

## **Chapter 13**

# **GIS Database Development**

## Chapter 13. GIS Database Development

### 13.1. Introduction of GIS

One of the important tasks of this Rural Electrification Master Plan Study is to develop a GIS (Geographical Information System) database to serve as a useful tool for planning rural electrification projects. The GIS system is a digital mapping system that can handle not only numerical data, such as population of the village and the number of commercial and public facilities, but also graphic information on the map. There are some different types of computer software for GIS systems in the world, but since many ministries in GRZ have an experience more or less of using ArcGIS, which is developed by ESRI in USA and the most popular software, the Study Team selected the latest version of ArcView 9.1, the primary package of ArcGIS as the standard GIS system for this Study.

### 13.2. The GIS Database

#### 13.2.1. Experience of Using GIS System

As of November 2006, DoE has neither GIS software nor a computer in which GIS software is installed, which means that DoE virtually has no professional skills to use GIS.

ZESCO uses GIS system for its business but only modestly and there appears to be no standardization. We found that one/some ZESCO's branch office(s) is/are using GIS system to manage the power system data such as transmission and distribution line routes, but the file format is different from that of ArcGIS and hence it would be difficult to incorporate the database as it is into the Rural Electrification GIS database that is created in Arc format.

REA, in the meanwhile, has GIS system, the latest version of ArcView 9.1, which is installed in their computer. In the beginning of this Study, REA's usage of GIS system is still limited to collecting GIS database from other Governmental organizations and ZESCO, and they have no experience of developing GIS database of its own for planning rural electrification projects. However, REA recruited a GIS expert, who has enough experience of GIS usage in a water service company, and they have started to utilize GIS in the actual planning of rural electrification including data collection of the site using GPS device.

In short, the counterpart organizations that will be responsible for updating the Rural Electrification GIS database needs training of basic operations of GIS during the project period before going into the details of the database excluding one GIS expert.

#### 13.2.2. Existing GIS Data

The Study Team obtained various GIS database from REA during the first mission in April/May 2006, which was originally owned by other related organizations such as Ministries. This database includes basic and necessary geographic information for this project, such as administrative boundaries, roads, and location of public facilities. These data shall be fully or partially incorporated into the Rural Electrification GIS Database.

REA is classifying the database into the "source" organization, which makes us find easily where each database comes from. However, the information regarding the time of data collection, the database updating, and the original map data that each GIS database referred to are not necessarily available. Therefore, we assume that the accuracy of these databases varies. For instance, by combining the topographical database with the village database on a same map, we find that some villages are positioned in a lake, and this kind of strange incidents, i.e. data input errors, occurs occasionally.

During the second field survey in Zambia, JICA study team obtained the Zambia Health Facility

Census Database compiled in October 2006, based on the field study by JICA between 2004 and 2006, on behalf of the Ministry of Health. The database compiled the information of health facilities in whole Zambia based on the same GIS maps that we obtained during the first field survey. The following table shows the GIS database that the Study Team has obtained so far.

**Table 13-1 GIS Database Obtained during the First Mission**

Ministry	Item
Agriculture and Cooperatives	Agro region, Farmers block, Resettlement area
Commerce, Trade and Industry	N.A.
Community development and Social Services	N.A.
Education	Basic school (electrified / unelectrified / no water service), Secondary school, Village centre, Roads (Main / Others), Railway, National parks, River (Major / Others), Wetland, Dam, Drainage, Administrative boundaries (Nation / Province / district)
Energy and Water development	Energy Power systems (330kV - 11kV, existing and plan), Hydropower stations (existing and plan), Diesel Power stations (existing and plan), Substations (existing and plan)
	Water affair Kafue River (river basin, sub basin, stream flow), Kafue Lake, Kafue Wetland, Zambezi River (agro climate, grow day, evaporation, annual rainfall, runoff, temperature in July and November, rapid point), Zambezi Lake, Zambezi Wetland, Luapula River, Environmental impact assessment in 1995, 2005 and 2015, Environmentally sensitive area, Priority management area, Wetland birds
Health	N.A.
Home Affairs	N.A.
Land	N.A.
Local Government and Housing	N.A.
Mines and Minerals Development	Mines, Minerals
Tourism, Environment and Natural Resources	Forest, Grassland, Termitary, Administrative boundary, Rivers, Roads, Railways
Works and Supply	N.A.
Central Statistics Office	Administrative boundary (Nation, Province, District), Constituency, Roads (Trunk, Major, Others)

Source: JICA study team

**Table 13-2 GIS Database Obtained during the Second Mission**

Ministry	Item
Health	Health Facility Census

Source: JICA study team

By scrutinizing each database, we find that some roads and administrative boundaries are recorded in different route and shapes that really have to be identical, and it's difficult to judge which data is the most probable without the information regarding the accuracy of each map. However, these errors are in general minor and acceptable in terms the purpose of this Study to develop a "nation-wide" Master Plan. The most appropriate data shall be selected case by case for the Rural Electrification GIS database.

In general, extension of distribution networks is made along the route of existing roads, thus lack or inaccuracy of road information strongly affects the accuracy of project plans. On top of that, geographic information of GIS system is less reliable than the paper-based maps. Hence the Study Team has improved the quality of GIS road data by comparing the GIS data with the paper-based 1/250,000 maps, which were issued by the Ministry of Lands. A drawback of paper-based maps is that they were originally published in 1986, more than twenty years ago, and they may lack a lot of information on new or reconstructed roads.

Accuracy of the length of distribution lines, which is essential for estimating the construction cost and for optimising the distribution system planning, also depends on the contour data that give the information of each site's elevation, but none of obtained GIS maps provide the information as such. Because it is physically difficult to obtain / make this information and Zambia is a relatively gently rolling land, the length of distribution lines are calculated assuming the plane land.

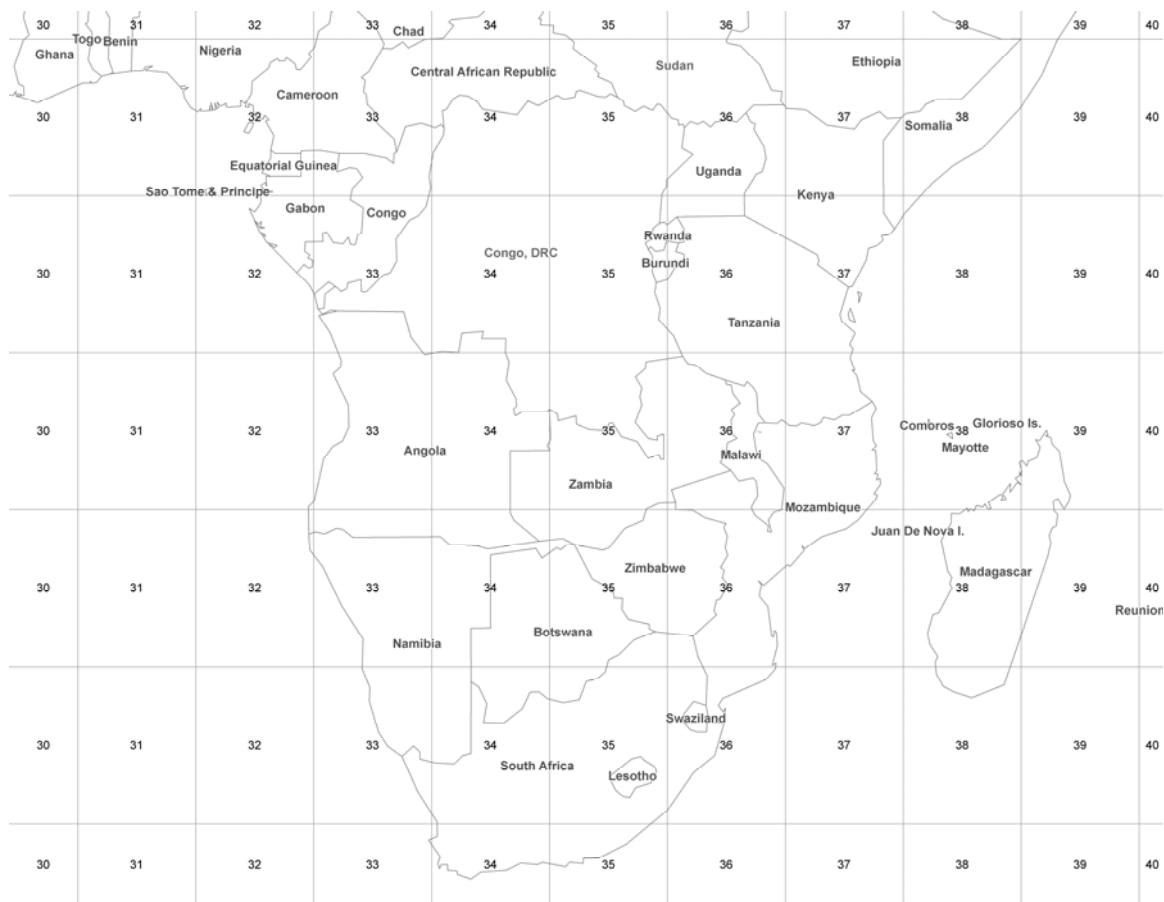
**13.2.3.Coordinates System of GIS database**

There are a lot of coordinates systems that ArcView can deal with, but the obtained GIS databases do not have the explicit coordinates system. In this case, the ArcView automatically defines the coordinates system as "GCS\_Assumed\_Geographi", which may cause errors in positioning. Appropriate definition of coordinates is necessary for accurate positioning.

