	105.2
Zhemgang	38,215	45,600	83,815	598	346	944	63.9	131.8	88.8
Total	4,607,140	5,589,039	10,196,180	47,071	26,941	74,012	91.3	182.4	117.9

Prepared by JBIC SAPROF Study Team with BPC CSD Data

E.4 Project Evaluation

The following table shows statistic calculation for the required sample number of village/household evaluation survey.

$$\text{Sample nos.} = \frac{N}{\left(\frac{E}{k}\right)^2 \times \frac{N-1}{P(100-P)} + 1}$$

, where N: Population Size
 E: Sampling Error Ratio, 5%
 P: Population Ratio, 50%
 k: Confidence Coefficient, 1.96

Figure-E.4.1 Statistical Formula for determining the Required Sample Number of Village/Household Survey

Table-E.4.1 Required Sample Number of Village/Household Survey

Dzongkhag	Village		Household	
	Target Nos.	Sample nos.	Target Nos.	Sample nos.
Chhukha	23	22	326	177
Dagana	26	25	359	186
Haa	11	11	86	71
Paro	3	3	35	33
Pemagatshel	13	13	149	108
Punakha	5	5	42	38
Samtse	75	63	814	262
Sarpang	62	54	648	242
Trongsa	22	21	241	149
Tsirang	6	6	54	48
Wangdue	14	14	144	105
TOTAL	260	156 *	2898	340 *

* The number is for the required sample number calculated for the total number of village/household, not total of required number of each Dzongkhag

Source: Prepared by JPST

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX


APPENDIX-F

REVIEW OF IEE-EIA REPORT

APPENDIX-F REVIEW OF IEE/EIA REPORTS


F.1 Environmental Clearance

The copies of Environmental Clearances for 11 Dzongkhags are attached.



འབྲུག་གྲོག་མེ་ལས་འཛིན།

Bhutan Power Corporation Limited
Rural Electrification Department
Thimphu : Bhutan



53/BPC/RED/ARE-JICA/2010/ 333 17 June 2010

✓ Programme Manager,
Planning & Coordination Division,
Department of Energy,
Ministry of Economic Affairs,
Thimphu: Bhutan

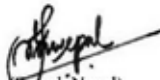
Subject: Environmental Clearance copies for the ARE Project.

Dear Sir,


With reference to letter No.DoE/PCD/JICA/2009-10/1302 dated 10th June 2010, please find attached copies of the Environmental Clearance of the targeted Dzongkhags under JICA Phase II Project under the Accelerated Rural Project.

This is for your kind perusal and necessary action.

Yours Sincerely,


(Suresh Nepal)
General Manager

Copy to: General Manager, EDCCD, BPC, Thimphu for kind information.

StcA Team Leader

13/06/2010

Phone: +975-2-333819; Fax: +975-2-335531; P.O. Box- 580; Website: www.bpc.bt

1. Chukha Dzongkhag


NATIONAL ENVIRONMENT COMMISSION
 of the Government of Bhutan

Environmental Clearance Affidavits

The National Environment Commission (NEC) issued general environmental clearance to Government Road Construction (ARC) works as detailed in Category A/Annexure 1.1.5 published in the development forecasting letter and guidelines.

1. As per Section 23.3.1 of the Environment and Environmental Engineering Act, 2002, any construction of any infrastructure that falls under this category shall comply with the National Environment Commission and 2002, Environment Commission Act, 2002 and its Regulations, 2002.
2. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
3. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
4. The holder shall ensure that the implementation of the project shall not affect the public, private parties and any other stakeholders.
5. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
6. Maximum permissible concentration (MPC) of noise shall be as follows:
 - a. Day (6:00 AM to 6:00 PM) 65 dB(A)
 - b. Night (6:00 PM to 6:00 AM) 55 dB(A)
7. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
8. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
9. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
10. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
11. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
12. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
13. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.
14. The holder shall ensure that the project complies with the Environmental Engineering Act, 2002 and its Regulations, 2002.

The environment clearance is valid from December 31, 2011 and is subject to the following conditions:


Yashraj Prasad
 Head, NEC Office

Environmental and GIS Division
 Bhutan Power Corporation
 Thimphu

Copy the kind intervention to:

1. Duan Dawa, Projecting Administration, Duan.
2. The Chief Project Officer, Technical Division, Duan.
3. Mr. Manoj Kumar Prasad, Projecting, Duan.
4. Managing Government Officer, Chukha, Bhutan.



3. Haa Dzongkhag

NATIONAL ENVIRONMENT COMMISSION
 Royal Government of Bhutan

Environmental Clearance (EC) Permit

14 Conditions:

- The holder shall ensure that the project complies with the Environmental Protection Act, 2002, and other relevant laws and regulations.
- The holder shall ensure that the project complies with the Environmental Protection Act, 2002, and other relevant laws and regulations.
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- The holder shall ensure that the project complies with the Environmental Protection Act, 2002, and other relevant laws and regulations.

Yalder Phuntsho
 Minister for Environment and Forests

Copy to be provided to:

- District Executive, District Administration, Haa.
- Chief Project Officer, Project Development, Haa.
- Municipal Office, Haa.
- Thangjing Environmental Office, Haa.

Scale: 1:10,000

Legend:

- Project Area
- Access Road
- Power Line
- Water Source
- Settlement
- Watercourse
- Boundary
- Other

5. Pemagatshel Dzongkhag



Code	Location	Sub-Station	Village	Area (sq. ft)	Area (sq. ft)	Area (sq. ft)
001	Pemagatshel	AG-0101	15	150	150	150
002	Pemagatshel	AG-0102	15	150	150	150
003	Pemagatshel	AG-0103	15	150	150	150
004	Pemagatshel	AG-0104	15	150	150	150
005	Pemagatshel	AG-0105	15	150	150	150
006	Pemagatshel	AG-0106	15	150	150	150
007	Pemagatshel	AG-0107	15	150	150	150
008	Pemagatshel	AG-0108	15	150	150	150
009	Pemagatshel	AG-0109	15	150	150	150
010	Pemagatshel	AG-0110	15	150	150	150
011	Pemagatshel	AG-0111	15	150	150	150
012	Pemagatshel	AG-0112	15	150	150	150
013	Pemagatshel	AG-0113	15	150	150	150
014	Pemagatshel	AG-0114	15	150	150	150
015	Pemagatshel	AG-0115	15	150	150	150
016	Pemagatshel	AG-0116	15	150	150	150
017	Pemagatshel	AG-0117	15	150	150	150
018	Pemagatshel	AG-0118	15	150	150	150
019	Pemagatshel	AG-0119	15	150	150	150
020	Pemagatshel	AG-0120	15	150	150	150
021	Pemagatshel	AG-0121	15	150	150	150
022	Pemagatshel	AG-0122	15	150	150	150
023	Pemagatshel	AG-0123	15	150	150	150
024	Pemagatshel	AG-0124	15	150	150	150
025	Pemagatshel	AG-0125	15	150	150	150
026	Pemagatshel	AG-0126	15	150	150	150
027	Pemagatshel	AG-0127	15	150	150	150
028	Pemagatshel	AG-0128	15	150	150	150
029	Pemagatshel	AG-0129	15	150	150	150
030	Pemagatshel	AG-0130	15	150	150	150
031	Pemagatshel	AG-0131	15	150	150	150
032	Pemagatshel	AG-0132	15	150	150	150
033	Pemagatshel	AG-0133	15	150	150	150
034	Pemagatshel	AG-0134	15	150	150	150
035	Pemagatshel	AG-0135	15	150	150	150
036	Pemagatshel	AG-0136	15	150	150	150
037	Pemagatshel	AG-0137	15	150	150	150
038	Pemagatshel	AG-0138	15	150	150	150
039	Pemagatshel	AG-0139	15	150	150	150
040	Pemagatshel	AG-0140	15	150	150	150
041	Pemagatshel	AG-0141	15	150	150	150
042	Pemagatshel	AG-0142	15	150	150	150
043	Pemagatshel	AG-0143	15	150	150	150
044	Pemagatshel	AG-0144	15	150	150	150
045	Pemagatshel	AG-0145	15	150	150	150
046	Pemagatshel	AG-0146	15	150	150	150
047	Pemagatshel	AG-0147	15	150	150	150
048	Pemagatshel	AG-0148	15	150	150	150
049	Pemagatshel	AG-0149	15	150	150	150
050	Pemagatshel	AG-0150	15	150	150	150

6. Punakha Dzongkhag



Table 1: Summary of Data and Tables

Table No.	Table Description	Page No.
1	Table 1: Summary of Data and Tables	1
2	Table 2: Summary of Data and Tables	2
3	Table 3: Summary of Data and Tables	3
4	Table 4: Summary of Data and Tables	4
5	Table 5: Summary of Data and Tables	5
6	Table 6: Summary of Data and Tables	6
7	Table 7: Summary of Data and Tables	7
8	Table 8: Summary of Data and Tables	8
9	Table 9: Summary of Data and Tables	9
10	Table 10: Summary of Data and Tables	10
11	Table 11: Summary of Data and Tables	11
12	Table 12: Summary of Data and Tables	12
13	Table 13: Summary of Data and Tables	13
14	Table 14: Summary of Data and Tables	14
15	Table 15: Summary of Data and Tables	15
16	Table 16: Summary of Data and Tables	16
17	Table 17: Summary of Data and Tables	17
18	Table 18: Summary of Data and Tables	18
19	Table 19: Summary of Data and Tables	19
20	Table 20: Summary of Data and Tables	20
21	Table 21: Summary of Data and Tables	21
22	Table 22: Summary of Data and Tables	22
23	Table 23: Summary of Data and Tables	23
24	Table 24: Summary of Data and Tables	24
25	Table 25: Summary of Data and Tables	25
26	Table 26: Summary of Data and Tables	26
27	Table 27: Summary of Data and Tables	27
28	Table 28: Summary of Data and Tables	28
29	Table 29: Summary of Data and Tables	29
30	Table 30: Summary of Data and Tables	30
31	Table 31: Summary of Data and Tables	31
32	Table 32: Summary of Data and Tables	32
33	Table 33: Summary of Data and Tables	33
34	Table 34: Summary of Data and Tables	34
35	Table 35: Summary of Data and Tables	35
36	Table 36: Summary of Data and Tables	36
37	Table 37: Summary of Data and Tables	37
38	Table 38: Summary of Data and Tables	38
39	Table 39: Summary of Data and Tables	39
40	Table 40: Summary of Data and Tables	40
41	Table 41: Summary of Data and Tables	41
42	Table 42: Summary of Data and Tables	42
43	Table 43: Summary of Data and Tables	43
44	Table 44: Summary of Data and Tables	44
45	Table 45: Summary of Data and Tables	45
46	Table 46: Summary of Data and Tables	46
47	Table 47: Summary of Data and Tables	47
48	Table 48: Summary of Data and Tables	48
49	Table 49: Summary of Data and Tables	49
50	Table 50: Summary of Data and Tables	50

7. Samtse Dzongkhag


NATIONAL ENVIRONMENTAL COMMISSION
 Royal Government of Bhutan

No. 23/2011
 Environmental Clearance ARV/2011/2377

Environmental Clearance ARV/2011/2377

The National Environmental Commission (NEC) hereby grants environmental clearance for Assessment, Review, Electrification (ARV) project to Samtse Dzongkhag, in accordance with Article 1.3 under Section 5(1) with following terms and conditions:

- The holder shall ensure the implementation of the Environmental Impact Assessment (EIA) and mitigation of proposed/impending threat and share copy with your appropriate level.
- The holder shall ensure the maintenance of the environmental law and related laws, rules, orders, with National Environmental Commission for a 10% Environmental Clearance Act, 2000 and its Regulation, 2002.
- The holder shall ensure that water protection from the EIA assessment guidelines and the water supply is managed as per Water Protection and Management Act, 2009.
- The holder shall ensure the implementation of the policy and any other rule, regulation, order, and any other guidelines.
- Holder shall ensure that all activities are implemented as per guidelines and Terms, Conditions Act, 1998 and its subsidiary, with local government officials.
- Holder shall ensure the implementation of any (SOW) or any other activity.
- The holder shall be responsible for any damage arising from activities.
- The holder shall ensure the first aid kit is made available on site.
- The holder shall ensure the proper health check up facilities are provided for the employees and health check up is mandatory.
- The holder shall ensure that safety items are provided in storage houses within the construction site, including fire tools including the ones, other specific items guidelines are required to be used.
- The holder shall ensure the discharge of effluents are treated.
- The holder shall ensure that a copy of the environmental clearance is shared to all relevant authorities.
- The holder shall ensure the environmental level performance implementation of any activities in accordance with the law.
- Holder shall ensure that all environmental activities are implemented in accordance with Environmental Act, 2000 and its Regulation, 2002 and any other subsidiary of environmental clearance which has authority to be applied to the project.

The government clearance is valid upto December 31, 2011 and is subject to the following conditions:

The Executive Officer,
 Government and IRR Division
 Thimphu Secretariat,
 Thimphu.

YONG DORJE
 Head, IRR Division

The Executive Officer,
 Government and IRR Division
 Thimphu Secretariat,
 Thimphu.

Copy for your information to:

- District Controller, Thimphu, Administrative, Thimphu
- The Chief Executive Officer, Thimphu Secretariat, Thimphu
- Mr. Abhang, Bhutan Power Corporation, Thimphu
- Dzongkhag Government, DZONGKHAG, Thimphu, for necessary implementation.

Project Name	Location	Area (Ha)	Population	Estimated Investment (USD)	Estimated Annual Revenue (USD)	Estimated Annual Expenditure (USD)	Estimated Annual Net Income (USD)	Estimated Annual Net Income (%)	Estimated Annual Net Income (Bhutanese Ngultrum)
ARV/2011/2377	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2378	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2379	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2380	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2381	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2382	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2383	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2384	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2385	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2386	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2387	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2388	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2389	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2390	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2391	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2392	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2393	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2394	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2395	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2396	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2397	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2398	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2399	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2400	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0

Project Name	Location	Area (Ha)	Population	Estimated Investment (USD)	Estimated Annual Revenue (USD)	Estimated Annual Expenditure (USD)	Estimated Annual Net Income (USD)	Estimated Annual Net Income (%)	Estimated Annual Net Income (Bhutanese Ngultrum)
ARV/2011/2401	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2402	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2403	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2404	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2405	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2406	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2407	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2408	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2409	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2410	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2411	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2412	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2413	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2414	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2415	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2416	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2417	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2418	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2419	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0
ARV/2011/2420	Samtse Dzongkhag	150	10000	1000000	100000	100000	0	0%	0

8. Sarpang Dzongkhag

National Environment Commission
Royal Government of Bhutan

NOTIFICATION NO. 7443

Date: 16/10/2012

Subject: Environmental Clearance for ABB-4 Sarpang

The National Environment Commission (NEC) has approved the Environmental Clearance (EC) for the proposed project of installing 400KV substation and 110KV transmission line in Sarpang Dzongkhag, Thimphu, Bhutan.

Sl. No.	Location	Transmission Voltage (KV)	Length (Kms)	Remarks
1	Substation	400KV	0.1	2.5 Hectare
2	Transmission Line	110KV	1.0	100 Hectare
3	Total			102.5 Hectare

The NEC has approved the EC for the proposed project on the following conditions:

- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
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- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.

Date: 16/10/2012

For the National Environment Commission,
Secretary and CEO, National Environment Commission,
Thimphu

(Signature)

(Stamp)

Bhutan Power Corporation Limited
Engineering & Design Department
Thimphu, Bhutan

NOTIFICATION NO. 7443

Date: 16/10/2012

Subject: Forwarding of Environmental Clearance for ABB-4 Sarpang

The NEC has approved the EC for the proposed project on the following conditions:

- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
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The NEC has approved the EC for the proposed project on the following conditions:

- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.
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- The project shall comply with the Environmental Clearance (EC) Act, 2003 and Regulations to the Environmental Clearance (EC) Act, 2003.

Date: 16/10/2012

For the Bhutan Power Corporation Limited,
Secretary and CEO, Bhutan Power Corporation Limited,
Thimphu

(Signature)

(Stamp)




9. Trongsa Dzongkhag



Project Name	Project Location	Project Type	Project Status	Project Area (Ha)	Project Cost (Nu.)	Project Start Date	Project End Date	Project Completion Date
1	Trongsa	Electricity	Completed	1.5	1000000	2015	2016	2016
2	Trongsa	Electricity	Completed	2.0	1500000	2015	2016	2016
3	Trongsa	Electricity	Completed	3.0	2000000	2015	2016	2016
4	Trongsa	Electricity	Completed	4.0	2500000	2015	2016	2016
5	Trongsa	Electricity	Completed	5.0	3000000	2015	2016	2016
6	Trongsa	Electricity	Completed	6.0	3500000	2015	2016	2016
7	Trongsa	Electricity	Completed	7.0	4000000	2015	2016	2016
8	Trongsa	Electricity	Completed	8.0	4500000	2015	2016	2016
9	Trongsa	Electricity	Completed	9.0	5000000	2015	2016	2016
10	Trongsa	Electricity	Completed	10.0	5500000	2015	2016	2016
11	Trongsa	Electricity	Completed	11.0	6000000	2015	2016	2016
12	Trongsa	Electricity	Completed	12.0	6500000	2015	2016	2016
13	Trongsa	Electricity	Completed	13.0	7000000	2015	2016	2016
14	Trongsa	Electricity	Completed	14.0	7500000	2015	2016	2016
15	Trongsa	Electricity	Completed	15.0	8000000	2015	2016	2016
				11 Villages				
				31 Villages in Total				

10. Tsirang Dzongkhag



འབྲུག་རྒྱལ་ཁབ་འཕྲོད་སྐྱོད་ལྷན་ཁག་
(གསལ་བཟང་གྲྭ་ཚོ)
National Environmental Commission
Nepal Government of Bhutan

འབྲུག་རྒྱལ་ཁབ་འཕྲོད་སྐྱོད་ལྷན་ཁག་ རྒྱུག་གི་རྒྱལ་ཁབ་

No. _____

ཐོག་མཐུན་འཕྲོད་སྐྱོད་ལྷན་ཁག་གི་འཕྲོད་སྐྱོད་ལྷན་ཁག་

The National Environmental Commission under the Environment Conservation Act 2002 was following these are outlined for construction of following Investment Road Construction (KAT) Light road (RT) and two village (UV) Investment (one -one) Roadway (one) Light Roadway.

ལྷན་ཁག་	ཐོག་མཐུན་འཕྲོད་སྐྱོད་ལྷན་ཁག་	འཕྲོད་སྐྱོད་ལྷན་ཁག་	ལྷན་ཁག་ (མུ་མི་མཚའ་)	ལྷན་ཁག་ (མུ་མི་མཚའ་)	ལྷན་ཁག་
རྒྱུག་གི་རྒྱལ་ཁབ་	ཐོག་མཐུན་འཕྲོད་སྐྱོད་ལྷན་ཁག་	འཕྲོད་སྐྱོད་ལྷན་ཁག་	1500	7.4	
ལྷན་ཁག་	10000 - 15000		10	4.4	
ལྷན་ཁག་	10000 - 15000			7.4	

- As per Section 11.7 of the Regulation Rural Investment Road Construction of Investment Roadway shall be done of Investment Roadway shall be done with more approval than 50%.
- The license shall ensure that construction activities are done with minimum disturbance to the environment. The Environment Conservation Act (2002), Environment Amendment (2003), and Regulation of Environment Conservation (2003) are applied.
- The license shall ensure that all construction activities are carried out at an environmentally friendly manner as per the Regulation of Environment Conservation Act (2002).
- Wherever there is a building or structure or structure shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.
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2. The license shall ensure that all construction activities are carried out at an environmentally friendly manner as per the Regulation of Environment Conservation Act (2002).

3. Wherever there is a building or structure or structure shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

4. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

5. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.


6. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

7. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

8. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

9. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.

10. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment. The license shall ensure that the construction shall be done in a way that it shall not disturb the environment.



The Environmental Officer,
Investment and the Environment
Investment and the Environment
Investment and the Environment

Signed and Stamped by:

- The Chief Executive, Investment and the Environment, Thimphu
- The Chief Executive, Investment and the Environment, Thimphu
- The Chief Executive, Investment and the Environment, Thimphu
- The Chief Executive, Investment and the Environment, Thimphu
- The Chief Executive, Investment and the Environment, Thimphu

F.2 Feeder Length in Protected Areas

Table-F.1 and **Table-F.2** are shows the required area located in protected area and biological corridor.

Table-F.1 Located in protected Area and Biological Corridor (Sarpang)

SL	Gewog	Village Name	Feeder Name	Sub Feeder	Vol tage	MV Length (m)	Protected Aare/ Biological corridor
1	Dekiling	Rati goan/Chepchepay	ARE1M1	ARE1M1F01	11	2.8	○
2	Doban	Khargoan A		ARE1M1F01	11	0.9	○
3	Doban	Maugaon C		ARE1M1F02	11	12.1	○
4	Doban	Maugaon B		ARE1M1F03	11	1.1	
5	Doban	Maugaon A1		ARE1M1F04	11	0.9	
6	Doban	Maugaon A2		ARE1M1F05	11	0.6	
7	Doban	Bhimerey		ARE1M1F06	11	3.7	
8	Doban	Gungring		ARE1M1F06	11	1.7	
9	Doban	Ramitey-B		ARE1M1F06	11	1.6	
10	Doban	Pangkey BHU Area		ARE1M1F06	11	0.5	
11	Doban	Doban B		ARE1M1F06	11	0.9	
12	Doban	Doban C		ARE1M1F06	11	0.7	
13	Doban	Bichkhola-A		ARE1M1F06	11	1.6	
14	Doban	Bichkhola-B		ARE1M1F06	11	1.7	
15	Doban	Ramitya-A		ARE1M1F07	11	0.4	
16	Doban	Pangkay School		ARE1M1F08	11	0.2	
17	Doban	Upper Pangkay		ARE1M1F08	11	0.2	
18	Doban	pangkay Sheer		ARE1M1F08	11	1.1	
19	Doban	Ranikhop		ARE1M1F09	11	0.7	
20	Doban	Maukhola-B		ARE1M1F09	11	1.0	
21	Doban	Maukhola-A		ARE1M1F09	11	1.1	
22	Doban	Teerkhola-B		ARE1M1F010	11	1.1	
23	Doban	Teerkhola-A		ARE1M1F010	11	1.4	
24	Doban	Fedi		ARE1M1F010	11	3.0	
25	Doban	Torkay		ARE1M1F011	11	2.9	
26	Doban	Bichkhola-C/Machukhola		ARE1M1F012	11	1.0	
27	Doban	Mongargoan-B		ARE1M1F013	11	3.2	
28	Doban	Mongargoan-A		ARE1M1F014	11	2.1	
29	Doban	Pathibora-D		ARE1M1F015	11	0.2	
30	Doban	Pathibora-C		ARE1M1F015	11	1.2	
31	Doban	Pathibora-A/Tarkharka		ARE1M1F015	11	1.0	
32	Doban	Baragaray		ARE1M1F015	11	2.8	
33	Doban	Chepkhola/Dekuti		ARE1M1F016	11	1.3	
34	Doban	Pathibora Dara		ARE1M1F017	11	0.9	
35	Doban	Pathibora-B		ARE1M1F018	11	1.5	
36	Doban	Khargoan-B		ARE1M1F019	11	2.6	○
37	Doban	Mongargoan-C		ARE1M1F020	11	1.7	
38	Jigmechholing	Bagjuanggay A		ARE1M1F020	11	0.5	
39	Jigmechholing	Bagjuanggay B		ARE1M1F020	11	1.0	
40	Jigmechholing	Dungay		ARE1M1F020	11	1.6	
41	Jigmechholing	Garigoan		ARE1M1F021	11	2.2	
42	Jigmechholing	Gongdara A		ARE1M1F021	11	0.8	
43	Jigmechholing	Gongdara C		ARE1M1F021	11	0.9	
44	Jigmechholing	Kholatar		ARE1M1F021	11	0.9	
45	Jigmechholing	Reti		ARE1M1F021	11	6.6	○
46	Jigmechholing	Gongdara B		ARE1M1F022	11	1.3	
47	Jigmechholing	Mongar Goan		ARE1M1F022	11	0.7	
48	Jigmechholing	Virigoan		ARE1M1F023	11	1.2	
49	Jigmechholing	Gong Goan		ARE1M1F023	11	2.0	
50	Jigmechholing	Madaley		ARE1M1F024	11	1.1	
51	Jigmechholing	Ashaney		ARE1M1F024	11	1.2	
52	Jigmechholing	Samkharka A		ARE1M1F025	11	1.5	
53	Jigmechholing	Samkharka B		ARE1M1F025	11	0.8	
54	Jigmechholing	Sukumbasi A		ARE1M1F025	11	5.9	○
55	Jigmechholing	Sukumbasi B		ARE1M1F025	11	1.1	
56	Jigmechholing	Tormey		ARE1M1F025	11	3.4	○
57	Jigmechholing	Pakhay A		ARE1M1F026	11	1.1	
58	Jigmechholing	Pakhay B		ARE1M1F026	11	1.1	
59	Jigmechholing	Lower Daragoan		ARE1M1F026	11	1.2	
60	Tarathang	Bomchendara A	ARE1M2	ARE1M2F01	11	1.9	
61	Tarathang	Rangdara B	ARE1M2	ARE1M2F01	11	0.7	
62	Tarathang	Daragoan	ARE1M2	ARE1M2F01	11	1.4	
63	Dekiling	Derbethang	ARE1M2	ARE1M2F01	11	0.0	
Total						105.4	34.2

Table-F.2 Located in Protected Area (Wangdue)

SL.	Gewog	Village Name	Feeder Name	Sub Feeder	Voltage	MV Length (m)	ProtectedAares
1	Nahi	Pantsho Gonpa	ARE3S3	ARE3S3F01	33	2.5	
2	Sephu	Tsagatintin	ARE3S4	ARE3S4F01	33	1.0	
3	Sephu	Rabu		ARE3S4F01	33	1.9	
4	Sephu	Nangkha		ARE3S4F02	33	0.6	
5	Bjina	Dolongdo I	ARE3S5	ARE3S5F01	33	0.1	
6	Bjina	Dolongdo II	ARE3S6	ARE3S6F01	33	0.1	
7	Bjina	Dechen Draphu Lhakhang	ARE3S7	ARE3S7F01	33	1.8	
8	Athang	Tshangzomsa	ARE1S8	ARE1S8F01	11	0.5	○
9	Athang	Samthang		ARE1S8F01	11	7.6	○
10	Athang	Mitina		ARE1S8F01	11	2.0	○
11	Athang	Rukha		ARE1S8F01	11	3.2	○
12	Athang	Lamga		ARE1S8F01	11	1.6	○
13	Athang	Kashacheko		ARE1S8F02	11	1.1	○
14	Athang	Lawa/Thaphu		ARE1S8F03	11	1.2	○
Total						29,221	17.3

F.3 Important Speices (Foula and Fauna list of IEE/EIA reports)

The IEE/EIA reports show the list of flora and fauna, which were list found or expected to be found along the feeders. There is no detailed information of the confirmation time / the spot in IEE/EIA.

Table-F.3 shows the important species which are listed in the IEE / EIA reports.

Table-F.3 (1) The List of Important Species of the Project Site (Chukha Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Chukha	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
2	Chukha	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
3	Chukha	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
4	Chukha	mammal	Sambar	<i>Rusa unicolor</i>	VU	
5	Chukha	mammal	Wild pig	<i>Sus scrofa</i>	LC	
6	Chukha	mammal	Goral	<i>Naemorhedus goral</i>	NT	
7	Chukha	mammal	Rhesus macaque	<i>Macaca mulatta</i>	LC	
8	Chukha	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
9	Chukha	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
10	Chukha	mammal	Serow	<i>Capricornis sumatraensis</i>		Schedule1
11	Chukha	mammal	Rhesus macaque	<i>Macaca mulatta</i>	LC	
12	Chukha	bird	Asian koel	<i>Eudynamis scolopacea</i>	LC	
13	Chukha	bird	Black Drongo	<i>Dicrurus macrocercus</i>	LC	
14	Chukha	bird	Blue-naped Pitta	<i>Pitta nipalensis</i>	LC	
15	Chukha	bird	Brown Bush Warbler	<i>Bradypterus luteoventris</i>	LC	
16	Chukha	bird	Coppersmith Barbet	<i>Megalaima haemacephala</i>	LC	
17	Chukha	bird	Dusky Warbler	<i>Phylloscopus fuscatus</i>	LC	
18	Chukha	bird	Great Egret	<i>Casmerodius albus</i>	LC	
19	Chukha	bird	Grey Nightjar	<i>Caprimulgus indicus</i>	LC	
20	Chukha	bird	Grey Wagtail	<i>Motacilla cinerea</i>	LC	
21	Chukha	bird	Indian Robin	<i>Saxicoloides fulicatus</i>	LC	
22	Chukha	bird	Jungle Babbler	<i>Turdoides striata</i>	LC	
23	Chukha	bird	Jungle Myna	<i>Acridotheres fuscus</i>	LC	
24	Chukha	bird	Little Cormorant	<i>Phalacrocorax niger</i>	LC	
25	Chukha	bird	Little Egret	<i>Egretta garzetta</i>	LC	
26	Chukha	bird	Red-breasted Parakeet	<i>Psittacula alexandri</i>	LC	
27	Chukha	bird	Red-headed Vulture	<i>Sarcogyps calvus</i>	CR	
28	Chukha	bird	Richard's Pipit	<i>Anthus richardi</i>	LC	
29	Chukha	bird	River Lapwing	<i>Vanellus duvaucelii</i>	LC	
30	Chukha	bird	Rufous-winged Bushlark	<i>Mirafra assamica</i>	LC	
31	Chukha	bird	Rusty-capped Fulvetta	<i>Alcippe dubia</i>	LC	
32	Chukha	bird	Sand Lark	<i>Calandrella raytal</i>	LC	
33	Chukha	bird	White-browed Wagtail	<i>Motacilla madaraspatensis</i>	LC	

Table-F.3 (2) The List of Important Species of the Project Site (Dagana Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Dagana	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
2	Dagana	mammal	Capped Langur	<i>Trachypithecus pileatus</i>	VU	
3	Dagana	mammal	Common Leopard	<i>Panthera pardus</i>	NT	Schedule1
4	Dagana	mammal	Gaur	<i>Bos gaurus</i>	VU	Schedule1
5	Dagana	mammal	Himalayan Black Bear	<i>Selenarctos thibetanus</i>	LC	Schedule1
6	Dagana	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
7	Dagana	mammal	Sambar	<i>Cervus unicolor</i>	LC	
8	Dagana	mammal	Sloth Bear	<i>Melursus ursinus</i>	VU	
9	Dagana	mammal	Wild Dog	<i>Cuon alpinus</i>	EN	
10	Dagana	mammal	Wild pig	<i>Sus scrofa</i>	LC	
11	Dagana	bird	Striated Yuhina	<i>Yuhina castaniceps</i>	LC	
12	Dagana	bird	Yellow-Vented Warbler	<i>Phylloscopus Cantator</i>	LC	
13	Dagana	bird	Grey Treepie	<i>Dendrocitta formosae</i>	LC	
14	Dagana	bird	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	
15	Dagana	bird	White-crested Laughingthrush	<i>Garrulax leucolophus</i>	LC	
16	Dagana	bird	Blue-capped Rock Thrush	<i>Monticola cinclorhynchus</i>	LC	
17	Dagana	bird	Grey-hooded Warbler	<i>Secicercus xanthoschistos</i>	DD	
18	Dagana	bird	Mountain Scops owl	<i>Otus Spilocephalus</i>	LC	
19	Dagana	bird	Mountain Tailorbird	<i>Orthotomus ciuculatus</i>	LC	
20	Dagana	bird	Barred Cuckoo Dove	<i>Macropygia unchall</i>	LC	
21	Dagana	bird	Eurasian Tree Sparrow	<i>Passer montanus</i>	LC	
22	Dagana	bird	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	LC	
23	Dagana	bird	Maroon Oriole	<i>Oriolus traillii</i>	LC	
24	Dagana	bird	Plain Prinia	<i>Prinia inornata</i>	LC	
25	Dagana	bird	Crested Bunting	<i>Melophus lathami</i>	LC	
26	Dagana	bird	Spotted Forktail	<i>Enicurus maculatus</i>	LC	
27	Dagana	bird	Red-tailed Minla	<i>Minla ignotincta</i>	LC	
28	Dagana	bird	Short-billed Minivet	<i>Pericrocotus brevirostris</i>	LC	
29	Dagana	bird	Striped Tit Babbler	<i>Macronous gularis</i>	LC	

Table-F.3 (3) The List of Important Species of the Project Site (Haa Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Haa	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
2	Haa	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
3	Haa	mammal	Wild pig	<i>Sus scrofa</i>	LC	
4	Haa	mammal	Sambar	<i>Cervus unicolor</i>	LC	
5	Haa	bird	Long-tailed Shrike	<i>Lanius schach</i>	LC	
6	Haa	bird	Plain Martin	<i>Riparia paludicola</i>	LC	
7	Haa	bird	Mrs Gould's Sunbird	<i>Aethopyga gouldiae</i>	LC	
8	Haa	bird	Grey-sided Bush Warbler	<i>Cettia brunnifrons</i>	LC	
9	Haa	bird	Eyebrowed Thrush	<i>Turdus obscurus</i>	LC	
10	Haa	bird	Scaly-breasted Wren Babbler	<i>Pnoepyga albiventer</i>	LC	
11	Haa	bird	Grey-cheeked Warbler	<i>Seicercus poliogenys</i>	LC	
12	Haa	bird	Brownish-flanked Bush Warbler	<i>Cettia fortipes</i>	LC	
13	Haa	bird	Ferruginous Flycatcher	<i>Muscicapa ferruginea</i>	LC	
14	Haa	bird	Russet Sparrow	<i>Passer rutilans</i>	LC	
15	Haa	bird	Alpine Accentor	<i>Prunella collaris</i>	LC	
16	Haa	bird	Brown Wood Owl	<i>Strix leptogrammica</i>	LC	
17	Haa	bird	White-tailed Nuthatch	<i>Sitta himalayensis</i>	LC	
18	Haa	bird	Snowy-browed Flycatcher	<i>Ficedula hyperythra</i>	LC	
19	Haa	bird	Chestnut Thrush	<i>Turdus rubrocanus</i>	LC	
20	Haa	bird	Ashy-throated Warbler	<i>Phylloscopus maculipennis</i>	LC	
21	Haa	bird	Chestnut-tailed Minla	<i>Minla strigula</i>	LC	
22	Haa	bird	Large-billed Leaf Warbler	<i>Phylloscopus magnirostris</i>	LC	
23	Haa	bird	Rusty-flanked Treecreeper	<i>Certhia nipalensis</i>	LC	
24	Haa	bird	Fire-tailed Sunbird	<i>Aethopyga ignicauda</i>	LC	
25	Haa	bird	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	LC	
26	Haa	bird	Blue-throated Flycatcher	<i>Cyornis rubeculoides</i>	LC	
27	Haa	bird	Chestnut -bellied Nuthatch	<i>Sitta castanea</i>	LC	
28	Haa	bird	White-bellied Yuhina	<i>Erpornis zantholeuca</i>	LC	

Table-F.3 (4) The List of Important Species of the Project Site (Paro Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Paro	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
2	Paro	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
3	Paro	mammal	Wild pig	<i>Sus scrofa</i>	LC	
4	Paro	mammal	Sambar	<i>Cervus unicolor</i>	LC	
5	Paro	bird	Common Quail	<i>Coturnix coturnix</i>	LC	
6	Paro	bird	Mallard	<i>Anas platyrhynchos</i>	LC	
7	Paro	bird	Common teal	<i>Anas crecca</i>	LC	
8	Paro	bird	Common Merganser (Goosander)	<i>Mergus merganser</i>	LC	
9	Paro	bird	Green Sandpiper	<i>Tringa ochropus</i>	LC	
10	Paro	bird	Wood Sandpiper	<i>Tringa glareola</i>	LC	
11	Paro	bird	Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	
12	Paro	bird	Crested Goshawk	<i>Accipiter trivirgatus</i>	LC	
13	Paro	bird	Northern Goshawk	<i>Accipiter gentilis</i>	LC	
14	Paro	bird	Cattle Egret	<i>Bubulcus ibis</i>	LC	
15	Paro	bird	Yellow-billed Cough	<i>Pyrrhocorax graculus</i>	LC	
16	Paro	bird	White-collared Backbird	<i>Turdus albocinctus</i>	LC	
17	Paro	bird	Common Myna	<i>Acridotheres tristis</i>	LC	
18	Paro	bird	Black-throated Tit	<i>Aegithalos concinnus</i>	LC	
19	Paro	bird	Rufous-fronted Tit	<i>Aegithalos iouschistos</i>	LC	

Table-F.3 (5) The List of Important Species of the Project Site (Pemagatshel Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Pema Gatshel	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
2	Pema Gatshel	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
3	Pema Gatshel	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
4	Pema Gatshel	mammal	Wild pig	<i>Sus scrofa</i>	LC	
5	Pema Gatshel	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
6	Pema Gatshel	mammal	Sambar	<i>Cervus unicolor</i>	LC	
7	Pema Gatshel	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
8	Pema Gatshel	bird	Hill partridge	<i>Arborophila torqueola</i>	LC	
9	Pema Gatshel	bird	Great Barbet	<i>Megalaima virens</i>	LC	
10	Pema Gatshel	bird	Golden-throated Barbet	<i>Megalaima franklinii</i>	LC	
11	Pema Gatshel	bird	Black Drongo	<i>Dicrurus macrocercus</i>	LC	
12	Pema Gatshel	bird	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	
13	Pema Gatshel	bird	Orange-bellied Leafbird	<i>Chloropsis hardwickii</i>	LC	
14	Pema Gatshel	bird	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	
15	Pema Gatshel	bird	Grey Treepie	<i>Dendrocitta formosae</i>	LC	
16	Pema Gatshel	bird	Long-tailed Shrike	<i>Lanius Schach</i>	LC	
17	Pema Gatshel	bird	Green-backed Tit	<i>Parus monticolus</i>	LC	
18	Pema Gatshel	bird	Striated Prinia	<i>Prinia crinigera</i>	LC	
19	Pema Gatshel	bird	Lesser Cuckoo	<i>Cuculus poliocephalus</i>	LC	
20	Pema Gatshel	bird	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	LC	
21	Pema Gatshel	bird	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	LC	
22	Pema Gatshel	bird	Spotted Dove	<i>Stigmatopelia chinensis</i>	LC	
23	Pema Gatshel	bird	Oriental Magpie Robin	<i>Copsychus saularis</i>	LC	
24	Pema Gatshel	bird	Black Eagle	<i>Ictinaetus malayensis</i>	LC	
25	Pema Gatshel	bird	Common kestrel	<i>Falco tinnunculus</i>	LC	
26	Pema Gatshel	bird	Great Hornbill	<i>Buceros bicornis</i>	NT	
27	Pema Gatshel	bird	Indian Cuckoo	<i>Cuculus micropterus</i>	LC	
28	Pema Gatshel	bird	Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	

Table-F.3 (6) The List of Important Species of the Project Site (Punaka Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Punaka	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
2	Punaka	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule I
3	Punaka	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
4	Punaka	mammal	Sambar	<i>Cervus unicolor</i>	LC	
5	Punaka	mammal	Wild pig	<i>Sus scrofa</i>	LC	
6	Punaka	mammal	Goral	<i>Naemorhedus goral</i>	NT	
7	Punaka	mammal	Rhesus macaque	<i>Macaca mulatta</i>	LC	
8	Punaka	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
9	Punaka	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule I
10	Punaka	mammal	Serow	<i>Capricornis sumatraensis</i>		Schedule I
11	Punaka	mammal	Rhesus macaque	<i>Macaca mulatta</i>	LC	
12	Punaka	bird	Ashy drongo	<i>Dicrurus leucophaeus</i>	LC	
13	Punaka	bird	Asian house martin	<i>Delichon dasypus</i>	LC	
14	Punaka	bird	Black drongo	<i>Dicrurus macrocercus</i>	LC	
15	Punaka	bird	Black-faced laughing thrush	<i>Garrulax affinis</i>	LC	
16	Punaka	bird	Blue whistling thrush	<i>Myophonus caeruleus</i>	LC	
17	Punaka	bird	Common hoopoe	<i>Upupa epops</i>	LC	
18	Punaka	bird	Common kestrel	<i>Falco tinnunculus</i>	LC	
19	Punaka	bird	Common myna	<i>Acridotheres tristis</i>	LC	
20	Punaka	bird	Darjeeling woodpecker	<i>Dendrocopos darjellensis</i>	LC	
21	Punaka	bird	Drongo cuckoo	<i>Surniculus lugubris</i>	LC	
22	Punaka	bird	Eurasian golden oriole	<i>Oriolus oriolus</i>	LC	
23	Punaka	bird	Eurasian tree sparrow	<i>Passer montanus</i>	LC	
24	Punaka	bird	Fork-tailed swift	<i>Apus pacificus</i>	LC	
25	Punaka	bird	Great barbet	<i>Megalaima virens</i>	LC	
26	Punaka	bird	Grey treepie	<i>Dendrocitta formosae</i>	LC	
27	Punaka	bird	Himalayan swiftlet	<i>Collocalia brevirostris</i>	LC	
28	Punaka	bird	Large-billed crow	<i>Corvus macrorhynchos</i>	LC	
29	Punaka	bird	Mrs Gould's sunbird	<i>Aethopyga gouldiae</i>	LC	
30	Punaka	bird	Spotted Nutcracker	<i>Nucifraga caryocatactes</i>	LC	
31	Punaka	bird	Oriental turtle dove	<i>Streptopelia orientalis</i>	LC	
32	Punaka	bird	Rock pigeon	<i>Columba livia</i>	LC	
33	Punaka	bird	Rufous-bellied woodpecker	<i>Dendrocopos hyperythrus</i>	LC	
34	Punaka	bird	Russet sparrow	<i>Passer rutilans</i>	LC	
35	Punaka	bird	Spotted dove	<i>Stigmatopelia chinensis</i>	LC	
36	Punaka	bird	Tickell's leaf warbler	<i>Phylloscopus affinis</i>	LC	
37	Punaka	bird	White wagtail	<i>Motacilla alba</i>	LC	
38	Punaka	bird	White-throated laughing thrush	<i>Garrulax albogularis</i>	LC	
39	Punaka	bird	Yellow-billed blue magpie	<i>Urocissa flavirostris</i>	LC	
40	Punaka	bird	Yellow-vented Warbler	<i>Phylloscopus cantator</i>	LC	

Table-F.3 (7) The List of Important Species of the Project Site (Samtse Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Samtse	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
2	Samtse	mammal	Clouded Leopard	<i>Neofelis nebulosa</i>	VU	Schedule1
3	Samtse	mammal	Himalayan yellow-throated marten	<i>Martes flavigula</i>	LC	
4	Samtse	mammal	Gaur	<i>Bos gaurus</i>	VU	Schedule1
5	Samtse	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
6	Samtse	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
7	Samtse	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
8	Samtse	mammal	Serow	<i>Capricornis sumatraensis</i>		Schedule1
9	Samtse	mammal	Small Indian Civet	<i>Viverricula indica</i>	LC	
10	Samtse	mammal	Wild pig	<i>Sus scrofa</i>	LC	
11	Samtse	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
12	Samtse	mammal	Sloth bear	<i>Melursus ursinus</i>	VU	
13	Samtse	mammal	Sambar	<i>Cervus unicolor</i>	LC	
14	Samtse	mammal	Goral	<i>Naemorhedus goral</i>	NT	
15	Samtse	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
16	Samtse	bird	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	
17	Samtse	bird	Asian koel	<i>Eudynamis scolopacea</i>	LC	
18	Samtse	bird	Asian Pied Starling	<i>Sturnus contra</i>	LC	
19	Samtse	bird	Black-hooded Oriole	<i>Oriolus xanthornus</i>	LC	
20	Samtse	bird	Blue-naped Pitta	<i>Pitta nipalensis</i>	LC	
21	Samtse	bird	Blyth's Leaf Warbler	<i>Phylloscopus reguloides</i>	LC	
22	Samtse	bird	Chestnut-bellied Nuthatch	<i>Sitta castanea</i>	LC	
23	Samtse	bird	Common Green Magpie	<i>Cissa chinensis</i>	LC	
24	Samtse	bird	Common Kestrel	<i>Falco tinnunculus</i>	LC	
25	Samtse	bird	Common Tailorbird	<i>Orthotomus sutorius</i>	LC	
26	Samtse	bird	Crimson Sunbird	<i>Aethopyga siparaja</i>	LC	
27	Samtse	bird	Dusky Warbler	<i>Phylloscopus fuscatus</i>	LC	
28	Samtse	bird	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	LC	
29	Samtse	bird	Fulvous-breasted Woodpecker	<i>Dendrocopos macei</i>	LC	
30	Samtse	bird	Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	LC	
31	Samtse	bird	Grey-breasted Prinia	<i>Prinia hodgsonii</i>	LC	
32	Samtse	bird	Grey-hooded Warbler	<i>Phylloscopus xanthoschistos</i>	LC	
33	Samtse	bird	Grey-throated Babbler	<i>Stachyris nigriceps</i>	LC	
34	Samtse	bird	Himalayan Swiftlet	<i>Collocalia brevirostris</i>	LC	
35	Samtse	bird	Hodgson's Redstart	<i>Phoenicurus hodgsoni</i>	LC	
36	Samtse	bird	Indian Pond Heron	<i>Ardeola grayii</i>	LC	
37	Samtse	bird	Indian Robin	<i>Saxicolides Fulicata</i>	LC	
38	Samtse	bird	Indian Peafowl	<i>Pavo cristatus</i>	LC	
39	Samtse	bird	Jungle Babbler	<i>Turdoides striata</i>	LC	
40	Samtse	bird	Jungle Myna	<i>Acridotheres fuscus</i>	LC	
41	Samtse	bird	Large Woodshrike	<i>Tephrodornis gularis</i>	LC	
42	Samtse	bird	Large-tailed Nightjar	<i>Caprimulgus imacrus</i>	LC	
43	Samtse	bird	Lesser coucal	<i>Centropus bengalensis</i>	LC	
44	Samtse	bird	Little Egret	<i>Egretta garzetta</i>	LC	
45	Samtse	bird	Maroon Oriole	<i>Oriolus traillii</i>	LC	
46	Samtse	bird	Puff-throated Babbler	<i>Pellorneum ruficeps</i>	LC	
47	Samtse	bird	Pygmy Wren Babbler	<i>Pnoepyga pusilla</i>	LC	
48	Samtse	bird	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	
49	Samtse	bird	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	LC	
50	Samtse	bird	Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	
51	Samtse	bird	Rufous-necked Laughingthrush	<i>Garrulax ruficollis</i>	LC	

Table-F.3 (8) The List of Important Species of the Project Site (Sarpang Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Sarpang	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
2	Sarpang	mammal	Clouded Leopard	<i>Neofelis nebulosa</i>	VU	Schedule1
3	Sarpang	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule1
4	Sarpang	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
5	Sarpang	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule1
6	Sarpang	mammal	Serow	<i>Capricomis sumatraensis</i>		Schedule1
7	Sarpang	mammal	Wild pig	<i>Sus scrofa</i>	LC	
8	Sarpang	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
9	Sarpang	mammal	Sloth bear	<i>Melursus ursinus</i>	VU	
10	Sarpang	mammal	Sambar	<i>Cervus unicolor</i>	LC	
11	Sarpang	mammal	Goral	<i>Naemorhedus goral</i>	NT	
12	Sarpang	mammal	Asian Elephant	<i>Elephas maximus</i>	EN	Schedule1
13	Sarpang	bird	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	
14	Sarpang	bird	Ashy Woodswallow	<i>Artamus fuscus</i>	LC	
15	Sarpang	bird	Asian koel	<i>Eudynamis scolopacea</i>	LC	
16	Sarpang	bird	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	LC	
17	Sarpang	bird	Barred Cuckoo Dove	<i>Macropygia unchall</i>	LC	
18	Sarpang	bird	Black-crested Bulbul	<i>Pycnonotus melanicterus</i>	LC	
19	Sarpang	bird	Blue-capped Rock Thrush	<i>Monticola cinclorhynchus</i>	LC	
20	Sarpang	bird	Blue-eared Barbet	<i>Megalaima australis</i>	LC	
21	Sarpang	bird	Blue-throated Barbet	<i>Megalaima asiatica</i>	LC	
22	Sarpang	bird	Blyth's Leaf Warbler	<i>Phylloscopus reguloides</i>	LC	
23	Sarpang	bird	Boreal Hawk Owl	<i>Ninox scutulata</i>	LC	
24	Sarpang	bird	Chestnut-winged Cuckoo	<i>Clamator coromandus</i>	LC	
25	Sarpang	bird	Collared Falconet	<i>Microhierax caerulescens</i>	LC	
26	Sarpang	bird	Common Hill Partridge	<i>Arborophila Torqueola</i>	LC	
27	Sarpang	bird	Common Stonechat	<i>Saxicola torquatus</i>	LC	
28	Sarpang	bird	Crow-billed Drongo	<i>Dicrurus annectans</i>	LC	
29	Sarpang	bird	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	LC	
30	Sarpang	bird	Large Cuckooshrike	<i>Coracina macei</i>	LC	
31	Sarpang	bird	Red-breasted Parakeet	<i>Psittacula alexandri</i>	LC	
32	Sarpang	bird	Rose-ringed Parakeet	<i>Psittacula krameri</i>	LC	
33	Sarpang	bird	Rosy Minivet	<i>Pericrocotus roseus</i>	LC	
34	Sarpang	bird	Ruby-cheeked Sunbird	<i>Anthreptes singalensis</i>	LC	
35	Sarpang	bird	Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	
36	Sarpang	bird	Rufous-faced Warbler	<i>Abroscopus albogularis</i>	LC	
37	Sarpang	bird	White-browed Wagtail	<i>Motacilla madaraspatensis</i>	LC	
38	Sarpang	bird	Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU	
39	Sarpang	bird	Great Hornbill	<i>Buceros bicornis</i>	NT	

Table-F.3 (9) The List of Important Species of the Project Site (Tongsa Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Tongsa	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule I
2	Tongsa	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
3	Tongsa	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule I
4	Tongsa	mammal	Wild pig	<i>Sus scrofa</i>	LC	
5	Tongsa	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
6	Tongsa	mammal	Sambar	<i>Cervus unicolor</i>	LC	
7	Tongsa	mammal	Tiger	<i>Panthera tigris</i>	EN	Schedule I
8	Tongsa	mammal	Himalayan yellow throated marten	<i>Martes flavigula</i>	LC	
9	Tongsa	mammal	Goral	<i>Naemorhedus goral</i>	NT	
10	Tongsa	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
11	Tongsa	bird	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	
12	Tongsa	bird	Black Drongo	<i>Dicrurus macrocercus</i>	LC	
13	Tongsa	bird	Blue Rock Thrush	<i>Monticola solitarius</i>	LC	
14	Tongsa	bird	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	LC	
15	Tongsa	bird	Blue-throated Barbet	<i>Megalaima asiatica</i>	LC	
16	Tongsa	bird	Greater Spotted Eagle	<i>Aquila clanga</i>	VU	
17	Tongsa	bird	House Crow	<i>Corvus splendens</i>	LC	
18	Tongsa	bird	house Sparrow	<i>Passer domesticus</i>	LC	
19	Tongsa	bird	Kalij Pheasant	<i>Lophura leucomelanos</i>	LC	
20	Tongsa	bird	Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	
21	Tongsa	bird	Lesser cuckoo	<i>Cuculus poliocephalus</i>	LC	
22	Tongsa	bird	Lesser yellownape	<i>Picus chlorolophus</i>	LC	
23	Tongsa	bird	Long-tailed Shrike	<i>Lanius schach</i>	LC	
24	Tongsa	bird	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	LC	
25	Tongsa	bird	Oriental Cuckoo	<i>Cuculus saturatus</i>	LC	
26	Tongsa	bird	Red Junglefowl	<i>Gallus gallus</i>	LC	
27	Tongsa	bird	Rock Pigeon	<i>Columba livia</i>	LC	
28	Tongsa	bird	Russet Sparrow	<i>Passer rutilans</i>	LC	
29	Tongsa	bird	Speckled Piculet	<i>Picumnus innominatus</i>	LC	
30	Tongsa	bird	Speckled Wood Pigeon	<i>Columba pulchricollis</i>	LC	

Table-F.3(10) The List of Important Species of the Project Site (Tirang Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Tirang	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
2	Tirang	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule I
3	Tirang	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
4	Tirang	mammal	Sambar	<i>Cervus unicolor</i>	LC	
5	Tirang	mammal	Wild pig	<i>Sus scrofa</i>	LC	
6	Tirang	mammal	Goral	<i>Naemorhedus goral</i>	NT	
7	Tirang	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
8	Tirang	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule I
9	Tirang	mammal	Serow	<i>Capricornis sumatraensis</i>		Schedule I
10	Tirang	mammal	Rhesus macaque	<i>Macaca mulatta</i>	LC	
11	Tirang	bird	Rufous-throated Partridge	<i>Arborophila rufogularis</i>	LC	
12	Tirang	bird	Indian Peafowl	<i>Pavo cristatus</i>	LC	
13	Tirang	bird	Blue-throated Barbet	<i>Megalaima asiatica</i>	LC	
14	Tirang	bird	Drongo Cuckoo	<i>Surniculus lugubris</i>	LC	
15	Tirang	bird	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	LC	
16	Tirang	bird	Dark-rumped Swift	<i>Apus acuticauda</i>	VU	
17	Tirang	bird	Rock Pigeon	<i>Columba livia</i>	LC	
18	Tirang	bird	Spotted Dove	<i>Stigmatopelia chinensis</i>	LC	
19	Tirang	bird	Emerald Dove	<i>Chalcophaps indica</i>	LC	
20	Tirang	bird	River Lapwing	<i>Vanellus duvaucelii</i>	LC	
21	Tirang	bird	Black Drongo	<i>Dicrurus macrocercus</i>	LC	
22	Tirang	bird	Blue-throated Flycatcher	<i>Cyornis rubeculoides</i>	LC	
23	Tirang	bird	Black-backed Forktail	<i>Enicurus immaculatus</i>	LC	
24	Tirang	bird	Slaty-backed Forktail	<i>Enicurus schistaceus</i>	LC	
25	Tirang	bird	Jungle Myna	<i>Acridotheres fuscus</i>	LC	
26	Tirang	bird	Beautiful Nuthatch	<i>Sitta formosa</i>	VU	
27	Tirang	bird	White-throated Bulbul	<i>Alophoixus flaveolus</i>	LC	
28	Tirang	bird	Greenish Warbler	<i>Phylloscopus trochiloides</i>	LC	
29	Tirang	bird	Jungle Babbler	<i>Turdoides striata</i>	LC	
30	Tirang	bird	White-bellied Yuhina	<i>Erpornis zantholeuca</i>	LC	
31	Tirang	bird	Grey Wagtail	<i>Motacilla cinerea</i>	LC	
32	Tirang	bird	White-rumped Munia	<i>Lonchura striata</i>	LC	

Table-F.3 (11) The List of Important Species of the Project Site (Wangdue Dzongkhag)

D-No	Dzongkhag	Category	Common Name	Scientific Name	Red List	Schedule
1	Wangdue	mammal	Tiger	<i>Panthera tigris</i>	EN	Schedule I
2	Wangdue	mammal	Wild dog	<i>Cuon alpinus</i>	EN	
3	Wangdue	mammal	Leopard	<i>Panthera pardus</i>	NT	Schedule I
4	Wangdue	mammal	Leopard Cat	<i>Prionailurus bengalensis</i>	LC	
5	Wangdue	mammal	Himalayan striped squirrel	<i>Tamias macclellandii</i>	LC	
6	Wangdue	mammal	Sambar	<i>Cervus unicolor</i>	LC	
7	Wangdue	mammal	Wild pig	<i>Sus scrofa</i>	LC	
8	Wangdue	mammal	Goral	<i>Naemorhedus goral</i>	NT	
9	Wangdue	mammal	Assamese macaque	<i>Macaca assamensis</i>	NT	
10	Wangdue	mammal	Himalayan Black Bear	<i>Ursus thibetanus</i>	LC	Schedule I
11	Wangdue	mammal	Serow	<i>Capricornis sumatraensis</i>		Schedule I
12	Wangdue	bird	Blue -throated barbet	<i>Megalaima asiatica</i>	LC	
13	Wangdue	bird	Blue whistling thrush	<i>Myophonus caeruleus</i>	LC	
14	Wangdue	bird	Black crested bulbul	<i>Pycnonotus melanicterus</i>	LC	
15	Wangdue	bird	Brown dipper	<i>Cinclus pallasii</i>	LC	
16	Wangdue	bird	Common kestrel	<i>Falco tinnunculus</i>	LC	
17	Wangdue	bird	Common hill partridge	<i>Arborophila torqueola</i>	LC	
18	Wangdue	bird	Eurasian tree sparrow	<i>Passer montanus</i>	LC	
19	Wangdue	bird	Golden throated barbet	<i>Megalaima franklinii</i>	LC	
20	Wangdue	bird	Great barbet	<i>Megalaima virens</i>	LC	
21	Wangdue	bird	Green-backed tit	<i>Parus monticolus</i>	LC	
22	Wangdue	bird	Green-tailed sunbird	<i>Aethopyga nipalensis</i>	LC	
23	Wangdue	bird	Grey-hooded warbler	<i>Phylloscopus xanthoschistos</i>	LC	
24	Wangdue	bird	Grey treepie	<i>Dendrocitta formosae</i>	LC	
25	Wangdue	bird	Kalij pheasant	<i>Lophura leucomelanos</i>	LC	
26	Wangdue	bird	Oriental turtle dove	<i>Streptopelia orientalis</i>	LC	
27	Wangdue	bird	Orange-flanked bush robin	<i>Tarsiger cyanurus</i>	LC	
28	Wangdue	bird	Red-vented bulbul	<i>Pycnonotus cafer</i>	LC	
29	Wangdue	bird	Red-tailed minla	<i>Minla ignotincta</i>	LC	
30	Wangdue	bird	River lapwing	<i>Vanellus duvaucelii</i>	LC	
31	Wangdue	bird	Slatty-backed forktail	<i>Enicurus schistaceus</i>	LC	
32	Wangdue	bird	Speckled wood pigeon	<i>Columba hodgsonii</i>	LC	
33	Wangdue	bird	Yellow-billed blue magpie	<i>Urocissa flavirostris</i>	LC	

Table-F.3 (12) The List of Important Species of the Project Site (All Dzongkhag Plant)

No	Scientific Name	IUCN Red List	Dzongkhak
1	<i>Engelhardtia spicata</i>	LR/Lc	1 Sarpang
2	<i>Pinus bhutanica</i>	LC	1 Pema Gatshel
3	<i>Pinus roxburghii</i>	LR/Lc	6 Dagana, Pema Gatshel, Punaka, Tongsa, Tirang, Wangdue
4	<i>Shorea robusta</i>	LR/Lc	1 Samtse

Prepared by JBIC SAPROF Study Team

Note: Red List; IUCN Red List, Schedule: Species listed in the Bhutan Forest and Nature Conservation Act

Category in Red List:

EN: Endangered, VU: Vulnerable, LC: Least Concern, LR/lc: Lower Risk, least concern,

LR/nt: Lower Risk, near threatened

Note: Prepared JICA Preparatory Survey Team based on IEE/EIA reports Produced by ADB PPTA study Team

F.4 JBIC Checklist for Confirmation of Social and Environmental Consideration

JBIC checklists prepared for 11 Dzongkhags targeted in the Phase 2 were shown as **Table-F.4**.

