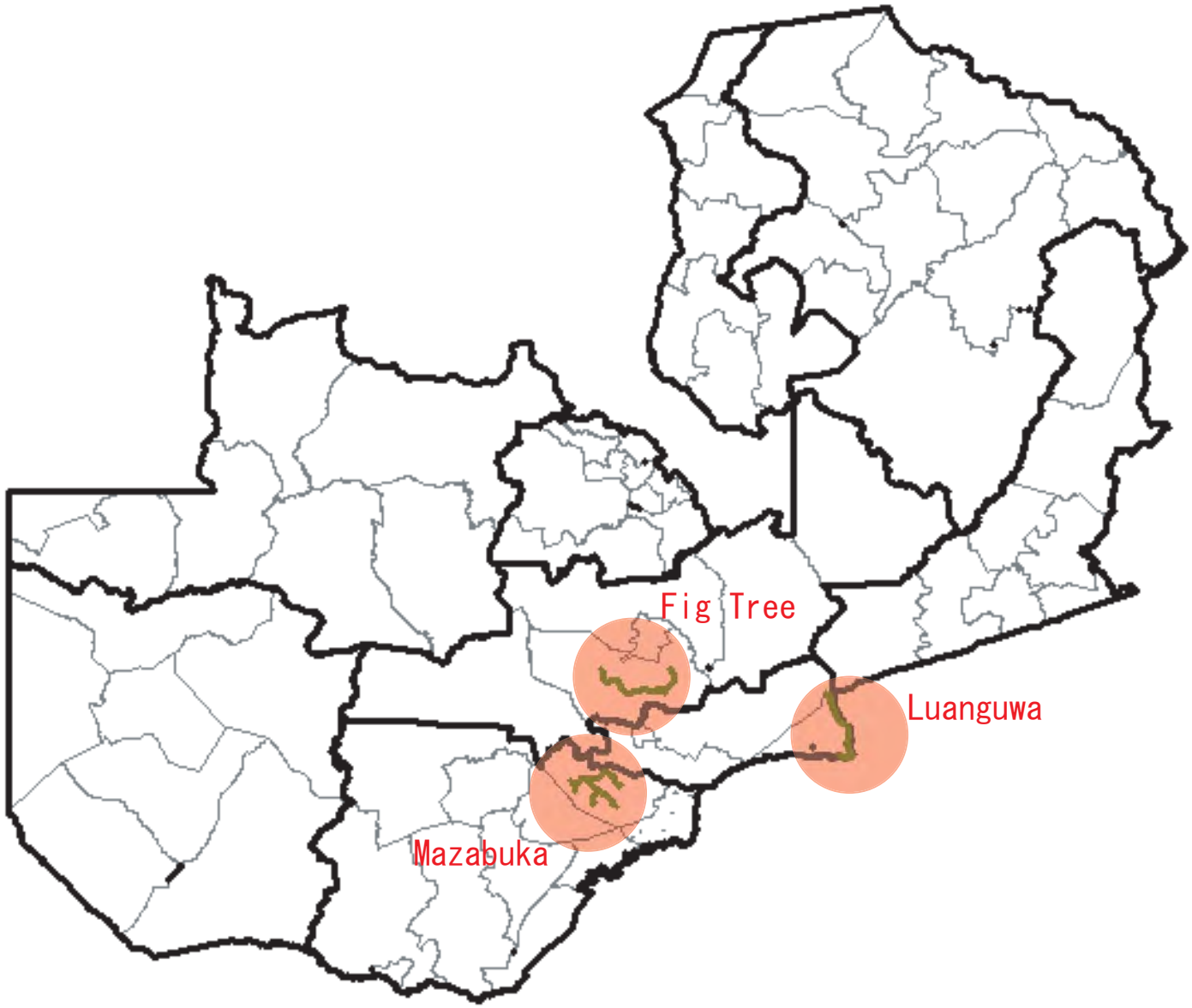
Appendix D

Case Study of Distribution Line



ZESCO

The Study for Development of the Rural Electrification Master Plan in Zambia

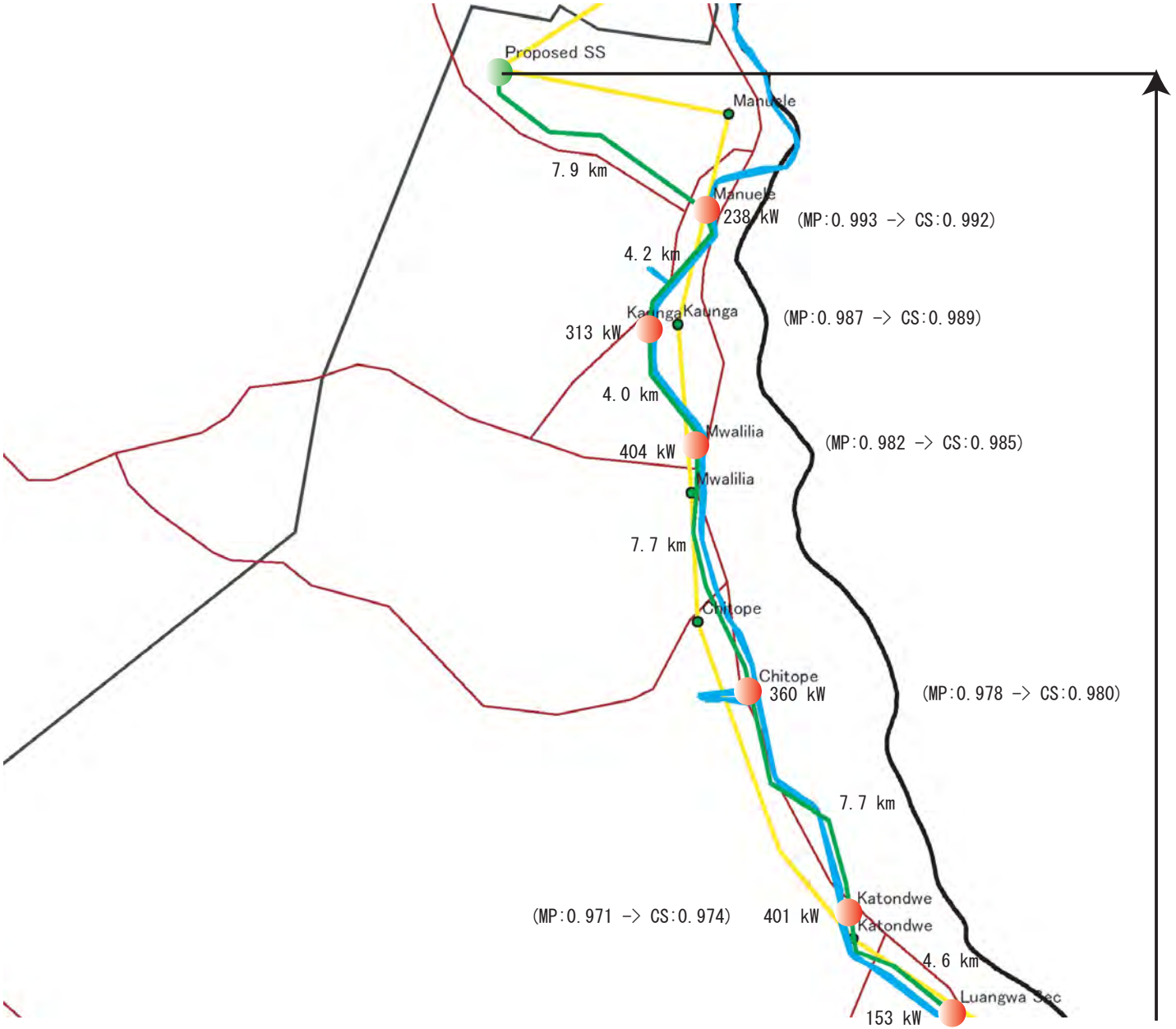
Tokyo Electric Power Company

TEPCO

Drawing No.

