

**The Integrated Master Plan Study  
for  
Dzongkhag-wise Electrification  
in Bhutan  
Final Report**

**October 2005**

**Japan International Cooperation Agency  
Economic Development Department**

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## Preface

In response to a request from Kingdom of Bhutan, the Government of Japan decided to conduct The Integrated Master Plan Study for Dzongkhag-wise Electrification in Bhutan and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Tomoyasu Fukuchi, Nippon Koei Co., Ltd. to Bhutan six times from December 2003 to November 2005.

The study team held discussions with the officials concerned of the Royal Government of Bhutan and conducted a series of field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope this report will be utilized for contributing to Dzongkhag-wise Electrification of Bhutan and to the promotion of amity between our two countries.

I also express my sincere appreciation to the officials concerned of the Royal Government of Bhutan for their close cooperation throughout the study.

November 2005

Tadashi IZAWA  
Vice President  
Japan International Cooperation Agency

November 2005

Mr. Tadashi IZAWA  
Vice President  
Japan International Cooperation Agency  
Tokyo, Japan

Dear Mr. Izawa,

### Letter of Transmittal

We are pleased to submit the Final Report on completion of the Integrated Master Plan Study for Dzongkhag-wise Electrification in Bhutan. The report consolidates the achievements of collaborative work between related organizations in Bhutan and the study team over the past two years.

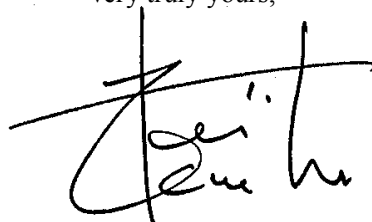
The Final Report has a role as an action plan for the Royal Government of Bhutan to materialize their ambitious goal of “electricity for all by 2020”. From the other point of view, the master plan shows how to derive a rational balance between two targets having potentially divergent objectives: environmental conservation and economic efficiency in the rural development. The balance point was planned to be the expansion of the distribution lines to 90% of the non-electrified rural households and providing off-grid electricity for the remaining 10%.

As for environmental consideration, the concept of Strategic Environmental Assessment was incorporated. The level of consideration given to the environment was significantly greater than had ever been done in the master plan stage.

In this study, technology transfer to the Bhutanese counterparts was performed diligently and with a sense of purpose. Technological innovation in the field of new energies, including renewable energy, is proceeding rapidly, and improvement in the economic efficiency of these technologies is accelerating. In the future, every time the master plan is reviewed, the balance point will be shifted towards the environmentally friendly side. The technology transfer was conducted so that the Bhutanese counterparts can review the master plan and modify the balance point by themselves. We hope that the master plan will continue to be modified toward the goals of Bhutan.

Finally, we would like to express sincere appreciation to the Bhutanese counterparts and other organizations in the Royal Government of Bhutan for their dedicated cooperation. In addition, we sincerely appreciate the support and guidance of JICA Head Office, JICA Bhutan Office and the JICA India Office. Furthermore, the study team would like to thank JBIC, the Embassy of Japan in India, and ADB for their cooperation and assistance toward the realization of the master plan.

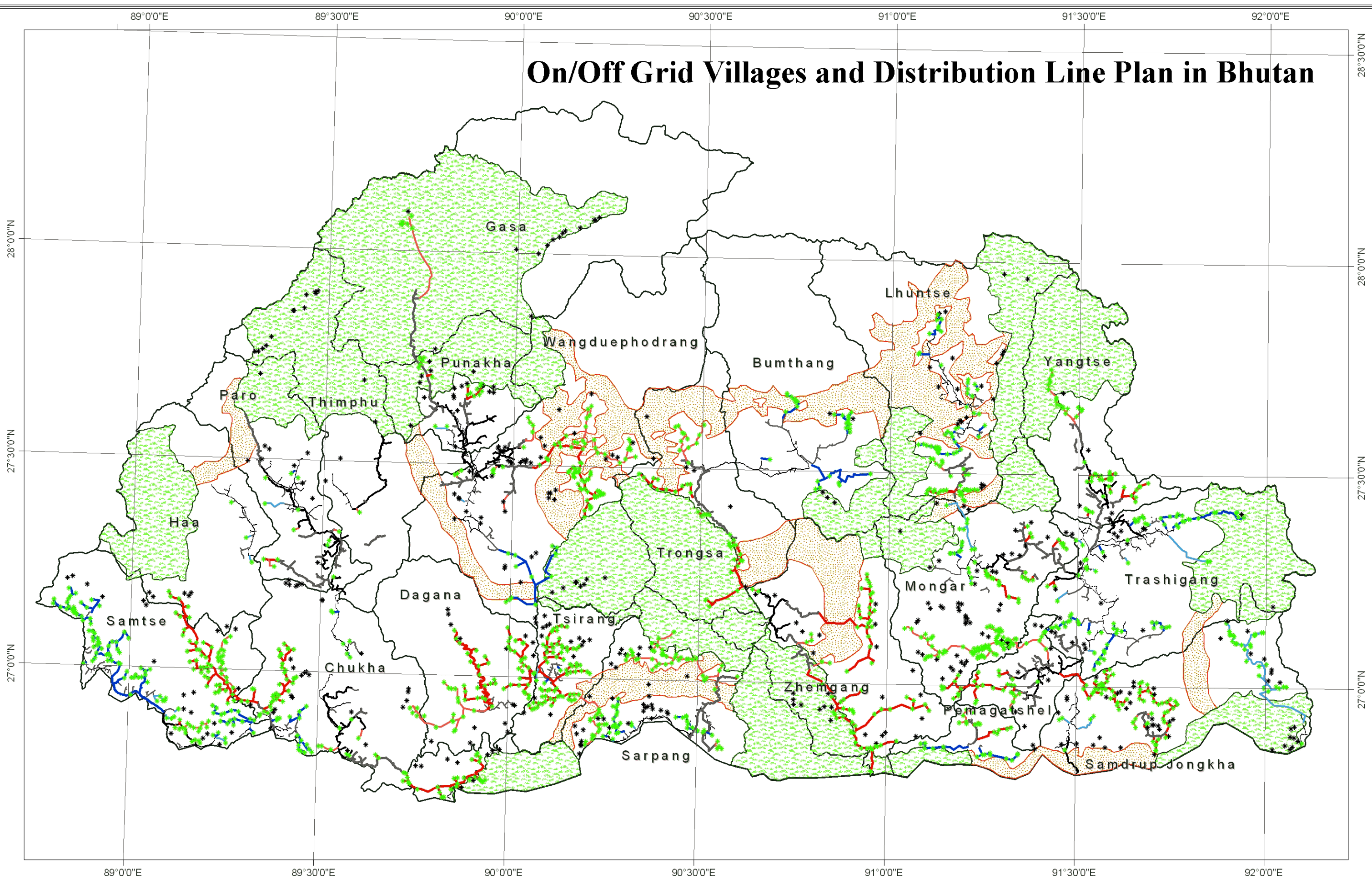
Very truly yours,



Tomoyasu FUKUCHI  
Team Leader

The Integrated Master Plan Study for  
Dzongkhag-wise Electrification in Bhutan

# On/Off Grid Villages and Distribution Line Plan in Bhutan

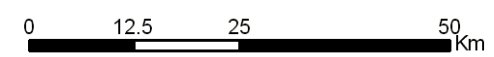


	9th FYP 11kV
	9th FYP 33kV
	Existing 11kV
	Existing 33kV

	10th FYP target 20,000 HH Electrified
	11kV 10th FYP 2007-2012
	33kV 10th FYP 2007-2012
	11kV 11th FYP 2012-2017
	33kV 11th FYP 2012-2017

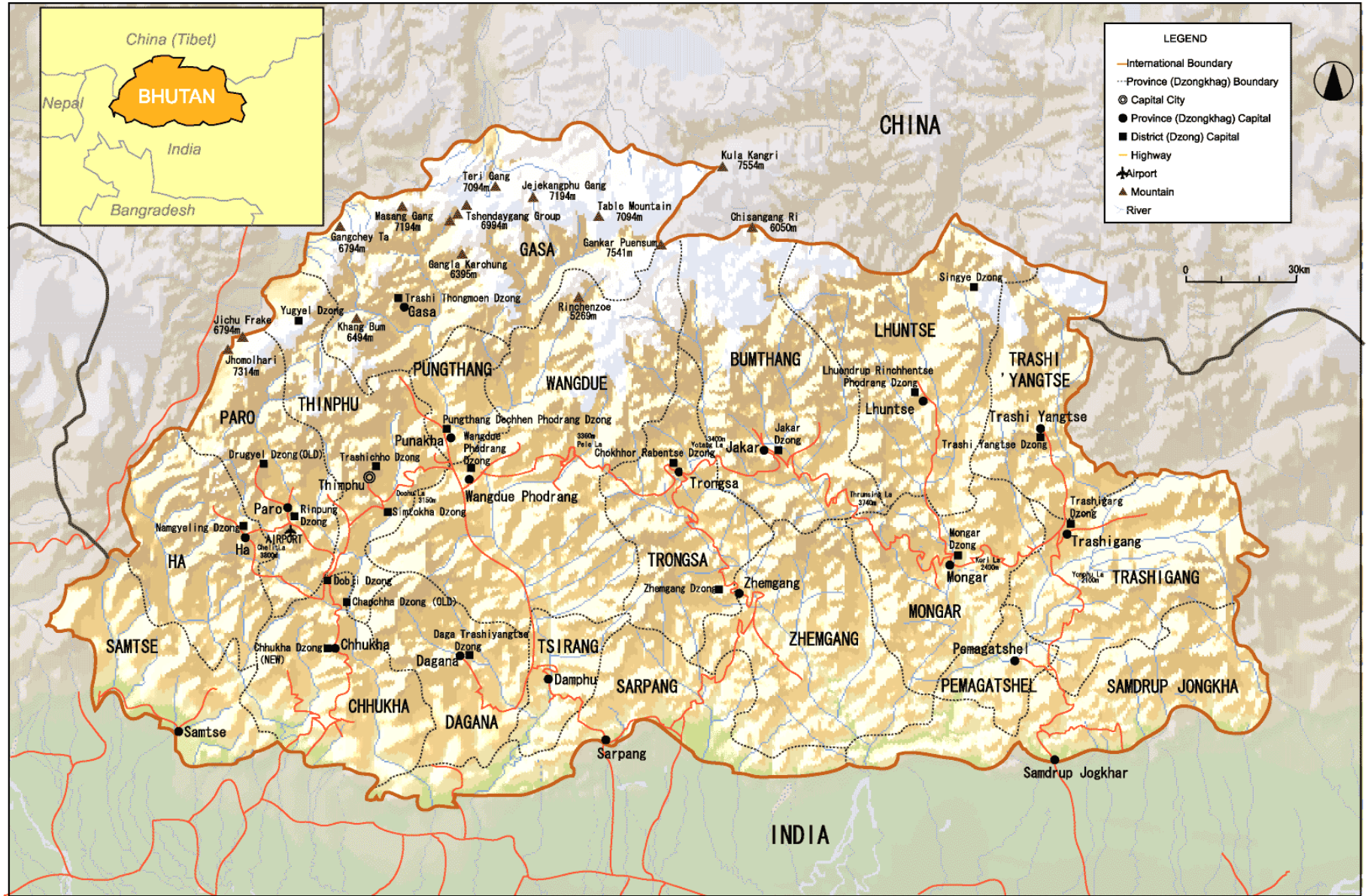
	Protected Area
	Corridor

	On-grid Village
	Off-grid Village



**JICA Study Team**  
 THE INTEGRATED MASTER PLAN STUDY  
 FOR DZONGKHAG-WISE ELECTRIFICATION  
 IN BHUTAN






Location Map of Study Area (Bhutan)

THE INTEGRATED MASTER PLAN STUDY  
FOR DZONGKHAG-WISE ELECTRIFICATION  
IN BHUTAN

FINAL REPORT

**PROFILES OF  
DZONGKHAG-WISE MASTER PLAN**

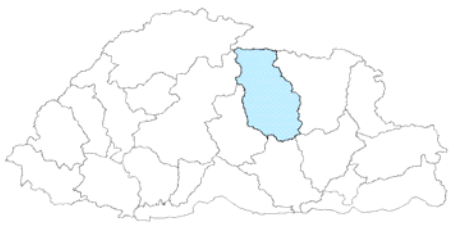
## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	-		
2	Name of Dzongkhag	<b>BHUTAN</b> (All 20 Dzongkhags)		
3	Nos of Non-electrified Village	in 2003 (Actual):	1,717	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	30,298	
		<b>in 2007 (Forecasted):</b>	<b>33,259</b>	
		in 2012 (Forecasted):	37,217	
		in 2017 (Forecasted):	41,469	
		in 2020 (Forecasted):	44,218	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	858	(50.0%)
		11th FYP (2012-2017):	410	(23.9%)
		<b>TOTAL</b>	1,268	(73.8%)
6	Nos of Villages to be electrified by Off-grid		449	(26.2%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	21,519	(64.7%)
		11th FYP (2012-2017):	7,819	(23.5%)
		<b>TOTAL</b>	29,338	(88.2%)
8	Nos of Household to be electrified by Off-grid*		3,918	(11.8%)
9	Investment for On-grid (x1000 Nu.)	10th FYP (2007-2012):	2,214,793	49,218 (US\$1,000)
		11th FYP (2012-2017):	996,217	22,138 (US\$1,000)
		<b>TOTAL</b>	3,211,010	71,356 (US\$1,000)
10	Investment for off-grid (x1000 Nu.)		114,407	2,542 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	1,579,952	
		11th FYP (2012-2017):	741,885	
		<b>TOTAL</b>	2,321,837	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	55.2%	
		On-grid in 2012:	84.0%	
		On-grid in 2017:	94.7%	
		Off-grid in 2017:	5.3%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	

\*: Numbers are based on the forecasted household number in 2007.

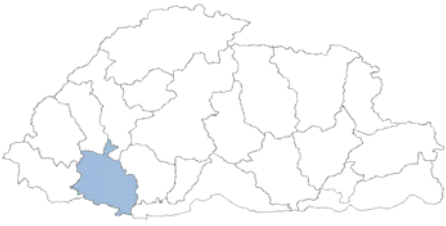


## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>A</b>		
2	Name of Dzongkhag	<b>Bumthang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	35	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	446	
		<b>in 2007 (Forecasted):</b>	<b>494</b>	
		in 2012 (Forecasted):	553	
		in 2017 (Forecasted):	630	
		in 2020 (Forecasted):	681	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	30	(85.7%)
		11th FYP (2012-2017):	0	(0.0%)
		<b>TOTAL</b>	30	<b>(85.7%)</b>
6	Nos of Villages to be electrified by Off-grid		5	(14.3%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	475	(96.2%)
		11th FYP (2012-2017):	0	(0.0%)
		<b>TOTAL</b>	475	<b>(96.2%)</b>
8	Nos of Household to be electrified by Off-grid *		19	(3.8%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	64,605	1,436 (US\$1,000)
		11th FYP (2012-2017):	0	0 (US\$1,000)
		<b>TOTAL</b>	64,605	<b>1,436 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		624	14 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	64,454	
		11th FYP (2012-2017):	0	
		<b>TOTAL</b>	64,454	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	75.4%	
		On-grid in 2012:	99.1%	
		On-grid in 2017:	99.1%	
		Off-grid in 2017:	0.9%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By the target year of 2020, 30 villages, corresponding 86% of non-electrified villages, are planned to be connected to the grid. This will provide on-grid electricity to 653 households, which is 96% of the non-electrified households. All grid extensions are to be implemented 10th FYP. There will be 28 off-grid households 5 villages. The total route length of the planned 11 kV medium voltage line is 64 km. The electricity will be supplied from Jakar and the proposed Garpang transmission substations. Since 8 km of the feeder MPA11F1 will pass through a biological corridor, covered conductors will be installed from this section of the feeder. The on-grid electrification cost is 65 million Nu. and that of off-grid is 0.62 million Nu. The on-grid electrification percentage is projected to be 75% in 2007, and will reach 99% in 10th FYP. The remaining 1% will be off-grid.			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>B</b>		
2	Name of Dzongkhag	<b>Chukha</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	108	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	1,814	
		<b>in 2007 (Forecasted):</b>	<b>1,985</b>	
		in 2012 (Forecasted):	2,244	
		in 2017 (Forecasted):	2,536	
		in 2020 (Forecasted):	2,699	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	63	(58.3%)
		11th FYP (2012-2017):	15	(13.9%)
		<b>TOTAL</b>	<b>78</b>	<b>(72.2%)</b>
6	Nos of Villages to be electrified by Off-grid		30	(27.8%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,422	(71.6%)
		11th FYP (2012-2017):	279	(14.1%)
		<b>TOTAL</b>	<b>1,701</b>	<b>(85.7%)</b>
8	Nos of Household to be electrified by Off-grid *		284	(14.3%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	122,292	2,718 (US\$1,000)
		11th FYP (2012-2017):	31,442	699 (US\$1,000)
		<b>TOTAL</b>	<b>153,734</b>	<b>3,416 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		8,626	192 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	94,186	
		11th FYP (2012-2017):	31,376	
		<b>TOTAL</b>	<b>125,562</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	56.4%	
		On-grid in 2012:	87.6%	
		On-grid in 2017:	93.8%	
		Off-grid in 2017:	6.2%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, 2,312 households in 78 villages, equivalent to 72% of the total number of non-electrified villages, will be connected the grid. A total of 387 households in 30 non-electrified villages will be off-grid. The total route length of the planned medium voltage line is 126 km, with 74% being 33 kV and the rest being 11 kV lines. 94 km will be constructed in 10th FYP and 31 km will be constructed in 11th FYP. There are no environmentally protected areas in this Dzongkhag. The on-grid electrification cost in 10th FYP is 122 million Nu., and that of 11th FYP is 32 million Nu. The off-grid investment is 8.7 million Nu. The on-grid electrification percentage in 2007 will be 56%, and will increase to 88% in 10th FYP and 94% in 11th FYP. The remaining 6% will be off-grid.			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>C</b>		
2	Name of Dzongkhag	<b>Dagana</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	83	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	2,121	
		<b>in 2007 (Forecasted):</b>	<b>2,360</b>	
		in 2012 (Forecasted):	2,692	
		in 2017 (Forecasted):	3,073	
		in 2020 (Forecasted):	3,313	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	48	(57.8%)
		11th FYP (2012-2017):	17	(20.5%)
		<b>TOTAL</b>	65	(78.3%)
6	Nos of Villages to be electrified by Off-grid		18	(21.7%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,731	(73.3%)
		11th FYP (2012-2017):	429	(18.2%)
		<b>TOTAL</b>	2,160	(91.5%)
8	Nos of Household to be electrified by Off-grid*		200	(8.5%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	191,245	4,250 (US\$1,000)
		11th FYP (2012-2017):	57,737	1,283 (US\$1,000)
		<b>TOTAL</b>	248,982	5,533 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		6,241	139 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	131,861	
		11th FYP (2012-2017):	42,850	
		<b>TOTAL</b>	174,711	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	34.2%	
		On-grid in 2012:	92.2%	
		On-grid in 2017:	93.3%	
		Off-grid in 2017:	5.9%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>On-grid connection to 3,033 households in 64 non-electrified villages, equivalent to 78% of the total of number of non-electrified villages, is the plan for 2020. This includes 545 households (forecast for the year 2020) connected to the existing 6.6 kV lines, for which power is currently supplied by a small hydropower. The 6.6 kV lines will be replaced with 33 kV lines. In addition, 18 villages with a total of 280 households will be off-grid.</p> <p>The total route length of the planned 33 kV medium voltage line is 175 km. For Dagana Dzongkhag, 132 km will be constructed in 10th FYP, including 45 km of existing 6.6 kV line replacement for the Dagana Small Hydropower. The remaining 43 km will be extended in 11th FYP. There are no environmentally protected areas in this Dzongkhag. Electricity will be supplied from the proposed Goshi substation, except for Lajab, Tsangkha and Drugelgang Gewog in the eastern areas, which will be supplied from Tsirang.</p> <p>Total on-grid electrification cost in 10th FYP is 191 million Nu., and that for 11th FYP is 58 million Nu. Total investment for on-grid electrification is 249 million Nu. and the off-grid investment is 6.3 million Nu.</p> <p>The on-grid electrification percentage in 2007 is projected to be relatively low at 34%. However, this will rise to 92% in 10th FYP and 93% in 11th FYP. The off-grid electrification will be 7%.</p>			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>D</b>		
2	Name of Dzongkhag	<b>Gasa</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	21	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	331	
		<b>in 2007 (Forecasted):</b>	<b>362</b>	
		in 2012 (Forecasted):	403	
		in 2017 (Forecasted):	448	
		in 2020 (Forecasted):	476	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	0	(0.0%)
		11th FYP (2012-2017):	7	(33.3%)
		<b>TOTAL</b>	<b>7</b>	<b>(33.3%)</b>
6	Nos of Villages to be electrified by Off-grid		14	(66.7%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	0	(0.0%)
		11th FYP (2012-2017):	184	(50.8%)
		<b>TOTAL</b>	<b>184</b>	<b>(50.8%)</b>
8	Nos of Household to be electrified by Off-grid *		178	(49.2%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	0	0 (US\$1,000)
		11th FYP (2012-2017):	30,255	672 (US\$1,000)
		<b>TOTAL</b>	<b>30,255</b>	<b>672 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		5,193	115 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	0	
		11th FYP (2012-2017):	32,039	
		<b>TOTAL</b>	<b>32,039</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	36.4%	
		On-grid in 2012:	36.4%	
		On-grid in 2017:	68.7%	
		Off-grid in 2017:	31.3%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>Half of the land in this Dzongkhag is covered by environmentally protected areas. By 2020, on-grid connection will be provided to 243 households in 7 villages, which is equivalent to 33% of the total number of non-electrified villages and 51% of the total of the non-electrified households. There is only one feeder, MPD33F1, which is 33 kV. This feeder, which will have a line length of 32 km, is planned to be extended in 11th FYP. Because of the environmental sensitivity of the route, feeder MPD33F1 was selected as the target for the draft TOR of an expected EIA study. This feeder extends in protected area and very steep mountains. Considering technical limitations anticipated especially over snow capped mountains during construction, as well as operation and maintenance and environmental issues, it would be recommended that small hydro be applied.</p> <p>As for 33 kV lines come from Lobesa 66/33/11 kV substation, only one 33 kV circuit breaker is installed for the supply to Punakha, Gasa, and Wangduephodraung. Thus, installation of separate 33 kV circuit breaker in each Dzongkhag needs to be examined in the F/S stage to enhance the reliability.</p> <p>Lunana Gewog will be all off-grid. There will be 233 off-grid households, equivalent to 49% of the non-electrified households in Gasa Dzongkhag. This is by far highest percentage of off-grid in the master plan for Bhutan.</p> <p>On the on-grid electrification investment is 30 million Nu. and the off-grid investment will be 5.2 million Nu.</p> <p>The on-grid electrification percentage in 2007 is projected to be 36%. No change will occur in 10th FYP. However, the percentage will increase to 69% in 11th FYP. Accordingly, it is preferred to prioritize the implementation of off-grid electrification from 10th FYP, taking Dzongkhag equity into account. At 31%, the planned off-grid electrification percentage is the highest in the nation.</p>			

\*: Numbers are based on the forecasted household number in 2007.