Table-F.4 JBIC Checklist Prepared for the Project

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
1 Permits and Explanation	(1) EIA and Environmental Permits	1) Have EIA reports been officially completed?	Yes, EIA reports have been officially completed on 10 March 2010 and submitted to the National Environmental Commission (NEC) on 12 March 2010.	According to the Regulation for the Environmental Clearance of projects (2002), the requirements of EIA procedure for the project with sensitive nature such as development project is judged through the environmental screening by NEC. The project in Wangdue was judged to be enough by IEE procedure. The IEE has been completed in 14 April 2010.	According to the Regulation for the Environmental Clearance of projects (2002), the requirements of EIA procedure for the project with sensitive nature such as development project is judged through the environmental screening by NEC. The projects in above 9 dzongkhags were judged to be enough by IEE procedure. The IEE has been completed in 1 April 2010 for Chukha, Dagana, Tsirang, and 18 January 2010 for the rest of areas. As for the additional feeders in Chuka, Dagana and Tshirang, IEE reports are under preparing as of November, 2010.
		2) Have EIA reports been approved by authorities of the host country's government?	Yes, EIA reports have been approved on 10 May 2010 as Environmental Clearance (EC) by NEC.	IEE reports have been approved on 21 May 2010 as Environmental Clearance (EC) by National Environmental Commission (NEC).	IEE reports have been approved on 10 May 2010 for Tsirang and 21 May 2010 for the rest of areas as Environmental Clearance (EC) by National Environmental Commission (NEC). As for the additional feeders in Chuka, Dagana and Tshirang, IEE reports are under preparing as of November, 2010.
		3) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	EC was issued with standard terms and conditions for its compliance. These conditions are confirmation of regulation obeying, confirmation of project contents, and employee's health and safety mainly. These conditions are basic contents to do the projects and satisfied by mitigation measurements in EIA.	EC was issued with standard terms and conditions for its compliance. These conditions are confirmation of regulation obeying, confirmation of project contents, and employee's health and safety mainly. These conditions are basic contents to do the projects and satisfied by mitigation measurements in IEE.	EC was issued with standard terms and conditions for its compliance. These conditions are confirmation of regulation obeying, confirmation of project contents, and employee's health and safety mainly. These conditions are basic contents to do the projects and satisfied by and mitigation measurements in IEE.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
1 Permits and Explanation	(1) EIA and Environmental Permits	4) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	No, The following environmental permits have been obtained; 1) Forestry clearance, 2) Approval of local communities and Dzongkhag Administration. Based on the permits obtained, EC has been issued.	No, The following environmental permits have been obtained; 1) Forestry clearance, 2) Approval of local communities and Dzongkhag Administration. Based on the permits obtained, EC has been issued.	No, The following environmental permits have been obtained; 1) Forestry clearance, 2) Approval of local communities and Dzongkhag Administration. Based on the permits obtained, EC has been issued.
	(2) Explanation to the Public	1) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public?	Yes, contents of the project, the positive and negative impacts adequately explained to the public in a public consultation held on 10 Feb 2010 by BPC. Yes, understanding obtained from the public.	Yes, contents of the project, the positive and negative impacts adequately explained to the public in a public consultation during the route survey by BPC. Yes, understanding obtained from the public.	Yes, contents of the project, the positive and negative impacts adequately explained to the public in a public consultation during route survey by BPC. Yes, understanding obtained from the public.
		2) Are proper responses made to comments from the public and regulatory authorities?	Yes, a summary of the meeting is attached in EIA report.	Although the IEE report does not include the public consultation in detail, the copy of official letter memorandum of agreement cum application for rural electrification of a village is attached in IEE report.	Although the IEE report does not include the public consultation in detail, the copy of official letter memorandum of agreement cum application for rural electrification of a village is attached in IEE report.
2 Mitigation Measures	(1) Water Quality	1) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If water quality degradation is anticipated, are adequate measures considered?	No, degradation of water quality is not anticipated, since the project is no large land modification such as cutting and filling.	No, degradation of water quality is not anticipated, since the project is no large land modification such as cutting and filling.	No, degradation of water quality is not anticipated, since the project is no large land modification such as cutting and filling.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
3 Natural Environment	(1) Protected Areas	<p>1) Is the project site located in protected areas designated by the country's laws or international treaties and conventions?</p> <p>Is there a possibility that the project will affect the protected areas?</p>	<p>Yes, the feeder ARE1M11 is located in Jigme Singye Wangchuck National Park and Biological Corridor. Other feeders are not located in any protected area.</p> <p>Yes, however, people have already lived in the Park and ARE1M11 proposed line is along the existing footpath and mule track. Therefore, the impact on the forests would be minimum.</p>	<p>Yes, the feeder ARE1S8 is located in Jigme Singye Wangchuck National Park. Other feeders are not located in any protected area.</p> <p>Yes, however, people have already lived in the Park and ARE1S8 proposed line is along the existing feeder road which vehicle can use, the footpath and mule track. Therefore, the impact on the forests would be minimum.</p>	<p>No, the feeder is not located in any protected area or biological corridors.</p>
	(2) Ecosystem	<p>1) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?</p>	<p>The feeder traverses 80.9 km of broadleaf forest and 5.4 km of scrub. Among these, 34.2 km of feeder is located inside the protected area and biological corridor. Standard Row width is 10 m for 11 kV. Mitigation measures are provided that the use of covered conductor will reduce Row to 6 m in the protected area and biological corridor.</p>	<p>The feeder traverses 17.3 km of broadleaf forest, conifer and scrub. Among these, 17.3 km of feeder is located inside the National Park. Standard Row width is 12 m for 33 kV, 10 m for 11 kV. Mitigation measures are provided that the use of covered conductor will reduce Row to 6 m in the protected area.</p>	<p>The feeder traverses following length of the forest. Chuka: 31.9 km, Dagana: 49.6 km, Haa: 23.0 km, Paro: 11.7 km, Pemagatshel: 14.8 km, Punaka: 9.8 km, Samtse: 70.7 km, Trongsa: 30.4 km, Tsirang: 9.8 km Standard Row width is 12 m for 33 kV, 10 m for 11 kV. As for the additional feeder in Chuka, Dagana and Tshirang, the feeder traverses length of the forest is under preparing as of November, 2010 and will be reported in IEE report.</p>

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
3 Natural Environment	(2) Ecosystem	2) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?	The EIA report shows list of flora and fauna, which were found or expected to be found along the feeders. There is no detailed information of the confirmation time / the spot in EIA. It is possible that some project site include the habitat area of species listed as important species in the Red List issued by IUCN and in Schedule 1 of the Forest and Nature Conservation Act of Bhutan. According to the specialist study on fauna and flora, the Rufus necked-Hornbill was sighted (it was listed as Vulnerable in the IUCN Red list).	The IEE report shows list of flora and fauna, which were list found or expected to be found along the feeders. There is no detailed information of the confirmation time / the spot in IEE. It is possible that some project site include the habitat area of species listed as important species in the Red List issued by IUCN and in Schedule 1 of the Forest and Nature Conservation Act of Bhutan.	The IEE report shows list of flora and fauna, which were list found or expected to be found along the feeders. There is no detailed information of the confirmation time / the spot in IEE. It is possible that some project site include the habitat area of species listed as important species in the Red List issued by IUCN and in Schedule 1 of the Forest and Nature Conservation Act of Bhutan.
		3) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	Yes, the mitigation measures such as avoidance of unnecessary tree clearing will be applied. Most of the proposed distribution lines go along the existing footpath/mule track so that impact on ecosystem is not significant.	Yes, the mitigation measures such as avoidance of unnecessary tree clearing will be applied. Most of the proposed distribution lines go along the existing footpath/mule track so the impact on ecosystem is not significant.	Yes, the mitigation measures such as avoidance of unnecessary tree clearing will be applied. Most of the proposed distribution lines go along the existing footpath/mule track so the impact on ecosystem is not significant .
		4) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife, and livestock?	The impact on migration or habitat fragmentation of wildlife and livestock is insignificant, Since migration of wildlife is not expected, and the livestock would able to migrate under distribution lines.	The impact on migration or habitat fragmentation of wildlife and livestock is insignificant, Since migration of wildlife is not expected, and the livestock would able to migrate under distribution lines.	The impact on migration or habitat fragmentation of wildlife and livestock is insignificant, Since migration of wildlife is not expected, and the livestock would able to migrate under distribution lines.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
3 Natural Environment	(2) Ecosystem	5) Is there a possibility that improved access by the project will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered?	No, such issues are not anticipated because of the reason given above. Regarding the poaching, mitigation measures such as prohibition of hunting and fishing by workers and its strict enforcement . The adequate measures for the impact are not required.	No, such issues are not anticipated because of the reason given above. Regarding the poaching, mitigation measures such as prohibition of hunting and fishing by workers and its strict enforcement . The adequate measures for the impact are not required.	No, such issues are not anticipated because of the reason given above. Regarding the poaching, mitigation measures such as prohibition of hunting and fishing by workers and its strict enforcement . The adequate measures for the impact are not required.
		6) In cases where the project site is located in undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	No, project sites of the rural electrification are quite long, but require very narrow liner area. As most of the proposed distribution lines go along the existing footpath/mule track and nature in a wide area remains around the project site, it seems that the new development will not result in extensive loss of natural environments.	No, project sites of the rural electrification are quite long, but require very narrow liner area. As most of the proposed distribution lines go along the footpath/mule track and nature in a wide area remains around the project site, it seems that the new development will not result in extensive loss of natural environments.	No, project sites of the rural electrification are quite long, but require very narrow liner area. As most of the proposed distribution lines go along the footpath/mule track and nature in a wide area remains around the project site, it seems that the new development will not result in extensive loss of natural environments.
	(3) Topography and Geology	1) Is there a soft ground on the route of power transmission lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed?	There are steep slopes in the project site. Main land modification is pole foundation. Steep topography is seen almost anywhere in the country, and has many construction in such areas. The pole is constructed by the standard method based on experienced skill.	There are steep slopes in the project site. Main land modification is pole foundation. Steep topography is seen almost anywhere in the country, and has many construction in such areas. The pole is constructed by the standard method based on experienced skill.	There are steep slopes in the project site. Main land modification is pole foundation. Steep topography is seen almost anywhere in the country, and has many construction in such areas. The pole is constructed by the standard method based on experienced skill.
		2) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides?	No, main land modification is only distribution pole construction.	No, main land modification is only distribution pole construction.	No, main land modification is only distribution pole construction.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
3 Natural Environment	(3) Topography and Geology	3) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	No, the project is not large land modification like cut and fill.	No, the project is not large land modification like cut and fill.	No, the project is not large land modification like cut and fill.
4 Social Environment	(1) Resettlement	1) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?	No, the project will not require resettlement.	No, the project will not require resettlement.	No, the project will not require resettlement.
		2) Is adequate explanation on relocation and compensation given to affected persons prior to resettlement?	Resettlement will not be caused by the project.	Resettlement will not be caused by the project.	Resettlement will not be caused by the project.
		3) Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	Not applicable.	Not applicable.	Not applicable.
		4) Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	Not applicable.	Not applicable.	Not applicable.
		5) Are agreements with the affected persons obtained prior to resettlement?	Not applicable.	Not applicable.	Not applicable.
		6) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	Not applicable.	Not applicable.	Not applicable.
		7) Is a plan developed to monitor the impacts of resettlement?	Not applicable.	Not applicable.	Not applicable.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
4 Social Environment	(2) Living and Livelihood	1) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	Lines may pass through and some poles will fall on private land. However the route alignment and location of poles have been chosen to minimize damage to agricultural field. Therefore the impact is not considered significant.	Lines may pass through and some poles will fall on private land. However the route alignment and location of poles have been chosen to minimize damage to agricultural field. Therefore the impact is not considered significant.	Lines may pass through and some poles will fall on private land. However the route alignment and location of poles have been chosen to minimize damage to agricultural field. Therefore the impact is not considered significant.
		2) Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary?	No, the mitigation measures are provided appropriately for worker's health (e.g. HIV, malaria). Contractor will provide migrant workers with housing and ample toilets with proper drainage and treatment for sewage.	No. The mitigation measures are provided appropriately for worker's health (e.g. HIV, malaria). Contractor will provide migrant workers with housing and ample toilets with proper drainage and treatment for sewage.	No. The mitigation measures are provided appropriately for worker's health (e.g. HIV, malaria). Contractor will provide migrant workers with housing and ample toilets with proper drainage and treatment for sewage.
		3) Is there a possibility that installation of structures, such as power line towers will cause a radio interference? If significant radio interference is anticipated, are adequate measures considered?	No, main structures on the ground are only poles, but not tower. A pole doesn't cause significant radio interference.	No, main structures on the ground are only poles, but not tower. A pole doesn't cause significant radio interference.	No, main structures on the ground are only poles, but not tower. A pole doesn't cause significant radio interference.
	(3) Heritage	1) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	No, the project will not damage historical/cultural sites, since careful attention was taken to avoid these areas in the planning.	No, the project will not damage historical/cultural sites, since careful attention was taken to avoid these areas in the planning.	No, the project will not damage historical/cultural sites, since careful attention was taken to avoid these areas in the planning.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
4 Social Environment	(4) Landscape	2) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	There is a possibility that the project will adversely affect the local landscape. The route alignment and location of poles and other facilities have been chosen to minimize negative environmental impacts on the landscape. During route survey, a village people accompanied the survey team to ensure that religious sites along the alignment. Thus the feeder is not expected to have any significant impact on the landscape.	There is a possibility that the project will adversely affect the local landscape. The route alignment and location of poles and other facilities have been chosen to minimize negative environmental impacts on the landscape. During route survey, a village people accompanied the survey team to ensure that religious sites along the alignment. Thus the feeder is not expected to have any significant impact on the landscape.	There is a possibility that the project will adversely affect the local landscape. The route alignment and location of poles and other facilities have been chosen to minimize negative environmental impacts on the landscape. During route survey, a village people accompanied the survey team to ensure that religious sites along the alignment. Thus the feeder is not expected to have any significant impact on the landscape.
	(5) Ethnic Minorities and Indigenous Peoples	1) Where ethnic minorities and indigenous peoples are living in the rights-of-way, are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?	Not applicable	Not applicable	Not applicable
		2) Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples?	Not applicable	Not applicable	Not applicable
5 Others	(1) Impacts during Construction	1) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	Although impact during construction is not significant, mitigation measures will be taken.	Although impact during construction is not significant, mitigation measures will be taken.	Although impact during construction is not significant, mitigation measures will be taken.
		2) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	Yes, it is planned to minimize impact on the natural environment by mitigation measures such as avoidance of unnecessary tree clearing.	Yes, it is planned to minimize impact on the natural environment by mitigation measures such as to avoidance of unnecessary tree clearing.	Yes, it is planned to minimize impact on the natural environment by mitigation measures such as to avoidance of unnecessary tree clearing.
		3) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	Although impact on the social environment is not assumed to be serious, mitigation measures will be taken.	Although impact on the social environment is not assumed to be serious, mitigation measures will be taken.	Although impact on the social environment is not assumed to be serious, mitigation measures will be taken.
		4) If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?	Yes, as per EIA report, contractor will prepare and implement a site Health and Safety Plan as health and safety education.	Yes, as per IEE report, contractor will prepare and implement a site Health and Safety Plan as health and safety education.	Yes, as per IEE report, contractor will prepare and implement a site Health and Safety Plan as health and safety education.

Category	Environmental Item	Main Check Items	Sarpang	Wangdue	Chuka, Dagana, Haa, Paro, Pemagatshel, Punaka, Samtse, Trongsa, Tsirang
5 Others	(2) Monitoring	1) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	Yes	Yes	Yes
		2) Are the items, methods and frequencies included in the monitoring program judged to be appropriate?	Yes, the Environmental monitoring plan is described appropriately; (i) mitigation measures, (ii) location, (iii) measurement method, (iv) frequency of monitoring, (v) responsibility. These are judged to be appropriate.	Yes, the Environmental monitoring plan is described appropriately; (i) mitigation measures, (ii) location, (iii) measurement method, (iv) frequency of monitoring, (v) responsibility. These are judged to be appropriate.	Yes, the Environmental monitoring plan is described appropriately; (i) mitigation measures, (ii) location, (iii) measurement method, (iv) frequency of monitoring, (v) responsibility. These are judged to be appropriate.
		3) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	Yes, the EIA report includes an environmental monitoring program with items such as organization, personnel, equipment, and adequate budget to sustain the monitoring framework.	Yes, the IEE report includes an environmental monitoring program with items such as organization, personnel, equipment, and adequate budget to sustain the monitoring framework.	Yes, the IEE report includes an environmental monitoring program with items such as organization, personnel, equipment, and adequate budget to sustain the monitoring framework.
		4) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	No, there is no regulatory requirement to report. But management and monitoring will be done appropriately to keep the conditions of EC.	No, there is no regulatory requirement to report. But management and monitoring will be done appropriately to keep the conditions of EC.	No, there is no regulatory requirement to report. But management and monitoring will be done appropriately to keep the conditions of EC.
6 Note	Note on Using Environmental Checklist	1) If necessary, the impacts to transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	The proposed project will not involve any transboundary impacts or global environmental issues.	The proposed project will not involve any transboundary impacts or global environmental issues.	The proposed project will not involve any transboundary impacts or global environmental issues.

- 1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan’s experience).
- 2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

F.5 Summary of Public Consultation Meeting in Sarpang dzongkhag

For the preparation of EIA report, a public consultation was held on the 20th of February, 2010 at the outreach clinic in Doban gewog with the approval of Sarpang dzongkhag authority. 35 participants attended the meeting from Maugaon, Pathibora and Khargaon.

The objective of the meeting was to disseminate information about the proposed project, its objectives, policy requirements and activities. As the same time, the meeting provided an opportunity to discuss potential positive and negative impacts anticipated from the project as well as possible mitigation measures.

Summary of discussions is below.

Rural Electrification Project;

The participants were very excited to hear about the project. They said that at the moment, the lack of socioeconomic development was deterring many residents from returning to the village. A number of farms are leased out to neighboring farmers. If electricity is provided then, it would definitely improve the living condition and also maybe encourage residents to return home. Also, there are many students from the village who study in Sarpang or Gelephu town and do not enjoy coming home due to lack of facilities.

Absentee Owners;

Regarding seeking public consensus from absentee owners, the tsogpa said that they would make sure that absentee owners were informed about the project and were confident that no issues regarding absentee owners would arise. Another participant said that the size of land required for constructing poles was so small that it would not impact hugely on any individual owners. It was clarified that where possible, the BPC would ensure that field boundaries are utilized instead of putting poles in the middle of fields to lessen the impact on private land holdings.

Use of Firewood;

Participants said that the demand for firewood would definitely reduce once the project has been implemented. However, even if electricity is provided, a number of households will still continue to use firewood, albeit to a lesser degree, as winters are pretty cold and also livestock feed need to be prepared in large quantities. It is expected that firewood use will reduce by at least 50%.

Alignment;

Much discussion focused on the alignment of the distribution lines. The present alignment is from Chepchepey to Maugaon village along the existing access route. However, a new farm road is being constructed to the village. Some farmers said that if the farm road is going to be

completed soon, they would recommend that the distribution line be aligned along the farm road but if the farm road is going to take some time, then they would prefer it if the distribution line was constructed along the already surveyed route.

Impacts from Electrification;

When asked about this, most participants said that since they have not yet experienced living with electricity, it was difficult for them to talk about the benefits or negative impacts of electrification. The older participants goaded the younger shyer students to speak on their behalf, but all they managed to say was that they really wanted it soon. A village elder said that health advisors always spoke of the ill effects of constant exposure to smoke, especially for the women and children who spend more time in the house.

Project Benefits;

There were some discussions on benefits from the project in terms of local employment. Participants shared their experiences of how a group of residents from Doban worked in Dagana for a contractor but due to lack of payment had returned back home. If the rural electrification project requires local labor, people are willing to work as long as the contractors are willing to pay a reasonable rate and in a timely manner.

Solar and Kerosene;

A few of the affluent farmers have purchased solar lights and have been using them for a number of years, but the majority of residents cannot afford to buy this. Many households also use kerosene for lighting. One participant said that he uses approximately 80 liters a year. Each liter costs Nu. 13 but more than the price it was troublesome to carry it all the way to the village for more than 8 hours as they have to be cautious not to split it.

Problems;

Some of the main problems faced by farmers are lack of access or market to sell their farm products. Only Mugaon has a Farmers Cooperative where individual households sell their milk products. Apart from this, it is too expensive and not worthwhile for farmers to carry their products to the nearest market, Gelephu. Other problems are lack of electricity and schools. However, it seems that the government is working to address all the three issues as the farm road is already under construction, rural electrification project is under process and schools are being reopened. Participants are eagerly awaiting the project and excited to be a part of the development process.

F.6 MONITORING FORM

1. Implementation of Mitigation Activities

(1) Construction Stage

Monitoring Item (Status of implementation of Mitigation Activities)	Monitoring Results	Location	Frequency	Method
Leave cut material to rot down in situ and do not burn		MV route	Monthly	Site observations
Follow BPC standard procedures and practices in clearing ROW		MV route	3 months	Site observation; villager survey
Only fell trees that have been marked by Dept of Forests		MV route	Monthly	Site observations
Locate poles at a minimum distance of 30 m from rivers, and construct these on stable ground		MV route, pole location	3 months	CC records; site observation
Create awareness among workers on importance of wildlife and habitats		MV route	3 months	CC records; worker survey
Locate labour camps where no forest clearance is needed		All sites	3 months	CC records; site observation
Identify sites of local significance; locate no poles nearby		LV lines	Monthly	Site observation; villager survey
Consult custodians of facilities: avoid working at sensitive times		LV lines	Monthly	Site observation; village survey
Employ as many local residents as possible in workforce		All sites	3 months	CC records; worker survey
House imported workers in adequate accommodation, including: - solid waste collected daily and buried offsite; - workers trained in required behaviour in host community; - prohibition of hunting and fishing by camp occupants		All sites	Monthly	Site observation; worker survey
Prepare/implement site Health and Safety Plan that include: a) excluding the public from construction sit, use of Personal Protective Equipment, Providing Health and Safety Training for staff, recording all accidents and Informing local communities about the work and dangers.		All sites	3 months	Site observation; CC records

Note: CC-Construction Contractor

(2) Operation Stage

Monitoring Item (Status of implementation of Mitigation Activities)	Monitoring Results	Location	Frequency	Method
Maintain system regularly; repair faults quickly and effectively		All sites	Annually,	ESD records; villager survey
Train & supervise BPC field operatives to ensure that they check house wiring and reject if deficient		New users	Annually,	BPC records; villager survey
Public education: raise villager awareness of dangers of electricity		New users	Annually,	BPC records; villager survey
Follow BPC O&M and H&S manuals and revise if necessary		ESD	As needed	BPC records
Regular training of BPC workers on dangers & working procedures		ESD	Annually,	BPC records; worker survey
Improve supervision of field workers		ESD	3 months	BPC records; site observations
Regular management reviews of safety, with remedial action		ESD	3 months	BPC records

(3) LONG-TERM SURVEYS

Monitoring Item (Status of implementation of Mitigation Activities)	Monitoring Results	Measurement Point	Frequency	Method
Monitor scheme benefits, adequacy of service, identify deficiencies		All sites	Annually	Customer satisfaction survey

2. Social Environment

- Resettlement

Monitoring Item	Monitoring Results during Report Period
Occurrence of Involuntary Resettlement	

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period
Claims for Crop Damage from Farmers	

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-G

**HOUSEHOLD SOCIO-ECONOMIC
SURVEY**

APPENDIX G HOUSEHOLD SOCIOECONOMIC SURVEY

The object of the household socioeconomic survey was to obtain the data for project evaluation. The JICA Study Team reviewed existing socioeconomic survey data, including the results of the household socioeconomic survey by ADB PPTA, and confirmed the necessary basic data for a supplemental site survey. The ADB household survey targeted non-electrified households, and therefore JICA Study Team conducted a supplemental survey for electrified households.

G.1 Result of Non-electrified Household Survey

Table-G.1.1 Number of the non-electrified villages and households surveyed

	Dzongkhag	No. of villages surveyed	No. of HHs surveyed
Targeted for the on-grid electricity supply	Chukha	6	67
	Dagana	8	120
	Haa	3	36
	Lhuntshe	3	29
	Mongar	22	255
	Paro	3	26
	Pemagatshel	3	25
	Punakha	1	4
	S/Jongkhar	13	210
	Samtse	17	156
	Sarpang	12	110
	T/ Gang	1	17
	T/ yangtshé	6	92
	Thimphu	2	12
	Trongsa	7	44
	Tsirang	3	27
	Wangdue	4	34
Zhemgang	33	345	
	Total of on-grid	147	1609
Targeted for the off-grid SHLS installation	Chukha	4	53
	Dagana	5	44
	Paro	3	16
	Punakha	2	41
	Samtse	5	57
	Sarpang	8	41
	Tsirang	4	30
	Wangdue	7	76
	Total of SHLS sample	38	358
	Total Number	185	1967

Source: Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.2 Family Members, Income, Expenditures and Land size of Sampled Non-Electrified Households

Type of Electrification	Dzongkhag	Average No. of Family Members			Average Annual Cash Income (Nu)	Average Annual Expenditures (Nu)						Land size (acres)
		Male	Female	Total		Food	Clothing	Travel	Housing	Religious ceremonies	Entertainment	
Grid Power	Chukha	2.9	2.8	5.7	9,901	16,230	5,011	4,251	12,333	7,573	1,215	7.3
	Dagana	3.3	3.1	6.3	34,240	7,973	4,567	1,765	24,000	1,778	-	5.9
	Haa	2.6	2.8	5.5	28,725	15,943	3,772	2,859	17,500	11,557	2,665	5.8
	Lhuntshe	3.0	3.2	6.2	15,462	15,666	6,960	6,148	22,214	4,566	2,076	4.9
	Mongar	2.2	2.2	4.4	18,654	5,358	2,524	2,695	23,706	2,778	1,286	2.7
	Paro	2.6	2.8	5.4	43,396	24,731	9,750	5,037	64,160	24,364	4,800	3.3
	Pemagatshel	2.2	1.9	4.1	29,032	6,292	1,641	2,605	1,500	2,891	692	5.4
	Punakha	4.8	2.5	7.3	25,325	11,250	5,000	-	-	10,333	800	8.8
	S/Jomgkhar	2.6	2.5	5.1	18,088	6,037	1,909	2,658	28,708	2,538	807	5.1
	Samtse	2.7	2.5	5.2	8,132	12,049	4,088	1,559	9,975	4,287	1,210	4.7
	Sarpang	3.5	3.5	7.0	30,994	10,766	5,162	1,570	30,722	2,011	100	5.9
	T/ Gang	2.2	3.4	5.6	11,294	11,143	5,382	3,594	20,000	4,353	1,350	4.2
	T/ yangtshel	2.8	2.7	5.5	17,037	11,709	5,335	4,747	24,190	8,088	2,076	4.4
	Thimphu	2.2	2.4	4.6	55,375	36,364	4,722	10,071	40,250	23,700	4,157	3.6
	Trongsa	2.1	3.0	5.1	17,407	6,805	4,063	3,370	32,000	7,771	2,342	3.8
	Tsirang	3.1	2.1	5.3	26,419	6,547	3,365	728	20,000	1,133	-	4.9
Wangdue	2.9	3.0	5.9	40,088	20,279	8,804	6,229	14,750	14,488	4,515	4.4	
Zhemgang	2.1	2.5	4.6	22,723	13,051	4,959	4,054	30,768	4,215	2,362	4.8	
	Sub Average	2.6	2.6	5.2	21,495	10,534	4,209	3,116	25,368	4,764	1,894	4.7
Solar Power	Chukha	2.2	2.3	4.4	9,625	11,817	4,657	3,239	30,286	7,471	153	4.8
	Dagana	3.6	3.3	6.9	32,384	9,963	6,138	3,569	35,780	2,425	-	5.6
	Paro	2.5	2.4	4.9	68,844	29,333	6,143	12,923	29,667	17,308	10,300	7.3
	Punakha	3.1	3.4	6.5	14,393	14,703	4,588	5,503	6,208	23,768	4,218	4.7
	Samtse	3.2	2.8	6.0	7,920	11,573	5,633	1,666	15,000	5,393	2,455	6.9
	Sarpang	3.4	2.9	6.3	24,988	7,244	3,480	1,058	-	1,036	-	4.5
	Tsirang	3.3	2.6	5.9	49,983	12,967	4,310	1,389	37,400	943	-	4.6
	Wangdue	3.2	3.4	6.6	27,184	13,440	4,268	5,137	37,250	11,538	2,327	3.3
	Sub Average	3.1	3.0	6.0	24,212	12,537	4,787	3,751	24,221	9,267	2,756	5.0
Total Average		2.7	2.7	5.3	21,990	10,899	4,319	3,229	25,166	5,516	2,012	4.7

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.3 Energy Use of Sampled Non-Electrified Households

Type of Electrification	Usage and Type of Energy Used by Sampled Households (%)																													
	Cooking						Heating						Lighting						Radio/Tape recorder/TV						Machinery					
	Firewood	LPG	Kerosene	Others	Firewood	LPG	Kerosene	Dry cell batteries	Others	Firewood	LPG	Kerosene	Dry cell batteries	Candle	Others	Firewood	LPG	Kerosene	Dry cell batteries	Others	Firewood	LPG	Kerosene	Petrol	Diesel	Dry cell batteries	Others			
Dzongkhag	Chukha	100.0	3.0	1.5	0.0	100.0	0.0	0.0	0.0	0.0	3.0	1.5	98.5	0.0	0.0	22.4	3.0	50.7	3.0	0.0	0.0	0.0	4.5	1.5	3.0	13.4				
	Dagana	100.0	1.7	0.0	0.0	97.5	0.0	1.7	0.0	0.0	5.0	0.0	100.0	0.8	10.0	60.8	2.5	60.8	2.5	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0			
	Haa	100.0	2.8	0.0	0.0	97.2	0.0	0.0	0.0	0.0	47.2	0.0	83.3	33.3	2.8	61.1	55.6	27.8	0.0	0.0	0.0	0.0	0.0	0.0	2.8	2.8	2.8			
	Lhunzhe	100.0	44.8	20.7	0.0	100.0	0.0	24.1	0.0	10.3	41.4	6.9	65.5	27.6	24.1	48.3	58.6	3.4	0.0	0.0	0.0	0.0	3.4	10.3	31.0	3.4	3.4			
	Mongar	100.0	0.0	7.5	0.0	98.8	0.0	12.5	0.0	2.0	34.9	0.0	90.2	2.0	7.1	43.1	40.0	3.1	0.0	0.0	0.0	0.0	1.6	3.5	2.7	0.0	7.8			
	Paro	100.0	76.9	0.0	0.0	96.2	23.1	3.8	0.0	0.0	38.5	34.6	65.4	7.7	23.1	42.3	76.9	34.6	0.0	0.0	0.0	0.0	0.0	7.7	7.7	0.0	3.8			
	Pemagatshel	100.0	4.0	8.0	0.0	96.0	0.0	16.0	0.0	0.0	32.0	0.0	96.0	0.0	8.0	16.0	84.0	0.0	0.0	0.0	0.0	0.0	4.0	12.0	0.0	0.0	0.0			
	Punakha	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	50.0	0.0	100.0	0.0	0.0	50.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0			
	S/Jongkhar	100.0	0.0	21.9	0.0	96.7	0.0	21.0	0.0	1.4	28.6	0.0	99.5	3.8	0.0	19.5	55.7	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	12.4		
	Samtse	100.0	1.3	0.0	0.0	64.5	0.0	0.0	0.0	0.0	12.5	0.0	99.3	0.0	0.0	2.6	63.8	2.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	4.6	9.9		
	Sarpang	100.0	0.9	3.6	0.0	95.5	0.0	1.8	0.0	0.0	20.0	0.0	96.4	7.3	2.7	15.5	89.1	11.8	0.0	0.0	0.0	0.0	2.7	2.7	1.8	2.7	6.4			
	T/Gang	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	29.4	0.0	5.9	0.0	0.0	100.0	76.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	T/yangtse	100.0	9.8	34.8	0.0	96.7	0.0	31.5	0.0	0.0	38.0	0.0	98.9	4.3	20.7	6.5	76.1	2.2	0.0	0.0	0.0	0.0	7.6	5.4	4.3	1.1	0.0	0.0		
	Thimphu	100.0	33.3	0.0	0.0	100.0	0.0	0.0	0.0	0.0	16.7	0.0	91.7	0.0	0.0	75.0	50.0	25.0	0.0	0.0	0.0	0.0	6.3	16.7	6.3	2.1	6.3			
	Trongsa	100.0	35.4	60.4	0.0	97.9	0.0	52.1	0.0	2.1	56.3	2.1	89.6	25.0	25.0	22.9	58.3	0.0	0.0	0.0	0.0	0.0	6.3	16.7	6.3	2.1	6.3			
	Tsirang	100.0	3.7	0.0	0.0	96.3	0.0	3.7	0.0	0.0	14.8	0.0	100.0	0.0	0.0	37.0	33.3	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Wangdue	100.0	61.8	5.9	0.0	97.1	0.0	8.8	0.0	2.9	29.4	11.8	91.2	5.9	2.9	35.3	55.9	5.9	0.0	0.0	0.0	0.0	0.0	23.5	11.8	0.0	0.0	0.0			
Zhemgang	98.8	25.5	42.0	0.0	88.4	0.0	17.4	0.0	0.0	22.6	0.0	93.9	14.2	14.5	29.3	46.7	12.8	0.0	0.0	0.0	0.0	17.4	5.5	1.4	1.7	13.6				
Sub Average	99.8	11.3	17.8	0.0	92.5	0.4	13.1	0.0	0.8	25.4	1.1	93.5	6.9	7.4	26.0	54.9	6.6	0.0	0.0	0.0	0.0	5.2	4.4	2.5	1.4	8.2				
Solar Power	Chukha	100.0	7.5	1.9	0.0	83.0	0.0	1.9	0.0	3.8	0.0	100.0	1.9	0.0	35.8	73.6	1.9	0.0	0.0	0.0	0.0	5.7	0.0	0.0	11.3	17.0				
	Dagana	100.0	4.5	0.0	0.0	86.4	0.0	0.0	0.0	4.5	0.0	100.0	2.3	0.0	20.5	54.5	13.6	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	4.5				
	Paro	100.0	56.3	12.5	0.0	100.0	6.3	25.0	0.0	0.0	31.3	18.8	81.3	6.3	12.5	43.8	87.5	12.5	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0			
	Punakha	100.0	22.0	34.1	0.0	90.2	0.0	34.1	0.0	2.4	46.3	0.0	100.0	19.5	4.9	34.1	70.7	7.3	0.0	0.0	0.0	0.0	9.8	4.9	12.2	4.9	17.1			
	Samtse	100.0	5.3	14.0	0.0	77.2	0.0	12.3	0.0	0.0	14.0	0.0	98.2	10.5	1.8	3.5	77.2	0.0	0.0	0.0	0.0	0.0	1.8	5.3	1.8	3.5	14.0			
	Sarpang	100.0	4.9	0.0	0.0	95.1	0.0	0.0	0.0	0.0	19.5	0.0	100.0	9.8	0.0	0.0	63.4	0.0	0.0	0.0	0.0	0.0	7.3	2.4	0.0	0.0	0.0	0.0		
	Tsirang	100.0	20.0	3.3	0.0	93.3	0.0	0.0	0.0	0.0	13.3	3.3	100.0	3.3	0.0	46.7	53.3	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Wangdue	100.0	5.3	2.6	0.0	100.0	1.3	3.9	0.0	0.0	31.6	1.3	100.0	11.8	0.0	23.7	76.3	0.0	0.0	0.0	0.0	0.0	19.7	11.8	2.6	1.3	3.9				
Sub Average	100.0	10.9	7.8	0.0	89.9	0.6	8.1	0.0	0.3	20.1	1.4	98.9	8.7	1.4	23.2	69.8	4.5	0.0	0.0	0.0	0.0	7.3	5.0	2.2	3.1	8.1				
Total Average	99.8	11.2	16.0	0.0	92.0	0.4	12.2	0.0	0.7	24.4	1.1	94.5	7.2	6.3	25.5	57.7	6.2	0.0	0.0	0.0	0.0	5.5	4.5	2.5	1.7	8.2				

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.4 Kerosene Consumption of Sampled Non-Electrified Households

Type of Electrification	Dzongkhag	Monthly Amount of Paying for Kerosene (Frequency of Sampled Households)				Monthly Traveling Time for Getting the Kerosene Replaced (Frequency of Sampled Households)				Total No. of Sampled Households
		Less than Nu.100	Nu.101 to 500	Nu.501 to 1000	N/A	1 hour	2 hours	3 to 5 hours	More than 5 hours	
Grid Power	Chukha	53	12	2	0	20	6	10	31	67
	Dagana	111	9	0	0	25	46	14	35	120
	Haa	12	24	0	0	0	4	6	26	36
	Lhuntshe	18	10	1	0	0	0	3	26	29
	Mongar	227	28	0	0	2	8	23	222	255
	Paro	15	11	0	0	2	4	7	13	26
	Pemagatshel	21	4	0	0	0	0	0	25	25
	Punakha	1	3	0	0	0	1	1	2	4
	S/Jomgkhar	166	44	0	0	0	0	0	210	210
	Samtse	144	8	0	0	6	52	32	62	152
	Sarpang	90	17	3	0	9	14	31	56	110
	T/ Gang	17	0	0	0	0	0	3	14	17
	T/ yangtshhe	33	57	2	0	0	0	42	50	92
	Thimphu	4	8	0	0	0	2	4	6	12
	Trongsa	24	22	2	0	7	6	19	16	48
	Tsirang	25	2	0	0	0	9	14	4	27
	Wangdue	12	22	0	0	1	1	5	27	34
Zhemgang	93	241	11	0	106	21	11	207	345	
	Sub Total	-	-	-	-	-	-	-	-	1,609
	Sub Average	1066	522	21	0	178	174	225	1032	-
	% of Applicable Households	66%	32%	1%	0%	11%	11%	14%	64%	-
Solar Power	Chukha	46	7	0	0	6	6	18	23	53
	Dagana	42	2	0	0	3	14	9	18	44
	Paro	8	8	0	0	0	0	5	11	16
	Punakha	13	18	10	0	1	3	11	26	41
	Samtse	52	5	0	0	0	8	24	25	57
	Sarpang	36	5	0	0	6	5	15	15	41
	Tsirang	28	2	0	0	0	6	15	9	30
	Wangdue	14	62	0	0	1	1	9	65	76
	Sub Total	-	-	-	-	-	-	-	-	358
	Sub Average	239	109	10	0	17	43	106	192	-
	% of Applicable Households	67%	30%	3%	0%	5%	12%	30%	54%	-
	Grand Total	-	-	-	-	-	-	-	-	1,967
	Total Average	1305	631	31	0	195	217	331	1224	-
	% of Total Applicable Households	66.3%	32.1%	1.6%	0.0%	9.9%	11.0%	16.8%	62.2%	-

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.5 Dry Cell Battery Consumption of Sampled Non-Electrified Households

Type of Electrification	Dzongkhag	Monthly Amount of Paying for Batteries (Frequency of Sampled Households)				Monthly Traveling Time for Getting Batteries (Frequency of Sampled Households)				Total No. of Sampled Households
		Less than Nu.100	Nu.101 to 500	Nu.501 to 1000	N/A	1 hour	2 hours	3 to 5 hours	More than 5 hours	
Grid Power	Chukha	57	5	1	4	24	6	6	27	67
	Dagana	111	9	0	0	28	40	15	37	120
	Haa	33	3	0	0	1	0	2	33	36
	Lhuntshe	21	8	0	0	2	5	16	6	29
	Mongar	241	7	1	6	12	26	27	184	255
	Paro	19	4	0	3	5	8	8	2	26
	Pemagatshel	25	0	0	0	0	0	1	24	25
	Punakha	4	0	0	0	0	4	0	0	4
	S/Jomgkhar	209	1	0	0	0	0	3	207	210
	Samtse	144	4	0	4	5	51	32	60	152
	Sarpang	104	3	1	2	51	16	26	15	110
	T/ Gang	14	3	0	0	0	5	7	5	17
	T/ yangtshhe	90	2	0	0	5	8	37	42	92
	Thimphu	3	7	0	2	1	1	2	6	12
	Trongsa	40	7	1	0	11	10	17	10	48
	Tsirang	26	1	0	0	1	10	12	4	27
	Wangdue	20	13	0	1	3	4	8	18	34
Zhemgang	278	62	3	2	121	14	14	194	345	
	Sub Total	-	-	-	-	-	-	-	-	1,609
	Sub Average	1439	139	7	24	270	208	233	874	-
	% of Applicable Households	89%	9%	0%	1%	17%	13%	15%	55%	-
Solar Power	Chukha	49	1	0	3	8	5	19	18	53
	Dagana	40	4	0	0	6	14	6	18	44
	Paro	14	1	0	1	0	2	2	11	16
	Punakha	34	6	0	1	6	8	9	17	41
	Samtse	54	3	0	0	4	6	23	24	57
	Sarpang	38	1	0	2	17	10	10	2	41
	Tsirang	30	0	0	0	9	2	12	7	30
	Wangdue	56	20	0	0	1	1	12	62	76
	Sub Total	-	-	-	-	-	-	-	-	358
	Sub Average	315	36	0	7	51	48	93	159	-
	% of Applicable Households	88%	10%	0%	2%	15%	14%	26%	45%	-
	Grand Total	-	-	-	-	-	-	-	-	1,967
	Total Average	1754	175	7	31	321	256	326	1033	-
	% of Total Applicable Households	89.2%	8.9%	0.4%	1.6%	16.6%	13.2%	16.8%	53.4%	-

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.6 LPG Consumption of Sampled Non-Electrified Households

Type of Electrification	Dzongkhag	Monthly Amount of Paying for LPG (Frequency of Sampled Households)				Traveling Time for Getting the LPG Replaced (Frequency of Sampled Households)				Total No. of Sampled Households
		Less than Nu.100	Nu.101 to 500	Nu.501 to 1000	N/A	1 hour	2 hours	3 to 5 hours	More than 5 hours	
Grid Power	Chukha	0	2	0	65	1	0	1	0	67
	Dagana	0	2	0	118	0	1	0	1	120
	Haa	0	1	0	35	0	0	0	1	36
	Lhuntshe	7	5	1	16	0	0	2	11	29
	Mongar	0	0	0	255	0	0	0	0	255
	Paro	1	18	1	6	2	10	6	2	26
	Pemagatshel	0	1	0	24	0	0	0	1	25
	Punakha	0	0	0	4	0	0	0	0	4
	S/Jomgkhar	0	0	0	210	0	0	0	0	210
	Samtse	1	1	0	150	1	0	1	0	152
	Sarpang	0	1	0	109	0	1	0	0	110
	T/ Gang	0	0	0	17	0	0	0	0	17
	T/ yangtshhe	5	1	2	84	0	0	4	4	92
	Thimphu	0	2	2	8	0	2	0	2	12
	Trongsa	2	12	3	31	3	4	8	2	48
	Tsirang	0	1	0	26	0	0	1	0	27
	Wangdue	0	20	0	14	1	0	2	17	34
Zhemgang	5	33	49	258	2	0	7	78	345	
	Sub Total	-	-	-	-	-	-	-	-	1,609
	Sub Average	21	100	58	1430	10	18	32	119	-
	% of Applicable Households	1%	6%	4%	89%	6%	10%	18%	66%	-
Solar Power	Chukha	4	0	0	49	3	1	0	0	53
	Dagana	0	2	0	42	0	0	0	2	44
	Paro	1	5	3	7	0	0	3	6	16
	Punakha	1	5	2	33	0	0	2	6	41
	Samtse	0	3	0	54	0	2	1	0	57
	Sarpang	1	1	0	39	0	1	1	0	41
	Tsirang	0	5	1	24	0	4	0	2	30
	Wangdue	0	4	0	72	0	0	1	3	76
	Sub Total	-	-	-	-	-	-	-	-	358
	Sub Average	7	25	6	320	3	8	8	19	-
	% of Applicable Households	2%	7%	2%	89%	8%	21%	21%	50%	-
	Grand Total	-	-	-	-	-	-	-	-	1,967
	Total Average	28	125	64	1750	13	26	40	138	-
	% of Total Applicable Households	1.4%	6.4%	3.3%	89.0%	6.0%	12.0%	18.4%	63.6%	-

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

Table-G.1.7 Firewood Consumption of Sampled Non-Electrified Households

Type of Electrification	Daily usage of firewood		Average Time for Collecting Firewood per day (Hours)	Proportion of Households with Purchasing Firewood (%)	Monthly Amount of Paying for Firewood (Frequency of Sampled Households)			Proportion of Households with Paying for Royalty (%)	Annual Amount of Paying for Royalty to cut trees (Frequency of Sampled Households)				Total No. of Sampled Households		
	(Backload)	(Nu)			Less than Nu.100	Nu.101 to 500	Nu.501 to 1000		Over Nu.1001	Less than Nu.50	Nu.51 to 100	Nu.101 to 150		Nu.151 to 200	Over Nu.201
Grid Power	Chukha	1.4	20.2	2.2	1.5	1	0	0	0	0	9	1	1	67	
	Dagana	1.5	15.1	1.5	1.7	2	0	0	0	0	3	1	0	120	
	Haa	2.2	29.8	2.1	0	0	0	0	0	0	1	0	0	36	
	Lhuntshe	1.9	31.1	2.2	13.8	1	3	0	0	0	5	14	4	29	
	Mongar	1.9	27.7	3.3	2.7	4	2	1	0	0	103	22	0	255	
	Paro	1.7	18.2	2.2	3.8	0	1	0	0	0	0	0	0	26	
	Pemagatshel	1.2	21.0	2.7	0	0	0	0	0	0	7	4	3	25	
	Punakha	1.5	11.5	0.3	25.0	1	0	0	0	0	0	0	0	4	
	S/Jomgkhar	2.1	35.0	3.8	1.4	2	1	0	0	0	58	11	0	210	
	Samtse	1.3	16.6	2.0	0.7	0	0	1	0	0	27	3	3	152	
	Sarpang	1.5	14.2	1.6	19.1	20	1	0	0	0	2	1	0	110	
	T/Gang	2.3	42.8	2.9	0	0	0	0	0	0	0	0	5	17	
	T/yangtse	2.8	40.3	2.8	1.1	0	0	1	0	0	28	28	1	92	
	Thimphu	2.0	31.3	1.2	0	0	0	0	0	0	4	1	0	12	
	Trongsa	1.6	17.1	1.7	2.1	0	1	0	0	0	4	6	0	48	
	Tsirang	1.3	14.3	1.4	3.7	1	0	0	0	0	5	0	0	27	
	Wangdue	1.7	22.4	2.1	2.9	1	0	0	0	0	4	0	0	34	
	Zhengang	1.4	16.9	2.1	3.8	3	6	1	3	56.5	146	21	14	2	345
	Sub Total	-	-	-	-	36	15	4	3	-	598	85	264	91	1,609
	Sub Average	1.7	23.2	2.4	3.6	-	-	-	-	66.6	-	-	-	-	-
% of Applicable Households	-	-	-	-	62%	26%	7%	5%	-	56%	8%	25%	8%	1%	
Solar Power	Chukha	1.5	19.8	1.9	3.8	1	1	0	0	0	0	0	0	53	
	Dagana	1.6	15.6	1.9	2.3	0	1	0	0	0	4	0	0	44	
	Paro	2.0	21.1	1.8	18.8	1	1	1	0	0	1	0	0	16	
	Punakha	3.4	32.1	2.2	29.3	8	4	0	0	0	19	0	0	41	
	Samtse	1.4	13.9	1.7	0	0	0	0	0	0	8	0	0	57	
	Sarpang	1.5	14.6	1.1	12.2	5	0	0	0	0	0	0	0	41	
	Tsirang	1.3	13.2	1.8	0	0	0	0	0	0	0	0	0	30	
	Wangdue	2.0	24.3	2.0	0	0	0	0	0	0	1	9	0	76	
	Sub Total	-	-	-	-	15	7	1	0	-	163	3	41	0	358
	Sub Average	1.8	19.6	1.8	6.4	-	-	-	-	58.9	-	-	-	-	-
% of Applicable Households	-	-	-	-	65%	30%	4%	0%	-	77%	1%	19%	0%	0%	
Grand Total	-	-	-	-	51	22	5	3	-	761	88	305	91	1,967	
Total Average	1.7	22.5	2.3	4.1	-	-	-	-	65.2	-	-	-	-	-	
% of Total Applicable Households	-	-	-	-	63.0%	27.2%	6.2%	3.7%	-	59.3%	6.9%	23.8%	7.1%	0.8%	

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPPTA Consultants Team, 2010)

Table-G.1.8 Willingness to Pay for Electricity Bill

Type of Electrification	Dzongkhag	Amount the households can afford to pay for Monthly Electricity Bill (Percentage)							Total No. of Sampled Households
		Up to Nu.100/m	Up to Nu.200/m	Up to Nu.300/m	Up to Nu.400/m	Up to Nu.500/m	More than Nu.500/m	Not surveyed	
Grid Power	Chukha	55%	43%	0%	1%	0%	0%	0%	67
	Dagana	24%	57%	15%	4%	0%	0%	0%	120
	Haa	31%	19%	31%	11%	6%	3%	0%	36
	Lhuntshe	48%	3%	14%	24%	0%	10%	0%	29
	Mongar	75%	16%	4%	2%	2%	1%	0%	255
	Paro	65%	27%	8%	0%	0%	0%	0%	26
	Pemagatshel	44%	48%	8%	0%	0%	0%	0%	25
	Punakha	100%	0%	0%	0%	0%	0%	0%	4
	S/Jomgkhar	63%	30%	0%	3%	1%	2%	0%	210
	Samtse	71%	24%	4%	0%	1%	0%	0%	152
	Sarpang	36%	28%	13%	12%	7%	4%	0%	110
	T/ Gang	24%	59%	6%	0%	0%	12%	0%	17
	T/ yangtshel	25%	52%	5%	11%	3%	3%	0%	92
	Thimphu	17%	25%	33%	8%	8%	8%	0%	12
	Trongsa	15%	25%	25%	2%	6%	27%	0%	48
	Tsirang	48%	30%	19%	4%	0%	0%	0%	27
	Wangdue	32%	62%	6%	0%	0%	0%	0%	34
Zhemgang	27%	35%	13%	4%	4%	16%	0%	345	
	Sub Total	-	-	-	-	-	-	-	1,609
	Sub Average	749	519	142	69	41	89	0	-
	% of Applicable Households	46.6%	32.3%	8.8%	4.3%	2.5%	5.5%	0.0%	-
Solar Power	Chukha	0%	0%	0%	0%	0%	0%	100%	53
	Dagana	0%	0%	0%	0%	0%	0%	100%	44
	Paro	0%	0%	0%	0%	0%	0%	100%	16
	Punakha	0%	0%	0%	0%	0%	0%	100%	41
	Samtse	0%	0%	0%	0%	0%	0%	100%	57
	Sarpang	0%	0%	0%	0%	0%	0%	100%	41
	Tsirang	0%	0%	0%	0%	0%	0%	100%	30
	Wangdue	0%	0%	0%	0%	0%	0%	100%	76
	Sub Total	-	-	-	-	-	-	-	358
	Sub Average	0	0	0	0	0	0	358	-
	% of Applicable Households	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	-
Grand Total		-	-	-	-	-	-	-	1,967
Total Average		749	519	142	69	41	89	358	-
% of Total Applicable Households		38.1%	26.4%	7.2%	3.5%	2.1%	4.5%	18.2%	-

Prepared by JICA Study Team based on the Household Socioeconomic Survey Preparing the Rural Renewable Energy Development Project (ADB PPTA Consultants Team, 2010)

G.2 Result of the Electrified Household Survey

Table-G.2.1 Name of the Gewogs and Villages Surveyed and No. of Samples

Dzongkhag	Gewog	Village	No. of Samples
Samtse	Chengmari	Chengmari	25
Thimphu	Kawang	Kabasa	35
Trashigang	Radi	Radhi	30
Punakha	Shenga-Bjime	Sengana Jarigang	10
Zhemgang	Trong	Tingtibi	25
Monggar	Monggar	Khidekhar	25
Total No. of Households Surveyed			150

Prepared by JICA Study Team

Table-G.2.2 Family Members, Income, Expenditures and Land size of Sampled Electrified Households

Dzongkhag	Average Family Members	Average Annual Cash Income (Nu)	Average Annual (Nu)						Land size (acres)
			Food	Clothing	Travel	Housing	Religious ceremonies	Entertainment	
Samtse	4.4	119,640	24,920	4,140	3,810	31,320	4,696	129	3.8
Thimphu	5.7	411,946	49,886	6,771	18,577	94,286	29,400	860	1.3
Trashigang	4.3	75,000	13,300	2,927	7,423	0	10,267	5,460	2.6
Punakha	3.6	49,400	13,800	1,860	4,560	16,000	15,550	151	2.3
Zhemgang	5.2	96,000	15,920	3,604	2,588	0	12,200	4,540	4.9
Monggar	4.7	73,800	11,800	1,748	1,960	0	10,740	3,952	1.9
Sub Average	4.8	162,654	23,993	3,871	7,516	28,287	14,556	2,740	2.7

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.3 Energy Use of Sampled Electrified Households

Dzongkhag	Type and Use of Energy Used by Sampled Households (%)																																				
	Electricity					Kerosene					Diesel Oil					Candle			Dry Cell Battery			LPG			Firewood												
	Lighting	Heating	Cooking	Radio/tape recorder	Others	Lighting	Heating	Cooking	Milling	Others	Lighting	Heating	Cooking	Security	Milling	Others	Lighting	Heating	Cooking	Lighting	Radio/tape recorder	Others	Lighting	Heating	Cooking	Others	Lighting	Heating	Cooking	Others							
Samtse	100	8	100	84	92	76	4	24	0	12	0	0	0	0	0	4	76	0	0	80	20	64	0	0	0	0	0	0	0	52	0	0	0	0	0	72	64
Thimphu	100	54	100	100	80	6	6	0	0	17	0	0	0	0	6	34	89	0	0	57	17	17	0	0	0	0	0	0	100	0	0	0	0	0	14	49	
Trashigang	100	83	97	63	10	20	0	0	0	0	0	0	0	0	27	10	80	0	0	53	7	0	0	0	0	0	0	0	67	0	0	3	37	93			
Punakha	100	80	100	60	20	20	0	0	0	20	0	0	0	0	0	10	90	0	0	40	0	10	0	0	0	0	0	0	70	0	0	80	80	90			
Zhemgang	100	88	100	60	72	0	0	0	0	0	0	0	0	0	0	4	96	0	0	28	0	0	0	0	0	0	0	84	0	0	32	20	24				
Monggar	100	68	100	48	0	28	0	0	0	0	0	0	0	0	4	0	48	0	0	52	0	0	0	0	0	0	0	40	0	0	0	72	96				
Sub Average	100	62	99	72	49	24	2	4	0	7	0	0	0	0	7	12	79	0	53	9	15	0	0	0	0	0	0	71	0	32	43	67					