Title

Position of Case Study



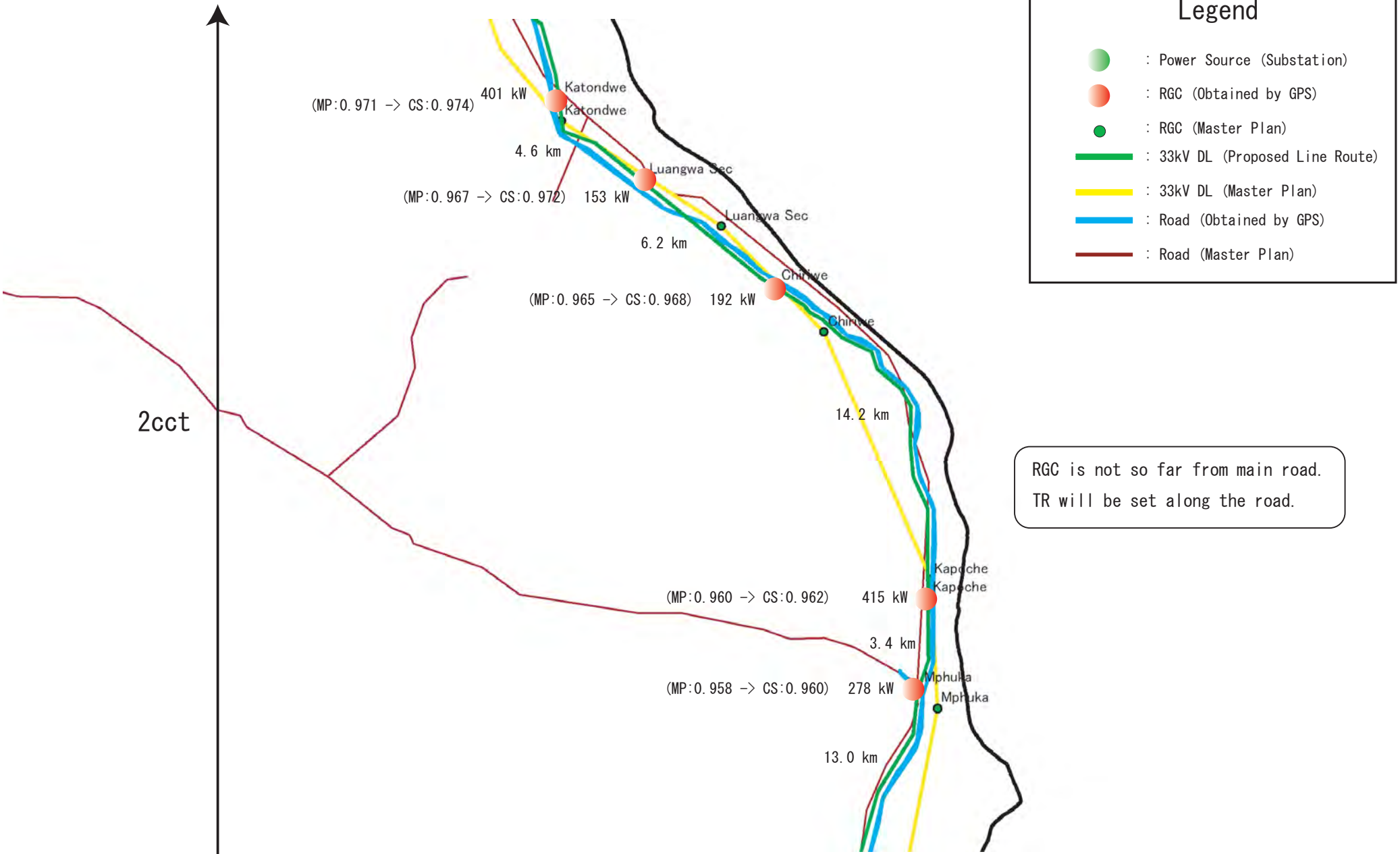
Legend

- : Power Source (Substation)
- : RGC (Obtained by GPS)
- : RGC (Master Plan)
- : 33kV DL (Proposed Line Route)
- : 33kV DL (Master Plan)
- : Road (Obtained by GPS)
- : Road (Master Plan)

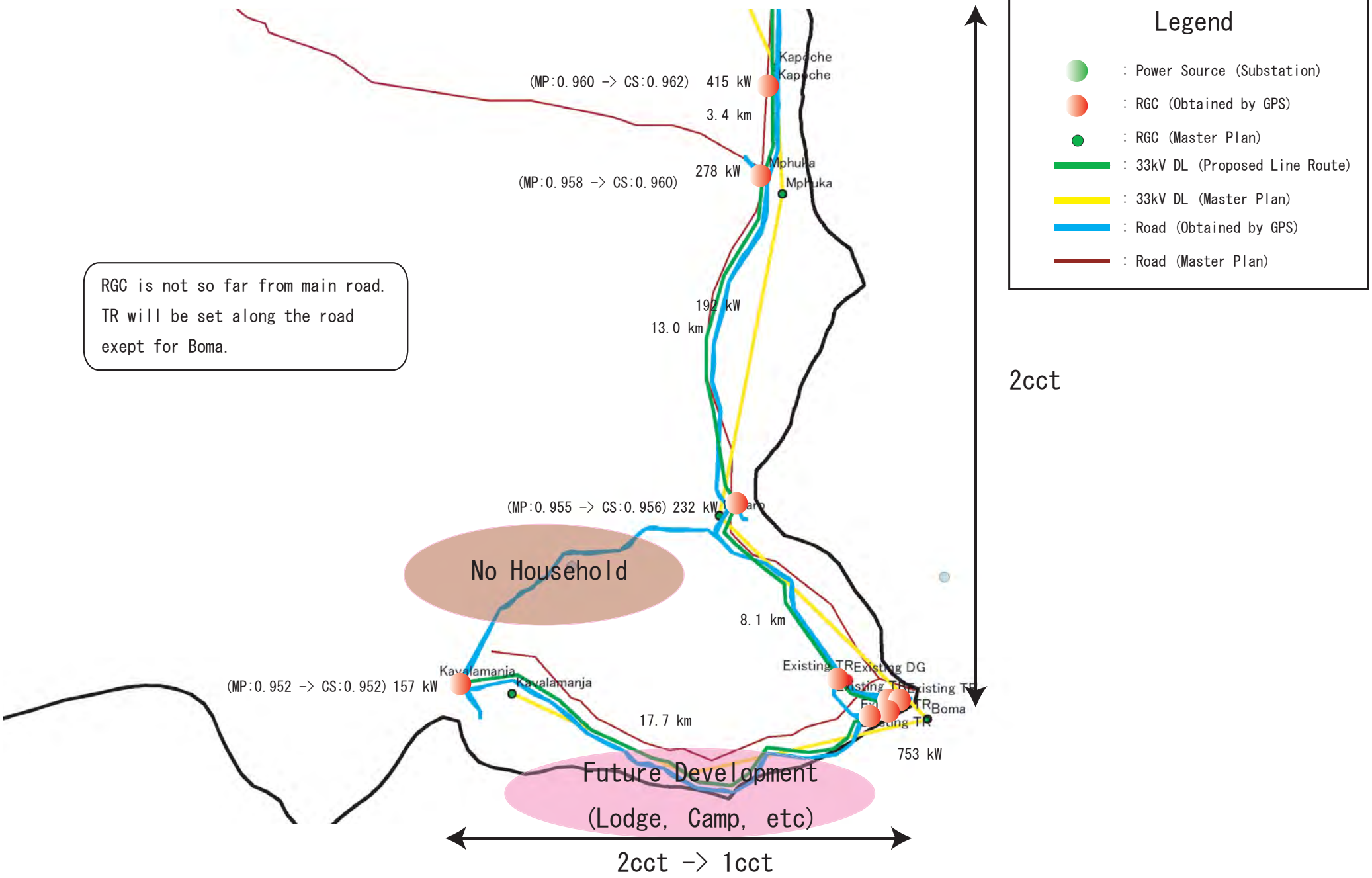
2cct

RGCs are not far from main road.
TR will be set along the road.

ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Luanguwa Area (1/4)



ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
TEPCO	Tokyo Electric Power Company	Title: Case Study at Luanguwa Area (2/4)