The Study Team combined the GCS\_Assumed\_Geographic based map and the UTM (Universal Transverse Mercator) based map. These maps are almost consistent with each other. The UTM projection is adopted as the standard in this Study.

The UTM is mainly used for the large scaled map (1/10,000 – 1/200,000) as an international standard. UTM divides longitude into the projection of Zone 1–Zone 60 (longitude of a Zone equals 6 degree = 360 km), and divides latitude into North and South Zone, which makes 120 Zones in total.

The error of one Zone is within 6/10,000 in the UTM projection. Theoretically, the UTM projection displays the map of one Zone seamlessly and it does not display the different Zones simultaneously within the abovementioned margin of error.



Source: JICA study team

**Figure 13-1 Southern African UTM Zones**

As shown in Figure 13-1, Zambia belongs to the UTM Zones from 34S to 36S, and over half the area of Zambia is positioned in Zone 35S. The Zone 35S is basically used in this study. The ArcView can shift the coordinates to another system without difficulty. To obtain more accurate distance in western Zambia near Angola, and eastern Zambia, near Malawi, UTM 34S or 36S should be used, of course.

#### 13.2.4. Newly Acquired GIS Data

The purpose of this Study to collect existing GIS databases and to develop a new database specialized for planning rural electrification by adding necessary information that has not been recorded as GIS format or even never collected systematically. The following is data are collected through the Provincial Workshops in November 2006 and are incorporated into the database:

- Existing medium-voltage distribution network (33kV – 11kV)
- Candidate Rural Growth Centres (RGCs) for electrification

The existing distribution network, especially medium voltage level, and RGCs data are crucial for developing the Master plan. The power system data in the existing GIS database needs to be improved because of the inaccuracy and incompleteness of some power system information. The Study Team distributed the paper-based 1/250,000 maps to branch office staffs of ZESCO and asked them to trace the power system on it by hand drawing, which was compiled into electronic GIS data. Figure 13-2 shows the updated map of the existing distribution systems.

Information regarding RGCs is also added to the database, including their position, demographic data, and priority order for electrification. The position of RGC is shown in Figure 13-3.

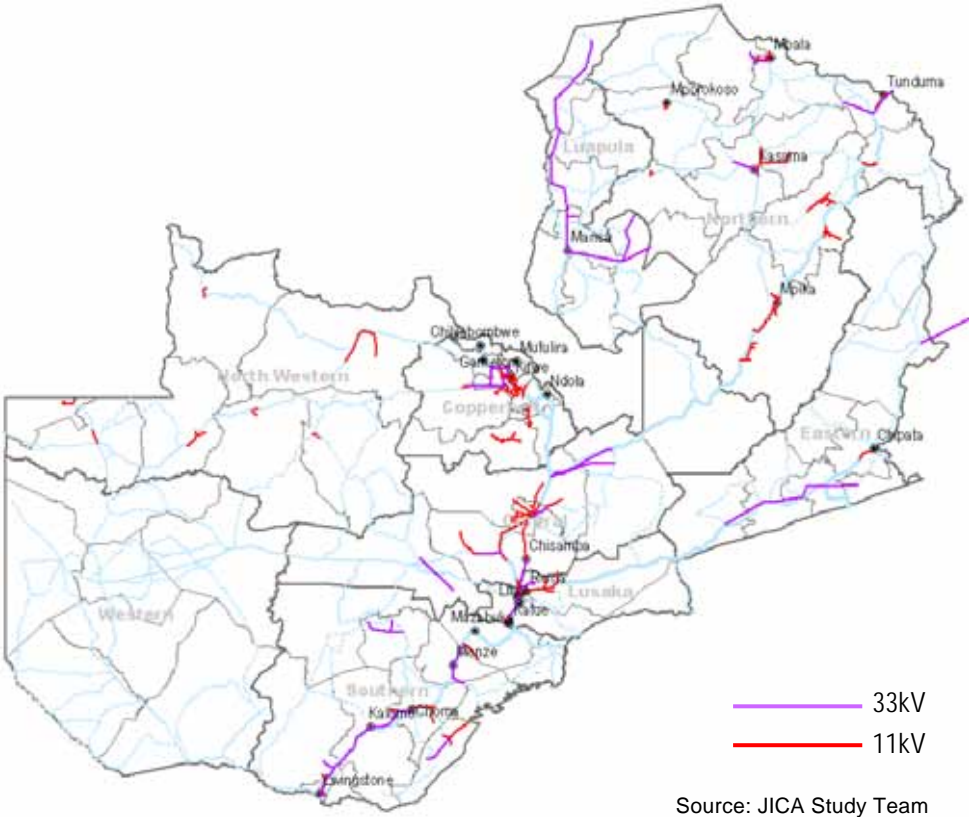


Figure 13-2 Distribution Network in Zambia

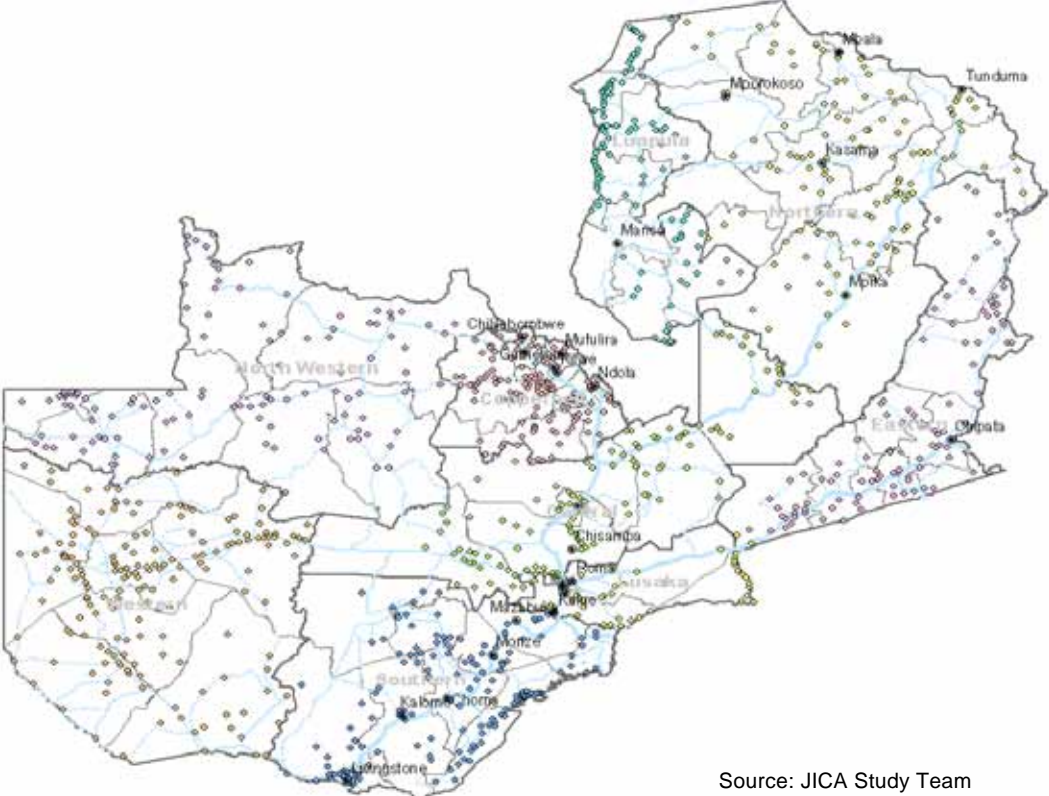


Figure 13-3 Rural Growth Centres Listed in Electrification Candidate

In the last result, this Study developed GIS database including the demand forecast of RGCs, electrification mode and year, and distribution expansion plan etc. as shown in Figure 13-4.