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.4 Paid Amount of Electricity Bills and Consumption of Electricity in Sampled Electrified Households

Dzongkhag	Average Amount of Electricity Bill (Nu / Month)		Average Amount of Electricity Bills in 2009 (Nu)				
	Winter	Summer	March 10	December 09	September 09	June 09	
Samtse	Average	64.4	78.4	64.7	71.2	70.5	82.5
	Highest	105.0	150.0	159.0	218.0	120.0	160.0
Thimphu	Average	276.4	170.2	261.6	332.8	183.0	163.7
	Highest	920.0	720.0	1000.0	1024.0	940.0	900.0
Trashigang	Average	167.7	124.7	122.3	160.6	159.4	123.5
	Highest	450.0	350.0	350.0	400.0	450.0	380.0
Punakha	Average	92.2	61.2	84.1	95.9	58.3	58.4
	Highest	109.0	90.0	100.0	129.0	94.0	80.0
Zhemgang	Average	202.0	174.4	159.5	212.5	201.2	150.1
	Highest	650.0	600.0	602.0	720.0	650.0	580.0
Monggar	Average	150.8	117.2	109.8	143.0	195.9	113.0
	Highest	200.0	180.0	180.0	200.0	1500.0	205.0
	Average	173.7	130.4	146.8	187.6	156.4	124.4
	Highest	920.0	720.0	1000.0	1024.0	1500.0	900.0

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.5 Punctuality and Mode of Making Payment in Sampled Electrified Households

Dzongkhag	Average Payment Interval of Electricity bills (Month)	Time Taken & Mode of Transportation for Paying Electricity Bills to BPC Office						
		By Walking		By Taking Bus / Taxi		By Taking Private Vehicle		
		No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	1.00	24	0.36	0	-	-	1	0.80
Thimphu	1.11	0	-	15	1.36	31	18	1.03
Trashigang	1.00	30	0.13	0	-	-	0	-
Punakha	1.00	0	-	10	2.00	140	0	-
Zhemgang	1.10	25	0.22	0	-	-	0	-
Monggar	1.00	0	-	25	0.33	25	0	-
Total	-	79.0	-	50.0	-	-	19.00	-
Average	1.04	-	0.23	-	0.97	50	-	1.02
Percentage of Applicable Households (%)	-	52.7%	-	33.3%	-	-	12.7%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.6 Kerosene Consumption of Sampled Electrified Households

Dzongkhag	Average Purchasing Interval of Kerosene (Days)	Average Buying Volume of Kerosene (Liters)	Average Amount of Paying for Kerosene (Nu / Litter)	Average Traveling Time for Buying for Kerosene (Hours)	Mode of Transportation for Purchasing Kerosene						
					By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
					No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	107	6.0	13	0.34	22	0.34	0	-	-	0	-
Thimphu	183	9.0	11	0.97	0	-	2	1.18	40	0	-
Trashigang	75	2.3	17	0.48	3	0.13	2	1.25	60	0	-
Punakha	135	5.5	11	2.00	0	-	2	2.00	140	0	-
Zhemgang	-	-	-	-	0	-	0	-	-	0	-
Monggar	77	5.0	12	0.33	0	-	7	0.33	25	0	-
Total	-	-	-	-	25.0	-	13.0	-	-	0.00	-
Average	111	5.8	13	0.53	-	0.3	-	0.9	50	-	-
Percentage of Applicable Households (%)	-	-	-	-	16.7%	-	8.7%	-	-	0%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.7 Diesel Oil Consumption of Sampled Electrified Households

Dzongkhag	Average Purchasing Interval of Diesel Oil (Days)	Average Buying Volume of Diesel Oil (Liters)	Average Amount of Paying for Diesel Oil (Nu / Litter)	Average Traveling Time for Buying for Diesel Oil (Hours)	Mode of Transportation for Purchasing Diesel Oil						
					By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
					No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	365	7.0	34	0.60	0	-	1	0.60	70	0	-
Thimphu	125	32.6	33	1.01	0	-	4	1.01	31	0	-
Trashigang	47	17.9	34	2.00	0	-	8	2.00	35	0	-
Punakha	60	30.0	33	2.00	0	-	1	2.00	140	0	-
Zhemgang	75	40.0	33	1.00	0	-	0	-	-	0	-
Monggar	45	17.9	34	0.33	0	-	1	0.33	25	0	-
Total	-	-	-	-	0.0	-	15.0	-	-	0.00	-
Average	98	25.5	33	1.37	-	-	-	1.5	43	-	-
Percentage of Applicable Households (%)	-	-	-	-	0%	-	10.0%	-	-	0%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.8 Candle Consumption of Sampled Electrified Households

Dzongkhag	Average Purchasing Interval of Candle (Days)	Average Buying Volume of Candle (Pieces)	Average Amount of Paying for Candle (Nu / Piece)	Average Traveling Time for Buying for Candle (Hours)	Mode of Transportation for Purchasing Candle						
					By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
					No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	142	7.4	4	0.22	19	0.22	0	-	-	0	-
Thimphu	73	4.1	15	0.42	23	0.12	4	1.63	35	0	-
Trashigang	76	6.0	3	0.09	24	0.09	0	-	-	0	-
Punakha	100	7.6	2	0.91	6	0.37	3	2.00	140	0	-
Zhemgang	64	6.0	3	0.18	24	0.18	0	-	-	0	-
Monggar	56	6.0	3	0.10	12	0.10	0	-	-	0	-
Total	-	-	-	-	108.0	-	7.0	-	-	0.00	-
Average	83	5.8	6	0.28	-	0.2	-	1.8	80	-	-
Percentage of Applicable Households (%)	-	-	-	-	72.0%	-	4.7%	-	-	0%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.9 Dry Cell Battery Consumption of Sampled Electrified Households

Dzongkhag	Average Purchasing Interval of Dry Cell Battery (Days)	Average Buying Volume of Dry Cell Battery (Pieces)	Average Amount of Paying for Dry Cell Battery (Nu / Piece)	Average Traveling Time for Buying for Dry Cell Battery (Hours)	Mode of Transportation for Purchasing Dry Cell Battery						
					By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
					No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	83	3.8	12	0.25	23	0.25	0	-	-	0	-
Thimphu	60	3.4	14	0.45	14	0.13	2	0.73	15	0	-
Trashigang	33	2.4	15	0.15	16	0.10	0	-	-	0	-
Punakha	60	4.0	13	1.63	1	0.50	3	2.00	140	0	-
Zhemgang	49	2.0	18	0.24	7	0.24	0	-	-	0	-
Monggar	31	2.4	18	0.10	13	0.10	0	-	-	0	-
Total	-	-	-	-	74.0	-	5.0	-	-	0.00	-
Average	56	3.0	14	0.32	-	0.2	-	1.5	90	-	-
Percentage of Applicable Households (%)	-	-	-	-	49.3%	-	3.3%	-	-	0%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.10 LPG Consumption of Sampled Electrified Households

Dzongkhag	Average Holding of LPG (Cylinder)		Average Duration of Refilling LPG (Months / Cylinder)		Average Amount of Paying for LPG (Nu / Cylinder)		Average Traveling Time for Buying for LPG (Hours)	Mode of Transportation for Purchasing LPG						
	(14 Kg)	(4 Kg)	(14 Kg)	(4 Kg)	(14 Kg)	(4 Kg)		By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
								No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	1.6	-	2.2	-	360	-	0.91	0	-	11	0.97	105	1	1
Thimphu	2.2	-	1.5	-	380	-	1.21	0	-	14	1.48	43	2	1
Trashigang	1.6	-	2.6	-	480	-	0.49	16	0.14	2	1.75	40	0	-
Punakha	1.7	-	1.9	-	460	-	2.00	0	-	7	2.00	140	0	-
Zhemgang	1.8	-	2.2	-	446	-	0.20	20	0.16	0	-	-	0	-
Monggar	1.2	-	3.1	-	450	-	0.33	0	-	10	0.33	25	0	-
Total	-	-	-	-	-	-	-	36.0	-	44.0	-	-	3.00	-
Average	1.8	-	2.1	-	421	-	0.81	-	0.2	-	1.2	70	-	1.1
Percentage of Applicable Households (%)	-	-	-	-	-	-	-	24.0%	-	29.3%	-	-	2.0%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.11 Stock and Use of Firewood in Sampled Electrified Households

Dzongkhag	Average Amount of Firewood Stock at Present by Different Unit				Average Lasting Duration of Current Stock (Days)		Average Use of Firewood by Sampled Households (%)							
	Backload	Cubic Feet	Kg	Truck Load	Winter	Summer	Winter				Summer			
							Lighting	Heating	Cooking	Others	Lighting	Heating	Cooking	Others
Samtse	24.8	-	-	0.8	81	94	0	0	59	41	0	0	61	39
Thimphu	16.6	-	-	0.5	29	17	0	77	1	22	0	0	4	54
Trashigang	30.6	-	-	-	66	71	0	3	11	85	0	0	13	83
Punakha	19.0	-	-	-	24	42	0	37	23	39	0	0	29	71
Zhemgang	16.5	-	-	-	40	41	0	40	26	34	0	0	30	43
Monggar	26.5	-	-	-	69	74	0	0	23	77	0	0	24	76
Sub Average	23.4	-	-	0.7	55	58	0	28	21	53	0	0	24	63

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.12 Purchasing of Firewood in Sampled Electrified Households

Dzongkhag	Purchasing of Firewood by Sampled Households (%)	Average Duration of Purchasing Firewood (Days)	Average Volume of Purchasing Firewood				Average Amount of Paying for Firewood (Nu)	Average Traveling Time for Buying Firewood (Hours)	Mode of Transportation for Purchasing Firewood						
			Backload	Cubic Feet	Kg	Truck Load			By Walking		By Taking Bus / Taxi			By Asking Someone to Buy	
									No. of Households	Average Time Taken (Hours)	No. of Households	Average Time Taken (Hours)	Average Round Fare (Nu)	No. of Households	Average Time Taken (Hours)
Samtse	0.0	-	-	-	-	-	-	0	-	0	-	-	0	-	
Thimphu	40.0	521	-	-	-	1.0	6,000	0.22	3	0.27	1	0.75	50	5	0.00
Trashigang	26.7	365	-	-	-	1.0	7,088	2.69	0	-	7	3.00	61	0	-
Punakha	0.0	-	-	-	-	-	-	-	0	-	0	-	-	0	-
Zhemgang	0.0	-	-	-	-	-	-	-	0	-	0	-	-	0	-
Monggar	4.0	365	-	-	-	1.0	7,000	0.33	0	-	1	0.33	25	0	-
Sub Total	-	-	-	-	-	-	-	-	3	-	9	-	-	5	-
Sub Average	15.3	460	-	-	-	1.0	6,422	1.08	-	0.27	-	2.45	56	-	0.00
Households (%)	-	-	-	-	-	-	-	-	2.0%	-	6.0%	-	-	3.3%	-

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.13 Hiring of Someone for Collecting Firewood in Sampled Electrified Households

Dzongkhag	Hiring of Someone of Collecting Firewood by Sampled Households (%)	Average Interval of Hiring Someone for Collecting Firewood (Months)	Average Number of Hiring Persons (Persons)	Average Duration of Hiring Persons (Days)	Average Volume of Collecting Firewood by Hiring Someone				Average Amount of Paying for Hiring Someone of Collecting Firewood (Nu / Day / Person)
					Backload	Cubic Feet	Kg	Truck Load	
Samtse	76.0	12.0	5.3	5.7	200.8	-	-	0.8	115.8
Thimphu	45.7	13.5	6.1	3.8	204.3	-	-	1.0	190.6
Trashigang	23.3	12.0	9.3	5.3	140.0	-	-	-	135.7
Punakha	10.0	12.0	6.0	7.0	170.0	-	-	-	150.0
Zhemgang	4.0	12.0	6.0	7.0	120.0	-	-	-	150.0
Monggar	80.0	10.2	7.5	4.5	130.5	-	-	-	125.0
Sub Average	42.7	11.8	6.6	4.8	160.8	-	-	0.9	140.6

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.14 Collecting by Family Members / Community in Sampled Electrified Households

Dzongkhag	Collecting Firewood by Family Members of Sampled Households and Its Community (%)	Average Collecting Interval of Firewood (Days in Months)		Average Number of Family / Community Members Collecting Firewood (Persons)	Average Volume of Collecting Firewood by Family / Community Members			
		(Days)	(Months)		Backload	Cubic Feet	Kg	Truck Load
Samtse	24.0	16.0	7.2	4.5	82.5	-	-	1.0
Thimphu	8.6	8.7	8.3	3.7	125.0	-	-	1.0
Trashigang	53.3	7.3	7.6	5.5	94.7	-	-	-
Punakha	80.0	4.4	2.1	4.8	47.9	-	-	-
Zhemgang	40.0	9.0	7.8	4.9	89.0	-	-	-
Monggar	12.0	11.0	10.0	5.0	182.0	-	-	-
Sub Average	30.7	8.6	6.8	5.0	91.0	-	-	1.0

Source: Household Survey for Electrified Village (JICA Study Team, 2010)

Table-G.2.15 Questionnaire for Electrified Households Socioeconomic Survey

Household Socioeconomic Survey Questionnaire
The Preparatory Survey on Rural Electrification Project (Phase2)
in Kingdom of Bhutan

Name of Interviewer _____ Date of interview ____/____/____

1. ID. No.	2. Thram number	3. Name of village	4. Name of Gewog	5. Dzongkhag
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6. Name of Interviewee _____

A. The following questions in this section are about your household members
(Circle or write the responses in the blanks as appropriate)

				Male	Female
1.	Are you the head of the household?	1. Yes (go to Q. 3)	2.No.		
2.	If you are not the head then who is the head of household?	1. Father 2. Mother 3. Grandfather 4. Grandmother 5. Brother	6. Sister 7. Brother-in-law 8. Sister-in-law 9. Others (specify) -----		
				Male	Female
3.	Including yourself how many members do you have living in the household for the last 6 months and of what age?	1. Less than 15 years ____ Nos. 2. 16 to 25 years ____ Nos. 3. 26 to 40 years ____ Nos. 4. 41 to 60 years ____ Nos. 5. More than 61 years ____ Nos.			

B. The following questions are about household's energy use

Electricity		
4.	What do you use Electricity for? <i>(Note: This is a multi-response question. More than 1 response can be selected by respondent)</i>	1. Not use (go to Q. 10) 2. Lighting 3. Heating 4. Cooking 5. Security 6. Radio, tape recorder or TV 7. Others (specify) _____
5.	How much do you usually pay for the electricity bills?	Winter (Nov. - Mar.) _____ Nu./month Summer (Apr. - Oct.) _____ Nu./month
6.	Please provide amount of payment of the electricity bills last year.	amount of payment (Nu./month)
	March 2010	
	December 2009	
	September 2009	
	June 2009	

7.	How often does the household make payment of the electricity bills?	Every _____ months	
8.	<u>By what mode of transportation</u> does the household usually <u>take</u> to go to BPC office for paying electricity bills?	1. Walking 2. Taking bus / taxi	3. Taking private vehicle
9.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it <u>take</u> to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.
Kerosene			
10.	What do you use Kerosene for? (Note: This is a multi-response question. More than 1 response can be selected by respondent)	1. Not use (go to Q. 17) 2. Lighting 3. Heating 4. Cooking	5. Security 6. Milling 7. Others (specify) _____
11.	<u>How often</u> does the household usually <u>buy</u> "Kerosene"? (put figure)	Every _____ days	
12.	<u>How many liters</u> does the household usually <u>buy</u> it at one time? (put figure)	_____ liters	
13.	<u>How much</u> does the household usually <u>pay</u> for it? (put figure)	_____ Nu / liters	
14.	<u>How far</u> does the household usually <u>travel</u> to buy it? (put figure)	_____ hours	
15.	<u>By what mode of transportation</u> does the household usually <u>take</u> to buy it?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
16.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it <u>take</u> to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.
Diesel oil			
17.	What do you use Diesel oil for? (Note: This is a multi-response question. More than 1 response can be selected by respondent)	1. Not use (go to Q. 24) 2. Lighting 3. Heating 4. Cooking	5. Security 6. Milling 7. Others (specify) _____
18.	<u>How often</u> does the household usually <u>buy</u> "Diesel oil"? (put figure)	Every _____ days	
19.	<u>How many liters</u> does the household usually <u>buy</u> it at one time? (put figure)	_____ liters	
20.	<u>How much</u> does the household usually <u>pay</u> for it? (put figure)	_____ Nu / liters	
21.	<u>How far</u> does the household usually <u>travel</u> to buy it? (put figure)	_____ hours	
22.	<u>By what mode of transportation</u> does the household usually <u>take</u> to buy it?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
23.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it <u>take</u> to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.

Candles			
24.	What do you use Candles for? <i>(Note: This is a multi-response question. More than 1 response can be selected by respondent)</i>	1. Not use (go to Q. 31) 2. Lighting 3. Heating	4. Cooking 5. Security
25.	<u>How often</u> does the household usually <u>buy</u> "Candles"? (put figure)	Every _____ days	
26.	<u>How many pieces</u> does the household usually <u>buy</u> it at one time? (put figure)	_____ pieces	
27.	<u>How much</u> does the household usually <u>pay</u> for it? (put figure)	_____ Nu / piece	
28.	<u>How far</u> does the household usually <u>travel</u> to buy it? (put figure)	_____ hours	
29.	<u>By what mode of transportation</u> does the household usually <u>take</u> to buy it?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
30.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it <u>take</u> to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.
Dry cell batteries			
31.	What do you use Dry cell batteries for? <i>(Note: This is a multi-response question. More than 1 response can be selected by respondent)</i>	1. Not use (go to Q. 38) 2. Lighting 3. Security	4. Radio, tape recorder or TV 5. Others (specify) _____
32.	<u>How often</u> does the household usually <u>buy</u> "Dry cell batteries"? (put figure)	Every _____ days	
33.	<u>How many pieces</u> does the household usually <u>buy</u> it at one time? (put figure)	_____ pieces	
34.	<u>How much</u> does the household usually <u>pay</u> for it? (put figure)	_____ Nu / piece	
35.	<u>How far</u> does the household usually <u>travel</u> to buy it? (put figure)	_____ hours	
36.	<u>By what mode of transportation</u> does the household usually <u>take</u> to buy it?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
37.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it take to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.
LPG			
38.	What do you use LPG for? <i>(Note: This is a multi-response question. More than 1 response can be selected by respondent)</i>	1. Not use (go to Q. 45) 2. Lighting 3. Heating 4. Cooking	5. Security 6. Others (specify) _____
39.	<u>How many "LPG cylinders"</u> does the household <u>has</u> ? (put figure)	LPG (14kg cylinder) _____ cylinders	LPG (4kg cylinder) _____ cylinders

40.	<u>How often</u> does the household usually <u>refill</u> "LPG cylinders"? (put figure)	LPG (14kg) _____ months / cylinder	LPG (4kg) _____ months / cylinder
41.	How much does the household usually pay for it? (put figure)	LPG (14kg) _____ Nu / cylinder	LPG (4kg) _____ Nu / cylinder
42.	<u>How far</u> does the household usually <u>travel to refill it</u> ? (put figure)	_____ hours	
43.	<u>By what mode of transportation</u> does the household usually <u>take to refill it</u> ?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
44.	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it take to buy it? (put figure)	(Transportation Time) _____ hours	(Transportation fee) _____ Nu.
Firewood			
45.	What do you use Firewood for? <i>(Note: This is a multi-response question. More than 1 response can be selected by respondent)</i>	1. Not use (go to Q. 50) 2. Lighting 3. Heating 4. Cooking	5. Security 6. Others (specify) _____
46.	Provide <u>approximate proportional use</u> of firewood between each use (put figure)	Winter (Nov. - Mar.) 1. Lighting _____% 2. Heating _____% 3. Cooking _____% 4. Others _____% <i>(Note: The total amount of figures should be 100%)</i>	Summer (Apr. - Oct.) 1. Lighting _____% 2. Heating _____% 3. Cooking _____% 4. Others _____% <i>(Note: The total amount of figures should be 100%)</i>
47.	<u>How much stock</u> of "Firewood" does the household <u>has at present</u> ?	Amount (put only figure) _____	Unit (choose one) 1. Backload 2. Cubic feet 3. kg 4. Truck load
48.	<u>How long</u> does the current stock usually <u>last</u> ?	Winter season _____ days	Summer season _____ days
49.	<u>How</u> does the household <u>get</u> "Firewood"?	a. Buying (go to Q. a-1 to a-6) b. Hiring someone (go to Q. b-1 to b-5)	c. Collecting by family members (go to Q. c-1 to c-4)
a-1	<u>How often</u> does the household usually <u>buy</u> "Firewood"? (put figure)	Every _____ days	
a-2	<u>How much volume</u> does the household usually <u>buy</u> it at one time? (put figure)	Amount (put only figure) _____	Unit (choose one) 1. Backload 2. Cubic feet 3. kg 4. Truck load

a-3	<u>How much</u> does the household usually <u>pay</u> for it? (put figure)	_____ Nu	
a-4	<u>How far</u> does the household usually <u>travel</u> to buy it? (put figure)	_____ hours	
a-5	<u>By what mode of transportation</u> does the household usually <u>take</u> to buy it?	1. Walking 2. Taking bus / taxi	3. Asking someone going to get it
a-6	How long (<u>transportation time</u>) and how much (<u>transportation fee</u>) does it take to buy it? (put figure)	(Transportation time) _____ hours	(Transportation fee) _____ Nu.
b-1	<u>How often</u> does the household usually <u>hire</u> someone to collect "Firewood"? (put figure)	Every _____ months	
b-2	<u>How many persons</u> does the household usually <u>hire</u> ? (put figure)	_____ persons	
b-3	<u>How many days</u> does the household usually <u>hire the persons</u> ? (put figure)	_____ days	
b-4	<u>How much volume</u> of firewood do the hired persons usually collect? (put figure)	Amount (put only figure) _____	Unit (choose one) 1. Backload 2. Cubic feet 3. kg 4. Truck load
b-5	<u>How much</u> does the household usually <u>pay</u> for hiring someone to collect firewood? (put figure)	_____ Nu/day/person	
c-1	<u>How often</u> does the household usually <u>collect</u> "Firewood"? (put figure)	_____ days on every _____ months	
c-2	<u>How many family members</u> do usually go out to <u>collect</u> it? (put figure)	_____ members	
c-3	<u>How many hours</u> do the family members usually <u>spend</u> to collect it? (put figure)	_____ hours/day	
c-4	<u>How much volume</u> of firewood do the family members usually collect? (put figure)	Amount (put only figure) _____	Unit (choose one) 1. Backload 2. Cubic feet 3. kg 4. Truck load

C. The following questions are about changes after electrification

50.	With electricity provided in the village/house	1. (Very much)	2.(A little)	3.(Not at all)	4. (Don't know)
i.	The village/house became better maintained in term of cleanliness				
ii.	There have been better houses coming up in the villages				
iii.	There have been more kinds of small businesses				
iv.	There have been more migrants coming back to the village				
v.	There have been less youth migration to cities				
vi.	Social life in the village has improved				
vii.	It became safer at night in the village				
viii.	New services and commercial activities became available in the village				

ix.	After receiving electricity, smoke-related diseases (cough, eye itch, tearful eyes) have been reduced				
x.	After receiving electricity, children spend more time at home in studying and have improved their academic results				
xi.	More information became available through media				
xii.	Burden on women has decreased				
xiii.	Service delivery for women and child health care has improved				
xiv.	More women have been enrolled in NFE (non-formal education)				
xv.	Do you think electricity connection has negatively affected village life?	1. Yes	2. No	3. Don't know	
xvi.	If yes, how?				
xvii.	Has electricity benefitted women more than men or men more than women or both? Explain.				

D. The following questions are about the status of income and expenditure

51.	How much of each of these assets does the household own?	1. Land (all categories) _____ acres 2. Cattle _____ heads 3. Poultry _____ 4. Horses/mules _____ 5. Farm machinery _____	6. Vehicle/2 wheelers _____ 7. LPG stove _____ 8. TV _____ 9. Radio _____ 10. Phone _____ 11. Mobile _____
52.	What type of material is your house wall made of?	1. Concrete 2. Wood 3. Tiles	4. CGI 5. Bamboo 6. Others (specify) _____
53.	How often do you charge your mobile phone?	Every _____ days	
54.	How much did you spend on the following last year? <i>(Note: If annual expenditure seems difficult for them, you can ask monthly expenditure and calculate annual amount later) *Leave notes in that case.</i>	1. Food Nu. _____ 2. Clothing Nu. _____ 3. House renovation/building Nu. _____ 4. Education Nu. _____ 5. Medicines Nu. _____ 6. Travel Nu. _____ 7. Religious ceremonies Nu. _____	8. Social occasions (birth, death, marriage) Nu. _____ 9. Entertainment Nu. _____ 10. Communication (phone, mobile) Nu. _____ 11. Farm machinery Nu. _____ 12. Cattle Nu. _____
55.	How much was the annual cash income of the household last year?	_____ Nu./year	
56.	Assuming that you lose your grid electricity connection, how much will you pay for the solar mobile charging system per month?	_____ Nu./month	

Data checked by _____ *Date of checking* ____/____/____

Data entered by _____ *Date of entry* ____/____/____

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-H

**ESTIMATION OF VOLTAGE DROP AND
SYSTEM LOSS**

APPENDIX-H ESTIMATION OF VOLTAGE DROP AND SYSTEM LOSS

H.1 Methodology

The following is the methodology to estimate the voltage drop and system loss.

Explanation will be made for the Feeder No. 1 as shown in Figure-Y.1 (Single Line Diagram for 33kV Conductor Change)

First step: Calculate the system loss between Substation A and Node 1, the assumed load is (SS-1 + SS-2 + SS-3), and the receiving voltage at Node 1 also be calculated.

Second step: Calculate the system loss between Node 1 and Node 2, the assumed load is (SS-2 + SS-3), in this case, sending voltage at Node 1 is assumed to be the same as receiving voltage calculated at first step.

Third step: Calculate the system loss between Node 1 and SS-2, the assumed load is 8MW, in this case, sending voltage at Node 1 is assumed to be the same as receiving voltage calculated at First step.

Fourth step: Calculate the system loss between Node 2 and SS-3, the assumed load is 4MW, in this case, sending voltage at Node 2 is assumed to be the same as receiving voltage calculated at Second step.

Fifth step: Calculate the system loss between Node 2 and Muladi SS, the assumed load is 4MW, in this case, sending voltage at Node 2 is assumed to be the same as receiving voltage calculated at Second step.

During above calculation, losses of each section are summed up, and system loss of Feeder No. 1 is calculated.

For Feeder Nos. 2 and 3, also the same methodology is applied, finally the system loss of Substation A is estimated.

The exact calculation of system loss should be made using load flow calculation method, so that results based on the above methodology are only rough estimation.

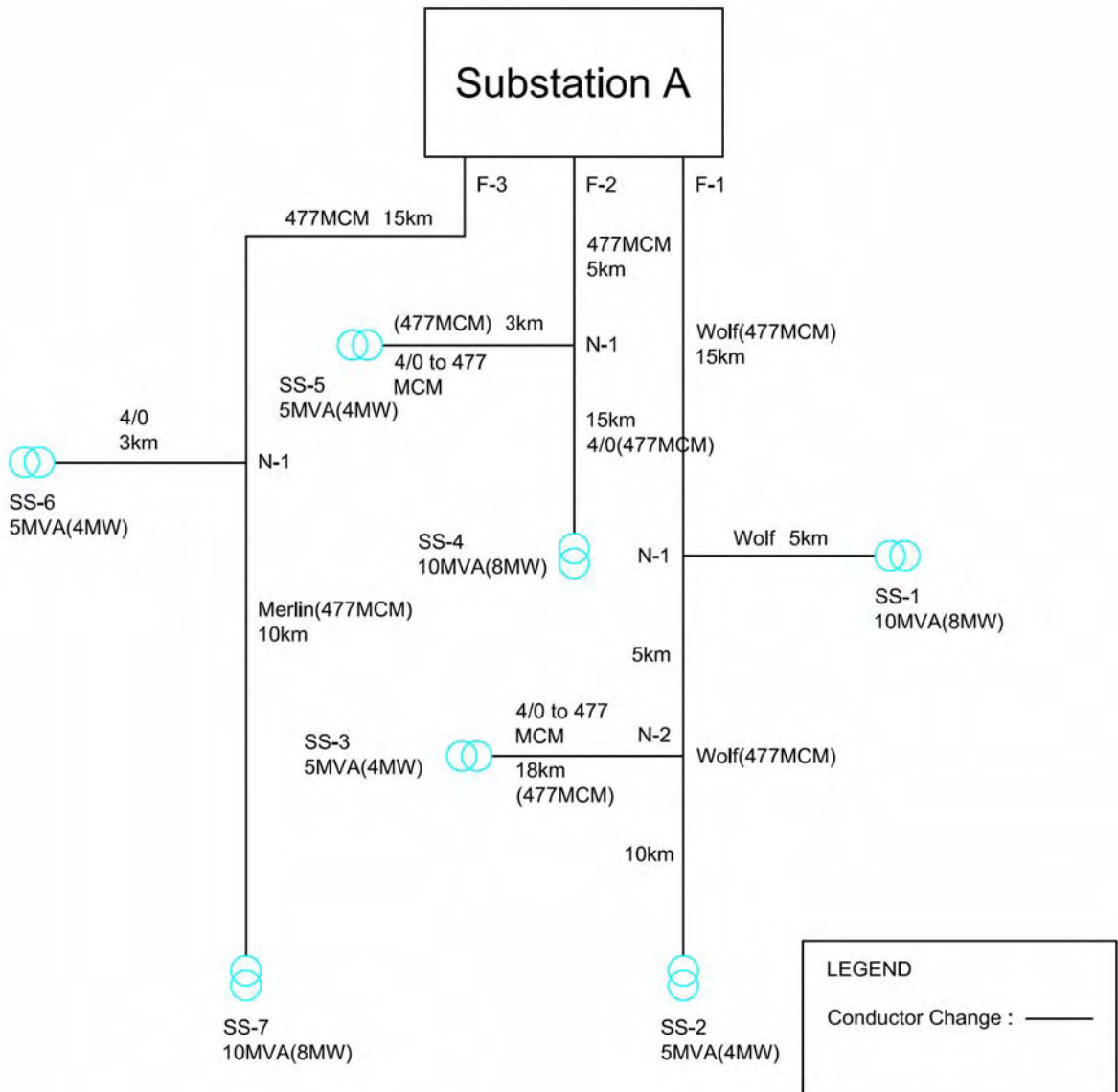


Figure-H.1 Single line diagram of substations

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-I

SAG CALCULATION OF CONDUCTORS

APPENDIX-I SAG CALCULATION OF CONDUCTORS

Table-I.1 Rabbit (Max. working tension: 400 kgf)

I. Design Condition

(1) Kind of conductor	50sqmm Rabbit (BS)	(2) Sectional area (sqmm)	61.7	(3) Outer diameter (mm)	10.05
(4) Weight (kg/m)	0.214	(5) Elastic modulus (kg/sqmm)	8,400	(6) UTS (kg)	1,870
(7) Coefficient of linear expansion (°C)	1.9E-05	(8) Elongation (%)	0.000	(10) Load condition (°C) high	15
(9) Max. working tension (kg)	400	(10) Load condition (°C) low	-10	(11) Wind pressure (H) (kg/sqm)	44
		(12) Design condition :	Low - temperature - design	Wind pressure (L) (kg/sqm)	44

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kg)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kg)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kg)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kg)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kg)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kg)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2														
No.	AO	DHO	LO														
1	100.00	0.00	99.986														
Total	100.00		99.986														
Temp	HO	No.	FAO	TAO	DAO	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL	
-10	242.5	1	2.53	242.7	1.10	2.53	242.7	1.10	242.5	2.53	242.7	1.10	2.53	242.7	1.10	0.000	
0	207.0	1	2.96	207.3	1.29	2.96	207.3	1.29	207.0	2.96	207.3	1.29	2.96	207.3	1.29	0.000	
10	180.8	1	3.39	181.1	1.48	3.39	181.1	1.48	180.8	3.39	181.1	1.48	3.39	181.1	1.48	0.000	
15	170.3	1	3.60	170.7	1.57	3.60	170.7	1.57	170.3	3.60	170.7	1.57	3.60	170.7	1.57	0.000	
20	161.2	1	3.80	161.5	1.66	3.80	161.5	1.66	161.2	3.80	161.5	1.66	3.80	161.5	1.66	0.000	
30	146.1	1	4.19	146.5	1.83	4.19	146.5	1.83	146.1	4.19	146.5	1.83	4.19	146.5	1.83	0.000	
40	134.2	1	4.56	134.6	1.99	4.56	134.6	1.99	134.2	4.56	134.6	1.99	4.56	134.6	1.99	0.000	
50	124.5	1	4.92	125.0	2.15	4.92	125.0	2.15	124.5	4.92	125.0	2.15	4.92	125.0	2.15	0.000	
60	116.6	1	5.25	117.1	2.30	5.25	117.1	2.30	116.6	5.25	117.1	2.30	5.25	117.1	2.30	0.000	
70	109.9	1	5.57	110.4	2.44	5.57	110.4	2.44	109.9	5.57	110.4	2.44	5.57	110.4	2.44	0.000	
75	106.9	1	5.72	107.5	2.50	5.72	107.5	2.50	106.9	5.72	107.5	2.50	5.72	107.5	2.50	0.000	
90	99.3	1	6.16	99.8	2.70	6.16	99.8	2.70	99.3	6.16	99.8	2.70	6.16	99.8	2.70	0.000	
120	87.7	1	6.97	88.4	3.05	6.97	88.4	3.05	87.7	6.97	88.4	3.05	6.97	88.4	3.05	0.000	

(Prepared by JPST)

Table-I.2 Rabbit (Max. working tension: 500 kgf)

1. Design Condition

(1) Kind of conductor	50sqmm Rabbit (BS)	(2) Sectional area (sqmm)	61.7	(3) Outer diameter (mm)	10.05
(4) Weight (kg/m)	0.214	(5) Elastic modulus (kg/sqmm)	8,400	(6) UTS (kg)	1,870
(7) Coefficient of linear expansion (°C)	1.9E-05	(8) Elongation (%)	0.000	(11) Wind pressure (H) (kg/sqm)	44
(9) Max. working tension (kg)	500	(10) Load condition (°C) high	15	Wind pressure (L) (kg/sqm)	44
		Load condition (°C) low	-10		
		(12) Design condition :	Low - temperature - design		

No ; Tower number of low number side at the span
 AO ; Horizontal span length (m)
 DHO ; Height difference between supporting points (m)
 LO ; Conductor length at 15°C (without tension)

(Clamping)

HO ; Horizontal tension (kg)
 FAO ; Catenary angle - low number side (deg)
 TAO ; Supporting tension - low number side (kg)
 DAO ; Horizontal sag (m)
 FBO ; Catenary angle - high number side (deg)
 TBO ; Supporting tension - high number side (kg)
 DO ; Inclined sag (m)

(Stringing)

H ; Horizontal tension (kg)
 FA ; Catenary angle - low number side (deg)
 TA ; Supporting tension - low number side (kg)
 DA ; Horizontal sag (m)
 FB ; Catenary angle - high number side (deg)
 TB ; Supporting tension - high number side (kg)
 D ; Inclined sag (m)
 DL ; Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2														
No.	AO	DHO	LO														
1	100.00	0.00	99.944														
Total	100.00		99.944														
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL	
-10	365.5	1	1.68	365.7	0.73	1.68	365.7	0.73	365.5	1.68	365.7	0.73	1.68	365.7	0.73	0.000	
0	302.0	1	2.03	302.2	0.89	2.03	302.2	0.89	302.0	2.03	302.2	0.89	2.03	302.2	0.89	0.000	
10	251.8	1	2.43	252.0	1.06	2.43	252.0	1.06	251.8	2.43	252.0	1.06	2.43	252.0	1.06	0.000	
15	231.4	1	2.65	231.7	1.16	2.65	231.7	1.16	231.4	2.65	231.7	1.16	2.65	231.7	1.16	0.000	
20	213.9	1	2.86	214.2	1.25	2.86	214.2	1.25	213.9	2.86	214.2	1.25	2.86	214.2	1.25	0.000	
30	186.0	1	3.30	186.3	1.44	3.30	186.3	1.44	186.0	3.30	186.3	1.44	3.30	186.3	1.44	0.000	
40	165.1	1	3.71	165.4	1.62	3.71	165.4	1.62	165.1	3.71	165.4	1.62	3.71	165.4	1.62	0.000	
50	149.1	1	4.11	149.5	1.79	4.11	149.5	1.79	149.1	4.11	149.5	1.79	4.11	149.5	1.79	0.000	
60	136.6	1	4.48	137.0	1.96	4.48	137.0	1.96	136.6	4.48	137.0	1.96	4.48	137.0	1.96	0.000	
70	126.5	1	4.84	127.0	2.12	4.84	127.0	2.12	126.5	4.84	127.0	2.12	4.84	127.0	2.12	0.000	
75	122.2	1	5.01	122.6	2.19	5.01	122.6	2.19	122.2	5.01	122.6	2.19	5.01	122.6	2.19	0.000	
90	111.3	1	5.50	111.8	2.41	5.50	111.8	2.41	111.3	5.50	111.8	2.41	5.50	111.8	2.41	0.000	
120	95.9	1	6.38	96.5	2.79	6.38	96.5	2.79	95.9	6.38	96.5	2.79	6.38	96.5	2.79	0.000	

(Prepared by JPST)

Table-I.3 Rabbit (Max. working tension: 600 kgf)

I. Design Condition

(1) Kind of conductor	50sqmm Rabbit (BS)	(2) Sectional area (sqmm)	61.7	(3) Outer diameter (mm)	10.05
(4) Weight (kg/m)	0.214	(5) Elastic modulus (kg/sqmm)	8,400	(6) UTS (kg)	1,870
(7) Coefficient of linear expansion (°C)	1.9E-05	(8) Elongation (%)	0.000		
(9) Max. working tension (kg)	600	(10) Load condition (°C) high	15	(11) Wind pressure (H) (kg/sqm)	44
		Load condition (°C) low	-10	Wind pressure (L) (kg/sqm)	44
		(12) Design condition :	Low - temperature - design		

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kg)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kg)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kg)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kg)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kg)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kg)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2													
No.	A0	DH0	L0													
1	100.00	0.00	99.912													
Total	100.00		99.912													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	495.5	1	1.24	495.6	0.54	1.24	495.6	0.54	495.5	1.24	495.6	0.54	1.24	495.6	0.54	0.000
0	414.8	1	1.48	415.0	0.64	1.48	415.0	0.64	414.8	1.48	415.0	0.64	1.48	415.0	0.64	0.000
10	343.4	1	1.79	343.5	0.78	1.79	343.5	0.78	343.4	1.79	343.5	0.78	1.79	343.5	0.78	0.000
15	312.1	1	1.96	312.3	0.86	1.96	312.3	0.86	312.1	1.96	312.3	0.86	1.96	312.3	0.86	0.000
20	284.1	1	2.16	284.3	0.94	2.16	284.3	0.94	284.1	2.16	284.3	0.94	2.16	284.3	0.94	0.000
30	238.1	1	2.57	238.4	1.12	2.57	238.4	1.12	238.1	2.57	238.4	1.12	2.57	238.4	1.12	0.000
40	203.9	1	3.01	204.1	1.31	3.01	204.1	1.31	203.9	3.01	204.1	1.31	3.01	204.1	1.31	0.000
50	178.5	1	3.43	178.8	1.50	3.43	178.8	1.50	178.5	3.43	178.8	1.50	3.43	178.8	1.50	0.000
60	159.4	1	3.84	159.8	1.68	3.84	159.8	1.68	159.4	3.84	159.8	1.68	3.84	159.8	1.68	0.000
70	144.7	1	4.23	145.1	1.85	4.23	145.1	1.85	144.7	4.23	145.1	1.85	4.23	145.1	1.85	0.000
75	138.6	1	4.42	139.0	1.93	4.42	139.0	1.93	138.6	4.42	139.0	1.93	4.42	139.0	1.93	0.000
90	123.6	1	4.95	124.1	2.16	4.95	124.1	2.16	123.6	4.95	124.1	2.16	4.95	124.1	2.16	0.000
120	103.7	1	5.90	104.2	2.58	5.90	104.2	2.58	103.7	5.90	104.2	2.58	5.90	104.2	2.58	0.000

(Prepared by JPST)

Table-I.4 Dog (Max. working tension: 800 kgf)

1. Design Condition

(1) Kind of conductor	100sqmm Dog (BS)	(2) Sectional area (sqmm)	118.5	(3) Outer diameter (mm)	14.15
(4) Weight (kg/m)	0.394	(5) Elastic modulus (kg/sqmm)	7,990	(6) UTS (kg)	3,340
(7) Coefficient of linear expansion (°C)	2E-05	(8) Elongation (%)	0.000	(11) Wind pressure (H) (kg/sqm)	44
(9) Max. working tension (kg)	800	(10) Load condition (°C) high	15	Wind pressure (L) (kg/sqm)	44
		Load condition (°C) low	-10		
		(12) Design condition :	Low - temperature - design		

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DH0 : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kg)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kg)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kg)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kg)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kg)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kg)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2																	
No.	A0	DH0	L0																	
1	100.00	0.00	99.951	Temp	H0	No.	FA0	TA0	DA0	FB0	TB0	D0	H	FA	TA	DA	FB	TB	D	DL
Total	100.00		99.951	-10	623.1	1	1.81	623.4	0.79	1.81	623.4	0.79	623.1	1.81	623.4	0.79	1.81	623.4	0.79	0.000
				0	513.3	1	2.20	513.7	0.96	2.20	513.7	0.96	513.3	2.20	513.7	0.96	2.20	513.7	0.96	0.000
				10	429.0	1	2.63	429.5	1.15	2.63	429.5	1.15	429.0	2.63	429.5	1.15	2.63	429.5	1.15	0.000
				15	395.5	1	2.85	396.0	1.25	2.85	396.0	1.25	395.5	2.85	396.0	1.25	2.85	396.0	1.25	0.000
				20	366.8	1	3.08	367.4	1.34	3.08	367.4	1.34	366.8	3.08	367.4	1.34	3.08	367.4	1.34	0.000
				30	321.1	1	3.51	321.7	1.53	3.51	321.7	1.53	321.1	3.51	321.7	1.53	3.51	321.7	1.53	0.000
				40	286.9	1	3.93	287.6	1.72	3.93	287.6	1.72	286.9	3.93	287.6	1.72	3.93	287.6	1.72	0.000
				50	260.5	1	4.33	261.3	1.89	4.33	261.3	1.89	260.5	4.33	261.3	1.89	4.33	261.3	1.89	0.000
				60	239.7	1	4.70	240.5	2.06	4.70	240.5	2.06	239.7	4.70	240.5	2.06	4.70	240.5	2.06	0.000
				70	222.8	1	5.06	223.7	2.21	5.06	223.7	2.21	222.8	5.06	223.7	2.21	5.06	223.7	2.21	0.000
				75	215.5	1	5.23	216.4	2.29	5.23	216.4	2.29	215.5	5.23	216.4	2.29	5.23	216.4	2.29	0.000
				90	197.1	1	5.72	198.1	2.50	5.72	198.1	2.50	197.1	5.72	198.1	2.50	5.72	198.1	2.50	0.000
				120	170.7	1	6.60	171.8	2.89	6.60	171.8	2.89	170.7	6.60	171.8	2.89	6.60	171.8	2.89	0.000

(Prepared by JPST)

Table-I.5 Dog (Max. working tension: 900 kgf)

I. Design Condition

(1) Kind of conductor	100sqmm Dog (BS)	(2) Sectional area (sqmm)	118.5	(3) Outer diameter (mm)	14.15
(4) Weight (kg/m)	0.394	(5) Elastic modulus (kg/sqmm)	7,990	(6) UTS (kg)	3,340
(7) Coefficient of linear expansion (°C)	2E-05	(8) Elongation (%)	0.000	(11) Wind pressure (H) (kg/sqm)	44
(9) Max. working tension (kg)	900	(10) Load condition (°C) high	15	Wind pressure (L) (kg/sqm)	44
		Load condition (°C) low	-10		
		(12) Design condition :	Low - temperature - design		

No ; Tower number of low number side at the span
 AO ; Horizontal span length (m)
 DHO ; Height difference between supporting points (m)
 LO ; Conductor length at 15°C (without tension)

(Clamping)

HO ; Horizontal tension (kg)
 FAO ; Catenary angle - low number side (deg)
 TAO ; Supporting tension - low number side (kg)
 DAO ; Horizontal sag (m)
 FBO ; Catenary angle - high number side (deg)
 TBO ; Supporting tension - high number side (kg)
 DO ; Inclined sag (m)

(Stringing)

H ; Horizontal tension (kg)
 FA ; Catenary angle - low number side (deg)
 TA ; Supporting tension - low number side (kg)
 DA ; Horizontal sag (m)
 FB ; Catenary angle - high number side (deg)
 TB ; Supporting tension - high number side (kg)
 D ; Inclined sag (m)
 DL ; Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2													
No.	A0	DH0	L0													
1	100.00	0.00	99.933													
Total	100.00		99.933													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	745.7	1	1.51	746.0	0.66	1.51	746.0	0.66	745.7	1.51	746.0	0.66	1.51	746.0	0.66	0.000
0	613.7	1	1.84	614.0	0.80	1.84	614.0	0.80	613.7	1.84	614.0	0.80	1.84	614.0	0.80	0.000
10	505.9	1	2.23	506.3	0.97	2.23	506.3	0.97	505.9	2.23	506.3	0.97	2.23	506.3	0.97	0.000
15	461.7	1	2.44	462.1	1.07	2.44	462.1	1.07	461.7	2.44	462.1	1.07	2.44	462.1	1.07	0.000
20	423.5	1	2.66	424.0	1.16	2.66	424.0	1.16	423.5	2.66	424.0	1.16	2.66	424.0	1.16	0.000
30	362.8	1	3.11	363.4	1.36	3.11	363.4	1.36	362.8	3.11	363.4	1.36	3.11	363.4	1.36	0.000
40	318.2	1	3.55	318.8	1.55	3.55	318.8	1.55	318.2	3.55	318.8	1.55	3.55	318.8	1.55	0.000
50	284.6	1	3.96	285.3	1.73	3.96	285.3	1.73	284.6	3.96	285.3	1.73	3.96	285.3	1.73	0.000
60	258.8	1	4.36	259.5	1.90	4.36	259.5	1.90	258.8	4.36	259.5	1.90	4.36	259.5	1.90	0.000
70	238.3	1	4.73	239.1	2.07	4.73	239.1	2.07	238.3	4.73	239.1	2.07	4.73	239.1	2.07	0.000
75	229.6	1	4.91	230.4	2.15	4.91	230.4	2.15	229.6	4.91	230.4	2.15	4.91	230.4	2.15	0.000
90	207.9	1	5.42	208.8	2.37	5.42	208.8	2.37	207.9	5.42	208.8	2.37	5.42	208.8	2.37	0.000
120	177.7	1	6.34	178.8	2.77	6.34	178.8	2.77	177.7	6.34	178.8	2.77	6.34	178.8	2.77	0.000

(Prepared by JPST)

Table-I.6 Dog (Max. working tension: 1,000 kgf)

1. Design Condition

(1) Kind of conductor	100sqmm Dog (BS)	(2) Sectional area (sqmm)	118.5	(3) Outer diameter (mm)	14.15
(4) Weight (kg/m)	0.394	(5) Elastic modulus (kg/sqmm)	7,990	(6) UTS (kg)	3,340
(7) Coefficient of linear expansion (°C)	2E-05	(8) Elongation (%)	0.000		
(9) Max. working tension (kg)	1000	(10) Load condition (°C) high	15	(11) Wind pressure (H) (kg/sqm)	44
		Load condition (°C) low	-10	Wind pressure (L) (kg/sqm)	44
		(12) Design condition :	Low - temperature - design		

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kg)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kg)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kg)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kg)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kg)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kg)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2														
No.	AO	DHO	LO														
1	100.00	0.00	99.917														
Total	100.00		99.917														
Temp	H0	No.	FA0	TA0	DA0	FB0	TB0	D0	H	FA	TA	DA	FB	TB	D	DL	
-10	867.2	1	1.30	867.5	0.57	1.30	867.5	0.57	867.2	1.30	867.5	0.57	1.30	867.5	0.57	0.000	
0	719.6	1	1.57	719.9	0.68	1.57	719.9	0.68	719.6	1.57	719.9	0.68	1.57	719.9	0.68	0.000	
10	591.8	1	1.91	592.1	0.83	1.91	592.1	0.83	591.8	1.91	592.1	0.83	1.91	592.1	0.83	0.000	
15	537.0	1	2.10	537.4	0.92	2.10	537.4	0.92	537.0	2.10	537.4	0.92	2.10	537.4	0.92	0.000	
20	488.8	1	2.31	489.2	1.01	2.31	489.2	1.01	488.8	2.31	489.2	1.01	2.31	489.2	1.01	0.000	
30	410.8	1	2.75	411.3	1.20	2.75	411.3	1.20	410.8	2.75	411.3	1.20	2.75	411.3	1.20	0.000	
40	353.5	1	3.19	354.1	1.39	3.19	354.1	1.39	353.5	3.19	354.1	1.39	3.19	354.1	1.39	0.000	
50	311.3	1	3.62	311.9	1.58	3.62	311.9	1.58	311.3	3.62	311.9	1.58	3.62	311.9	1.58	0.000	
60	279.4	1	4.04	280.1	1.76	4.04	280.1	1.76	279.4	4.04	280.1	1.76	4.04	280.1	1.76	0.000	
70	254.7	1	4.43	255.4	1.93	4.43	255.4	1.93	254.7	4.43	255.4	1.93	4.43	255.4	1.93	0.000	
75	244.3	1	4.62	245.1	2.02	4.62	245.1	2.02	244.3	4.62	245.1	2.02	4.62	245.1	2.02	0.000	
90	219.0	1	5.15	219.8	2.25	5.15	219.8	2.25	219.0	5.15	219.8	2.25	5.15	219.8	2.25	0.000	
120	184.7	1	6.10	185.7	2.67	6.10	185.7	2.67	184.7	6.10	185.7	2.67	6.10	185.7	2.67	0.000	

(Prepared by JPST)

Table-I.7 Dog (Max. working tension: 1,100 kgf)

1. Design Condition

(1) Kind of conductor	100sqmm Dog (BS)	(2) Sectional area (sqmm)	118.5	(3) Outer diameter (mm)	14.15
(4) Weight (kg/m)	0.394	(5) Elastic modulus (kg/sqmm)	7,990	(6) UTS (kg)	3,340
(7) Coefficient of linear expansion (°C)	2E-05	(8) Elongation (%)	0.000	(11) Wind pressure (H) (kg/sqm)	44
(9) Max. working tension (kg)	1100	(10) Load condition (°C) high	15	Wind pressure (L) (kg/sqm)	44
		Load condition (°C) low	-10		
		(12) Design condition :	Low - temperature - design		

No ; Tower number of low number side at the span
 AO ; Horizontal span length (m)
 DHO ; Height difference between supporting points (m)
 LO ; Conductor length at 15°C (without tension)

(Clamping)

HO ; Horizontal tension (kg)
 FAO ; Catenary angle - low number side (deg)
 TAO ; Supporting tension - low number side (kg)
 DAO ; Horizontal sag (m)
 FBO ; Catenary angle - high number side (deg)
 TBO ; Supporting tension - high number side (kg)
 DO ; Inclined sag (m)

(Stringing)

H ; Horizontal tension (kg)
 FA ; Catenary angle - low number side (deg)
 TA ; Supporting tension - low number side (kg)
 DA ; Horizontal sag (m)
 FB ; Catenary angle - high number side (deg)
 TB ; Supporting tension - high number side (kg)
 D ; Inclined sag (m)
 DL ; Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2														
No.	AO	DHO	LO														
1	100.00	0.00	99.903														
Total	100.00		99.903														
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL	
-10	986.0	1	1.14	986.2	0.50	1.14	986.2	0.50	986.0	1.14	986.2	0.50	1.14	986.2	0.50	0.000	
0	827.9	1	1.36	828.1	0.59	1.36	828.1	0.59	827.9	1.36	828.1	0.59	1.36	828.1	0.59	0.000	
10	684.7	1	1.65	685.0	0.72	1.65	685.0	0.72	684.7	1.65	685.0	0.72	1.65	685.0	0.72	0.000	
15	620.8	1	1.82	621.1	0.79	1.82	621.1	0.79	620.8	1.82	621.1	0.79	1.82	621.1	0.79	0.000	
20	562.9	1	2.00	563.3	0.87	2.00	563.3	0.87	562.9	2.00	563.3	0.87	2.00	563.3	0.87	0.000	
30	466.6	1	2.42	467.0	1.06	2.42	467.0	1.06	466.6	2.42	467.0	1.06	2.42	467.0	1.06	0.000	
40	394.4	1	2.86	394.9	1.25	2.86	394.9	1.25	394.4	2.86	394.9	1.25	2.86	394.9	1.25	0.000	
50	341.5	1	3.30	342.1	1.44	3.30	342.1	1.44	341.5	3.30	342.1	1.44	3.30	342.1	1.44	0.000	
60	302.3	1	3.73	302.9	1.63	3.73	302.9	1.63	302.3	3.73	302.9	1.63	3.73	302.9	1.63	0.000	
70	272.5	1	4.14	273.2	1.81	4.14	273.2	1.81	272.5	4.14	273.2	1.81	4.14	273.2	1.81	0.000	
75	260.2	1	4.33	260.9	1.89	4.33	260.9	1.89	260.2	4.33	260.9	1.89	4.33	260.9	1.89	0.000	
90	230.6	1	4.89	231.4	2.14	4.89	231.4	2.14	230.6	4.89	231.4	2.14	4.89	231.4	2.14	0.000	
120	191.7	1	5.88	192.8	2.57	5.88	192.8	2.57	191.7	5.88	192.8	2.57	5.88	192.8	2.57	0.000	

(Prepared by JPST)

Table-I.8 Fluorine (Max. working tension: 400 kgf)

1. Design Condition

(1) Kind of conductor	AAAC/Fluorine	(2) Sectional area (sqmm)	49.48	(3) Outer diameter (mm)	15.3
(4) Weight (kg/m)	0.26	(5) Elastic modulus (kg/sqmm)	6,500	(6) UTS (kg)	1,204
(7) Coefficient of linear expansion (°C)	2.3E-05	(8) Elongation (%)	0.000	(10) Load condition (°C) high	15
(9) Max. working tension (kg)	400	(10) Load condition (°C) low	-10	(11) Wind pressure (H) (kg/sqm)	44.86
		(12) Design condition :	Low - temperature - design	Wind pressure (L) (kg/sqm)	44.86