ZESCO

The Study for Development of the Rural Electrification Master Plan in Zambia

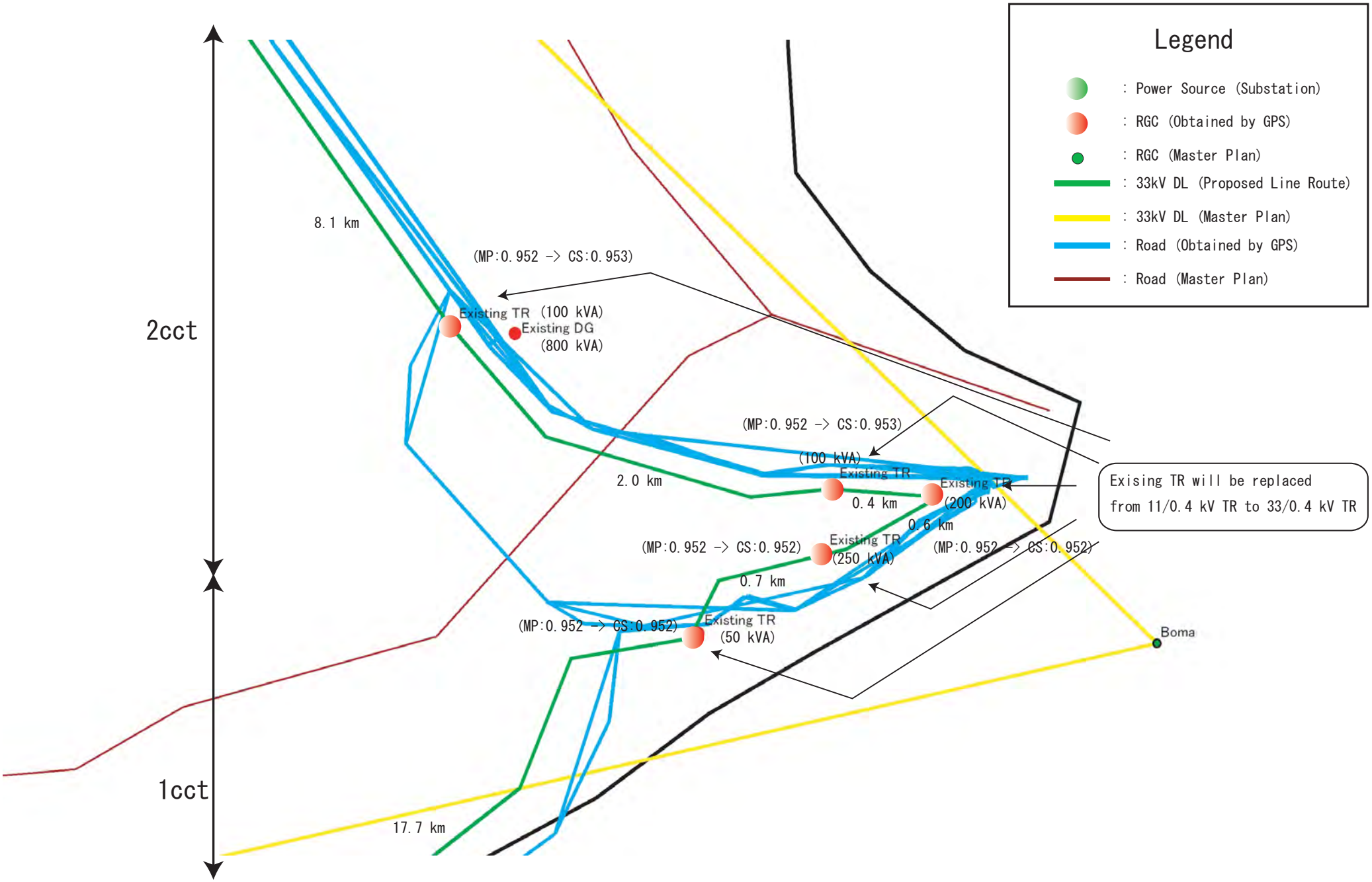
Tokyo Electric Power Company

TEPCO

Drawing No.

Title

Case Study at Luanguwa Area (3/4)



ZESCO

The Study for Development of the Rural Electrification Master Plan in Zambia

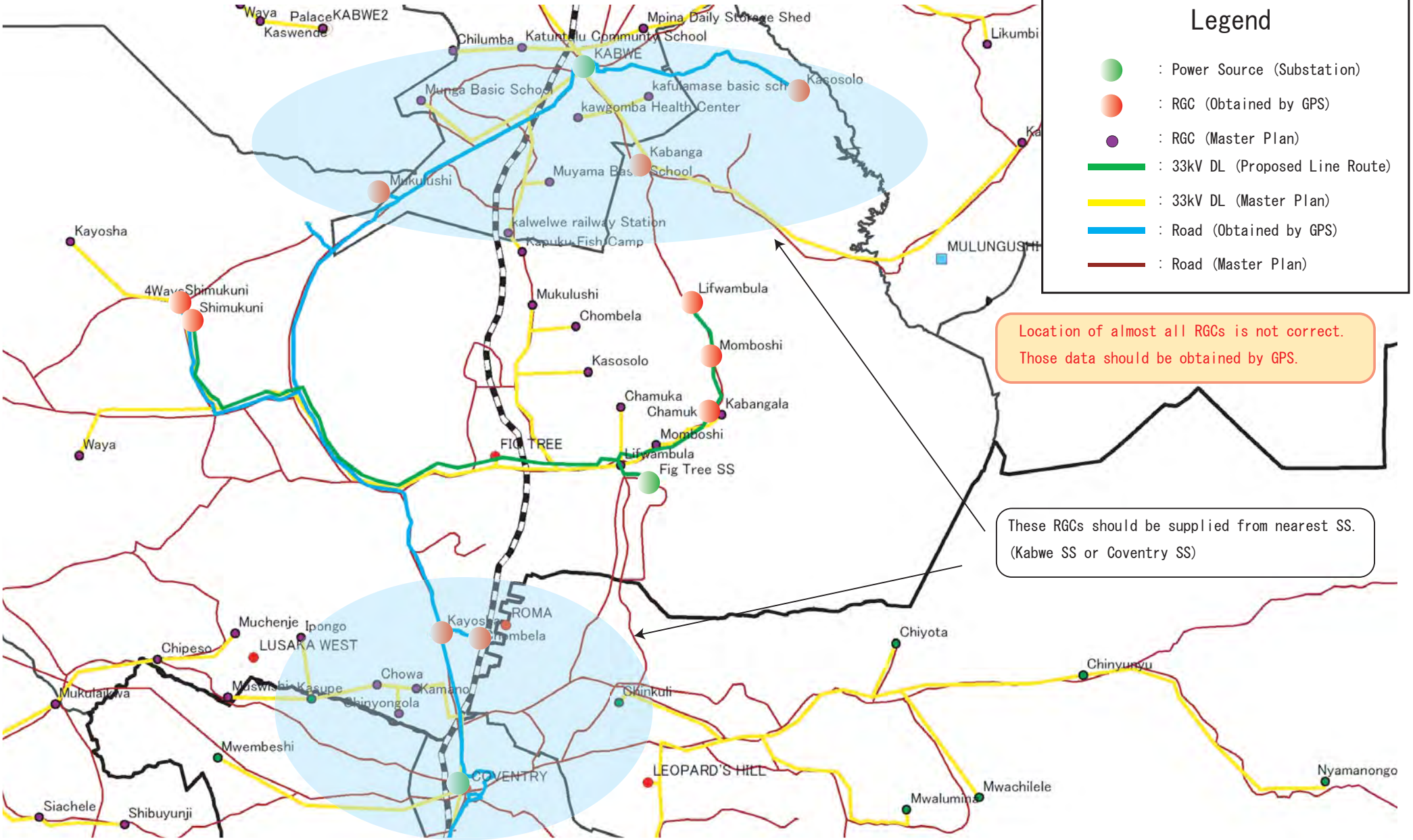
Tokyo Electric Power Company

TEPCO

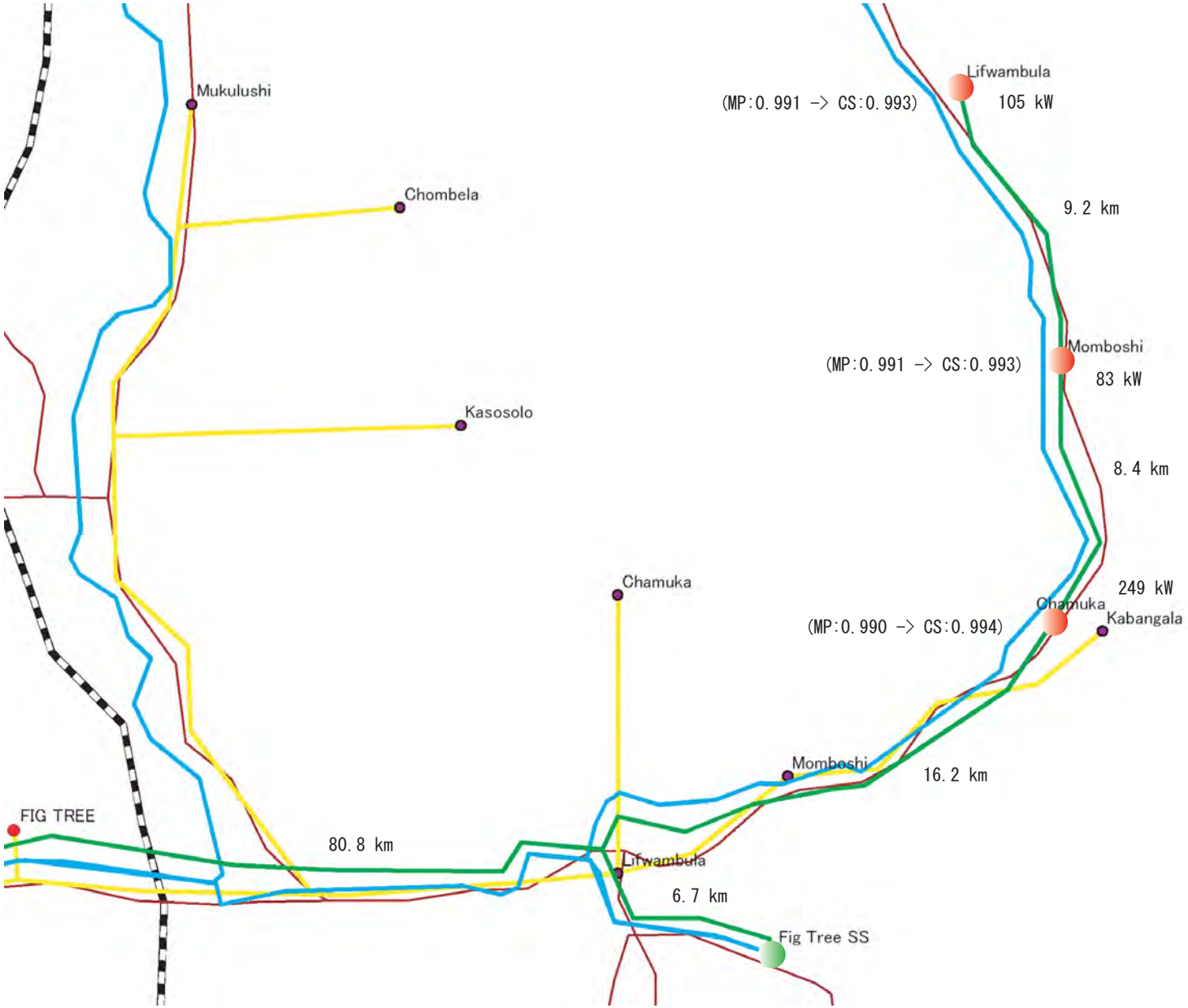
Drawing No.