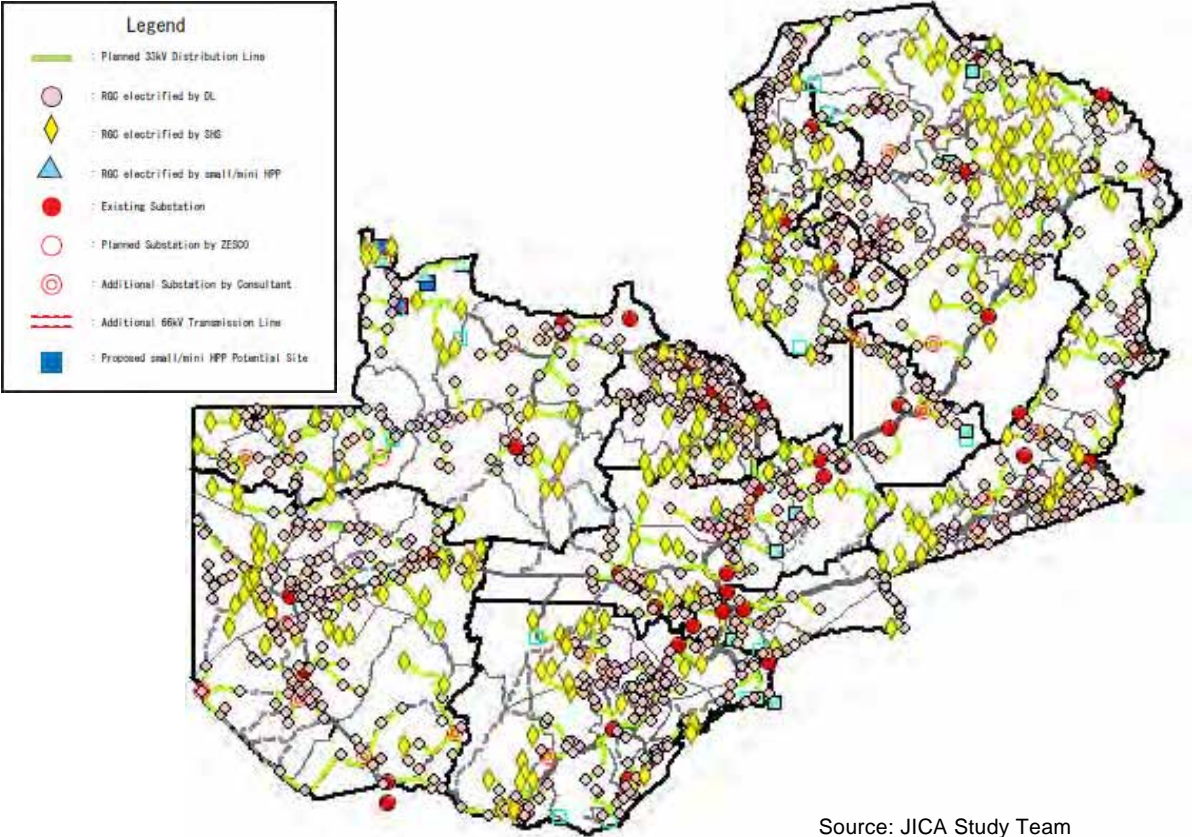


Figure 13-4 Example of Final GIS Database

### 13.2.5. GIS Training

The GIS training was held on 9<sup>th</sup> and 12<sup>th</sup> November 2007 at REA with support from GIS expert of REA. The staffs of DOE, REA and ZESCO took this 2-day training course for GIS. This training covered the basic operation of ArcView and how-to utilize GPS device into this Study to improve efficiency of data collection. The tutorial manual was distributed to participants; about 15 people touched the software and became familiar with it. They realized importance of GIS for this kind of project because they need to draw the actual plan on Zambian map. It can manage the map and database with ease. However, the problem is that they don't have enough license of ArcView. It is better to have at least one license by one organization to share and update the data each other.



**Figure 13-5 GIS Training**



## **Chapter 14**

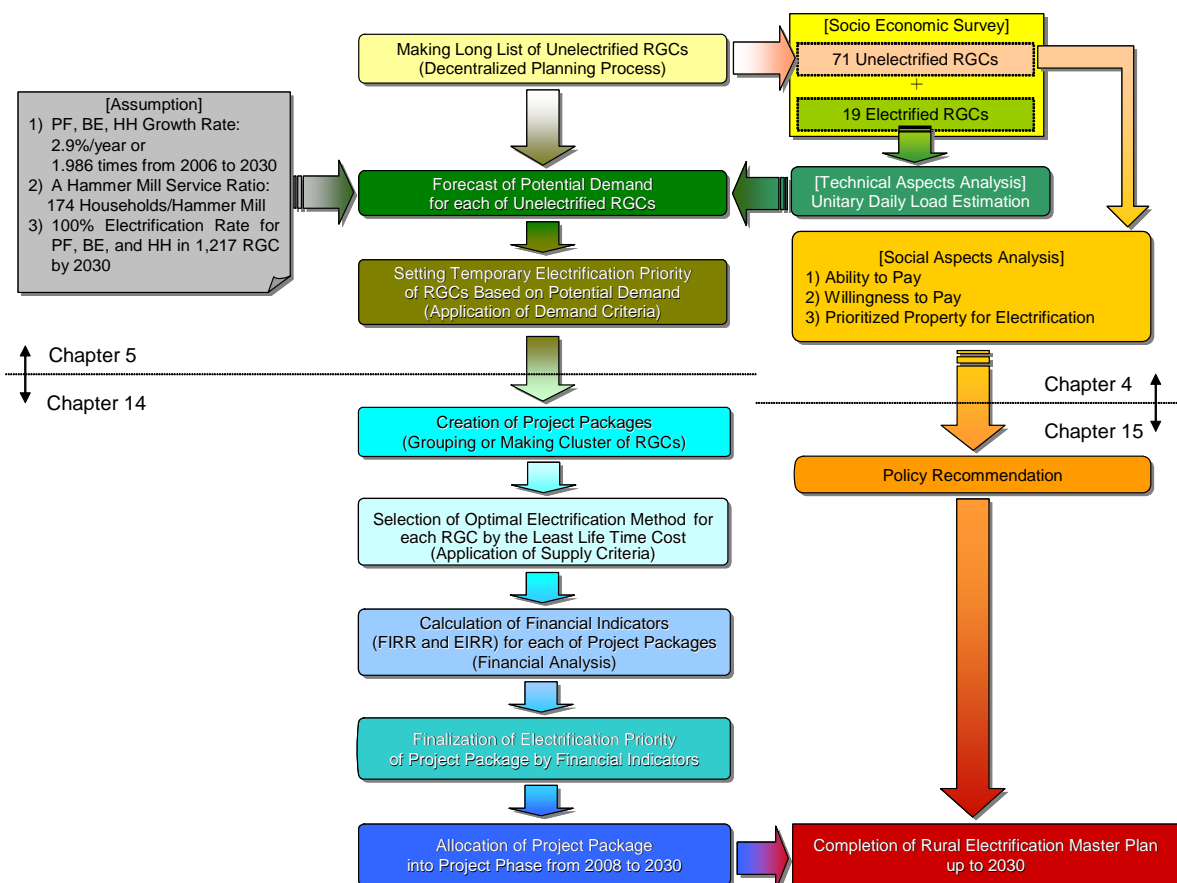
# **Rural Electrification Master Plan by 2030**

## Chapter 14. Rural Electrification Master Plan by 2030

### 14.1. Purpose of Development of Master Plan and Development Flow

To execute rural electrification projects in Zambia, a systematic implementation plan that indicates electrification targets, electrification order, electrification method, time schedule, and required budget is necessary. Therefore, a systematic implementation plan was developed as the Rural Electrification Master Plan (REMP) targeting 2030 along the following principles:

- Develop logical, objective, numerical/quantitative, and convincing Master Plan
- Adopt decentralized planning process
- Provide realistic financial plan to be implemented



**Figure 14-1 Flowchart of Rural Electrification Master Plan Development**

The development flow of the REMP is shown in Figure 14-1. As was explained in Chapter 4, a Rural Growth Center (RGC) was selected as the electrification target in the REMP. Based on the information submitted from District Planners in the Workshop held in all the 9 Provincial Centers, 1,217 RGCs were selected as electrification candidates. This is called “Decentralized Planning Process.” Then, the potential daily peak demands for the 1,217 unelectrified RGCs were forecasted by using the demographic data of these 1,217 RGCs and analysing the data collected from 19 electrified RGCs in the Socio-Economic Survey. Using the size of the potential peak demand, 1,217

RGCs were given an initial ranking (refer to Table 5-11 in Chapter 5). This process is the application of “Demand Criteria.”

Next, the unelectrified RGCs located on a route of a transmission/distribution line extension were grouped to form a Project Package. Each Project Package was then broken down to several Components by shorten the length of the transmission/distribution line extension and introducing stand-alone electrification mode (such as mini-hydro, Solar Home System, or diesel generator) to supply the RGCs where the transmission/distribution line would not reach. For all Components, the Unit Life Time Cost (US\$/kWh) of each electrification mode was estimated, and electrification mode having the least Unit Life Time Cost was selected as the optimal Case for each Project Package. This process is the application of “Supply Criteria”, which was used to select the optimal electrification method for each of the 1,217 RGCs.

For all Project Packages with the optimal Case, Financial Indicators such as Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR) were calculated, and the final electrification priority of Project Packages was determined by the value of Indicators. Finally, Project Packages were grouped into Annual Project Phases from 2008 to 2030 by the uniform total project cost per year. The process is referred to as “Technical Aspect Analysis.”

In addition to the “Technical Aspect Analysis”, a “Social Aspect Analysis” (such as for ability to pay, willingness to pay, and prioritized property for electrification) was carried out by using the data collected during the Socio-Economic Survey (refer to Chapter 4).

In this Chapter, applied methods and findings after the process of “Creation of Project packages” in the “Technical Aspect Analysis” are explained. Policy recommendation, elaborated with Stakeholders by taking into account the “Social Aspect Analysis” results, is also introduced in Chapter 15 as a part of conclusion of this Master Plan Study.

### 14.2. Creation of Project Packages and Subdivided into Project Components

As it was explained in Chapter 5, 1,217 RGCs were initially ranked by the size of potential demand (application of Demand Criteria). Based on this initial ranking, Project Packages or cluster of RGCs electrified by a transmission/distribution line extension were created (refer to Figure 14-2). Process of making Project Package starts from the highest ranked RGC. Along the route to the highest prioritized RGC, some unelectrified RGCs may exist. These RGCs were clustered or grouped into a Project Package as candidates to be electrified by a transmission/distribution line extension project.