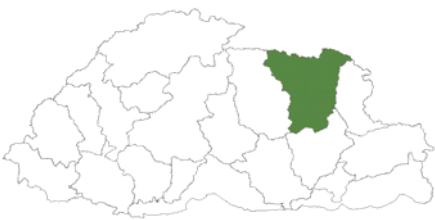
## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>E</b>		
2	Name of Dzongkhag	<b>Haa</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	15	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	248	
		<b>in 2007 (Forecasted):</b>	<b>277</b>	
		in 2012 (Forecasted):	320	
		in 2017 (Forecasted):	368	
		in 2020 (Forecasted):	402	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	8	(53.3%)
		11th FYP (2012-2017):	2	(13.3%)
		<b>TOTAL</b>	<b>10</b>	<b>(66.7%)</b>
6	Nos of Villages to be electrified by Off-grid		5	(33.3%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	182	(65.7%)
		11th FYP (2012-2017):	26	(9.4%)
		<b>TOTAL</b>	<b>208</b>	<b>(75.1%)</b>
8	Nos of Household to be electrified by Off-grid*		69	(24.9%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	23,349	519 (US\$1,000)
		11th FYP (2012-2017):	3,123	69 (US\$1,000)
		<b>TOTAL</b>	<b>26,472</b>	<b>588 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		2,229	50 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	20,925	
		11th FYP (2012-2017):	3,465	
		<b>TOTAL</b>	<b>24,389</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	77.0%	
		On-grid in 2012:	92.1%	
		On-grid in 2017:	94.3%	
		Off-grid in 2017:	5.7%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>A total of 302 households in 10 villages, equivalent to 75% of non-electrified households and 67% of the non-electrified villages, will be connected to the grid by 2020. Half of the Dzongkhag is covered by a national park. However, there are no target non-electrified villages found in the area. In Haa Dzongkhag, 100 households, representing 30% of the non-electrified households in 5 villages, will have off-grid electrification.</p> <p>The total route length of the planned medium voltage line is 24 km. For this line, 85% will be 33 kV and the remaining 15% will be 11 kV. Most of this route (21 km) will be constructed in 10th FYP and 3 km will be constructed in 11th FYP. The starting point of the line will be Chukha in the southern part of the Dzongkhag, and the line will also pass through Samtse.</p> <p>The on-grid electrification cost in 10th FYP is 23 million Nu., and that of 11th FYP is 3 million Nu., bringing the total to 27 million Nu. The off-grid investment will be 2.3 million Nu.</p> <p>The on-grid electrification percentage in 2007 will be 77%, and increase to 92% in 10th FYP and 94% in 11th FYP. The remaining 6% is the off-grid electrification percentage.</p>			

\*: Numbers are based on the forecasted household number in 2007.




## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>F</b>		
2	Name of Dzongkhag	<b>Luntse</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	103	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	1,377	
		<b>in 2007 (Forecasted):</b>	<b>1,477</b>	
		in 2012 (Forecasted):	1,619	
		in 2017 (Forecasted):	1,753	
		in 2020 (Forecasted):	1,852	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	46	(44.7%)
		11th FYP (2012-2017):	27	(26.2%)
		<b>TOTAL</b>	<b>73</b>	<b>(70.9%)</b>
6	Nos of Villages to be electrified by Off-grid		30	(29.1%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	821	(55.6%)
		11th FYP (2012-2017):	362	(24.5%)
		<b>TOTAL</b>	<b>1,183</b>	<b>(80.1%)</b>
8	Nos of Household to be electrified by Off-grid*		294	(19.9%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	96,182	2,137 (US\$1,000)
		11th FYP (2012-2017):	49,451	1,099 (US\$1,000)
		<b>TOTAL</b>	<b>145,632</b>	<b>3,236 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		8,202	182 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	53,376	
		11th FYP (2012-2017):	34,379	
		<b>TOTAL</b>	<b>87,755</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	44.1%	
		On-grid in 2012:	75.2%	
		On-grid in 2017:	88.9%	
		Off-grid in 2017:	11.1%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>By 2020, 73 villages with 1,484 households, equivalent to 71% of the total number of non-electrified villages and 80% of the non-electrified households, will be connected the grid. Off-grid electrification will be provided to 368 households in 30 villages, which represents 29% of the non-electrified villages and 20% of non-electrified households.</p> <p>The total route length of the planned medium voltage line is 88 km. For this route, 33% will be 33 kV lines and the remaining 67% will be 11 kV lines. Construction of 53 km will be completed in 10th FYP and 34 km will be constructed in 11th FYP. Many areas of the Dzongkhag are environmentally protected areas. This will require covered conductors being installed for a total of 3.2 km of the distribution line, of which 1.8 km will be constructed in 10th FYP.</p> <p>Currently, 132 kV transmission line from Kilikhar (Mongar) to Tangmachu (Lhuntse) is charged at 33 kV and 33 kV source for Autsho is directly tapped from 132 kV line. It is needed to include the study for the construction of substations in F/S.</p> <p>It is preferable to introduce off-grid electrification for villages in environmentally protected areas that are far from the planned distribution lines. Khoma Gewog is the priority location for off-grid electrification.</p> <p>The on-grid electrification cost in 10th FYP is 96 million Nu., and that of 11th FYP is 49 million Nu., bringing the total to 145 million Nu. The required off-grid investment will be 8 million Nu.</p> <p>The on-grid electrification percentage in 2007 will be 44%, and increase to 75% in 10th FYP and 89% in 11th FYP. The off-grid electrification percentage will be 11%.</p>			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>G</b>		
2	Name of Dzongkhag	<b>Mongar</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	183	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	2,662	
		<b>in 2007 (Forecasted):</b>	<b>2,865</b>	
		in 2012 (Forecasted):	3,172	
		in 2017 (Forecasted):	3,480	
		in 2020 (Forecasted):	3,686	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	44	(24.0%)
		11th FYP (2012-2017):	82	(44.8%)
		<b>TOTAL</b>	126	(68.9%)
6	Nos of Villages to be electrified by Off-grid		57	(31.1%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,057	(36.9%)
		11th FYP (2012-2017):	1,310	(45.7%)
		<b>TOTAL</b>	2,367	(82.6%)
8	Nos of Household to be electrified by Off-grid *		498	(17.4%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	119,282	2,651 (US\$1,000)
		11th FYP (2012-2017):	172,939	3,843 (US\$1,000)
		<b>TOTAL</b>	292,221	6,494 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		14,309	318 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	62,856	
		11th FYP (2012-2017):	111,164	
		<b>TOTAL</b>	174,019	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	51.0%	
		On-grid in 2012:	69.1%	
		On-grid in 2017:	91.5%	
		Off-grid in 2017:	8.5%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, 126 villages with 3,044 households, equivalent to 69% of the total number of non-electrified villages and 83% of the non-electrified households, will be connected the grid. There will be 642 off-grid households, which is the largest number of off-grid households in one Dzongkhag in Bhutan. The total route length of the planned medium voltage line is 174 km. For this route, 80% will be 33 kV lines and the remaining 20% will be 11 kV lines. There will be 63 km of line constructed in 10th FYP and 111 km in 11th FYP. Electricity is provided from Pemagatshel in the southern part of the Dzongkhag. The feeder that extends to Lhuntse includes 17 km in environmentally protected areas. This section of the line will use covered conductors. The on-grid electrification cost in 10th FYP is 120 million Nu., and that of 11th FYP is 173 million Nu., bringing the total to 292 million Nu. The off-grid investment will be 14 million Nu. The on-grid electrification percentage in 2007 will be 51%, and increase to 69% in 10th FYP and 91% in 11th FYP. The off-grid electrification percentage will be 9%.			

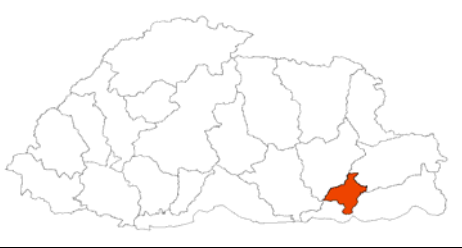
\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>H</b>		
2	Name of Dzongkhag	<b>Paro</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	22	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	162	
		<b>in 2007 (Forecasted):</b>	<b>174</b>	
		in 2012 (Forecasted):	196	
		in 2017 (Forecasted):	221	
		in 2020 (Forecasted):	234	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	5	(22.7%)
		11th FYP (2012-2017):	6	(27.3%)
		<b>TOTAL</b>	<b>11</b>	<b>(50.0%)</b>
6	Nos of Villages to be electrified by Off-grid		11	(50.0%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	57	(32.8%)
		11th FYP (2012-2017):	47	(27.0%)
		<b>TOTAL</b>	<b>104</b>	<b>(59.8%)</b>
8	Nos of Household to be electrified by Off-grid *		70	(40.2%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	5,447	121 (US\$1,000)
		11th FYP (2012-2017):	8,735	194 (US\$1,000)
		<b>TOTAL</b>	<b>14,182</b>	<b>315 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		2,051	46 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	5,577	
		11th FYP (2012-2017):	12,297	
		<b>TOTAL</b>	<b>17,874</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	96.0%	
		On-grid in 2012:	97.3%	
		On-grid in 2017:	98.4%	
		Off-grid in 2017:	1.6%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b>  Almost all the households in Paro (96%) will be electrified in 2007, as most already have electricity. By 2020, on-grid connection will be provided to 11 villages with 142 households, equivalent to 50% of non-electrified villages and 61% of non-electrified households. There will be 92 off-grid households. The total route length of the planned medium voltage line is 18 km, of which 48% will be 33 kV lines and the remaining 17% will be 11 kV lines. For this route, 6 km will be constructed in 10th FYP and 12 km will be constructed in 11th FYP. There are some non-electrified villages in environmentally protected areas in the northern part of the Dzongkhag, and these will be off-grid. The on-grid electrification cost in 10th FYP will be 5 million Nu., that of 11th FYP will be 9 million Nu., bringing the total to 14 million Nu. The off-grid investment will be 2 million Nu.  The on-grid electrification percentage in 2007 will be 96%, which is the highest in Bhutan. This is because most parts of the Dzongkhag are already connected to the grid. It will increase to 97% in 10th FYP and 98% in 11th FYP. The off-grid electrification percentage will be 2% by 2020.			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>I</b>		
2	Name of Dzongkhag	<b>Pemagatshel</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	33	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	650	
		<b>in 2007 (Forecasted):</b>	<b>643</b>	
		in 2012 (Forecasted):	643	
		in 2017 (Forecasted):	643	
		in 2020 (Forecasted):	643	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	16	(48.5%)
		11th FYP (2012-2017):	10	(30.3%)
		<b>TOTAL</b>	<b>26</b>	<b>(78.8%)</b>
6	Nos of Villages to be electrified by Off-grid		7	(21.2%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	470	(73.1%)
		11th FYP (2012-2017):	125	(19.4%)
		<b>TOTAL</b>	<b>595</b>	<b>(92.5%)</b>
8	Nos of Household to be electrified by Off-grid *		48	(7.5%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	48,320	1,074 (US\$1,000)
		11th FYP (2012-2017):	22,991	511 (US\$1,000)
		<b>TOTAL</b>	<b>71,311</b>	<b>1,585 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		1,070	24 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	31,521	
		11th FYP (2012-2017):	23,752	
		<b>TOTAL</b>	<b>55,273</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	76.8%	
		On-grid in 2012:	93.8%	
		On-grid in 2017:	98.3%	
		Off-grid in 2017:	1.7%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, 26 villages with 595 households, equivalent to 79% of the total number of the non-electrified villages and 93% of the non-electrified households, will be connected the grid. The number of off-grid households will be 48. The total route length of the planned 33 kV medium voltage line is 55 km. 32 km will be constructed in 10th FYP and the remaining 24 km will be constructed in 11th FYP. There are no environmentally protected areas in this Dzongkhag. The on-grid electrification cost in 10th FYP is 48 million Nu., and that of 11th FYP is 23 million Nu., bringing the total to 71 million Nu. The off-grid investment will be one million Nu. The on-grid electrification percentage in 2007 will be 77%. This will increase to 94% in 10th FYP and 98% in 11th FYP. The off-grid electrification percentage will be 2%.			

\*: Numbers are based on the forecasted household number in 2007.

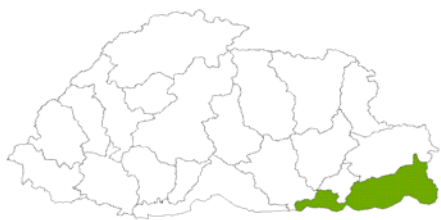
## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>J</b>		
2	Name of Dzongkhag	<b>Punakha</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	35	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	263	
		<b>in 2007 (Forecasted):</b>	<b>275</b>	
		in 2012 (Forecasted):	294	
		in 2017 (Forecasted):	313	
		in 2020 (Forecasted):	331	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	15	(42.9%)
		11th FYP (2012-2017):	2	(5.7%)
		<b>TOTAL</b>	17	(48.6%)
6	Nos of Villages to be electrified by Off-grid		18	(51.4%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	167	(60.7%)
		11th FYP (2012-2017):	15	(5.5%)
		<b>TOTAL</b>	182	(66.2%)
8	Nos of Household to be electrified by Off-grid *		93	(33.8%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	21,812	485 (US\$1,000)
		11th FYP (2012-2017):	3,211	71 (US\$1,000)
		<b>TOTAL</b>	25,023	556 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		2,496	55 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	22,139	
		11th FYP (2012-2017):	5,426	
		<b>TOTAL</b>	27,565	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	88.6%	
		On-grid in 2012:	95.5%	
		On-grid in 2017:	96.1%	
		Off-grid in 2017:	3.9%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, 17 villages with 219 households, equivalent to 49% of the total number of non-electrified villages and 66% of the non-electrified households, will be connected the grid. The number of off-grid household will be 112. The total route length of the planned medium voltage line is 25 km. For this route, 76% will be 33 kV lines and remaining 24% will be 11 kV lines. There will be 22 km constructed in 10th FYP and 3 km will be constructed in 11th FYP. In addition, 7 km of the distribution line passes through environmentally protected areas and covered conductors will be installed in this section. All of the line that is in the environmentally protected area will be constructed in 10th FYP. As for 33 kV lines come from Lobesa 66/33/11 kV substation, only one 33 kV circuit breaker is installed for the supply to Punakha, Gasa, and Wangduephodraung. Thus, installation of separate 33 kV circuit breaker in each Dzongkhag needs to be examined in the F/S stage to enhance the reliability. The on-grid electrification cost in 10th FYP will be 22 million Nu., and that of 11th FYP will be 3 million Nu., bringing the total to 25 million Nu. The off-grid investment will be 2.5 million Nu. The on-grid electrification percentage in 2007 will be 89%, which is the third highest in Bhutan. It will increase to 95.5% in 10th FYP and 96.2% in 11th FYP. The off-grid electrification percentage will be 4%.			

\*: Numbers are based on the forecasted household number in 2007.




## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>K</b>		
2	Name of Dzongkhag	<b>Samdrup Jongkhar</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	177	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	3,573	
		<b>in 2007 (Forecasted):</b>	<b>3,837</b>	
		in 2012 (Forecasted):	4,200	
		in 2017 (Forecasted):	4,590	
		in 2020 (Forecasted):	4,842	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	83	(46.9%)
		11th FYP (2012-2017):	45	(25.4%)
		<b>TOTAL</b>	<b>128</b>	<b>(72.3%)</b>
6	Nos of Villages to be electrified by Off-grid		49	(27.7%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	2,212	(57.7%)
		11th FYP (2012-2017):	1,221	(31.8%)
		<b>TOTAL</b>	<b>3,433</b>	<b>(89.5%)</b>
8	Nos of Household to be electrified by Off-grid*		401	(10.5%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	203,489	4,522 (US\$1,000)
		11th FYP (2012-2017):	173,691	3,860 (US\$1,000)
		<b>TOTAL</b>	<b>377,180</b>	<b>8,382 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		11,300	251 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	144,186	
		11th FYP (2012-2017):	106,173	
		<b>TOTAL</b>	<b>250,358</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	31.2%	
		On-grid in 2012:	70.7%	
		On-grid in 2017:	92.8%	
		Off-grid in 2017:	7.2%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>There are 4,842 non-electrified households predicted for 2020, which is the second largest in Bhutan after Samtse. There are 4,335 households in 128 villages, equivalent to 72% of the total number of the non-electrified villages, that will be connected to the grid. The total route length of planned medium voltage lines is 250 km. Of this, 50% will be 33 kV lines and the remaining 68% will be 11kV lines. Lauri and Serthing Gewog in the northeastern part of the Dzongkhag will be supplied from India. In addition, 14 km of feeder MPK11F2-4 passes through a national park. This is the longest length of line in a protected area. In addition, the source identified for grid extension is from Daifam which receives electric supply from India and this supply is known for its poor reliability. Therefore, the feasibility study of micro hydro is recommended for not only provide reliable supply of electricity to the Shingkar Lauri villages but can also feed back the Daifam villages by our own supply in the future.</p> <p>The on-grid electrification cost in 10th FYP is 203 million Nu., and that of 11th FYP is 174 million Nu., bringing the total to 377 million Nu. The off-grid investment is 11 million Nu.</p> <p>The on-grid electrification percentage in 2007 will be quite low at 31%. However, it will become 71% in 10th FYP and 93% in 11th FYP. The off-grid electrification percentage will be 7%.</p>			

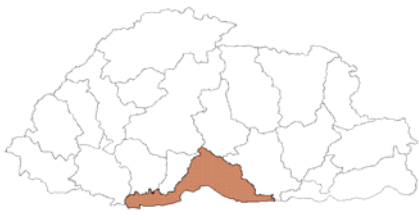
\*: Numbers are based on the foreasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>L</b>		
2	Name of Dzongkhag	<b>Samtse</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	181	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	4,318	
		<b>in 2007 (Forecasted):</b>	<b>4,765</b>	
		in 2012 (Forecasted):	5,366	
		in 2017 (Forecasted):	6,088	
		in 2020 (Forecasted):	6,541	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	119	(65.7%)
		11th FYP (2012-2017):	41	(22.7%)
		<b>TOTAL</b>	<b>160</b>	<b>(88.4%)</b>
6	Nos of Villages to be electrified by Off-grid		21	(11.6%)
7	Nos of Household to be electrified by On-grid*	10th FYP (2007-2012):	3,658	(76.8%)
		11th FYP (2012-2017):	852	(17.9%)
		<b>TOTAL</b>	<b>4,510</b>	<b>(94.6%)</b>
8	Nos of Household to be electrified by Off-grid*		255	(5.4%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	280,368	6,230 (US\$1,000)
		11th FYP (2012-2017):	71,205	1,582 (US\$1,000)
		<b>TOTAL</b>	<b>351,573</b>	<b>7,813 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		7,756	172 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	243,224	
		11th FYP (2012-2017):	57,265	
		<b>TOTAL</b>	<b>300,488</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	39.5%	
		On-grid in 2012:	85.9%	
		On-grid in 2017:	96.8%	
		Off-grid in 2017:	3.2%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>By 2020, 6,193 households in 160 villages, equivalent to 88% of the total number of the non-electrified villages and 95% of the non-electrified households, will be on-grid. This is the largest number of on-grid houses in a Dzongkhag in Bhutan. The number of off-grid households will be 348.</p> <p>The total route length of the planned medium voltage lines is 292 km. For this route, 45% of the lines are 33 kV and the remainders are 11kV lines. Most of the route (234 km) is planned to be extended in 10th FYP, and the remaining 57 km will be extended in 11th FYP. There route does not pass through any environmentally protected areas.</p> <p>Mayona, Dungtoe, Dorokha, Denchhukha and Tading Gewogs in the eastern part of the Dzongkhag are to be supplied from Chukha. Bara and Tendu Gewogs in the northwestern part of the Dzongkhag are to be supplied from Jaldhaka substation in India. This will require installation of two voltage regulators and replacement of 20 km of existing lines. As the demand and characteristics of the lines in India is not clear, it is needed that the design be examined measuring the voltage at the receiving point from India.</p> <p>The on-grid electrification cost in 10th FYP is 280 million Nu., and that in 11th FYP is 71 million Nu., bringing the total to 352 million Nu. The off-grid investment will be 8 million Nu.</p> <p>The on-grid electrification percentage in 2007 will be 40%. It will increase to 86% in 10th FYP and 97% in 11th FYP. The off-grid electrification percentage will be 3%.</p>			