Title

Case Study at Luanguwa Area (4/4)



ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Fig Tree SS Area (1/3)



Legend

- : Power Source (Substation)
- : RGC (Obtained by GPS)
- : RGC (Master Plan)
- : 33kV DL (Proposed Line Route)
- : 33kV DL (Master Plan)
- : Road (Obtained by GPS)
- : Road (Master Plan)

RGCs are not far from main road.
TR will be set along the road.

ZESCO

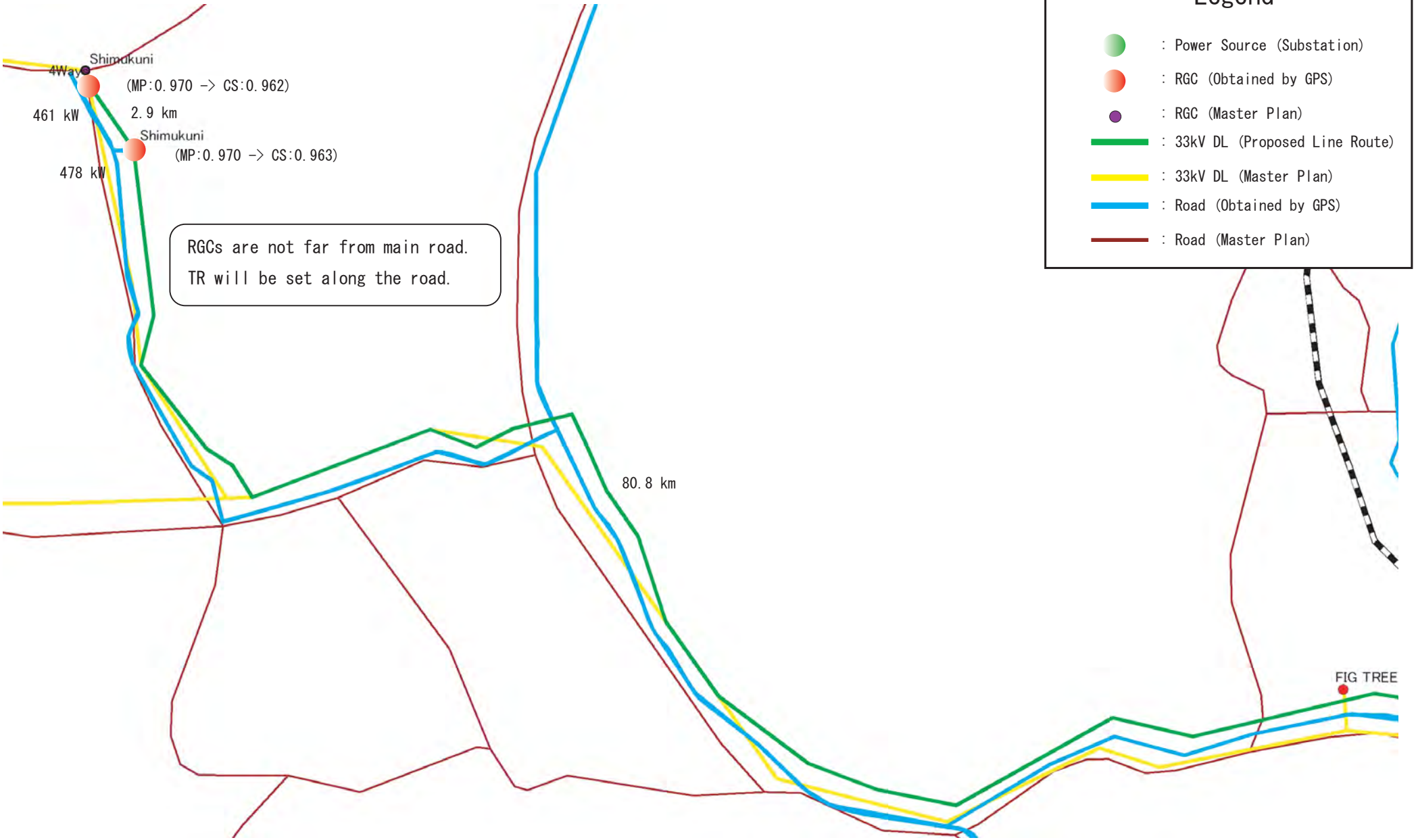
The Study for Development of the Rural Electrification Master Plan in Zambia

Tokyo Electric Power Company

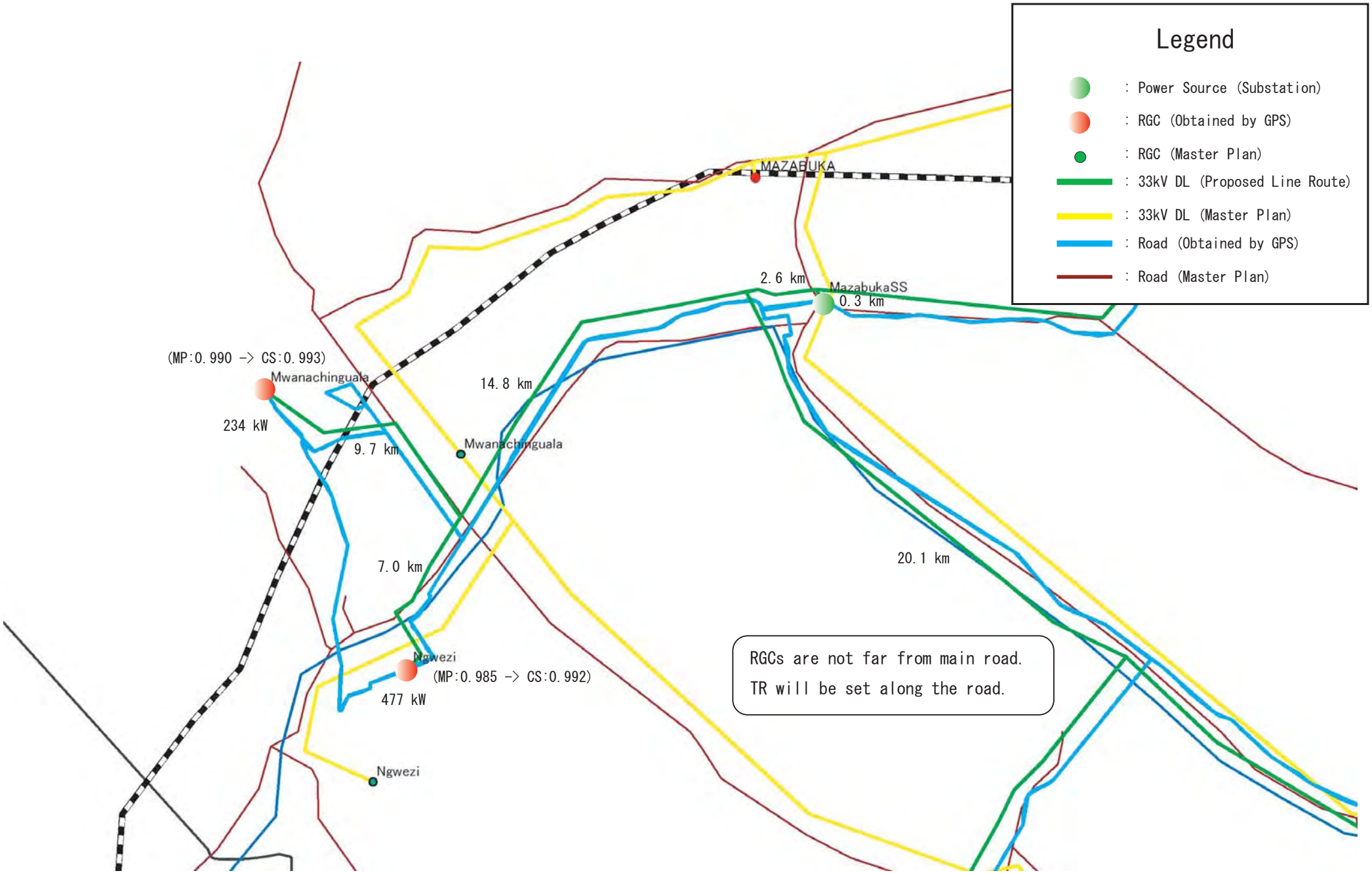
Drawing No.