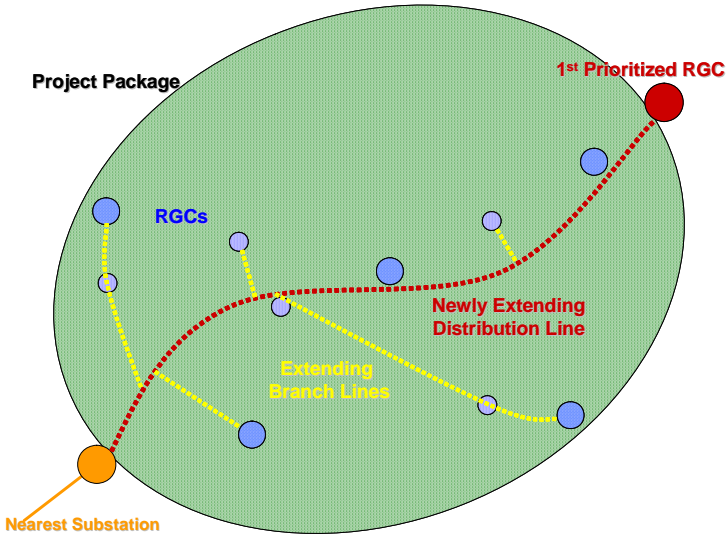
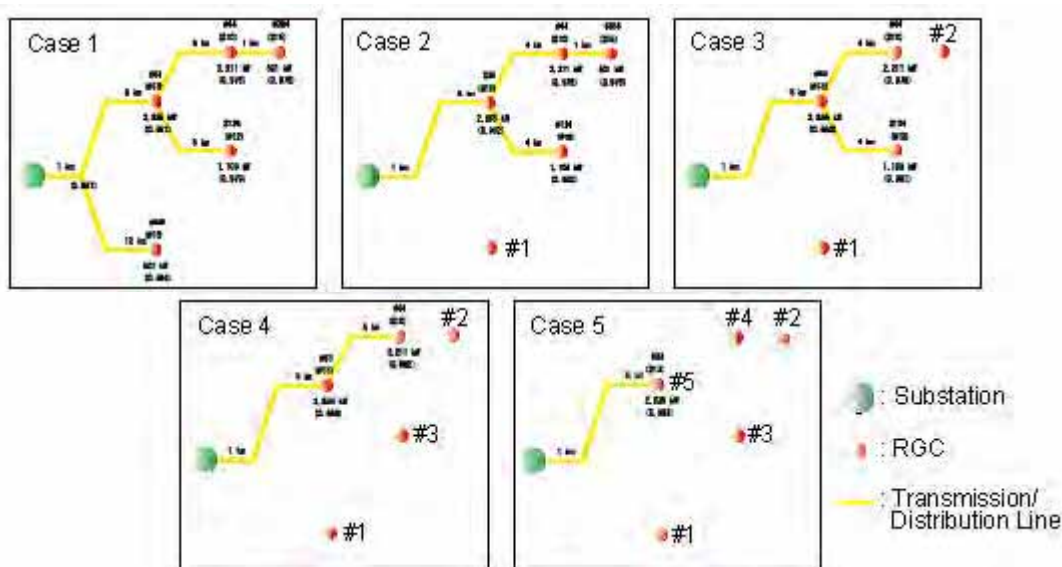


Figure 14-2 Concept of Project Package

Then, each Project Package was subdivided into several Components by shortening the length of transmission/distribution line extension. The process of a Project Package subdivided into Components is shown in Figure 14-3. For example, all the RGCs are connected to transmission/distribution line in Case 1. Then, instead of extending the line to RGC #1, it is electrified by a stand-alone electrification mode (such as Solar Home System, Mini-Hydro, or Diesel Generator) as shown in Case 2. In Case 3, RGC #2 is also isolated and electrified by the stand-alone mode. In Case 4, RGC #3 is additionally isolated. Finally, only RGC #5 is electrified by the line connection, and all other RGCs are electrified by the stand-alone mode as shown in Case 5.



**Figure 14-3 Process of a Project Package Broken Down to Cases**

This process resulted in grouping the 1,217 unelectrified RGCs into 180 Project Packages subdivided into 835 project Components. In the next step of “Selection of Optimal Electrification Mode for Each RGC”, the optimal Case for each Project Package is determined.

### 14.3. Selection of Optimal Electrification Method for Each RGC

#### 14.3.1. Definition of Unit Life Time Cost

To select the optimal electrification mode for each RGC and define the optimal Case for each Project Package, some criteria were necessary. In general, Financial Indicators (such as FIRR and EIRR) are the most suitable selection criteria. These criteria, however, were not applicable here, since the Financial Indicators for an electrification mode of the Solar Home System (SHS) would always have negative values. This situation would occur under the assumption that SHS equipment would be sold outright to customers and they would operate and maintain (O&M) the equipments. In this situation, there would be no future income from the operation of SHS. Thus, in the calculation of the Financial Indicators, only expenditure for initial cost (equipment cost) and O&M expenses would be appear.

As an alternative criterion of the Financial Indicators, “Unit Life Time Cost in Net Present Value (US\$/kWh)” was adopted in this study. The method of calculating the Unit Life Time Cost in Net Present Value is shown in Equation 14-1.

Unit Life Time Cost in Net Present Value (US\$/kWh)

$$=F_{NPV}\{[Construction/Initial Cost (US\$)+Total O\&M Cost for Life Time (US\$)]\} \div Total Amount of Electricity Consumable during the Life Time (kWh) \quad (Equation 14-1)$$

$F_{NPV}\{X\}$ : Function of converting value of X into the Net Present Value (US\$)

First, the net present value (“Total Life Time Cost”) was calculated from the necessary construction/initial cost and O&M cost for life time of each electrification mode (US\$). Next, the total amount of electricity consumable during the life time of each electrification mode (kWh) was worked out (“Life Time Consumable Electricity”). Then, the Unit Life Time Cost in Net Present Value of each electrification mode was estimated by dividing the Total Life Time Cost by the Life Time Consumable Electricity. Finally, electrification mode having the least Unit Life Time Cost in Net Present Value was selected as the optimal electrification mode for each RGC and the optimal Case for each Project Package. The assumed Life Time for each electrification mode is summarized in Table 14-1.

**Table 14-1 Assumed Life Time for Each Electrification Mode**

Electrification Mode	Life Time
1) Transmission/Distribution Line	30 years
2) Solar Home System	15 years for SHS Panel 5 years for Battery
3) Mini-Hydro	40 years
4) Diesel Generator	20 years

14.3.2. Results of Selecting Optimal Electrification Method

The Unit Life Time Cost in Net Present Value of each electrification mode was calculated for all 835 Project Components made up from 180 Project Packages. The component with the least value was selected as the optimal electrification mode for a Project Package. The number of Project Packages for each combination of electrification mode was summarized in Table 14-2. The majority is either the combination of distribution extension and SHS or that of transmission and distribution extension (56 and 55 Project Packages respectively). It is also found that only three of the mini-hydro power plants, among 29 possible candidate sites considered in this study, are feasible: a Project Package each for the combination of mini-hydro, SHS and distribution extension, for the combination of mini-hydro and SHS, and for the mini-hydro only. The diesel generator option was not selected in any of the Project Package, since the operation cost is too high due to the fuel price (also refer to Appendix-E Current Situation of Diesel Generation in Rural Area).

**Table 14-2 Number of Project Packages in Each Combination of Electrification Mode**

Combination of Electrification Mode				Project Package
Transmission	Distribution	SHS	Mini-Hydro	
○	○			55 ( 30.6% )
○	○	○		27 ( 15.0% )
	○			39 ( 21.7% )
	○	○		56 ( 31.1% )
	○	○	○	1 ( 0.6% )
		○	○	1 ( 0.6% )
			○	1 ( 0.6% )
-	-	-	-	180 ( 100.0% )

The number of RGCs and households for each electrification mode were also summarized in Table 14-3. Approximately 80% of RGCs and 95% of households fall under electrification by transmission/distribution line extension. Only 4 RGCs or 9,702 households will be electrified by three mini-hydro power plants. As the SHS market, 241 RGCs are identified and their names are listed by Province in Table 14-6.

**Table 14-3 Number of RGCs and Households Electrified by Each Mode**

Electrification Mode	RGC	HH
Transmission/Distribution Line Extension	972 ( 79.9% )	1,008,622 ( 94.5% )
Solar Home System Installation	241 ( 19.8% )	49,405 ( 4.6% )
Mini-Hydro Power Development	4 ( 0.3% )	9,702 ( 0.9% )
<b>Total</b>	<b>1,217 ( 100.0% )</b>	<b>1,067,729 ( 100.0% )</b>

## 14.4. Electrification Priority of Project Package

### 14.4.1. Calculation of Financial Indicators

For all 180 Project Packages (with each optimal Case), Financial Indicators (namely FIRR and EIRR) were calculated. The assumptions used for the calculation were summarized in Table 14-4. It is important to note that the calculation of the Financial Indicators excluded all SHS in Project Packages. As discussed earlier, it was assumed that the O&M costs would be borne by the beneficiaries, and that there was no income from the operation of SHS installation.