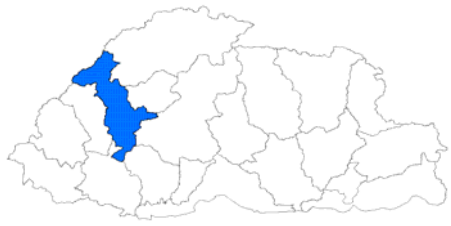
\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>M</b>		
2	Name of Dzongkhag	<b>Sarpang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	162	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	2,570	
		<b>in 2007 (Forecasted):</b>	<b>2,993</b>	
		in 2012 (Forecasted):	3,457	
		in 2017 (Forecasted):	3,999	
		in 2020 (Forecasted):	4,346	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	59	(36.4%)
		11th FYP (2012-2017):	64	(39.5%)
		<b>TOTAL</b>	123	(75.9%)
6	Nos of Villages to be electrified by Off-grid		39	(24.1%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,385	(46.3%)
		11th FYP (2012-2017):	1,223	(40.9%)
		<b>TOTAL</b>	2,608	(87.1%)
8	Nos of Household to be electrified by Off-grid*		385	(12.9%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	123,481	2,744 (US\$1,000)
		11th FYP (2012-2017):	134,572	2,990 (US\$1,000)
		<b>TOTAL</b>	258,053	5,735 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		12,370	275 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	92,646	
		11th FYP (2012-2017):	105,796	
		<b>TOTAL</b>	198,443	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	41.2%	
		On-grid in 2012:	68.4%	
		On-grid in 2017:	92.4%	
		Off-grid in 2017:	7.6%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, there will be 3,791 on-grid electrified households in 123 villages, which is equivalent to 76% of the total of the non-electrified villages and 87% of non-electrified household. The number of off-grid households will be 555, which is the second largest number for a Dzongkhag. The total route length of the planned medium voltage lines is 198 km. For this route, 82% of the lines will be 33 kV and the remaining lines will be 11kV. 92 km is planned to be extended in 10th FYP and 106 km is planned to be extended in 11th FYP. The electricity needs of Lhamnozinkha and Michula Gewogs are currently supplied by diesel generators. These Gewogs have been prioritized for 10th FYP implementation to save the cost diesel fuel. Lhamozinkha, Deorali, and Nichula Gewogs will be supplied from Chukha, while Senge and Hiley Gewogs will be supplied from Tsirang. Belkhola, Larpani and Hiley Gewogs will be supplied from the Golephu substation, and an installation of voltage regulator is required for these areas. In addition, currently, there is no 33 kV source at Gelephu Substation. Therefore, it needs to examine to install either 132/33 or 66/33kV transformer at the substation in the F/S stage. Four (4) feeders go through environmentally protected areas and these lines will have covered conductors within the protected areas. The total length of the lines in the protected areas is 32 km. Of this, 11.1 km is planned to be implemented in 10th FYP. The on-grid electrification cost in 10th FYP is 123 million Nu., and that in 11th FYP is 134 million Nu., bringing the total to 258 million Nu. The off-grid investment will be 12 million Nu. The on-grid electrification percentage in 2007 will be 41%. This will increase to 68% in 10th FYP and 92% in 11th FYP. The off-grid electrification percentage will be 8%.			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>N</b>		
2	Name of Dzongkhag	<b>Thimphu</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	16	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	132	
		<b>in 2007 (Forecasted):</b>	<b>135</b>	
		in 2012 (Forecasted):	146	
		in 2017 (Forecasted):	152	
		in 2020 (Forecasted):	157	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	0	(0.0%)
		11th FYP (2012-2017):	1	(6.3%)
		<b>TOTAL</b>	1	(6.3%)
6	Nos of Villages to be electrified by Off-grid		15	(93.8%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	0	(0.0%)
		11th FYP (2012-2017):	14	(10.4%)
		<b>TOTAL</b>	14	(10.4%)
8	Nos of Household to be electrified by Off-grid*		121	(89.6%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	0	0 (US\$1,000)
		11th FYP (2012-2017):	1,604	36 (US\$1,000)
		<b>TOTAL</b>	1,604	36 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		3,143	70 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	0	
		11th FYP (2012-2017):	1,482	
		<b>TOTAL</b>	1,482	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	93.0%	
		On-grid in 2012:	93.0%	
		On-grid in 2017:	93.7%	
		Off-grid in 2017:	6.3%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, just 16 households in one village, equivalent to 6% of the total of the non-electrified villages, will be on-grid. The total route length of the planned 33 kV medium voltage line is only 1 km. No village will be connected to the grid in 10th FYP and the 14 households will be connected in 11th FYP. 141 households in 15 villages will be off-grid. The on-grid electrification cost in 11th FYP is 1.6 million Nu. and that of the off-grid electrification is 3.2 million Nu. The on-grid electrification percentage in 2007 will be as much as 93%, as almost all the areas are already electrified. It will be the same in 10th FYP and finally increase to 94% in 11th FYP. The off-grid electrification percentage will be 6%.			

\*: Numbers are based on the forecasted household number in 2007.


## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>O</b>		
2	Name of Dzongkhag	<b>Trashigang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	105	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	2,087	
		<b>in 2007 (Forecasted):</b>	<b>2,206</b>	
		in 2012 (Forecasted):	2,370	
		in 2017 (Forecasted):	2,553	
		in 2020 (Forecasted):	2,663	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	67	(63.8%)
		11th FYP (2012-2017):	15	(14.3%)
		<b>TOTAL</b>	<b>82</b>	<b>(78.1%)</b>
6	Nos of Villages to be electrified by Off-grid		23	(21.9%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,606	(72.8%)
		11th FYP (2012-2017):	444	(20.1%)
		<b>TOTAL</b>	<b>2,050</b>	<b>(92.9%)</b>
8	Nos of Household to be electrified by Off-grid*		156	(7.1%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	172,827	3,841 (US\$1,000)
		11th FYP (2012-2017):	46,825	1,041 (US\$1,000)
		<b>TOTAL</b>	<b>219,653</b>	<b>4,881 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		4,279	95 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	102,740	
		11th FYP (2012-2017):	30,457	
		<b>TOTAL</b>	<b>133,197</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	74.8%	
		On-grid in 2012:	93.1%	
		On-grid in 2017:	98.2%	
		Off-grid in 2017:	1.8%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b>  By 2020, there will be 82 villages with 2,471 households connected to the grid. This is equivalent to 78% of the total number of non-electrified villages and 93% of non-electrified households. The number of off-grid households will be 192. The total route length of the planned 11 kV medium voltage line is 133 km. Of this, 102 km (97%) will be constructed in 10th FYP and 31 km will be constructed in 11th FYP. The 17 households in Merak Gewog will be supplied from Samdrup Jongkhar. An ABS will be installed in Sakten and Kangpara Gewogs. Lines in Sakten and Merak Gewogs pass through environmentally protected areas and will require covered conductors to be used in these areas. Feeder MPO11F1-3 will be expanded in 10th FYP and there will be 18 km within protected areas. One option for MPO11F1-3 is to apply 33 kV system instead of change the feeder from 11 kV system with voltage regulator. There is a technical merit for 33 kV including reduction of power loss, however, 11 kV has a cost merit. It is recommended to conduct additional examination from overall perspective in a feasibility study. The on-grid electrification cost in 10th FYP is 173 million Nu., and that in 11th FYP is 48 million Nu., bringing the total to 220 million Nu. The off-grid investment is 4 million Nu. The on-grid electrification percentage in 2007 will be 75%. It will increase to 93% in 10th FYP and 98% in 11th FYP. The off-grid electrification percentage will be 2%.			

\*: Numbers are based on the forecasted household number in 2007.

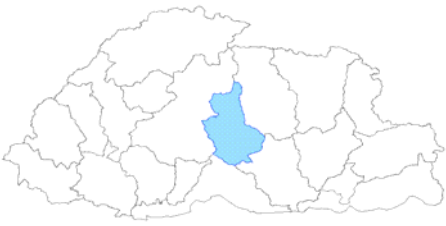


## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>P</b>		
2	Name of Dzongkhag	<b>Yangtse</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	56	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	1,157	
		<b>in 2007 (Forecasted):</b>	<b>1,262</b>	
		in 2012 (Forecasted):	1,407	
		in 2017 (Forecasted):	1,570	
		in 2020 (Forecasted):	1,678	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	31	(55.4%)
		11th FYP (2012-2017):	20	(35.7%)
		<b>TOTAL</b>	<b>51</b>	<b>(91.1%)</b>
6	Nos of Villages to be electrified by Off-grid		5	(8.9%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	874	(69.3%)
		11th FYP (2012-2017):	353	(28.0%)
		<b>TOTAL</b>	<b>1,227</b>	<b>(97.2%)</b>
8	Nos of Household to be electrified by Off-grid *		35	(2.8%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	90,770	2,017 (US\$1,000)
		11th FYP (2012-2017):	51,674	1,148 (US\$1,000)
		<b>TOTAL</b>	<b>142,444</b>	<b>3,165 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		1,025	23 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	36,694	
		11th FYP (2012-2017):	28,571	
		<b>TOTAL</b>	<b>65,265</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	59.3%	
		On-grid in 2012:	87.5%	
		On-grid in 2017:	98.9%	
		Off-grid in 2017:	1.1%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, there will be 51 villages with the households of 1,632 connected to the grid. This is equivalent to 91% of the total number of the non-electrified villages and 97% of the non-electrified households. A total of 46 households will be off-grid. The total route length of the planned 33 kV medium voltage line is 65 km. All electricity will be supplied from the Trashigang substation. There will be 37 km of line constructed in 10th FYP and 29 km constructed in 11th FYP. Covered conductors will be installed for 14 km of the distribution line, where it passes through environmentally protected areas. The on-grid electrification cost in 10th FYP will be 91 million Nu., and that in 11th FYP will be 52 million Nu., bringing the total to 142 million Nu. The off-grid investment will be one million Nu. The on-grid electrification percentage in 2007 will be 59%. It will increase to 87% in 10th FYP and 99% in 11th FYP. The off-grid electrification percentage will be only 1%.			

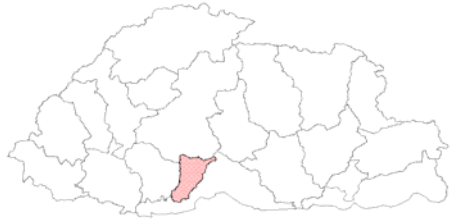
\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>Q</b>		
2	Name of Dzongkhag	<b>Trongsa</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	49	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	860	
		<b>in 2007 (Forecasted):</b>	<b>961</b>	
		in 2012 (Forecasted):	1,115	
		in 2017 (Forecasted):	1,278	
		in 2020 (Forecasted):	1,404	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	33	(67.3%)
		11th FYP (2012-2017):	11	(22.4%)
		<b>TOTAL</b>	<b>44</b>	<b>(89.8%)</b>
6	Nos of Villages to be electrified by Off-grid		5	(10.2%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	706	(73.5%)
		11th FYP (2012-2017):	223	(23.2%)
		<b>TOTAL</b>	<b>929</b>	<b>(96.7%)</b>
8	Nos of Household to be electrified by Off-grid *		32	(3.3%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	99,236	2,205 (US\$1,000)
		11th FYP (2012-2017):	36,591	813 (US\$1,000)
		<b>TOTAL</b>	<b>135,827</b>	<b>3,018 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		1,092	24 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	68,650	
		11th FYP (2012-2017):	26,991	
		<b>TOTAL</b>	<b>95,641</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	44.4%	
		On-grid in 2012:	85.3%	
		On-grid in 2017:	98.1%	
		Off-grid in 2017:	1.9%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>By 2020, there will be 44 villages with 1,355 households connected to the grid. This is equivalent to 90% of the total number of non-electrified villages and 97% of the non-electrified households. There will be 49 off-grid households. The total route length of the planned 33 kV medium voltage line is 96 km. Electricity will be supplied from the Trongsa substation. There will be 69 km of line constructed in 10th FYP and 27 km will be constructed in 11th FYP. Three feeders pass through environmentally protected areas and covered conductors will be required where this occurs. There are 27 km (68% of total length) in protected areas. All of these lines will be constructed in 10th FYP. The on-grid electrification cost in 10th FYP is 100 million Nu., and that of 11th FYP is 37 million Nu., bringing the total to 136 million Nu. The off-grid investment will be 1.1 million Nu. The on-grid electrification percentage in 2007 will be 44%. It will increase to 85% in 10th FYP and 98% in 11th FYP. The off-grid electrification percentage will be 2%.</p>			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>R</b>		
2	Name of Dzongkhag	<b>Tsirang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	86	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	2,186	
		<b>in 2007 (Forecasted):</b>	<b>2,594</b>	
		in 2012 (Forecasted):	3,064	
		in 2017 (Forecasted):	3,432	
		in 2020 (Forecasted):	3,686	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	69	(80.2%)
		11th FYP (2012-2017):	1	(1.2%)
		<b>TOTAL</b>	<b>70</b>	<b>(81.4%)</b>
6	Nos of Villages to be electrified by Off-grid		16	(18.6%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	2,423	(93.4%)
		11th FYP (2012-2017):	30	(1.2%)
		<b>TOTAL</b>	<b>2,453</b>	<b>(94.6%)</b>
8	Nos of Household to be electrified by Off-grid *		141	(5.4%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	234,916	5,220 (US\$1,000)
		11th FYP (2012-2017):	3,182	71 (US\$1,000)
		<b>TOTAL</b>	<b>238,099</b>	<b>5,291 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		4,413	98 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	117,228	
		11th FYP (2012-2017):	3,623	
		<b>TOTAL</b>	<b>120,851</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	23.8%	
		On-grid in 2012:	95.0%	
		On-grid in 2017:	95.9%	
		Off-grid in 2017:	4.1%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, there will be 70 villages with 3,488 households connected to the grid. This is equivalent to 81% of the total number of non-electrified villages and 95% of the non-electrified households. There will be 198 off-grid households. The total route length of the planned medium voltage line is 121 km. For this route, 95% of the lines will be 33 kV supplied from the Dhajay substation. The remaining 5% will be 11kV lines. The route will also provide electricity to Dagana. Most of the route (117 km) will be constructed in 10th FYP and the remainder (3 km) will be constructed in 11th FYP. The on-grid electrification cost in 10th FYP will be 235 million Nu., and that in 11th FYP will be 3 million Nu., bringing the total to 238 million Nu. The off-grid investment will be 4.5 million Nu. The on-grid electrification percentage in 2007 will be 25%, which is the lowest for a Dzongkhag. This will increase to 95% in 10th FYP and finally 96% in 11th FYP. The off-grid electrification percentage will be 4%.			


\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>S</b>		
2	Name of Dzongkhag	<b>Wangdue phodrang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	155	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	1,714	
		<b>in 2007 (Forecasted):</b>	<b>1,837</b>	
		in 2012 (Forecasted):	2,011	
		in 2017 (Forecasted):	2,190	
		in 2020 (Forecasted):	2,305	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	65	(41.9%)
		11th FYP (2012-2017):	37	(23.9%)
		<b>TOTAL</b>	102	(65.8%)
6	Nos of Villages to be electrified by Off-grid		53	(34.2%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	937	(51.0%)
		11th FYP (2012-2017):	526	(28.6%)
		<b>TOTAL</b>	1,463	(79.6%)
8	Nos of Household to be electrified by Off-grid *		374	(20.4%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	128,685	2,860 (US\$1,000)
		11th FYP (2012-2017):	77,878	1,731 (US\$1,000)
		<b>TOTAL</b>	206,563	4,590 (US\$1,000)
10	Investment for off-grid (x1,000 Nu.)		10,275	228 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	124,608	
		11th FYP (2012-2017):	71,367	
		<b>TOTAL</b>	195,975	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	56.5%	
		On-grid in 2012:	78.7%	
		On-grid in 2017:	91.1%	
		Off-grid in 2017:	8.9%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> <p>By 2020, there will be 102 villages with 1,844 households connected the grid. This is equivalent to 66% of the total number of non-electrified villages and 80% of the non-electrified households. The number of off-grid households will be 461. The total route length of the planned medium voltage line is 196 km. Of this, 72% will be 33 kV lines and the remaining 28% will be 11 kV lines. For this route, 125 km will be constructed in 10th FYP and 71 km will be constructed in 11th FYP.</p> <p>A combined length of 58 km of covered conductors will be required for four feeders which go through environmentally protected areas. Two of these feeders, having a length of 45 km, will be constructed in 10th FYP. The other two feeders, having a length of 13 km, will be constructed in 11th FYP. The lines pass through protected areas in total of 60 km.</p> <p>As for 33 kV lines come from Lobesa 66/33/11 kV substation, only one 33 kV circuit breaker is installed for the supply to Punakha, Gasa, and Wangduephodraung. Thus, installation of separate 33 kV circuit breaker in each Dzongkhag needs to be examined in the F/S stage to enhance the reliability.</p> <p>The on-grid electrification cost in 10th FYP will be 130 million Nu., and that in 11th FYP will be 78 million Nu., bringing the total to 208 million Nu. The off-grid investment will be 10 million Nu.</p> <p>The on-grid electrification percentage in 2007 will be 57%. It will increase to 79% in 10th FYP and finally reach 91% in 11th FYP. The off-grid electrification percentage will be 9%.</p>			

\*: Numbers are based on the forecasted household number in 2007.

## Dzongkhag-wise Rural Electrification Master Plan

1	Dzongkhag Code	<b>T</b>		
2	Name of Dzongkhag	<b>Zhemgang</b>		
3	Nos of Non-electrified Village	in 2003 (Actual):	92	
4	Forecasted Nos of Non-electrified Household	in 2003 (Actual):	1,627	
		<b>in 2007 (Forecasted):</b>	<b>1,757</b>	
		in 2012 (Forecasted):	1,945	
		in 2017 (Forecasted):	2,152	
		in 2020 (Forecasted):	2,279	
5	Nos of Villages to be electrified by On-grid	10th FYP (2007-2012):	57	(62.0%)
		11th FYP (2012-2017):	7	(7.6%)
		<b>TOTAL</b>	<b>64</b>	<b>(69.6%)</b>
6	Nos of Villages to be electrified by Off-grid		28	(30.4%)
7	Nos of Household to be electrified by On-grid *	10th FYP (2007-2012):	1,336	(76.0%)
		11th FYP (2012-2017):	156	(8.9%)
		<b>TOTAL</b>	<b>1,492</b>	<b>(84.9%)</b>
8	Nos of Household to be electrified by Off-grid *		265	(15.1%)
9	Investment for On-grid (x1,000 Nu.)	10th FYP (2007-2012):	188,487	4,189 (US\$1,000)
		11th FYP (2012-2017):	19,112	425 (US\$1,000)
		<b>TOTAL</b>	<b>207,599</b>	<b>4,613 (US\$1,000)</b>
10	Investment for off-grid (x1,000 Nu.)		7,712	171 (US\$1,000)
11	Distribution Line Length (m)	10th FYP (2007-2012):	163,081	
		11th FYP (2012-2017):	13,412	
		<b>TOTAL</b>	<b>176,493</b>	
12	Dzongkhag Electrified Ratio	On-grid in 2007:	24.3%	
		On-grid in 2012:	81.9%	
		On-grid in 2017:	88.6%	
		Off-grid in 2017:	11.4%	
		<b>TOTAL in 2017:</b>	<b>100.0%</b>	
13	<b>Features for the Master Plan</b> By 2020, there will be 64 villages with the 1,933 households connected to the grid. This is equivalent to 70% of the total number of non-electrified villages and 85% of the non-electrified households. The number of off-grid households will be 346. The total route length of the planned 33 kV medium voltage line is 176 km. Two (2) feeders pass through environmentally protected areas. This will required covered conductors to be applied over a total length of 39 km. Both of these feeders are to be constructed in 10th FYP. The on-grid electrification cost in 10th FYP will be 188 million Nu., and that in 11th FYP will be 19 million Nu., bringing the total to 208 million Nu. The off-grid investment will be 8 million Nu. The on-grid electrification percentage in 2007 will be 24%, which is second lowest for a Dzongkhag. It will increase to 82% in 10th FYP and 89% in 11th FYP. The off-grid electrification percentage will be 11%.			

\*: Numbers are based on the forecasted household number in 2007.