Title

Case Study at Fig Tree SS Area (2/3)

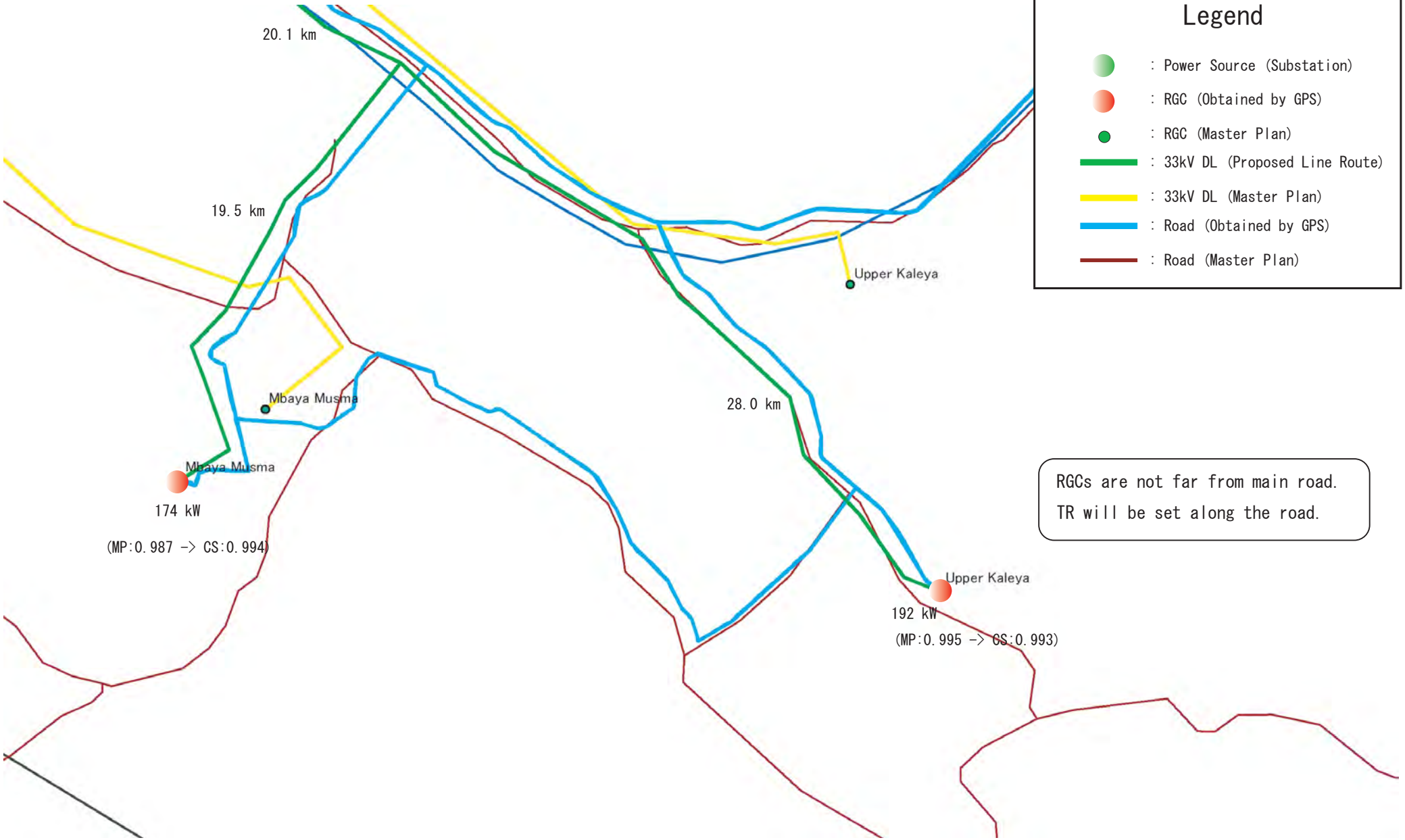


ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Fig Tree SS Area (3/3)



ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Mazabuka SS Area (1/3)

ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Mazabuka SS Area (2/3)



ZESCO	The Study for Development of the Rural Electrification Master Plan in Zambia	Drawing No.
	Tokyo Electric Power Company	Title: Case Study at Mazabuka SS Area (3/3)

Appendix E

Current Situation of Diesel Generation in Rural Area

1.0 Introduction

ZESCO is currently running a number of diesel power plants scattered through out the country. Most of the towns in Northwestern Province are powered by diesel plants except for Solwezi and Kasempa which are connected to the grid. Mwinilunga, Chavuma, Zambezi, Kabompo and Mufumbwe are all powered by diesel generators. Table 1 shows the list of diesel generator power plants.

Considering that the cost of running these plants is constantly going up due to price hike of fossil fuel and also the negative effect on the environment, ZESCO is considering replacing these plants by connecting to the national grid or with renewable energy source such as micro-hydro. Last year, Kaoma district in Western province was connected to the National Grid replacing the diesel power plant. . On average Diesel consumption per month for one district is about 70,000 litres (approximately K300 million) and only about K20 million is collected as revenue from the customers

Government's policy is to ensure that all the 72 District Centres (BOMAs) are electrified so that the economic activities and socio welfare of the people are improved. Diesel generators have been installed to power Shang'ombo district in Western Province. Works have been competed and operations will soon start.

2.0 Current status of the District Diesel Generators Power Plants

2.1 Mwinilunga Diesel Power Plant

The machines at Mwinilunga were commissioned in April 2006. There are two 630kW Cummins machines, manufactured in 2005. The peak demand of the town is 1,000kW and has about 640 customers. The machines consume about 138,000 litres of diesel per month and collects about ZMK22 million from electricity sales.

Fig.2.1 Mwinulunga Diesel Power Plant

Chavuma Diesel Power Plant

This is a new plant that was commissioned in August 2005. It has two second hand generators, a 440kW Unlec machine and a 250 kW, 1988 Cummins machine. The peak demand for the District is 203 kW with about 200 customers. The power station consumes about 70,000 litres of diesel per month and less K20 million is collected from the customers per month. Because of the age of the machines some of the spares are difficult to procure from the manufactures.

Fig.2.2 Chavuma Diesel Power Plant

2.2 Zambezi Diesel Power Plant

There are two 400 kW machines in Zambezi town and the peak demand is 630kW. One machine was commissioned in July 2004 and is due for a complete overhaul. The second machine was installed in May 2007. Zambezi has about 683 customers and uses about 70,000 liters of diesel per month. The revenue collected per month is less than ZMK20 million.

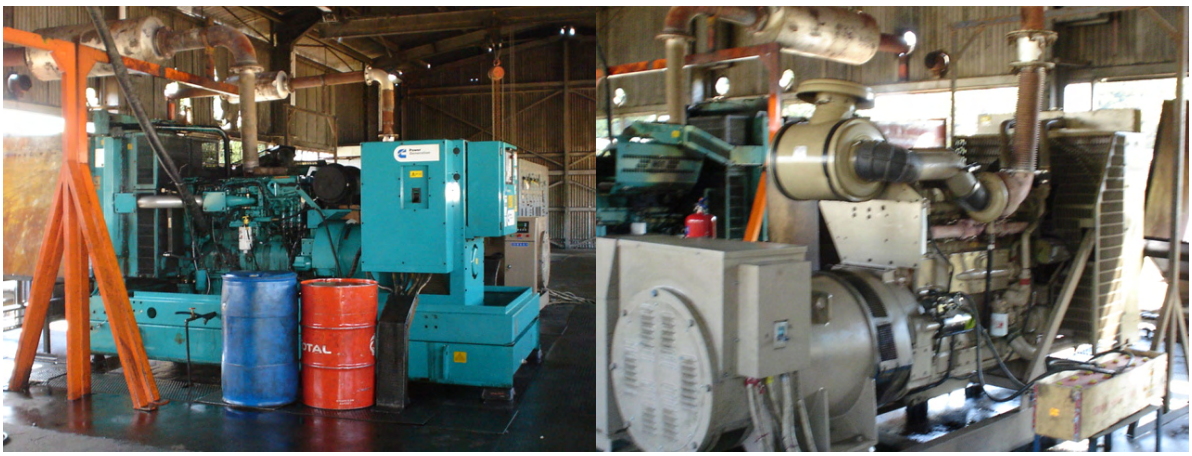


Fig.2.3 Zambezi Diesel Power Plant

2.3 Kabompo Diesel Power Plant

A 1,200kW machine was installed on 10th July 2007. This machine has been relocated from Kaoma (i.e. after the district was connected to the grid) to Kabompo. Due to the long period of time the machine was unused, the radiator became clogged and need to be cleaned (flushed) to improve its performance. There is a plan to take the radiator from the other machine for cleaning so that it could replace the one on the machine in Kabompo. The second machine which was on standby by during the tour was a caterpillar engine rated at 580kW, 2001 model. This engine has had two overhauls so far.

Kabompo has a peak demand of 700kW with about 610 customers. The total revenue collected per month is about K30 million.