**Table 14-4 Assumptions for Financial Indicator Calculation**

Monthly Unit Electricity Consumption (kWh)		Tariffs		K	US \$	
Households	163	Metered Households				
Commercial Customers	163	0-300 kWh	102	0.026		
Hammer Mills	5,931	301-700 kWh	145	0.036		
Public Facilities		>700 kWh	236	0.059		
1) Basic/Primary School	331	Monthly fixed charge	8,475	2.12		
2) High/Secondary School	54	Commercial Tariffs	245	0.061		
3) Tertiary School	1,609	Monthly fixed charge	43,841	10.96		
4) Hospital	12,904	Social Tariffs	201	0.050		
5) Health Center/Clinic	337	Monthly fixed charge	34,839	8.71		
6) Police Office	125	Annual Increase Rate				
7) Post Office	144	Households	2.9%			
8) Church	58	Commercial Consumers	2.9%			
9) Mosque	58	Social Consumers	2.9%			
10) Community Center	455	A Unit Hammer Mill Service Ratio (HH/HM)	174			
11) Agriculture Depot	215	Annual Tariff increase	1.0%			
12) Orphanage	250	Zesco Collection Efficiency	90%			
13) Central Government Office	181	Operation Costs				
14) Provincial Government Office	438	Percentages of Initial Capital Cost				
15) District Government Office	696	DL	SHS	Diesle	Hydro	
16) Other Local Administration Office	438	Operation & Maintenance	1.00%	1.00%	0.024 US\$/kWh	0.024 US\$/kWh
17) Court	297	Customer care	0.10%	0.00%	0.10%	0.10%
18) Other (Average)	297	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				
		Increase pa	K	US \$		
			65	0.016		
				1.0%		
		Inflation Rate				
		Foreign Currency		2%		
		Domestic Currency		8%		
		Exchange rate	K	US\$		
			4,000.00	1.00		
		Standard Conversion Factor			0.892	
		Conversion Factor for Unskilled Labor			0.70	
		Current Monthly Average Cost for Alternative Energy				
			K	US \$		
		Household & Business Entity	65,534	16.38		
		Willingness to Pay	K / Month	US\$ / Month		
		Households	37,197	9.30		
		Discount Factor			12.00%	

#### 14.4.2. Final Electrification Priority Order of Project Packages by Financial Indicators

The final electrification priority order of Project Packages in the Master Plan was determined by FIRR (calculated excluding the SHS portion for Project Packages), since it was the most important indicator to evaluate the project's financial viability and the project's capacity to redeem a loan. The final priority order of Project Packages was shown in Table 14-5, together with the Unit Life Time Cost in Net Present Value, project costs with each electrification mode, and EIRR for each of Project Packages (a sample of the financial indicators' calculation process is also shown in Appendix-F).

Project Packages are listed in the order of priority (set by FIRR) for each Province in Table 14-6. In the table, the optimal electrification mode selected for each of RGCs is also indicated. The number of Project Packages and RGCs electrified by each mode are summarized by Province in Table 14-7.

**Table 14-7 Number of Project Packages and Electrification Mode for RGCs by Province**

Province	# of PP	# of Elec. RGCs by DL	# of Elec. RGCs by SHS	# of Elec. RGCs by Hydro	Total # of RGCs
Central	19	105	19		124
Copperbelt	16	105	24		129
Eastern	25	104	18		122
Luapula	18	98	23		121
Lusaka	5	36	4		40
Northern	32	140	55		195
North-Western	18	94	24	4	122
Southern	21	140	33		173
Western	26	150	41		191
<b>Total</b>	<b>180</b>	<b>972</b>	<b>241</b>	<b>4</b>	<b>1,217</b>

#### 14.5. Allocation of Project Packages into Annual Project Phases

As summarized in Table 14-8, US\$ 1,103 million is needed to implement all 180 Project Packages. This translates to approximately US\$ 50 million per year for 22 years from 2008 to 2030.

**Table 14-8 Necessary Electrification Project Cost by 2030 in Each Mode**

Electrification Mode	Cost in US\$
Transmission/Distribution Line Extension	1,022,385,240 ( 92.7% )
Solar Home System Installation	58,489,689 ( 5.3% )
Mini-Hydro Power Development	22,210,313 ( 2.0% )
<b>Total</b>	<b>1,103,085,242 ( 100.0% )</b>

Then, the prioritized 180 Project Packages are grouped into 22 Annual Project Phases each requiring US\$ 50 million, as shown in Table 14-9.

**Table 14-5 Final Electrification Priority of Project Packages by 2030 (1/2)**

FIRR Ranking	Substation	Province	Feeder & Package	Trans./Dist Line Cost (US\$)	SHS Cost (US\$)	Hydro Cost (US\$)	Total Project Package Cost	Least Life Time Cost	Project Package FIRR	Project Package EIRR
1	Isoka	Northern	1 - 1	673,272	990,123		1,663,395	0.0092	22.0%	59.9%
2	Azele	Eastern	2 - 2	1,899,936			1,899,936	0.0060	20.5%	57.5%
3	Kapiri Mposhi	Central	2 - 2	2,701,296			2,701,296	0.0064	18.1%	50.2%
4	Kansunswa	Copperbelt	1 - 8	4,522,824			4,522,824	0.0078	13.2%	35.1%
5	Azele 2	Eastern	2 - 1	2,596,212			2,596,212	0.0060	12.1%	34.1%
6	Azele	Eastern	1 - 2	1,608,120			1,608,120	0.0080	12.0%	33.9%
7	Azele 3	Eastern	1 - 2	3,388,392			3,388,392	0.0082	11.5%	32.4%
8	Isoka	Northern	2 - 1	747,576	1,243,873		1,991,449	0.0167	11.0%	29.5%
9	Azele 1	Eastern	1 - 5	3,600,612			3,600,612	0.0085	11.0%	31.1%
10	Ndola 1	Copperbelt	1 - 4	3,675,672			3,675,672	0.0087	10.8%	29.5%
11	Lundazi	Eastern	3 - 2	2,733,588			2,733,588	0.0094	9.5%	26.1%
12	Chipata	Eastern	2 - 2	4,280,904	416,277		4,697,181	0.0100	9.2%	26.3%
13	Mbereshi	Luapula	1 - 3	2,620,728	622,820		3,243,548	0.0116	9.1%	22.2%
14	Azele 5	Eastern	1 - 3	7,189,452			7,189,452	0.0096	8.7%	25.6%