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kgf)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kgf)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kgf)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kgf)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kgf)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kgf)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2													
No.	A0	DH0	L0													
1	60.00	0.00	59.956													
Total	60.00		59.956													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	279.3	1	1.60	279.5	0.42	1.60	279.5	0.42	279.3	1.60	279.5	0.42	1.60	279.5	0.42	0.000
0	227.0	1	1.97	227.1	0.52	1.97	227.1	0.52	227.0	1.97	227.1	0.52	1.97	227.1	0.52	0.000
10	185.0	1	2.41	185.2	0.63	2.41	185.2	0.63	185.0	2.41	185.2	0.63	2.41	185.2	0.63	0.000
15	168.1	1	2.66	168.3	0.70	2.66	168.3	0.70	168.1	2.66	168.3	0.70	2.66	168.3	0.70	0.000
20	153.8	1	2.91	154.0	0.76	2.91	154.0	0.76	153.8	2.91	154.0	0.76	2.91	154.0	0.76	0.000
30	131.2	1	3.40	131.5	0.89	3.40	131.5	0.89	131.2	3.40	131.5	0.89	3.40	131.5	0.89	0.000
40	114.9	1	3.89	115.2	1.02	3.89	115.2	1.02	114.9	3.89	115.2	1.02	3.89	115.2	1.02	0.000
50	102.8	1	4.34	103.1	1.14	4.34	103.1	1.14	102.8	4.34	103.1	1.14	4.34	103.1	1.14	0.000
60	93.5	1	4.78	93.8	1.25	4.78	93.8	1.25	93.5	4.78	93.8	1.25	4.78	93.8	1.25	0.000
70	86.1	1	5.18	86.5	1.36	5.18	86.5	1.36	86.1	5.18	86.5	1.36	5.18	86.5	1.36	0.000
75	83.0	1	5.38	83.4	1.41	5.38	83.4	1.41	83.0	5.38	83.4	1.41	5.38	83.4	1.41	0.000
90	75.2	1	5.93	75.6	1.56	5.93	75.6	1.56	75.2	5.93	75.6	1.56	5.93	75.6	1.56	0.000
120	64.4	1	6.93	64.8	1.82	6.93	64.8	1.82	64.4	6.93	64.8	1.82	6.93	64.8	1.82	0.000
Section	2	-	3													
No.	A0	DH0	L0													
2	80.00	0.00	79.972													
Total	80.00		79.972													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	225.3	2	2.64	225.6	0.92	2.64	225.6	0.92	225.3	2.64	225.6	0.92	2.64	225.6	0.92	0.000
0	193.0	2	3.09	193.2	1.08	3.09	193.2	1.08	193.0	3.09	193.2	1.08	3.09	193.2	1.08	0.000
10	168.2	2	3.54	168.5	1.24	3.54	168.5	1.24	168.2	3.54	168.5	1.24	3.54	168.5	1.24	0.000
15	158.2	2	3.77	158.5	1.32	3.77	158.5	1.32	158.2	3.77	158.5	1.32	3.77	158.5	1.32	0.000
20	149.3	2	3.99	149.7	1.39	3.99	149.7	1.39	149.3	3.99	149.7	1.39	3.99	149.7	1.39	0.000
30	134.8	2	4.42	135.2	1.54	4.42	135.2	1.54	134.8	4.42	135.2	1.54	4.42	135.2	1.54	0.000
40	123.2	2	4.83	123.7	1.69	4.83	123.7	1.69	123.2	4.83	123.7	1.69	4.83	123.7	1.69	0.000
50	114.0	2	5.22	114.5	1.83	5.22	114.5	1.83	114.0	5.22	114.5	1.83	5.22	114.5	1.83	0.000
60	106.4	2	5.59	106.9	1.96	5.59	106.9	1.96	106.4	5.59	106.9	1.96	5.59	106.9	1.96	0.000
70	100.0	2	5.95	100.5	2.08	5.95	100.5	2.08	100.0	5.95	100.5	2.08	5.95	100.5	2.08	0.000
75	97.2	2	6.12	97.7	2.14	6.12	97.7	2.14	97.2	6.12	97.7	2.14	6.12	97.7	2.14	0.000
90	89.9	2	6.61	90.5	2.32	6.61	90.5	2.32	89.9	6.61	90.5	2.32	6.61	90.5	2.32	0.000
120	79.0	2	7.52	79.7	2.64	7.52	79.7	2.64	79.0	7.52	79.7	2.64	7.52	79.7	2.64	0.000
Section	3	-	4													
No.	A0	DH0	L0													
3	100.00	0.00	100.016													
Total	100.00		100.016													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	192.7	3	3.86	193.1	1.69	3.86	193.1	1.69	192.7	3.86	193.1	1.69	3.86	193.1	1.69	0.000
0	174.0	3	4.28	174.5	1.87	4.28	174.5	1.87	174.0	4.28	174.5	1.87	4.28	174.5	1.87	0.000
10	159.0	3	4.68	159.6	2.04	4.68	159.6	2.04	159.0	4.68	159.6	2.04	4.68	159.6	2.04	0.000
15	152.6	3	4.87	153.2	2.13	4.87	153.2	2.13	152.6	4.87	153.2	2.13	4.87	153.2	2.13	0.000
20	146.9	3	5.07	147.4	2.21	5.07	147.4	2.21	146.9	5.07	147.4	2.21	5.07	147.4	2.21	0.000
30	136.8	3	5.44	137.4	2.38	5.44	137.4	2.38	136.8	5.44	137.4	2.38	5.44	137.4	2.38	0.000
40	128.4	3	5.79	129.1	2.53	5.79	129.1	2.53	128.4	5.79	129.1	2.53	5.79	129.1	2.53	0.000
50	121.3	3	6.13	121.9	2.68	6.13	121.9	2.68	121.3	6.13	121.9	2.68	6.13	121.9	2.68	0.000
60	115.1	3	6.46	115.8	2.83	6.46	115.8	2.83	115.1	6.46	115.8	2.83	6.46	115.8	2.83	0.000
70	109.7	3	6.77	110.5	2.97	6.77	110.5	2.97	109.7	6.77	110.5	2.97	6.77	110.5	2.97	0.000
75	107.3	3	6.93	108.1	3.03	6.93	108.1	3.03	107.3	6.93	108.1	3.03	6.93	108.1	3.03	0.000
90	100.8	3	7.37	101.7	3.23	7.37	101.7	3.23	100.8	7.37	101.7	3.23	7.37	101.7	3.23	0.000
120	90.6	3	8.19	91.6	3.59	8.19	91.6	3.59	90.6	8.19	91.6	3.59	8.19	91.6	3.59	0.000

(Prepared by JPST)

Table-I.9 Fluorine (Max. working tension: 460 kgf)

1. Design Condition

(1) Kind of conductor	AAAC/Fluorine	(2) Sectional area (sqmm)	49.48	(3) Outer diameter (mm)	15.3
(4) Weight (kg/m)	0.26	(5) Elastic modulus (kg/sqmm)	6.500	(6) UTS (kg)	1.204
(7) Coefficient of linear expansion (°C)	2.3E-05	(8) Elongation (%)	0.000	(10) Load condition (°C) high	15
(9) Max. working tension (kg)	460	(10) Load condition (°C) low	-10	(11) Wind pressure (H) (kg/sqm)	44.86
		(12) Design condition :	Low - temperature - design	(11) Wind pressure (L) (kg/sqm)	44.86

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kgf)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kgf)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kgf)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kgf)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kgf)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kgf)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2													
No.	A0	DHO	L0													
1	60.00	0.00	59.937													
Total	60.00		59.937													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL
-10	362.1	1	1.23	362.1	0.32	1.23	362.1	0.32	362.1	1.23	362.1	0.32	1.23	362.1	0.32	0.000
0	299.6	1	1.49	299.7	0.39	1.49	299.7	0.39	299.6	1.49	299.7	0.39	1.49	299.7	0.39	0.000
10	244.1	1	1.83	244.2	0.48	1.83	244.2	0.48	244.1	1.83	244.2	0.48	1.83	244.2	0.48	0.000
15	219.9	1	2.03	220.0	0.53	2.03	220.0	0.53	219.9	2.03	220.0	0.53	2.03	220.0	0.53	0.000
20	198.4	1	2.25	198.5	0.59	2.25	198.5	0.59	198.4	2.25	198.5	0.59	2.25	198.5	0.59	0.000
30	163.5	1	2.73	163.7	0.72	2.73	163.7	0.72	163.5	2.73	163.7	0.72	2.73	163.7	0.72	0.000
40	138.3	1	3.23	138.5	0.85	3.23	138.5	0.85	138.3	3.23	138.5	0.85	3.23	138.5	0.85	0.000
50	120.1	1	3.72	120.3	0.97	3.72	120.3	0.97	120.1	3.72	120.3	0.97	3.72	120.3	0.97	0.000
60	106.7	1	4.19	106.9	1.10	4.19	106.9	1.10	106.7	4.19	106.9	1.10	4.19	106.9	1.10	0.000
70	96.5	1	4.63	96.8	1.21	4.63	96.8	1.21	96.5	4.63	96.8	1.21	4.63	96.8	1.21	0.000
75	92.3	1	4.84	92.6	1.27	4.84	92.6	1.27	92.3	4.84	92.6	1.27	4.84	92.6	1.27	0.000
90	82.1	1	5.43	82.5	1.43	5.43	82.5	1.43	82.1	5.43	82.5	1.43	5.43	82.5	1.43	0.000
120	68.7	1	6.49	69.1	1.71	6.49	69.1	1.71	68.7	6.49	69.1	1.71	6.49	69.1	1.71	0.000
Section	2	-	3													
No.	A0	DHO	L0													
2	80.00	0.00	79.940													
Total	80.00		79.940													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL
-10	304.3	2	1.96	304.4	0.68	1.96	304.4	0.68	304.3	1.96	304.4	0.68	1.96	304.4	0.68	0.000
0	256.1	2	2.33	256.3	0.81	2.33	256.3	0.81	256.1	2.33	256.3	0.81	2.33	256.3	0.81	0.000
10	217.0	2	2.75	217.2	0.96	2.75	217.2	0.96	217.0	2.75	217.2	0.96	2.75	217.2	0.96	0.000
15	200.7	2	2.97	201.0	1.04	2.97	201.0	1.04	200.7	2.97	201.0	1.04	2.97	201.0	1.04	0.000
20	186.5	2	3.19	186.8	1.12	3.19	186.8	1.12	186.5	3.19	186.8	1.12	3.19	186.8	1.12	0.000
30	163.3	2	3.65	163.7	1.27	3.65	163.7	1.27	163.3	3.65	163.7	1.27	3.65	163.7	1.27	0.000
40	145.6	2	4.09	146.0	1.43	4.09	146.0	1.43	145.6	4.09	146.0	1.43	4.09	146.0	1.43	0.000
50	131.8	2	4.52	132.2	1.58	4.52	132.2	1.58	131.8	4.52	132.2	1.58	4.52	132.2	1.58	0.000
60	120.9	2	4.92	121.4	1.72	4.92	121.4	1.72	120.9	4.92	121.4	1.72	4.92	121.4	1.72	0.000
70	112.1	2	5.31	112.6	1.86	5.31	112.6	1.86	112.1	5.31	112.6	1.86	5.31	112.6	1.86	0.000
75	108.3	2	5.50	108.8	1.92	5.50	108.8	1.92	108.3	5.50	108.8	1.92	5.50	108.8	1.92	0.000
90	98.6	2	6.03	99.2	2.11	6.03	99.2	2.11	98.6	6.03	99.2	2.11	6.03	99.2	2.11	0.000
120	84.9	2	7.00	85.6	2.45	7.00	85.6	2.45	84.9	7.00	85.6	2.45	7.00	85.6	2.45	0.000
Section	3	-	4													
No.	A0	DHO	L0													
3	100.00	0.00	99.963													
Total	100.00		99.963													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL
-10	256.5	3	2.90	256.8	1.27	2.90	256.8	1.27	256.5	2.90	256.8	1.27	2.90	256.8	1.27	0.000
0	224.5	3	3.32	224.9	1.45	3.32	224.9	1.45	224.5	3.32	224.9	1.45	3.32	224.9	1.45	0.000
10	199.2	3	3.74	199.6	1.63	3.74	199.6	1.63	199.2	3.74	199.6	1.63	3.74	199.6	1.63	0.000
15	188.6	3	3.95	189.1	1.72	3.95	189.1	1.72	188.6	3.95	189.1	1.72	3.95	189.1	1.72	0.000
20	179.2	3	4.15	179.6	1.81	4.15	179.6	1.81	179.2	4.15	179.6	1.81	4.15	179.6	1.81	0.000
30	163.2	3	4.56	163.7	1.99	4.56	163.7	1.99	163.2	4.56	163.7	1.99	4.56	163.7	1.99	0.000
40	150.3	3	4.95	150.8	2.16	4.95	150.8	2.16	150.3	4.95	150.8	2.16	4.95	150.8	2.16	0.000
50	139.7	3	5.33	140.3	2.33	5.33	140.3	2.33	139.7	5.33	140.3	2.33	5.33	140.3	2.33	0.000
60	130.8	3	5.68	131.5	2.49	5.68	131.5	2.49	130.8	5.68	131.5	2.49	5.68	131.5	2.49	0.000
70	123.3	3	6.03	124.0	2.64	6.03	124.0	2.64	123.3	6.03	124.0	2.64	6.03	124.0	2.64	0.000
75	120.0	3	6.20	120.7	2.71	6.20	120.7	2.71	120.0	6.20	120.7	2.71	6.20	120.7	2.71	0.000
90	111.3	3	6.68	112.0	2.92	6.68	112.0	2.92	111.3	6.68	112.0	2.92	6.68	112.0	2.92	0.000
120	98.2	3	7.56	99.0	3.32	7.56	99.0	3.32	98.2	7.56	99.0	3.32	7.56	99.0	3.32	0.000

(Prepared by JPST)

Table-I.10 Hydrogen (Max. working tension: 800 kgf)

1. Design Condition

(1) Kind of conductor	AAAC/Hydrogen	(2) Sectional area (sqmm)	111.3	(3) Outer diameter (mm)	20.3
(4) Weight (kg/m)	0.485	(5) Elastic modulus (kg/sqmm)	6,500	(6) UTS (kg)	2,470
(7) Coefficient of linear expansion (°C)	2.3E-05	(8) Elongation (%)	0.000		
(9) Max. working tension (kg)	800	(10) Load condition (°C) high	15	(11) Wind pressure (H) (kg/sqm)	44.86
		Load condition (°C) low	-10	Wind pressure (L) (kg/sqm)	44.86
		(12) Design condition :	Low - temperature - design		

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kgf)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kgf)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kgf)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kgf)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kgf)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kgf)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section		1	-		2											
No.	A0	DHO	L0													
1	60.00	0.00	59.949													
Total	60.00		59.949													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	675.4	1	1.23	675.6	0.32	1.23	675.6	0.32	675.4	1.23	675.6	0.32	1.23	675.6	0.32	0.000
0	540.6	1	1.54	540.8	0.40	1.54	540.8	0.40	540.6	1.54	540.8	0.40	1.54	540.8	0.40	0.000
10	427.0	1	1.95	427.2	0.51	1.95	427.2	0.51	427.0	1.95	427.2	0.51	1.95	427.2	0.51	0.000
15	380.3	1	2.19	380.6	0.57	2.19	380.6	0.57	380.3	2.19	380.6	0.57	2.19	380.6	0.57	0.000
20	340.7	1	2.45	341.0	0.64	2.45	341.0	0.64	340.7	2.45	341.0	0.64	2.45	341.0	0.64	0.000
30	280.0	1	2.98	280.4	0.78	2.98	280.4	0.78	280.0	2.98	280.4	0.78	2.98	280.4	0.78	0.000
40	238.2	1	3.50	238.6	0.92	3.50	238.6	0.92	238.2	3.50	238.6	0.92	3.50	238.6	0.92	0.000
50	208.6	1	3.99	209.1	1.05	3.99	209.1	1.05	208.6	3.99	209.1	1.05	3.99	209.1	1.05	0.000
60	186.9	1	4.46	187.4	1.17	4.46	187.4	1.17	186.9	4.46	187.4	1.17	4.46	187.4	1.17	0.000
70	170.3	1	4.89	170.9	1.28	4.89	170.9	1.28	170.3	4.89	170.9	1.28	4.89	170.9	1.28	0.000
75	163.4	1	5.10	164.0	1.34	5.10	164.0	1.34	163.4	5.10	164.0	1.34	5.10	164.0	1.34	0.000
90	146.5	1	5.68	147.2	1.49	5.68	147.2	1.49	146.5	5.68	147.2	1.49	5.68	147.2	1.49	0.000
120	123.8	1	6.72	124.7	1.76	6.72	124.7	1.76	123.8	6.72	124.7	1.76	6.72	124.7	1.76	0.000
Section		2	-		3											
No.	A0	DHO	L0													
2	80.00	0.00	79.947													
Total	80.00		79.947													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	603.6	2	1.84	603.9	0.64	1.84	603.9	0.64	603.6	1.84	603.9	0.64	1.84	603.9	0.64	0.000
0	496.7	2	2.24	497.1	0.78	2.24	497.1	0.78	496.7	2.24	497.1	0.78	2.24	497.1	0.78	0.000
10	412.8	2	2.69	413.3	0.94	2.69	413.3	0.94	412.8	2.69	413.3	0.94	2.69	413.3	0.94	0.000
15	379.1	2	2.93	379.6	1.02	2.93	379.6	1.02	379.1	2.93	379.6	1.02	2.93	379.6	1.02	0.000
20	350.2	2	3.17	350.8	1.11	3.17	350.8	1.11	350.2	3.17	350.8	1.11	3.17	350.8	1.11	0.000
30	304.3	2	3.65	304.9	1.28	3.65	304.9	1.28	304.3	3.65	304.9	1.28	3.65	304.9	1.28	0.000
40	270.1	2	4.11	270.8	1.44	4.11	270.8	1.44	270.1	4.11	270.8	1.44	4.11	270.8	1.44	0.000
50	244.0	2	4.55	244.7	1.59	4.55	244.7	1.59	244.0	4.55	244.7	1.59	4.55	244.7	1.59	0.000
60	223.5	2	4.97	224.4	1.74	4.97	224.4	1.74	223.5	4.97	224.4	1.74	4.97	224.4	1.74	0.000
70	207.1	2	5.36	208.0	1.87	5.36	208.0	1.87	207.1	5.36	208.0	1.87	5.36	208.0	1.87	0.000
75	200.1	2	5.55	201.0	1.94	5.55	201.0	1.94	200.1	5.55	201.0	1.94	5.55	201.0	1.94	0.000
90	182.3	2	6.09	183.3	2.13	6.09	183.3	2.13	182.3	6.09	183.3	2.13	6.09	183.3	2.13	0.000
120	157.1	2	7.06	158.3	2.47	7.06	158.3	2.47	157.1	7.06	158.3	2.47	7.06	158.3	2.47	0.000
Section		3	-		4											
No.	A0	DHO	L0													
3	100.00	0.00	99.959													
Total	100.00		99.959													
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	D0	H	FA	TA	DA	FB	TB	D	DL
-10	540.9	3	2.57	541.4	1.12	2.57	541.4	1.12	540.9	2.57	541.4	1.12	2.57	541.4	1.12	0.000
0	463.0	3	3.00	463.6	1.31	3.00	463.6	1.31	463.0	3.00	463.6	1.31	3.00	463.6	1.31	0.000
10	402.9	3	3.45	403.6	1.51	3.45	403.6	1.51	402.9	3.45	403.6	1.51	3.45	403.6	1.51	0.000
15	378.3	3	3.67	379.1	1.60	3.67	379.1	1.60	378.3	3.67	379.1	1.60	3.67	379.1	1.60	0.000
20	356.8	3	3.89	357.6	1.70	3.89	357.6	1.70	356.8	3.89	357.6	1.70	3.89	357.6	1.70	0.000
30	321.1	3	4.32	322.0	1.89	4.32	322.0	1.89	321.1	4.32	322.0	1.89	4.32	322.0	1.89	0.000
40	293.0	3	4.74	294.0	2.07	4.74	294.0	2.07	293.0	4.74	294.0	2.07	4.74	294.0	2.07	0.000
50	270.4	3	5.13	271.5	2.24	5.13	271.5	2.24	270.4	5.13	271.5	2.24	5.13	271.5	2.24	0.000
60	251.9	3	5.51	253.1	2.41	5.51	253.1	2.41	251.9	5.51	253.1	2.41	5.51	253.1	2.41	0.000
70	236.5	3	5.87	237.7	2.57	5.87	237.7	2.57	236.5	5.87	237.7	2.57	5.87	237.7	2.57	0.000
75	229.7	3	6.04	231.0	2.64	6.04	231.0	2.64	229.7	6.04	231.0	2.64	6.04	231.0	2.64	0.000
90	212.1	3	6.54	213.5	2.86	6.54	213.5	2.86	212.1	6.54	213.5	2.86	6.54	213.5	2.86	0.000
120	186.1	3	7.45	187.7	3.26	7.45	187.7	3.26	186.1	7.45	187.7	3.26	7.45	187.7	3.26	0.000

(Prepared by JPST)

Table-I.11

Hydrogen (Max. working tension: 850 kgf)

1. Design Condition

(1) Kind of conductor	AAAC/Hydrogen	(2) Sectional area (sqmm)	111.3	(3) Outer diameter (mm)	20.3
(4) Weight (kg/m)	0.485	(5) Elastic modulus (kg/sqmm)	6.500	(6) UTS (kg)	2.470
(7) Coefficient of linear expansion (°C)	2.3E-05	(8) Elongation (%)	0.000	(11) Wind pressure (H) (kg/sqm)	44.86
(9) Max. working tension (kg)	850	(10) Load condition (°C) high	15	Wind pressure (L) (kg/sqm)	44.86
		Load condition (°C) low	-10		
		(12) Design condition :	Low - temperature - design		

No : Tower number of low number side at the span
 AO : Horizontal span length (m)
 DHO : Height difference between supporting points (m)
 LO : Conductor length at 15°C (without tension)

(Clamping)

HO : Horizontal tension (kgf)
 FAO : Catenary angle - low number side (deg)
 TAO : Supporting tension - low number side (kgf)
 DAO : Horizontal sag (m)
 FBO : Catenary angle - high number side (deg)
 TBO : Supporting tension - high number side (kgf)
 DO : Inclined sag (m)

(Stringing)

H : Horizontal tension (kgf)
 FA : Catenary angle - low number side (deg)
 TA : Supporting tension - low number side (kgf)
 DA : Horizontal sag (m)
 FB : Catenary angle - high number side (deg)
 TB : Supporting tension - high number side (kgf)
 D : Inclined sag (m)
 DL : Clipping offset
 (+) from low number side
 (-) from high number side

(3) Sag Table

Section	1	-	2														
No.	AO	DHO	LO														
1	60.00	0.00	59.943														
Total	60.00		59.943														
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL	
-10	737.1	1	1.13	737.2	0.30	1.13	737.2	0.30	737.1	1.13	737.2	0.30	1.13	737.2	0.30	0.000	
0	595.8	1	1.40	596.0	0.37	1.40	596.0	0.37	595.8	1.40	596.0	0.37	1.40	596.0	0.37	0.000	
10	472.1	1	1.77	472.4	0.46	1.77	472.4	0.46	472.1	1.77	472.4	0.46	1.77	472.4	0.46	0.000	
15	419.5	1	1.99	419.8	0.52	1.99	419.8	0.52	419.5	1.99	419.8	0.52	1.99	419.8	0.52	0.000	
20	373.9	1	2.23	374.2	0.58	2.23	374.2	0.58	373.9	2.23	374.2	0.58	2.23	374.2	0.58	0.000	
30	303.1	1	2.75	303.4	0.72	2.75	303.4	0.72	303.1	2.75	303.4	0.72	2.75	303.4	0.72	0.000	
40	254.2	1	3.28	254.6	0.86	3.28	254.6	0.86	254.2	3.28	254.6	0.86	3.28	254.6	0.86	0.000	
50	220.0	1	3.79	220.5	0.99	3.79	220.5	0.99	220.0	3.79	220.5	0.99	3.79	220.5	0.99	0.000	
60	195.4	1	4.26	195.9	1.12	4.26	195.9	1.12	195.4	4.26	195.9	1.12	4.26	195.9	1.12	0.000	
70	176.8	1	4.71	177.4	1.23	4.71	177.4	1.23	176.8	4.71	177.4	1.23	4.71	177.4	1.23	0.000	
75	169.2	1	4.92	169.8	1.29	4.92	169.8	1.29	169.2	4.92	169.8	1.29	4.92	169.8	1.29	0.000	
90	150.8	1	5.52	151.5	1.45	5.52	151.5	1.45	150.8	5.52	151.5	1.45	5.52	151.5	1.45	0.000	
120	126.5	1	6.58	127.3	1.73	6.58	127.3	1.73	126.5	6.58	127.3	1.73	6.58	127.3	1.73	0.000	
Section	2	-	3														
No.	AO	DHO	LO														
2	80.00	0.00	79.937														
Total	80.00		79.937														
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL	
-10	667.6	2	1.66	667.8	0.58	1.66	667.8	0.58	667.6	1.66	667.8	0.58	1.66	667.8	0.58	0.000	
0	549.7	2	2.02	550.0	0.71	2.02	550.0	0.71	549.7	2.02	550.0	0.71	2.02	550.0	0.71	0.000	
10	453.7	2	2.45	454.1	0.86	2.45	454.1	0.86	453.7	2.45	454.1	0.86	2.45	454.1	0.86	0.000	
15	414.4	2	2.68	414.8	0.94	2.68	414.8	0.94	414.4	2.68	414.8	0.94	2.68	414.8	0.94	0.000	
20	380.5	2	2.92	381.0	1.02	2.92	381.0	1.02	380.5	2.92	381.0	1.02	2.92	381.0	1.02	0.000	
30	326.5	2	3.40	327.1	1.19	3.40	327.1	1.19	326.5	3.40	327.1	1.19	3.40	327.1	1.19	0.000	
40	286.7	2	3.87	287.3	1.35	3.87	287.3	1.35	286.7	3.87	287.3	1.35	3.87	287.3	1.35	0.000	
50	256.7	2	4.33	257.5	1.51	4.33	257.5	1.51	256.7	4.33	257.5	1.51	4.33	257.5	1.51	0.000	
60	233.6	2	4.75	234.4	1.66	4.75	234.4	1.66	233.6	4.75	234.4	1.66	4.75	234.4	1.66	0.000	
70	215.3	2	5.16	216.1	1.80	5.16	216.1	1.80	215.3	5.16	216.1	1.80	5.16	216.1	1.80	0.000	
75	207.4	2	5.35	208.4	1.87	5.35	208.4	1.87	207.4	5.35	208.4	1.87	5.35	208.4	1.87	0.000	
90	188.0	2	5.90	189.0	2.07	5.90	189.0	2.07	188.0	5.90	189.0	2.07	5.90	189.0	2.07	0.000	
120	160.8	2	6.90	162.0	2.42	6.90	162.0	2.42	160.8	6.90	162.0	2.42	6.90	162.0	2.42	0.000	
Section	3	-	4														
No.	AO	DHO	LO														
3	100.00	0.00	99.944														
Total	100.00		99.944														
Temp	H0	No.	FA0	TA0	DA0	FBO	TBO	DO	H	FA	TA	DA	FB	TB	D	DL	
-10	601.7	3	2.31	602.2	1.01	2.31	602.2	1.01	601.7	2.31	602.2	1.01	2.31	602.2	1.01	0.000	
0	511.0	3	2.72	511.6	1.19	2.72	511.6	1.19	511.0	2.72	511.6	1.19	2.72	511.6	1.19	0.000	
10	439.8	3	3.16	440.5	1.38	3.16	440.5	1.38	439.8	3.16	440.5	1.38	3.16	440.5	1.38	0.000	
15	410.6	3	3.38	411.3	1.48	3.38	411.3	1.48	410.6	3.38	411.3	1.48	3.38	411.3	1.48	0.000	
20	385.1	3	3.61	385.9	1.57	3.61	385.9	1.57	385.1	3.61	385.9	1.57	3.61	385.9	1.57	0.000	
30	343.1	3	4.05	344.0	1.77	4.05	344.0	1.77	343.1	4.05	344.0	1.77	4.05	344.0	1.77	0.000	
40	310.4	3	4.47	311.4	1.95	4.47	311.4	1.95	310.4	4.47	311.4	1.95	4.47	311.4	1.95	0.000	
50	284.5	3	4.88	285.5	2.13	4.88	285.5	2.13	284.5	4.88	285.5	2.13	4.88	285.5	2.13	0.000	
60	263.5	3	5.27	264.6	2.30	5.27	264.6	2.30	263.5	5.27	264.6	2.30	5.27	264.6	2.30	0.000	
70	246.2	3	5.64	247.4	2.46	5.64	247.4	2.46	246.2	5.64	247.4	2.46	5.64	247.4	2.46	0.000	
75	238.6	3	5.81	239.8	2.54	5.81	239.8	2.54	238.6	5.81	239.8	2.54	5.81	239.8	2.54	0.000	
90	219.2	3	6.33	220.6	2.77	6.33	220.6	2.77	219.2	6.33	220.6	2.77	6.33	220.6	2.77	0.000	
120	190.9	3	7.26	192.5	3.18	7.26	192.5	3.18	190.9	7.26	192.5	3.18	7.26	192.5	3.18	0.000	

(Prepared by JPST)

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-J

CALCULATION OF CURRENT CAPACITY OF CONDUCTORS

APPENDIX-J CALCULATION OF CURRENT CAPACITY OF CONDUCTORS

Table-J.1 Rabbit

Kind of size	Rabbit(50sqmm)	Outer diameter of strand (cm)	0.335
Single(T) / Composite (G)	G	Outdoor (D) / indoor (I)	D
Outer diameter (cm)	1.005	Outer dia. Of steel (cm)	0.3350
Temperature coefficient of resistance α	0.00403	No. of layer of strand	1
Conductor resistance at 20°C (Ω /km)	0.54260	Cross sectional area of conductor A (mm ²)	52.88
Actual measurement value β (ACSR single layer of strand)			1.02000

(Calculation condition)

System frequency f (Hz)	50	Amount of solar radiation W_s (W/cm ²)	0.1
Wind velocity V (m/sec)	0.5	Coefficient of radiation η	0.9
Ambient temp. T (°C)	40	Elevation above sea level z	0.0
Temperature case for calculation	8	(Max. 10 cases)	

A(i)

1	2	3	4	5	6	7	8	9	10
60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No. cond.	temp	temp rise	Rdct	hr	hw	x	β_1	β_2	β	Ic
	(θ)									(A)
1	60	20	0.6301	0.000765	0.00213		0.00000	0.00000	1.02000	116.76
2	70	30	0.6519	0.000802	0.00213		0.00000	0.00000	1.02000	164.49
3	75	35	0.6629	0.000821	0.00213		0.00000	0.00000	1.02000	183.21
4	80	40	0.6738	0.000841	0.00213		0.00000	0.00000	1.02000	199.89
5	90	50	0.6957	0.000881	0.00214		0.00000	0.00000	1.02000	228.92
6	100	60	0.7175	0.000922	0.00214		0.00000	0.00000	1.02000	253.90
7	110	70	0.7394	0.000965	0.00214		0.00000	0.00000	1.02000	276.04
8	120	80	0.7613	0.001010	0.00214		0.00000	0.00000	1.02000	296.05
9										
10										

	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λf	ρr	v	Re	Rf	B1	n	Nu	$0.846Nu$
1	50	0.02780	1.000	1.8E-05	279.94	0.5000	0.641	0.471	9.108	7.705
2	55	0.02816	1.000	1.84E-05	272.73	0.5000	0.641	0.471	8.997	7.611
3	58	0.02834	1.000	1.87E-05	269.26	0.5000	0.641	0.471	8.943	7.565
4	60	0.02852	1.000	1.89E-05	265.87	0.5000	0.641	0.471	8.890	7.521
5	65	0.02888	1.000	1.94E-05	259.35	0.5000	0.641	0.471	8.786	7.433
6	70	0.02924	1.000	1.99E-05	253.15	0.5000	0.641	0.471	8.687	7.349
7	75	0.02960	1.000	2.03E-05	247.23	0.5000	0.641	0.471	8.590	7.267
8	80	0.02996	1.000	2.08E-05	241.59	0.5000	0.641	0.471	8.497	7.189
9										
10										

Source: Prepared by JPST

Table-J.2 Dog

Kind of size	Dog(100sqmm)	Outer diameter of strand (cm)	0.472
Single(T) / Composite (G)	G	Outdoor (D) / indoor (I)	D
Outer diameter (cm)	1.415	Outer dia. Of steel (cm)	0.4710
Temperature coefficient of resistance α	0.00403	No. of layer of strand	1
Conductor resistance at 20°C (Ω /km)	0.27330	Cross sectional area of conductor A (mm ²)	105
Actual measurement value β (ACSR single layer of strand)			1.02000

(Calculation condition)

System frequency f (Hz)	50	Amount of solar radiation W_s (W/cm ²)	0.1
Wind velocity V (m/sec)	0.5	Coefficient of radiation η	0.9
Ambient temp. T (°C)	40	Elevation above sea level z	0.0
Temperature case for calculation	8	(Max. 10 cases)	

A(i)

1	2	3	4	5	6	7	8	9	10
60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No.	cond.	temp	Rdct	hr	hw	x	β_1	β_2	β	Ic
	(θ)	(θ)								(A)
1	60	20	0.3174	0.000765	0.00178		0.00000	0.00000	1.02000	168.58
2	70	30	0.3284	0.000802	0.00178		0.00000	0.00000	1.02000	248.14
3	75	35	0.3339	0.000821	0.00178		0.00000	0.00000	1.02000	278.74
4	80	40	0.3394	0.000841	0.00178		0.00000	0.00000	1.02000	305.85
5	90	50	0.3504	0.000881	0.00178		0.00000	0.00000	1.02000	352.84
6	100	60	0.3614	0.000922	0.00178		0.00000	0.00000	1.02000	393.18
7	110	70	0.3724	0.000965	0.00179		0.00000	0.00000	1.02000	428.91
8	120	80	0.3834	0.001010	0.00179		0.00000	0.00000	1.02000	461.23
9										
10										

	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λf	ρr	v	Re	Rf	B1	n	Nu	0.846Nu
1	50.0	0.02780	1.000	1.8E-05	394.15	0.5011	0.641	0.471	10.701	9.053
2	55.0	0.02816	1.000	1.84E-05	383.99	0.5011	0.641	0.471	10.570	8.942
3	57.5	0.02834	1.000	1.87E-05	379.10	0.5011	0.641	0.471	10.506	8.888
4	60.0	0.02852	1.000	1.89E-05	374.34	0.5011	0.641	0.471	10.444	8.836
5	65.0	0.02888	1.000	1.94E-05	365.16	0.5011	0.641	0.471	10.323	8.733
6	70.0	0.02924	1.000	1.99E-05	356.42	0.5011	0.641	0.471	10.205	8.634
7	75.0	0.02960	1.000	2.03E-05	348.09	0.5011	0.641	0.471	10.092	8.538
8	80.0	0.02996	1.000	2.08E-05	340.14	0.5011	0.641	0.471	9.983	8.446
9										
10										

Source: Prepared by JPST

Table-J.3 Wolf

Kind of size	Wolf (150sqmm)	Outer diameter of strand (cm)	0.259
Single(T) / Composite (G)	G	Outdoor (D) / indoor (I)	D
Outer diameter (cm)	1.813	Outer dia. Of steel (cm)	0.7770
Temperature coefficient of resistance α	0.00403	No. of layer of strand	2
Conductor resistance at 20°C (Ω /km)	0.18280	Cross sectional area of conductor A (mm ²)	158.1
Actual measurement value β (ACSR single layer of strand)			0.00000

(Calculation condition)

System frequency f (Hz)	50	Amount of solar radiation W_s (W/cm ²)	0.1
Wind velocity V (m/sec)	0.5	Coefficient of radiation η	0.9
Ambient temp. T (°C)	40	Elevation above sea level z	0.0
Temperature case for calculation	8	(Max. 10 cases)	

A(i)

1	2	3	4	5	6	7	8	9	10
60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No.	cond.	temp	Rdct	hr	hw	x	β_1	β_2	β	Ic
	(θ)	(θ)								(A)
1	60	20	0.2123	0.000765	0.00156	0.63261	1.00098	1.00000	1.00098	209.18
2	70	30	0.2196	0.000802	0.00156	0.62191	1.00093	1.00000	1.00093	321.25
3	75	35	0.2233	0.000821	0.00156	0.61676	1.00090	1.00000	1.00090	363.54
4	80	40	0.2270	0.000841	0.00156	0.61174	1.00088	1.00000	1.00088	400.84
5	90	50	0.2344	0.000881	0.00156	0.60205	1.00083	1.00000	1.00083	465.26
6	100	60	0.2417	0.000922	0.00156	0.59280	1.00079	1.00000	1.00079	520.44
7	110	70	0.2491	0.000965	0.00157	0.58397	1.00075	1.00000	1.00075	569.28
8	120	80	0.2565	0.001010	0.00157	0.57552	1.00071	1.00000	1.00071	613.47
9										
10										

	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λf	ρr	v	Re	Rf	B1	n	Nu	0.846Nu
1	50.0	0.02780	1.000	1.8E-05	505.01	0.1000	0.641	0.471	12.026	10.174
2	55.0	0.02816	1.000	1.84E-05	491.99	0.1000	0.641	0.471	11.879	10.049
3	57.5	0.02834	1.000	1.87E-05	485.73	0.1000	0.641	0.471	11.807	9.989
4	60.0	0.02852	1.000	1.89E-05	479.63	0.1000	0.641	0.471	11.737	9.930
5	65.0	0.02888	1.000	1.94E-05	467.87	0.1000	0.641	0.471	11.601	9.814
6	70.0	0.02924	1.000	1.99E-05	456.68	0.1000	0.641	0.471	11.469	9.703
7	75.0	0.02960	1.000	2.03E-05	446.00	0.1000	0.641	0.471	11.342	9.595
8	80.0	0.02996	1.000	2.08E-05	435.82	0.1000	0.641	0.471	11.219	9.492
9										
10										

Source: Prepared by JPST

Table-J.4 Panther

Kind of size	Panrger (200 sqmm)				Outer diameter of strand (cm)	0.3				
Single(T) / Composite (G)	G				Outdoor (D) / indoor (I)	D				
Outer diameter (cm)	2.100				Outer dia. Of steel (cm)	0.9000				
Temperature coefficient of resistance α	0.00403				No. of layer of strand	2				
Conductor resistance at 20°C (Ω /km)	0.13630				Cross sectional area of conductor A (mm ²)	212.1				
Actual measurement value β (ACSR single layer of strand)						0.00000				
(Calculation condition)										
System frequency f (Hz)	50				Amount of solar radiation Ws (W/cm ²)	0.1				
Wind velocity V (m/sec)	0.5				Coefficient of radiation η	0.9				
Ambient temp. T (°C)	40				Elevation above sea level z	0.0				
Temperature case for calculation	8				(Max. 10 cases)					
A(i)										
	1	2	3	4	5	6	7	8	9	10
	60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No. cond.	temp	temp rise	Rdct	hr	hw	x	β 1	β 2	β	Ic
	(θ)									(A)
1	60	20	0.1583	0.000765	0.00144	0.73262	1.00161	1.00000	1.00161	241.28
2	70	30	0.1638	0.000802	0.00144	0.72023	1.00152	1.00000	1.00152	382.28
3	75	35	0.1665	0.000821	0.00144	0.71426	1.00148	1.00000	1.00148	434.77
4	80	40	0.1693	0.000841	0.00145	0.70844	1.00144	1.00000	1.00144	480.90
5	90	50	0.1748	0.000881	0.00145	0.69722	1.00136	1.00000	1.00136	560.40
6	100	60	0.1802	0.000922	0.00145	0.68651	1.00129	1.00000	1.00129	628.39
7	110	70	0.1857	0.000965	0.00145	0.67629	1.00123	1.00000	1.00123	688.55
8	120	80	0.1912	0.001010	0.00145	0.66650	1.00117	1.00000	1.00117	742.99
9										
10										
	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λ f	ρ r	v	Re	Rf	B1	n	Nu	0.846Nu
1	50.0	0.02780	1.000	1.8E-05	584.96	0.1000	0.641	0.471	12.888	10.903
2	55.0	0.02816	1.000	1.84E-05	569.88	0.1000	0.641	0.471	12.730	10.770
3	57.5	0.02834	1.000	1.87E-05	562.63	0.1000	0.641	0.471	12.654	10.705
4	60.0	0.02852	1.000	1.89E-05	555.56	0.1000	0.641	0.471	12.578	10.641
5	65.0	0.02888	1.000	1.94E-05	541.94	0.1000	0.641	0.471	12.432	10.518
6	70.0	0.02924	1.000	1.99E-05	528.97	0.1000	0.641	0.471	12.291	10.398
7	75.0	0.02960	1.000	2.03E-05	516.61	0.1000	0.641	0.471	12.155	10.283
8	80.0	0.02996	1.000	2.08E-05	504.81	0.1000	0.641	0.471	12.023	10.172
9										
10										

Source: Prepared by JPST

Table-J.5 Zebra

Kind of size	Zebra(400 sqmm)				Outer diameter of strand (cm)	0.318				
Single(T) / Composite (G)	G				Outdoor (D) / indoor (I)	D				
Outer diameter (cm)	2.862				Outer dia. Of steel (cm)	0.9540				
Temperature coefficient of resistance α	0.00403				No. of layer of strand	3				
Conductor resistance at 20°C (Ω /km)	0.06740				Cross sectional area of conductor A (mm ²)	428.9				
Actual measurement value β (ACSR single layer of strand)						0.00000				
(Calculation condition)										
System frequency f (Hz)	50				Amount of solar radiation Ws (W/cm ²)	0.1				
Wind velocity V (m/sec)	0.5				Coefficient of radiation η	0.9				
Ambient temp. T (°C)	40				Elevation above sea level z	0.0				
Temperature case for calculation	8				(Max. 10 cases)					
A(i)										
	1	2	3	4	5	6	7	8	9	10
	60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No. cond.	temp	temp rise	Rdct	hr	hw	x	β_1	β_2	β	Ic
	(θ)									(A)
1	60	20	0.0783	0.000765	0.00123	1.12000	1.00807	1.01830	1.02651	328.26
2	70	30	0.0810	0.000802	0.00123	1.10105	1.00753	1.02820	1.03595	565.01
3	75	35	0.0823	0.000821	0.00123	1.09193	1.00729	1.03109	1.03860	649.64
4	80	40	0.0837	0.000841	0.00123	1.08304	1.00705	1.03335	1.04064	723.34
5	90	50	0.0864	0.000881	0.00123	1.06588	1.00662	1.03670	1.04356	849.47
6	100	60	0.0891	0.000922	0.00123	1.04951	1.00622	1.03909	1.04555	956.88
7	110	70	0.0918	0.000965	0.00123	1.03388	1.00586	1.04087	1.04697	1,051.78
8	120	80	0.0946	0.001010	0.00123	1.01892	1.00553	1.04225	1.04801	1,137.68
9										
10										
	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λf	ρr	v	Re	Rf	B1	n	Nu	0.846Nu
1	50.0	0.02780	1.000	1.8E-05	797.21	0.0714	0.641	0.471	14.911	12.615
2	55.0	0.02816	1.000	1.84E-05	776.66	0.0714	0.641	0.471	14.728	12.460
3	57.5	0.02834	1.000	1.87E-05	766.78	0.0714	0.641	0.471	14.640	12.385
4	60.0	0.02852	1.000	1.89E-05	757.14	0.0714	0.641	0.471	14.553	12.312
5	65.0	0.02888	1.000	1.94E-05	738.58	0.0714	0.641	0.471	14.384	12.169
6	70.0	0.02924	1.000	1.99E-05	720.91	0.0714	0.641	0.471	14.221	12.031
7	75.0	0.02960	1.000	2.03E-05	704.06	0.0714	0.641	0.471	14.063	11.897
8	80.0	0.02996	1.000	2.08E-05	687.98	0.0714	0.641	0.471	13.911	11.769
9										
10										

Source: Prepared by JPST

Table.J-6 Moose

Kind of size	Moose(500 sqmm)				Outer diameter of strand (cm)	0.353				
Single(T) / Composite (G)	G				Outdoor (D) / indoor (I)	D				
Outer diameter (cm)	3.177				Outer dia. Of steel (cm)	1.0590				
Temperature coefficient of resistance α	0.00403				No. of layer of strand	3				
Conductor resistance at 20°C (Ω /km)	0.05470				Cross sectional area of conductor A (mm^2)	528.5				
Actual measurement value β (ACSR single layer of strand)						1.00000				
(Calculation condition)										
System frequency f (Hz)	50				Amount of solar radiation W_s (W/cm^2)	0.1				
Wind velocity V (m/sec)	0.5				Coefficient of radiation η	0.9				
Ambient temp. T (°C)	40				Elevation above sea level z	0.0				
Temperature case for calculation	8				(Max. 10 cases)					
A(i)										
	1	2	3	4	5	6	7	8	9	10
	60	70	75	80	90	100	110	120		

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
No. cond.	temp	temp rise	Rdct	hr	hw	x	β_1	β_2	β	I_c
	(θ)									(A)
1	60	20	0.0635	0.000765	0.00116	1.24323	1.01226	1.01638	1.02884	356.29
2	70	30	0.0657	0.000802	0.00116	1.22221	1.01145	1.02644	1.03819	637.80
3	75	35	0.0668	0.000821	0.00116	1.21208	1.01107	1.02936	1.04076	736.85
4	80	40	0.0679	0.000841	0.00116	1.20221	1.01071	1.03167	1.04272	822.85
5	90	50	0.0701	0.000881	0.00116	1.18317	1.01005	1.03512	1.04552	969.67
6	100	60	0.0723	0.000922	0.00116	1.16500	1.00945	1.03761	1.04741	1,094.51
7	110	70	0.0745	0.000965	0.00116	1.14764	1.00889	1.03950	1.04875	1,204.77
8	120	80	0.0767	0.001010	0.00117	1.13104	1.00839	1.04099	1.04972	1,304.55
9										
10										
	E2	E3	E4	E5	E6	E7	E8	E9	F2	F3
No.	Tf	λf	ρr	v	Re	Rf	B1	n	Nu	0.846Nu
1	50.0	0.02780	1.000	1.8E-05	884.96	0.0714	0.641	0.471	15.662	13.250
2	55.0	0.02816	1.000	1.84E-05	862.14	0.0714	0.641	0.471	15.471	13.088
3	57.5	0.02834	1.000	1.87E-05	851.17	0.0714	0.641	0.471	15.378	13.010
4	60.0	0.02852	1.000	1.89E-05	840.48	0.0714	0.641	0.471	15.287	12.932
5	65.0	0.02888	1.000	1.94E-05	819.87	0.0714	0.641	0.471	15.109	12.782
6	70.0	0.02924	1.000	1.99E-05	800.25	0.0714	0.641	0.471	14.937	12.637
7	75.0	0.02960	1.000	2.03E-05	781.55	0.0714	0.641	0.471	14.772	12.497
8	80.0	0.02996	1.000	2.08E-05	763.70	0.0714	0.641	0.471	14.612	12.362
9										
10										

Source: Prepared by JPST

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-K

REVIEW OF LOAD FLOW STUDY

APPENDIX-K REVIEW OF LOAD FLOW STUDY

K.1 Current Status of Existing Feeder in Samtse

According to the load flow study, the bus voltage at Deorali Substation for 69% loading is 0.5278 PU while the bus voltage is 0.8227 PU for the 30% loading. However, no calculation has been made to compute the bus voltage between Deorali Substation to D-Bindu Substation which is located at the feeder end. Many sub-feeders are planned to extend from D-Bindu Substation and other neighboring substations in JICA RE-1 Project. JPST considered that it is necessary to estimate the bus voltage at D-Bindu Substation to secure the power to the remote areas which are covered under JICA RE-1 and RE-1 projects. BPC started to record SAIDI, SAIFI, and CAIDI from January 2005 in all Dzongkhags other than Gasa.

The calculation of voltage drop was carried out from Samtse 11 kV bus to D-Bindu Substation using the method shown in Appendix-H.

According to the calculated results, bus voltage is 0.785 PU at 30% loading and 0.6 PU at 50% loading. The 50% loading is the equivalent peak load of 1.9 MW of this feeder. (Beginning of August 2010)

Accordingly, the voltage level at D-Bindu area should be improved to supply electricity to customers with allowable voltage range.

According to the latest information (received load flow study on Aug. 31, 2010), Sipsoo Substation was added as an existing substation to interconnect with the Indian power system¹.

K.2 Countermeasure of Voltage Drop

To avoid the excessive voltage drop, installation of step-voltage regulator (SVR) is one of the options².

In the radial MV distribution system, it is often necessary to regulate the feeder voltage by means of step voltage regulator.

Step-voltage regulators can be either (1) station-type, which can be single- or three-phase, and which can be used in substations for bus voltage regulation or individual feeder voltage

¹The bus voltage at Sipsoo Substation is 0.8561 PU. (0.8561 PU at the interconnecting point seems to be too low to import power from Indian power system.

²The construction of new hydro power station is planned near Sipsoo. And interconnection with Indian power system is also another option.

regulation, or (2) distribution-type, which can be only single-phase and used pole-mounted out on overhead MV feeders.

The step-voltage regulator basically is an autotransformer which has numerous taps in the series winding. Taps are changed automatically under load by switching mechanism which responds to a voltage-sensing control in order to maintain voltage as close as practicable to a predetermined level. The voltage-sensing control receives its inputs from potential and current transformers and provides control of system voltage level and band width. In addition, it provides features such as operation counter, time-delay selection, test terminal, and control switch.

In case of MV lines of BPC, the feeder length sometimes reaches to eighty (80) km, it is difficult to maintain the feeder voltage to an allowable level, installation of distribution-type may be the option to improve the consumer end voltage.

According to the load flow study report (2009) made by BPC, the study have been made for 30% load of transformer capacity at the initial stage and 69% load after load growth. According to this report, no voltage problem will be occurred at the initial stage. JPST also reviewed the feeder voltage for the typical feeders, no voltage problem was found at the initial stage. Hence no SVR is required at the time of completion of this project. (However, the voltage at the Sipsoo area in Samtse dzongkhag have to be confirmed.)

K.3 BPC's Development Plan in Samtse Area

According to the load flow study (2008) conducted by BPC as shown in Annexure-2, load flow from Malbase – Phuentsholing – Gomtsu – Samtse is summarized as follows:

- Malbase – Phuentsholing 30.37 + j17.97 (conductor : dog)
- Phuentsholing – Gomtu 17.97 + j10.14 (conductor : dog)
- Gomtu – Samtse Through 33 kV line.

The current capacity of ACSR dog at 75 degrees Celsius is approximately 280 A.

Therefore, the thermal capacity of a single circuit of transmission line with dog conductor is:

Thermal capacity of dog conductor = $\sqrt{3} \times 280 \text{ A} \times 66 \text{ kV} = 31 \text{ MVA}$.

Assuming that power factor is 0.9, effective power is $0.9 \times 31 = 27.9 \text{ MW}$

Accordingly, the transmission line between Malbase and Phuentsholing is being operated under overloaded condition. Also, this resulted in the low voltage being received at Gomtu Substation.

Gomtu Town and Samtse District centers are both identified as special economic zone (SEZ) areas so that many industries requiring good quality power supply could expand their businesses. To solve the voltage problem in Gomtu and provide stable power supply to Samtse, BPC has drawn up a plan to construct new transmission lines as shown in Table-K.3.1.

Table-K.3.1 Investment Plan of BPC (2016)

TRANSMISSION PROGRAMME		Investment Schedule					Figures in million Nu.
Sl. No.	Project activities	2009	2010	2011	2012	2013	Total
1	East-West transmission link (220 kV double circuit Tsirang-Jigmeling, 132(220) kV double circuit Jigmeling-Gelephu, 220 kV single circuit Dagachhu-Tsirang)	100.000	364.187	182.766	0.000	0.000	646.953
2	132 kV LILO substation at Motanga	6.000	57.103	0.000	0.000	0.000	63.103
3	2x63/80 MVA, 220/132 kV ICT substation with feeder bays at Jigmeling	0.000	238.768	425.635	117.366	0.000	781.769
4	2x10 MVA, 220/66 kV Tsirang substation with feeder bays	0.000	84.500	100.000	20.500	0.000	205.000
5	220 kV Malbase-Samtse transmission line	0.000	51.642	163.538	174.571	67.931	457.681
6	66 kV Samtse-Gomtu transmission line on WOLF conductor	0.000	6.198	35.663	38.065	13.979	93.904
7	2x15 MVA, 66/33 kV substation at Samtse with bays	0.000	0.000	39.990	142.672	32.453	215.115
8	66 kV Samtse-Sibusu transmission line	0.000	0.000	30.998	82.691	20.154	133.843
9	220 kV Dagachhu-Dagapela Line extension	0.000	0.000	49.554	5.506	0.000	55.060
10	Substation at Dagapela 220/33 kV, 2x10 MVA	0.000	0.000	20.500	164.000	20.500	205.000
11	66 kV Thimphu/Lobeysa-Gasa transmission link Project	0.000	0.000	0.000	68.750	68.750	137.500
12	Spillover Project activities (Tsirang, Trongsa, Malbase and Bumthang)	234.120	97.000	0.000	0.000	0.000	331.120
	TOTAL	340.120	899.398	1,048.644	814.120	223.767	3,326.049

Source : BPC

From Table-K.3.1 above, 220 kV single circuit transmission line is planned from Malbase to Samtse with zebra conductor. Meanwhile, 66 kV single circuit transmission line with dog conductor is planned between Samtse and Gomtu, and between Samtse and Sipsoo. These transmission lines are planned to secure the power source to the Phase-2 project area and are in process for construction³.

- ✓ 220 kV transmission line between Malbase and Samtse

The contract for construction is scheduled in the middle of March, 2011, and the construction period will be eighteen months.

- ✓ 66 kV transmission line along Gomtu – Samtse – Sipsoo

Technical evaluation is being processed and the contract for construction is scheduled in December, 2010 after financial evaluation of tender documents. The construction period will be fifteen months.

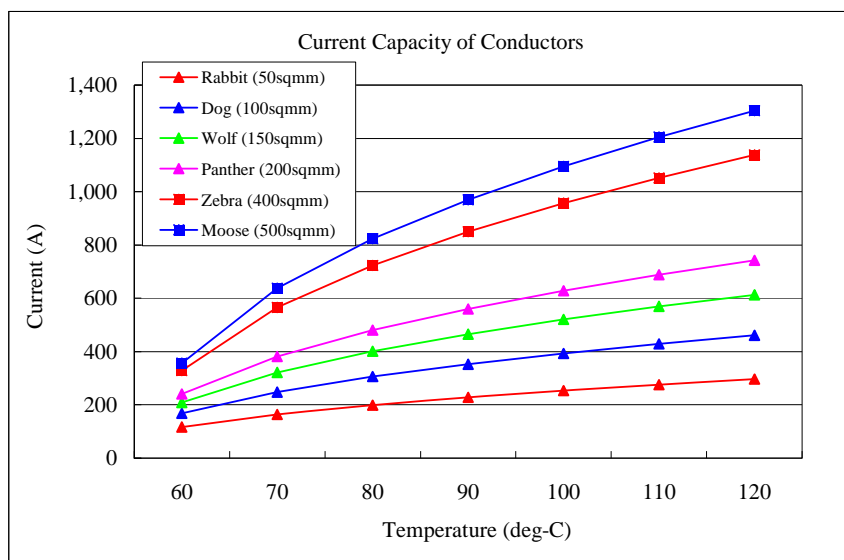
The tender specification of associated substations is being prepared by EDCD and scheduled to be completed by the time of completion of above transmission lines.

In case of voltage problem in Sipsoo area before the completion of these transmission lines and associated substations, the installation of shunt capacitors will be one of the option to improve the system voltage.

Figure-K.3.1 shows the current capacity of conductors which are used for the transmission lines in Bhutan. The current capacity was calculated based on the formula in Japan Electric Association Code (JEAC) 6001-2000. The calculated results are shown in Appendix-J.

³ Source : DNCD (Development and Construction Department), as of beginning of November, 2010.

Conductors	Temperature (deg-C)						
	60	70	80	90	100	110	120
Rabbit (50sqmm)	117	164	200	229	254	276	296
Dog (100sqmm)	169	248	306	353	393	429	461
Wolf (150sqmm)	209	321	401	465	520	569	613
Panther (200sqmm)	241	382	481	560	628	689	743
Zebra (400sqmm)	328	565	723	849	957	1,052	1,138
Moose (500sqmm)	356	638	823	970	1,095	1,205	1,305



Source : JPST

Figure-K.3.1 Current Capacity of Conductors (Prepared by JPST)

K.4 Transformer Capacity of RE

The transformer capacity and its peak load at existing substations are summarized in Table-K4.1.

The lines marked with yellow color indicate the overloaded transformers while those marked with blue color indicate transformers with more than 80% of load ratio.

(1) Overloaded Transformer

It is recommended that the transformer capacity in Semtokha Substation be augmented by replacing it with a bigger capacity or by installing additional transformer.

(2) Transformer with High Load Factor

Transformers marked with blue color should carefully be monitored to determine the loading condition for future substation augmentation.