Fig.2.4 Kabompo Diesel Power Plant

2.4 Mumfumbwe Diesel Power Plant

The District has had problems with generators following the machine break down. The power supply problems were normalized on Friday 13th July 2007. The problems in Mufumbwe started on 19th June 2007 when the machine broke down. The town has a peak demand of about 380kW with 200 customers. Currently one 400kW machine is running and there is no standby generator. This implies that once this machine breaks down Mufumbwe will have no power supply.

Fig.2.5 Mufumbwe Diesel Power Plant

2.5 Shan'gombo Diesel Power Plant

2.6 Luangwa Diesel Power Plant

2.7 Chama Diesel Power Plant

2.8 Kaputa Diesel Power Plant

2.9 Lukulu Diesel Power Plant

3.0 Challenges

The following are the challenges for running the diesel power plants:

1. Lack of operational vehicles by ZESCO district offices

2. The recent diesel shortages experienced in the country made the operations of these plants even more challenging. This led to reduce power supply hours to the customers.

3. In general, the maintenance schedules of the machines are very tight. A machine can not be taken out for maintenance without compromising the reliability of supply. This means that once one machine is taken out for routine maintenance or due to a breakdown, the remaining machine may not be able to meet the demand adequately.

4.0 RECOMMENDATIONS

1. Since it is Government policy to replace the costly diesel generations with small hydropower, which resource is abundant in the province, the Ministry should aggressively promote the development of small hydropower stations
2. To improve the operations of these branches, ZESCO needs to provide at least two operational vehicles for each of these power stations/branches.

Table 1 Listing of Districts Running on Diesel Generation

No.	District	Capacity of Gen Set (kW)	No. of Gen Set Installed	Year of Man and Type of M/c	Year of Re/Commissioned	Peak Demand (kW)	No. of Clients	Average Revenue /Month (K'million)	Diesel Storage Capacity (liters)	Distance to National Grid (km)
1	Mwinilunga	630	02	2005 - Cummins	April o6	1000	640	<22	135,000	400
		630		2005 - Cummins	April 06					
2	Chavuma	250	01	1988 – Cummins	Aug 05	203	200	<20	135,000	
		440	01	Unlec	Aug 05					
3	Zambezi	400	01	2004 - Cummins	Jul 04	630	683	<21	135,000	
		400	01	2004 - Cummins	May 07					
4	Kabompo	1200	01	1999 - Caterpillar	Jul 07	700	610	<30	135,000	
		580	01	2001- Caterpillar	2001					
5	Mumfumbwe	400			1994	380	200		45,000	110
6	Chama									
7	Kaputa									
8	Luangwa	640	2	Perkins	2007		240	<9		190 Lsk 33 Nyimba
9	Shang'ombo									
10	Lukulu									

Appendix F

FIRR & EIRR Calculation Sample

Assumption

	# of Consumers (2006)	# of Consumers (2008)	Monthly Consumption (kWh)
Households	1,900	2,012	163
Commercial Customers	-	-	163
Hammer Mills	-	12	5,931
Public Facilities			
1) Basic/Primary School	0	0	331
2) High/Secondary School	0	0	54
3) Tertiary School	0	0	1,609
4) Hospital	0	0	12,904
5) Health Center/Clinic	0	0	337
6) Police Office	0	0	125
7) Post Office	0	0	144
8) Church	0	0	58
9) Mosque	0	0	58
10) Community Center	0	0	455
11) Agriculture Depot	0	0	215
12) Orphanage	0	0	250
13) Central Government Office	0	0	181
14) Provincial Government Office	0	0	438
15) District Government Office	0	0	696
16) Other Local Administration Office	0	0	438
17) Court	0	0	297
18) Other (Average)	0	0	297

Tariffs	K	US $	Old Tariffs
Metered households			
0-300 kWh	102	0.026	70
301-700 kWh	145	0.036	100
>700 kWh	236	0.059	163
Monthly fixed charge	8,475	2.12	5,845
Commercial tariffs	245	0.06	163
Monthly fixed charge	43,841	10.96	29,227
Social tariffs	201	0.050	135
Monthly fixed charge	34,839	8.71	23,382

Annual Increase Rate	
Households	2.9%
Commercial Consumers	2.9%
Social Consumers	2.9%
A Unit Hammer Mill Service Ratio (HH/HM)	174
Annual Tariff increase	1.0%
Zesco Collection Efficiency	90%

The increase in energy consumption for social consumers remains 0% because requirements for energy do not increase

	K	US$
Exchange rate	**4,000.00**	**1.00**

Standard Conversion Factor	**0.892**
This is the ratio of the bid rate of K4,200 to US$1 and the exchange rate of K4,300. The bid rate was obtained from Citibank on 7 Feb 2007	

Shadow Wage Rate Factor	
Shadow Wage Rate for Unskilled Labour	
Minimum wage rate before Tax	500,000
Minimum wage rate after Tax	446,000

Conversion Factor for Unskilled Labor	**0.70**

Operation Costs

Percentages of Initial Capital Cost

	DL	SHS	Diesle		Hydro	
Operation & Maintenance	1.00%	1.00%	0.024	US$/kWh	0.024	US$/kWh
Customer care	0.10%	0.00%	0.10%		0.10%	
Overheads	0.10%	0.00%	0.10%		0.10%	
Depreciation	3.3%	6.60%	5.00%		2.50%	
Fuel Cost	-	-	0.27	US$/kWh	-	

Bulk Supply Tariff	
K	**US $**
65	0.016
Increase pa	1.0%

Current Monthly Average Cost for Alternative Energy (firewood, charcoal, candle, kerosene, dry batteries)

	K	US $	
Household & Business Entity	65,534	16.38 *(this is from the consumer survey results)*	Increase p.a. 1.0%

Willingness to Pay	**K / Month**	**US$ / Month**
Households	37,197	9.30

Demand (Distribution Line)

ENERGY CONSUMPTION IN kWh

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Number of Consumers																														
Housholds	2012	2131	2193	2256	2322	2389	2458	2530	2603	2678	2756	2836	2918	3003	3090	3179	3272	3366	3464	3564	3668	3774	3884	3996	4112	4231	4354	4480	4610	4744
Commercial Customers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hammer Mills	12	13	13	13	14	14	15	15	15	16	16	17	17	18	18	19	19	20	20	21	22	22	23	23	24	25	26	26	27	28
Public Facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1) Basic/Primary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2) High/Secondary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
3) Tertiary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
4) Hospital	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
5) Health Center/Clinic	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
6) Police Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
7) Post Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
8) Church	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
9) Mosque	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
10) Community Center	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
11) Agriculture Depot	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
12) Orphanage	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
13) Central Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
14) Provincial Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
15) District Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
16) Other Local Administration Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
17) Court	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
18) Other (Average)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Energy Consumption /Yr.	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
Households	3,935,472	4,168,236	4,289,508	4,412,736	4,541,832	4,672,884	4,807,848	4,948,680	5,091,468	5,238,168	5,390,736	5,547,216	5,707,608	5,873,868	6,044,040	6,218,124	6,400,032	6,583,896	6,775,584	6,971,184	7,174,608	7,381,944	7,597,104	7,816,176	8,043,072	8,275,836	8,516,424	8,762,880	9,017,160	9,279,264
Commercial Customers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hammer Mills	854,064	925,236	925,236	925,236	996,408	996,408	1,067,580	1,067,580	1,067,580	1,138,752	1,138,752	1,209,924	1,209,924	1,281,096	1,281,096	1,352,268	1,352,268	1,423,440	1,423,440	1,494,612	1,565,784	1,565,784	1,636,956	1,636,956	1,708,128	1,779,300	1,850,472	1,850,472	1,921,644	1,992,816
Public Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1) Basic/Primary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2) High/Secondary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
3) Tertiary School	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
4) Hospital	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
5) Health Center/Clinic	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
6) Police Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
7) Post Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
8) Church	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
9) Mosque	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
10) Community Center	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
11) Agriculture Depot	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
12) Orphanage	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
13) Central Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
14) Provincial Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
15) District Government Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
16) Other Local Administration Office	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
17) Court	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
18) Other (Average)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total	**4,789,536**	**5,093,472**	**5,214,744**	**5,337,972**	**5,538,240**	**5,669,292**	**5,875,428**	**6,016,260**	**6,159,048**	**6,376,920**	**6,529,488**	**6,757,140**	**6,917,532**	**7,154,964**	**7,325,136**	**7,570,392**	**7,752,300**	**8,007,336**	**8,199,024**	**8,465,796**	**8,740,392**	**8,947,728**	**9,234,060**	**9,453,132**	**9,751,200**	**10,055,136**	**10,366,896**	**10,613,352**	**10,938,804**	**11,272,080**

Household Consumption	3,935,472	4,168,236	4,289,508	4,412,736	4,541,832	4,672,884	4,807,848	4,948,680	5,091,468	5,238,168	5,390,736	5,547,216	5,707,608	5,873,868	6,044,040	6,218,124	6,400,032	6,583,896	6,775,584	6,971,184	7,174,608	7,381,944	7,597,104	7,816,176	8,043,072	8,275,836	8,516,424	8,762,880	9,017,160	9,279,264
Non-Household Consumption	854,064	925,236	925,236	925,236	996,408	996,408	1,067,580	1,067,580	1,067,580	1,138,752	1,138,752	1,209,924	1,209,924	1,281,096	1,281,096	1,352,268	1,352,268	1,423,440	1,423,440	1,494,612	1,565,784	1,565,784	1,636,956	1,636,956	1,708,128	1,779,300	1,850,472	1,850,472	1,921,644	1,992,816