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## APPENDIX

(included into CD-ROM attachment)

APPENDIX A    PRESENT STATE AND PLANING CONDITION
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### **Appendix A-I    Result of Village Baselinne Survey**

- Appendix A-I-1            (A). Surveys on Non-electrified Villages
- Appendix A-I-2            (B). Surveys on Electrified Villages

### **Appendix A-II    Present Status of On-grid**

- Appendix A-II-1            The Number of Customers for BPC by Category

### **Appendix A-III    Present Status of Off-grid**

- Appendix A-III-1            The Number of Small PV Power Generation Systems and Aid Agencies by Dzongkhag
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### **Appendix A-IV    Present Status of Information and Communications**

- Appendix A-IV-1            PV Power Facilities Installed for Telecom by Dzongkhag

APPENDIX B    PLANNING METHODOLOGY AND ANALYSIS
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### **Appendix B-I    Finance and Economics**

- Appendix B-I-1            Economic Analysis
- Appendix B-I-2            List of Unit Price for Development of Distribution Lines
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### **Appendix B-II    Power Flow Analysis**

- Appendix B-II-1            Result of Power System Analysis by MiPower software
- Appendix B-II-2            Distribution Line Diagram by Dzongkhag
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### **Appendix B-III    Power Demand Forecast**

- Appendix B-III-1            Power Demand Forecast

**Appendix B-IV Electrification Priority**

- Appendix B-IV-1 Priority Areas of Grid Extension by Road  
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**Appendix B-V Problems in the Power Distribution Planning of the Past****APPENDIX C MASTER PLAN AND IMPLEMENTATION STRATEGY****Appendix C-I Environment**

- Appendix C-I-1 Document required by JICA Guidelines for Environment and Social Considerations  
 Appendix C-I-2 Environmental Statement  
 Appendix C-I-3 Terms of Reference for Environmental Impact Assessment of Rural Electrification Project Connecting Gasa to Laya

**Appendix C-II Off-grid Micro Hydro Study****Appendix C-III Dzongkhag-wise Rural Electrification Plan**

- Appendix C-III-1 Manuals for Rural Electrification Network Option Program  
 Appendix C-III-2 Dzongkhag-wise Rural Electrification Master Plan  
 Appendix C-III-3 Optional Phase Development Plan

**Appendix C-IV Examples of Off-grid Institution and Subsidy Program****ANNEX**

( Annex-1, Annex-2 are included in the main body and others are included into CD-ROM attachment)

- Annex-1: Scope of Work (June 27, 2003)  
 Annex-2: Minutes of Meeting (June 27, 2003)  
 Annex-3: Minutes of Meeting, First Site Work: No.1 (December 24, 2003)  
 Annex-4: Minutes of Meeting, First Site Work: No.2 (February 9, 2004)  
 Annex-5: Minutes of Meeting, Second Site Work (July 9, 2004)  
 Annex-6: Minutes of Meeting, Third Site Work (November 16, 2004)  
 Annex-7: Minutes of Meeting, Fourth Site Work (February 18, 2005)  
 Annex-8: Minutes of Meeting, Fifth Site Work (June 15, 2005)  
 Annex-9: Minutes of Meeting, Sixth Site Work (September 8, 2005)

### List of Terms

Abbreviations	English
<b>Bhutan Agencies</b>	
BBSC	Bhutan Broadcasting Service Corporation
BEA	Bhutan Electricity Authority
BHU	Basic Health Unit
BPC	Bhutan Power Corporation
BTL	Bhutan Telecom Ltd.
CHPCL	Chukha Hydro Power Corporation Ltd. (former: Chukha Hydro Power Corporation: CHPC)
DFO	District Forestry Office
DOA	Department of Agriculture
DOE	Department of Energy (former: Department of Power)
DOF	Department of Forest (former: Department of Forestry Services)
DOP	former: Department of Power (now: Department of Energy)
DoSLR	Department of Survey and Land Records
DOR	Department of Roads
DYT	Dzongkhag Yargay Tshogdu / Dzongkhag Development Committee
GYT	Gewog Yargay Tshogdu / Gewog Development Committee
HSD	Hydromet Services Division
MTI	Ministry of Trade and Industry
MHA	former: Ministry of Home Affairs (now: Ministry of Home and Cultural Affairs)
MoWHS	Ministry of Works and Human Settlement
MOA	Ministry of Agriculture
MOF	Ministry of Finance
NEC	National Environment Commission
NECS	National Environment Commission Secretariat
RCSC	Royal Civil Service Commission
RED	Renewable Energy Division
RGoB	Royal Government of Bhutan
RNR-RC	Renewable Natural Resources Research Centre
<b>Foreign organizations</b>	
ADB	Asian Development Bank
ADF	Asian Development Fund
ANSI	American National Standards Institute
DANIDA	Danish Development Assistance (under the Royal Danish Ministry of Foreign Affairs)
e7	An international NGO consisted of major 9 electric power companies from the seven G7 member countries
EOJ	Embassy of Japan
GEF	Global Environment Facility
Helvetas	NGO based in Switzerland
IDA	International Development Association
IEC	International Electrotechnical Commission
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature and Natural Resources
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency (Japan)
NORAD	Norwegian Agency for Development Cooperation

### List of Terms

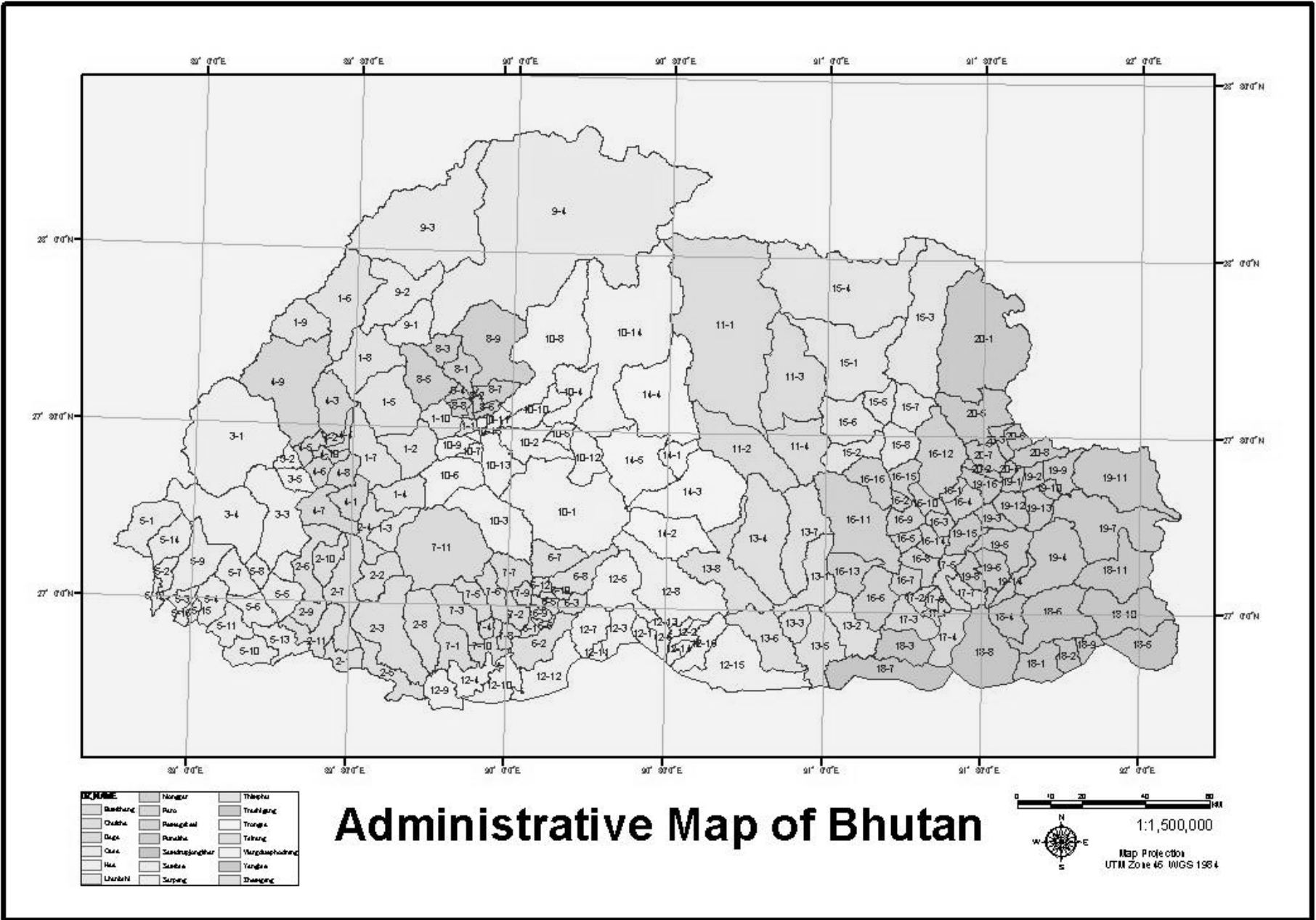
Abbreviations	English
PTC	Power Trading Corporation of India Ltd.
SNV	Stichting Nederlandse Vrijwilligers; NPO established in Netherlands
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WB	World Bank
WWF	World Wildlife Fund
<b>Unit/Technical Terms</b>	
AAAC	All-Aluminum Alloy Conductor
AAC	All-Aluminum Conductor
ABC	Aerial Bundle Cable
ACSR	Aluminum Conductor Steel Reinforced
ASTER	Advanced Spaceborne Thermal Emission and Reflection radiometer
AVR	Automatic Voltage Regulator
BS	British Standards
B-C, B/C	B: Benefit, C: Cost
CFL	Compact Fluorescent Lamp
Ch	Chetrum
EIRR, FIRR	Economic/Financial Internal Rate of Return
EL.( ) m	Meters above Sea level
FY	Fiscal Year
GIS	Geographic Information System
GDP	Gross Domestic Product
GHG	Green House Gas
GWh	Giga Watt Hour (one billion watt hour)
HV	High Voltage
IRR	Internal Rates of Return
kW	kilo Watt
LED	Light Emitting Diode
LV	Low Voltage
MV	Middle Voltage
MW	Mega Watt (one million watt)
Nu.	Ngultrum; Bhutanese currency; 1 Nu. ≈ ¥2.6 US\$1=45 Nu., if not specified
OPGW	Optical-Fiber Composite Overhead Ground Wire
Paise	Paise (singular); Indian currency; Rs 1 = 100 paise
PLC	Power Line Carrier
PV	Photovoltaic
SHS	Solar Home System
SHWS	Solar Hot Water System
SWER	Single Wire Earth Return
USc	US Cent; \$1 = 100 c
US\$	US Dollar
<b>Others</b>	
CDM	Clean Development Mechanism
Chimi	Member of Congress
Dungkhag	Sub-district
Dungkhag Administration	Sub-district administration
Dungpa	Sub-district administrator
Dzongkhag	District
Dzongda	Governor of the district

### List of Terms

Abbreviations	English
Dzongkhag Administration	District administration
Dzongrab	Vice Governor of the district
EIA	Environment Impact Assessment
FYP	Five Year Plan
F/S	Feasibility Study
Gewog	Block
GNH	Gross National Happiness
Gup or Mandal	Executive Officer of Gewog
HEPP	Hydroelectric Power Project
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
LCB	Local Competitive Bidding
L/A	Loan Agreement
Mangmi	Elected Representative of Gewog
MOU	Memorandum of Understanding
M/M	Minutes of Meeting
M/P	Master Plan
NGOs	Non Governmental Organizations
ODA	Official Development Assistance
O&M	Operation and Maintenance
PA	Protected Area
PSMP	Power System Master Plan
RE	Rural Electrification
REC	Rural Electrification Center
RESCO	Rural Electrification Service company
RE-1	Rural Electrification Programme Phase I
RE-2	Rural Electrification Programme Phase II
RE-3	Rural Electrification Programme Phase III
SEA	Strategic Environmental Assessment
S/W	Scope of Works
TOR	Terms of Reference
T/A	Technical Assistance
Tshogpa	Member of the village council
VEC	Village Electrification Committee

Prepared by JICA Study Team





# Administrative Map of Bhutan

## Standard Spelling of Administrative Units (Dzongkhag & Gewog)

**Number of Dzongkhags: 20**

**Number of Gewogs: 201**

<b>1 Thimphu Dzongkhag</b>	<b>6 Tsirang Dzongkhag</b>	<b>11 Bumthang Dzongkhag</b>	<b>17 Pemagatshel Dzongkhag</b>
1-1 Bapisa	6-1 Barshong	11-1 Chhoekhor	17-1 Borang
1-2 Chang	6-2 Beteni	11-2 Chimume	17-2 Chhimung
1-3 Dagala	6-3 Dunglegang	11-3 Tang	17-3 Dungme
1-4 Genye	6-4 Gosaling	11-4 Ura	17-4 Khar
1-5 Kawang	6-5 Kikhorthang	<b>12 Sarpang Dzongkhag</b>	17-5 Shume
1-6 Lingzhi	6-6 Mendrelgang	12-1 Bhur	17-6 Yurung
1-7 Mewang	6-7 Patala	12-2 Chhuzagang	17-7 Zobel
1-8 Naro	6-8 Phuentsenchhu	12-3 Dekiling	<b>18 Samdrup Jongkhar Dzongkhag</b>
1-9 Soe	6-9 Rangthang Ung	12-4 Deorali	18-1 Dechenling
1-10 Toepisa	6-10 Semjong	12-5 Doban	18-2 Gomdar
<b>2 Chukha Dzongkhag</b>	6-11 Tshokhorlong	12-6 Gelephu	18-3 Hastinapur
2-1 Bhalujhora	6-12 Tsiurangtoe	12-7 Hiley	18-4 Lauri
2-2 Bjachho	<b>7 Dagana Dzongkhag</b>	12-8 Jigmechhoeling	18-5 Martshala
2-3 Bongo	7-1 Dorona	12-9 Lhamoi Zinkha	18-6 Norbugang
2-4 Chapchha	7-2 Drujegang	12-10 Nichula	18-7 Orong
2-5 Dala	7-3 Gesarling	12-11 Sarpang	18-8 Pemathang
2-6 Dungna	7-4 Goshi	12-12 Senge	18-9 Phuentshothang
2-7 Geling	7-5 Kana	12-13 Serzhong	18-10 Samrang
2-8 Getana	7-6 Khebisa	12-14 Taklai	18-11 Serthig
2-9 Logchina	7-7 Lajab	12-15 Umling	<b>19 Trashigang Dzongkhag</b>
2-10 Metap	7-8 Trashiding	<b>13 Zhemgang Dzongkhag</b>	19-1 Bartsham
2-11 Phuentsholing	7-9 Tsangkha	13-1 Bardo	19-2 Bidung
<b>3 Haa Dzongkhag</b>	7-10 Tsendagang	13-2 Bjoka	19-3 Kanglung
3-1 Bji	7-11 Tseza	13-3 Goshing.	19-4 Kangpara
3-2 Katsho	<b>8 Punakha Dzongkhag</b>	13-4 Nangkhor	19-5 Khaling
3-3 Sama	8-1 Chhubu	13-5 Ngangla	19-6 Lumang
3-4 Sangbay	8-2 Dzoma	13-6 Phangkhar	19-7 Mera
3-5 Uesu	8-3 Goenshari	13-7 Shingkar	19-8 Nanong
<b>4 Paro Dzongkhag</b>	8-4 Guma	13-8 Trong	19-9 Phongme
4-1 Doga	8-5 Kabjisa	<b>14 Trongsa Dzongkhag</b>	19-10 Radi
4-2 Dopshari	8-6 Lingmukha	14-1 Dragteng	19-11 Sakteng.
4-3 Doteng	8-7 Shenga- Bjime	14-2 Korphu	19-12 Samkhar
4-4 Hungrel	8-8 Talo	14-3 Langthil	19-13 Shongphu
4-5 Lamgong	8-9 Toewang	14-4 Nubi	19-14 Thrimshing
4-6 Lungnyi	<b>9 Gasa Dzongkhag</b>	14-5 Tangsibji	19-15 Udorong
4-7 Naja	9-1 Goenkhamé	<b>15 Lhuntse Dzongkhag</b>	19-16 Yangnyer
4-8 Shapa	9-2 Goenkhatoe	15-1 Gangzur	<b>20 Yangtse Dzongkhag</b>
4-9 Tsento	9-3 Laya	15-2 Jaray	20-1 Bumdeling
4-10 Wangchang	9-4 Lunana	15-3 Khoma	20-2 Jamkhar
<b>5 Samtse Dzongkhag</b>	<b>10 Wangduephodrang Dzongkhag</b>	15-4 Kurtoe	20-3 Khamdang
5-1 Bara	10-1 Athang	15-5 Menbi	20-4 Ramjar
5-2 Biru	10-2 Bjena	15-6 Metsho	20-5 Tashi Yangtse
5-3 Chargharay	10-3 Daga	15-7 Minjay	20-6 Toetsho
5-4 Chengmari	10-4 Dangchhu	15-8 Tsenkhar	20-7 Tomzhangtshen
5-5 Denchhukha	10-5 Gangte	<b>16 Mongar Dzongkhag</b>	20-8 Yalang
5-6 Dorokha	10-6 Gasetsho Gom	16-1 Balam	
5-7 Dungtoe	10-7 Gasetsho Wom	16-2 Chaskhar	
5-8 Mayona	10-8 Kazhi	16-3 Chhali	
5-9 Namgyeltchholing	10-9 Nahi	16-4 Drametse	
5-10 Pagli	10-10 Nyisho	16-5 Drepung	
5-11 Samtse	10-11 Phangyuel	16-6 Gongdue	
5-12 Sipsu	10-12 Phobji	16-7 Jumme	
5-13 Tading	10-13 Ruepisa	16-8 Kengkhar	
5-14 Tendu	10-14 Sephu	16-9 Mongar	
5-15 Ugyentse	10-15 Thedtsho	16-10 Ngatshang	
5-16 Yoeseltse		16-11 Saleng	
		16-12 Shermung	
		16-13 Silambi	
		16-14 Thangrong	
		16-15 Tsakaling	
		16-16 Tsamang	

Source: Ministry of Home and Cultural Affairs, Central Statistics Office, Survey of Bhutan, Department of Energy

THE INTEGRATED MASTER PLAN STUDY  
FOR DZONGKHAG-WISE ELECTRIFICATION  
IN BHUTAN

FINAL REPORT

**PART-A**  
**PRESENT STATE**  
**AND PLANING CONDITION**

## CHAPTER 1 INTRODUCTION

### 1.1 Background

At present, the electricity supply in Bhutan is less than 50% of the whole population. As a background of the “the Integrated Master Plan Study for Dzongkhag (District)-wise Electrification in Bhutan” (hereinafter referred to as “the master plan”), there is a long-term and ambitious target of 100% rural electrification by the year 2020. This target is considered an important policy mark and has been set up, along with poverty reduction, industrial promotion, etc, as the definite numerical target in the long-term vision up to year 2020 (“A Vision for Peace, Prosperity and Happiness”) by the Royal Government of Bhutan (hereinafter referred to as “RGoB”) in 1999. The target can only be achieved through the achievement of rural electrification.

Before this target was set, rural electrification in Bhutan had been performed by coordinating with the development of the electric power supply and transmission lines, taking advantage of ADB (Asian Development Bank) loans, Indian and other donors’ assistance, and government activities.

A request for assistance was officially submitted to the Government of Japan in August 2001 through the official procedures of RGoB. Accordingly, Japan International Cooperation Agency (hereinafter referred to as “JICA”), which is an official agency responsible for implementation of the technical cooperation programme of the Government of Japan, sent a study team to Bhutan for project formulation in October 2002, then sent a preliminary study team in June 2003, and the study teams held discussions with RGoB on the Scope of Work of the Study. As a result, this Study has proceeded.

### 1.2 Purpose of the Study

The main objectives of the master plan are (i) to formulate a village-level rural electrification master plan which covers all of the twenty Dzongkhags (districts) of Bhutan with a combined system of on-grid and off-grid power supplies, (ii) to strengthen the capacity of updating of the master plan and implementation for the achievement of the goal of the electrification program up to the year 2020 by the Bhutanese side.

The main subjects of the master plan are as follows;

- (1) Database preparation (including GIS mapping) of non-electrified villages after the 9th five year plan (2002-2007),
- (2) Presentation of methods of rural electrification by on-grid and off-grid electrification in the non-electrified areas. (For distribution line extension: basic policy, standardization of planning methodology, specification of equipment adopted, and techniques for equipment. For off-grid systems: Application Method of system and technology, and operation and maintenance)
- (3) Based on the above (1) and (2), formulation of an optimal Dzongkhag-wise rural electrification plan in the non-electrified villages (for on-grid systems, number of

target consumers, extension length of distribution lines, requirement of new construction and reinforcement of substations, and system planning with the drawings of 11 kV and 33 kV distribution line systems, and cost estimation. For off-grid systems; selection of power sources and their capacities, areas of supply, target numbers of consumers, cost estimation, and so forth.

- (4) Social study and economic evaluation and policy recommendations for the efficient implementation of the projects.
- (5) Technology transfer (capacity building) to the counter parts of relevant organizations.