Table-K.4.1 Transformer Capacity and Peak Load under Transmission Department

Sl. No	Substation	Voltage.Ratio	No.of Trf	Total Capacity (MVA)	Vector Group	MW@0.85PF	Peakload on Feb 2010(MW)	Peakload on July 2010(MW)	Load factor
1	MALBASE	400 /220	1 X200	200	YNa0d11	170	idle change	71	41.8
		220 /66	3 X63	189	YNyn0	160.65	89	50.004	55.4
		66 /11	2 X20	40	Dyn11	34	1	2.004	5.9
2	SINGHIGAON	220 /66	1 X50	50	YNyn0	42.5	24.2	24.51	57.7
		220 /66	2 X35	70	YNyn1	59.5	38.6	32	64.9
		66 /11	1 X5	5	Dyn11	4.25	4.487	6.197	48.6
		66 /11	1 X10	10	Dyn11	8.5			
3	COMTU	66 /33	1 X5	5	Dyn11	4.25	2.42	2.68	63.1
		66 /11	1 X5	5	Dyn11	4.25	4.5515	3.294	66.9
		66 /11	1 X3	3	Dyn11	2.55			
		33 /11	1 X2.5	2.5	YNyn0	2.125			
4	PHUENTSHOLING	66 /33	1 X10	10	Dyn11	8.5	6.3	7.41	87.2
		66 /33	1 X10	10	Dyn11	8.5	3.01	2.82	35.4
		66 /11	1 X3	3	Dyn11	2.55			
		66 /11	1 X12.5	12.5	Dyn11	10.625	1.445	1.535	14.4
5	GEDU	66 /33	2 X8	16	Dyn11	13.6	1.21	0.41	8.9
		66 /11	2 X5	10	Dyn11	8.5	2.01	1.623	23.6
6	SEMTOKHA	220 /66	6 X6.67	40	Dyn11	34	38.1	14.9	112.1
		66 /11	2 X10	20	YNyn0	17	14.2	9.6	83.5
7	OLAKHA	66 /33	2 X20	40	Dyn11	34	7.2	7.8	22.9
8	DECHENCHHOLING	66 /33	2 X10	20	Dyn11	17	10.883	6.853	64.0
		33 /11	2 X2.5	5	Dyn11	4.25	1.695	0.883	39.9
9	BJEMINA	66 /33	1 X10	10	Dyn11	8.5	1.6	1.34	18.8
		33 /11	1 X5	5	Dyn11	4.25	1.604	1.339	37.7
10	PARO	66 /33 /11	1 X2.5 /2.5	5	Dyn11	4.25	2.261	1.716	53.2
		66 /11	1 X10	10	YNyn0	8.5	6.93	4.622	81.5
11	HAA	66 /11	2 X5	10	Dyn11	8.5	1.905	1.682	22.4
12	LOBEYSA	66 /33	1 X5	5	YNyn0	4.25	0.799	0.172	18.8
		66 /11	2 X5	10	Dyn11	8.5	4.56	3.93	53.6
13	WATCHA	66 /33	1 X5	5	YNyn0	4.25	0.474	0.58	13.6
14	CHUMDO Switching	66	0	0		0			
15	GELEPHU	132 /66	2 X25	50	Ynyn0	42.5	3.929	3.888	9.2
		66 /11	1 X10	10	Ynyn0	8.5	3.929	3.888	46.2
		66 /33 /11	2 X2.5 /2.5	10	Dyn11,y11	8.5			
16	TINTIBI	132 /33	2 X3	6	Ynd1	5.1	1.88	1.08	36.9
		33 /11	2 X1.5	3	Ynd1	2.55			
17	DARJEY	66 /33	2 X5	10	Dyn11	8.5	1.243	2.29	26.9
18	DEOTHANG	132 /33	2 X5	10	Ynd1	8.5	1.496	1.02	
		33 /11	2 X2.5	5	Dyn11	4.25	0.3776	0.3995	9.4
19	NANGKOR	132 /33	2 X5	10	Ynd1	8.5	1.266	1.15	14.9
		33 /11	2 X2.5	5	Dyn11	4.25	3.6	0.5	84.7
20	KILIKHAR	132 /33	2 X5	10	Ynd1	8.5	2.5	1.95	29.4
		33 /11	2 X2.5	5	Dyn11	4.25	1.29	0.78	30.4
21	KANGLUNG	132 /33	2 X5	10	Ynd1	8.5	4.535	3.43	53.4
		33 /11	2 X2.5	5	Dyn11	4.25	3.46	1.68	81.4
22	NGANGILAM	132 /33	2 X3	6	Ynd1	5.1	0.485	0.484	9.5
		33 /11	2 X1.5	3	Dyn11	2.55	0.448	0.36	17.6
23	TANGMACHHU*	33 /11	2 X1.5	3	Dyn11	2.55	0.76	0.569	29.8
TOTAL						838.95	301.64	284.37	

Source : BPC Transmission Department

K.5 Employment of ARCB

The 33 kV and 11 kV medium voltage (MV) lines have been extended to remote areas and some feeders reached 60 km or longer length. In such long feeders with small sized conductor such as rabbit conductor (50 mm²), there may be a possibility to miss the fault current at the line to line fault and single phase to ground fault, because of the small fault current due to the bigger line impedance. To clarify this issue for the protection range from respective substation, feeders with 20km or longer length from a power source or from a substation are selected as shown in Table-K.5.2 (1/3), (2/3) and (3/3), and BPC conducted

the line to line fault and single phase to ground fault calculation for the typical four feeders. (selected four feeders are shadowed in the Table-K.5.2 (1/3), (2/3) and (3/3).

Table-K3 shows the fault calculation results and this results shows that these fault current are considered to be in the protection range of the protection system of existing substations. The purpose and installation condition of ARCB are mentioned in 4.4.3 of main report.

Table-K.5.1 Calculation Results of Fault Currents

Short circuit current (kA) at 0.1s fault duration (in kA) at the end

Sl.No	NAME OF THE FEEDER	LINE ROUTE	Line to line fault		Single phase to ground fault	
			Fault MVA	Fault kA	Fault MVA	Fault kA
1	11 KV (PCA Phase-2)	Lampay 5/5 to Namu	20	0.402	7.6	0.281
2	11 KV (PCA Phase-2)	Blou PWD 5/5 to Reg User 2 10	17	0.612	7.9	0.383
3	11 KV (PCA Phase-1)	Tyot (4.2) to Khye me ye chengpa to Mchakay	5	0.297	3.8	0.187
4	11 KV (PCA Phase-2)	Rawathang to Mtop	21	0.376	5.1	0.238

Table-K.5.2 (1/3) Feeder List with 20km or Longer Length

SL.#	DZONGKHAG	GEWOG	LINE ROUTE	PROJECT	VOLTAGE	NAME OF THE SUBSTATION	LINE LENGTH OF THE RE WORK FROM THE	REMARKS
1	Bumthang	Chokhor Dorona, Gesarling, Kadlingzingkha (Dagana), Getama Goshi, Kalidzingkha, Khibisa, Tsaza Tsaza	Kunjei to Kuenzangcholing Deorali to Gangu School Goshi Substation to Gema T-off(0.5KM from Tashigang) to Bazingkha 4.77KM T-off from the S/S to Pachutar T-off(1.45KM T-off before line to Tading) to Nindhulakha	JBIC ARE ADB ARE JBIC JBIC	 33kV 11kV	Garpang Substation Goshi Substation Phuntsholing Substation	20.83 34.43 34.87 35.61 31.17 24.08 56.54	RABBIT(7.7KM), DOG (13.13KM) RABBIT(2.11KM), DOG (32.32KM) RABBIT RABBIT (33.57KM), DOG (1.54KM) RABBIT(8.44KM), DOG(17.96KM) RABBIT RABBIT(17.79KM), DOG (29.98KM)
2	Dagana & Chhuk	Phuntsholing, Loekchina,Dungna, Tading	Bosokha to Saabay dzong	JBIC	33kV	Phuntsholing Substation	24.08	RABBIT
3	Chhukha	Phuntsholing, Loekchina, Dorona(Chhukha), dungloe,		JBIC	11kV		56.54	RABBIT
4	Chhukha, Samtsi	Phuntsholing, Loekchina, Dorona(Chhukha), dungloe,	Bosokha to Saabay dzong	JBIC	33kV	Phuntsholing Substation	56.54	RABBIT(17.79KM), DOG (29.98KM)
5	Haa	Gakadling Sombaykha Sombaykha	Lower Thongdokcha to Sayizong Gerekha to Shabje Sangbay to Shama	ARE ARE ARE	33kV		48.26 69.55 86.38	RABBIT RABBIT RABBIT
6	Samtse	Denchukha Dorokha	Lower Lalikha to Benekha Tumburev to Sevichang	ARE ARE			40 31.15	DOG RABBIT(22.4KM), DOG(8.7KM)
7	Sarpang	Lhamozingkhari Bongo	Baikinza to Odhalhang Gangu S/S to Upper Phasuma	ADB ARE			75.2 20.21	DOG(52.59KM), WOLF(22.58KM) DOG
8		Bhatujora/ Sampheing Darla	T-OFF(1.25 Km before line to Yagoo & Monitor) to Upper Dungeha T-OFF(1.63 Km before line to Selley village) to Kashlakha	ARE ARE		Gedu Substation	23.11	DOG
	Chhukha	Bongo Kurtoe Gangzur	Baikinza to Gedaphu T-off(1.46km from tabee S/S) to Jasabee Lingabee S/S to Lower Ney-2	ARE ADB ADB			20.1 35.75 35.08	DOG RABBIT RABBIT
		Khoma Kurtoe Gangzur	Upper Pangkhar to Upper Tsango Sugpai S/S to Wawa Thrima S/S to Shaawa	ARE ADB ARE	11kV	Tangmachhu Substation	30.52 25.4 39.28 25.18	RABBIT RABBIT DOG DOG
9	Lhuntse	Khoma Metsho	Khema to Nyetang Tshochen S/S to Ongar Thapshang	ARE ADB			20.85 27.9	RABBIT RABBIT
		Tshenkar Jarey Tsamang	Autsho to Upper yangla Phawan S/S to Upper Karphu Lower Karphu to Phomeydung Autsho to yeedang Upper Ladrong to Pampa	ADB ADB ARE ADB ARE	33kV	Kilikhar Substation	27.79 26.41 28.89 33.95 37.95	RABBIT RABBIT RABBIT RABBIT DOG
10	Pemagatshel	Norbugang, Khar Dechiling	T-off(1km before line to Bapta) to Khatasho	ADB	33kV	Nganglam Substation	30.34	RABBIT
11	Pemagatshel & Mongar	Chimung, Duingmien, & Gongdue(Mongar)	Bangdala S/S to Barbee S/S	ADB			50.09	Dog & RABBIT
12	S/Jongkhar	Gondar, Wangphu	T-off(0.48km before line to Nangshing) to Kulung S/S to Muna S/S T-off(1.9km before line to Gerti) to Upper Chongshing S/S to Upper Lanari Upper Zimzor to Nome	ADB ADB ADB ADB ARE	33kV	Nangkhor Substation	43.84 34.96 20.36 20.25 20.24	RABBIT RABBIT RABBIT RABBIT RABBIT
13	Pemagatshel	Nanong Dungmeim		ADB ARE			71.12	DOG
14	Mongar	Khenkhar, Jurney, Gondue, Silambi	Maan S/S to Changchangma S/S	ARE				

Table-K.5.2 (2/3) Feeder List with 20km or Longer Length

SL.#	DZONGKHAG	GEWOG	LINE ROUTE	PROJECT	VOLTAGE	NAME OF THE SUBSTATION	LINE LENGTH OF THE RE WORK FROM THE	REMARKS
15	Wangdue	Nyisho	Khelekha S/S to Goga S/S	ADB	33kV	Lobesa Substation	32.22	RABBIT
			Gangtu S/S to Khamenang S/S	ADB			25.87	RABBIT
			Zongphye S/S to Chebigang S/S	ARE			37.68	RABBIT
			T-off(1.14km from Gumzena S/S) to Jiri	ADB			60.09	DOG(10.58KM), RABBIT(22.59KM)
			Wangdi Goempa to Nangkha S/S	ARE			59.59	DOG(10.58KM), RABBIT(22.11KM)
16	Punakha	Goenshari	Chuzadzong to Zhenqosa-II S/S	ADB	33kV	Lobesa Substation	23.58	RABBIT
			T-off (2.24km from Geonshari S/S) to	ADB			27.43	RABBIT
			Tshorim-zam to Drochukha S/S	ADB			28.49	RABBIT
			Tshorim-zam to Gumgang S/S	ADB			29.42	RABBIT
			Bumtakha S/S to Nidupchhu	ADB			21.41	RABBIT
			T-off (0.17km from Samtekha-Bazar) to	ADB			26.49	RABBIT
			Toewang	ARE			29.98	RABBIT
17	Wangdue	Daga, Athang	Bayechhu S/S to Slay S/S	ADB	11kV	Runchhu Substation	33.02	DOG
			T-off(3.62km from Garawa S/S) to Sukuni	ARE			20.76	DOG
18	S/Jongkhar	Phuntshothang	T-off(5.1km before line to Tshangchuthama) to Shangshingzor	ARE	33kV	Deowathang Substation	22.7	DOG
			T-off(4.5km before line to Tshangchuthama) to Meridaza	ARE			22.15	DOG
			T-off(0.4km before line to Kharbandi) to Samdrupcholing S/S to Lower Khamethang	ARE			30.56	DOG
			Upper Dungkhar ehong S/S to Shillengay	ADB			32.19	RABBIT
			Shilening S/S to Phaju Goempa S/S	ARE			31.22	RABBIT
			Lower Dungkharcholing to Bhawani S/S	ADB			124.97	DOG
			Upper bedara to Dungkharcholing Dajayzor	ADB			33.55	RABBIT
			Martsala S/S to Teakari S/S	ADB			39.72	RABBIT
			Teakari S/S, Jakarta S/S	ARE			34.37	RABBIT
			Kakpadung S/S to Chodung S/S	ADB			35.68	DOG
			Thrizor S/S to Saytsalo S/S	ARE			49.12	RABBIT
			Laymi to Paiphung	ARE			38.03	RABBIT
			Betupam to Dungshepa	ADB			23.96	RABBIT
19	Mongar	Khaling, Thrinising	Phakpari to Bedlungma top	ADB	33kV	Kanglung Substation	31.44	RABBIT
			Resirboo to Ghapho	ADB			48	DOG(9.13km), RABBIT(5.10km)
			Lumang to Gangzor	ADB			35.57	RABBIT
			Lumang to Chengney	ADB			37.84	RABBIT
			Chemsara to Baydingphu-B	ADB			43.05	DOG
20	Trashigang	Merak	Trepthu to Kashingteng	ARE	11kV	Kanglung Substation	57.11	DOG(4.38km), RABBIT(4.95km)
			Narang	ARE			71.45	DOG
			Phongme, Radhi, Saktan, Merak	ADB			35.62	RABBIT
			Yangtse	JBIC			26.8	RABBIT
			Teotsho	JBIC			29.97	RABBIT
			Tapped from Jangphutse line to Thangdrang	JBIC			28.23	RABBIT
			Tapped from Kamazom line to Faketi	JBIC			21.23	RABBIT
			Serpaug S/S to Kikhorechen	JBIC			25.48	RABBIT
			Serpaug to Jalian	JBIC			35.08	RABBIT
			Thargom to Upper Dukti-B	JBIC			23.97	RABBIT
21	Trashiyangtse	Khamdang	Tapped from Renja & Gangkhar line to	JBIC	33kV	Cheneary Substation	24.1	RABBIT
			Tapped from Renja & Gangkhar line to	JBIC			48.65	DOG
			Tapped from Fanteng Existing line to Shong	ARE			59.74	DOG
			Dungzan S/S to Longkhar	ARE			49.36	DOG
			North Baling Existing S/S to Dechenphodrang	ARE				

Table-K.5.2 (3/3) Feeder List with 20km or Longer Length

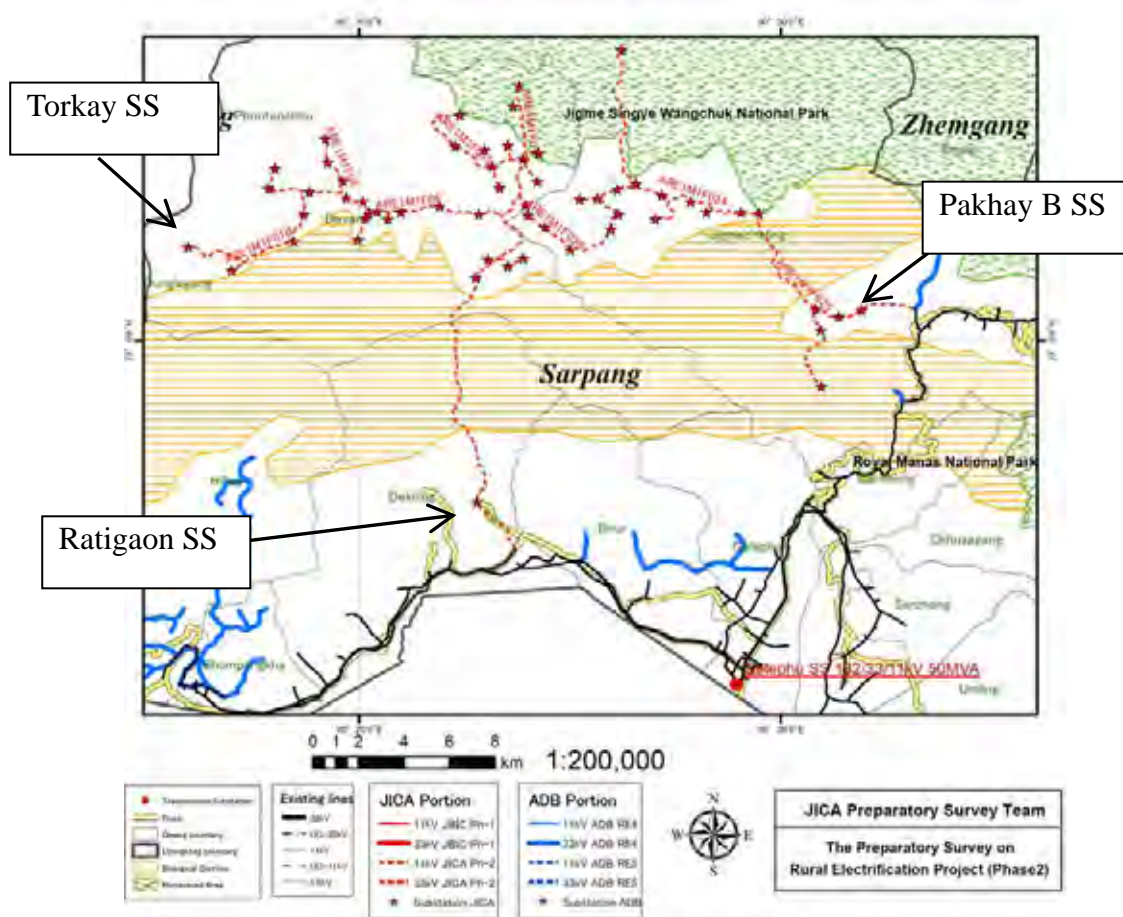
SL.#	DZONGKHAG	GEWOG	LINE ROUTE	PROJECT	VOLTAGE	NAME OF THE SUBSTATION	LINE LENGTH OF THE RE WORK FROM THE	REMARKS
22	Mongar	Chaskhar	Kadam S/S to L.Gomdari S/S	JBIC	33kV	Kilikhar Substation	24.99	RABBIT
			T-OFF (1.66 km from Khaphu S/S) to Mühung	JBIC			22.98	DOG
			Shershong School to Jabkhang	JBIC			27.51	RABBIT
			Gewog office S/S to Waiathang	JBIC			27.26	DOG
			Pangling S/S to L.Jengkar	ARE			39.79	DOG
			Tapped from Sangbari line to Atingkhar	ARE			21.32	DOG
			Tridangbi-II S/S to Chugudowa	JBIC			24.88	RABBIT
			Tsamang	JBIC			26.35	DOG
			Tsamang	ARE			30.55	RABBIT
			Tsakaling	ARE			23.28	RABBIT
23	Sarpang	Jigmecholing, Doban, Dekling	Bhur PWD S/S to Beatchoan S/S	ARE	11kV	Gelephu Substation	62.6	DOG(20.3 km), RABBIT(27.7 km)
			Beatchoan-B S/S to Chungshing	ADB			25.3	RABBIT
			Gaden Existing S/S to Daragoan S/S	ARE			26.4	RABBIT
			Lodarat Substation to Sarpang Substation	ADB			34.5	WOLF(15 km), DOG(19.5 km)
24	Tongsa	Drakten, Tongsibji, Langthil, Korphu	Kewathang Substation to Nabji	JBIC	33kV	Kewathang Substation	62.28	DOG
			Semjee-1 to Thangmil	ARE			27.23	DOG
25	Tsirang	Kilkhorhang, Senjong, Tshonlingkhar, Patai, Tsirang, Toe, Phuentenchu	substation to Sanumeley	JBIC	33kV	Darjay Substation	24.43	WOLF & DOG
			T-off (before 0.47km line to Dhanser) to Bathakhey	ARE			21.34	RABBIT
			T-off (before 0.12km line to Thulomeley) to Bathakhey	ARE			24.16	RABBIT
			T-off (before 0.66km line to Tshangay) to Bathakhey	ARE			23.24	RABBIT
			T-off (before 3.1 km line to Sanumeley) to Bathakhey	ARE			23.66	RABBIT
26	Dagana	Tshangkha, Lajab, Drugejjang	T-off (2 km from Tintale) to Balung	JBIC	33kV	Tingtibi Substation	20.92	WOLF, DOG, RABBIT
			T-off (19.46 km from the Tintibi S/S) to Upper Tsaidang	ARE			33.68	DOG
27	Zhemgang	Nangkhor, Bardo, Shingkar	Buli S/S to Changkhar	ARE	33kV	Tingtibi Substation	54.11	RABBIT
			Bardo, Nangkhor	ARE			47.76	DOG
			Trong, Pangkhar, Goshing,	ARE			69.91	DOG, RABBIT
28	Samtse	Changharey, Yoeseltse, Changharey	Lamitar-2 to Ghalagoan	JBIC	11kV	Samtse Substation	23.43	RABBIT
			0.389KM T-off from U-Gathia to Sombekha	JBIC			27.73	RABBIT
			0.86KM T-off from Jitri-A to Chappa	JBIC			49.22	RABBIT
			U-Namgaycholing to Gangatay	JBIC			36.58	RABBIT
			Baraney to Bhatbakay	JBIC			63.3	RABBIT
			D-Bindu to Kachin IIA	JBIC			61.39	RABBIT
			Doraney to Khenatong-I	JBIC			57.92	RABBIT
0.9KM T-off from RBA Camp to L.Changlu	JBIC	65.71	RABBIT					

K.6 Power Supply to New Feeders in Sarpang and Supply Reliability

According to the GIS map prepared by BPC, the east-end substation (Pakhay B) is located 1.2 km from the existing 11 kV lines. JPST studied power supply only from this eastern side to the west-end substation (Torkay). Consequently, it was found that the feeder voltage at Torkay Substation is 0.76 PU and thus, the power to the new feeders in the Dovan and Jigmecholing areas will be supplied via Ratigoan to T-off 69. Even for the power supply from Ratigoan Substation side, it is required to adjust the transformer tap at Gelephu Substation. (Refer to Annexures-3 & 4 of Load Flow Study Report.)

To improve the supply reliability to the Dovan and Jigmecholing areas, east-end substation (Pakhay B) should be connected to the existing MV lines at Beachgoun_B substation. However, this line should be opened during normal operating conditions. (Please refer to Figure-K.6.1)

Figure-K.6.1. GIS map of Sarpang



THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-L

QUANTITY AND COST ESTIMATION

APPENDIX-L QUANTITY AND COST ESTIMATION

L.1 Quantity and Cost by feeders

Cost summary by feeders and items is shown in Table-L.1. Quantity of materials used for the cost estimation is shown in Table-L.2. Cost of material is listed in Table-L.3, cost of erection excluded the headloading cost is in Table-L.4, cost of headloading is in Table-L.5, cost of transportation is in Table-L.6, and the total summary of the cost estimation by feeders is shown in Table-L.7. Note that those tables do not contain the cost of ARCB and lightning damage prevention.

Table-L.1 Cost summary by feeders*

	No	Feeder	Total line Length		Total Trans No.	Material cost (USD)	Erection cost (USD)	Headloading cost (USD)	Transportation cost (USD)	Total (USD)	
			MV(km)	LV (m)							
Dzongkhag											
	Chhukha	1	ARE3B1	11.4	10,293	8	281,985	41,076	104,181	4,166	431,407
		2	ARE3B2	1.3	4,042	1	59,662	7,922	20,901	905	89,390
		3	ARE3B3	0.1	3,246	1	35,050	5,051	13,058	511	53,669
		4	ARE3B4	6.0	3,299	3	121,627	17,193	43,989	2,007	184,817
		5	ARE3B5	2.0	310	1	28,092	4,085	10,503	452	43,132
		6	ARE3B6	19.9	10,606	9	375,730	55,192	145,018	5,499	581,439
		7	ARE3B7	4.4	1,245	1	62,298	8,928	24,099	933	96,258
		8	ARE3B8	7.4	3,039	3	138,380	18,720	48,865	2,306	208,271
		9	ARE3B9	5.3	1,954	4	92,550	13,694	34,205	1,486	141,936
		10	ARE3B10	1.9	2,226	1	43,109	6,058	16,121	664	65,951
		11	ARE3B11	4.0	3,108	1	88,778	11,372	30,727	1,443	132,320
		12	ARE3B12	2.4	454	1	33,927	4,885	12,782	538	52,132
		13	ARE3B13	5.3	2,647	5	113,467	16,304	39,719	1,900	171,390
		14	ARE3B14	1.2	482	1	21,165	3,108	7,721	347	32,342
		15	ARE3B15	16.5	5,394	5	261,571	36,716	97,390	4,173	399,849
		16	ARE1B16	11.1	3,059	5	169,516	25,565	66,248	3,098	264,427
		17	ARE1B17	1.7	2,311	1	50,061	6,588	17,187	844	74,680
		18	ARE3B18	4.1	951	1	55,499	7,948	21,369	848	85,664
		19	ARE3B19	1.8	1,271	1	34,561	5,023	13,040	532	53,157
		20	ARE3B20	5.4	4,063	2	121,405	15,887	41,927	1,969	181,188
		21	ARE3B21	2.3	662	1	42,055	5,840	14,972	706	63,573
		22	ARE3B22	3.6	1,200	1	52,834	7,568	20,288	806	81,496
		23	ARE3B23	2.0	543	1	29,201	4,384	11,409	568	45,561
	24	LV Extention	0.0	2,007	1	21,934	3,234	7,944	338	33,450	
Dagana	25	ARE3C1	52.5	41,065	23	1,210,805	156,276	231,261	23,877	1,622,218	
	26	ARE3C2	0.8	4,289	2	69,571	8,088	11,985	1,324	90,969	
	27	ARE3C3	1.5	2,205	1	48,653	5,915	8,756	983	64,308	
	28	ARE3C4	9.0	4,024	3	142,348	19,394	28,691	2,793	193,226	
	29	ARE3C5	5.7	1,633	3	93,335	12,520	18,541	1,903	126,299	
	30	ARE3C6	2.5	1,676	1	44,595	5,996	8,870	888	60,349	
	31	ARE3C7	3.0	2,773	1	58,975	7,990	11,818	1,143	79,926	
	32	ARE3C8	2.3	2,763	1	51,482	6,949	10,279	999	69,709	
	33	LV Extention	0.0	1,360	0	15,359	1,655	2,445	280	19,738	
	Haa	34	ARE3E1	7.1	953	3	96,984	16,419	82,659	4,141	200,201
		35	ARE3E2	7.5	1,833	3	113,256	18,955	95,891	4,652	232,754
36		ARE3E3	14.0	5,580	5	242,483	38,528	199,812	10,219	491,042	
Paro	37	ARE1H2	5.5	412	1	73,883	10,137	9,149	2,762	95,931	
	38	ARE3H3	1.6	269	1	25,266	3,268	3,107	970	32,611	
	39	LV Extention	0.0	782	0	11,358	857	739	186	13,140	
Pemagatshel	40	ARE3I1	2.3	696	1	60,262	5,413	13,246	691	79,613	
	41	ARE3I2	7.6	7,088	5	181,023	25,883	62,573	3,551	273,030	
	42	ARE3I3	7.6	5,060	4	130,489	20,759	50,723	2,638	204,608	
	43	ARE3I4	3.4	4,326	1	75,497	10,768	27,457	1,431	115,153	
	44	ARE1J1	3.9	576	1	50,812	6,874	3,678	2,738	64,103	
Punakha	45	ARE3J2	6.6	5,572	4	137,130	17,535	9,998	5,979	170,641	
	46	ARE1L1	5.0	7,404	4	146,229	19,345	33,914	1,432	200,921	
Samtse	47	ARE1L2	7.5	5,064	3	139,707	19,227	33,965	1,439	194,338	
	48	ARE1L5	1.9	793	1	30,328	4,301	7,556	340	42,525	
	49	ARE1L6	25.8	31,346	25	696,281	92,888	162,023	7,172	958,363	
	50	ARE1L7	1.9	892	1	31,521	4,503	7,899	344	44,267	
	51	ARE1L9	6.6	2,769	5	113,289	15,989	27,829	1,284	158,391	
	52	ARE1L10	3.1	758	1	41,996	6,026	10,636	462	59,120	
	53	ARE1L11	3.3	6,506	3	122,590	15,813	27,658	1,192	167,254	
	54	ARE1L12	1.9	2,274	1	47,769	6,500	11,427	485	66,180	
	55	ARE3L1	38.9	62,080	37	1,351,776	172,450	300,538	12,086	1,836,849	
	56	ARE3L2	4.0	1,890	1	74,177	9,491	16,788	728	101,184	
Sarpang	57	ARE1M1	116.6	96,042	62	2,697,507	414,432	1,934,533	74,033	5,120,505	
	58	ARE1M2	2.4	3,258	3	85,820	15,587	59,980	2,092	163,480	
Trongsa	59	ARE3Q1	35.7	28,619	22	826,229	104,338	99,320	27,892	1,057,779	
Tsirang	60	ARE3R2	2.6	2,784	1	54,386	7,322	10,040	916	72,665	
	61	ARE3R3	5.5	5,816	3	119,628	16,019	22,021	2,049	159,718	
	62	ARE3R4	2.1	2,496	1	55,541	7,039	9,679	995	73,254	
	63	ARE3R5	2.3	3,848	1	71,085	8,796	12,069	1,246	93,196	
	64	ARE1R6	5.9	5,606	2	131,575	17,301	23,732	2,571	175,180	
	65	ARE3R7	2.2	2,311	1	54,515	6,859	9,434	981	71,789	
	66	ARE3S3	2.5	146	1	31,053	4,098	5,725	1,584	42,459	
Wangdue	67	ARE3S4	3.5	1,215	3	69,907	8,975	12,725	3,157	94,764	
	68	ARE3S5	0.1	391	1	13,012	1,561	2,259	552	17,384	
	69	ARE3S6	0.1	319	2	20,606	2,509	3,663	882	27,659	
	70	ARE3S7	1.8	28	1	24,309	3,233	4,570	1,141	33,254	
	71	ARE1S8	17.3	9,346	8	404,274	49,814	70,146	19,830	544,064	
Total			566.0	447,351.2	317	12,723,137.0	1,766,929.8	4,675,469.3	278,073.8	19,443,610	

* The cost of ARCB and lightning damage prevention is excluded.

Table-L.6 Transportation Cost by Feeders

District	No	Feeder	Conductor (USD)		Transformer (USD)															ABS (USD)		LV ABC (USD)	Service feeder (USD)	Stoppum	Total									
			kV Length (km)	LV Jem (kcm)	35kV			11kV			Covered conductor			35kV			11kV			35kV	11kV													
					ACSR			ACSR			3Phase			1Phase			1Phase																	
					Dog	Rabbit	Rabbit	Dog	Rabbit	Rabbit	Dog	Rabbit	Rabbit	3Phase	25kVA	16kVA	10kVA	25kVA	16kVA							10kVA								
Chokkha	1	ARE3B1	17.4	10,293	4	0	1,705	286	0	0	0	0	0	157	272	0	41	0	95	0	0	0	0	0	0	47	0	1,230	181	4,166				
Chokkha	2	ARE3B2	1.2	4,042	1	0	262	39	0	0	0	0	0	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	239	38	965			
Chokkha	3	ARE3B3	0.1	3,246	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	367	48	911		
Chokkha	4	ARE3B4	6.0	6,299	3	0	1,254	0	0	0	0	0	0	0	279	0	0	0	0	0	0	0	0	0	0	0	0	0	418	55	2,007			
Chokkha	5	ARE3B5	2.0	310	1	0	0	306	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	7	452		
Chokkha	6	ARE3B6	19.9	10,606	9	2,533	137	591	0	0	0	0	0	0	186	379	104	162	0	0	0	0	0	0	0	0	0	47	0	1,308	152	5,409		
Chokkha	7	ARE3B7	4.4	1,245	1	0	691	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141	19	933		
Chokkha	8	ARE3B8	7.4	3,039	3	0	1,344	153	0	0	0	0	0	0	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	464	53	2,366		
Chokkha	9	ARE3B9	5.3	1,954	4	0	198	631	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	221	39	1,486		
Chokkha	10	ARE3B10	1.9	2,226	1	0	0	301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	282	7	664			
Chokkha	11	ARE3B11	4.0	3,108	1	0	842	0	0	0	0	0	0	0	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	479	29	1,443		
Chokkha	12	ARE3B12	2.4	454	1	0	0	377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	6	538		
Chokkha	13	ARE3B13	5.3	2,647	5	0	728	278	0	0	0	0	0	0	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	362	37	1,900	
Chokkha	14	ARE3B14	1.2	482	1	0	0	189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	3	347		
Chokkha	15	ARE3B15	16.5	5,394	5	0	2,179	752	0	0	0	0	0	0	186	196	0	81	0	0	0	0	0	0	0	0	0	0	0	0	699	86	4,173	
Chokkha	16	ARE3B16	11.1	3,059	5	0	0	0	1,286	882	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	152	117	0	0	386	88	3,098	
Chokkha	17	ARE3B17	1.7	2,311	1	0	0	381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	356	13	944	
Chokkha	18	ARE3B18	4.1	961	1	0	0	637	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108	10	848	
Chokkha	19	ARE3B19	1.8	1,271	1	0	0	282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	134	10	612	
Chokkha	20	ARE3B20	5.4	4,063	2	0	1,319	0	0	0	0	0	0	0	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	629	39	1,969	
Chokkha	21	ARE3B21	2.3	662	1	0	488	0	0	0	0	0	0	0	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	22	706		
Chokkha	22	ARE3B22	3.4	1,200	1	0	0	562	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	13	806	
Chokkha	23	ARE3B23	2.0	543	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	4	568	
Chokkha	24	LV Extension	0.0	2,007	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	227	14	338	
Dagana	25	ARE3C1	52.5	41,065	23	5,751	5,452	1,781	0	0	0	0	0	0	201	2,036	245	0	104	122	0	0	0	0	0	0	0	117	0	7,438	631	23,877		
Dagana	26	ARE3C2	0.8	4,288	2	0	204	0	0	0	0	0	0	0	241	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	833	48	1,324	
Dagana	27	ARE3C3	1.5	2,205	1	0	413	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	23	983	
Dagana	28	ARE3C4	9.0	4,024	3	0	0	1,802	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	587	44	2,793	
Dagana	29	ARE3C5	5.7	1,633	3	0	348	877	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206	53	1,903	
Dagana	30	ARE3C6	2.5	1,676	1	0	502	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	244	8	888	
Dagana	31	ARE3C7	3.0	2,773	1	0	0	603	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	404	13	1,143	
Dagana	32	ARE3C8	2.3	2,763	1	0	0	462	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	403	12	999	
Dagana	33	LV Extension	0.0	1,360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276	10	286	
Hlas	34	ARE3E1	7.1	993	3	0	2,972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	286	46	4,141	
Hlas	35	ARE3E2	7.5	1,833	3	0	1,858	1,278	0	0	0	0	0	0	211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	608	138	4,652
Hlas	36	ARE3E3	14.0	5,880	5	0	4,797	1,794	0	0	0	0	0	0	725	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,347	292	10,219	
Hlas	37	ARE3E4	5.5	412	0	0	0	0	2,348	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	129	114	2,762
Hlas	38	ARE3E5	1.6	299	1	0	683	0	0	0	0	0	0	0	189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	39	979	
Hlas	39	LV Extension	0.0	782	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	176	18	186
Pemugahel	40	ARE3H1	2.3	696	1	0	440	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	39	691	
Pemugahel	41	ARE3H2	7.6	7,088	5	0	1,717	0	0	0	0	0	0	0	518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,137	180	3,551	
Pemugahel	42	ARE3H3	7.6	5,060	4	0	0	1,428	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	607	98	2,638
Pemugahel	43	ARE3H4	3.4	4,326	1	0	0	641	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	642	34	1,431
Pemugahel	44	ARE3H5	3.9	576	1	0	0	0	2,093	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	255	64	2,738
Pemugahel	45	ARE3H6	6.6	5,572	4	0	0	2,961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,812	191	5,979
Samxe	46	ARE3L1	5.0	7,404	4	0	0	0	584	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	572	52	1,432	
Samxe	47	ARE3L2	7.5	5,064	3	0	0	0	880	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	368	36	1,439
Samxe	48	ARE3L3	1.9	793	1	0	0	0	0	0	212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72	0	340
Samxe	49	ARE3L4	25.8	31,346	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Samxe	50	ARE3L5	1.9	892	1	0	0	0	211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	7	344
Samxe	51	ARE3L6	6.6	2,769	5	0	0	0	282	487	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	213	1,899
Samxe	52	ARE3L7	3.1	758	1	0</																												

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-M

**LOCATION-WISE ANALYSIS OF
LIGHTNING FAULTS**

APPENDIX-M LOCATION-WISE ANALYSIS OF LIGHTNING FAULTS

M.1 Detailed Information of Lightning Faults

The frequency of power interruption due to lightning yearly and dzongkhag-wise is summarized in Table-4.3.12 in the main body of this report. The detailed information to know the fault location and influenced feeders due to lightning is summarized in Table M.1 to Table- M.13.

These tables show the features that the lightning faults were frequently occurred on the same feeders as observed in the following section.

M.2 Features of Typical Dzongkhag

✓ Chukha

Malbase substation and associated 220kV transmission lines were frequently influenced by lightning in the beginning of 2007, since then no fault due to lightning is recorded at these grid systems.

Regarding the MV lines, the same feeders such as “11kV feeder (Microwave)”, “11kV feeder (BBPL/Darla)”, etc. have been continuously influenced by lightning, hence it is recommended to take countermeasures to reduce faults due to lightning together with reviewing the fault records of 2010.

✓ Lhentse

The faults only occurred at Tangamachu substation in 2008, since then only one case is recorded. It seems that some kind of countermeasures have been taken at Tangamachu substation.

✓ Pemagatsel

Almost all faults were occurred at 132kV grid system, 132kV substation and power house, hence it is recommended to take countermeasures for these facilities together with reviewing the fault records of 2010, and coordination of protection system seems to be required, however, countermeasures for the MV lines may also be require after improving above grid system, 132kV substations and power house.

✓ Samtse

Almost all faults were occurred on the line segment, and many customers have been affected by power interruption especially “33kV Outgoing Feeder No. II” may require countermeasure to improve power supply reliability to the consumers.

Table-M.1 Location-wise Analysis of Lightning (Bumthang)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-03	Bumthang				15/3/007	331	BBS Yotola
2007-04	Bumthang	Feeder No. iv	Trongsar and chumey local	11kV	2/4/007	338	Gyetsa
2007-05	Bumthang	Feeder No. iv	Trongsar and chumey local	11kV	17/5/07	338	Yotala, BBS
2008-02	Bumthang	Feeder No. ii	Nangar local and colony	11kV	2008/2/7	137	

Table-M.2(1/2) Location-wise Analysis of Lightning (Chukha)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-01	Chukha	11 kV outgoing feeder I	Druk Cement Feeder	11kV	6.01.07	98	Malbase Substation
2007-01	Chukha	11 kV outgoing feeder no II	BBCL Feeder	11kV	6.01.07	4	Malbase Substation
2007-01	Chukha	11 kV outgoing feeder no. IV	Bhutan Steel Feeder	11kV	6.01.07	1	Malbase Substation
2007-01	Chukha	11 kV Outgoing feeder no. VI	New industrail feeder (Lower terrace feeder)	11kV	6.01.07	14	Malbase Substation
2007-01	Chukha	11 kV outgoing feeder no. VII	Substation feeder	11kV	6.01.07	1	Malbase Substation
2007-01	Chukha	11 kV outgoing feeder no. VIII	THPA (Malbase) Feeder	11kV	6.01.07	2	Malbase Substation
2007-02	Chukha	11 kV outgoing feeder I	Druk Cement Feeder	11kV	25/2/07	273	220 kV line
2007-02	Chukha	11 kV outgoing feeder no II	BBCL Feeder	11kV	25/2/07	7	220 kV line
2007-02	Chukha	11 kV outgoing feeder no. IV	Bhutan Steel Feeder	11kV	25/2/07	1	220 kV line
2007-02	Chukha	11 kV Outgoing feeder no. VI	New industrail feeder (Lower terrace feeder)	11kV	25/2/07	15	220 kV line
2007-02	Chukha	11 kV outgoing feeder no. VII	Substation feeder	11kV	25/2/07	1	220 kV line
2007-02	Chukha	11 kV outgoing feeder no. VIII	THPA (Malbase) Feeder	11kV	25/2/07	2	220 kV line
2007-02	Chukha	Nil	66 kV BCCL Feeder	66 kV	25/2/07	1	220 kV line
2007-02	Chukha	Nil	66 kV BFAL Feeder	66 kV	25/2/07	1	220 kV line
2007-02	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	25/2/07	93	
2007-02	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	25/2/07	93	
2007-02	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	25/2/07	93	
2007-02	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	25/2 to 28/2	93	
2007-02	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	25/2/07	435	
2007-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	16/3/07	93	
2007-03	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	16/3/07	434	
2007-03	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	16/3/07	434	
2007-03	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	16/3/07	434	
2007-05	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	17/5/07	918	
2007-05	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	24/5/07	918	
2007-05	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	24/5/07	269	
2007-05	Chukha	11 kV outgoing feeder No. III	Tading (Rural Feeder)	11kV	24/5/07	450	
2007-05	Chukha	11 kV outgoing feeder No. VIII	Pling Lower Market Feeder	11 kV	24/5/07	1688	
2007-05	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	24/5/07	917	
2007-05	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2007/8/5	93	
2007-05	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2007/9/5	93	
2007-05	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	13/5/07	434	
2007-05	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	20/5/07	434	
2007-05	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	23/5/07	434	
2007-05	Chukha	Feeder No. IV	11 kV Feeder (Mirchingchu)	11kV	23/5/07	16	
2007-06	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	23/6/07	93	
2007-06	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2007/8/6	448	
2007-06	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	16/6/07	448	
2007-06	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	23/6/07	89	
2007-06	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	24/6/07	89	
2007-09	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	18/9/07	905	
2007-09	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	18/9/07	905	
2008-02	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	25.2.08	73	
2008-03	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	28.3.08	1	
2008-03	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	14.3.2008	331	
2008-03	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	14.3.08	331	
2008-03	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	28.3.08	331	
2008-03	Chukha	11 kV outgoing feeder No. III	Tading (Rural Feeder)	11kV	28.3.08	306	
2008-03	Chukha	11 kV outgoing feeder no. IV	Industrail area feeder	11kV	28.3.08	17	
2008-03	Chukha	11 kV outgoing feeder no. V	Substation Feeder	11kV	28.3.08	1	
2008-03	Chukha	11 kV outgoing feeder No. VI	Pepsi - Bhutan Dairy Feeder	11 kV	28.3.08	1	
2008-03	Chukha	11 kV outgoing feeder No. VII	Hospital Feeder	11 kV	28.3.08	1	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/3	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/3	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/3	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/14	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/16	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/16	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/18	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/26	111	
2008-03	Chukha	Feeder No. I	11 kV Feeder (Mirrowave)	11kV	2008/3/30	111	
2008-03	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2008/3/14	457	
2008-03	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2008/3/14	457	
2008-03	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	2008/3/14	89	
2008-03	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	2008/3/15	89	

Table-M.2(2/2) Location-wise Analysis of Lightning (Chukha)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2008-03	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	2008/3/16	89	
2008-03	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	2008/3/31	89	
2008-04	Chukha	33 kV O/G Feeder No. IV	Serina Bosokha Feeder	33 kV	12.4.08	91	
2008-04	Chukha	11 kV outgoing feeder No. III	Tading (Rural Feeder)	11kV	2.4.08	306	
2008-04	Chukha	11 kV outgoing feeder no. IV	Industrail area feeder	11kV	2.4.08	17	
2008-04	Chukha	Nil	11 kV outgoing Druk Cement feeder (Malbase)	11 kV	3.4.08	67	
2008-04	Chukha	Feeder NO. I	33 kV Feeder No - I (Gurungdara)	33 kV	1.4.08	56	
2008-04	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	27.4.08	904	
2008-04	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	24.4.08	120	
2008-04	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	26.4.08	120	
2008-04	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	27.4.08	120	
2008-04	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	27.04.08	120	
2008-04	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	1.4.08	477	
2008-04	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	4.4.08	477	
2008-04	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	27.4.08	477	
2008-04	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	3.4.08	89	
2008-04	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	18.4.08	89	
2008-05	Chukha	33 kV O/G Feeder No. IV	Serina Bosokha Feeder	33 kV	8.5.08	91	
2008-05	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	27.5.08	477	
2008-05	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	19.5.08	89	
2008-05	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	31.5.08	89	
2008-06	Chukha	33 kV O/G Feeder No. I	Druk Iron & Steel Feeder	33 kV	5.6.08	1	
2008-06	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	18.6.08	1	
2008-06	Chukha	33 kV O/G Feeder No. I	Druk Iron & Steel Feeder	33 kV	5.6.08	1	
2008-08	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2008/8/29	1	Line
2008-08	Chukha	33 kV O/G Feeder No. I	Sector 2 feeder	33 kV	2008/8/29	3186	Substation
2008-08	Chukha	33 kV O/G Feeder No. II	Sector 2 Feeder	33 kV	2008/8/29	0	Substation
2008-08	Chukha	33 kV O/G Feeder No. IV	Serina Bosokha Feeder	33 kV	2008/8/29	91	Substation
2008-08	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2008/8/29	1	Line
2008-09	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2008/9/3	1	line section
2008-09	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	2008/9/2	3	66 kV substation
2008-09	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	2008/9/2	349	66 kV substation
2008-09	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	2008/9/12	349	Line
2008-09	Chukha	11 kV outgoing feeder No. III	Tading (Rural Feeder)	11kV	2008/9/2	319	66 kV substation
2008-09	Chukha	11 kV outgoing feeder no. IV	Industrail area feeder	11kV	2008/9/2	17	66 kV substation
2008-09	Chukha	11 kV outgoing feeder no. V	Substation Feeder	11kV	2008/9/2	1	66 kV substation
2008-09	Chukha	11 kV outgoing feeder No. VI	Pepsi - Bhutan Dairy Feeder	11 kV	2008/9/2	125	66 kV substation
2008-09	Chukha	11 kV outgoing feeder No. VII	Hospital Feeder	11 kV	2008/9/2	1	66 kV substation
2008-09	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2008/9/3	1	line section
2009-03	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	26/3/09	180	
2009-05	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2009/10/5	1	Line segment
2009-05	Chukha	B150	Druk Iron & Steel Feeder	33 kV	30/5/09	1	linne segment
2009-05	Chukha	33 kV O/G Feeder No. I	Sector 2 feeder	33 kV	19/5/09	3395	
2009-05	Chukha	33 kV O/G Feeder No. II	Sector 2 Feeder	33 kV	19/5/09	0	
2009-05	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	2009/12/5	3	
2009-05	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	30/5/09	3	
2009-05	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	2009/10/5	357	
2009-05	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	26/5/09	138	
2009-05	Chukha	Feeder No. V	11 kV THPA Colony - I	11kV	26/5/09	138	
2009-05	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2009/10/5	1	Line segment
2009-05	Chukha	B150	Druk Iron & Steel Feeder	33 kV	30/5/09	1	linne segment
2009-06	Chukha	B150	Druk Iron & Steel Feeder	33 kV	29/6/09	1	Line segment
2009-06	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	2009/2/6	3	
2009-06	Chukha	11 kV Outgoing Feeder No. I	Kharbandi - Toribari Feeder	11kV	20/6/09	3	
2009-06	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	20/6/09	359	
2009-06	Chukha	11 kV outgoing feeder no. IV	Industrail area feeder	11kV	2009/1/6	19	
2009-06	Chukha	11 kV outgoing feeder No. VI	Pepsi - Bhutan Dairy Feeder	11 kV	2009/8/6	128	
2009-06	Chukha	11 kV outgoing feeder No. VIII	Pling Lower Market Feeder	11 kV	19/6/09	0	
2009-06	Chukha	B150	Druk Iron & Steel Feeder	33 kV	29/6/09	1	Line segment
2009-08	Chukha	Feeder No. I	11 kV Feeder (Mircowave)	11kV	18/8/09	181	Line segment
2009-09	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2009/9/13	1	Line segment
2009-09	Chukha	B150	Druk Iron & Steel Feeder	33 kV	2009/9/13	1	Line segment
2009-10	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2009/10/7	517	line segment
2009-10	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2009/10/7	517	line segment
2009-10	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2009/10/8	517	line segment
2009-10	Chukha	Feeder No. II	11 kV Feeder (BBPL/Darla)	11kV	2009/10/8	517	line segment
2010-03	Chukha	B150	Druk Iron & Steel Feeder	33 kV	29/3/2010	1	Line
2010-03	Chukha	11 kV outgoing feeder No. III	Tading (Rural Feeder)	11kV	26/3/2010	377	line
2010-03	Chukha	11 kV outgoing feeder No. VIII	Pling Lower Market Feeder	11 kV	26/3/2010	0	Line
2010-03	Chukha	B150	Druk Iron & Steel Feeder	33 kV	29/3/2010	1	Line
2010-04	Chukha	B150	Druk Iron & Steel Feeder	33 kV	22/4/2010	1	Line
2010-04	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	22/4/2010	386	Line segment
2010-04	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	22/4/2010	386	Line segment
2010-04	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	23/4/2010	386	Line segment
2010-04	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	23/4/2010	386	Line segment
2010-04	Chukha	11 kV outgoing feeder No. II	Kabray - Ramitey Feeder	11kV	23/4/2010	386	Line segment
2010-04	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	18/4/2010	894	Line
2010-04	Chukha	Feeder NO. III	33 kV Feeder No. II (Gurungdara)	33 kV	19/4/2010	894	line
2010-04	Chukha	B150	Druk Iron & Steel Feeder	33 kV	22/4/2010	1	Line

Table-M.3 Location-wise Analysis of Lightning (Haa)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2010-04	Haa	Outgoing Feeder No.V	Wangtsa & Damthang	11kV	25/04/2010	550	

Table-M.4 Location-wise Analysis of Lightning (Lhuentse)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-06	LHUENTSE			33KV	29/6/07	1118	Yadhi
2007-07	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	21.07.2007	15	Lhuentse Feeder
2007-07	LHUENTSE	Outgoing feeder No. - I		11KV	26/7/07	1068	Mongar Town
2007-07	LHUENTSE			33KV	2007/3/7	1118	Yadhi
2007-07	LHUENTSE	Outgoing feeder No. - I		11KV	26/7/07	1068	Mongar Town
2009-03	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	07.03.2009	221	do
2009-03	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	10.03.2009	221	do
2009-05	LHUENTSE	OUT GOING FEEDER No.II	SHAGMA - TANGMACHU FEEDER	11 KVA	30.05.2009	1	
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	01.08.2009	217	Tangmachu Substation
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	03.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	05.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	06.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	10.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	10.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	14.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	16.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	22.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	22.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	22.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	26.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	26.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	26.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	26.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	27.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.I	SHAGMA - LHUENTSE FEEDER	11 KVA	28.08.2009	217	do
2009-08	LHUENTSE				29.08.2009	217	do
2009-08	LHUENTSE				30.08.2009	217	do
2009-08	LHUENTSE				30.08.2009	217	do
2009-08	LHUENTSE	OUT GOING FEEDER No.II	SHAGMA - TANGMACHU FEEDER	11 KVA	11.08.2009	269	Tangmachu Substation
2009-08	LHUENTSE	OUT GOING FEEDER No.I	GORGAN - AUTSHO FEEDER	33 KV	22.08.2009	329	do
2009-08	LHUENTSE	OUT GOING FEEDER No.2	GORGAN - CHANGKHARLA FEEDER	33 KV	22.08.2009	86	do
2010-04	LHUENTSE	OUT GOING FEEDER No.III	SHAGMA - MINJI FEEDER	11 KVA	2010/4/11	185	Tangmochu Substation

Table-M.5 (1/4) Location-wise Analysis of Lightning (Pemagatshel)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-02	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	25.02.07	287	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	25.02.07	287	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	25.02.07	207	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	25.02.07	207	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder III		11kV	25.02.07	3	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder III		11kV	25.02.07	3	132 kV Eastern Grid
2007-02	Pemagatshel			33 kV	25.02.07	285	132 kV Eastern Grid
2007-02	Pemagatshel			33 kV	25.02.07	285	132kV Ngangkor S/Station
2007-02	Pemagatshel			33 kV	25.02.07	285	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder no. V		33kV	25.02.07	473	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder no. V		33kV	25.02.07	473	132kV Ngangkor S/Station
2007-02	Pemagatshel	Outgoing feeder no. V		33kV	26.02.07	473	Fadi Substation
2007-02	Pemagatshel	Outgoing feeder no. V		33kV	25.02.07	473	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder no VI		33kV	25.02.07	179	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing feeder no VI		33kV	25.02.07	179	132 kV Eastern Grid
2007-02	Pemagatshel			11kV	25.02.07	15	132 kV Eastern Grid
2007-02	Pemagatshel			11kV	25.02.07	15	132 kV Eastern Grid
2007-02	Pemagatshel			11kV	25.02.07	1	132 kV Eastern Grid
2007-02	Pemagatshel			11kV	25.02.07	1	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	25.02.07	287	132 kV Eastern Grid
2007-02	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	25.02.07	287	132 kV Eastern Grid
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	07.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	07.04.07	290	Kurichu Power House
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	09.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	07.04.07	207	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	07.04.07	207	Kurichu Power House
2007-04	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	09.04.07	207	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing feeder III		11kV	07.04.07	3	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing feeder III		11kV	07.04.07	3	Kurichu Power House
2007-04	Pemagatshel	Outgoing feeder III		11kV	09.04.07	3	132 kV Ngangkor Substation
2007-04	Pemagatshel			33 kV	07.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel			33 kV	07.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel			33 kV	07.04.07	290	Mongling S/Station
2007-04	Pemagatshel			33 kV	07.04.07	290	Kurichu Power House
2007-04	Pemagatshel			33 kV	09.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing feeder no. V		33kV	07.04.07	475	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing feeder no. V		33kV	07.04.07	475	Kurichu Power House
2007-04	Pemagatshel	Outgoing feeder no VI		33kV	07.04.07	179	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing feeder no VI		33kV	07.04.07	179	Kurichu Power House
2007-04	Pemagatshel	Outgoing feeder no VI		33kV	09.04.07	179	132 kV Ngangkor Substation
2007-04	Pemagatshel			11kV	07.04.07	15	132 kV Ngangkor Substation
2007-04	Pemagatshel			11kV	07.04.07	15	Kurichu Power House
2007-04	Pemagatshel			11kV	09.04.07	15	132 kV Ngangkor Substation
2007-04	Pemagatshel			11kV	07.04.07	1	132 kV Ngangkor Substation
2007-04	Pemagatshel			11kV	07.04.07	1	Kurichu Power House
2007-04	Pemagatshel			11kV	09.04.07	1	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	07.04.07	290	132 kV Ngangkor Substation
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	07.04.07	290	Kurichu Power House
2007-04	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	09.04.07	290	132 kV Ngangkor Substation
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	12.05.07	290	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	16.05.07	290	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	24.05.07	290	Kurichu Power House
2007-05	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	12.05.07	206	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	16.05.07	206	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	24.05.07	206	Kurichu Power House
2007-05	Pemagatshel	Outgoing feeder III		11kV	12.05.07	3	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder III		11kV	16.05.07	3	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder III		11kV	24.05.07	3	Kurichu Power House
2007-05	Pemagatshel			33 kV	12.05.07	290	Kurichu Power house
2007-05	Pemagatshel			33 kV	16.05.07	290	Kurichu Power house
2007-05	Pemagatshel			33 kV	24.05.07	290	Kurichu Power House
2007-05	Pemagatshel	Outgoing feeder no. V		33kV	12.05.07	475	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder no. V		33kV	16.05.07	475	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder no. V		33kV	24.05.07	475	Kurichu Power House
2007-05	Pemagatshel	Outgoing feeder no VI		33kV	12.05.07	180	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder no VI		33kV	16.05.07	180	Kurichu Power house
2007-05	Pemagatshel	Outgoing feeder no VI		33kV	24.05.07	180	Kurichu Power House
2007-05	Pemagatshel			11kV	12.05.07	15	Kurichu Power house
2007-05	Pemagatshel			11kV	16.05.07	15	Kurichu Power house
2007-05	Pemagatshel			11kV	24.05.07	15	Kurichu Power House
2007-05	Pemagatshel			11kV	12.05.07	1	Kurichu Power house
2007-05	Pemagatshel			11kV	16.05.07	1	Kurichu Power house
2007-05	Pemagatshel			11kV	24.05.07	1	Kurichu Power House
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	12.05.07	290	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	16.05.07	290	Kurichu Power house
2007-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	24.05.07	290	Kurichu Power House