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Construction Cost (Distribution Line)

Item	Unit Price (US$)	Units	Estimated Cost (US$)
33kV DL	36,000	23	828,000.00
66kV TL	40,000	0	0.00
33/0.4Tr (100kVA)	13,700	41	561,700.00
New SS 2.5MVA	600,000	0	0.00
New SS 5MVA	800,000	0	0.00
New SS 10MVA	1,000,000	0	0.00
New SS 15MVA	1,300,000	0	0.00
33kV Bay Extension	99,300	1	99,300.00
			1,489,000.00

: Excluding Consultant Fee

O&M Cost (Distribution Line)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$
Bulk Supply Tariff	78,608	84,433	87,307	90,264	94,587	97,794	102,363	105,865	109,461	114,466	118,377	123,729	127,933	133,647	138,194	144,249	149,193	155,642	160,961	167,861	175,038	180,982	188,642	195,048	203,210	211,640	220,384	227,879	237,215	246,887
Operation & Maintenance	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890	14,890
Customer care	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
Overheads	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489	1,489
Sub total	**96,476**	**102,301**	**105,175**	**108,132**	**112,455**	**115,662**	**120,231**	**123,733**	**127,329**	**132,334**	**136,245**	**141,597**	**145,801**	**151,515**	**156,062**	**162,117**	**167,061**	**173,510**	**178,829**	**185,729**	**192,906**	**198,850**	**206,510**	**212,916**	**221,078**	**229,508**	**238,252**	**245,747**	**255,083**	**264,755**
Depreciation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cost	**96,476**	**102,301**	**105,175**	**108,132**	**112,455**	**115,662**	**120,231**	**123,733**	**127,329**	**132,334**	**136,245**	**141,597**	**145,801**	**151,515**	**156,062**	**162,117**	**167,061**	**173,510**	**178,829**	**185,729**	**192,906**	**198,850**	**206,510**	**212,916**	**221,078**	**229,508**	**238,252**	**245,747**	**255,083**	**264,755**

Cost of using alternative energy (firewood, charcoal, candles and dry batteries) for all Domestic Consumers

Cost per year	395,562	418,958	431,147	443,533	456,509	469,681	483,246	497,402	511,754	526,499	541,834	557,562	573,683	590,394	607,499	624,996	643,280	661,761	681,028	700,688	721,134	741,974	763,600	785,620	808,425	831,821	856,003	880,775	906,333	932,677

Willingness to Pay

Household	226,766	242,580	252,134	261,971	272,332	282,992	294,077	305,718	317,684	330,106	343,118	356,609	370,589	385,198	400,321	415,970	432,420	449,291	466,996	485,282	504,437	524,205	544,879	566,197	588,460	611,544	635,616	660,550	686,515	713,535
Commercial Customers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	226,766	242,580	252,134	261,971	272,332	282,992	294,077	305,718	317,684	330,106	343,118	356,609	370,589	385,198	400,321	415,970	432,420	449,291	466,996	485,282	504,437	524,205	544,879	566,197	588,460	611,544	635,616	660,550	686,515	713,535

Note: Bulk Supply Tariff is the cost of Generation and Transimmision. The two are taken from the IPA report and assumed to increase at the rate of 1% per year.

Revenue (Distribution Line)

Yr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Consumer Category	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$	US$
Households	101,358	108,426	112,697	117,094	121,725	126,489	131,444	136,647	141,996	147,548	153,364	159,394	165,643	172,172	178,932	185,927	193,279	200,820	208,734	216,907	225,469	234,305	243,545	253,074	263,025	273,343	284,102	295,247	306,853	318,930
Commercial Customers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hammer Mills	52,835	57,810	58,388	58,972	64,143	64,785	70,106	70,807	71,515	77,046	77,816	83,507	84,342	90,196	91,098	97,120	98,092	104,287	105,330	111,702	118,192	119,374	126,048	127,308	134,172	141,160	148,274	149,757	157,072	164,518
Public Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fixed Charge on the bill																														
Households	51,155	54,181	55,757	57,359	59,037	60,740	62,495	64,325	66,181	68,088	70,071	72,105	74,190	76,351	78,563	80,826	83,191	85,581	88,072	90,615	93,259	95,954	98,751	101,598	104,548	107,573	110,700	113,904	117,209	120,616
Commercial Customers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hammer Mills	1,578	1,710	1,710	1,710	1,841	1,841	1,973	1,973	1,973	2,104	2,104	2,236	2,236	2,367	2,367	2,499	2,499	2,630	2,630	2,762	2,894	2,894	3,025	3,025	3,157	3,288	3,420	3,420	3,551	3,683
Public Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Revenue	**206,926**	**222,127**	**228,552**	**235,134**	**246,746**	**253,855**	**266,018**	**273,752**	**281,665**	**294,786**	**303,356**	**317,242**	**326,410**	**341,087**	**350,961**	**366,372**	**377,061**	**393,318**	**404,766**	**421,986**	**439,813**	**452,526**	**471,369**	**485,005**	**504,900**	**525,364**	**546,496**	**562,328**	**584,685**	**607,747**
Revenue 90% collection efficiency	**186,233**	**199,914**	**205,696**	**211,621**	**222,071**	**228,470**	**239,416**	**246,377**	**253,499**	**265,308**	**273,020**	**285,518**	**293,769**	**306,978**	**315,865**	**329,735**	**339,355**	**353,987**	**364,290**	**379,788**	**395,832**	**407,273**	**424,232**	**436,505**	**454,410**	**472,828**	**491,847**	**506,095**	**526,216**	**546,972**
Unit Charge																														
Households	6.32	6.73	6.98	7.23	7.49	7.75	8.03	8.32	8.62	8.93	9.25	9.59	9.93	10.29	10.66	11.05	11.45	11.86	12.29	12.74	13.20	13.68	14.18	14.69	15.22	15.78	16.35	16.95	17.56	18.21
Commercial Customers	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Hammer Mills	377.87	413.33	417.35	421.40	458.23	462.68	500.55	505.42	510.33	549.65	555.00	595.43	601.23	642.80	649.06	691.80	698.55	742.48	749.72	794.89	840.87	849.08	896.34	905.09	953.67	1,003.11	1,053.43	1,063.73	1,115.44	1,168.06
Public Facilities	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Note: Fixed Charge assumed constant for the 20 yrs. The increase over the years is due to increase in the number or consumers.

Economic Value (Distribution Line)

Total Construction Costs, US$ 1,489,000

Total Capital Costs, US$

Cost Items	Percentage	Financial Costs			Conversion Factor	Cost Items	Economic Cost		
		Foreign	Domestic	Total			Foreign	Domestic	Total
Foreign Costs (Material)	80.2%	1,193,683		1,193,683	1.00	Foreign Costs (Material)	1,193,683		1,193,683
Domestic Costs (Material)	11.8%		175,950	175,950	0.89	Domestic Costs (Material)		156,947	156,947
Foreign Skilled Labour	0.0%	0		0	1.00	Foreign Skilled Labour	0		0
Domestic Skilled Labour	3.2%		47,747	47,747	0.89	Domestic Skilled Labour		42,591	42,591
Unskilled Labour (Domestic)	4.8%		71,621	71,621	0.70	Unskilled Labour (Domestic)		50,135	50,135
Foreign Consulting Service Fee	8.0%	119,120		119,120	1.00	Foreign Consulting Service Fee	119,120		119,120
Domestic Consulting Service Fee	0.0%		0	0	0.89	Domestic Consulting Service Fee		0	0
Sub-Total (Const + Consul Fee)	**108.0%**	1,312,803	295,318	**1,608,121**		**Sub-Total**	1,312,803	249,672	**1,562,475**
Domestic Tax	17.5%		51,681	51,681		Domestic Tax	0	0	0
Base Cost		1,312,803	346,999	1,659,801		**Base Cost**	1,312,803	249,672	1,562,475
Physical Contingency	5.0%	65,640	17,350	82,990		Physical Contingency	65,640	12,484	78,124
Real Price		1,378,443	364,348	**1,742,791**		**Real Price**	1,378,443	262,156	1,640,599
Price Contingency		66,515	73,692	140,207		**Total Cost**	1,378,443	262,156	1,640,599
Total Cost		1,444,958	438,040	**1,882,999**					

Estimation of Price Contingency

Year	1	2	3	Total
Annual Investment Rate	25%	50%	25%	100%
Foreign Investment Cost	344,611	689,222	344,611	1,378,443
Foreign Price Contingency	3,446	20,883	42,186	66,515
Domestic Investment Cost	91,087	182,174	91,087	364,348
Domestic Price Contingency	3,643	22,735	47,313	73,692

Foreign Currency Infration	2%
Domestic Currency Infration	8%

Initial Investment

Year	1	2	3	Total
Annual Investment Rate	25%	50%	25%	100%
Economic Investment Amount	410,150	820,299	410,150	1,640,599