15	Kasama 1	Northern	1 - 2	4,137,372	483,813		4,621,185	0.0105	8.7%	24.9%
16	Senanga	Western	1 - 1	2,146,932			2,146,932	0.0102	8.5%	23.3%
17	Mbereshi	Luapula	2 - 1	1,854,468			1,854,468	0.0100	8.4%	23.9%
18	Kitwe	Copperbelt	1 - 3	2,269,080	368,850		2,637,930	0.0114	8.2%	22.6%
19	Azele 2	Eastern	1 - 3	4,538,160			4,538,160	0.0101	8.2%	23.8%
20	Luwingu	Northern	3 - 3	1,395,468			1,395,468	0.0103	7.7%	23.2%
21	Mponqwe	Copperbelt	3 - 2	2,048,868	80,283		2,129,151	0.0107	7.6%	22.8%
22	Monqu 2	Western	2 - 3	5,644,512	460,417		6,104,929	0.0112	7.5%	22.1%
23	Nchelenge	Luapula	1 - 4	2,087,748	364,872		2,452,620	0.0127	7.5%	19.1%
24	Azele 3	Eastern	2 - 1	2,509,596			2,509,596	0.0105	7.5%	22.6%
25	Azele 1	Eastern	2 - 2	3,545,532	1,139,130		4,684,662	0.0130	7.1%	21.9%
26	Monqu 2	Western	1 - 3	4,102,704	219,028		4,321,732	0.0114	7.1%	20.9%
27	Mumbwa	Central	1 - 3	2,034,072	684,666		2,718,738	0.0133	7.0%	21.3%
28	Nchelenge	Luapula	2 - 4	4,227,552	235,395		4,462,947	0.0121	6.8%	19.1%
29	Nakonde	Northern	1 - 2	3,076,272	1,064,965		4,141,237	0.0154	6.7%	16.6%
30	Monqu	Western	1 - 4	3,890,700			3,890,700	0.0119	5.9%	19.0%
31	Muzuma 2	Southern	2 - 1	3,703,968			3,703,968	0.0125	5.6%	17.7%
32	Luwingu 3	Northern	2 - 5	4,202,496			4,202,496	0.0126	5.5%	17.4%
33	Samfya 2	Luapula	2 - 2	2,752,596			2,752,596	0.0139	5.0%	14.4%
34	Luano	Copperbelt	1 - 3	2,387,772	284,120		2,671,892	0.0148	4.9%	15.5%
35	Mbereshi 1	Luapula	2 - 5	6,313,140	559,897		6,873,037	0.0147	4.9%	15.2%
36	Mbala	Northern	2 - 4	5,112,504	2,547,823		7,660,327	0.0174	4.8%	17.1%
37	Pensulo	Central	1 - 1	599,616			599,616	0.0146	4.6%	13.7%
38	Msoro	Eastern	1 - 1	1,486,296			1,486,296	0.0139	4.6%	14.4%
39	Azele 4	Eastern	2 - 3	5,366,628	341,988		5,708,616	0.0140	4.6%	16.4%
40	Kabwe 1	Central	1 - 3	4,443,228			4,443,228	0.0136	4.5%	16.0%
41	Solwezi	North-Western	1 - 1	3,196,692			3,196,692	0.0134	4.5%	16.3%
42	Senanga	Western	3 - 3	4,424,004			4,424,004	0.0138	4.4%	15.6%
43	Luwingu 2	Northern	2 - 5	6,526,008			6,526,008	0.0135	4.4%	16.3%
44	Victoria Falls	Southern	3 - 1	1,862,120	1,365,257		3,027,377	0.0213	4.4%	16.0%
45	Kabwe 2	Central	1 - 2	5,905,008			5,905,008	0.0137	4.3%	15.9%
46	Luano	Copperbelt	2 - 4	2,782,080	512,429		3,294,509	0.0165	4.3%	13.8%
47	Senanga 3	Western	1 - 2	5,513,508			5,513,508	0.0141	4.2%	15.2%
48	Ndola	Copperbelt	1 - 3	4,725,756			4,725,756	0.0143	4.1%	14.6%
49	Kitwe	Copperbelt	2 - 3	2,922,804	314,531		3,237,335	0.0171	4.0%	11.9%
50	Samfya 1	Luapula	2 - 3	4,234,788			4,234,788	0.0153	3.9%	13.2%
51	Samfya	Luapula	1 - 1	1,286,388	293,925		1,580,313	0.0169	3.7%	14.6%
52	Muzuma 1	Southern	2 - 1	2,582,172	2,251,605		4,833,777	0.0243	3.6%	14.0%
53	Mwinilunga 1	North-Western	1 - 0		3,070,610	2,654,970	5,725,580	0.0195	3.6%	14.5%
54	Mporokoso	Northern	2 - 6	7,404,372			7,404,372	0.0148	3.6%	14.3%
55	Kawambwa Tea	Luapula	1 - 6	4,996,188	401,485		5,397,673	0.0183	3.5%	10.4%
56	Mbereshi 1	Luapula	1 - 3	4,493,664	531,461		5,025,125	0.0170	3.4%	12.7%
57	Samfya 2	Luapula	1 - 3	4,748,220			4,748,220	0.0159	3.3%	12.4%
58	Kaoma	Western	4 - 2	3,370,788	397,632		3,768,420	0.0168	3.2%	13.4%
59	Nampundwe	Central	1 - 5	6,327,072	521,627		6,848,699	0.0166	3.1%	13.2%
60	Luwingu 1	Northern	1 - 5	7,400,916			7,400,916	0.0157	2.9%	13.2%
61	Isoka	Northern	3 - 2	4,738,824			4,738,824	0.0160	2.9%	12.9%
62	Kasama 2	Northern	1 - 4	7,680,960			7,680,960	0.0162	2.8%	12.3%
63	Kalabo	Western	1 - 3	6,112,368	723,406		6,835,774	0.0174	2.7%	13.0%
64	Muzuma 3	Southern	1 - 3	4,332,960			4,332,960	0.0166	2.7%	12.1%
65	Pensulo 1	Central	2 - 5	5,346,756			5,346,756	0.0164	2.7%	12.5%
66	Luwingu 3	Northern	1 - 3	3,819,528			3,819,528	0.0161	2.6%	13.0%
67	Lundazi	Eastern	1 - 2	2,785,860	1,479,405		4,265,265	0.0240	2.3%	11.5%
68	Monqu	Western	2 - 5	7,319,376			7,319,376	0.0167	2.3%	12.3%
69	Nchelenge 1	Luapula	1 - 3	4,821,120			4,821,120	0.0185	2.3%	10.1%
70	Luwingu	Northern	1 - 4	7,722,972			7,722,972	0.0168	2.2%	12.3%
71	Senanga 2	Western	2 - 2	2,739,744			2,739,744	0.0171	2.2%	11.8%
72	Kabwe	Central	2 - 5	6,232,788	225,782		6,458,570	0.0180	2.1%	11.5%
73	Senanga 3	Western	2 - 3	7,618,536			7,618,536	0.0174	2.1%	11.6%
74	Kapiri Mposhi	Central	1 - 6	5,497,848	399,856		5,897,704	0.0189	2.0%	11.0%
75	Kalabo	Western	2 - 1	2,756,268	794,187		3,550,455	0.0216	1.8%	11.4%
76	Senanga 2	Western	1 - 3	3,328,452			3,328,452	0.0187	1.8%	10.2%
77	Mporokoso	Northern	1 - 5	4,094,712			4,094,712	0.0182	1.7%	10.6%
78	Muzuma 1	Southern	1 - 4	6,212,464	1,331,379		7,543,863	0.0220	1.7%	10.1%
79	Monqu 1	Western	1 - 4	6,380,748	2,847,936		9,228,684	0.0241	1.6%	11.1%
80	Lundazi 1	Eastern	1 - 3	4,215,024			4,215,024	0.0184	1.5%	10.8%
81	Kaoma	Western	1 - 2	3,539,376	1,801,008		5,340,384	0.0288	1.5%	8.5%
82	Mazabuka	Southern	1 - 3	3,732,048	738,598		4,470,646	0.0279	1.5%	3.5%
83	Luwingu 2	Northern	1 - 5	7,625,988			7,625,988	0.0182	1.5%	11.0%
84	Mfuwe 1	Eastern	1 - 5	4,821,120	175,869		4,996,989	0.0190	1.5%	10.7%
85	Solwezi	North-Western	2 - 4	2,663,712			2,663,712	0.0188	1.5%	10.4%
86	Kafwe Town	Lusaka	1 - 3	1,582,632			1,582,632	0.0199	1.5%	9.2%
87	Mumbwa	Central	3 - 4	6,012,576			6,012,576	0.0191	1.3%	10.2%
88	Lundazi	Eastern	2 - 7	8,256,276			8,256,276	0.0203	1.2%	9.1%
89	Isoka 1	Northern	1 - 1	4,628,988			4,628,988	0.0199	1.2%	9.5%
90	Muzuma 3	Southern	2 - 6	5,251,284			5,251,284	0.0200	1.1%	9.4%