Table-M.5 (2/4) Location-wise Analysis of Lightning (Pemagatshel)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	23.06.07	290	Kurichu Powerhouse
2007-06	Pemagatshel	Outgoing Feeder No.II	Ngangkor feeder	11KV	23.06.07	206	Kurichu Powerhouse
2007-06	Pemagatshel	Outgoing feeder III		11kV	23.06.07	3	Kurichu Powerhouse
2007-06	Pemagatshel			33 kV	21.06.07	752	132 kV Nangkor S/S
2007-06	Pemagatshel			33 kV	23.06.07	752	Kurichu Powerhouse
2007-06	Pemagatshel	Outgoing feeder no. V		33kV	08.06.07	475	Shenari S/Station
2007-06	Pemagatshel	Outgoing feeder no. V		33kV	08.06.07	475	Shenari S/Station
2007-06	Pemagatshel	Outgoing feeder no. V		33kV	23.06.07	475	Kurichu Powerhouse
2007-06	Pemagatshel	Outgoing feeder no VI		33kV	23.06.07	189	Kurichu Powerhouse
2007-06	Pemagatshel			11kV	23.06.07	15	Kurichu Powerhouse
2007-06	Pemagatshel			11kV	23.06.07	1	Kurichu Powerhouse
2007-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel Town Feeder	11kV	23.06.07	290	Kurichu Powerhouse
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	04.07.07	290	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	15.07.07	290	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	16.07.07	290	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	18.07.07	290	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	25.07.07	290	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	04.07.07	206	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	15.07.07	206	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	16.07.07	206	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	18.07.07	206	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	25.07.07	206	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	04.07.07	3	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	15.07.07	3	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	16.07.07	3	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	18.07.07	3	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	25.07.07	3	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	04.07.07	764	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	15.07.07	764	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	16.07.07	764	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	18.07.07	764	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	25.07.07	764	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	04.07.07	475	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	15.07.07	475	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	16.07.07	475	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	18.07.07	475	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	25.07.07	475	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	04.07.07	189	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	11.07.07	189	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	15.07.07	189	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	16.07.07	189	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	18.07.07	189	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	25.07.07	189	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VII	Colony Feeder	11kV	04.07.07	15	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.VII	Colony Feeder	11kV	15.07.07	15	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VII	Colony Feeder	11kV	16.07.07	15	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VII	Colony Feeder	11kV	25.07.07	15	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VIII	Station Feeder	11kV	04.07.07	1	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.VIII	Station Feeder	11kV	15.07.07	1	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VIII	Station Feeder	11kV	16.07.07	1	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.VIII	Station Feeder	11kV	18.07.07	1	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.VIII	Station Feeder	11kV	25.07.07	1	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	04.07.07	290	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	15.07.07	290	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	16.07.07	290	Kurichu Power House
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	18.07.07	290	132 kV Nangkor S/Station
2007-07	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	25.07.07	290	132 kV Nangkor S/Station
2008-03	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	17.03.2008	520	Nangkor S/Station
2008-03	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	30.03.2008	768	Nangkor S/Station
2008-03	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	18.03.2008	669	Nangkor S/Station
2008-04	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	12.04.2008	679	132 kV Nangkor S/Station
2008-04	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	14.04.2008	679	Bartsheeri S/Station
2008-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	19.05.2008	303	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	19.05.2008	520	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	19.05.2008	4	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	19.05.2008	752	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	19.05.2008	752	132 kV Nangkor S/Station
2008-05	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	19.05.2008	752	132 kV Nangkor S/Station
2008-05	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	19.05.2008	752	132 kV Nangkor S/Station
2008-05	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	19.05.2008	679	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	33kV	19.05.2008	525	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.VII	Station Feeder	11kV	19.05.2008	1	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.VIII	Colony Feeder	11kV	19.05.2008	16	Khurichu Power house
2008-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	19.05.2008	303	Khurichu Power house
2008-06	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	16.06.2008	753	Nangkor S/Station
2008-06	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	24.06.2008	753	Nangkor S/Station
2008-08	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	01.08.2008	310	Salakata S/Station
2008-08	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	09.08.2008	310	Nganglam S/Station
2008-08	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	09.08.2008	310	Kurichu Power House

Table-M.5 (4/4) Location-wise Analysis of Lightning (Pemagatshel)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2009-05	Pemagatshel	Outgoing Feeder No.VII	Station Feeder	11kV	3.05.2009	1	Salakata S/Station
2009-05	Pemagatshel	Outgoing Feeder No.VIII	Colony Feeder	11kV	1.05.2009	16	Salakata S/Station
2009-05	Pemagatshel	Outgoing Feeder No.VIII	Colony Feeder	11kV	3.05.2009	16	Salakata S/Station
2009-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	1.05.2009	331	Salakata S/Station
2009-05	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	3.05.2009	331	Salakata S/Station
2009-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	09.06.2009	333	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	14.06.2009	333	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	09.06.2009	542	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	14.06.2009	542	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	09.06.2009	3	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.III	POP Feeder	11kV	14.06.2009	3	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	09.06.2009	777	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.IV	Nanong Feeder	33kV	14.06.2009	777	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	09.06.2009	717	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.III	Tshebar Feeder	33kV	14.06.2009	717	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	11kV	09.06.2009	535	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VI	Yurung Feeder	11kV	14.06.2009	535	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VII	Station Feeder	11kV	09.06.2009	1900/1/1	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VII	Station Feeder	11kV	14.06.2009	1	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VIII	Colony Feeder	11kV	09.06.2009	16	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.VIII	Colony Feeder	11kV	14.06.2009	16	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	09.06.2009	333	Khurichu power house
2009-06	Pemagatshel	Outgoing Feeder No.I	Pemagatshel feeder	11kV	14.06.2009	333	Khurichu power house
2009-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	27.07.2009	543	Nangkor S/Station
2009-07	Pemagatshel	Outgoing Feeder No.II	Nangkor Feeder	11kV	29.07.2009	543	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.IV	Nanong feeder	33kV	28.03.2010	779	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	22.03.2010	721	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	23.03.2010	721	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	23.03.2010	721	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	23.03.2010	721	Nangkor S/Station
2010-03	Pemagatshel	Outgoing Feeder No.V	Tshebar Feeder	33kV	23.03.2010	721	Nangkor s/station

Table-M.6 (1/3) Location-wise Analysis of Lightning (Samtse)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-01	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/01/2007	2618	
2007-01	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/01/2007	2618	
2007-01	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/01/2007	2618	
2007-01	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/01/2007	2618	
2007-02	Samtse	Outgoing Feeder No. III	DDPL/Pugli	11kV	7 to 26/2/2007	113	-
2007-02	Samtse	Outgoing Feeder No. V	Market/Gomtu	11kV	2007/11/2	230	-
2007-03	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2007/10/3	2	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/1/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/1/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/2/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	23/4/2007	151	-
2007-04	Samtse	Outgoing Feeder No. II	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	11kV	2007/2/4	1	Lhaki Cement Pvt. Limited (LCPL) Near M.D's Bungalow at Lhaki
2007-04	Samtse	Outgoing Feeder No. II	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	11kV	2007/7/4	1	-
2007-04	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	21/4/2007	113	-
2007-04	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	26/4/2007	113	-
2007-04	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	0	21/4/2007	2	-
2007-04	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	4/2007 to 9/4/2007	2474	Near Samtse Checkpost areas, & Duarpani.
2007-04	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	23/4/2007	2474	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/1/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/1/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/2/4	151	-
2007-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	23/4/2007	151	-
2007-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	22/5/07	101	-
2007-05	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	0	25/5/07	2	-
2007-05	Samtse	Outgoing Feeder No. V	Market/Gomtu	0	25/5/07	341	-
2007-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	14/5/07	3477	-
2007-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	19/5/07	3477	-
2007-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	23/5/07	3477	-
2007-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	25/5/07	3477	-
2007-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	28/5/07	3477	-
2007-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	22/5/07	101	-
2007-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	14/6/2007	151	-
2007-06	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	28/6/2007	113	-
2007-06	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	0	28/6/2007	2	-
2007-06	Samtse	Outgoing Feeder No. V	Market/Gomtu	0	2007/4/6	341	-
2007-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	28/6/2007	2784	-
2007-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	14/6/2007	151	-
2007-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/2/7	151	-
2007-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/4/7	151	-
2007-07	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	0	2007/4/7	1	-
2007-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/5/7	3101	-
2007-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/9/7	3101	-
2007-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/10/7	3101	-
2007-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	26/7/2007	3101	-
2007-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/2/7	151	-
2007-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/4/7	151	-
2007-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/7/8	151	-
2007-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	29/8/2007	151	-
2007-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/6/8	3110	-
2007-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/7/8	3110	-
2007-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/7/8	151	-
2007-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	29/8/2007	151	-
2007-09	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/9/11	151	-
2007-09	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	0	2007/9/13	1	Lhaki Cement Factory Ltd. Substation, Gomtu
2007-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/9/18	3106	-
2007-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/9/19	3106	-
2007-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/9/22	3106	-
2007-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/9/22	3106	-
2007-09	Samtse	Outgoing Feeder No. I	Samtse	11kV	2007/9/11	151	-
2007-10	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/10/1	3121	-
2007-10	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2007/10/2	3121	-
2008-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	16/3/2008	100	-
2008-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	30/3/2008	100	-
2008-03	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	0	2008/2/3	1	66/33/11kV S/S, Gomtu
2008-03	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV S at Samtse	0	30/3/2008	1	66/33/11kV S/S, Gomtu
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/1/3	115	Line segment
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/3/3	115	Line segment
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/3/3	115	Line segment
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/3/3	115	-
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/4/3	115	-
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/7/3	115	-
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/9/3	115	Near Pugli Khola
2008-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	20/3/2008	115	-

Table-M.6 (2/3) Location-wise Analysis of Lightning (Samtse)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2008-03	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	20/3/2008	2	66/33/11kV S/S, Gomtu
2008-03	Samtse	Outgoing Feeder No. V	Market/Gomtu	0	20/3/2008	254	66/33/11kV S/S, Gomtu
2008-03	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2008/2/3	3207	66/33/11kV S/S, Gomtu
2008-03	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2008/7/3	3207	-
2008-03	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	21/3/2008	3207	-
2008-03	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	30/3/2008	3207	66/33/11kV S/S, Gomtu
2008-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	16/3/2008	100	-
2008-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	30/3/2008	100	-
2008-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	03.04.2008	100	-
2008-04	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	03.04.2008	115	Line segment
2008-04	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	04.04.2008	115	Line segment
2008-04	Samtse	Outgoing Feeder No. V	Market/Gomtu	0	03.04.2008	255	-
2008-04	Samtse	Outgoing Feeder No. I	Samtse	11kV	03.04.2008	100	-
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	02.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	18.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	19.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	28.05.2008	99	Line segment
2008-05	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV	0	08.05.2008	1	Line segment
2008-05	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV	0	08.05.2008	1	Line segment
2008-05	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	08.05.2008	115	Temporary fault on line segment
2008-05	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	11.05.2008	115	Line segment
2008-05	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	12.05.2008	115	Line segment
2008-05	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	11.05.2008	2	Line segment
2008-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	02.05.2008	3733	
2008-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	08.05.2008	3733	Line segment
2008-05	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	28.05.2008	3733	Line Segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	02.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	18.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	19.05.2008	99	Line segment
2008-05	Samtse	Outgoing Feeder No. I	Samtse	11kV	28.05.2008	99	Line segment
2008-06	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	09.06.2008	179	Line Segment
2008-06	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	09.06.2008	179	Line Segment
2008-06	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	09.06.2008	2	Line segment
2008-06	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	10.06.2008	2	Line segment
2008-06	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	10.06.2008	2	Line segment
2008-07	Samtse	Outgoing Feeder No. III	DDPL/Pugli	et from S/S	2008/4/7	179	Line Segment
2008-07	Samtse	Outgoing Feeder No. III	DDPL/Pugli	et from S/S	2008/9/7	179	Line Segment
2008-09	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV	0	2008/9/14	1	33kV Lineman segment
2008-09	Samtse	Outgoing Fdr. No. 33/11kV - III	Lhaki Cement Pvt. Limited 33/11kV	0	2008/9/16	1	33kV Lineman segment
2008-09	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2008/9/11	180	66/11kV Incomer -II & Line segment
2008-09	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2008/9/11	2	66/11kV Incomer -II & Line segment
2008-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2008/9/25	4012	33kV Line segment
2008-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2008/9/27	4012	33kV Line segment
2009-03	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2009/3/24	183	line
2009-04	Samtse	Outgoing Feeder No. III	DDPL/Pugli	0	2009/4/6	184	Line segment
2009-04	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2009/4/6	2	Line segment
2009-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/6/19	98	Line Segment
2009-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/6/27	98	Line Segment
2009-06	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomt	0	2009/6/19	1	Line Segment
2009-06	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomt	0	2009/6/19	1	Line Segment
2009-06	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomt	0	2009/6/27	1	Line Segment
2009-06	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2009/6/19	2	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/1	0	Above Yangzom Cement Factory
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/5	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/8	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/15	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/19	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/19	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/19	0	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/24	4011	Line Segment
2009-06	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/6/26	4011	Line Segment
2009-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/6/19	98	Line Segment
2009-06	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/6/27	98	Line Segment
2009-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/7/11	98	Near Sinkauley
2009-07	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	0	2009/7/17	188	Line Segment
2009-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/7/5	4051	Line segment
2009-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/7/28	4051	Duarpani
2009-07	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/7/30	4051	Line segment
2009-07	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/7/11	98	Near Sinkauley
2009-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/8/8	99	Line segment
2009-08	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomt	0	2009/12/8	1	Line segment

Table-M.6 (3/3) Location-wise Analysis of Lightning (Samtse)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2009-08	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomtu	0	2009/12/8	1	Lhaki Cement Factory, Gomtu
2009-08	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomtu	0	19/8/2009	1	Lhaki Cement Factory, Gomtu
2009-08	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	0	2009/3/8	188	Line Segment
2009-08	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	0	24/8/2009	188	Line Segment
2009-08	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2009/8/8	2	Line Segment
2009-08	Samtse	Outgoing Feeder No. V	Market/Gomtu	0	2009/12/8	261	Line Segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/3/8	4058	Line segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/7/8	4058	Line segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/8/8	4058	Line segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/10/8	4058	Line segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	24/8/2009	4058	Line segment
2009-08	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	26/8/2009	4058	Line segment
2009-08	Samtse	Outgoing Feeder No. I	Samtse	11kV	2009/8/8	99	Line segment
2009-09	Samtse	Outgoing Fdr. No. III	Lhaki Cement Pvt. Limited, Gomtu	0	2009/8/9	1	Lineman segment
2009-09	Samtse	Outgoing Feeder No. IV	Bhutan Polymer Company Ltd & Jigme Polytex	11kV	2009/5/9	2	
2009-09	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	2009/1/9	4081	Line segment
2010-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	30/03/2010	101	Near Sangla village
2010-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/03/2010	101	Line Segment
2010-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	30/03/2010	101	Near Sangla village
2010-03	Samtse	Outgoing Feeder No. I	Samtse	11kV	31/03/2010	101	Line Segment
2010-04	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	11kV	24/4/2010	207	Line segment
2010-04	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	11kV	25/4/2010	207	Line segment
2010-04	Samtse	Outgoing Fdr. No. 33/11kV - III	DDPL/Pugli (33/11kV)	11kV	26/4/2010	207	Line segment
2010-04	Samtse	Outgoing Feeder No. V	Gomtu Market	11kV	23/4/2010	262	Line segment
2010-04	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	24/4/2010	4165	Line segment
2010-04	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	24/4/2010	4165	Duarpani
2010-04	Samtse	33kV Outgoing Feeder No. II	Samtse	33 kV	26/4/2010	4165	Line segment

Table-M.7 Location-wise Analysis of Lightning (Sarpang)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-02	Sarpang	Outgoing Feeder No.I	Sarpang feeder I	11kV	21/2/07	573	Gelephu
2007-09	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	2007/9/10	995	Lower Dzomlingthang substation
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/2/4	979	Emergency shutdown
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/2/4	979	Emergency shutdown
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	15/4/2008	979	Emergency shutdown
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/2/4	979	Emergency shutdown
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/2/4	979	Emergency shutdown
2008-04	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	15/4/2008	979	Emergency shutdown
2008-05	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	2008/8/5	705	Not known
2008-05	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	30/5/2008	705	GO switch at AWP
2008-07	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/7/9	1161	Not known
2008-07	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/7/13	1161	Near Truck parking
2008-07	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	2008/7/9	705	Not known
2008-07	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	2008/7/9	705	Umling
2008-07	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	2008/7/9	705	Planned shut down
2008-07	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/7/9	1161	Not known
2008-07	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/7/13	1161	Near Truck parking
2008-08	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/9/8	1086	Near Saran Workshop
2008-08	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	2008/9/8	1086	Near Saran Workshop
2009-04	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	30.4.2012	1171	Lodrai
2009-04	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	6.4.2009	849	Surey
2009-05	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	5.5.2009	1079	Charily Substation
2009-05	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	9.5.2009	1079	Gelephu area
2009-05	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	5.5.2009	816	Gelephu
2009-05	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	9.5.2009	816	Maggi Basty
2009-05	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	5.5.2009	1122	Gelephu/Lodrai
2009-05	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	9.5.2009	1122	Zomlingthang
2009-05	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	5.5.2009	819	Gelephu
2009-05	Sarpang	Outgoing Feeder No.IV	Jigmecholing feeder	11kV	8.5.2009	819	Serkam
2009-05	Sarpang	Outgoing Feeder No.I	Sarpang feeder I	11kV	5.5.2009	847	Aipali Khola
2009-05	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	5.5.2009	1079	Charily Substation
2009-05	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	9.5.2009	1079	Gelephu area
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	9.6.2009	1172	Fishery Side
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	19.6.2009	1172	Gelephu
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	23.6.2009	1172	Gelephu
2009-06	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	9.6.2009	1206	Gelephu
2009-06	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	19.6.2009	1206	Gelephu
2009-06	Sarpang	Outgoing Feeder No.II	Sarpang feeder II	11kV	15.6.2009	862	Planned shutdown
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	9.6.2009	1172	Fishery Side
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	19.6.2009	1172	Gelephu
2009-06	Sarpang	Outgoing Feeder No.I	Gelephu feeder	11kV	23.6.2009	1172	Gelephu
2009-07	Sarpang	Outgoing Feeder No.III	RBA feeder	11kV	25.7.2009	1229	Kholakhola
2010-03	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	19.3.2010	1362	Sershong
2010-03	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	24.3.2010	1362	Planned shut down
2010-04	Sarpang	Outgoing Feeder No.II	ADP feeder	11kV	23.4.2010	1371	Gelephu

Table-M.8 Location-wise Analysis of Lightning (Thimphu)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2008-10	Thimphu	Outgoing Feeder No.IV	Semtokha 11 KV O/G Feeder No.IV (Changbangdu &	11KV	28/10/2008	1963	Olakha area

Table-M.9 Location-wise Analysis of Lightning (Trashigang)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-04	Trashigang	0110Hx	Radi	11kV	26/4/2007	1026	do
2007-04	Trashigang	0100Hx	Bidung	11kV	26/4/2007	435	do
2007-06	Trashigang	Not available	College	11kV	15/6/2007	2280	Kanglung S/S
2007-06	Trashigang	Not available	Town	11kV	2007/5/6	1595	Town line
2007-07	Trashigang	Not available	College	11kV	17/7/2007	2280	College line
2007-07	Trashigang	Not available	College	11kV	17/7/2007	do	College line
2008-03	Trashigang	Not available	Town	11kV	2008/3/20	1614	do

Table-M.10 Location-wise Analysis of Lightning (Trashiyangtse)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-05	TRASHIYANGTSE	Outgoing Feeder No.I	Yallang Feeder	33kV	18/5/2007	120	Kanglung SS
2007-05	TRASHIYANGTSE	Outgoing Feeder No.II	Khamdang Feeder	33KV	18/5/2007	551	Kanglung SS
2007-05	TRASHIYANGTSE	Outgoing feeder III		33kV	18/5/2007	793	Kanglung SS
2007-05	TRASHIYANGTSE			33 kV	18/5/2007	336	Kanglung SS
2007-05	TRASHIYANGTSE	Incoming Main Feeder No. I		33kV	18/5/2007	65	Kanglung SS
2007-05	TRASHIYANGTSE			33kV	18/5/2007	259	Kanglung SS
2007-05	TRASHIYANGTSE	Outgoing Feeder No.I	Yallang Feeder	33kV	18/5/2007	120	Kanglung SS

Table-M.11 Location-wise Analysis of Lightning (Trongsa)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-03	TRONGSA				15/3/007	508	BBS Yotola
2007-04	TRONGSA	10	CHUMEY-TRONGSA 11kV LIN	11kV	2/4/007	522	Gyetsa
2007-04	TRONGSA	10	CHUMEY-TRONGSA 11kV LIN	11kV	2/4/007	522	Gyetsa
2007-05	TRONGSA	10	CHUMEY-TRONGSA 11kV LIN	11kV	17/5/07	338	Yotala, BBS
2007-05	TRONGSA	10	CHUMEY-TRONGSA 11kV LIN	11kV	17/5/07	338	Yotala, BBS

Table-M.12 Location-wise Analysis of Lightning (Wandue)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2007-04	Wangdue	Outgoing feeder No.11	Sha area and Nahi geog	33kV	16/4/07	919	66kv substation
2007-04	Wangdue	Outgoing feeder No.11	Sha area and Nahi geog	33kV	16/4/07	919	66kv substation
2009-02	Wangdue	Outgoing feeder No.2	Sha area and Nahi geog	33kV	24/2/2009	428	Rubesa area
2009-02	Wangdue	Outgoing feeder No.2	Sha area and Nahi geog	33kV	24/2/2009	428	Rubesa area
2009-03	Wangdue	Outgoing feeder No.2	Sha area and Nahi geog	33kV	18/3/09	176	Rutokha, Ningegang
2009-03	Wangdue	Outgoing feeder No.2	Sha area and Nahi geog	33kV	18/3/09	176	Rutokha, Ningegang

Table-M.13 Location-wise Analysis of Lightning (Zhemgang)

Month	Dzongkhag:	Feeder Number:	Feeder Name	Voltage	Date	Affected Customers	Location of fault
2008-03	ZHEMGANG			33kV	30/3/2008	172	Tingtibi to Dakpai/Buli
2009-03	Zhemgang	FEEDER No 1 (T10)	Zhemgang	33kV	11.03.09	491	Tingtibi to Zhemgang
2009-03	Zhemgang	FEEDER No 1 (T10)	Zhemgang	33kV	18.03.2009	491	Tingtibi to Zhemgang
2009-03	ZHEMGANG	Outgoing Feeder No.II (T20)	Gomphu	33kV	11.03.09	243	Tingtibi -Gomphu
2009-03	ZHEMGANG	Outgoing Feeder No.II (T20)	Gomphu	33kV	19.3.2009	243	Tingtibi to Gomphu
2009-03	ZHEMGANG			6.6kV	18.3.09		Tingtibi micro hydel
2009-03	ZHEMGANG			6.6kV	21.3.2009		Tingtibi micro hydel
2009-03	ZHEMGANG			6.6kV	26.3.2009		Tingtibi micro hydel
2009-03	Zhemgang	FEEDER No 1 (T10)	Zhemgang	33kV	11.03.09	491	Tingtibi to Zhemgang
2009-03	Zhemgang	FEEDER No 1 (T10)	Zhemgang	33kV	18.03.2009	491	Tingtibi to Zhemgang
2010-03	ZHEMGANG	Outgoing Feeder No.II (T20)	Gomphu	33kV	2010/3/22	280	Tingtibi to Gomphu

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-N

SINGLE LINE DIAGRAM FOR

ARCB LOCATION

APPENDIX-N SINGLE LINE DIAGRAM OF ARCB LOCATION

N.1 Single Line Diagram for ARCB Location

The single line diagrams which indicate the proposed location of ARCBs have been submitted to BPC Head Office (as of November 12, 2010) from the following dzongkhags and are shown in Figure-N1 to N10.

- ✓ Chukha
- ✓ Haa
- ✓ Pemagatsel
- ✓ Samtse
- ✓ Trongsa
- ✓ Tsirang
- ✓ Wangdue
- ✓ Samdrupjongkhar
- ✓ Trashiyangtze
- ✓ Zhemgang
- ✓

N.2 Proposed Number of ARCBs

Thirty-seven sets of 33kV and twenty sets of ARCBs are proposed for JICA Phase-2, however, twenty sets of 33kV and thirteen sets of 11kV ARCBs are included in the scope of JICA phase-2. Hence the proposed location will be reviewed and evaluated by the responsible person of BPC at the implementation stage, and ARCBs will be installed by the priority order.

Table-N.1 Proposed Number of ARCBs

Donor	Dzongkhag	33kV (sets)	11kV (sets)
JICA	Chukha	5	0
	Haa	4	4
	Pemagatsel	7	0
	Samtse	3	6
	Trongsa	6	4
	Tsirang	8	1
	Wangdue	4	5
	Sub-total	37	20
ADB	Samdrupjongkhar	9	9
	Trashiyangtze	3	0
	Zhemgang	27	0
	Sub-total	39	9
(JICA + ADB)	Total	76	29

ARCB Proposals for 33 kV Gurungtang Feeder II for Existing & ARE Lines (ESD, Phuntsholing)

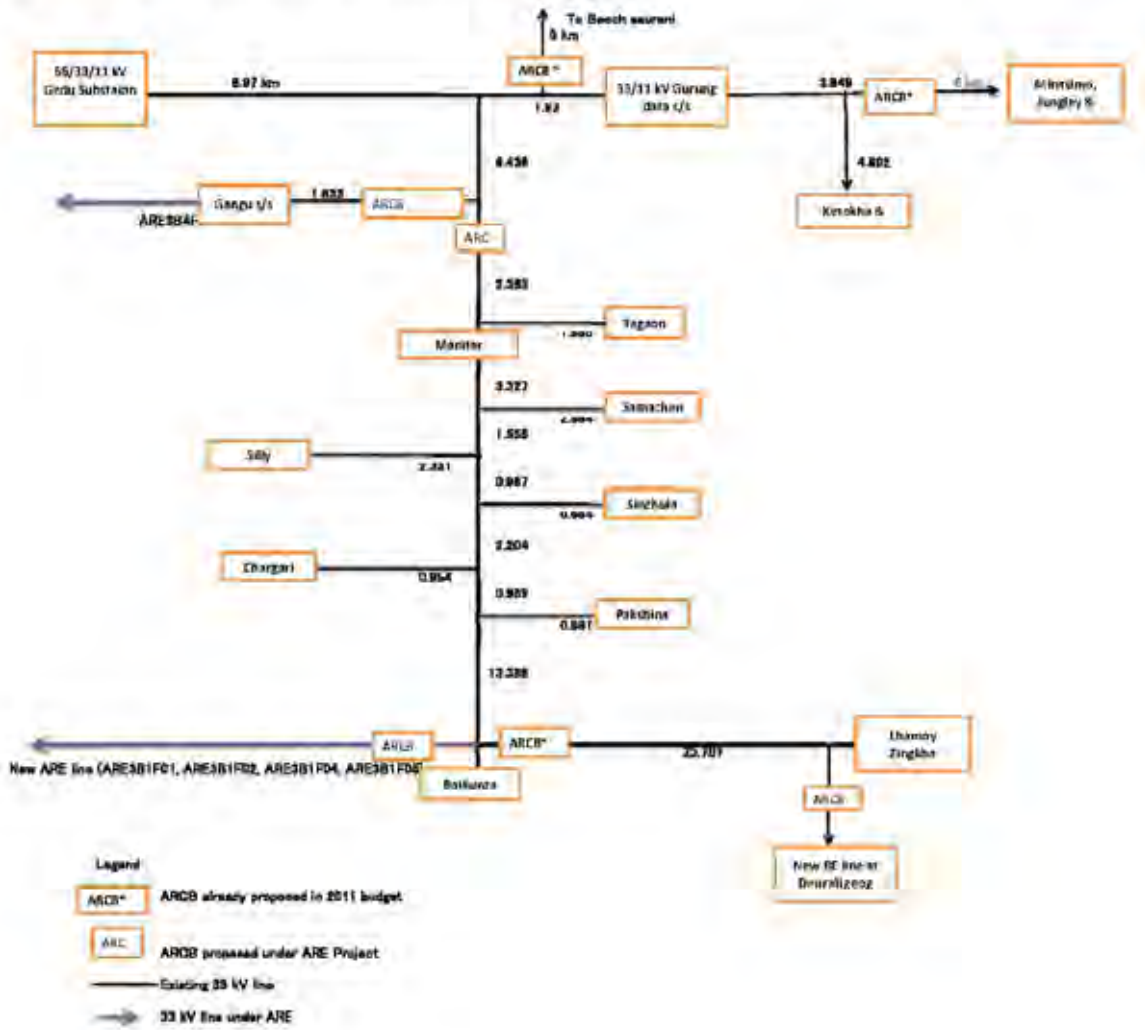


Figure-N.1 (1/2) ARCB Location (Chukha)

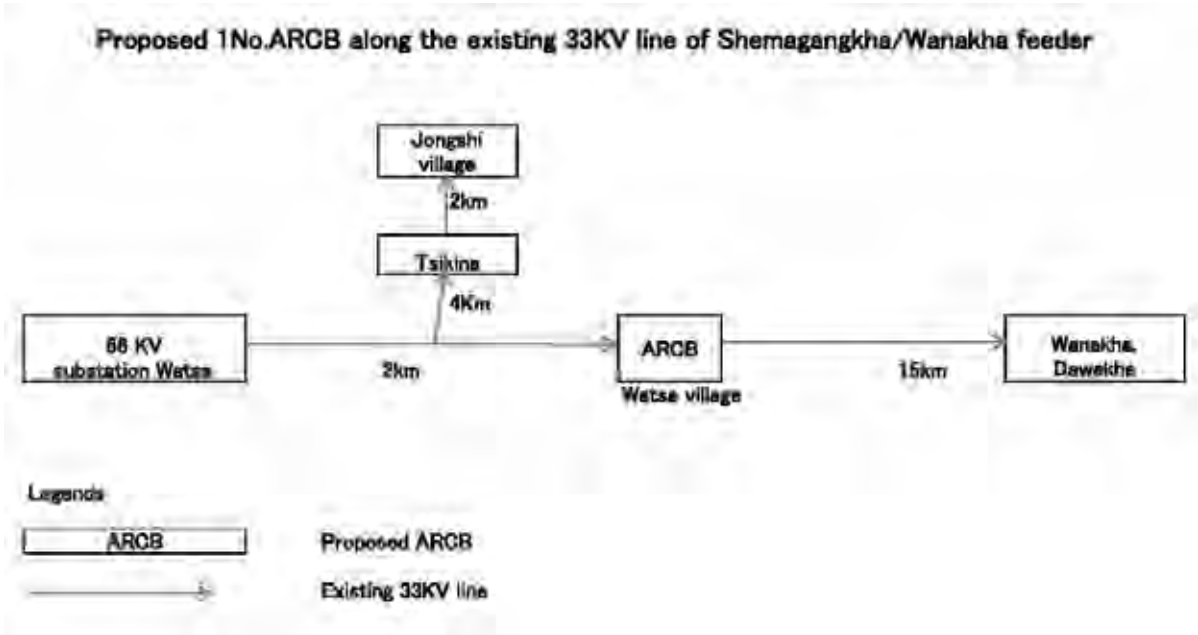


Figure-N.1 (2/2) ARCB Location (Chukha)

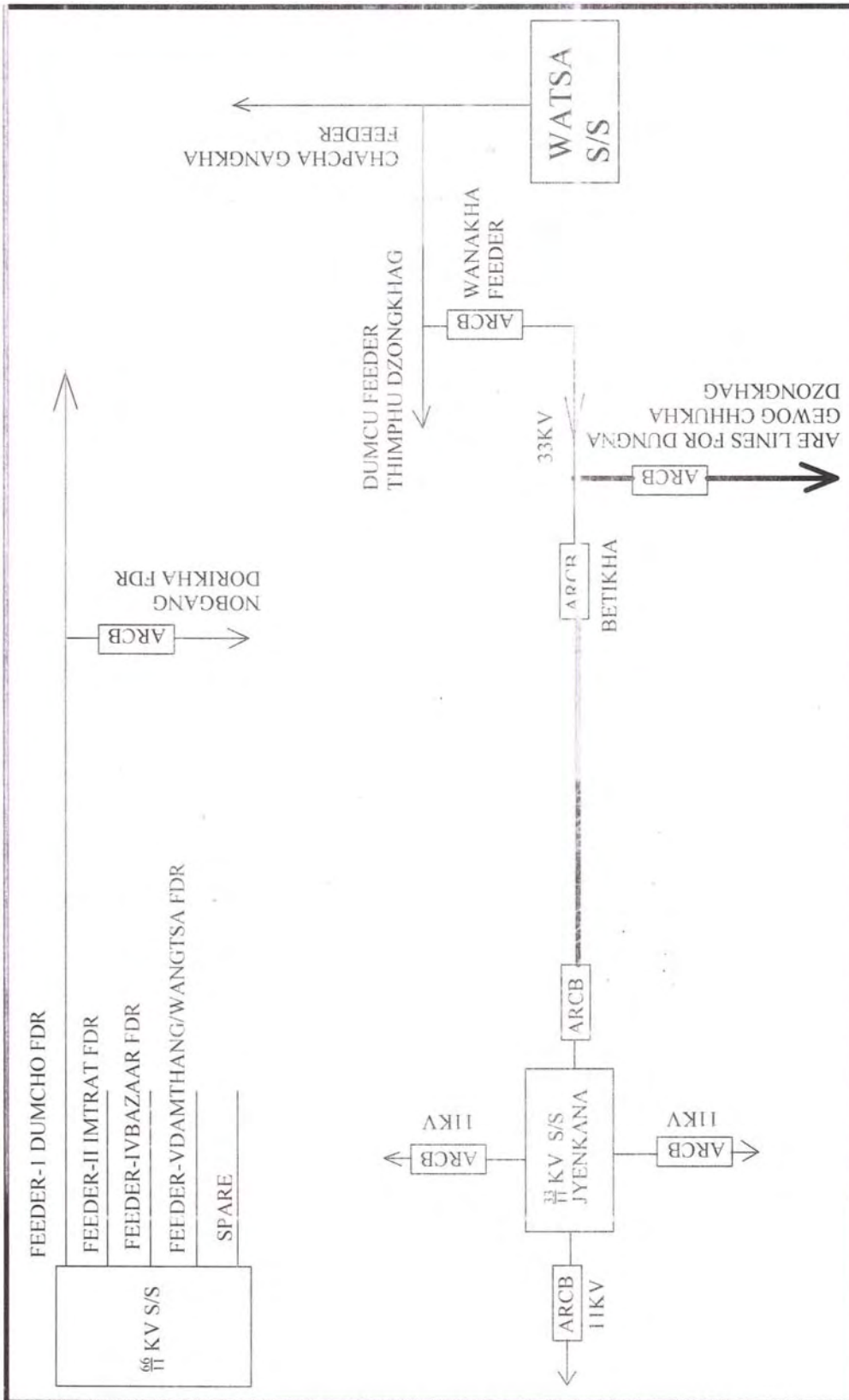


Figure-N.2 ARCB Location (Haa)

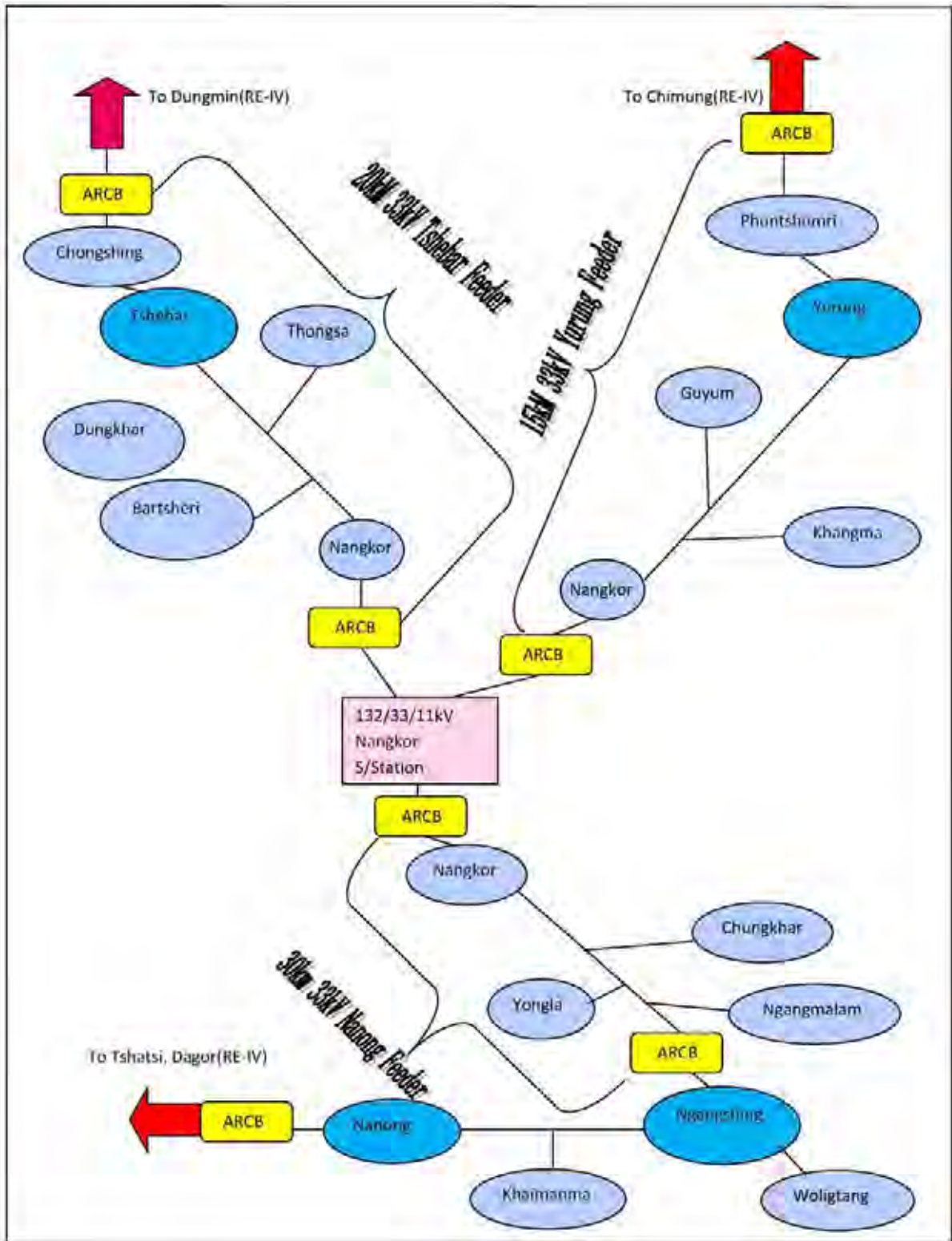


Figure-N.3 ARCB Location (Pemagatse)

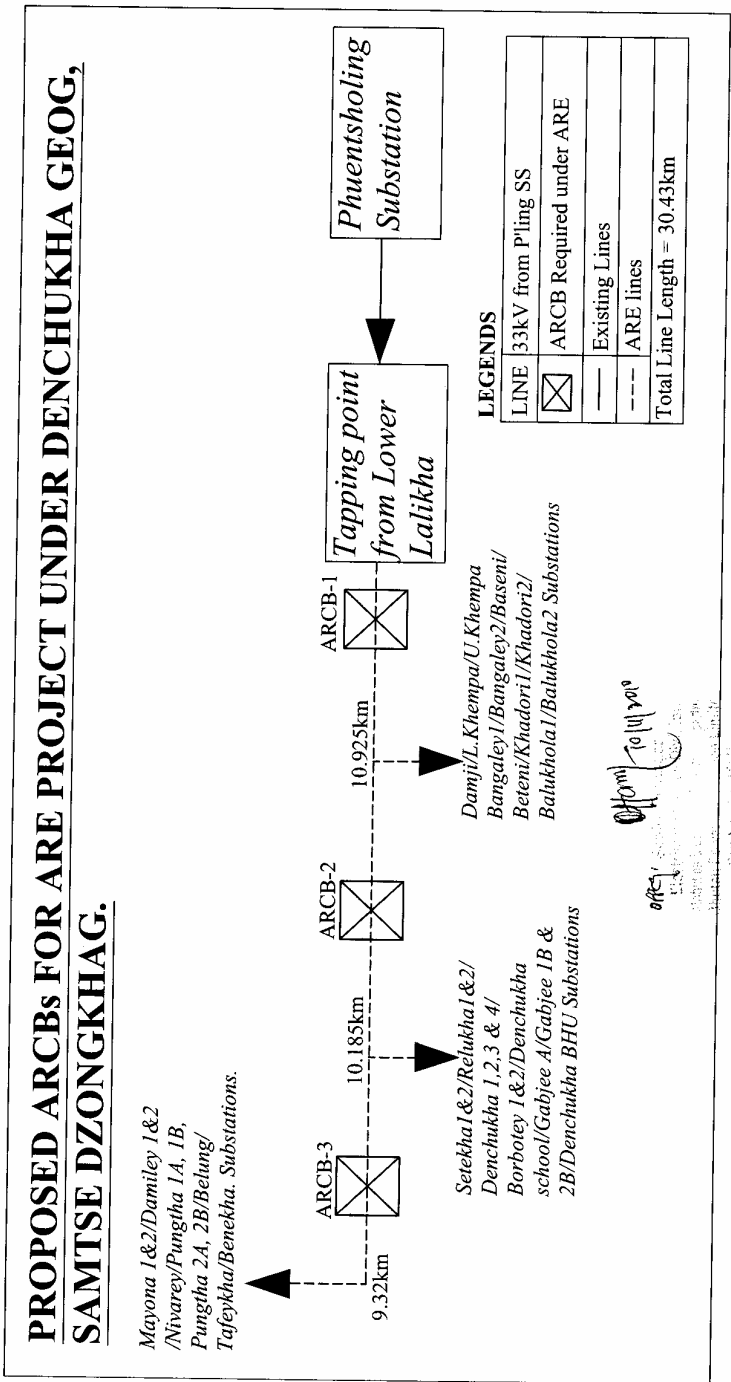


Figure-N.4 (1/3) ARCB Location (Samtse)

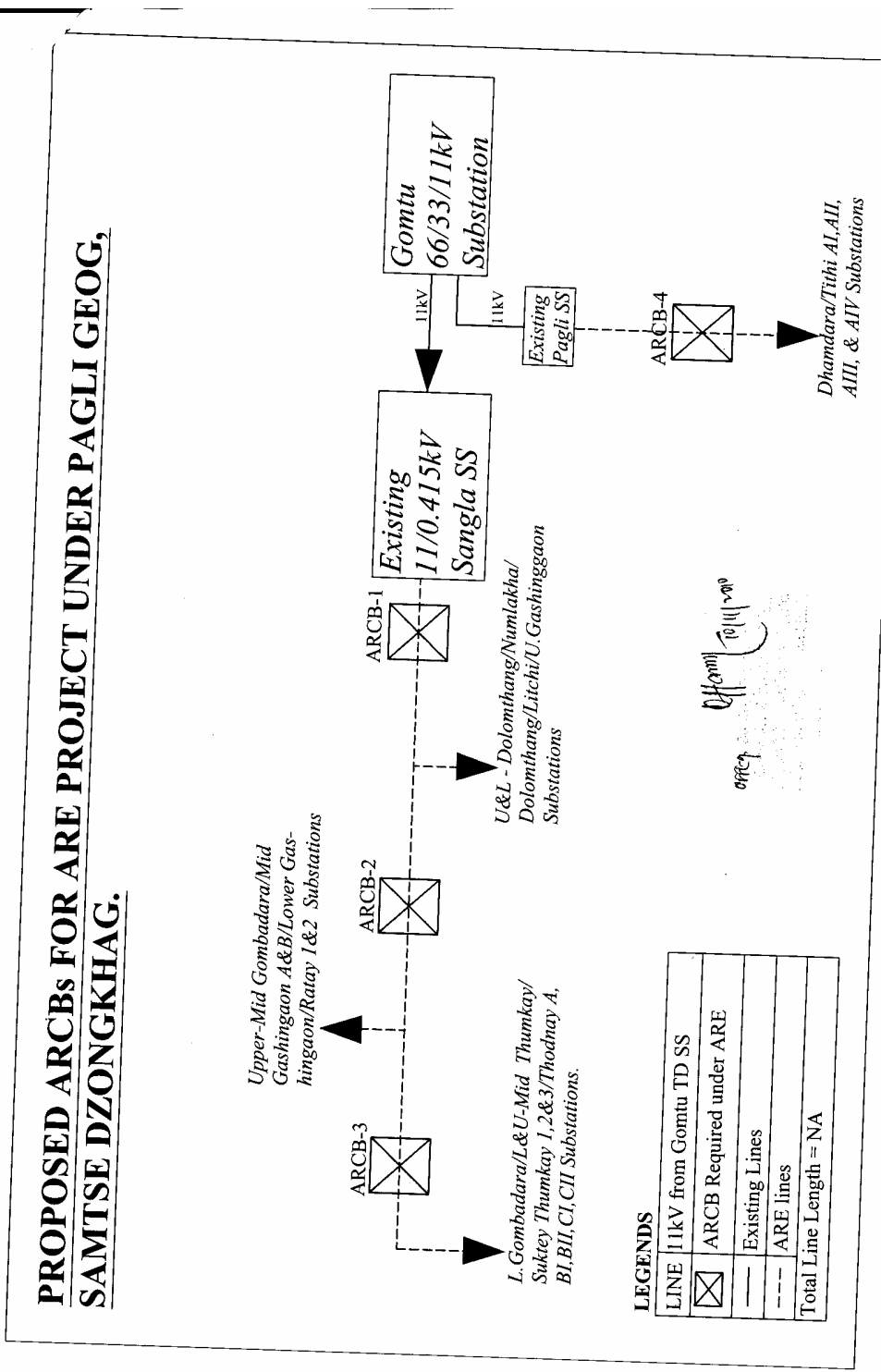


Figure-N.4 (2/3) ARCB Location (Samtse)

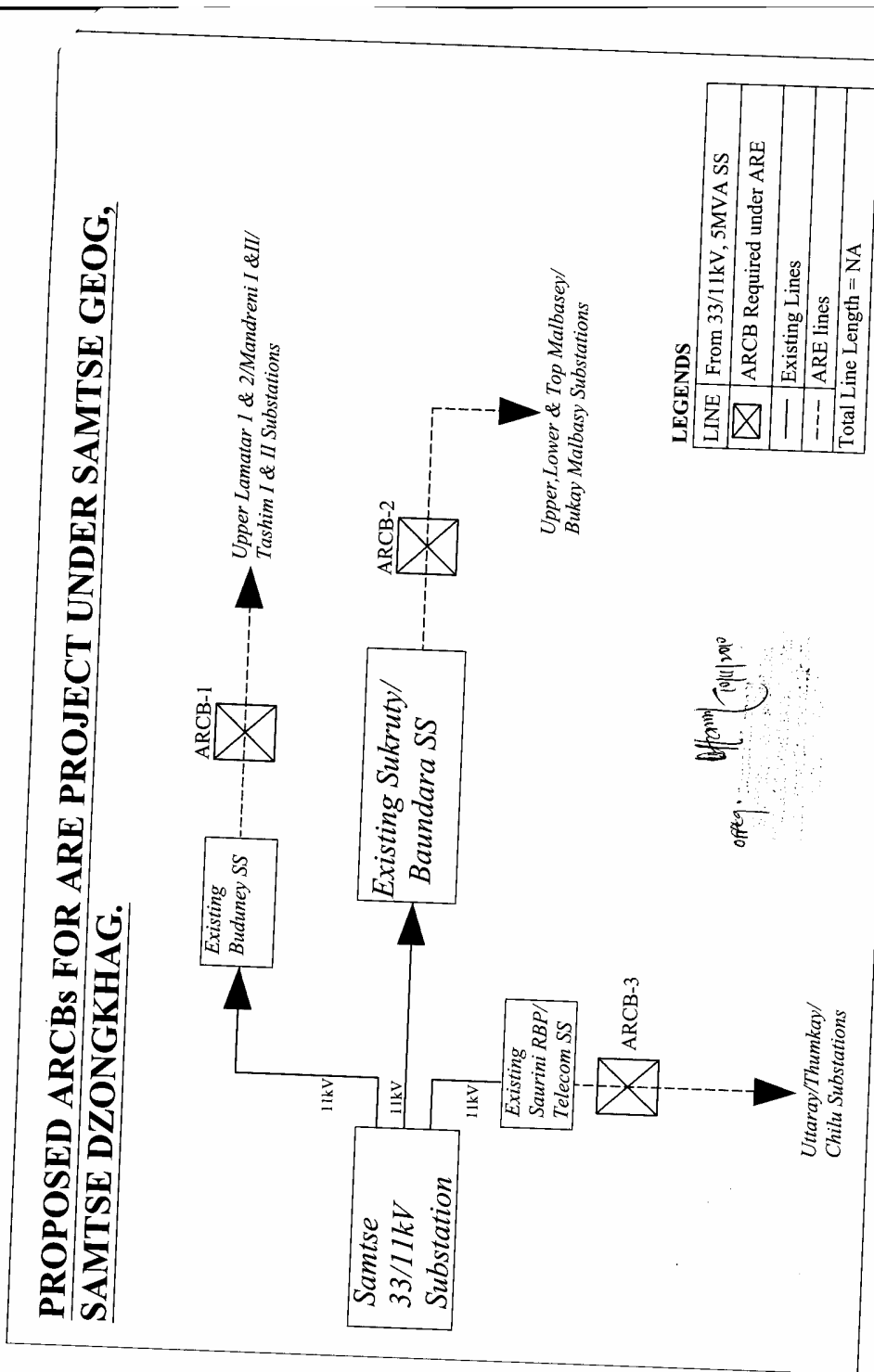


Figure-N.4 (3/3) ARCB Location (Samtse)

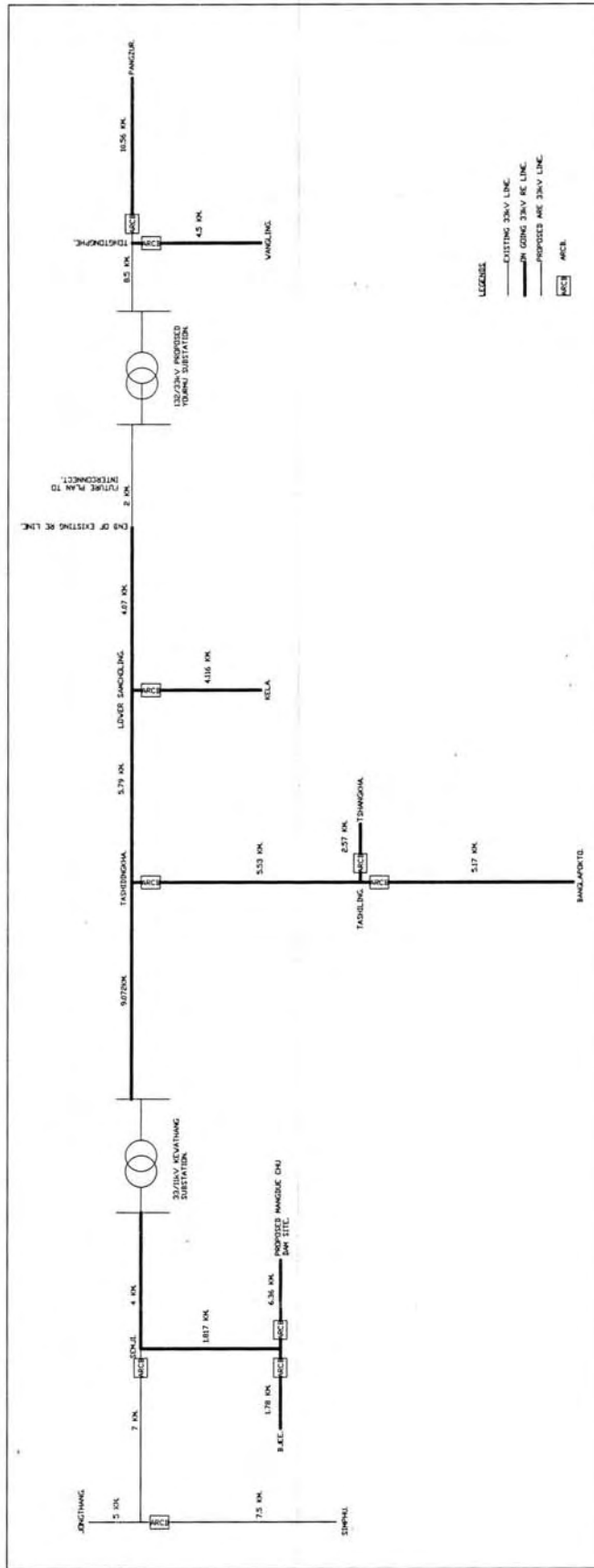


Figure-N.5 ARCB Location (Trongsa)

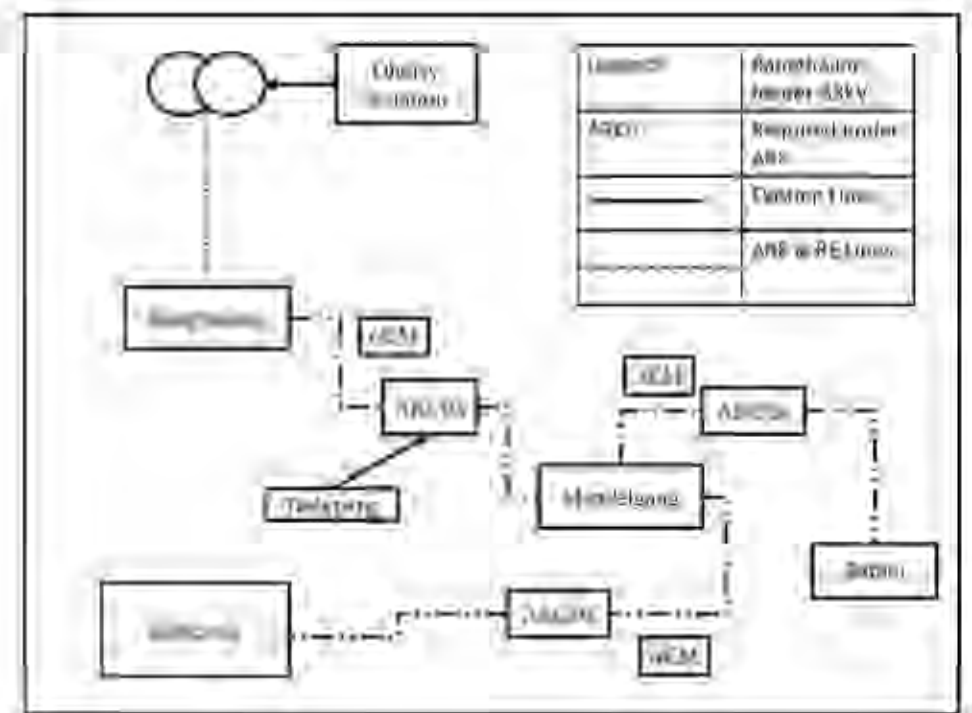
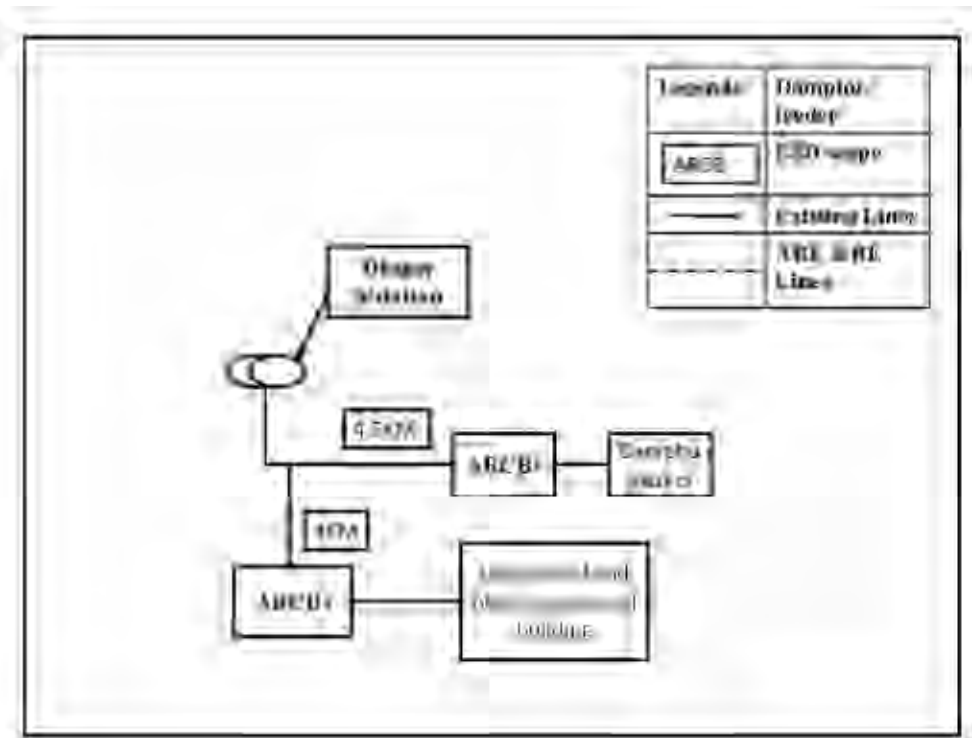


Figure-N.6 (1/3) ARCB Location (Tsirang)