Life Time O&M Cost & FIRR (Distribution Line)

Unit Life Time Cost	
Life Time Generation (kWh)	230,122,800
Life Time Cost (Present Value)	2,486,789
Unit Life Time Cost (US$/kWh)	**0.011**

Financial

NPV FOR PESSIMISTIC SCENARIO - BST

i) Annual Number Growth @ 2.9%

ii) Annual Tariff Increase @ 1.0%

Simulation Factor	
Cost Simulation Factor (Capital)	1.0
Cost Simulation Factor (O&M)	1.0
Benefit Simulation Factor	1.0

FIRR = 7.10%

Discount Factor = 12.00%

Year	Capital Costs	Operational costs	Total Cost	Present Cost	Revenues	Net Revenue	Net Present Value	FY	Operation Year
0	435,698		435,697.87	435,697.87		(435,697.87)	(435,697.87)	**2008**	
1	871,396		871,395.73	778,031.90		(871,395.73)	(778,031.90)	**2009**	
2	435,698	96,476.26	532,174.12	424,245.95	186,233.39	(345,940.73)	(275,781.83)	**2010**	1
3		102,300.58	102,300.58	72,815.53	199,914.04	97,613.46	69,479.33	**2011**	2
4		105,175.28	105,175.28	66,840.79	205,696.40	100,521.12	63,882.99	**2012**	3
5		108,132.12	108,132.12	61,357.07	211,620.68	103,488.56	58,722.19	**2013**	4
6		112,455.12	112,455.12	56,973.26	222,071.25	109,616.13	55,534.94	**2014**	5
7		115,661.60	115,661.60	52,319.43	228,469.86	112,808.26	51,028.73	**2015**	6
8		120,230.88	120,230.88	48,559.24	239,415.82	119,184.94	48,136.80	**2016**	7
9		123,732.65	123,732.65	44,619.23	246,377.20	122,644.56	44,226.86	**2017**	8
10		127,328.98	127,328.98	40,996.52	253,498.71	126,169.73	40,623.28	**2018**	9
11		132,334.41	132,334.41	38,042.98	265,307.69	132,973.28	38,226.64	**2019**	10
12		136,245.08	136,245.08	34,970.72	273,020.31	136,775.24	35,106.80	**2020**	11
13		141,597.36	141,597.36	32,450.46	285,517.51	143,920.15	32,982.78	**2021**	12
14		145,800.95	145,800.95	29,833.76	293,769.30	147,968.35	30,277.26	**2022**	13
15		151,515.26	151,515.26	27,681.27	306,978.35	155,463.09	28,402.53	**2023**	14
16		156,062.15	156,062.15	25,457.12	315,864.55	159,802.40	26,067.23	**2024**	15
17		162,117.30	162,117.30	23,611.47	329,734.89	167,617.59	24,412.55	**2025**	16
18		167,060.60	167,060.60	21,724.49	339,354.61	172,294.01	22,405.04	**2026**	17
19		173,509.76	173,509.76	20,145.66	353,986.55	180,476.78	20,954.58	**2027**	18
20		178,829.36	178,829.36	18,538.66	364,289.76	185,460.40	19,226.08	**2028**	19
21		185,728.55	185,728.55	17,190.96	379,787.65	194,059.10	17,962.04	**2029**	20
22		192,906.32	192,906.32	15,942.26	395,831.92	202,925.61	16,770.28	**2030**	21
23		198,850.41	198,850.41	14,672.77	407,273.22	208,422.81	15,379.09	**2031**	22
24		206,509.68	206,509.68	13,605.29	424,231.84	217,722.17	14,343.99	**2032**	23
25		212,916.25	212,916.25	12,524.44	436,504.87	223,588.62	13,152.22	**2033**	24
26		221,078.33	221,078.33	11,611.21	454,410.45	233,332.12	12,254.79	**2034**	25
27		229,507.65	229,507.65	10,762.44	472,827.53	243,319.88	11,410.14	**2035**	26
28		238,251.56	238,251.56	9,975.42	491,846.81	253,595.25	10,617.85	**2036**	27
29		245,747.05	245,747.05	9,186.83	506,094.83	260,347.78	9,732.65	**2037**	28
30		255,083.49	255,083.49	8,514.16	526,216.50	271,133.01	9,049.86	**2038**	29
31		264,755.24	264,755.24	7,890.16	546,972.23	282,217.00	8,410.55	**2039**	30
				2,486,789.33		**NPV**	**(640,731.53)**		
							(640,731.53)		

Assumptions for Calculation of NPV and FIRR

1 Operation costs

The operating cost takes into account the operating and maintenance costs, customer care and overheads which are 1%, 0.1% and 0.1% of initial capital investment respectively.

2 Revenue is calculated by making the following assumptions:

i) Ipusukilo is assumed to have 233 consumers of which 220 are domestic, 8 commercial and 5 social consumers.

ii) The consumption is assumed to grow by 0% per year in the pessimistic scenario

iii) The BST is assumed to increase at 1% pa

iv) The Tariff will increase annually by 1% pa

v) The exchange rate is fixed at K4,300 to US$ 1

Results

1 The project has a positive Financial NPV .

2 FIRR is 7.10%

EIRR (Distribution Line)

Economics

NPV FOR PESSIMISTIC SCENARIO- BST

i) Annual consumption growth @ 2.9%

ii) Annual tariff increase @ 1.0%

Simulation Factor	
Cost Simulation Factor (Capital)	**1.0**
Cost Simulation Factor (O&M)	**1.0**
Benefit Simulation Factor	**1.0**

EIRR = 21.62%

Discount Factor = 12.00%

Year	Capital Costs	Operational costs	Consumer Willingness to Pay (charcoal, candles, batteries & kerosene)	Net Saving	NPV	FY	Operation Year
0	410,149.74			(410,149.74)	(410,149.74)	**2008**	
1	820,299.48			(820,299.48)	(732,410.25)	**2009**	
2	410,149.74	86,056.82	395,562.19	(100,644.37)	(80,233.08)	**2010**	1
3		91,252.11	418,957.77	327,705.65	233,254.41	**2011**	2
4		93,816.35	431,147.06	337,330.70	214,379.76	**2012**	3
5		96,453.85	443,532.95	347,079.10	196,942.00	**2013**	4
6		100,309.97	456,508.65	356,198.68	180,461.34	**2014**	5
7		103,170.15	469,680.95	366,510.80	165,790.87	**2015**	6
8		107,245.94	483,246.45	376,000.51	151,860.30	**2016**	7
9		110,369.52	497,401.76	387,032.24	139,567.71	**2017**	8
10		113,577.45	511,753.67	398,176.22	128,202.09	**2018**	9
11		118,042.30	526,498.78	408,456.48	117,421.48	**2019**	10
12		121,530.61	541,833.69	420,303.09	107,881.33	**2020**	11
13		126,304.85	557,561.81	431,256.97	98,832.97	**2021**	12
14		130,054.44	573,683.14	443,628.69	90,775.22	**2022**	13
15		135,151.61	590,394.26	455,242.65	83,171.13	**2023**	14
16		139,207.44	607,498.59	468,291.15	76,388.43	**2024**	15
17		144,608.63	624,996.12	480,387.49	69,965.72	**2025**	16
18		149,018.06	643,280.06	494,262.00	64,273.63	**2026**	17
19		154,770.71	661,760.60	506,989.89	58,864.96	**2027**	18
20		159,515.79	681,027.55	521,511.76	54,063.44	**2028**	19
21		165,669.87	700,687.70	535,017.83	49,521.04	**2029**	20
22		172,072.43	721,134.25	549,061.82	45,375.85	**2030**	21
23		177,374.56	741,974.01	564,599.44	41,660.64	**2031**	22
24		184,206.63	763,600.17	579,393.54	38,171.66	**2032**	23
25		189,921.30	785,619.54	595,698.24	35,040.94	**2033**	24
26		197,201.87	700,687.70	503,485.83	26,443.48	**2034**	25
27		204,720.82	721,134.25	516,413.43	24,216.47	**2035**	26
28		212,520.39	741,974.01	529,453.61	22,167.84	**2036**	27
29		219,206.37	763,600.17	544,393.80	20,351.22	**2037**	28
30		227,534.47	785,619.54	558,085.06	18,627.72	**2038**	29
31		236,161.67	808,425.31	572,263.64	17,054.44	**2039**	30
				NPV	**1,219,073.85**		

Assumptions for Calculation of NPV and EIRR

1 Consumers willingness to pay

The assumption for wiillingness to pay is taken to be the amount the consumers are currently spending on alternative energy.

The average amount spent per household per month was established from the social survey undertaken for the Ipusukilo area to be US$61.83

The increase per year in the cost of alternative energy is fixed at 1% pa.

2 Capital Cost

The capital cost includes the Shadow Exchange Factor of 0.98 on 65% of the financial cost assumed to be foreign costs of imports. The unskilled labour is assumed at 15% and has a shadow wage factor of 0.89.

Results

1 The project has a positive Economic NPV

2 The EIRR is 21.62%