**Table 14-5 Final Electrification Priority of Project Packages by 2030 (2/2)**

FIRR Ranking	Substation	Province	Feeder & Package	Trans./Dist. Line Cost (US\$)	SHS Cost (US\$)	Hydro Cost (US\$)	Total Project Package Cost	Least Life Time Cost	Project Package FIRR	Project Package EIRR
91	Luano 2	Copperbelt	1 - 5	6,468,768	109,535		6,578,303	0.0209	1.1%	8.8%
92	Isoka 1	Northern	2 - 1	4,419,792			4,419,792	0.0196	1.1%	9.8%
93	Azele 4	Eastern	1 - 4	11,500,056			11,500,056	0.0193	1.0%	10.1%
94	New SS at Lukulu	Western	1 - 5	8,474,976			8,474,976	0.0228	1.0%	8.9%
95	Mongu 1	Western	2 - 8	10,201,680			10,201,680	0.0193	1.0%	10.2%
96	Mpika	Northern	1 - 1	1,251,288	508,921		1,760,209	0.0280	0.9%	9.5%
97	Mkushi	Central	1 - 7	5,977,476	951,259		6,928,735	0.0257	0.8%	7.1%
98	Nchelenge 1	Luapula	2 - 4	7,155,648			7,155,648	0.0215	0.8%	8.3%
99	Luwingu	Northern	2 - 5	6,742,008	726,749		7,468,756	0.0216	0.7%	9.7%
100	Mfuwe	Eastern	1 - 3	7,515,828			7,515,828	0.0203	0.8%	9.5%
101	Mazabuka 1	Southern	2 - 6	6,055,668			6,055,668	0.0222	0.8%	7.7%
102	Maposa	Copperbelt	2 - 4	3,617,136			3,617,136	0.0221	0.4%	8.1%
103	Chinsali	Northern	2 - 1	1,129,140	1,201,445		2,330,585	0.0438	0.4%	8.3%
104	Senanga	Western	2 - 3	8,819,172			8,819,172	0.0213	0.4%	8.7%
105	Kasama	Northern	2 - 5	7,077,132			7,077,132	0.0217	0.4%	8.5%
106	Kasama	Northern	1 - 3	2,891,484	2,922,026		5,713,510	0.0372	0.3%	8.7%
107	Mpika	Northern	2 - 3	3,820,824	1,316,505		5,137,329	0.0276	0.3%	8.4%
108	Mpika	Northern	3 - 1	2,613,816	1,384,800		3,998,616	0.0311	0.0%	8.2%
109	Azele 6	Eastern	2 - 2	3,756,780			3,756,780	0.0221	0.0%	8.4%
110	Maposa	Copperbelt	1 - 6	9,154,296	37,124		9,191,420	0.0238	-0.3%	7.3%
111	Chipili	Luapula	1 - 4	4,341,080	90,503		4,431,583	0.0255	-0.4%	6.4%
112	Mumbwa	Central	2 - 3	4,442,904			4,442,904	0.0257	-0.5%	5.7%
113	Mpika 1	Northern	1 - 2	7,672,860			7,672,860	0.0240	-0.5%	7.3%
114	Kitwe	Copperbelt	3 - 8	6,919,884	201,447		7,121,331	0.0282	-0.7%	4.7%
115	Sesheke	Western	1 - 4	8,686,008			8,686,008	0.0253	-0.7%	6.4%
116	Chilundu	Southern	1 - 3	3,358,044	296,011		3,654,055	0.0278	-0.8%	6.1%
117	Azele 8	Eastern	1 - 3	7,118,712	142,129		7,260,841	0.0246	-0.8%	7.3%
118	Mkushi Farm Block	Central	1 - 5	7,182,452	665,468		7,827,920	0.0300	-0.8%	5.1%
119	Chipata	Eastern	1 - 4	6,059,016	481,549		6,540,564	0.0267	-0.9%	6.8%
120	Pensulo 1	Central	1 - 4	5,382,180			5,382,180	0.0246	-0.9%	7.1%
121	Mazabuka 1	Southern	3 - 8	6,448,248			6,448,248	0.0262	-1.0%	6.1%
122	Muzuma 2	Southern	1 - 4	7,654,932	254,481		7,909,413	0.0255	-1.0%	7.0%
123	Chinsali	Northern	3 - 1	710,748	813,992		1,524,740	0.0510	-1.0%	5.4%
124	New SS at Kabompo	North-Western	2 - 5	11,671,020			11,671,020	0.0253	-1.1%	6.7%
125	New SS at Lukulu	Western	2 - 2	5,237,244	1,774,905		7,012,149	0.0335	-1.2%	6.1%
126	Sinazongwe	Southern	1 - 8	6,275,908	805,526		6,081,434	0.0320	-1.2%	4.9%
127	Kabwe	Central	1 - 7	6,657,012			6,657,012	0.0265	-1.3%	6.1%
128	New SS at Zambezi	North-Western	2 - 2	5,388,680	334,115		5,702,795	0.0277	-1.3%	6.3%
129	Zambezi 1	North-Western	1 - 4	8,354,180	279,755		8,633,935	0.0275	-1.6%	6.3%
130	New SS at Mwinilunga	North-Western	4 - 0			8,688,211	8,688,211	0.0261	-2.0%	4.6%
131	New SS at Zambezi	North-Western	1 - 8	10,004,384	1,185,245		11,189,609	0.0327	-2.2%	4.7%
132	Luano 1	Copperbelt	1 - 4	4,479,516	134,174		4,613,690	0.0341	-2.4%	3.4%
133	Samfya 1	Luapula	1 - 5	6,764,040			6,764,040	0.0317	-2.4%	4.1%
134	Muzuma 1	Southern	3 - 1	2,671,272	353,982		3,025,234	0.0340	-2.4%	4.6%
135	Pensulo 2	Central	2 - 2	12,876,408	164,408		13,040,814	0.0308	-2.5%	4.8%
136	Mpongwe	Copperbelt	2 - 1	1,717,848	79,938		1,797,786	0.0330	-2.6%	4.1%
137	Senanga 1	Western	1 - 4	17,644,176			17,644,176	0.0308	-2.6%	4.6%
138	Pensulo 2	Central	1 - 5	10,138,284			10,138,284	0.0317	-2.6%	4.4%
139	Luano 1	Copperbelt	2 - 4	6,293,808			6,293,808	0.0347	-2.9%	3.0%
140	New SS at Chilundu	Lusaka	2 - 1	12,229,184	306,618		12,535,782	0.0355	-2.9%	2.9%
141	Coventry	Lusaka	1 - 4	5,448,276	145,637		5,593,913	0.0370	-3.0%	2.2%
142	Mpika 2	Northern	1 - 3	9,631,764			9,631,764	0.0331	-3.1%	4.0%
143	Kaoma	Western	2 - 3	8,182,620	915,627		9,098,247	0.0376	-3.1%	3.4%
144	Mpika 1	Northern	2 - 3	11,886,696			11,886,696	0.0354	-3.4%	3.2%
145	Mazabuka 1	Southern	1 - 4	4,611,924			4,611,924	0.0374	-3.5%	2.4%
146	New SS at Mwinilunga	North-Western	3 - 2	3,620,616			3,620,616	0.0357	-3.5%	3.1%
147	New SS at Mwinilunga	North-Western	2 - 4	9,098,892			9,098,892	0.0360	-3.6%	3.1%
148	New SS at Mwinilunga	North-Western	1 - 1	7,986,492	1,449,173	10,867,131	20,302,796	0.0556	-3.9%	0.4%
149	Fig Tree	Central	1 - 6	7,295,940	282,271		7,568,211	0.0422	-3.9%	1.6%
150	Leopard's Hill	Lusaka	1 - 11	12,860,984			12,860,984	0.0378	-4.0%	2.5%
151	Serenie	Central	1 - 3	7,325,532			7,325,532	0.0398	-4.2%	2.4%
152	Victoria Falls	Southern	2 - 4	5,194,692	287,828		5,482,320	0.0479	-4.2%	0.3%
153	New SS at Mufumbwe	North-Western	1 - 7	13,583,916	342,885		13,926,801	0.0438	-4.5%	1.4%
154	Kalabo	Western	3 - 5	16,060,140	532,911		16,593,051	0.0422	-5.0%	2.1%
155	Kaoma	Western	3 - 3	10,689,516			10,689,516	0.0449	-5.1%	0.8%
156	Mpongwe	Copperbelt	1 - 5	8,589,996	143,027		8,733,023	0.0434	-5.1%	1.7%
157	Muzuma	Southern	2 - 2	4,124,628			4,124,628	0.0434	-5.3%	1.5%
158	Kasempa	North-Western	2 - 4	6,585,084	319,324		6,904,408	0.0499	-5.3%	0.2%
159	Chipili	Luapula	2 - 2	8,145,792	199,099		8,344,891	0.0488	-6.0%	0.7%
160	Solwezi	North-Western	3 - 5	10,115,604			10,115,604	0.0487	-6.0%	0.5%
161	Isoka 1	Northern	3 - 1	5,762,340			5,762,340	0.0482	-6.0%	0.7%
162	Sesheke 1	Western	1 - 5	12,350,988	988,951		13,319,939	0.0531	-6.0%	0.1%
163	Muzuma	Southern	1 - 5	5,281,740			5,281,740	0.0533	-6.1%	-0.7%
164	Mansa	Luapula	2 - 3	1,619,784	203,035		1,822,819	0.0675	-6.1%	-2.5%
165	Chilundu	Southern	2 - 8	8,734,500			8,734,500	0.0525	-6.5%	-0.2%
166	Victoria Falls	Southern	1 - 5	3,954,312			3,954,312	0.0662	-6.8%	-3.1%
167	New SS at Mumbwezi	North-Western	1 - 2	6,636,492			6,636,492	0.0523	-6.8%	0.0%
168	New SS at Chavuma	North-Western	1 - 8	8,411,204	357,387		8,768,591	0.0641	-7.0%	-1.7%
169	Muzuma	Southern	3 - 1	2,869,452	213,808		3,083,260	0.0579	-7.0%	-0.5%
170	New SS at Kabompo	North-Western	1 - 4	11,623,500			11,623,500	0.0579	-7.0%	-1.9%
171	New SS at Chama	Eastern	2 - 5	11,377,800			11,377,800	0.0538	-7.0%	-0.1%
172	New SS at Chama	Eastern	1 - 3	14,867,712			14,867,712	0.0609	-7.8%	-1.3%
173	Chinsali	Northern	1 - 4	9,725,076			9,725,076	0.0673	-7.8%	-2.8%
174	New SS at Chilundu	Lusaka	1 - 1	5,460,912	364,872		5,825,784	0.0634	-8.1%	-1.1%
175	New SS at Nyimba	Eastern	1 - 6	8,449,544	421,373		8,870,917	0.0744	-8.2%	-4.4%
176	Kasempa	North-Western	1 - 4	3,180,492	254,357		3,434,849	0.0679	-8.7%	-3.0%
177	Maamba	Southern	1 - 8	15,099,588	71,983		15,171,571	0.0800	-9.8%	-3.8%
178	Sesheke 2	Western	1 - 4	21,945,600			21,945,600	0.0743	-10.2%	-2.7%
179	Mansa	Luapula	1 - 5	7,531,272	738,142		8,269,414	0.1071	-12.6%	-5.8%
180	Mbala	Northern	1 - 2	5,990,898	599,286		6,590,154	0.0964	-13.1%	-4.2%
	<b>Total</b>	-	-	<b>1,022,365,240</b>	<b>58,489,689</b>	<b>22,210,313</b>	<b>1,103,085,242</b>	-	-	-

**Table 14-6 Electrification Priority of Project Packages by Province (1/12)  
Central Province**

Provincial Ranking	1	2	3	4	5
Substation	Kapiri Mposhi	Mumbwa	Pensulo	Kabwe 1	Kabwe 2
District	Kapiri Mposhi	Mumbwa	Serenje	Kapiri Mposhi	Chibombo
RGCs by DL	KPG Market Lukanda Luashimba	Mumba Maimwene settlement Chiwena	Mukando	Nchembwe Kafulu Koni Bunda Community	Palace Chipepo Mutuni-Ngombe Chilwa Kaswende Waya
RGCs by SHS		Ngabwe Kapopo Chikonkomene Nambwa			

Provincial Ranking	6	7	8	9	10
Substation	Nampundwe	Pensulo 1	Kabwe	Kapiri Mposhi	Mumbwa
District	Mumbwa	Serenje	Kabwe	Kapiri Mposhi	Mumbwa
RGCs by DL	Muchabi keezwa Shibuyunji Siachele Myooye Nalubanda Mukulaikwa	Lukulu HC, Sch, Mkt Nakatambo Katikululu Musangashi Nsala	Lukali Community School Josias Chiwala Farm Chilumba Katuntulu Com. School Likumbo Mpima Dairy Scheme Shed Mubofwa	Chilese Kaloko Fikola Chankomo Lunchu Mubalashi	Big Concession Kaindu Mpusu Kamiliambo
RGCs by SHS	Chipepo Muchenje Mamvule		Chipepo	Nkole	

Provincial Ranking	11	12	13	14	15
Substation	Mkushi	Mumbwa	Mkushi Farm Block	Pensulo 1	Kabwe
District	Mkushi	Mumbwa	Mkushi	Serenje	Kabwe
RGCs by DL	Chalata Kasalamakanga Ndabala Malali Nkumbi Nshinso Munsakamba Lunsemfwa Chitina	Matala Naluvwi Chibuluma Lulili Nakanjoli Chikanda Nalusanga	Old Mkushi Masansa Makolongo Lubuto Masansa Kanyemhya Resettlement Scheme Mpale_Tuyu Chikupili	Mailo C. Salli Kawama Masase C. Serenje	Kangomba Health Centre Kafumba Munwa Basic School Katlamase Basic School Kalwelwe Rail Station Munyama B. School Kapuku Fish Camp
RGCs by SHS	Fibanga Musofu Kalombe		Chikwasha Chingombe Fiwila		