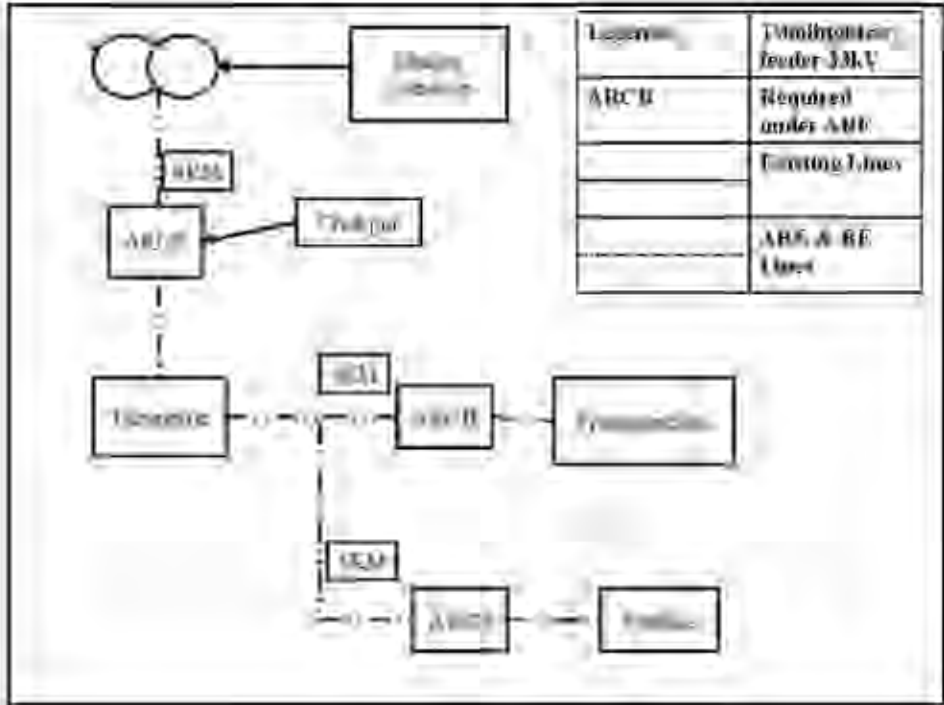
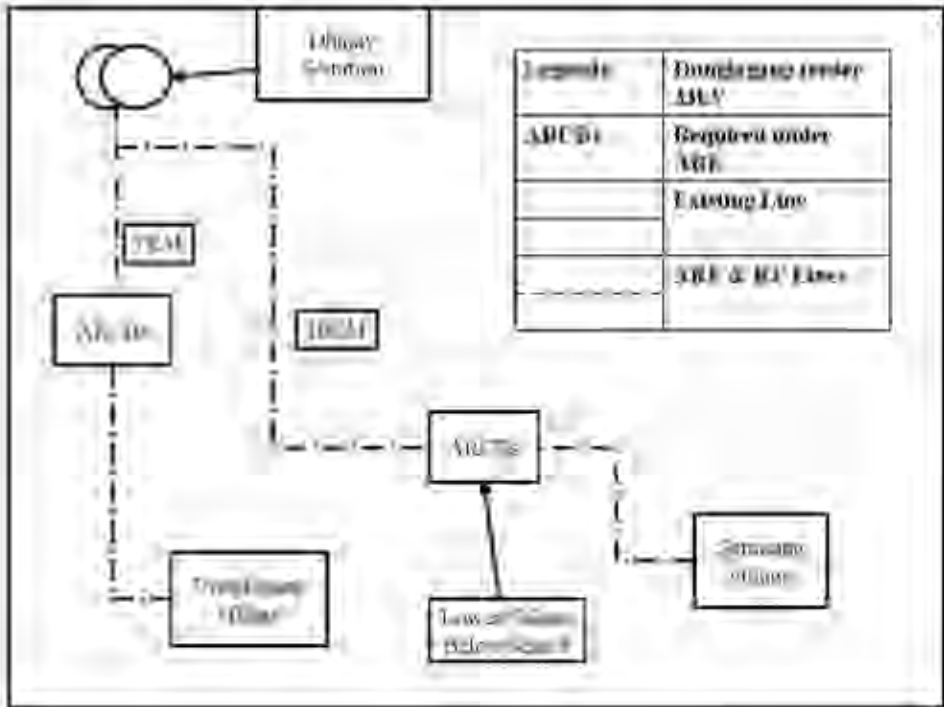


Figure-N.6 (2/3) ARCB Location (Tsirang)

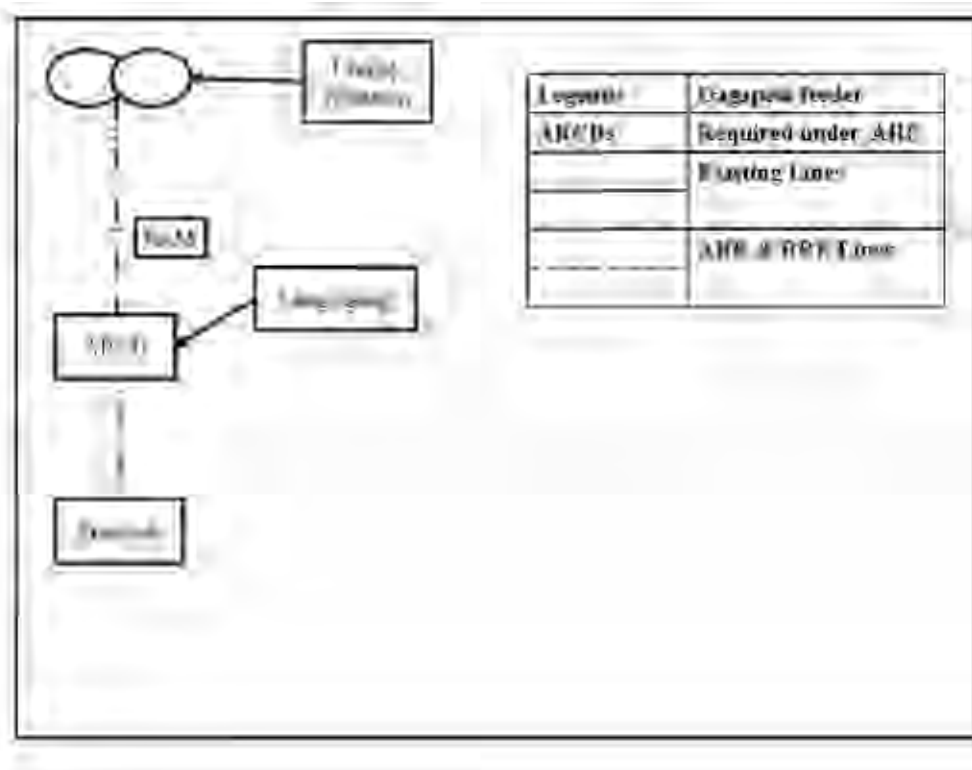


Figure-N.6 (3/3) ARCB Location (Tsirang)

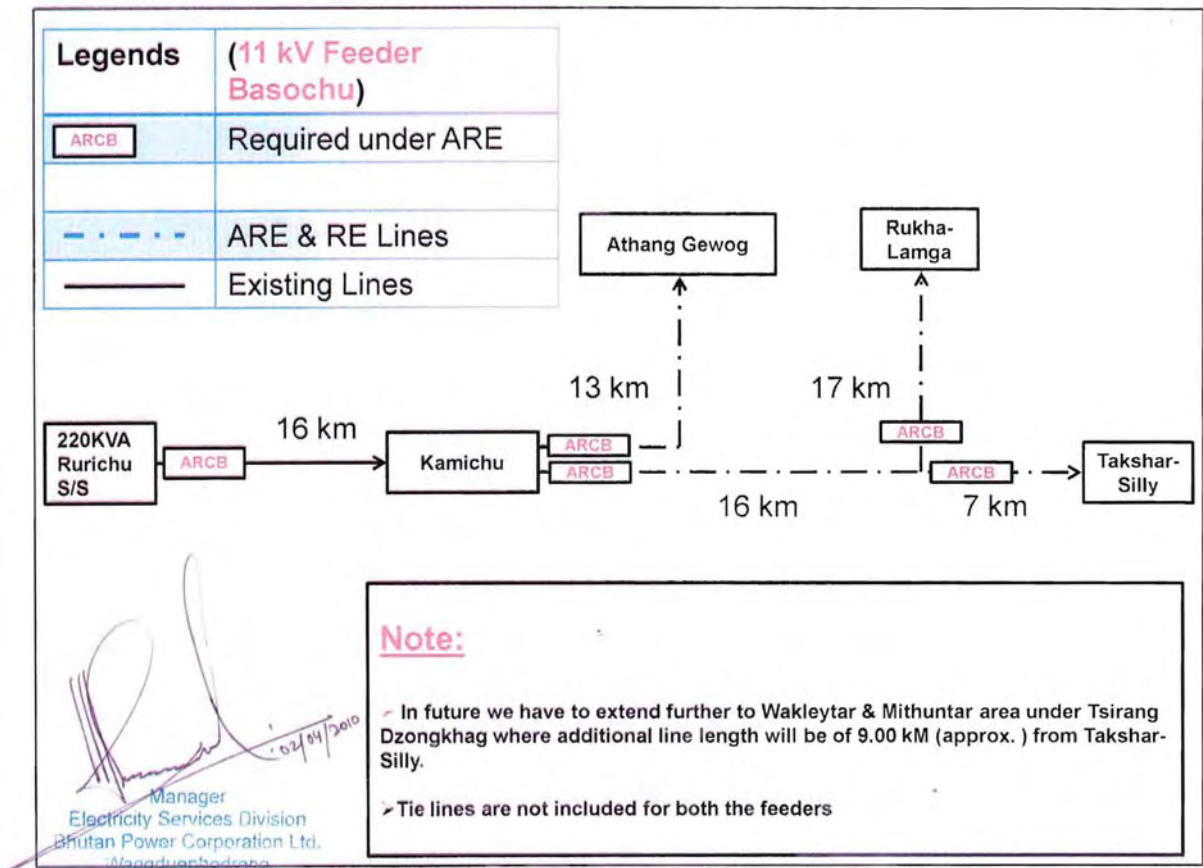


Figure-N.7 (1/2) ARCB Location (Wangduephodrang)

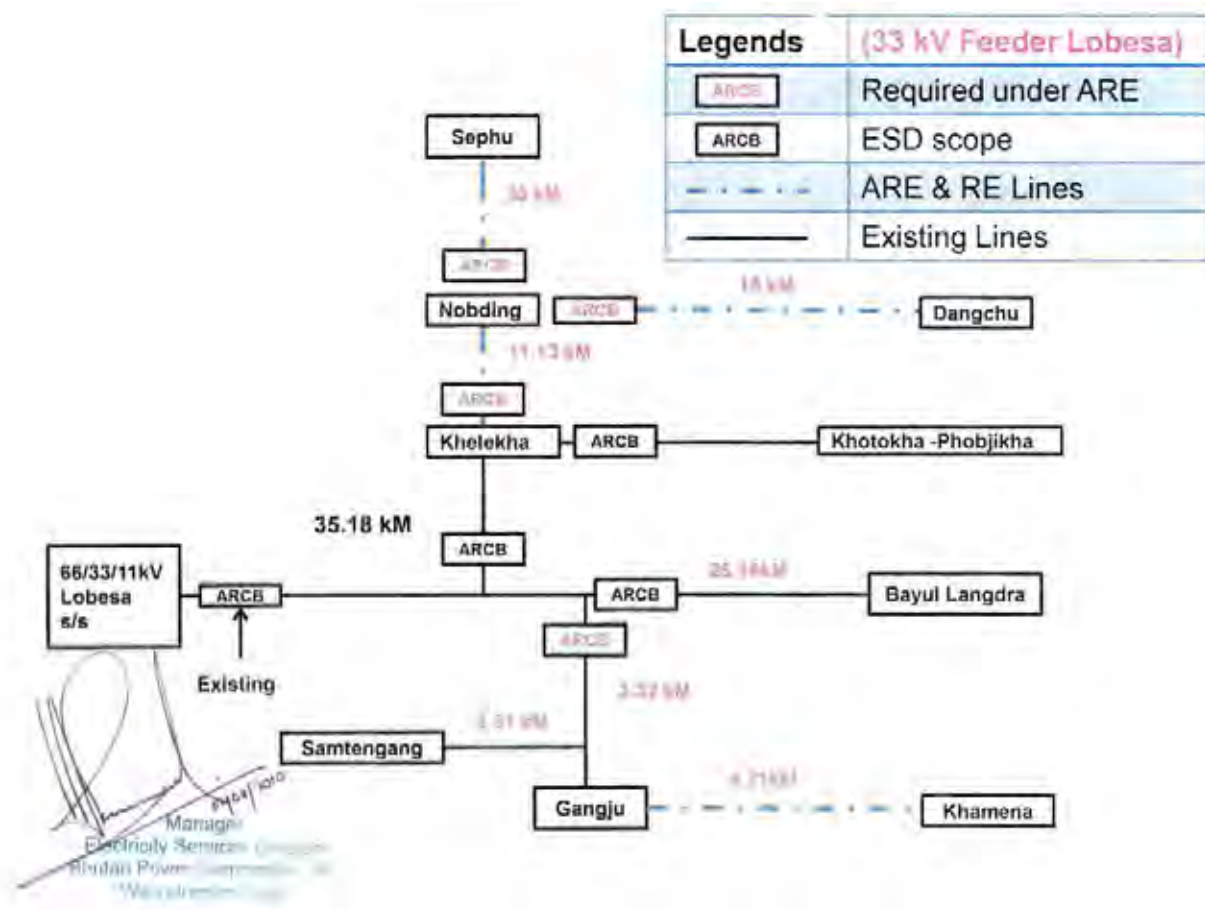


Figure-N.7 (2/2) ARCB Location (Wangduephodrang)

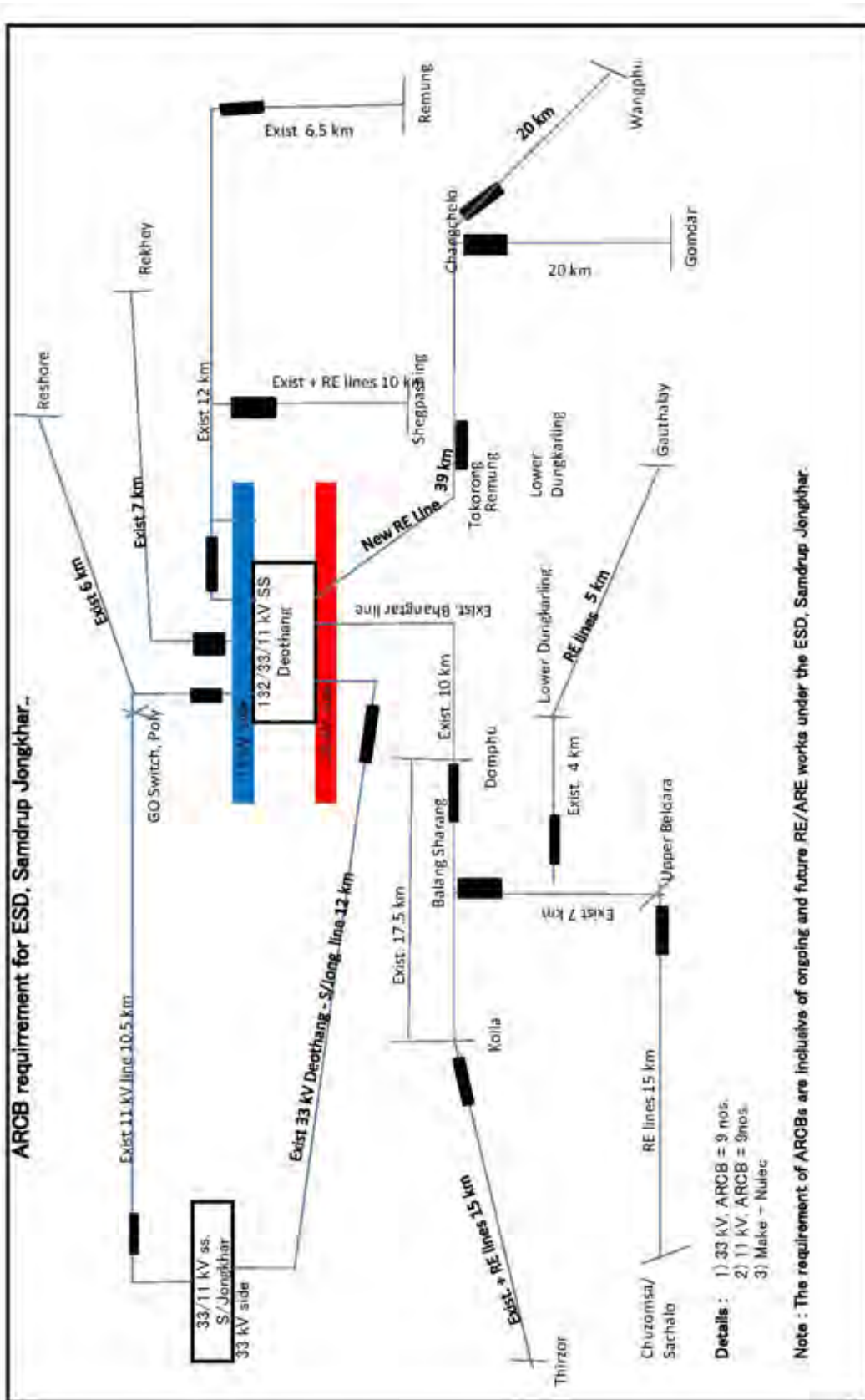


Figure-N.8 ARCB Location (Samdrupjongkhar)

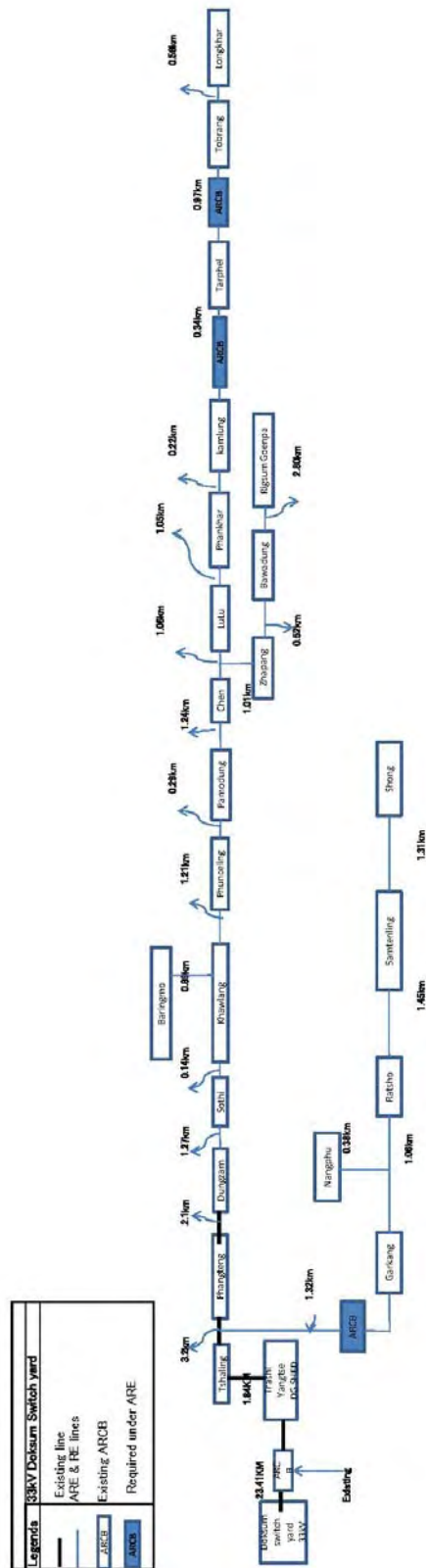


Figure-N.9 ARCB Location (Trashiyangtse)

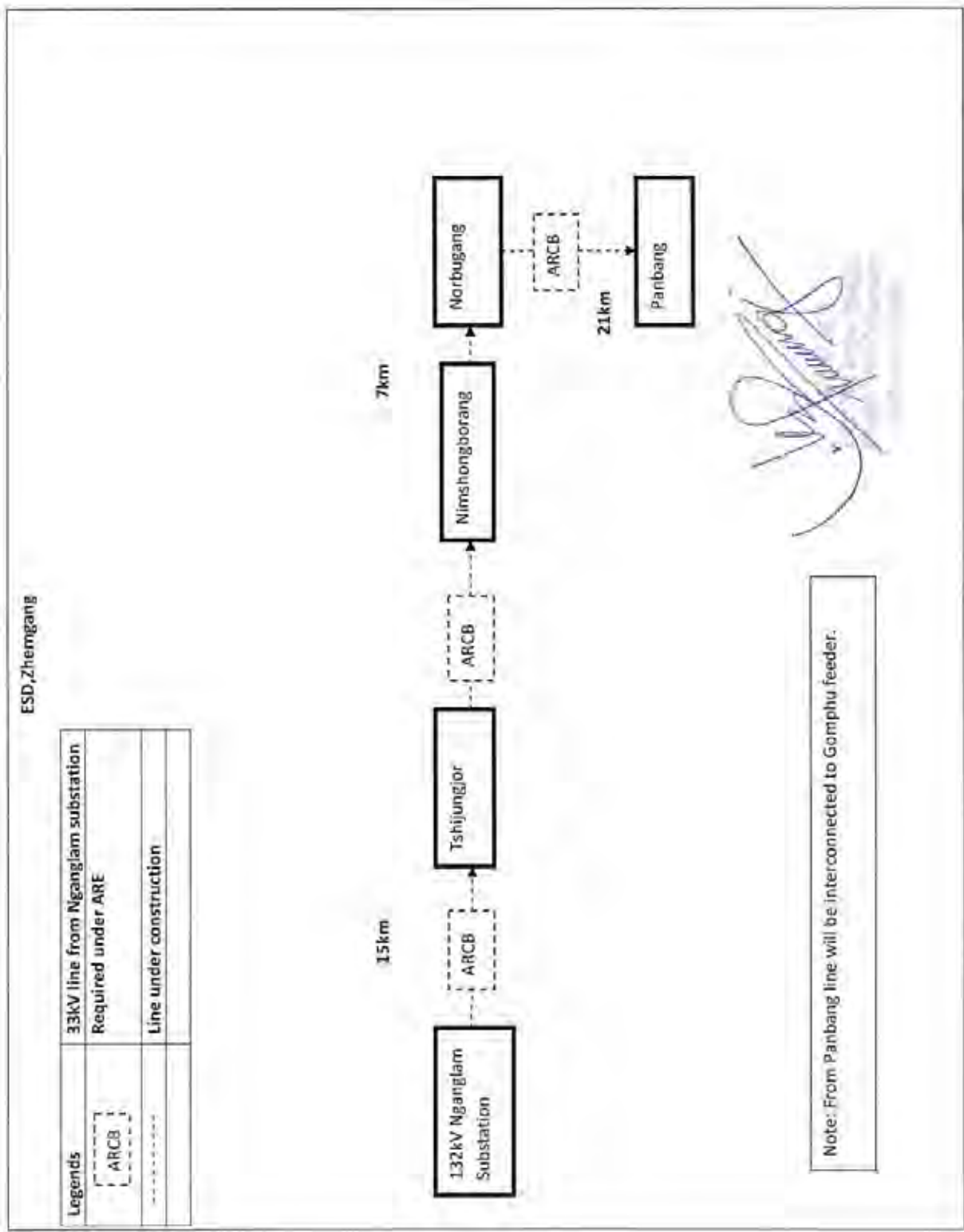


Figure-N.10 (1/4) ARCB Location (Zhemgang)

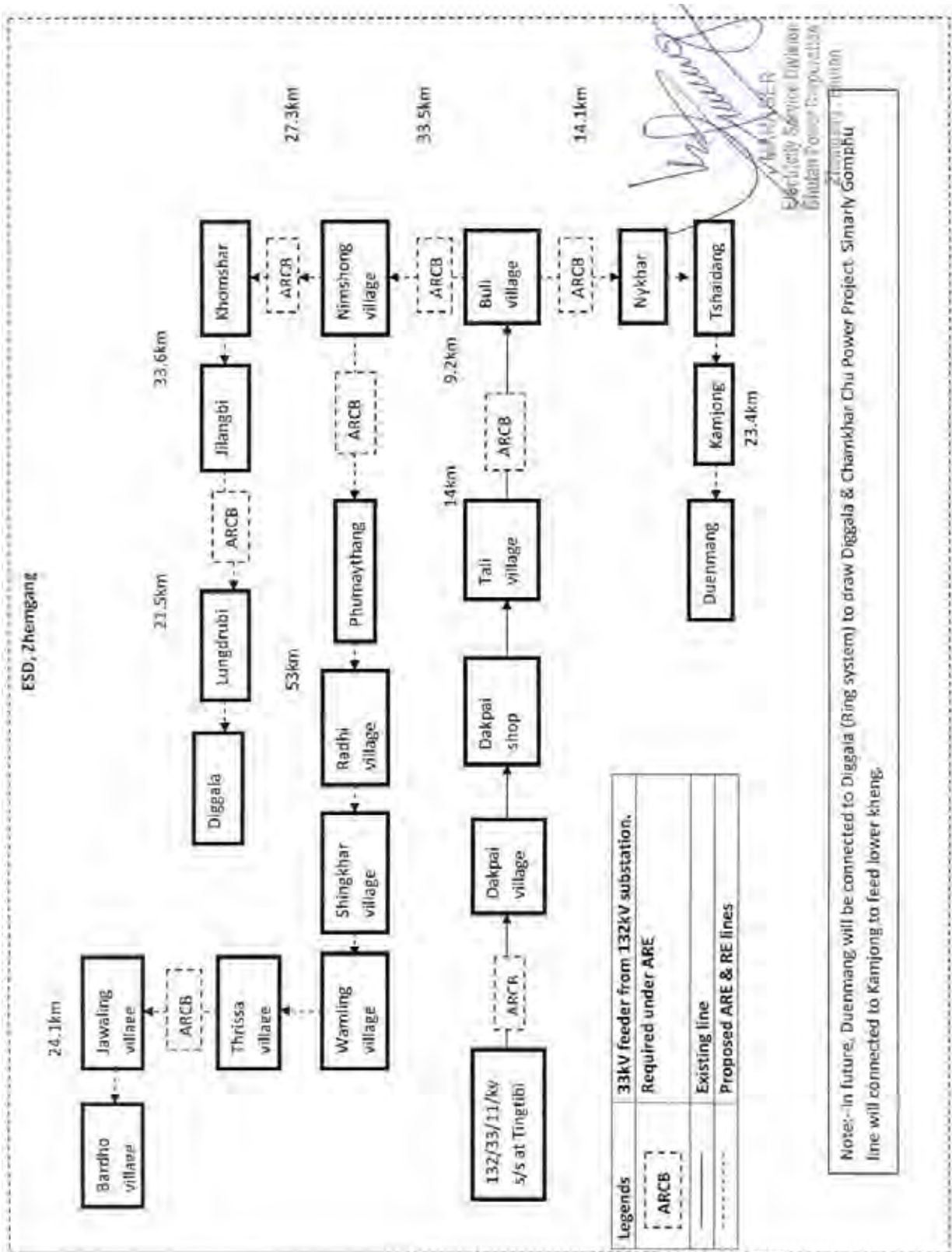


Figure-N.10 (2/4) ARCB Location (Zhemgang)

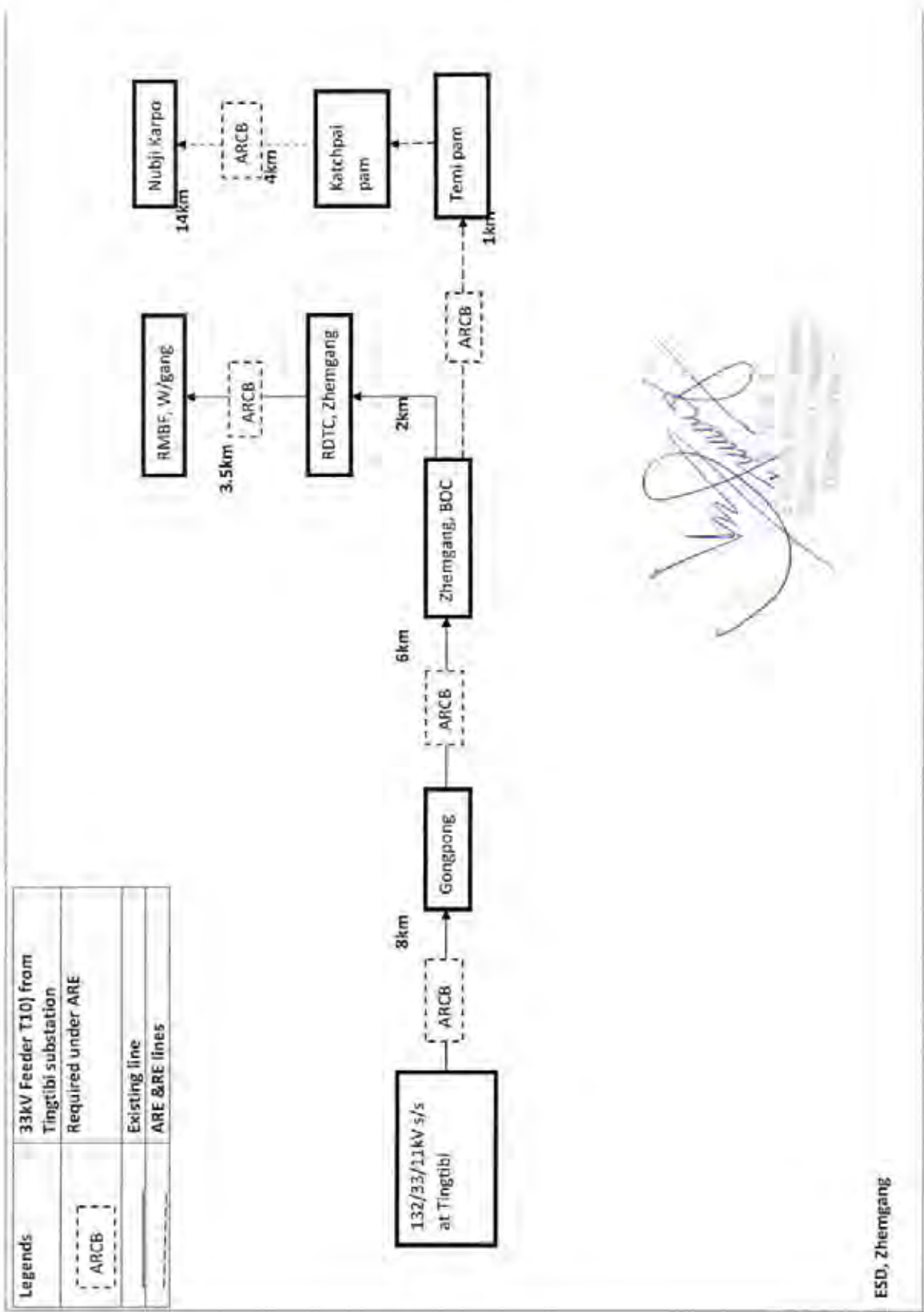


Figure-N.10 (3/4) ARCB Location (Zhemgang)

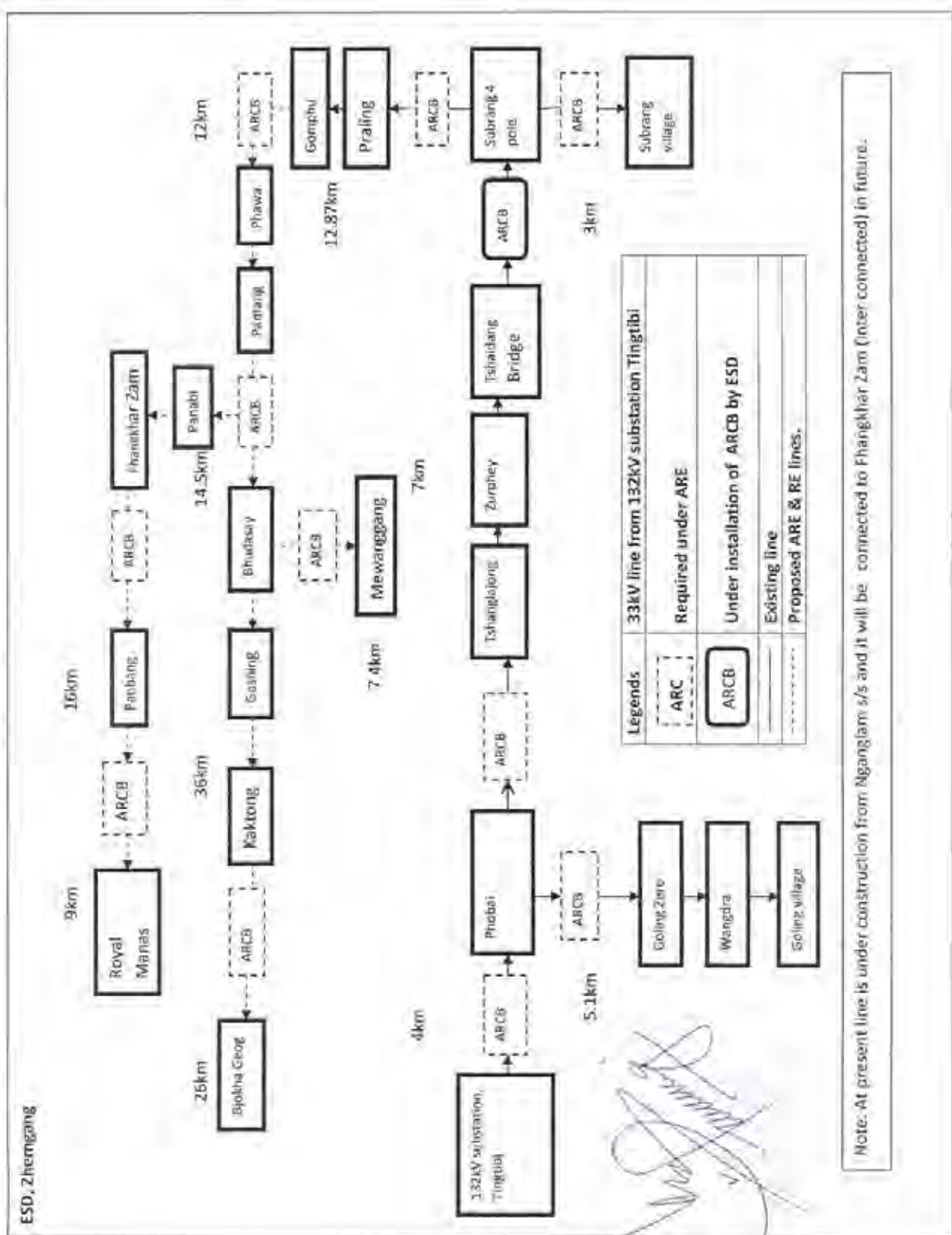


Figure-N.10 (4/4) ARCB Location (Zhemgang)

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-O

**SAMPLE CALCULATION OF POLE
STRENGTH**

APPENDIX-O SAMPLE CALCULATION OF POLE STRENGTH

O.1 General Tublar Poles

The tubular poles have been used for existing MV lines and being used for ADB RE-4 and JICA RE-1 projects. The use of telescopic poles are decided by BPC for ADB RE-5 and JICA RE-2 projects due to the difficulty of transportation to the remote project site. The tubular poles are specified in Indian Standard (IS : 2713 (Part I to III) : 1980) and IS 2713 include sample calculation for the wind load. At the same time, there is no standard to specify the telescopic poles and, hence telescopic poles will be designed and type-tested by each manufacture. The sample calculation for wind load of telescopic poles are executed based on the formula in JEAC-7001-1999 to know the similarity of pole strength with tubular poles.

O.2 Tublar Poles

The following calculation was made in accordance with IS-2713.

Indian Standard

SPECIFICATION FOR TUBULAR STEEL POLES FOR OVERHEAD POWER LINES
(Second Revision)

A-1 Symbols

- A-A = Line of application of resultant of wind loads on wires and pole
 H = Overall height above ground in meters
 l₁, l₂, l₃ = Distance in meters from A-A to bottom of each section
 D₁, D₂, D₃ = Outside diameter of top, middle and bottom sections of pole in centime
 p = Wind pressure on flat surface in newtons per square meter
 h = Height of conductors on cross arm from GL in meters
 n = Number of conductors
 d = Diameter of conductors in centi-meters
 s = Sum of half the span on each side of pole in meters
 P₁ = Equivalent wind load on pole, calculated as acting at A-A.
 P₂ = Equivalent wind load on conductors, calculated as acting at A-A.
 P = Total wind load as acting at A-A = P₁ + P₂ in newtons
 GL = Ground level
 BM = Bending moment

A-2 Wind Load

(1) On wires

$$\text{Wind load on conductors} = \frac{pnsdh}{100} \text{ N,}$$

acting at h metres from GL

$$BM \text{ due to wind load at GL} = \frac{pnsdh}{100} \text{ N.m}$$

$$\text{Equivalent load acting at A-A} = \frac{pnsdh}{100 l_3} \text{ N}$$

Therefore, $P_2 = \frac{pnsdh}{150 l_3} \text{ N}$

(2) On pole

$$\text{Wind load on pole} = \frac{PD_1}{100} [H - (l_3 - l_1)] \frac{3}{8},$$

acting at a distance of $H - \frac{H - (l_3 - l_1)}{2}$ from GL

$$+ \frac{PD_2}{100} (l_2 - l_1) \frac{3}{8}, \text{ acting at a distance of}$$

$$\left[(l_3 - l_2) + \frac{l_2 - l_1}{2} \right] \text{ from GL}$$

$$+ \frac{PD_3}{100} (l_3 - l_2) \frac{3}{8}, \text{ acting at a distance of}$$

$$\frac{l_3 - l_2}{2} \text{ from GL}$$

$$BM \text{ due to wind on pole at GL} =$$

$$\frac{3}{8} p/100 \left[D_1 \{H - (l_3 - l_1)\} \right.$$

$$\left. \left\{ H - \frac{H - (l_3 - l_1)}{2} \right\} + D_2 (l_2 - l_1) \right.$$

$$\left. (l_3 - \frac{1}{2}l_1 - \frac{1}{2}l_2) + D_3 (l_3 - l_2) \frac{l_3 - l_2}{2} \right] \text{ N.m}$$

say WM

$$\text{Equivalent load acting at A-A} = P_1 = \frac{WM}{l_3}$$

So, total load $P = (P_1 + P_2) \text{ N}$

Sample calculation in page-9 of IS : 2713 (Part-1) - 1980

for 410 SP-45 (Table-2 of Part II)

	conductor	
wind pressure on conductor	p2 (N/sqm)	440
wind pressure on poles	p1 (N/sqm)	1,910
number of conductors	n	3
sum of half span	s (m)	100
diameter of conductor (cm)	d (cm)	1.42 (ACSR dog)
Conductor height (from ground)	h (m)	8.1
<hr/>		
Wind load on conductors acting at h meters from GL		1,249.60
Equivalent load acting at A-A (P2 =)		1,219.49
<hr/>		
h3	(m)	5.2
h2	(m)	2.4
h1	(m)	2.4
<hr/>		
D3	(mm)	165.1
D2	(mm)	139.7
D1	(mm)	114.3
<hr/>		
Clipping load (410 SP-45)	(N)	4,040
Planting depth (dp)	(m)	1.6
Overall length (L)	(m)	10.0
From top (df)	(m)	0.3 arm fix point
GL to arm level	(m)	8.1 L-dp-df
H (above ground)	(m)	8.4 L-dp
<hr/>		
l1	(m)	2.1 h1-df
l2	(m)	4.5 h1+h2-df
l3	(m)	8.3 h1+h2+h3-df+0.2
const		150
<hr/>		
Load due to wind on pole after transferring it to act at A-A (P1)		
	1.53	25.146 7.30
	1.53	33.528 5.00
	1.53	62.738 1.90
<hr/>		
Total wind load as acting at A-A = P1 + P2 in newtons	(N)	1,941.16
<hr/>		
Assuming a safety factor of 2.0 based on crippling load according to Indian Standard, the working load of pole selected should not exceed	2,020	> 1,941.16

	Load
	281.62
	257.18
	182.87
P1 =	721.67

Above results shows that tubular pole “type 410-SP-45” is able to use to the span length of 100 meters with dog conductor within safety factor 2.0.

O.3 Telescopic Poles

The following calculation was made in accordance with the formula in JEAC-7001-1999.

The conditions for calculation is the same as previous tubular pole, however the calculation was done to know P (breaking load : it seems to be the same meaning of crippling load in IS-2713).

JEAC-7001-1999 (Power Distribution Code)

JEAC : Japan Electric Association Code

Pole for sample calculation

	length (mm)	Lap length(mm)	Thickness (mm)
Section P1	2,500	300	2.5
Section P2	2,500	350	2.5
Section P3	2,500	400	2.5
Section P3	2,500	450	2.5
Section P5	2,500		

Strength calculation for wind load

$$\frac{(H-0.25)P}{f} \geq \frac{K_1(2D_1+D_0)H^2}{6} + K_2S(\sum dh) \quad \text{---A}$$

where,

H (m)	: length above ground level	9.2
P (kN)	: pole strength (breaking load: crippling load in IS-2713)	
f	: safety factor	2
K1 (Pa)	: wind pressure on support	1,910
K2 (Pa)	: wind prpressure on conductor	440
S (m)	: sum of half the span on each side of pole	100
d (m)	: diameter of conductor	0.01415
h (m)	: height of arm	8.9

L (m)	: pole overall length	11.0
D1(m)	: diameter of pole (top)	0.170
D2(m)	: diameter of pole (bottom)	0.405
Do(m)	: diameter of pole at G.L	0.367
(pole dimension is according to BPC calculation sheet)		
dp (m)	: planting depth	1.8

Conductor	: ACSR dog (diameter = 14.15(mm))	
n	: number of conductor	3

$$\frac{K_1(2D_1+D_0)H^2}{6} = 19,049$$

$$K_2S(\sum dh) = 16,623$$

$$\frac{K_1(2D_1+D_0)H^2}{6} + K_2S(\sum dh) = 35,673$$

Substitute above value to equation A, then P is calculated

$$P = 8,016 \text{ (N)}$$

Accordingly, the reequired atrength of pole is 4.0 (kN)

According to the above calculation, the required strength is 4.0 kN, this means that the comparison should be made with same manner. (In tubular poles, type 410-SP-45 with 2.02 strength is usable within its safety factor.)

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-P

**ECONOMIC INTERNAL RATE OF
RETURN ON INVESTMENT BY
SUBSTATION**

APPENDIX-P ECONOMIC INTERNAL RATE OF RETURN ON INVESTMENT BY SUBSTATION

Trans ID	Dzongkhap	Gewog	Village	Feeder	Sub Feeder	Cost(USD)	Total Investment	IRR
B001	Chhukha	Samphelling	Yusidungkha	ARE301	ARE301F01	7,155	12	1%
B002	Chhukha	Samphelling	Tastima	ARE301	ARE301F02	9,600	5	-1%
B003	Chhukha	Samphelling	Lower Pakchina	ARE301	ARE301F03	3,661	9	-3%
B004	Chhukha	Samphelling	Middle Pakchina	ARE301	ARE301F03	2,212	15	12%
B005	Chhukha	Samphelling	Upper Pakchina	ARE301	ARE301F03	2,295	26	12%
B006	Chhukha	Samphelling	Lower Dungena	ARE301	ARE301F04	4,701	21	4%
B007	Chhukha	Samphelling	Upper Dungena	ARE301	ARE301F04	1,610	36	17%
B008	Chhukha	Dala	Kushridala	ARE302	ARE302F01	4,505	20	-4%
B009	Chhukha	Dala	Rupang	ARE303	ARE303F01	1,960	20	14%
B010	Chhukha	Dala	Middle Dala (Lower Samu)	ARE303	LT extension	2,120	7	13%
B011	Chhukha	Bongso	Lower Phostima	ARE304	ARE304F01	11,619	10	-2%
B012	Chhukha	Bongso	Upper Phostima	ARE304	ARE304F01	2,794	27	9%
B010	Chhukha	Bongso	Laga	ARE305	ARE305F01	8,664	3	0%
B013	Chhukha	Getama	Pangesa II	ARE306	ARE306F01	31,217	10	-5%
B015	Chhukha	Getama	Yetshey	ARE306	ARE306F01	7,090	12	1%
B014	Chhukha	Getama	Pangesa I	ARE306	ARE306F02	3,357	13	7%
B016	Chhukha	Getama	Nobha	ARE306	ARE306F03	10,670	4	-2%
B017	Chhukha	Getama	Chucyel	ARE306	ARE306F03	5,000	16	-4%
B018	Chhukha	Getama	Itafo	ARE306	ARE306F03	2,698	27	10%
B019	Chhukha	Getama	Geog Office	ARE306	ARE306F03	4,383	6	-5%
B020	Chhukha	Getama	Gomgo School	ARE306	ARE306F03	3,186	8	2%
B022	Chhukha	Bongri	Gedapha	ARE307	ARE307F01	7,313	13	1%
B021	Chhukha	Bongso	Zobgoe	Existing 3	ARE307F01	3,083	11	8%
B023	Chhukha	Dungena	Chozhi	ARE308	ARE308F01	10,705	10	-2%
B024	Chhukha	Dungena	Papalug	ARE308	ARE308F01	4,323	18	-5%
B025	Chhukha	Dungena	Saehok Gompa	ARE308	ARE308F02	8,264	3	0%
B026	Chhukha	Dungena	Aringkhā	ARE309	ARE309F01	9,203	5	-1%
B029	Chhukha	Dungena	Relungkha	ARE309	ARE309F01	5,771	6	-2%
B027	Chhukha	Dungena	Hafama	ARE309	ARE309F02	8,000	4	0%
B028	Chhukha	Dungena	Khumri	ARE309	ARE309F02	3,723	8	6%
B030	Chhukha	Chapcho	Lomzhi/Mendur/ Jongneki	ARE3010	ARE3010F01	13,259	5	-2%
B031	Chhukha	Manapkha	Brolykha	ARE3011	ARE3011F01	7,407	18	1%
B032	Chhukha	Lokelima	Dorlakra	ARE3012	ARE3012F01	13,888	4	-3%
B033	Chhukha	Lokelima	Lassap	ARE3013	ARE3013F01	9,862	7	-1%
B034	Chhukha	Lokelima	Nerichu	ARE3013	ARE3013F02	5,529	8	7%
B035	Chhukha	Lokelima	Lorma	ARE3013	ARE3013F02	6,545	5	-2%
B036	Chhukha	Lokelima	Japnar	ARE3013	ARE3013F02	5,825	5	-2%
B037	Chhukha	Lokelima	Omdo	ARE3014	ARE3014F01	16,254	2	-4%
B038	Chhukha	Geling	Posenkha	ARE3015	ARE3015F01	8,359	8	0%
B039	Chhukha	Geling	Sedokha	ARE3015	ARE3015F01	8,002	8	-2%
B040	Chhukha	Geling	Dup	ARE3015	ARE3015F01	4,707	13	-4%
B041	Chhukha	Geling	Okaku	ARE3015	ARE3015F01	6,455	17	-2%
B042	Chhukha	Geling	Tsendugang	ARE3015	ARE3015F01	16,452	10	-1%
B043	Chhukha	Geling	Naukha Gomi	ARE3016	ARE3016F01	5,928	15	2%
B044	Chhukha	Geling	Naukha Wom	ARE3016	ARE3016F01	2,258	9	12%
B045	Chhukha	Geling	Gelungkha	ARE3016	ARE3016F02	4,280	15	5%
B047	Chhukha	Geling	Geling Goepra	ARE3016	ARE3016F02	3,138	14	2%
B046	Chhukha	Geling	Nabji	ARE3016	ARE3016F03	6,576	9	-2%
B048	Chhukha	Pfuntsoling	Aldangra	ARE3017	ARE3017F01	8,364	9	10%
B049	Chhukha	Darji	Pepratlung	ARE3018	ARE3018F01	14,731	6	-3%
B050	Chhukha	Darji	Atay	ARE3019	ARE3019F01	7,630	7	1%
B051	Chhukha	Getama	Tustingang	ARE3020	ARE3020F01	8,098	10	0%
B052	Chhukha	Getama	Dron	ARE3020	ARE3020F01	6,349	16	-2%
B053	Chhukha	Getama	Phansa	ARE3021	ARE3021F01	4,921	13	-4%

The Preparatory Survey on Rural Electrification Project (Phase-2) in Kingdom of Bhutan

Trans_ID	Dzongkhag	Gewog	Village	Feeder	Sub Feeder	Cost/HH	Total Customer	EIRR
B054	Chhukha	Bongo	Labana	ARE3B22	ARE3B22F01	9,092	9	-1%
B055	Chhukha	Balujhora/ Sam	Teeling	ARE3B23	ARE3B23F01	15,235	3	-4%
C002	Dagana	Geserling	Geserling School	ARE3C1	ARE3C1F01	1,319	26	21%
C003	Dagana	Geserling	Geserling Bazar	ARE3C1	ARE3C1F02	2,258	28	12%
C004	Dagana	Geserling	Gangjab/Sano Dapper	ARE3C1	ARE3C1F02	8,681	9	0%
C005	Dagana	Geserling	Samtengang	ARE3C1	ARE3C1F03	6,877	24	1%
C011	Dagana	Dorona	Mommeythang	ARE3C1	ARE3C1F03	7,333	10	1%
C012	Dagana	Dorona	Chhukam	ARE3C1	ARE3C1F03	5,263	10	3%
C013	Dagana	Dorona	Lalai Dapper	ARE3C1	ARE3C1F03	4,806	10	4%
C006	Dagana	Geserling	Tanju	ARE3C1	ARE3C1F04	4,890	16	4%
C007	Dagana	Kalidzingkha	Ayetoshel	ARE3C1	ARE3C1F04	7,598	17	1%
C008	Dagana	Kalidzingkha	Namjey Gang	ARE3C1	ARE3C1F04	3,390	16	7%
C009	Dagana	Kalidzingkha	Buchunag	ARE3C1	ARE3C1F04	2,943	23	9%
C010	Dagana	Kalidzingkha	Bartshap	ARE3C1	ARE3C1F04	3,544	22	7%
C014	Dagana	Dorona	Nimtola lower village	ARE3C1	ARE3C1F05	5,860	19	2%
C015	Dagana	Dorona	Nimtola upper village	ARE3C1	ARE3C1F05	3,312	13	7%
C016	Dagana	Dorona	Banglachu	ARE3C1	ARE3C1F05	7,682	13	0%
C017	Dagana	Dorona	Sano Dorona	ARE3C1	ARE3C1F05	10,025	14	-1%
C019	Dagana	Dorona	Balukhop	ARE3C1	ARE3C1F06	11,552	7	-2%
C020	Dagana	Dorona	Tshalabji	ARE3C1	ARE3C1F06	6,830	12	1%
C021	Dagana	Dorona	Susithang	ARE3C1	ARE3C1F06	13,245	7	-3%
C018	Dagana	Dorona	Thulo Dorona	ARE3C1	ARE3C1F07	7,137	11	1%
C022	Dagana	Tseza	Bazingkha	ARE3C3	ARE3C3F01	5,030	13	4%
C023	Dagana	Tsangkha	Budaychu	ARE3C2	ARE3C2F01	3,708	25	6%
CL01	Dagana	Tseza	Hobathangkha	LT Extensi	ARE3C2F01	4,030	5	5%
C024	Dagana	Deorali	Deorali A	ARE3C4	ARE3C4F01	9,350	11	-1%
C025	Dagana	Deorali	Deorali B	ARE3C4	ARE3C4F01	3,253	8	7%
C026	Dagana	Deorali	Bashney	ARE3C4	ARE3C4F01	16,705	4	-4%
C027	Dagana	Tseza	Tongsho	ARE3C5	ARE3C5F01	2,852	13	9%
C028	Dagana	Tseza	Khenju	ARE3C5	ARE3C5F01	7,858	6	0%
C029	Dagana	Tseza	Peling	ARE3C5	ARE3C5F01	6,254	7	2%
C030	Dagana	Dorona	Pickto	ARE3C6	ARE3C6F01	15,286	4	-4%
C031	Dagana	Kana	Benji	ARE3C7	ARE3C7F01	0	7	-2%
C032	Dagana	Tshangkha	Babeythang	ARE3C8	ARE3C8F01	0	6	-2%
E001	Haa	Gakiling	Garim	ARE3E1	ARE3E1F01	24,800	3	-6%
E002	Haa	Gakiling	Sayizong	ARE3E1	ARE3E1F01	26,072	3	-6%
E003	Haa	Gakiling	Gesakha	ARE3E1	ARE3E1F02	11,350	4	-2%
E004	Haa	Sombaykha	Yaba	ARE3E3	ARE3E3F01	12,449	11	-2%
E005	Haa	Sombaykha	Tashigang_A	ARE3E3	ARE3E3F01	9,942	15	-1%
E006	Haa	Sombaykha	Tashigang_B	ARE3E3	ARE3E3F02	3,715	17	6%
E007	Haa	Sombaykha	Tiema	ARE3E3	ARE3E3F02	9,376	8	-1%
E011	Haa	Sombaykha	Shama	ARE3E3	ARE3E3F03	6,226	10	2%
E008	Haa	Sombaykha	Shaba	ARE3E2	ARE3E2F01	10,589	12	-2%
E009	Haa	Sombaykha	Anakhan	ARE3E2	ARE3E2F02	8,074	7	0%
E010	Haa	Sombaykha	Shabje	ARE3E2	ARE3E2F02	5,198	9	3%
H003	Paro	Lungnyi	Kila Goenpa	ARE1H2	ARE1H2F01	3,146	31	8%
H004	Paro	Doga	Tenchekha	ARE3H3	ARE3H3F01	3,320	10	7%
HL01	Paro	Doga	Drolaykha Lhaxhang	LV Extenti	ARE3H3F01	4,299	2	5%
I001	Pemagatshe	Dechhenling	Kulamanti	ARE3I1	ARE3I1F01	3,053	19	8%
I002	Pemagatshe	Dechhenling	Laysheri	ARE3I2	ARE3I2F01	3,038	14	8%
I003	Pemagatshe	Dechhenling	Lower Kholomri	ARE3I2	ARE3I2F02	4,188	15	5%
I005	Pemagatshe	Dechhenling	Dungchilo	ARE3I2	ARE3I2F02	3,390	22	7%
I006	Pemagatshe	Dechhenling	Dungchilo Pam	ARE3I2	ARE3I2F02	3,673	17	6%
I004	Pemagatshe	Dechhenling	Upper kholomri	ARE3I2	ARE3I2F03	2,152	19	12%

Appendix-P Economic Internal Rate of Return on Investment by Substation

Trans_ID	Dzongkhag	Gewog	Village	Feeder	Sub Feeder	Cost(TH)	Total Customer	EIRR
I007	Pemagatshé	Dungmn	Gompuen (Tome)	ARE3I3	ARE3I3F01	3,059	13	8%
I008	Pemagatshé	Dungmn	Tome	ARE3I3	ARE3I3F01	6,163	9	2%
I009	Pemagatshé	Dungmn	Wongborang	ARE3I3	ARE3I3F01	4,803	11	4%
I010	Pemagatshé	Dungmn	Nome	ARE3I3	ARE3I3F02	6,477	8	2%
I011	Pemagatshé	Zobel	Thokenang	ARE3I4	ARE3I4F01	11,650	8	-2%
I101	Pemagatshé	Chomshing	Thongsa jug	ARE3I4	ARE3I4F01	4,047	2	5%
I102	Pemagatshé	Chomshing	Lektekborang	ARE3I4	ARE3I4F01	3,259	6	8%
J001	Punakha	Gumá	Bhochung Karn	ARE3J1	ARE3J1F01	5,444	12	3%
J002	Punakha	Tewang	Tamdamchhu A	ARE3J2	ARE3J2F01	6,414	11	2%
J003	Punakha	Tewang	Tamdamchhu B	ARE3J2	ARE3J2F01	2,169	13	12%
J004	Punakha	Tewang	Tamina	ARE3J2	ARE3J2F01	4,495	7	4%
J005	Punakha	Tewang	Kawma	ARE3J2	ARE3J2F01	7,749	6	7%
L002	Samtse	Samtse	Mandru A I	ARE1L1	ARE1L1F01	4,712	13	4%
L001	Samtse	Samtse	Mandru A II	ARE1L1	ARE1L1F01	3,243	14	8%
L004	Samtse	Samtse	Tashu I	ARE1L1	ARE1L1F03	3,083	14	8%
L005	Samtse	Samtse	Tashu II	ARE1L1	ARE1L1F02	5,378	10	3%
L007	Samtse	Samtse	Utaray	ARE1L2	ARE1L2F02	3,415	13	7%
L008	Samtse	Samtse	Thunkey	ARE1L2	ARE1L2F01	8,264	9	0%
L009	Samtse	Samtse	Chiru	ARE1L2	ARE1L2F01	5,980	13	2%
L015	Samtse	Samtse	Chagay Sangla	ARE1L5	ARE1L5F01	10,737	4	-2%
L016	Samtse	Pagli	Upper Dolamthang	ARE1L6	ARE1L6F01	2,996	15	8%
L048	Samtse	Pagli	Nunlakha	ARE1L6	ARE1L6F01	15,528	4	-4%
L017	Samtse	Pagli	Lower Dolamthang	ARE1L6	ARE1L6F02	2,357	17	11%
L018	Samtse	Pagli	Dolamthang	ARE1L6	ARE1L6F03	4,198	10	5%
L019	Samtse	Pagli	Lachi	ARE1L6	ARE1L6F04	3,828	13	6%
L020	Samtse	Pagli	Upper Gashinggaon	ARE1L6	ARE1L6F05	5,152	9	3%
L025	Samtse	Pagli	Mid Gombudara	ARE1L6	ARE1L6F05	3,756	9	6%
L026	Samtse	Pagli	Lower Gombudara	ARE1L6	ARE1L6F05	2,495	19	10%
L029	Samtse	Pagli	Upper Thunkey	ARE1L6	ARE1L6F05	5,788	13	2%
L021	Samtse	Pagli	Mid Gashinggaon A	ARE1L6	ARE1L6F05	2,385	18	12%
L022	Samtse	Pagli	Mid Gashinggaon B	ARE1L6	ARE1L6F06	2,265	22	12%
L023	Samtse	Pagli	Lower Gashinggaon	ARE1L6	ARE1L6F06	3,488	9	7%
L024	Samtse	Pagli	Upper Gombudara	ARE1L6	ARE1L6F07	3,056	11	8%
L027	Samtse	Pagli	Ratay I	ARE1L6	ARE1L6F08	2,890	9	9%
L028	Samtse	Pagli	Ratay II	ARE1L6	ARE1L6F08	3,013	14	8%
L030	Samtse	Pagli	Mid Thunkey	ARE1L6	ARE1L6F12	2,872	10	9%
L031	Samtse	Pagli	Suktay Thunkey I	ARE1L6	ARE1L6F13	10,483	3	-1%
L032	Samtse	Pagli	Suktay Thunkey II	ARE1L6	ARE1L6F13	4,658	4	4%
L033	Samtse	Pagli	Suktay Thunkey III	ARE1L6	ARE1L6F14	4,925	6	4%
L034	Samtse	Pagli	Lower Thunkey	ARE1L6	ARE1L6F09	4,497	9	4%
L035	Samtse	Pagli	Thodney C I	ARE1L6	ARE1L6F09	9,505	3	-1%
L036	Samtse	Pagli	Thodney C II	ARE1L6	ARE1L6F09	7,723	3	1%
L037	Samtse	Pagli	Thodney A	ARE1L6	ARE1L6F09	10,119	4	-1%
L038	Samtse	Pagli	Thodney B I	ARE1L6	ARE1L6F10	6,394	3	2%
L039	Samtse	Pagli	Thodney B II	ARE1L6	ARE1L6F11	4,100	9	5%
L040	Samtse	Pagli	Suktay B	ARE1L7	ARE1L7F01	6,389	7	2%
L042	Samtse	Pagli	Dhandara	ARE1L9	ARE1L9F02	6,144	8	2%
L043	Samtse	Pagli	Tilo A	ARE1L9	ARE1L9F03	6,193	7	2%
L044	Samtse	Pagli		ARE1L9	ARE1L9F05	4,025	6	5%
L045	Samtse	Pagli		ARE1L9	ARE1L9F01	9,848	3	-1%
L046	Samtse	Pagli		ARE1L9	ARE1L9F04	3,476	4	7%
L047	Samtse	Pagli	Tilo B	ARE1L10	ARE1L10F01	7,461	8	-1%
L049	Samtse	Denchukha	Damji	ARE3L1	ARE3L1F02	4,727	19	4%
L050	Samtse	Denchukha	Lower Khampa	ARE3L1	ARE3L1F03	4,755	18	4%