### **1.3 Scope of Work**

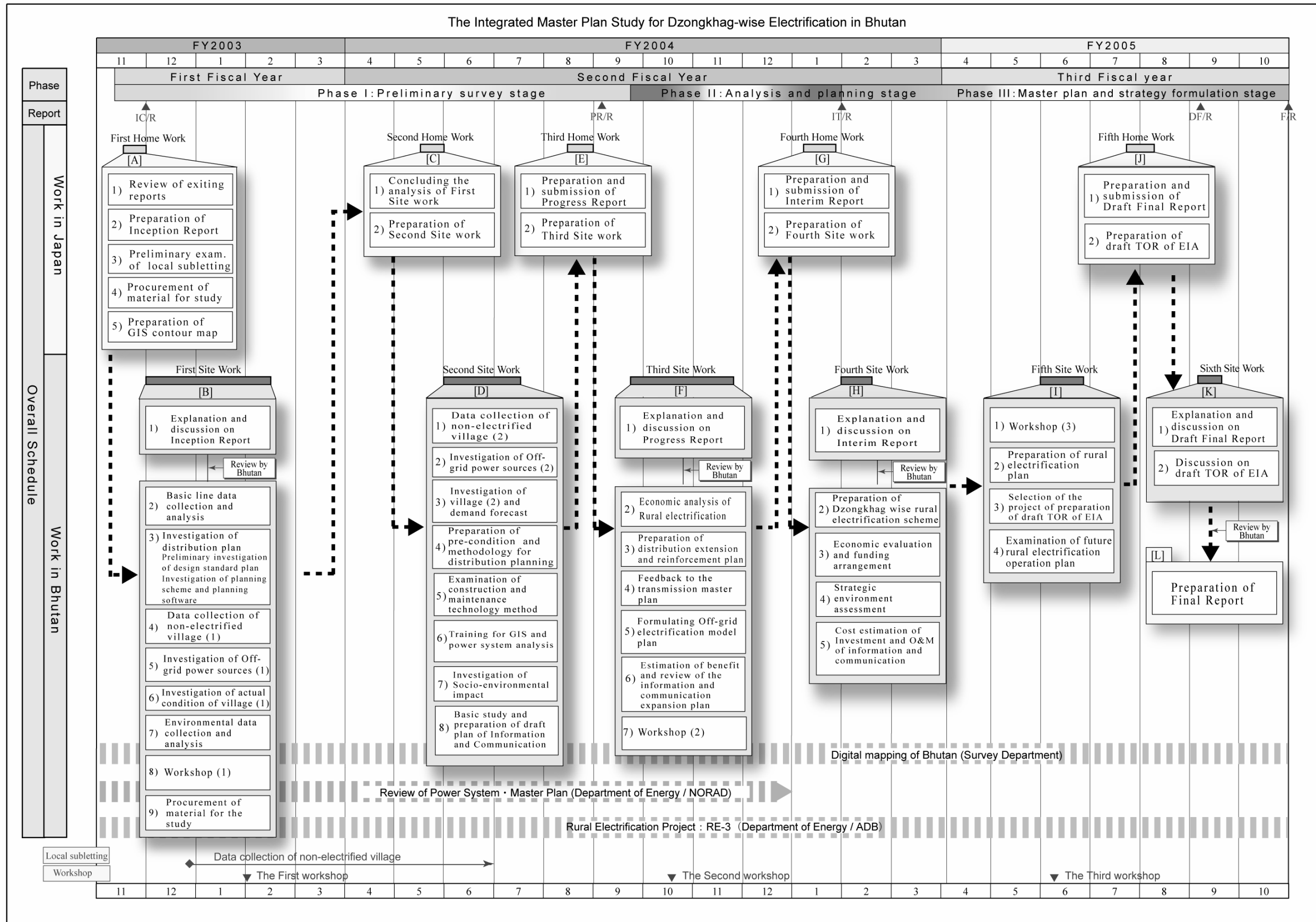
This study started in the middle of November, 2003, and was carried out up to the end of November, 2005. The details are shown in **Table-1.3.1**.

### **1.4 Study Flow**

The master study was implemented over two years from November, 2003, to November, 2005. Site works in Bhutan have been conducted at six (6) times. Three workshops were held in the First, Third, and Fifth Site Works. The workflow of the whole study is shown in **Figure-1.4.1**.

**Table-1.3.1 Scope of Work**

Fiscal Year	Phase	Task	Work Period (months)
First Year	(1) First Home Work	<ul style="list-style-type: none"> <li>Review of the existing documents</li> <li>Preparation of Inception Report</li> <li>Preliminary examination on subletting to a local consultant</li> <li>Arrangement of equipment for the study (local procurement)</li> </ul>	0.5
	(2) First Site Work	<ul style="list-style-type: none"> <li>Submittal of Inception Report, explanation, and consultation</li> <li>Collection of baseline data and analysis</li> <li>Examination of the planning method for distribution networks</li> <li>Collection of data on non-electrified villages (1)</li> <li>Basic study on off-grid electrification (1)</li> <li>Research on actual condition of the villages (1)</li> <li>Collection of environmental data and analysis</li> <li>Holding of workshop (1)</li> <li>Local procurement of equipment for the study</li> </ul>	2.5
Second Year	(3) Second Home Work	<ul style="list-style-type: none"> <li>Summary of First Site Work</li> <li>Preparation for Second Site Work</li> </ul>	0.2
	(4) Second Site Work	<ul style="list-style-type: none"> <li>Collection of data on non-electrified villages (2)</li> <li>Basic study on off-grid electrification (2)</li> <li>Research on actual condition of the villages (2) and power demand assumptions</li> <li>Organization of prerequisites for distribution planning and determination of the planning method</li> <li>Examination of the construction and maintenance technologies for power distribution equipment</li> <li>Training of the technologies for distribution system analysis and for GIS mapping</li> <li>Examination of socio-environmental impacts</li> <li>Basic study on information and telecommunication, and preparation of a draft plan</li> </ul>	1.5
	(5) Third Home Work	<ul style="list-style-type: none"> <li>Preparation of Progress Report</li> <li>Preparation for Third Site Work</li> </ul>	0.3
	(6) Third Site Work	<ul style="list-style-type: none"> <li>Submittal of Progress Report, explanation, and consultation</li> <li>Economic analysis on Rural Electrification Project</li> <li>Preparation of a draft plan for development of Dzongkhag-wise distribution lines</li> <li>Feedback of the development plan for the transmission system</li> <li>Formulation of the model plan for off-grid electrification</li> <li>Estimation of benefits from expansion and improvement of information and telecommunication networks, and review of the draft plan</li> <li>Holding of workshop (2)</li> </ul>	1.8
	(7) Forth Home Work	<ul style="list-style-type: none"> <li>Preparation of Interim Report</li> <li>Preparation for Forth Site Work</li> </ul>	0.3
	(8) Forth Site Work	<ul style="list-style-type: none"> <li>Submittal of Interim Report, explanation, and consultation</li> <li>Formulation of a draft basic plan for Dzongkhag-wise rural electrification</li> <li>Economic evaluation and building perspective on the demand for funds</li> <li>Strategic environmental assessment</li> <li>Operation and maintenance of information and telecommunication networks, and estimation of the cost</li> </ul>	0.7
Third Year	(9) Fifth Site Work	<ul style="list-style-type: none"> <li>Holding of workshop (3)</li> <li>Preparation of a basic plan for rural electrification</li> <li>Selection of the project of preparation of draft TOR of EIA</li> <li>Examination of implementation measures for the future rural electrification</li> </ul>	0.6
	(10) Fifth Home Work	<ul style="list-style-type: none"> <li>Presentation of Draft Final Report</li> <li>Presentation of draft TOR of EIA</li> </ul>	0.07
	(11) Sixth Site Work	<ul style="list-style-type: none"> <li>Submittal of Draft Final Report, explanation, and consultation</li> <li>Discussion on draft TOR of EIA</li> </ul>	0.3
	(12) Preparation of Final Report		



Prepared by JICA Study Team

Figure-1.4.1 Study Flow

## 1.5 Study Team

The members of the Study Team were as follows.

No.	Charge	Name
1	Team Leader / Power Planning	FUKUCHI Tomoyasu
2	Distribution System and Design Standard Planning	SHIRAKI Keiji
3	Power Distribution Facilities Planning	ARITA Toshiyuki
4	Socio Economic Study	DOBETA Kazuhiko
5	GIS / Database	USUDA Kyoko
6	Power Transmission Planning	OHARA Kazunori
7	Power Demand and Supply Planning (National Level)	NAKAJIMA Ko
8	Financial and Economic Analysis	NISHIMAKI Hiroshi
9	Small Hydro Power / Power Demand and Supply Planning (Village Level)	HIRATA Kiyoshi
10	Solar Power and Renewable Energies Planning	Deepak BISTA
11	Environmental Impact Analysis	KAMISHITA Takahiro
12	Information and Telecommunication Planning	OGAWA Ryosuke
13	Coordinator (1)	YAMAMURA Kensuke
14	Coordinator (2) / Biomass Planning	NAKAGAWA Yuka



## CHAPTER 2 OVERVIEW OF THE KINGDOM OF BHUTAN

### 2.1 Land, Ethnic Composition, Political Organization, and Development Policy

#### 2.1.1 Land

Bhutan is a small country located in the eastern Himalayas with a total area of 38,394 square kilometer and is surrounded by steep mountains and dense forest. The country is bordered by Tibet (China) in the north and northeast, Sikkim (India) in the west, West Bengal (India) in the southwest, Assam (India) in the south and Arunachal Pradesh (India) in the east. The total population of the country is estimated to be about 750,000<sup>1</sup>.

#### 2.1.2 Ethnic Composition

The Bhutanese are roughly classified into the following three main ethnic groups. The *Sharchop* who live in the eastern part of the country are recognized as the original inhabitants of the country and called Eastern Bhutanese in the broad sense. Eastern Bhutan stands to the area that includes Pele La and eastward. The *Ngalop* are descendants of Tibetan immigrants who came to Bhutan from the 9th century and settled in the western part of the country. The *Lhotshampa* are originally Nepali and settled in the southern part of the country in the 19th century. In addition to these three groups, there are several smaller groups with their own languages, but the total number of population of each of these groups is quite small.

#### 2.1.3 Political Organization

Bhutan is a country with a hereditary monarch. The first king, Ugyen Wangchuck, was appointed in 1907. In Bhutan, a Draft Constitution was distributed on March 2005. Government notifications, traditional customary laws, imperial orders, including oral decrees of His Majesty the King, are considered effective as laws. Under His Majesty the King, the National Assembly, Royal Advisory Council, Cabinet and High Court stand side by side.

The present Cabinet consists of 10 Cabinet Ministers, each of whom heads a ministry: (a) Ministry of Home and Cultural Affairs, (b) Ministry of Foreign Affairs, (c) Ministry of Finance, (d) Ministry of Works and Human Settlements, (e) Ministry of Agriculture, (f) Ministry of Education, (g) Ministry of Health, (h) Ministry of Trade and Industry, (i) Ministry of Information and Communication and (j) Ministry of Labor and Human Resources.

The Prime Minister is elected from among the Cabinet Ministers in rotation for a tenure of up to 1 year. The National Assembly is a one-chamber system and consists of 151 members composed of 106 representatives elected from the people in the nation, 10 representatives selected from the Central Monastic Body and 35 representatives appointed by the Royal Civil Service Commission (RCSC) from senior civil servants, district administrators and other government officials.

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<sup>1</sup> Statistical Yearbook 2003, NSB, RGoB

#### 2.1.4 Development Policy

The present king, His Majesty the King Jigme Singye Wangchuck, advocated the Gross National Happiness (GNH) policy in 1976. The principal development policy of the country follows the idea of GNH, and its principal measures are to promote socio-economic development while taking actions to preserve and maintain the natural and cultural environment. These measures have been advocated to rectify the negative side of economic development, such as regional, income and educational disparities experienced by Bhutan since 1970's when modernization and the market economy were being implemented. The six (6) development goals expressed by the present Majesty the King are as follows:

- (a) self-reliance,
- (b) sustainability,
- (c) improvement of efficiency and development for the private sector,
- (d) people's participation and decentralization,
- (e) human resources development and
- (f) regionally balanced development.

Development in Bhutan is managed in five-year plans (FYP's). The First Five Year Plan (FYP) of Bhutan commenced in 1961. Currently, the 9th FYP is in operation, and this plan will finish in 2007.

## 2.2 Local Administration and Development

### 2.2.1 Local Administration Units

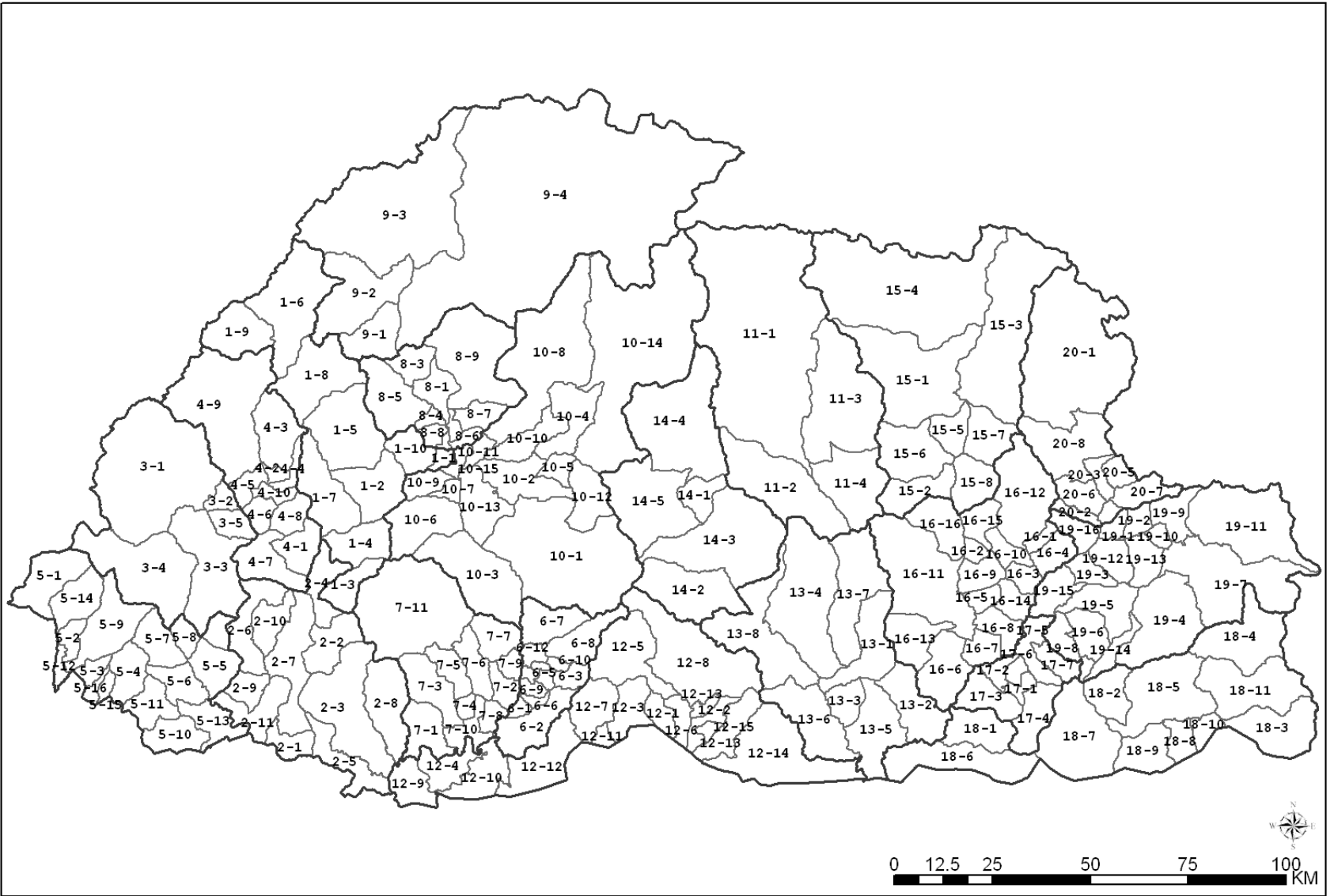
Local administration in Bhutan is under the jurisdiction of the Ministry of Home and Cultural Affairs and is being implemented by local administration units called Dzongkhags (Districts) and Blocks (Gewogs). However, the 8 larger Dzongkhags of the 20 Dzongkhags have some Dungkhangs (Sub-Districts) and administer some Gewogs under their jurisdiction. At present, the total number of Dzongkhags and Gewogs is 20 and 201, respectively.

Administrative maps by Dzongkhags and by Gewogs are shown in **Figure-2.2.1** and **Figure-2.2.2**, respectively. Name and code of Gewogs is listed in **Table-2.2.1**.



Prepared by JICA Study Team

**Figure-2.2.1 Administrative Map by Dzongkhag (District)**



Prepared by JICA Study Team referring to DOE and National Statistical Bureau

**Figure 2.2.2 Administrative Map by Gewog (Block)**

Table-2.2.1 Gewog Name and Code by Dzongkhag

Number of Gewog (Block) = 201

DC	Dzongkhag Name	No.	Code	Gewog Name	DC	Dzongkhag Name	No.	Code	Gewog Name	DC	Dzongkhag Name	No.	Code	Gewog Name	DC	Dzongkhag Name	No.	Code	Gewog Name		
1	Thimphu	1	1-1	Bapisa	6	Tsirang	1	6-1	Barshong	12	Sarpang	1	12-1	Bhur	17	Pemagatshel	1	17-1	Borang		
		2	1-2	Chang			2	6-2	Beteni			2	12-2	Chhuzagang			2	17-2	Chhimung		
		3	1-3	Dagala			3	6-3	Dunglegang			3	12-3	Dekiling			3	17-3	Dungme		
		4	1-4	Genye			4	6-4	Gosaling			4	12-4	Deoral			4	17-4	Khar		
		5	1-5	Kawang			5	6-5	Kikhorthang			5	12-5	Doban			5	17-5	Shume		
		6	1-6	Lingzhi			6	6-6	Mendrelgang			6	12-6	Gelephu			6	17-6	Yurung		
		7	1-7	Mewang			7	6-7	Patala			7	12-7	Hiley			7	17-7	Zobel		
		8	1-8	Naro			8	6-8	Phuentenchhu			8	12-8	Jigmechhoeling			18	Samdrup Jongkhar	1	18-1	Dechhenling
		9	1-9	Soe			9	6-9	Rangthang Ung			9	12-9	Lhamoi Zinkha					2	18-2	Gomdar
		10	1-10	Toevisa			10	6-10	Semjong			10	12-10	Nichula					3	18-3	Hastinapur
2	Chukha	1	2-1	Bhalujhora			11	6-11	Tshokhorlong			11	12-11	Sarpang	4	18-4			Lauri		
		2	2-2	Bjachho			12	6-12	Tsirangtoe			12	12-12	Senge	5	18-5			Martshala		
		3	2-3	Bongo	7	Dagana	1	7-1	Dorona			13	12-13	Serzhong	6	18-6			Norbugang		
		4	2-4	Chapchha			2	7-2	Drugyelgang			14	12-14	Taklai	7	18-7			Orong		
		5	2-5	Dala			3	7-3	Gesarling			15	12-15	Umling	8	18-8			Pemathang		
		6	2-6	Dungna			4	7-4	Gozhi	13	Zhengang	1	13-1	Bardo	9	18-9			Phuentshothang		
		7	2-7	Geling			5	7-5	Kalidzinkha			2	13-2	Bjoka	10	18-10			Samrang		
		8	2-8	Getana			6	7-6	Khipisa			3	13-3	Goshing	11	18-11	Serthig				
		9	2-9	Logchina			7	7-7	Lajab			4	13-4	Nangkhor	19	Trashigang	1	19-1	Bartsham		
		10	2-10	Metap			8	7-8	Trashidhing			5	13-5	Ngangla			2	19-2	Bidung		
		11	2-11	Phuentsholing			9	7-9	Tsangkha			6	13-6	Phangkhar			3	19-3	Kanglung		
3	Haa	1	3-1	Bji			10	7-10	Tsendagang			7	13-7	Shingkhar			4	19-4	Kangpara		
		2	3-2	Katsho			11	7-11	Tseza			8	13-8	Trong			5	19-5	Khaling		
		3	3-3	Sama	8	Punakha	1	8-1	Chhubu			1	14-1	Dragteng			6	19-6	Lumang		
		4	3-4	Sangbay			2	8-2	Dzoma			2	14-2	Korphu			7	19-7	Mera		
		5	3-5	Uesu			3	8-3	Goenshari	3	14-3	Langthil	8	19-8			Nanong				
4	Paro	1	4-1	Doga			4	8-4	Guma	4	14-4	Nubi	9	19-9			Phongme				
		2	4-2	Dopshari			5	8-5	Kabjisa	5	14-5	Tangsibji	10	19-10			Radi				
		3	4-3	Doteng	6	8-6	Lingmukha	15	Lhuntse	1	15-1	Gangzur	11	19-11	Sakteng						
		4	4-4	Hungrel	7	8-7	Shenga- Bjime			2	15-2	Jaray	12	19-12	Samkhar						
		5	4-5	Lamgong	8	8-8	Talo			3	15-3	Khoma	13	19-13	Shongphu						
		6	4-6	Lungnyi	9	8-9	Toewang			4	15-4	Kurtoe	14	19-14	Thrimshing						
		7	4-7	Naja	9	Gasa	1			9-1	Goenkham	5	15-5	Menbi	15	19-15	Udzorong				
		8	4-8	Shapa			2			9-2	Goenkhatoe	6	15-6	Metsho	16	19-16	Yangnver				
		9	4-9	Tsento			3			9-3	Laya	7	15-7	Minjay	20	Yangtse	1	20-1	Bumdeling		
		10	4-10	Wangchang			4			9-4	Lunana	8	15-8	Tsenkhar			2	20-2	Jamkhar		
5	Samtse	1	5-1	Bara			10			Wangduephodrang	1	10-1	Athang	1			16-1	Balam	3	20-3	Khamdang
		2	5-2	Biru	2	10-2					Bjena	2	16-2	Chaskhar			4	20-4	Ramjar		
		3	5-3	Chargharay	3	10-3		Daga	3		16-3	Chhali	5	20-5			Tashi Yangtse				
		4	5-4	Chengmari	4	10-4		Dangchhu	4		16-4	Drametse	6	20-6			Toetsho				
		5	5-5	Denchhukha	5	10-5		Gangte	5		16-5	Drepung	7	20-7			Tomzhangtshen				
		6	5-6	Dorokha	6	10-6		Gasetsho Gom	6		16-6	Gongdue	8	20-8			Yalang				
		7	5-7	Dungtoe	7	10-7		Gasetsho Wom	7		16-7	Jurme	16	Mongar			1	16-1	Balam		
		8	5-8	Mayona	8	10-8		Kazhi	2		16-2	Chaskhar					2	16-2	Chaskhar		
		9	5-9	Namgyeltchholing	9	10-9		Nahi	3		16-3	Chhali			3	16-3	Chhali				
		10	5-10	Pagji	10	10-10		Nyisho	4		16-4	Drametse			4	16-4	Drametse				
		11	5-11	Samtse	11	10-11		Phangyuel	5		16-5	Drepung			5	16-5	Drepung				
		12	5-12	Sipsu	12	10-12		Phobji	6		16-6	Gongdue			6	16-6	Gongdue				
		13	5-13	Tading	13	10-13		Ruepisa	7		16-7	Jurme			7	16-7	Jurme				
		14	5-14	Tendu	14	10-14		Sephu	8		16-8	Kengkhar			8	16-8	Kengkhar				
		15	5-15	Ugyentse	15	10-15		Theedtsho	9		16-9	Mongar			9	16-9	Mongar				
		16	5-16	Yoeseltse	16	10-16	Ura	10	16-10	Ngatshang	10	16-10			Ngatshang						
11	Bumthang	1	11-1	Chhoeckhor	11	16-11	Saleng	11	16-11	Saleng	11	16-11	Saleng								
		2	11-2	Chimume	12	16-12	Shermung	12	16-12	Shermung	12	16-12	Shermung								
		3	11-3	Tang	13	16-13	Silambi	13	16-13	Silambi	13	16-13	Silambi								
		4	11-4	Ura	14	16-14	Thangrong	14	16-14	Thangrong	14	16-14	Thangrong								

Prepared by JICA Study Team referring to DOE and National Statistical Bureau

### 2.2.2 Local Administration Organization

The chief executive officer of Dzongkhag Administration is the Dzongkhag Administrator (Dzongda) who is appointed by the central government and is responsible directly to the Minister of Home and Cultural Affairs. The Deputy Dzongkhag Administrator (Dzongrab) who assists the Dzongkhag Administrator is the head of the administration and finance section and appointed by the central government as well. Under these two senior officials, administrative sections are placed. In sub-Dzongkhag administration (Dungkhag), the executive officer is the Sub-Dzongkhag Administrator (Dungpa) who is appointed by the central government, and the executive officer of a Gewog, who is directly elected by the people, is called Gup in the north and Mandal in the south. In Dzongkhag administration and Sub-Dzongkhag administration, professional officers, who are mostly assigned and dispatched by the related ministries of the central government, assist Dzongkhag and sub-Dzongkhag administrators.