Trans_ID	Dzongkhag	Township	Village	Feeder	Sub Feeder	Cost/ADB	Total Customer	EIRR
L051	Samtse	Denchukha	Upper Khempa	ARE3L1	ARE3L1F01	5,511	15	7%
L052	Samtse	Denchukha	Bhangaley 1	ARE3L1	ARE3L1F01	7,464	10	1%
L054	Samtse	Denchukha	Basent	ARE3L1	ARE3L1F01	3,116	20	8%
L057	Samtse	Denchukha	Khadori 2	ARE3L1	ARE3L1F01	5,474	14	3%
L058	Samtse	Denchukha	Batukhola 2	ARE3L1	ARE3L1F01	4,123	18	5%
L085	Samtse	Denchukha	Benekha	ARE3L1	ARE3L1F01	4,560	7	5%
L074	Samtse	Denchukha	BHU area	ARE3L1	ARE3L1F01	3,504	13	7%
L053	Samtse	Denchukha	Bhangaley 2	ARE3L1	ARE3L1F05	2,685	13	10%
L055	Samtse	Denchukha	Bteteni	ARE3L1	ARE3L1F06	5,481	15	7%
L056	Samtse	Denchukha	Khadori 1	ARE3L1	ARE3L1F07	2,149	19	12%
L059	Samtse	Denchukha	Batukhola 1	ARE3L1	ARE3L1F08	2,442	10	11%
L060	Samtse	Denchukha	Shetkha 1	ARE3L1	ARE3L1F09	2,331	17	11%
L061	Samtse	Denchukha	Shetkha 2	ARE3L1	ARE3L1F10	2,582	18	10%
L062	Samtse	Denchukha	Relokha 1	ARE3L1	ARE3L1F11	4,028	14	5%
L063	Samtse	Denchukha	Relokha 2	ARE3L1	ARE3L1F12	2,330	14	11%
L064	Samtse	Denchukha	Denchukha 1	ARE3L1	ARE3L1F13	2,988	17	8%
L065	Samtse	Denchukha	Denchukha 2	ARE3L1	ARE3L1F13	2,810	13	9%
L066	Samtse	Denchukha	Denchukha 4	ARE3L1	ARE3L1F14	4,839	12	4%
L067	Samtse	Denchukha	Denchukha 3	ARE3L1	ARE3L1F14	2,496	13	10%
L068	Samtse	Denchukha	Boribotey 1	ARE3L1	ARE3L1F15	3,675	12	6%
L069	Samtse	Denchukha	Boribotey 2	ARE3L1	ARE3L1F15	2,308	14	11%
L071	Samtse	Denchukha	Gabjee A	ARE3L1	ARE3L1F15	2,719	18	9%
L072	Samtse	Denchukha	Gabjee 1B	ARE3L1	ARE3L1F15	3,139	12	8%
L073	Samtse	Denchukha	Gabjee 2B	ARE3L1	ARE3L1F15	3,505	8	7%
L075	Samtse	Denchukha	Moyona 1	ARE3L1	ARE3L1F18	3,461	11	7%
L076	Samtse	Denchukha	Moyona 2	ARE3L1	ARE3L1F19	4,603	10	4%
L077	Samtse	Denchukha	Damley 2	ARE3L1	ARE3L1F20	4,050	14	5%
L078	Samtse	Denchukha	Damley 1	ARE3L1	ARE3L1F20	3,586	17	7%
L079	Samtse	Denchukha	Nevarey	ARE3L1	ARE3L1F21	4,313	13	5%
L080	Samtse	Denchukha	Pungtha 1A	ARE3L1	ARE3L1F22	5,089	15	3%
L081	Samtse	Denchukha	Pungtha 2A	ARE3L1	ARE3L1F22	3,005	12	8%
L082	Samtse	Denchukha	Pungtha 1B	ARE3L1	ARE3L1F23	3,483	17	7%
L084	Samtse	Denchukha	Taleykha	ARE3L1	ARE3L1F25	5,205	13	3%
L086	Samtse	Denchukha	Belung	ARE3L1	ARE3L1F24	4,165	10	5%
L083	Samtse	Denchukha	Pungtha 2B	ARE3L1	ARE3L1F26	3,418	10	7%
L087	Samtse	Dorokha	Sebichung	ARE3L2	ARE3L2F01	7,884	13	10%
L088	Samtse	Tendu	Okhorbole-y-I	ARE1L11	ARE1L11F01	3,603	24	6%
L089	Samtse	Tendu	Okhorbole-y-II	ARE1L11	ARE1L11F01	2,482	20	11%
L090	Samtse	Tendu	Fita	ARE1L11	ARE1L11F02	2,397	14	11%
L091	Samtse	Tendu	Bhidukhoop	ARE1L12	ARE1L11F01	3,722	18	6%
M001	Sarpang	Dekling	Ratigoo/Chepchepay	ARE1M1	ARE1M1F01	8,343	19	10%
M010	Sarpang	Doban	Khargoan A	ARE1M1	ARE1M1F01	5,554	10	3%
M002	Sarpang	Doban	Maugaon C	ARE1M1	ARE1M1F02	18,261	26	-5%
M003	Sarpang	Doban	Maugaon B	ARE1M1	ARE1M1F03	5,192	26	3%
M004	Sarpang	Doban	Maugaon A1	ARE1M1	ARE1M1F04	4,563	23	4%
M005	Sarpang	Doban	Maugaon A2	ARE1M1	ARE1M1F05	3,103	36	8%
M018	Sarpang	Doban	Bhunerey	ARE1M1	ARE1M1F06	14,559	8	-3%
M019	Sarpang	Doban	Gangrong	ARE1M1	ARE1M1F06	6,875	14	1%
M020	Sarpang	Doban	Ramitey-B	ARE1M1	ARE1M1F06	9,800	9	-1%
M022	Sarpang	Doban	Pangkey BHU Area	ARE1M1	ARE1M1F06	2,080	21	13%
M026	Sarpang	Doban	Doban B	ARE1M1	ARE1M1F06	5,893	9	2%
M027	Sarpang	Doban	Doban C	ARE1M1	ARE1M1F06	5,100	10	3%
M031	Sarpang	Doban	Bichkhola-A	ARE1M1	ARE1M1F06	6,534	20	2%
M032	Sarpang	Doban	Bichkhola-B	ARE1M1	ARE1M1F06	7,431	9	1%

Appendix-P Economic Internal Rate of Return on Investment by Substation

Trans_ID	Dzongkhag	Gewog	Village	Feeder	Sub Feeder	Cost/HH	Total Customer	EIRR
M021	Sarpang		Ramitya-A	ARE1M1	ARE1M1F07	4,616	10	4%
M023	Sarpang	Doban	Pangkay School	ARE1M1	ARE1M1F08	3,329	9	7%
M024	Sarpang	Doban	Upper Pangkay	ARE1M1	ARE1M1F08	4,356	8	5%
M025	Sarpang	Doban	pangkay Sheer	ARE1M1	ARE1M1F08	6,996	8	1%
M028	Sarpang	Doban	Ranikhop	ARE1M1	ARE1M1F09	5,109	11	3%
M029	Sarpang	Doban	Maukhola-B	ARE1M1	ARE1M1F09	4,195	15	5%
M030	Sarpang	Doban	Maukhola-A	ARE1M1	ARE1M1F09	6,240	8	2%
M034	Sarpang	Doban	Teerkhola-B	ARE1M1	ARE1M1F010	6,166	14	2%
M035	Sarpang	Doban	Teerkhola-A	ARE1M1	ARE1M1F010	4,641	19	4%
M036	Sarpang	Doban	Fedi	ARE1M1	ARE1M1F010	13,787	7	-3%
M037	Sarpang	Doban	Torkay	ARE1M1	ARE1M1F011	11,707	10	-2%
M033	Sarpang	Doban	Bichkhola-C/Machukhola	ARE1M1	ARE1M1F012	8,568	11	0%
M007	Sarpang	Doban	Mongargoan-B	ARE1M1	ARE1M1F013	13,410	9	-3%
M008	Sarpang	Doban	Mongargoan-A	ARE1M1	ARE1M1F014	6,544	14	2%
M011	Sarpang	Doban	Pathibora-D	ARE1M1	ARE1M1F015	4,986	13	4%
M014	Sarpang	Doban	Pathibora-C	ARE1M1	ARE1M1F015	7,601	11	1%
M016	Sarpang	Doban	Pathibora-A/Tarkharka	ARE1M1	ARE1M1F015	8,438	6	0%
M017	Sarpang	Doban	Baragaray	ARE1M1	ARE1M1F015	11,710	8	-2%
M012	Sarpang	Doban	Chepkhola/Dekuti	ARE1M1	ARE1M1F016	7,216	8	1%
M013	Sarpang	Doban	Pathibora Dara	ARE1M1	ARE1M1F017	5,443	6	3%
M015	Sarpang	Doban	Pathibora-B	ARE1M1	ARE1M1F018	7,780	7	0%
M009	Sarpang	Doban	Khargoan-B	ARE1M1	ARE1M1F019	10,579	10	-2%
M006	Sarpang	Doban	Mongargoan-C	ARE1M1	ARE1M1F020	8,870	9	0%
M057	Sarpang	Jigmechholing	Bagjuanggay A	ARE1M1	ARE1M1F020	4,440	9	5%
M056	Sarpang	Jigmechholing	Bagjuanggay B	ARE1M1	ARE1M1F020	16,370	2	-4%
M055	Sarpang	Jigmechholing	Dungay	ARE1M1	ARE1M1F020	8,103	15	0%
M054	Sarpang	Jigmechholing	Garigoan	ARE1M1	ARE1M1F021	11,874	9	-2%
M053	Sarpang	Jigmechholing	Gongdara A	ARE1M1	ARE1M1F021	8,089	9	0%
M050	Sarpang	Jigmechholing	Gongdara C	ARE1M1	ARE1M1F021	7,977	10	0%
M048	Sarpang	Jigmechholing	Kholatar	ARE1M1	ARE1M1F021	5,263	10	3%
M049	Sarpang	Jigmechholing	Reti	ARE1M1	ARE1M1F021	19,570	12	-5%
M051	Sarpang	Jigmechholing	Gongdara B	ARE1M1	ARE1M1F022	8,749	8	0%
M052	Sarpang	Jigmechholing	Mongar Goan	ARE1M1	ARE1M1F022	6,434	11	2%
M047	Sarpang	Jigmechholing	Virigoan	ARE1M1	ARE1M1F023	5,112	17	3%
M046	Sarpang	Jigmechholing	Gong Goan	ARE1M1	ARE1M1F023	6,701	15	1%
M045	Sarpang	Jigmechholing	Madaley	ARE1M1	ARE1M1F024	12,104	3	-2%
M044	Sarpang	Jigmechholing	Ashaney	ARE1M1	ARE1M1F024	10,385	6	-1%
M043	Sarpang	Jigmechholing	Samkharka A	ARE1M1	ARE1M1F025	9,726	6	-1%
M042	Sarpang	Jigmechholing	Samkharka B	ARE1M1	ARE1M1F025	6,393	9	2%
M041	Sarpang	Jigmechholing	Sukumbasi A	ARE1M1	ARE1M1F025	25,936	7	-6%
M040	Sarpang	Jigmechholing	Sukumbasi B	ARE1M1	ARE1M1F025	8,029	6	0%
M058	Sarpang	Jigmechholing	Tormey	ARE1M1	ARE1M1F025	11,153	11	-2%
M039	Sarpang	Jigmechholing	Pakhay A	ARE1M1	ARE1M1F026	11,170	4	-2%
M038	Sarpang	Jigmechholing	Pakhay B	ARE1M1	ARE1M1F026	17,393	2	-4%
MV connec	Sarpang	Jigmechholing	Lower Daragoan	ARE1M1	ARE1M1F026	27,584	0	#NUM!
M060	Sarpang	Tarathang	Rangdara B	ARE1M2	ARE1M2F01	2,021	31	13%
M059	Sarpang	Tarathang	Daragoan	ARE1M2	ARE1M2F01	2,201	35	12%
ML01	Sarpang	Dekiling	Derbethang	ARE1M2	ARE1M2F01	2,300	10	12%
Q003	Trongsa	Nubi	Karshong School Area	ARE3Q1	ARE3Q1F01	26,562	3	-6%
Q004	Trongsa	Nubi	Karshong Shedra	ARE3Q1	ARE3Q1F01	2,921	11	9%
Q006	Trongsa	Nubi	Karshong Pam	ARE3Q1	ARE3Q1F01	3,915	15	6%
Q009	Trongsa	Nubi	Lower Pang	ARE3Q1	ARE3Q1F01	4,091	9	5%
Q010	Trongsa	Nubi	Upper Pang	ARE3Q1	ARE3Q1F01	4,211	9	5%
Q001	Trongsa	Nubi	Gagar Choshi	ARE3Q1	ARE3Q1F02	3,058	12	8%

Trans_ID	Dzongkhag	Gewog	Village	Feeder	Sub Feeder	Cost/HH	Total Customer	EIRR
Q002	Trongsa	Nubi	Gagar Pam	ARE3Q1	ARE3Q1F03	3,478	13	7%
Q005	Trongsa	Nubi	Karshong Trong	ARE3Q1	ARE3Q1F04	5,390	10	3%
Q008	Trongsa	Nubi	Jongthang	ARE3Q1	ARE3Q1F05	3,052	41	8%
Q007	Trongsa	Nubi	Thrisipang	ARE3Q1	ARE3Q1F06	6,430	3	2%
Q011	Trongsa	Nubi	Bemjee	ARE3Q1	ARE3Q1F07	2,079	39	13%
Q012	Trongsa	Nubi	Kaba	ARE3Q1	ARE3Q1F07	3,133	17	8%
Q013	Trongsa	Nubi	Daba	ARE3Q1	ARE3Q1F07	2,268	15	12%
Q014	Trongsa	Nubi	Simphu School	ARE3Q1	ARE3Q1F07	9,041	3	-1%
Q015	Trongsa	Nubi	Simjuling	ARE3Q1	ARE3Q1F07	5,119	7	3%
Q016	Trongsa	Nubi	Simphu	ARE3Q1	ARE1Q1F08	2,065	32	13%
Q017	Trongsa	Nubi	Simphu Goenpo	ARE3Q1	ARE1Q1F08	2,414	17	11%
Q018	Trongsa	Nubi	Thangnil	ARE3Q1	ARE1Q1F08	2,340	10	11%
Q021	Trongsa	Nubi	Kakaling	ARE3Q1	ARE1Q1F09	9,857	6	-1%
Q022	Trongsa	Nubi	Drenshing	ARE3Q1	ARE1Q1F09	2,485	24	11%
Q019	Trongsa	Nubi	Chela	ARE3Q1	ARE1Q1F010	2,068	19	13%
Q020	Trongsa	Nubi	Zilu Goenpo	ARE3Q1	ARE1Q1F010	5,548	6	3%
R003	Tsirang	Phuntenchu	Kharkhola	ARE3R2	ARE3R2F01	12,284	6	-2%
R006	Tsirang	Phuntenchu	Dhaphkhol	ARE3R3	ARE3R3F01	8,746	8	0%
R004	Tsirang	Phuntenchu	Baithakey	ARE3R3	ARE3R3F02	8,623	6	0%
R005	Tsirang	Phuntenchu	Saprali	ARE3R3	ARE3R3F02	8,065	5	0%
R007	Tsirang	Phuntenchu	Jogitar	ARE3R4	ARE3R4F01	5,726	13	3%
R008	Tsirang	Phuntenchu	Phaladhay	ARE3R5	ARE3R5F01	5,576	17	3%
R009	Tsirang	Patala	Walkhleytar	ARE1R6	ARE1R6F02	8,591	15	0%
R010	Tsirang	Patala	Rilangthang	ARE1R6	ARE1R6F01	3,494	14	7%
R011	Tsirang	Patala	Burichudoban	ARE3R7	ARE3R7F01	8,106	9	0%
S004	Wangdue	Nahi	Pantsho Gonpa	ARE3S3	ARE3S3F01	6,145	7	2%
S005	Wangdue	Sephu	Tsagatintin	ARE3S4	ARE3S4F01	4,641	6	4%
S007	Wangdue	Sephu	Rabu	ARE3S4	ARE3S4F01	12,160	3	-2%
S006	Wangdue	Sephu	Nangkha	ARE3S4	ARE3S4F02	1,688	19	16%
S008	Wangdue	Bjina	Dolongdo I	ARE3S5	ARE3S5F01	1,267	14	22%
S009	Wangdue	Bjina	Dolongdo II	ARE3S6	ARE3S6F01	1,129	25	24%
S010	Wangdue	Bjina	Dechen Draphu Lhakhang	ARE3S7	ARE3S7F01	16,847	2	-4%
S011	Wangdue	Athang	Tshangzomsa	ARE1S8	ARE1S8F01	6,581	4	2%
S012	Wangdue	Athang	Samthang	ARE1S8	ARE1S8F01	19,507	10	-5%
S013	Wangdue	Athang	Mitina	ARE1S8	ARE1S8F01	6,536	10	2%
S014	Wangdue	Athang	Rukha	ARE1S8	ARE1S8F01	5,782	22	2%
S015	Wangdue	Athang	Lamga	ARE1S8	ARE1S8F01	3,323	17	7%
S016	Wangdue	Athang	Kashacheke	ARE1S8	ARE1S8F02	7,433	4	1%
S017	Wangdue	Athang	Lawa/Thaphu	ARE1S8	ARE1S8F03	2,412	22	11%

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)
IN KINGDOM OF BHUTAN
FINAL REPORT

APPENDIX

APPENDIX-Q

**SUB-PACKAGES OF ERECTION
WORKS**

APPENDIX-Q SUB-PACKAGES OF ERECTION WORKS

Considering the contract volume and the geographical proximity of erection site, a recommendation of feeder-basis sub-packages of erection works is shown in Table-L.1.

The contract volume (Total cost of single package) was set to above 2.0 million BTN up to 9.0 million BTN accordance with the allowable range of contract costs of contractor “class C” in the regulation made by BPC. The total number of the sub-package is 47.

Table-Q.1 Sub-packages of Erection works

Dzongkhag	Lot No.	Feeder No.	Feeder ID	Erection cost (USD)	Headloading cost (USD)	Total cost (USD)	Total cost of Single Package (USD)	Total cost of Single Package (million BTN)	MV line length(km)	Erection + headloading cost per MV line length (USD/km)	
Chhukha	B1	1	ARE3B1	41,076	104,181	145,256	174,079	8.1	11.4	12,718	
		2	ARE3B2	7,922	20,901	28,823			1.3	22,934	
	B2	3	ARE3B3	5,051	13,058	18,109	93,879	4.4	0.1	128,870	
		4	ARE3B4	17,193	43,989	61,182			6.0	10,186	
		5	ARE3B5	4,085	10,503	14,588			2.0	7,454	
	B3, B4	6	ARE3B6	55,192	145,018	200,210	100,105	4.7	19.9	10,085	
		7	ARE3B7	8,928	24,099	33,027	33,027	1.5	4.4	7,459	
	B6	8	ARE3B8	18,720	48,865	67,586	137,664	6.4	7.4	9,102	
		9	ARE3B9	13,694	34,205	47,899			5.3	9,016	
		10	ARE3B10	6,058	16,121	22,179			1.9	11,523	
	B7	11	ARE3B11	11,372	30,727	42,099	187,033	8.7	4.0	10,434	
		14	ARE3B14	3,108	7,721	10,829			1.2	9,085	
		15	ARE3B15	36,716	97,390	134,105			16.5	8,150	
	B8	12	ARE3B12	4,885	12,782	17,667	97,464	4.5	2.4	7,314	
		13	ARE3B13	16,304	39,719	56,022			5.3	10,658	
		17	ARE1B17	6,588	17,187	23,775			1.7	14,179	
	B9	16	ARE1B16	25,565	66,248	91,813	91,813	4.3	11.1	8,296	
		18	ARE3B18	7,948	21,369	29,317	47,380	2.2	4.1	7,193	
		19	ARE3B19	5,023	13,040	18,064			1.8	9,957	
		B11	20	ARE3B20	15,887	41,927	57,813	78,625	3.7	5.4	10,792
			21	ARE3B21	5,840	14,972	20,811			2.3	8,881
		B12	22	ARE3B22	7,568	20,288	27,856	54,826	2.6	3.6	7,739
	23		ARE3B23	4,384	11,409	15,792			2.0	7,722	
	24		LV Extention	3,234	7,944	11,178			0.0	NA	
Dagana	C1,C2	25	ARE3C1	156,276	231,261	387,536	193,768	9.0	52.5	7,382	
		26	ARE3C2	8,088	11,985	20,073	169,891	7.9	0.8	26,517	
	C3	27	ARE3C3	5,915	8,756	14,671			1.5	9,515	
		28	ARE3C4	19,394	28,691	48,084			9.0	5,362	
		29	ARE3C5	12,520	18,541	31,060			5.7	5,490	
		30	ARE3C6	5,996	8,870	14,866			2.5	5,946	
		31	ARE3C7	7,990	11,818	19,808			3.0	6,603	
		32	ARE3C8	6,949	10,279	17,228			2.3	7,491	
		33	LV Extention	1,655	2,445	4,099			0.0	NA	
Haa	E1	34	ARE3E1	16,419	82,659	99,077	99,077	4.6	7.1	13,942	
	E2	35	ARE3E2	18,955	95,891	114,846	114,846	5.4	7.5	15,352	
	E3, E4	36	ARE3E3	38,528	199,812	238,339	238,339	11.1	14.0	17,046	
Paro	H1	37	ARE1H2	10,137	9,149	19,286	27,256	1.3	5.5	3,511	
		38	ARE3H3	3,268	3,107	6,375			1.6	3,906	
		39	LV Extention	857	739	1,595			0.0	NA	
Pemagatshel	I1	40	ARE3I1	5,413	13,246	18,659	107,116	5.0	2.3	7,971	
		41	ARE3I2	25,883	62,573	88,456			7.6	11,609	
	I2	42	ARE3I3	20,759	50,723	71,481	109,707	5.1	7.6	9,394	
		43	ARE3I4	10,768	27,457	38,225			3.4	11,209	
Punakha	J1	44	ARE1J1	6,874	3,678	10,553	38,085	1.8	3.9	2,699	
		45	ARE3J2	17,535	9,998	27,533			6.6	4,169	
Samtse	L1	46	ARE1L1	19,345	33,914	53,259	118,308	5.5	5.0	10,569	
		47	ARE1L2	19,227	33,965	53,192			7.5	7,068	
		48	ARE1L5	4,301	7,556	11,857			1.9	6,095	
	L2	49	ARE1L6	92,888	162,023	254,911	127,455	5.9	25.8	9,891	
		50	ARE1L7	4,503	7,899	12,401	134,280	6.3	1.9	6,420	
		51	ARE1L9	15,989	27,829	43,818			6.6	6,649	
		52	ARE1L10	6,026	10,636	16,662			3.1	5,445	
		53	ARE1L11	15,813	27,658	43,472			3.3	13,259	
	L4-L6	54	ARE1L12	6,500	11,427	17,927			1.9	9,528	
		55	ARE3L1	172,450	300,538	472,987	157,662	7.3	38.9	12,148	
56		ARE3L2	9,491	16,788	26,279	26,279	1.2	4.0	6,551		
57		ARE1M1	414,432	1,934,533	2,348,966	195,747	9.1	116.6	20,142		
Sarpang	M13	58	ARE1M2	15,587	59,980	75,567	75,567	3.5	2.4	31,479	
	59	ARE3Q1	104,338	99,320	203,658	101,829	4.7	35.7	5,708		
Trongsa	R1	60	ARE3R2	7,322	10,040	17,362	150,312	7.0	2.6	6,776	
		61	ARE3R3	16,019	22,021	38,041			5.5	6,970	
		62	ARE3R4	7,039	9,679	16,718			2.1	7,777	
		63	ARE3R5	8,796	12,069	20,865			2.3	9,253	
		64	ARE1R6	17,301	23,732	41,034			5.9	6,913	
		65	ARE3R7	6,859	9,434	16,293			2.2	7,431	
		66	ARE3S3	4,098	5,725	9,822	169,277	7.9	2.5	3,990	
Wangdue	S1	67	ARE3S4	8,975	12,725	21,700			3.5	6,207	
		68	ARE3S5	1,561	2,259	3,820			0.1	52,832	
		69	ARE3S6	2,509	3,663	6,172			0.1	48,420	
		70	ARE3S7	3,233	4,570	7,803			1.8	4,272	
		71	ARE1S8	49,814	70,146	119,960			17.3	6,932	
Total				1,607,986.6	4,254,890.2	6,442,399			566.0		

THE PREPARATORY SURVEY ON
RURAL ELECTRIFICATION PROJECT (PHASE-2)

IN KINGDOM OF BHUTAN

FINAL REPORT

APPENDIX

APPENDIX-R

ANNUAL FUND REQUIREMENT

APPENDIX-R ANNUAL FUND REQUIREMENT

Here are the all worksheets of the detail of cost estimation in the format of JICA's cost estimation supporting system made in Excel.

Table-R.1 Precondition Worksheet

Precondition

Common terms for Appraisal

Name of Local Currency

			Nu	
(1)	Yen/\$	US\$ 1 =	87.7	Yen
(2)	LC/\$	US\$ 1 =	46.6	Nu
(3)	Yen/Nu	Nu 1 =	1.88	Yen

Price Escalation

(1)	FC	1.8%	LC	2.4%
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Physical Contingency

Construction	10.0%	Consultant	10.0%
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Base Year for Cost Estimation:

2010/11

Schedule

Start 2011/01 End 2013/06

Billing Rate of Consultant

	FC Yen	LC Nu
Pro-(A)	2,630,000	1,399,000
Pro-(B)	439,000	234,000
Supporting Sta	220,000	117,000

Others

Rate of Tax

VAT	12.0%	Import Tax	10.0%
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Rate of Administration Cost

10.0%

Rate of Interest During Construction

Construction	0.55%	Consultant	0.01%
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Rate of Commitment Charges

0.1%

Payment Method for Interest during construction and Commitment charge

loan-covered

Fiscal Year

Jul - Jun

Table-R.2 Cost break down Worksheet (1/5)

Cost Breakdown for Package

US \$ =yen 87.7
Nu =yen 1.88

item	Local	Total
	Nu	yen
Land Acquisition Cost		0

1. Substation and Line Materials 借款对象率 100

Lot No.
1-A

item	unit	Quantity	Unit Price		Cost		Total yen
			Foreign yen	Local Nu	Foreign yen	Local Nu	
			MV STEEL TELESCOPIC POLES, FITTINGS & ACCESSORIES FOE THE WESTERN DZONGKHAGS (CHUKHA, HAA, PARO, PHUNAKA, SAMTSE)				
Steel telescopic poles 11 mtr. long with base plate, fixing bolts, etc.	Nos.	5,984	34,318.8		205,356,784		205,356,784
33 kV single pole cross arm assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	744	1,818.9		1,353,408		1,353,408
11 kV single pole cross arm assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	721	1,432.8		1,033,424		1,033,424
33 kV top hamper assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	744	968.4		720,557		720,557
11 kV top hamper assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	721	777.3		560,688		560,688
33 kV cross arm assembly for H-frame (O) complete with M clamps, nuts, bolts and other accessories.	Set	1,116	7,454.4		8,320,054		8,320,054
11 kV cross arm assembly for H-frame (O) complete with M clamps, nuts, bolts and other accessories.	Set	827	5,176.4		4,281,321		4,281,321
33 kV cross brace arm assembly for H-frame with full clamps, nuts, bolts and other accessories.	Set	1,116	5,334.7		5,954,237		5,954,237
11 kV cross brace arm assembly for H-frame with full clamps, nuts, bolts and other accessories.	Set	827	5,334.7		4,412,286		4,412,286
G.I. stay set assembly (1 no. turn buckle, 1 no. stay rod with base plate)	Set	7,563	2,170.6		16,416,087		16,416,087
Barbed wire	kg	68,872	150.4		10,357,522		10,357,522
G.I. stay wire 7/8 GSW	kg	73,147	150.4		11,000,411		11,000,411
Danger plate (enamelled) 33 kV	No.	2,048	266.2		545,292		545,292
Danger plate (enamelled) 11 kV	No.	1,676	266.2		446,298		446,298

1-B

MV STEEL TELESCOPIC POLES, FITTINGS & ACCESSORIES FOE THE EASTERN DZONGKHAGS (DAGANA, PEMAGATSHEL, SARPANG, TRONGSA, TSIRANG, WANGD)							
Steel telescopic poles 11 mtr. long with base plate, fixing bolts, etc.	Nos.	3,874	34,318.8		132,943,439		132,943,439
33 kV single pole cross arm assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	626	1,818.9		1,138,495		1,138,495
11 kV single pole cross arm assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	343	1,432.8		490,741		490,741
33 kV top hamper assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	626	968.4		606,137		606,137
11 kV top hamper assembly complete with M&U clamps, nuts, bolts and other accessories.	Set	343	777.3		266,253		266,253
33 kV cross arm assembly for H-frame (O) complete with M clamps, nuts, bolts and other accessories.	Set	939	7,454.4		6,998,883		6,998,883
11 kV cross arm assembly for H-frame (O) complete with M clamps, nuts, bolts and other accessories.	Set	514	5,176.4		2,659,490		2,659,490
33 kV cross brace arm assembly for H-frame with full clamps, nuts, bolts and other accessories.	Set	939	5,334.7		5,008,743		5,008,743
11 kV cross brace arm assembly for H-frame with full clamps, nuts, bolts and other accessories.	Set	514	5,334.7		2,740,843		2,740,843
G.I. stay set assembly (1 no. turn buckle, 1 no. stay rod with base plate)	Set	2,421	2,170.6		5,255,376		5,255,376
Barbed wire	kg	48,422	150.4		7,282,150		7,282,150
G.I. stay wire 7/8 GSW	kg	29,053	150.4		4,369,290		4,369,290
Danger plate (enamelled) 33 kV	No.	1,565	266.2		416,600		416,600
Danger plate (enamelled) 11 kV	No.	856	266.2		227,969		227,969

2A

MV OVERHEAD BARED CONDUCTORS							
ACSR conductor - RABBIT	km	1,214	57,208.7		69,435,538		69,435,538
ACSR conductor - DOG	km	209	111,775.4		23,327,223		23,327,223

Table-R.2 Cost break down Worksheet (2/5)

Lot No.	item	unit	Quantity	Unit Price		Cost		Total yen
				Foreign	Local	Foreign	Local	
				yen	Nu	yen	Nu	
2B	MV OVERHEAD ACCESSORIES							
	P.G. clamp for RABBIT	No.	8,534	81.3		693,777		693,777
	P.G. clamp for DOG	No.	1,212	103.6		125,598		125,598
	Insulation piercing connector & insulation cover for covered AAAC (120 sq.mm)	No.	299	150.4		45,041		45,041
	Insulation piercing connector & insulation cover for covered AAAC (80 sq.mm)	No.	784	137.0		107,416		107,416
	Preform dead end terminations - RABBIT	No.	15,573	94.5		1,471,658		1,471,658
	Preform dead end terminations - DOG	No.	2,424	302.7		733,570		733,570
	Preform dead end terminations-covered AAAC (120 sq.mm)	No.	599	142.3		85,213		85,213
	Preform dead end terminations-covered AAAC (80 sq.mm)	No.	1,464	104.3		152,683		152,683
	Terminal lugs - RABBIT	No.	3,024	39.6		119,839		119,839
	Terminal lugs - AAAC (80 sq.mm)	No.	176	31.5		5,546		5,546
	2 core, 70 mm2 underground cable glands	No.	296	157.5		46,621		46,621
	4 core, 70 mm2 underground cable glands	No.	336	261.1		87,746		87,746
	Tension joints - RABBIT	No.	3,511	235.7		827,754		827,754
	Tension joints - DOG	No.	606	471.5		285,673		285,673
	Tension joints with insulation cover - covered AAAC (120 sq.mm)	No.	150	392.2		58,736		58,736
	Tension joints with insulation cover - covered AAAC (80 sq.mm)	No.	348	392.2		136,533		136,533
	Stay clamp assembly, 33 kV	Set	3,801	532.5		2,023,887		2,023,887
	Stay clamp assembly, 11 kV	Set	2,604	532.5		1,386,533		1,386,533
	Substation cross arm (100x50x6 mm channel) complete with M clamps, nuts, bolts and other accessories.	Set	316	7,142.4		2,257,014		2,257,014
	Transformer mounting platform (125x65x6 channel) complete with M clamps, nuts, bolts and other accessories	Set	316	11,668.3		3,687,194		3,687,194
	M.S. channel (75x40x6 mm) support for DO fuse complete with clamps, nuts, bolts, etc.	Set	632	7,957.4		5,029,072		5,029,072
	Steel support for lightning arrester (75x40x6 channel) complete with clamps, nuts, bolts, etc.	Set	316	2,798.4		884,310		884,310
3	INSULATORS & FITTINGS							
	33 kV pin insulator assembly with pin	Set	4,116	1,480.5		6,093,938		6,093,938
	11 kV pin insulator assembly with pin	Set	3,011	609.7		1,835,529		1,835,529
	33 kV stay insulator	No.	3,801	168.7		641,155		641,155
	11 kV stay insulator	No.	2,604	168.7		439,245		439,245
	Polymer Strain Insulator 33kV	No.	11,874	2,488.5		29,549,444		29,549,444
	Polymer Strain Insulator 11kV	No.	8,186	1,169.6		9,574,246		9,574,246
4A	MV COVERED CONDUCTOR, LV ABC CONDUCTORS & SERVICE CABLES							
	Covered AAAC - 120 sq.mm	km	52	143,452.5		7,399,344		7,399,344
	Covered AAAC - 80 sq.mm	km	120	82,782.4		9,944,844		9,944,844
	LV ABC conductor, 4 core, 50 mm2	km	216	277,168.4		59,983,180		59,983,180
	LV ABC conductor, 2 core, 50 mm2	km	272	145,772.9		39,688,784		39,688,784
	PVC insulated PVC sheathed unarmoured copper cable, 500 V grade, 2 core, 4 mm2.	km	79	127,017.5		10,004,914		10,004,914
	PVC insulated PVC sheathed unarmoured copper cable, 500 V grade, 2 core, 6 mm2.	km	15	168,679.2		2,491,224		2,491,224
	PVC insulated PVC sheathed unarmoured copper cable, 500 V grade, 2 core, 10 mm2.	km	5	252,510.8		1,243,111		1,243,111
	PVC insulated PVC sheathed unarmoured copper cable, 500 V grade, 4 core, 10 mm2.	km	14	443,037.0		6,206,949		6,206,949
	2 core, 650/1100 volts, 70 mm2 armoured PVC underground cable	Mtr.	740	642.2		475,228		475,228
	4 core, 650/1100 volts, 70 mm2 armoured PVC underground cable	Mtr.	840	990.7		832,219		832,219

Table-R.2 Cost break down Worksheet (3/5)

Lot No.	item	unit	Quantity	Unit Price		Cost		Total
				Foreign	Local	Foreign	Local	
				yen	Nu	yen	Nu	
4B	LV TELESCOPIC POLES, ABC ACCESSORIES & DISTRIBUTION BOARDS							
	Steel telescopic poles 9 mtr. long with base plate, fixing bolts, etc.	Nos.	7,158	28,199.7		201,842,855		201,842,855
	Hook bolt assembly for LV ABC line with route bolt of 16 mm dia., 175 mm long.	Nos.	2,684	356.7		957,502		957,502
	Strain Clamps/Dead End Clamps for 4 core, 50 mm2 LV ABC	Nos.	1,179	1,254.0		1,478,485		1,478,485
	Strain Clamps/Dead End Clamps for 2 core, 50 mm2 LV ABC	Nos.	1,505	1,254.0		1,887,278		1,887,278
	Suspension Clamps (Small angle) for 4 core, 50 mm2 LV ABC	Nos.	1,376	837.1		1,151,519		1,151,519
	Suspension Clamps (Small angle) for 2 core, 50 mm2 LV ABC	Nos.	1,756	837.1		1,469,908		1,469,908
	Suspension Clamps (Large angle) for 4 core, 50 mm2 LV ABC	Nos.	1,179	1,245.3		1,468,288		1,468,288
	Suspension Clamps (Large angle) for 2 core, 50 mm2 LV ABC	Nos.	1,505	1,245.3		1,874,263		1,874,263
	Set of terminal caps for 50 mm2 LV ABC	Set	895	260.1		232,741		232,741
	Insulation tension jointing sleeves for 50 mm2 LV ABC	Nos.	8,947	188.2		1,683,655		1,683,655
	Insulated service T-off connection 50 to 4 mm2	Nos.	5,252	283.0		1,486,346		1,486,346
	Insulated service T-off connection 50 to 6 mm2	Nos.	984	283.0		278,478		278,478
	Insulated service T-off connection 50 to 10 mm2	Nos.	1,262	283.0		357,153		357,153
	Insulated piercing connector (IPC 50/50 mm2)	Nos.	3,863	382.2		1,476,660		1,476,660
	Service dead end for 2 core, 4 mm2	Nos.	5,252	135.6		711,947		711,947
	Service dead end for 2 core, 6 mm2	Nos.	984	180.7		177,851		177,851
	Service dead end for 2 core, 10 mm2	Nos.	328	180.7		59,284		59,284
	Service dead end for 4 core, 10 mm2	Nos.	934	180.7		168,814		168,814
	Stay clamp assembly, LV	Nos.	3,579	454.2		1,625,548		1,625,548
	Single phase LV Distribution Board 2 way 100 Amps. (bus rating) with 4 nos. 50 Amps. fuses	No.	114	29,610.3		3,375,576		3,375,576
	Single phase LV Distribution Board, 3 way 200 Amps. (bus rating) with 4 nos. 100 Amps. fuses	No.	34	24,552.1		834,770		834,770
	Three Phase LV Distribution Board 2 way 100 Amps. (bus rating) with 6 nos. 50 Amps. fuses	No.	156	35,478.5		5,534,650		5,534,650
	Three phase LV Distribution Board, 4 way 200 Amps. (bus rating) with 12 nos. 100 Amps. fuses	No.	12	52,677.7		632,133		632,133
	LV distribution pillar support (100x50x6 MS channel) complete with clamps, nuts, bolts, etc.	Set	316	6,608.0		2,088,115		2,088,115
	Terminal lugs for 2 core, 70 mm2 underground cable	No.	592	37.6		22,258		22,258
	Terminal lugs for 4 core, 70 mm2 underground cable	No.	1,344	37.6		50,531		50,531
	Terminal lugs for 2 core, 50 mm2 LV ABC	No.	1,184	31.5		37,296		37,296
	Terminal lugs for 4 core, 50 mm2 LV ABC	No.	2,016	31.5		63,505		63,505
	2 core, 50 mm2 LV ABC glands	No.	296	147.3		43,611		43,611
	4 core, 50 mm2 LV ABC glands	No.	504	256.1		129,062		129,062
5	EARTHING EQUIPMENT							
	Spike earthing set 2500x20 mm complete with connecting plates, nuts & bolts with 4 metre G.I. wire 8 GSW .	Set	9,226	846.4		7,808,934		7,808,934
	Pipe earthing set, 2500 x 40mm	Set	800	2,097.3		1,677,850		1,677,850
	Earthing conductor, G.I. strip 25x6 mm	Mtr.	22,752	139.2		3,167,333		3,167,333
6	DISTRIBUTION TRANSFORMERS							
	Single Phase Transformer 33/0.240 kV, 10 kVA	No.	26	199,988.5		5,199,702		5,199,702
	Single Phase Transformer 33/0.240 kV, 16 kVA	No.	44	204,213.7		8,985,401		8,985,401
	Single Phase Transformer 33/0.240 kV, 25 kVA	No.	20	211,959.7		4,239,194		4,239,194
	Three Phase Transformer 33/0.415 kV, 25 kVA	No.	90	310,545.6		27,949,103		27,949,103
	Three Phase Transformer 33/0.415 kV, 63 kVA	No.	8	341,769.0		2,734,152		2,734,152
	Single Phase Transformer 11/0.240 kV, 10 kVA	No.	24	196,065.2		4,705,565		4,705,565
	Single Phase Transformer 11/0.240 kV, 16 kVA	No.	20	201,598.1		4,031,962		4,031,962
	Single Phase Transformer 11/0.240 kV, 25 kVA	No.	14	207,646.1		2,907,045		2,907,045
	Three Phase Transformer 11/0.415 kV, 16 kVA	No.	22	295,254.7		6,495,604		6,495,604
	Three Phase Transformer 11/0.415 kV, 25 kVA	No.	44	304,308.5		13,389,575		13,389,575
	Three Phase Transformer 11/0.415 kV, 63 kVA	No.	4	331,972.9		1,327,892		1,327,892

Table-R.2 Cost break down Worksheet (4/5)

Lot No.	item	unit	Quantity	Unit Price		Cost		Total yen
				Foreign	Local	Foreign	Local	
				yen	Nu	yen	Nu	
7	SWITCHING EQUIPMENT, AUTO RECLOSER, AND ACCESSORIES							
	33 kV DO fuse unit (1 set = 2 DO fuses)	Set.	90	12,701.8		1,143,158		1,143,158
	33 kV DO fuse unit (1 set = 3 DO fuses)	Set.	98	18,798.6		1,842,262		1,842,262
	11 kV DO fuse unit (1 set = 2 DO fuses)	Set.	58	7,804.0		452,629		452,629
	11 kV DO fuse unit (1 set = 3 DO fuses)	Set.	70	11,705.9		819,415		819,415
	33 kV Air Break Switch complete with support frame, handle support, etc.	Set.	9	61,852.0		556,668		556,668
	11 kV Air Break Switch complete with support frame, handle support, etc.	Set.	5	44,180.0		220,900		220,900
	Steel support for 11 kV & 33 kV ABS complete with clamps, bolts, nuts, etc. (1 set = 2 nos.)	Set.	14	5,746.1		80,445		80,445
	Steel support for ABS handle complete with clamps, bolts, nuts, etc. (1 set = 2 nos.)	Set.	14	4,867.8		68,149		68,149
	Steel support for ABS intermediate complete with clamps, bolts, nuts, etc. (1 set = 1 no.)	Set.	14	2,433.4		34,068		34,068
	Steel support for jumpers complete with clamps, bolts, nuts, etc. (1 set = 1 no.)	Set.	14	2,433.4		34,068		34,068
	30 kV, 5 kA Lightning (Surge) arrester complete set (gapless type) - set of 2	Set.	90	11,685.6		1,051,705		1,051,705
	30 kV, 5 kA Lightning (Surge) arrester complete set (gapless type) - set of 3	Set.	98	16,969.5		1,663,015		1,663,015
	9 kV, 5 kA Lightning (Surge) arrester complete set (gapless type) - set of 2	Set.	58	5,893.6		341,829		341,829
	9 kV, 5 kA Lightning (Surge) arrester complete set (gapless type) - set of 3	Set.	70	8,637.2		604,603		604,603
	Single phase MCB with 2 pole ELCB with customer meter box, 10 Amps	Nos.	3,118	3,353.3		10,455,471		10,455,471
	Single phase MCB with 2 pole ELCB with customer meter box, 20 Amps	Nos.	164	3,353.3		549,935		549,935
	33kV Auto Recloser Circuit Breaker	Nos.	20	3,087,040.0		61,740,800		61,740,800
	11kV Auto Recloser Circuit Breaker	Nos.	13	2,113,570.0		27,476,410		27,476,410
8	CUSTOMER EQUIPMENT - ENERGY METERS							
	Energy meter, 1 Phase, 2.5/10 Amps.	Nos.	2,626	1,217.3		3,196,724		3,196,724
	Energy meter, 1 Phase, 5/20 Amps.	Nos.	492	1,217.3		598,929		598,929
	Energy meter, 1 Phase, 10/40 Amps.	Nos.	164	1,229.5		201,643		201,643
	Energy meter, 3 Phase, 10/60 Amps.	Nos.	467	3,861.3		1,803,242		1,803,242
	Energy meter seal	Nos.	3,749	4.1		15,238		15,238
9	MISCELLANEOUS CONSTRUCTION ITEMS							
	Bituminous black paint	Ltr.	19,035		73.9		1,407,548	2,646,190
	Cement	MT	1,288		3,956.0		5,097,065	9,582,482
	Sand	Cft	56,033		23.0		1,288,759	2,422,867
	Stone chips 20 mm aggregate	Cft	92,023		23.0		2,116,520	3,979,057
	Boulder for double pole bonding	Cft	28,258		57.5		1,624,853	3,054,723
10	LIGHTNING DAMAGE PREVENTION							
	Shield Wire Installation	km	290	81,824		23,728,989		23,728,989
	Counter-poise	nos	700	7,367		5,156,760		5,156,760
	Total					1,212,236,753	11,534,744	1,233,922,073

Table-R.2 Cost break down Worksheet (5/5)

2. Transportation Cost		借款对象率					100
item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Nu	yen	Nu	
Chhukha		1		1,725,899		1,725,899	3,244,690
Dagana		1		1,597,981		1,597,981	3,004,204
Haa		1		888,556		888,556	1,670,485
Paro		1		183,117		183,117	344,260
Pemagatshel		1		388,405		388,405	730,201
Punakha		1		407,407		407,407	765,926
Samtse		1		1,260,123		1,260,123	2,369,031
Sarpang		1		3,537,564		3,537,564	6,650,621
Trongsa		1		1,304,736		1,304,736	2,452,904
Tsirang		1		409,347		409,347	769,571
Wangdue		1		1,268,713		1,268,713	2,385,180
Lightning damage protection		1		614,590		614,590	1,155,430
ARCB		1		1,898,239		1,898,239	3,568,688
Total					0	15,484,677	29,111,192

3. Erection Cost		借款对象率					100
item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Nu	yen	Nu	
Chhukha		1		55,792,133		55,792,133	104,889,209
Dagana		1		26,003,387		26,003,387	48,886,367
Haa		1		21,097,568		21,097,568	39,663,428
Paro		1		1,271,481		1,271,481	2,390,385
Pemagatshel		1		10,114,528		10,114,528	19,015,312
Punakha		1		1,776,648		1,776,648	3,340,098
Samtse		1		46,964,538		46,964,538	88,293,331
Sarpang		1		113,101,878		113,101,878	212,631,530
Trongsa		1		9,500,413		9,500,413	17,860,776
Tsirang		1		7,011,910		7,011,910	13,182,391
Wangdue		1		7,896,582		7,896,582	14,845,574
Lightning damage protection		1		5,070,371		5,070,371	9,532,297
ARCB		1		15,660,468		15,660,468	29,441,679
Total					0	321,261,903	603,972,378

4. Tools and Vehicles		借款对象率					100
item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Nu	yen	Nu	
		1		23,324,468		23,324,468	23,324,468
Total					23,324,468	0	23,324,468

5. Compensation including the removal of orchard trees		借款对象率					100
item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Nu	yen	Nu	
		1		40,331,775		40,331,775	75,823,737
Total					0	40,331,775	75,823,737

6. Environmental Monitoring		借款对象率					100
item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Nu	yen	Nu	
		1		5,262,800.00		5,262,800	9,894,064
Total					0	5,262,800	9,894,064

Table-R.3 Schedule Worksheet

Implementation Schedule

	2011												2012												2013					Month
	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
																														0
Pledge																														0
Signing of Loan Agreement																														0
																														0
Pre Construction Stage																														
Implementing Consultant																														11
Preparation of Bid Document																														1
Concurrence by JICA																														1
Tender Floating																														2
Bid Evaluation																														1
Approval by CTC and Board Committee																														1
Concurrence by JICA																														1
Contract procedure with Consultant																														1
Procurement of Materials (ICB)																														18
Preparation of BOQ																														2
Preparation of Bid Document																														1
Concurrence by JICA																														1
Tender Floating																														1.5
Bid Evaluation																														1.5
Approval by CTC and Board Committee																														1
Concurrence by JICA																														1
Contract with Suppliers																														1
Civil and Installation Work (LCB)																														
Preparation of Bid Document																														2
Concurrence by JICA																														1
Tender Floating																														1.5
Bid Evaluation																														1.5
Approval by CTC and Board Committee																														1
Concurrence by JICA																														1
Contract with Suppliers																														1
Construction Stage																														
Design and Type Tests on Telescopic Poles																														2
Manufacturing of Telescop Poles and Delivery to P'lin																														8
Manufacturing of Other Materials and Delivery to P'lin																														9
Inland Transportation from P'lin to MicroStories																														3
Civil and Installation Work																														14
Commissioning																														10
Land Acquisition																														2
1. Substation and Line Materials																														10
2. Transportation Cost																														3
3. Erection Cost																														14
4. Tools and Vehicles																														1
5. Compensation including the removal of rochard trees																														2
6. Envrenmental Monitoring																														14

Table-R.4 Consul Cost Break Worksheet

Cost Breakdown for the Consulting Services

US \$ = yen 87.7
Nu = yen 1.88

	Unit	Qty.	Foreign Portion		Local Portion		Combined Total
			(Yen)		Nu		
			Rate	Amount ('000)	Rate	Amount ('000)	('000) Yen
A Remuneration							
1 Professional (A)	M/M	11	2,630,000	28,930	0	0	28,930
2 Professional (B)	M/M	0	0	0	0	0	0
3 Supporting Staffs	M/M	0	0	0	0	0	0
Subtotal of A				28,930		0	28,930
B Direct Cost							
1 International Airfare		10	500,000	5,000		0	5,000
2 Domestic Airfare		10	0	0	27,000	270	508
3 Domestic Travel			0	0		0	0
3 Accommodation Allowance	Month	11	0	0	150,000	1,650	3,102
	Month	0	0	0		0	0
	Month	0	0	0		0	0
4 Vehicle Rental	Month	11	0	0	32,000	352	662
5 Office Rental	M/M	11	0	0		0	0
6 International Communications	M/M	11	0	0		0	0
7 Domestic Communications	M/M	11	0	0	5,000	55	103
8 Office Supply	M/M	11	0	0		0	0
9 Office Furniture and Equipment	M/M	11	0	0		0	0
10 Report Preparation	Month	7	0	0	5,000	35	66
Subtotal of B				5,000		2,362	9,441
Total				33,930		2,362	38,371

Table-R.6 Annual Distribution I Worksheet

Annual Distribution of Cost

Item	Total			2011			2012			2013		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Substation and Line Materials	100%	100%	0%	40%	40%		60%	60%		0%	0%	
2. Transportation Cost	100%	100%	0%	0%	0%		100%	100%		0%	0%	
3. Erection Cost	100%	100%	0%	0%	0%		64%	64%		36%	36%	
4. Tools and Vehicles	100%	100%	0%	0%	0%		100%	100%		0%	0%	
5. Compensation including the removal of rochard trees	100%	100%	0%	0%	0%		100%	100%		0%	0%	
6. Environmenta Monitoring	100%	100%	0%	0%	0%		64%	64%		36%	36%	
7. Capacity Development Program	0%	0%	0%	0%	0%		0%	0%		0%	0%	
Land Acquisition						0%			100%			0%
Consultant	100%	100%	0%	0%	0%	0%	45%	45%	0%	55%	55%	0%

Table-R.7 Total Annual Fund Worksheet

Annual Fund Requirement

Base Year for Cost Estimation: Nov, 2010
 Exchange Rates: Nu = Yen 1.88
 Price Escalation: FC: 1.8% LC: 2.4%
 Physical Contingency 10%
 Physical Contingency for Consultant 10%

FC & Total: million JPY
 LC : million Nu

Item	2011			2012			2013		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION									
I.) Procurement / Construction	1,348	395	2,091	533	814	1,299	0	132	249
1. Substation and Line Materials	1,212	12	1,234	485	727	740	0	0	0
2. Transportation Cost	0	0	29	0	0	29	0	0	0
3. Erection Cost	0	321	604	0	0	207	0	115	216
Base cost for JICA financing	1,212	348	1,867	485	727	229	0	115	216
Price escalation	13	11	34	0	13	5	0	6	10
Physical contingency	123	36	190	48	49	74	23	118	23
II.) Consulting services	38	3	43	0	17	20	21	1	24
Base cost	34	2	38	0	15	17	19	1	21
Price escalation	1	0	1	0	0	0	0	0	1
Physical contingency	3	0	4	0	2	2	2	0	2
Total (I + II)	1,386	398	2,134	533	832	1,319	21	134	273
B. NON ELIGIBLE PORTION									
a Procurement / Construction	0	51	97	0	0	49	0	2	4
5. Compensation including the removal of orchard trees	0	40	76	0	0	40	0	0	0
6. Environmental Monitoring	0	5	10	0	0	3	6	0	4
Base cost for RCoB financing	0	46	86	0	0	44	82	0	4
Price escalation	0	1	2	0	0	1	2	0	0
Physical contingency	0	5	9	0	0	4	8	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0
c Administration cost	0	119	223	0	29	54	75	141	28
BIT (local)	0	8	15	0	0	5	10	0	5
BIT (foreign)	0	1	1	0	0	0	1	0	1
d Duties and Sales Tax	0	129	242	0	52	97	77	145	0
Total (a+b+c+d+e+f)	0	308	578	0	81	151	0	207	37
TOTAL (A+B)	1,386	706	2,713	533	832	1,708	21	154	310
C. Interest during Construction	25	0	25	3	0	10	12	0	12
Interest during Construction(Const.)	25	0	25	3	0	10	12	0	12
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0
D. Commitment Charge	6	0	6	2	0	2	2	2	2
GRAND TOTAL (A+B+C+D)	1,417	706	2,744	539	844	1,721	35	154	324
E. JICA finance portion incl. IDC (A + C + D)	1,417	398	2,166	539	844	1,331	35	134	286

Administration Cost = 10%
 BIT local = 2% of the expenditure in local currency of the eligible portion
 BIT foreign = 3% of the expenditure in foreign currency(consultation) of the eligible portion
 Duties and Sales Tax = 20% of the expenditure in foreign currency(material) of the eligible portion

Table-R.8 PSR(Cost by Item) Worksheet

Breakdown of Cost	Foreign Currency Portion			Local Currency Portion			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
1. Construction of MV line	1,212	1,212	0	12	12	0	1,234	1,234	0
2. Installation of pole mounted sub station	0	0	0	15	15	0	29	29	0
3. Construction of LV line	0	0	0	321	321	0	604	604	0
4. Tools and Vehicles	0	0	0	0	0	0	0	0	0
5. Compensation including the removal of	0	0	0	40	0	40	76	0	76
6. Environmental Monitoring	0	0	0	5	0	5	10	0	10
7. Capacity Development Program	0	0	0	0	0	0	0	0	0
Price Escalation	13	13	0	12	11	1	36	34	2
Physical Contingency	123	123	0	41	36	5	199	190	9
Consulting Services	38	38	0	3	3	0	43	43	0
Land Acquisition	0	0	0	0	0	0	0	0	0
Administration Cost	0	0	0	119	0	119	223	0	223
VAT	0	0	0	8	0	8	15	0	15
Import Tax	0	0	0	1	0	1	1	0	1
Interest during construction	25	25	0	0	0	0	25	25	0
Commitment Charge	6	6	0	0	0	0	6	6	0
Total	1,417	1,417	0	577	398	179	2,501	2,166	336

Table-R.9 PSR(Cost by Year) Worksheet

Breakdown of Cost	Total	JICA Portion	Others
2011	700	548	151
2012	1,721	1,331	389
2013	324	286	37
Total	2,744	2,166	578