### 2.2.3 Decentralization

Since 1981, under the initiative of His Majesty the King, establishment of a local administration system, whose principal idea is based on decentralization and people's participation, has been promoting in the socio-economic development of the country. In the preset 9th Five Year Plan (FYP) (2002-2007), autonomy of local administration units was regarded to be important, and it was the first trial in which a national development plan was prepared on the basis of a local development plan. In this process, under the guidance of the central government, each Dzongkhag prepared a Dzongkhag Development Plan and each Gewog also prepared a Gewog Development Plan, through the process of people's participation. The prepared Dzongkhag and Gewog Development Plans included the budget allocated by the central government for the first time, which can be used for implementing original projects and/or programs of Dzongkhag and Gewog.

### 2.2.4 Local Development Committee

The local organizations, which play an important role in establishing a local government system based on decentralization and people's participation, are DYT (Dzongkhag Yargye Tshogchung or Dzongkhag Development Committee) and GYT (Gewog Yargye Tshogchung or Gewog Development Committee). These are official local decision-making bodies where the committee members who are representing the people engage in consultations, discussions and decisions on local development activities at Dzongkhag and Gewog levels. In the 9th Five Year Plan, the Dzongkhag Development Committee Act (Dzongkhag Yargye Tshogdu Chathrim) and Gewog Development Committee Act (Gewog Yargye Tshogchung Chathrim) were amended in 2002, in order to strengthen decentralization and people's participation. The following two points were included in the amended acts: (a) more administrative authority is given to local administrations and (b) preparation of the Dzongkhag Development Plan and Gewog Development Plan and their implementation by Dzongkhag and Gewog administrations. The composition of DTY and GYT is summarized in **Table-2.2.2**.

**Table-2.2.2 Composition of District and Block Development Committees**

Members of District Development Committee (DYT)	Right to Vote		Members of Block Development Committee (GYT)	Right to Vote	
	Voting Members	Observer		Voting Members	Observer
Chairperson <sup>(Note 1)</sup>	○	-	Chairperson <sup>(Note 2)</sup>	○	-
Member of National Assembly Elected from Concerned District (Chimi)	○	-	Elected Representative of Gewog (Mangmi)	○	-
Elected Leader of Gewog (Gup or Mandal)	○	-	Representative (Tshogpa)	○	-
Elected Representative of Gewog (Mangmi)	○	-	Member of National Assembly Elected from Concerned District (Chimi)	-	○
Representative of municipalities and towns	○	-	Block Clark (Gewog Clark)	-	○
Deputy District Administrator (Dzongrab)	-	○	Representatives of Various Sectors in Gewog	-	○
Sub-District Administrator (Dungpa)	-	○	-	-	-
Representatives of Various Sectoral Agencies	-	○	-	-	-

Source: District Development Committee Act (Amended 2002) and Block Development Committee Act (Amended in 2002)

Note 1) DYT chairperson is elected by the Committee from among the voting members for tenure up to 3 years.

Note 2) GYT chairperson is concurrently held by Gap or Mandal for tenure up to 3 years.

## 2.3 Economic Outlook

### 2.3.1 Economic Outlook

Both the Bhutanese economy and government has maintained good performance in recent years. GDP growth rates averaged 6.6% during 1997 and 2001 (**Table-2.3.1**). The inflation rate that hovered around 9% during the 1990s fell to less than 4% after the year 2000. The debt-service-ratio was a little over 6% during the year 2001/02, indicating a sound fiscal management for the government. However, the debt-GDP ratio increased from 38.7% in the year 1999/2000 to 55% in the year 2001/02. As a result, the country's current balance shows an increasing trend toward deficit, resulting from recent public borrowings that pushed the debt level upward.

One important caution when formulating a loan project for Bhutan is the country's small size, with its population of 750 thousand and GDP of US\$500 million. A size is significant since one project with an investment of US\$50 million could raise the debt-GDP ratio by 10%.

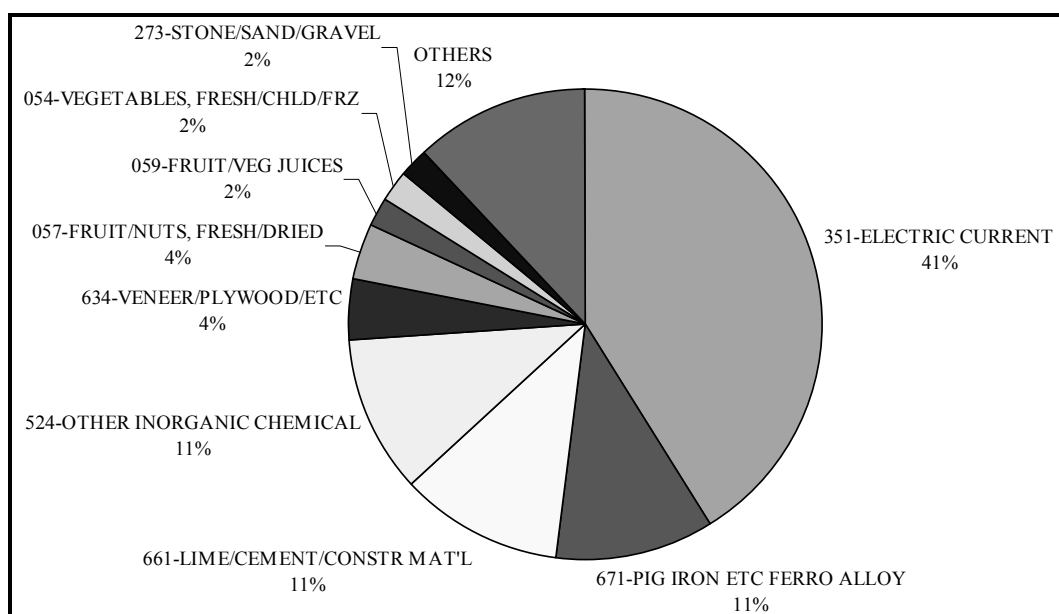
As a small country, like Bhutan, with its single resource-oriented economy, is more vulnerable to external economic shocks. Bhutan has only three major foreign exchange sources: power sales, tourism, and foreign aid. According to trade statistics, sales of power comprised 41% of the total export in 1999, a clear indication of the importance of the power sector in Bhutan. Other major exports are steel products, inorganic chemicals, veneer/plywood, highlighting the resource-based export industries of the country (**Figure-2.3.1**).

Internally Bhutan is a predominantly agro-based economy. According to labor statistics, agricultural workers comprise 75% of the total labor force while the workers in service and

manufacturing constitute 12% and 5% respectively. In terms of professions, government workers comprise 11% and the most of the service sector is covered by civil officers.

In spite of its previous closed-door policy, Bhutan has been progressive in education. Most mid-level education is conducted in English. An overall literacy rate of the nation is 54%, although almost all younger generations can communicate in English. Enrollment in higher education is also relatively high.

The key to future economic progress lies in the development of power. The development approach in this important industry demonstrates the prudence of government leaders. India is the export market for power. The recent outstanding economic development activities in India have created a chronic lack of power supply. Bhutan has a power generation potential of more than 23 GW, while the present level of utilization is a mere 5% of the potential. Currently a master plan study of the development of hydropower supported by the Norwegian government is nearly completed, indicating the possibility for many good hydropower projects<sup>2</sup>. For an Indian market-based project, normally the Indian government offers 60% of the investment cost as a grant and 40% as a loan, providing a good hedge for the project. Since the Bhutanese currency is pegged to the Indian rupee, there is no risk in dealing with foreign exchange. Rural electrification programs funded by ADB, i.e. ADB/RE-1 and RE-2, cannot generate foreign exchange as national income.



Source: International Trade Center, International Trade Statistics, <http://www.intracen.org/tradstat/site3-3d/er064.htm>

**Figure-2.3.1 Composition of Exports from Bhutan, 1999**

<sup>2</sup> The capacity of 500-1,000 MW class large hydropower has been studied. The unit cost is US\$700-1,000/kW, which is about half of general hydropower project.



**Table-2.3.1 Economic Indicators of Bhutan**

	1997/98	1998/99	1999/00	2000/01	2001/02
<b>GDP growth and prices (percent change)</b>					
Real GDP at factor cost 2/	7.2	6.4	7.6	5.3	6.6
Consumer Prices	9.0	9.2	3.6	3.6	2.7
<b>Government budget (in percent of GDP)</b>					
Total revenue and grants	32.9	40.0	39.6	38.5	34.1
Of which : foreign grants	12.1	18.8	16.5	16.5	12.9
Total expenditure and net lending	31.9	41.7	43.4	49.6	39.6
Of which : current expenditure	17.5	18.4	18.6	19.7	18.1
Current balance	3.4	2.8	4.4	2.4	3.1
Overall balance	1.0	-1.8	-3.9	-11.1	-5.4
<b>Balance of Payment (In millions of US\$)</b>					
Merchandise exports	111.3	104.7	114.3	99.5	97.7
Merchandise imports	-136.1	-162.3	-185.0	-196.3	-188.4
Current account balance 3/	32.1	21.9	4.0	-26.7	-28.2
(in percent of GDP)	8.2	5.4	0.9	-5.5	-5.3
Loans (net)	4.4	26.0	42.0	49.8	57.3
Overall balance	41.7	48.3	33.6	-24.0	20.4
(in percent of GDP)	10.6	11.9	7.4	-4.9	3.8
<b>External indicators</b>					
Gross official reserves (in millions of US\$)	215.5	258.5	292.6	294.1	316.6
(In months of imports)	19.0	19.1	19.0	18.0	20.2
External debt (in percent of GDP; end of period)	36.8	40.1	38.7	49.0	55.0
Debt-service ratio (percent of exports)	8.3	8.1	5.6	6.1	6.6

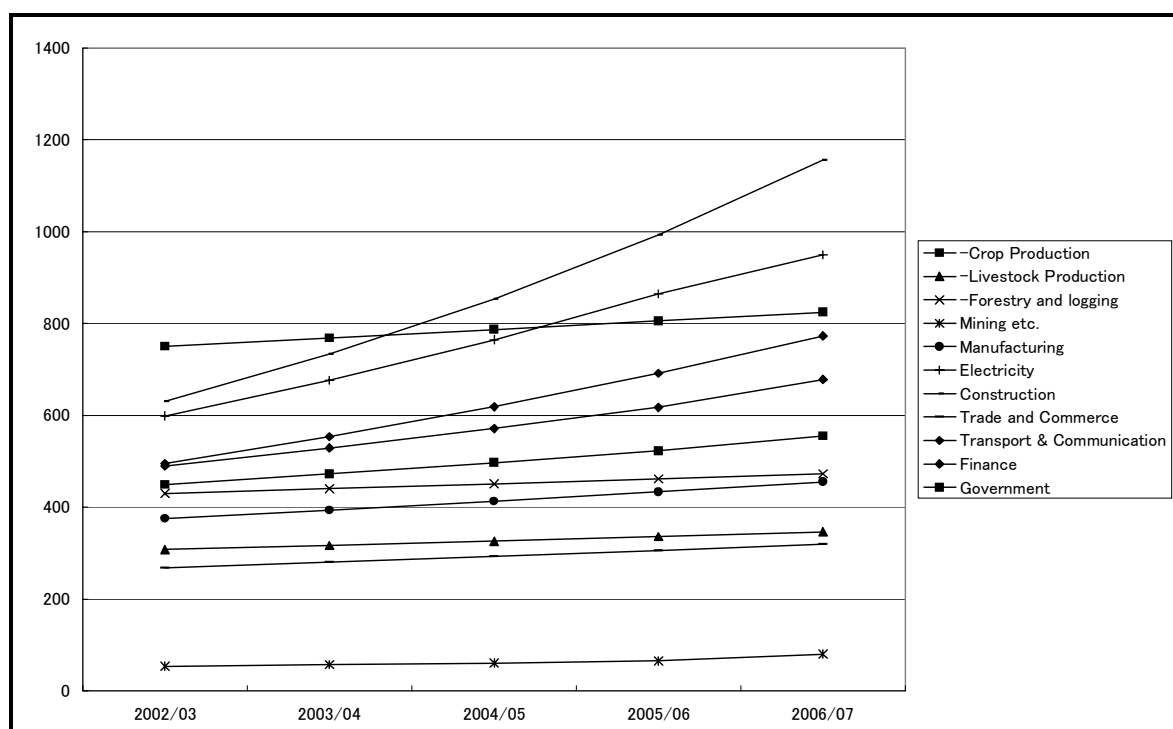
Source: International Trade Center, International Trade Statistic, <http://www.intracen.org/tradstat/sitc3-3d/or064.htm>

1) Fiscal year starts July in Bhutan. 2) 1998/99 means year 1998. 3) Grants are included

### 2.3.2 Economic Forecast

As **Figure-2.3.2** indicates, the economic forecast used in 9th FYP relies on the rapid growth of power and construction sector as the engine of growth with an overall growth rate of 8.2% per annum.

In the year 2000, the agricultural sector comprising of grain production (17.4%), livestock (7.1%), and forestry (10%) contributed 34.5% of the total GDP in Bhutan while power and construction sectors had a share of 9.7%, 11.4% respectively. By the end of 2007 when 9th FYP completes, the power and construction sectors are expected to increase their shares to 14.6% and 17.8% respectively, surpassing 12.7% of grain production. These buoyant development forecasts incorporate the construction and commissioning of the large hydropower stations including Tala.



Source : 9th Plan Main Document [2002-2007], Planning Commission, Royal Government of Bhutan

**Figure-2.3.2 Economic Forecast by Sector in 9th Five Year Plan**

### 2.3.3 Fiscal Balance and Foreign Aid

**Table-2.3.2** shows the budget for 9th FYP. The total expenditure for 9th FYP is 70 billion Nu., out of which 31.7 billion Nu. are planned for current expenses and 38.3 billion Nu. for capital expenditures. These budgets do not include major project budgets that would incur a large sum of expense at one time such as Tala Hydropower and Basochu Hydropower. Allocation for ministries shows that the Ministry of Trade and Industry that oversees power sector receives 12.2% and the Ministry of Communication that oversees road development receives 14.8%, both surpassing the budget for the Ministry of Health and Education with its budgetary share of 10.7%. Investment allocation-wise, the Ministry of Trade and Industry receives 16.6% and the Ministry of Communication receives 22.6%. In terms of departmental budget allocations, the Department of Energy receives 6.2 billion Nu. (8.9%) as a total budget with an investment budget of 4.5 billion Nu., and the Department of Road receives a total budget of 6.7 billion Nu. (9.5%) with an investment budget of 5.5 billion Nu. (14.4%), indicating a high priority attached to these two sectors.

**Table-2.3.2 Fiscal Balance Forecast in 9th Five Year Plan (million Nu.)**

	ORGANIZATION	RECURRENT	CAPITAL	TOTAL	Percent
1	Autonomous Agencies	4,649,248	4,972,517	9,621,765	13.7%
a	His Majesty's Secretariat	77,172	3,950	81,122	0.1%
b	National Assembly Secretariat	83,058	6,720	89,778	0.1%
c	Royal Advisory Council	52,183	1,300	53,483	0.1%
d	Council for Ecclesiastical Affairs	719,926	77,657	797,583	1.1%
e	National Commission for Cultural Affairs	193,974	215,831	409,805	0.6%
f	Judiciary	364,164	125,966	490,130	0.7%
g	Royal Audit Authority	190,578	24,500	215,078	0.3%
h	Royal Civil Service Commission	64,075	3,000,000	3,064,075	4.4%
I	Bhutan Olympic Committee	166,483	43,720	210,203	0.3%
J	Dzongkha Development Commission	48,464	10,000	58,464	0.1%
k	National Environment Commission	29,240	31,728	60,968	0.1%
l	Cabinet Secretariat	16,277	1,300	17,577	0.0%
m	Bhutan Broadcasting Service	0	348,000	348,000	0.5%
n	Planning Commission Secretariat	63,955	45,000	108,955	0.2%
o	Police Jail and Fire Services	2,064,353	355,010	2,419,363	3.5%
p	Royal Institute of Management	156,345	149,000	305,345	0.4%
q	National Technical Training Authority	335,925	500,000	835,925	1.2%
r	Office of the Legal Affairs	17,709	17,595	35,304	0.1%
s	Centre for Bhutan Studies	5,367	15,240	20,607	0.0%
2	Ministry of Home Affairs	486,384	130,569	616,953	0.9%
a	Secretariat	230,469	30,661	261,130	0.4%
b	Department of Survey and Land Records	183,647	22,845	206,492	0.3%
c	Department of Registration	72,268	77,063	149,331	0.2%
3	Ministry of Finance	1,257,252	354,865	1,612,117	2.3%
a	Secretariat	675,892	27,500	703,392	1.0%
b	Department of Budget and Accounts	44,263	17,800	62,063	0.1%
c	Department of National Properties	150,992	25,330	176,322	0.3%
d	Department of Revenue and Customs	357,346	257,535	614,881	0.9%
e	Department of Aid and Debt Management	28,759	26,700	55,459	0.1%
4	Ministry of Foreign Affairs	1,278,692	176,209	1,454,901	2.1%
5	Ministry of Health and Education	4,581,093	2,893,409	7,474,502	10.7%
a	Secretariat	129,076	0	129,076	0.2%
b	Department of Health	2,802,426	1,703,409	4,505,835	6.4%
c	Department of Education	1,598,485	998,476	2,596,961	3.7%
d	Department of Employment and Labour	51,106	191,524	242,630	0.3%
6	Ministry of Agriculture	2,548,361	2,000,000	4,548,361	6.5%
a	Secretariat	435,063		435,063	0.6%
b	RNR-RC	2,113,298	2,000,000	4,113,298	5.9%
7	Ministry of Trade and Industry	2,210,434	6,351,081	8,561,515	12.2%
a	Secretariat	112,070	371,320	483,390	0.7%
b	Department of Trade	73,129	384,252	457,381	0.7%
c	Department of Industry	110,277	900,000	1,010,277	1.4%
d	Department of Power	1,717,949	4,500,000	6,217,949	8.9%
e	Department of Geology and Mines	138,846	70,000	208,846	0.3%
f	Department of Tourism	58,163	125,509	183,672	0.3%
8	Ministry of Communication	1,710,618	8,672,516	10,383,134	14.8%
a	Secretariat	111,265	38,112	149,377	0.2%
b	Department of Urban Development and Housing	187,379	2,400,000	2,587,379	3.7%
c	Department of Roads	1,136,165	5,524,094	6,660,259	9.5%
d	Department of Civil Aviation	127,206	403,920	531,126	0.8%
e	Standard Quality and Control Division	21,491	45,100	66,591	0.1%
f	Road Safety and Transport Authority	89,666	162,112	251,778	0.4%
g	Bhutan Telecom Authority	17,646	21,050	38,696	0.1%
h	Division of Information Technology	19,800	60,000	79,800	0.1%
i	Construction Development Board		18,128	18,128	0.0%
9	Others	5,156,921	3,449,046	8,605,967	12.2%
a	Debt Servicing	393,240	3,449,046	3,842,286	5.5%
b	Common Public Expenditure	2,009,804	0	2,009,804	2.9%
c	Contingency for Remuneration	2,753,877	0	2,753,877	0.0%
<b>I</b>	<b>Total (Central, Autonomous and Others)</b>	<b>23,879,003</b>	<b>29,000,212</b>	<b>52,879,215</b>	<b>0.1%</b>
10	Dzongkhags	7,655,281	7,224,734	14,880,015	0.0%
11	Gewogs	147,183	2,093,587	2,240,770	0.0%
<b>II</b>	<b>Total (Dzongkhags and Gewogs)</b>	<b>7,802,464</b>	<b>9,318,321</b>	<b>17,120,785</b>	<b>0.0%</b>
<b>III</b>	<b>Total Plan Outlay (I + II)</b>	<b>31,681,467</b>	<b>38,318,533</b>	<b>70,000,000</b>	<b>100.0%</b>

Source: 9th Five Year Plan Main Document [2002-2007], Planning Commission, Royal Government of Bhutan

**Table-2.3.3** shows the forecasts for fiscal balance and foreign aid in 9th FYP. Basically the Bhutanese government balances the recurrent budget through domestic revenues while it channels foreign aid toward public capital formation.

**Table-2.3.3 9th Five Year Plan Fiscal Balance Forecast (million Nu.)**

	2002/03	2003/04	2004/05	2005/06	2006/07	合計
Domestic Revenue	5,451	5,964	6,492	6,616	6,999	31,522
Foreign Aid(Grant)	6,065	6,066	6,066	6,066	6,066	30,329
Total Fiscal Revenue	11,516	12,030	12,558	12,682	13,065	61,851
Fiscal Expense (A+B)	11,978	12,494	13,296	14,039	14,744	66,551
A. Current outlay	5,190	5,607	6,484	6,964	7,436	31,681
B. Capital outlay	6,788	6,877	6,812	7,075	7,308	34,870
Fiscal Balance	- 462	- 464	- 738	- 1,357	- 1,679	- 4,700
Financial Sourcing	462	464	738	1,357	1,679	4,700
Debt Amortization	- 617	- 724	- 697	- 676	- 735	- 3,449
Project-related foreign borrowings	1,003	1,003	1,003	1,003	1,003	5,015
Financing Gap	- 76	- 185	- 432	- 1,030	- 1,411	- 3,134
Fiscal Gap GDP ratio (%)	- 1.7	- 1.5	- 2.1	- 3.3	- 3.5	

Source : 9th Five Year Plan Main Document [2002-2007], Planning Commission, Royal Government of Bhutan

The major government revenue sources in 9th FYP are from public corporations (power generation) and taxes. The plan expects increased revenues from corporatization of public services such as telecommunication, postal service, power generation and distribution. Personal Income Tax have been introduced from the year 2002. 9th FYP envisages the capital expenditure of 34,870 million Nu. to be financed with grants from foreign governments at 30,329 million Nu. and project based borrowing of 5,015 million Nu. The plan sets aside 3,449 million Nu. for debt services during the period.

The Bhutanese government belongs to a group of governments demonstrating good debt management programs. The debt-service ratio was 6% during 2001/02. However, the debt-GDP ratio increased from 38.7% in 1999/2000, to 47% in the following year, then to 55% in the year 2001/02. This increase in borrowing also increased the deficits in current account balance. As of June 2002, the outstanding external debt was US\$350 million, but the majority of the debt consists of loans with concessional terms, thereby limiting the debt-service ratio at the 6% level, proving the merit of the government's prudent management style. It is known that the majority of foreign aid is grant-based. India is by far the largest donor in bilateral aid because of its involvements in hydropower and highway. In the case of hydropower development through Indian financing, the ratio between grant to borrowing is usually set at 6 to 4. In addition, Bhutanese currency Ngultrum (Nu.) is fixed to Indian rupee with one to one ratio. In other words there is little risk in foreign currency exchanges with India. Sales of power to India are based on a long-term contract and contributes significantly to foreign exchange earning of Bhutan (41% in 1999).

## 2.4 Nature and Environment

Bhutan is characterized by high altitudes, steep topography, and extensive forest coverage. The altitude of Bhutan varies from 160 m to over 7,000 m, and most of the territory is

mountainous. As the country is rich in flora and fauna, it is admired as one of the “10 global hotspots”.

The climate in Bhutan varies greatly according to the altitude of each area. It is explained generally that it has high humidity and temperature in the southern areas, a dry climate and low temperatures in the north, warm and dry in the ravines, and severe cold in the Himalayas. Precipitation in each area is different as well. It is less than 500 mm/year in the north, moderate in the central region with over 1,000 mm/year, and more than 5,000 mm/year in the southern areas that are subject to high temperatures and high humidity.

The precipitation, temperature and humidity in the Dzongkhags in Bhutan are shown in **Table-2.4.1**.

**Table-2.4.1 Climate in Each Area**

Dzongkhag (observatory)	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total/Average	Year
Thimphu (Simotokha)	Precipitation (mm)	31.3	4.5	32.8	20.4	32.3	129.6	253.7	189.2	121.4	17.3	1.9	5	839.4	2002
	Max. Temp. (°C)	14.1	17.1	18.6	19.7	23.4	25.4	25.8	25.0	24.7	20.9	19.6	16.2	20.9	
	Min. Temp. (°C)	0.5	0.5	1.0	4.0	9.0	13.0	15.0	13.0	11.0	8.5	4.5	0.5	6.7	
	Humidity (%)	33.1	28.3	30.5	39.4	47.0	57.1	57.5	59.6	53.4	42.6	32.6	31.8	42.7	
Samtse (Sipsu)	Precipitation (mm)	42.2	28.6	61.2	527.8	251.8	1514.6	1290.6	855.6	505.4	136.8	0.0	64.6	5279.2	2002
	Max. Temp. (°C)	23.5	28.5	31.0	30.0	31.6	31.0	33.0	33.0	34.0	32.0	29.0	26.5	30.3	
	Min. Temp. (°C)	12.0	14.0	17.0	16.5	19.5	22.2	23.0	22.0	21.5	19.2	16.0	12.5	18.0	
	Humidity (%)	59.8	59.6	67.2	74.5	72.6	83.1	87.1	82.2	76.8	66.3	55.9	59.1	70.4	
Bumthang (Chhoekhor)	Precipitation (mm)	0.0	6.4	17.0	55.7	136.7	110.4	121.5	154.5	60.4	21.9	2.4	0	686.9	2000
	Max. Temp. (°C)	13.0	14.0	16.5	18.0	21.5	24.0	25.0	24.0	23.0	23.0	18.0	14.5	19.5	
	Min. Temp. (°C)	-12.0	-11.0	-6.0	1.0	4.0	12.0	12.0	13.0	7.0	-3.0	0.0	-11	0.5	
	Humidity (%)	77.4	71.1	75.5	70.8	72.7	75.6	80.1	82.6	79.0	72.7	70.1	72.8	75.0	
Mongar (Mongar)	Precipitation (mm)	0.0	0.0	24.6	123.6	54.2	157.6	238.4	302.6	86.4	18.0	0.0	0	1005.4	2002
	Max. Temp. (°C)	19.5	23.5	27.5	27.5	30.0	30.0	30.5	31.0	32.0	28.0	24.0	22	27.1	
	Min. Temp. (°C)	4.0	5.5	9.5	10.0	11.0	16.0	17.0	16.0	15.0	11.0	8.5	6	10.8	
	Humidity (%)	71.7	71.0	70.4	75.6	76.6	87.1	89.6	84.0	80.7	71.7	65.2	65.5	75.8	
Samdrup Jongkhar (Deothang)	Precipitation (mm)	5.1	38.4	3.6	340.1	596.6	316.6	620.7	545.8	435.9	114.3	49.8	0	3066.9	2001
	Max. Temp. (°C)	22.5	23.0	29.5	29.0	30.5	31.5	30.0	31.0	31.5	29.0	28.5	22	28.2	
	Min. Temp. (°C)	7.0	9.0	11.5	14.5	16.5	19.0	19.5	20.0	19.0	15.5	12.0	9	14.4	
	Humidity (%)	65.0	67.8	60.5	76.8	85.8	85.3	90.0	90.1	90.5	78.9	72.6	60.1	77.0	

Source: DOE

## CHAPTER 3 THE CURRENT STATUS OF THE POWER SECTOR

### 3.1 Policy, Laws, and Institutions

#### 3.1.1 History of Power Sector Policy

In order to fulfill its national policy of Gross National Happiness, 100% rural electrification by the year 2020 is one of the core policies in power sector. As of June 2004, among 68,851 households in rural areas 24,833 households (36%) have access to electricity, leaving the balance of 44,018<sup>1</sup> households non-electrified. Bhutanese government electrified 7,360 households during 6th Five Year Plan (FYP), 5,476 households during 7th FYP, 8,822 households during 8th FYP. The government target electrification of 15,023 households during 9th FYP and so far achieved 447 households (**Table-3.1.1** and **Appendix-A-I**).

**Table-3.1.1 Target Electrification Number of Households during 9th FYP**

Sl#	Dzongkhag	Plan target (HH)	Surveyed target (HH)	Fund* secured (HH)	Resource gap (HH)
1	Chukha	896	901	1041	
2	Gasa	110	207	207	
3	Haa	281	117	49	68
4	Paro	702	743	758	
5	Punakha	519	585	688	
6	Samtse	1250	1259	1361	
7	Thimphu	646	239	182	57
8	Wangduephodrang	831	845	895	
9	Bumthang	337	516	217	299
10	Trongsa	367	573	221	369
11	Sarpang	935	936	971	
12	Dagana	672	702	0	702
13	Tsirang	687	801	0	801
14	Zhemgang	516	281	303	
15	Mongar	1091	1093	1122	
16	Lhuentse	628	633	633	
17	Pemagatshel	980	981	1153	
18	Trashigang	1728	1729	2068	
19	Yangtse	812	867	897	
20	Samdrup_ongkhar	1012	1015	1015	
	<b>Total Households</b>	<b>15000</b>	<b>15023</b>	<b>13781</b>	<b>2296</b>

\* Fund secured from ACB, ADB, SDS & RGoB  
Source : DOE

<sup>1</sup> Source: DOE, Reporting of National Electrification Data to the National Assembly Session (June – July 2004).

The Asian Development Bank (ADB) has provided funds continuously for rural electrification (RE) in Bhutan. During 7th FYP under ADB/RE-1, ADB financed for 3,000 households. During 8th FYP, under ADB/RE-2, it covered over 8,000 households. During 9th FYP, ADB/RE-3 aims to finance the electrification of 8,000 households<sup>2</sup>. Another pillar in power sector policy, but often in conflict with rural electrification programs, is the promotion of efficiency in power sector management, since hydropower is the primary industry in foreign exchange earnings. In conjunction with this policy, Parliament passed the Electricity Act in July 2001. According to this law, the Department of Power, the entity responsible for all the matters relating power, i.e. power sector policy, power generation, and power sales, was split into three entities. The Department of Energy (DOE) is solely responsible for policy making, the Bhutan Power Corporation (BPC) for transmission and distribution of power, and the Bhutan Electricity Authority for the regulation of the power sector. In July 2002 the government “corporatized” the BPC as an independent body responsible for transmission and distribution of power. The three power generation plants of Chukka, Kurichhu, and Basochhu have remained as independent corporations. However, realizing the gaps in management efficiency because of differences in operation size, the government is now considering to integrate the three generation companies into one, the Druk Hydro Power Corporation, in order to have better share resources and to achieve economy of scale.

### 3.1.2 Acts Related to Rural Electrification

The Bhutanese authority is fully aware of the financial viability difficulties of rural electrification especially when dealing with 100% rural electrification. Therefore, the government aims to instill efficiency in the rural electrification process by the preparation of a by-law, the "Regulations For Subsidies To Entities Carrying Out Non-economic Viable Electricity Supply."

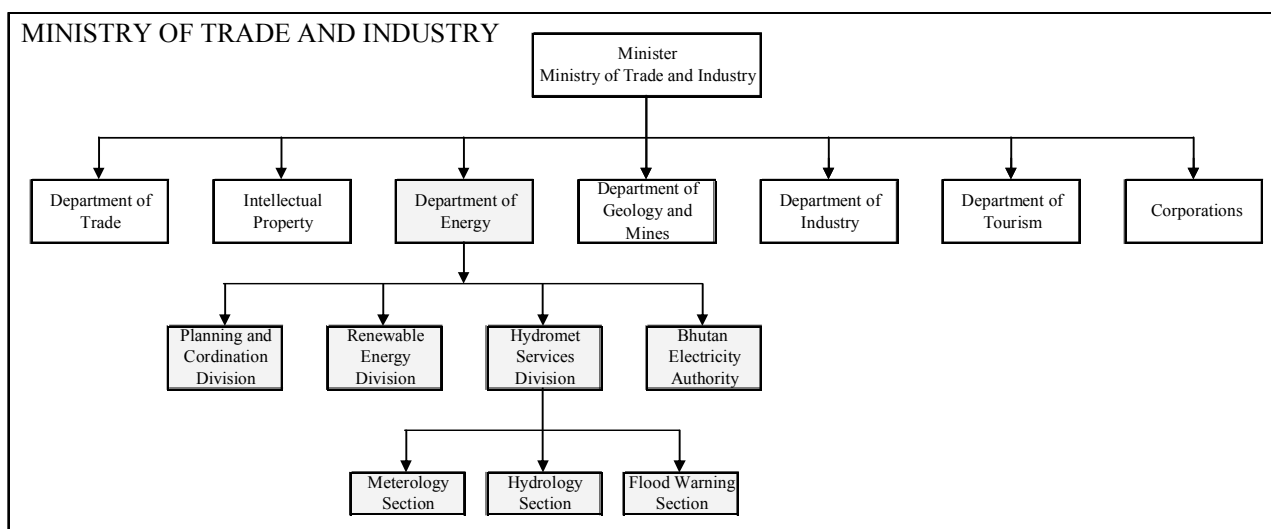
### 3.1.3 Institutions of Power Sector

At present the Department of Energy (DOE) of the Ministry of Trade and Industry formulates policies and oversees power generation, transmission and distribution. The DOE is comprised of four sections -- the Planning and Coordination Division, Renewable Energy Division, Hydromet Services Division, and Bhutan Electricity Authority. The Electricity Authority is now fully responsible for overseeing and regulating power generation and supply in the future. Bhutan Power Corporation (BPC) solely manages transmission and distribution of power. Prior to the establishment of the BPC, the Department of Power managed power supply in tandem with policy making. The global trend of privatizing and restructuring the power sector pushed the Bhutanese government to “corporatize” BPC in July 2002. The agency transferred 987 employees from the Department of Power and 226

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<sup>2</sup> The total cost for the electrification projects of 9th FYP is US\$13 million, among which US\$9.4 million is financed from ADB. This is a soft loan provided from Asian Development Fund (ADF). The grace period is 8 years and repayment period is 32 years. The interest is 1% in the grace period and 1.5% in the repayment period. The target electrification areas is Chukha, Lhuntse, Mongar, Pemagatshel, Punakha, Samtse, Sarpang, and Trashigang. The loan is combined with technical assistance projects. US\$400,000 is planned to be provided for BEA capacity building, and US\$500,000 for the feasibility study for the establishment of Druk Hydropower Corporation. Out of remaining 7,000 non-electrified households, 3,000 households are to be covered by Dutch grant and 1,000 households are by Austria. The fund source for the rest of 3,000 households is not secured yet (as of August 2005).

employees from CHPC, a total of 1193 employees, into its realm. It is now the largest corporation in Bhutan.



Prepared by JICA study team interview with MTI

**Figure-3.1.1 Organization Chart of Ministry of Trade and Industry**

**Table-3.1.2** shows the annual achievements in power supply in Bhutan. It shows nearly doubled rates in rural electrification from 363 villages in 1996-97 to 690 villages in 2001-02.

**Table-3.1.2 Power Supplies in Bhutan (96/97-01/02)**

Year	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02
a) No. of Consumers	21,777	23,036	24,992	27,152	29,880	32,637
b) CHPC Consumers	1,128	1,187	1,293	1,357	1,356	1,356
Total registered consumers	22,905	24,223	26,285	28,509	31,236	33,993
c) Non-registered consumers	7,416	7,416	7,416	7200	4,735	4,698
Total consumers	30,321	31,639	33,701	35,709	35,971	38,691
No. of Towns Electrified	39	39	40	40	40	40
No. of Villages Electrified	363	370	443	552	646	690
Revenue earned from energy sale (million Nu.)	178.743	229.454	236.374	280.741	268.730	381.105
Per Capita Energy Consumption (Units)	599.367~	619.426~	665.670~	720.000	632.151	807.974

Source: BPC

During the fiscal year of July 2001 to June 2002, prior to the establishment of BPC, the revenue from energy sales increased 42% from 269 million Nu. to 381 million Nu. The revenue increased more than twice in comparison to that in 1996-97.

There had been no fixed charge in power tariff in Bhutan. The latest revision in tariff July 2004 has introduced a fixed charge so-called demand charge for the category of industrial users. The government has been emphasizing in its public relations about the fact that the cost of providing electricity in domestic market is 4 Nu./kWh, while the price of power sales averages is only 0.9 Nu./kWh, and the electricity sales unit for consumers is far smaller than accrual cost of generation and distributions. The basic power tariff policy of Bhutan is to gradually increase the tariff to cover the economic cost while maintaining the provisions for poverty alleviations.



## 3.2 Power Tariff

### 3.2.1 Power Tariff System

Since its incorporation of BPC, the second power tariff revision came into effect in July 2004. This revision envisages an average tariff increase of 10%. The lowest tariff range of 0-80 kWh remains without any increase. The tariff table for household consumers in BPC is shown in **Table-3.2.1**.

**Table-3.2.1 Tariff Table for Household**

Range	Tariff (Nu./kWh)
1-80 kWh	0.6
81- 200 kWh	0.95
201 above	1.2

Source: BPC

According to BPC, the average tariff was 0.9 Nu./kWh due to progressive pricing. For business users, a new access charge was introduced in the name of a Demand Charge which charges 54 Nu./kW (fixed). Volume charges are 0.95 Nu./kWh for middle voltage users, and 1.2 Nu./kWh for high voltage users.

For the consumer of power, the cost of using electricity arises not only from the monthly tariff, but also from the initial connection costs. The average connection cost in Bhutan is estimated to be 3,145 Nu. per household and this mainly covers the cost for equipment and materials required to make the power connection. The connection cost is equivalent to one month's income for low income families, thus this cost could inhibit connection to electricity in such cases. The ADB/RE-3 program funded by ADB includes some program to offer free connection for low income families.

**Table-3.2.2 Electricity Connection Cost**

	Cost (Nu.)	Average Cost (Nu.)	Note
Single Phase Meter	250	250	
Energy Security Charge	120-480	300	12 Nu. per Ampere
Connection Charge	25	25	75 Nu. for three phase
Service Cable Charge	60	60	
Contingency Charge	10	10	20 Nu. for three phase
Outlet:2 Light Point and One Power Point	2,500	2,500	
Total		3,145	

Source: BPC

### 3.2.2 Electricity Tariff Collection Method

BPC's local offices dispatch meter readers every month to check the meters of the consumers and to hand out the bills. The consumer needs to pay in cash at each sale office. Each sale office is now equipped with a PC and database software for billing and collection. A sale office is located in each Dzongkhag. Therefore it is often the case for consumers that the transportation to reach the sale office costs more than the electricity bill. Though tariff collection by meter readers at the site should be an alternative but appear to have not been experimented so far. Further rural electrification would add more costs to local operations. Therefore it is necessary to examine the ways to increase efficiency in tariff collection.

### 3.3 Balance of Electricity Supply and Demand

#### 3.3.1 Past Records of Balance

**Table-3.3.1** shows the actual performance of electricity supply and demand in the whole Bhutan in the period of 1997-2002. Total installed capacity of generation was 445 MW against the system peak power demand of 105 MW in the year 2002 excluding PV/Solar facilities. Hydropower sources share 97% of the total installed generation capacity. The total generated energy in 2002 was 2,200 GWh. In contrast, the total energy requirement for the whole country in 2002, including the system energy losses, was 664 GWh. Thus, the supply capacity for the whole country has sufficient surplus for both demands of peak power and energy.

Bhutan exports the surplus to Indian grid. Total exported electric energy was 1,560 GWh in the year 2002, which was equivalent to 2.3 times total electric energy required in the same year in the whole Bhutan.

However, import of electric energy was needed in some areas where on-grid distribution system from the domestic electricity sources has not been facilitated. The electricity import is also needed in some areas where domestic supply is short in the dry season.

**Table-3.3.1 Power and Energy Balance in Whole Bhutan (1997-2002)**

Year		1996-7	1997-8	1998-9	1999-2000	2001-2	2002-3
Installation Capacity of Generation (MW/year)	Hydro	343.350	343.350	343.350	343.350	412.350	427.320
	Micro Hydro	0.980	0.980	0.980	1.108	1.308	1.308
	Diesel	12.336	12.321	15.668	16.363	15.390	16.404
	Total	356.666	356.651	360.006	360.821	430.048	445.032
Domestic Peak Demand (MW)		77.000	80.000	89.000	92.000	92.630	105.329
Energy Generation (GWh/year)	Hydro	1,874.238	1,874.238	1,874.238	1,874.238	2,055.675	2,199.554
	Micro Hydro	2.231	2.231	2.231	2.531	3.232	included above
	Diesel	0.222	0.229	0.406	0.424	0.605	0.909
	Total	1,876.691	1,876.698	1,876.875	1,877.193	2,059.512	2,200.463
Energy Import (GWh/year)		7.544	8.154	9.157	9.932	6.901	24.302
Total Energy Consumption in the Country (GWh)		381.422	396.574	445.548	401.896	510.451	664.330
Energy Export (GWh/Year)	Chukha HPC	1,357.202	1,302.215	1,625.961	1,380.147	1,368.570	1,340.664
	Basochu-I HPC	-	-	-	-	22.362	-
	Kurichu HPC	-	-	-	-	109.118	219.771
	Total	1,357.202	1,302.215	1,625.961	1,380.147	1,500.050	1,560.435

Source : Power Data 2001-2002, Power Data 2002-2003 issued by DOE

**Table-3.3.2** shows numbers of consumers by categories in the whole Bhutan as of April 2004.

Average annual growth rate of consumers' number in the past 6 years was 12%. Numbers of district-wise and category-wise consumers are tabled in **Appendix A-II**.

**Table-3.3.2 Numbers of Consumers**

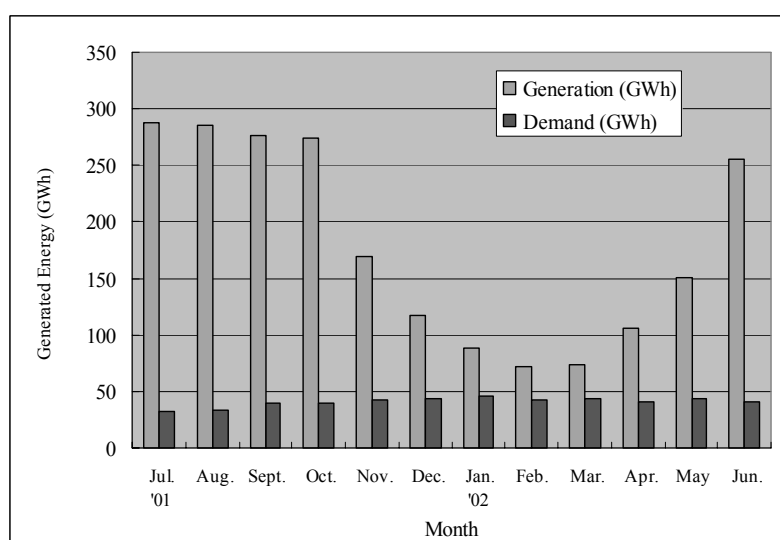
Voltage-wise	Domestic	Commerce	Industry	Agri- culture	Public	Street Light	Bulk Supply	Others	Total
LV consumer	38,914	4,331	150	242	2,546	101	348	1,189	47,821
MV consumer	1	0	19	1	6	0	24	3	54
HV consumer	0	0	3	0	0	0	0	0	3
Total	38,914	4,331	172	243	2,550	101	372	1,192	47,878

Source : DOE (Records of Customer's Service Department of BPC)

### 3.3.2 Seasonal and Daily Characteristics of Supply and Demand

#### (1) Seasonal Characteristics

Approximately 97% of electricity energy in Bhutan has been generated by Chukha, Basochhu and Kurichhu hydropower stations. Those power stations are of Run-of-River type, and accordingly amount of generated energy of those power stations is to be declined during the dry season of December to April due to less water-inflow. **Figure-3.3.1** shows the total monthly energy production of these three stations in the period of July 2001 to June 2002 and energy demand in Bhutan. The balance between production and demand, i.e., surplus after consumption in the country was exported to India.



Source : DOE

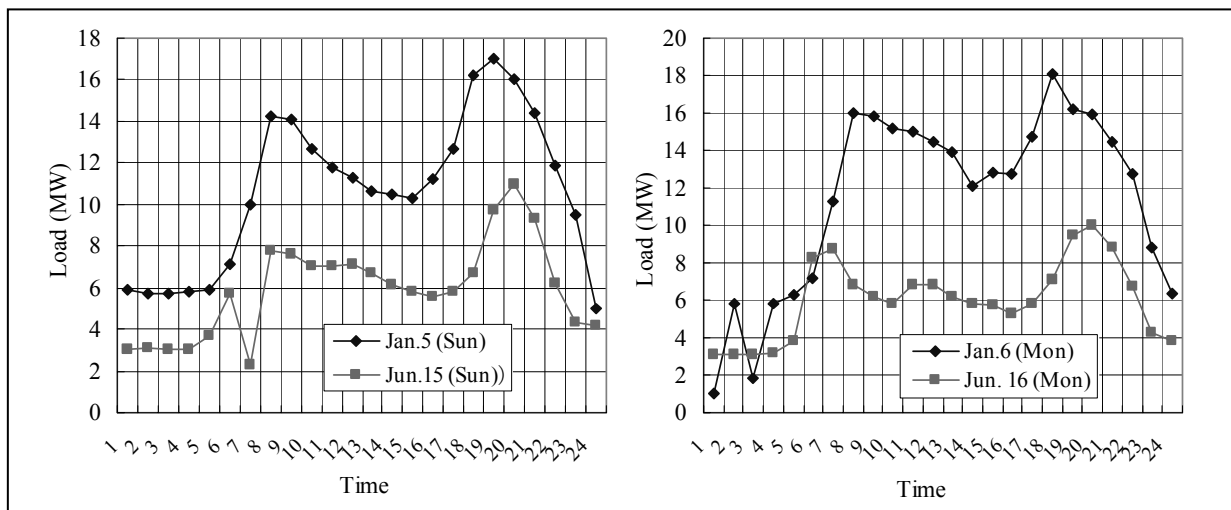
**Figure-3.3.1 Monthly Energy Production and Consumption in Bhutan**

The figure indicates a tendency that energy consumption increases during the winter season when demand increases by the needs of heating and water inflow into the power stations becomes less. It is obvious that there is a sufficient surplus in the total annual energy production, but seasonal energy surplus is extremely varied. All large-scale hydropower stations under construction and under planning are of Run-of-River type. On this account it is evident that such a seasonal fluctuation of the energy production and consumption will continue. Since production capacity of the planned power stations is huge against the demand increase of the country, such seasonal fluctuation deems not to be serious in the future. However, particular countermeasures for the seasonal output fluctuation should be

carefully studied in the eastern power system having less development plan of power stations.

(2) Daily Load Curves of Differing Localities

Daily load data covering the whole country is not available at present. **Figure-3.3.2** indicates typical daily load curves in Thimphu for January (winter, dry season) and June (summer, rainy season) 2003. The figures show loadings in a holiday (Sunday) and a working day (Monday) for comparison.

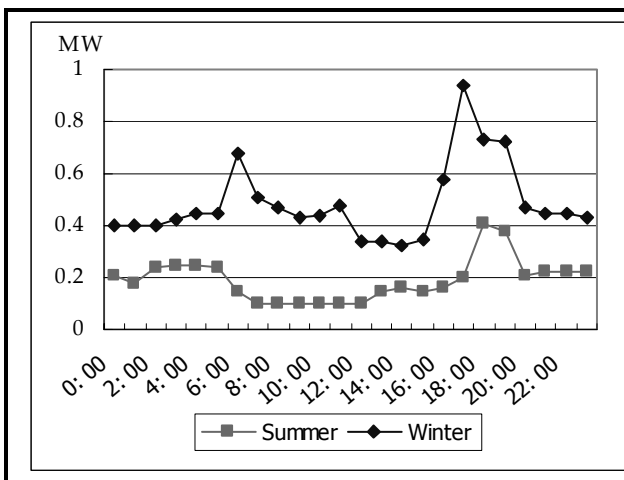


Source: BPC

**Figure-3.3.2 Daily Load Curve (Thimphu-2003)**

In Thimphu, domestic (household) demand shares 65% of the total demand, while industrial demand is 3% only. In any case two (2) daily peaks (morning and evening) appear. This seems to be a typical urban type. Demand in the winter season is almost double amount in the summer. Demands in Sunday and Monday in the winter season are similar in timing and loading. It seems that heating facilities are popularized in Thimphu. The load factor in Thimphu (load factor = average power demand / maximum power demand) is 65-70%, higher than of rural areas.

Mongar

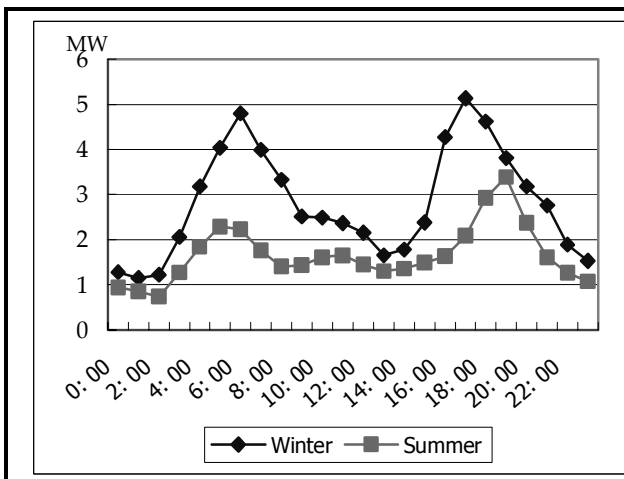


In Mongar, major demand lies in rural areas, surpassing 60% of total demand in the Dzongkhag. In comparison to that in Thimphu, sag in the daytime is more conspicuous. The daily load factors are 52% at its annual maximum and 47% at its annual minimum showing substantially low figures compare to 65-70% in Thimphu.

Source: BPC

**Figure-3.3.3 Daily Load Curve at Mongar**

Paro

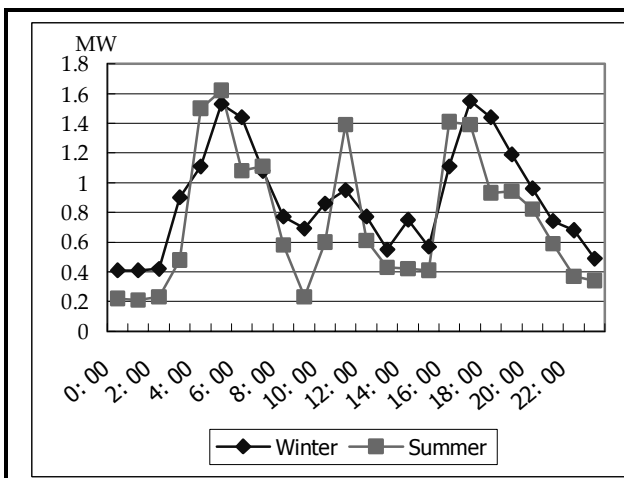


Paro has the Bhutan's international gateway, Paro Airport, and also major tourist spots. The electrification ratio exceeds 90%. The daily load curve shows a typical two humps reflecting rural power demands during meal times. Similar to Mongar, Paro shows a big drop in the daytime. The daily load factors are 55% at its annual maximum and 49% at its annual minimum.

Source: BPC

**Figure-3.3.4 Daily Load Curve at Paro**

Haa

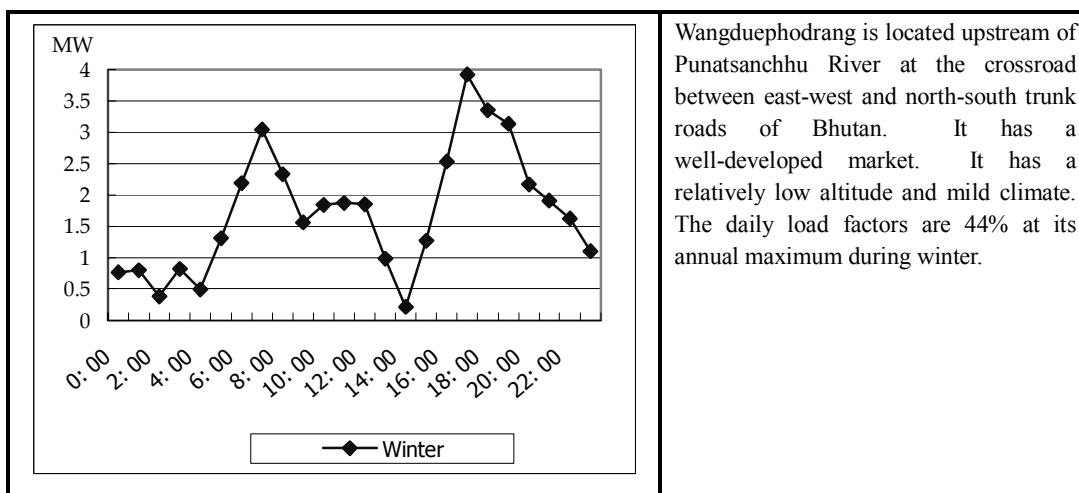


Haa is an agricultural area and also has some industries with relatively high income levels in Bhutan. There are also some military facilities. The peculiar feature of the daily load curve of Haa is three humps. The conspicuous surge in the lunch time during summer may be attributed to the use of electric fans and rice cookers. The daily load factors are 58% at its annual maximum during winter and 48% at its annual minimum during summer, much lower than those of Thimphu.

Source: BPC

**Figure-3.3.5 Daily Load Curve at Haa**

Wangduephodrang



Wangduephodrang is located upstream of Punatsanchhu River at the crossroad between east-west and north-south trunk roads of Bhutan. It has a well-developed market. It has a relatively low altitude and mild climate. The daily load factors are 44% at its annual maximum during winter.

Source: BPC

**Figure-3.3.6 Daily Load Curve at Wangduephodrang**

3.3.3 System Energy Loss

Power Data 2002-2003 issued by DOE reports the following system energy loss in the whole country including those of transmission and distribution lines, distribution networks, and other power facilities.

**Table-3.3.3 Energy Loss in Whole Country (GWh/year)**

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2001-03
Energy Req.	383.16	396.08	424.11	480.81	441.24	578.46	664.33
Energy Loss	16.57	14.66	27.53	35.27	39.35	68.01	93.05
Loss Rate (%)	4.32	3.70	6.49	7.22	8.92	11.76	14.01

Source: DOE Power Data (2002-2003)

Energy loss level within the Bhutan power system has rapidly increased during the last 7 years. The energy loss in the identical system composition is to increase at square of increase of the system demand. Although no statistics of energy losses produced in each facility of transmission and distribution line system, the losses in the distribution network are considered to be significant.

The losses are decreased in the newly constructed distribution facility of ADB/RE-1 and ADB/RE-2. However, regarding the rural electrification starting from existing lines expansion, the loss will be increased since larger current is expected to come to the existing lines. For the formulation of the grid extension plan, it would be necessary to include the improvement of the existing facilities and upgrading of existing distribution lines.

**3.4 Financial Status of Power Sector**

The power sector in Bhutan is now divided into two divisions, power generation part and transmission and distribution part. Three major power generation companies independently operate power stations and BPC is solely responsible for the latter transmission and distribution part.

### 3.4.1 Financial Status of BPC

The balance sheet of BPC at the time of its establishment is summarized as shown in **Table-3.4.1**.

**Table-3.4.1 BPC Balance Sheet**

Unit: million Nu.

Asset		Liabilities	
Working Capital	50	Borrowings	670
from Ministry of Finance	50	from DOP	670
Fixed Assets	4,274	Equity	3,654
Kurichu	600	DOP	2,795
CHPC	209	CHPC	209
Others	3,465	Kurichu	600
		Ministry of Finance	50
Total	4,342	Total	4,324

Source: BPC

### 3.4.2 Financial Status of Power Generation Companies

For power generation, comparing Chukha, Kurichhu, and Basochhu hydropower stations shows that it is Chukha, operated in the Bhutan's west power system, that most significantly contributes to the state income. **Table-3.4.2** indicates the financial status of the power generation companies. Tala hydropower (1,020 MW) is a mega-project that is scheduled to be commissioned in 2006. The annual energy output is planned to be 3,962 MWh and it is expected that the state income will be doubled by this project.

**Table-3.4.2 Financial Status of Power Generation Companies**

	Hydro Power Generation Corporations				
	Chukha	Kurichhu	Basochhu I	Basochhu II	Tala
Installed Capacity	336 MW	60 MW	24 MW	40 MW	1,020 MW
Date of Commission	1988	2001	2001	2005	2006
Generated Energy	1,860 GWh	400 GWh	105 GWh		3,962 GWh
Completion Cost	2,815 million Nu.	6,676 million Nu.	1,441 million Nu.	1,422 million Nu.	40,000 million Nu.
Loan Component	1,340 million Nu.	3,276 million Nu.	708 million Nu.	1,290 million Nu.	18,520 million Nu.
Loan Repayment Terms	15 years	12 Years	15 Years	12 Years	12 Years
Interest	5%	10.75%	0%	2.80%	9%
Performance 2003 *					
Energy Generation	1,957 GWh	278 GWh	119 GWh		3,444 GWh
Income	2,448 million Nu.	441 million Nu.	107 million Nu.		5,308 million Nu.
Expenditure w/o depreciation		295 million Nu.			
Expenditure w/ depreciation	537 million Nu.	545 million Nu.	72 million Nu.		2,959 million Nu.
Tax + Divident (2003)	1,871 million Nu.	-	22 million Nu.		2,020 million Nu.

Note: \* performance data for Tala are estimated values  
Source: DOE

### 3.5 Agreement for Power Trade between Bhutan and India

An agreement for exporting to India the surplus energy from the Chukha hydropower station (336 MW) has been concluded between DOE of Bhutan and Power Trading Corporation of India Ltd. (PTC). The effective period of the Agreement is 14.5 years from 1st October 2002 to 31st March 2017.

Following are abstracts of the Agreement.

(1) Energy for Sale

All surplus energy of Chukha power station is to be sold to India. In the Agreement, specific amount of energy to be sold is not indicated, accordingly. The Chukha HydroPower Corporation (CHPC) is to inform to PTC the estimated power energy on monthly basis in the month of January for the year.

(2) Delivery Point

The Chukha power station is interconnected with Indian grid through two (2) routes of 220 kV transmission lines; one is a direct connection to the Indian grid and another is via Singhegaon substation in Bhutan near the border.

Accordingly, delivery points of energy are Chukha power station for the former route and Singhegaon substation for the latter route.

(3) Import of Energy from India

During outages of Chukha power station, in the event of any failure in Bhutan network, or for consumption in local areas near the border, Bhutan can import energy from Indian grid. Energy import will be made through the above 220 kV transmission lines and through 11 kV lines to two (2) places in Samtse at the border. In addition to the Chukha system in this Agreement energy is currently imported and at Gelephu and Samdrup Jongkhar through 132 kV transmission lines.

(4) Metering of Trading Energy

Energy meters of 0.5 class or better accuracy class are installed at the following points:

- 1) One each on all four generators at Chukha power station on the 11 kV side.
- 2) One main meter and one check meter each on the 220 kV lines from Chukha power station to Birpara substation in India to record import and export of energy.
- 3) One main and one check meter each at Singhegaon substation in Bhutan and Birpara substation in India to record import and export of energy.

The person in charge is to check the meters installed in the partner country every month. All main and check meters are to be tested and calibrated at mutually agreed test laboratories at intervals not exceeding 12 months.

(5) Amount of Traded Energy

Amount of energy traded is determined as follows:

- 1) Amount of energy delivered through 220 kV direct lines from Chukha power



station is determined to be average of the measurements at Chukha power station and Birpara substation in India.

- 2) Amount of energy delivered through Singhegaon-Birpara 220 kV line is determined by the measurement of the meter provided at Singhegaon substation in Bhutan.

(6) Tariff

- 1) Payment is made in Indian currency.
- 2) Tariff for energy delivered by Bhutan to India is 1.50 Rs./kWh for Chukha HPC (1.75 Rs./kWh for Kurichu HPC). Payment is made for net energy measurement multiplied by this tariff.

(Note: Export tariff from Chukha was revised to 2.00 Rs./kWh since Jan. 1, 2005. Tariff from Kurichhu remains unchanged.)

- 3) Charge of energy imported by Bhutan from India is at the rate of 1.50 Rs./kWh on the re-imported energy multiplied by 0.88 considering 12% losses. Wheeling charges are added at the rate of 20 paisa/kWh for the re-imported energy.

Tariff for the energy trading is to be reviewed every 3 to 4 years during effectiveness of 14.5 years of this agreement under the mutual agreement of both countries.

### 3.6 Policy Related to the Renewable Energy System

The Renewable Energy Division (DOE-RED) was created under the Department of Energy (DOE) in July 2002. The policy and institution regarding renewable energy conducted in DOE-RED have not formulated yet so far (June 2004). However, DOE-RED being a Government promotion channel for Renewable energy within the country, it is mandated to develop and promote all modern forms of renewable energy resources/technologies, manpower development including energy conservation and efficiency improvement measures. Therefore the current focus of DOE-RED is mainly in Solar Energy programme, Biomass programme, energy conservation and efficiency improvement programme, development of integrated energy master plan, and institutional capacity development.

As a future activity of DOE-RED, it is required to develop the relevant renewable energy policy and legal frame work for the electrification with renewable energies. For instance, the places like public facilities, monastery, temple, individual households, where grid extension is not feasible, the power supply plan have to be carried out by available renewable energy resources utilizing development budget of State and foreign donor agencies for public and subsidies for private households.