Provincial Ranking	16	17	18	19
Substation	Pensulo 2	Pensulo 2	Fig Tree	Serenje
District	Serenje	Serenje	Chibombo	Serenje
RGCs by DL	Talayi Mushili Kasanka Sokontwe Chipe Chipundu Kapumbu	Mpelembe Machende Njelele Chalilo Gibson Katongo Chipundu	Shimukuni Waya Mukulushi Chamuka Lifwambula Kabangala Momboshi	Chibale Nchimishi Kofi Kunda Mpande
RGCs by SHS	Musolo		Kasosolo Kayosha	

**Table 14-6 Electrification Priority of Project Packages by Province (2/12)  
Copperbelt Province**

Provincial Ranking	1	2	3	4	5
Substation	Kansunswa	Ndola 1	Kitwe	Mpongwe	Luano
District	Mufulira	Ndola	Kitwe	Mpongwe	Chitilabombwe
RGCs by DL	Kawama East	Twapia	Musakashi	Mulela	Kailo
	Murundu	George Camp	Luela	St. Anthony	Mimbula Block
	Mupambe	Sakania	Lungo		Kansoka
	Luansobe	Chichele	Council Farm		
	Mutundu North (Conner Bar)				
	Mokambo				
	Mutamba				
RGCs by SHS	Kafironda		Mirsenga	Kapili	Chisangwa
	Lukoshi			Ipumbu	
				Mushine	
				Machiya	
				Luswishi	
				Munkunpa	
				Munsongwe	

Provincial Ranking	6	7	8	9	10
Substation	Luano	Ndola	Kitwe	Luano 2	Maposa
District	Chitilabombwe	Masaiti	Kitwe	Chingola	Luanshya
RGCs by DL	Kamiteta	Mutaba	St. Joseph	Mutenda	Kaf Miss
	Fitobaula	Kambowa	Nkana	Muchinshi	Kamifungo
	Kawama	Kanglonga	Emerald Mining Area	Ipafu	Shombe
	Lubansa	Chondwe	Kambila	Milopa	Chilobwe
	Mingomba	Mupapa	Kabombo	Muchinshi	Kawama
	Kasapa	Chikumbi	Chibuluma Mine Area	Kansoka	Kangalati
			Chapula	Milulu Mitambo	Lima
RGCs by SHS	Kanenga		Kandole	Mutenda	
	Chilimna		Chantete		

Provincial Ranking	11	12	13	14	15
Substation	Maposa	Kitwe	Luano 1	Mpongwe	Luano 1
District	Luanshya	Kitwe	Lufwanyama	Mpongwe	Lufwanyama
RGCs by DL	Chifulube	Mukutuma	Mbalango Mine Farm Block	Mukumbo	Kambilombilo
	Maposa	Saw-Mills	Kapilamikwa	Shingwa	Nchakwa
	Kafubu	Kalisha	Kangalati	Kasamba	Lumwana
	Kaf GRZ	Michinka	St. Mary's		Kanyafimbolo
	Kakolo	Kafubu Depot	Kartende		Mushingashi
	Chinondo	Chamanza Resettlement	Fumbwe		Fungulwe
	Kapupulu	Kameme			Funda
	Misaka	Milopa			Mapunga
		Kansoka			Kawe Kasakalawe
		Lumpuma			
		Kapimbe			
RGCs by SHS	Salati	Chitabuke	Chinemu	Chitabale	
				Luela	

Provincial Ranking	16
Substation	Mpongwe
District	Mpongwe
RGCs by DL	Mpongwe
	Lukanga
	Chowa
	Mukubwe
	Mushipushi
	Chisanga
	Musofu
	Ibenga
RGCs by SHS	Chibuli
	Kotinteden
	Chisapa
	Chirwa
	Mikata
	Matete
	Fidashi

**Table 14-6 Electrification Priority of Project Packages by Province (3/12)  
Eastern Province**

Provincial Ranking	1	2	3	4	5
Substation	Azele	Azele 2	Azele	Azele 3	Azele 1
District	Katete	Katete	Katete	Petauke	Katete
RGCs by DL	Chindenza School Chitawe RHC	Mtandaza RHC	Chimutende, Kapeya Farms	Kapungwe Chikalawa	Chinkhombe Nyembe Matunga School Chisale Kafunka
RGCs by SHS					

Provincial Ranking	6	7	8	9	10
Substation	Lundazi	Chipata	Azele 5	Azele 2	Azele 3
District	Lundazi	Chipata	Petauke	Katete	Petauke
RGCs by DL	Sikatengwa Mwase Mwata	Kasenegeva Rural Centre Madimawe Rural Health Centre Madzimoyo Sec. School Chinyaku Palace	Mwanjawanthu Mumbi Matonje Kaulu	Kagoro Kafumbwe School Kapurimphika Taferansoni	Nyamphinga
RGCs by SHS		Maguya			

Provincial Ranking	11	12	13	14	15
Substation	Azele 1	Mgoro	Azele 4	Lundazi	Lundazi 1
District	Katete	Mambwe	Petauke	Lundazi	Lundazi
RGCs by DL	Kamphambe Chilasa	Kasamanda Nkhoko	Nyamphande NSS Monde Misolo	Mchereka Mphamba Khulamayen Chasefu	Mwimba Kazonde Phikalalaza
RGCs by SHS	Zemba Kalimeta Kenje		Kalongo Mwape Mulilo	ZASP Mapamba Lumimba	

Provincial Ranking	16	17	18	19	20
Substation	Mfuwe 1	Lundazi	Azele 4	Mfuwe	Azele 6
District	Mambwe	Lundazi	Petauke	Mambwe	Chadiza
RGCs by DL	Ncheka Kamphasa Kamphasa Ncheka Chikowa Chikowa	Emusa Kapichila Egichakeni Kazembe Nkhanga M Mphanga Chikomem Hoya Mtambali	Mng'omba School Sasali Chikowa Ukwimi	Chasela Nsefu Chilanga Chilanga	Naviluri Madziyera Marie
RGCs by SHS	Nyamaluma				

Provincial Ranking	21	22	23	24	25
Substation	Azele 6	Chipata	New SS at Chama	New SS at Chama	New SS at Nyimba
District	Chadiza	Chipata	Chama	Chama	Nyimba
RGCs by DL	Zingalume Chikonka Chigwe Kapachi Kalemba Vubwi Mchenjera	Chinunda Kmgubudu Mphomwa Mphomwa Tse-tse Kapara Maguya Chiparamba Chisengu	Kaozi Settlement Mangwere Mabinga Siwe Kalinkhu Chifunda Manga	Muyombe Kanselele Mnauke Bulbe	Chipembe Mulira Mtilizi Scheme Vizimumba Central Hofmeyre Ndake Mchimadzi Scheme Chambula Chimphanje
RGCs by SHS	Chiwaula	Lima Com. School Mwanya			Mbilisao Kacholola Kalingindi Wilson Chalubilo

**Table 14-6 Electrification Priority of Project Packages by Province (4/12)**  
**Luapula Province**

Provincial Ranking	1	2	3	4	5
Substation	Mbereshi	Mbereshi	Nchelenge	Nchelenge	Samfya 2
District	Nchelenge	Nchelenge	Nchelenge	Nchelenge	Samfa
RGCs by DL	Mwansabombwe	Chipashi Island	Kambwali	Nile Kapambwe	Lubwe
	Chipepa	Shabo (Kapambwe)	Mubamba	Kenani	Mbilimawenge
	Mbereshi	Kanyembo	Kabosha	Mabo Kafutuma	Mundubi
	Mukamba		Nchelenge boma	Mwatishi Farm block 2	
	Salanga		Kashikishi	Kabole	
	Lufubu		Nshinda	Mununga	
RGCs by SHS	Chipunka		Kampampi (Chipakila)	Kabuta Central	
			Chilongo (Mtepuke)	Kaputa	
	Chama		Lukwesa	Kaputo	
	Kalamba				
	Muyembe				

Provincial Ranking	6	7	8	9	10
Substation	Mbereshi 1	Samfya 1	Samfya	Kawambwa Tea	Mbereshi 1
District	Mwense	Samfa	Samfa	Kawambwa	Mwense
RGCs by DL	Mwense	Chinsanka	Mano	Township	Mulundu
	Musangu	Katanhsya		Katungulu	Kashiba
	Lubunda	Mabo-Ninge		Mushota	Mutima
	Mulonga	Twingi		Mukuma	Kanyemba
	Lukwesa			Chama	Chibondo
	Mumpolokoso			Lengwe	Kabila
	Kapala			Mufwaya	
RGCs by SHS	Mununshi				
	Chibwe		Ndoba	Kanengo	Muchinga
			Mibenge	Chibote	Katuta

Provincial Ranking	11	12	13	14	15
Substation	Samfya 2	Nchelenge 1	Nchelenge 1	Chipili	Samfya 1
District	Samfa	Chiengi	Chiengi	Mansa	Samfa
RGCs by DL	Kasaba	Putu	Chiengi	Mwenda	Kalimankonde
	Mwansakombe	Kalobwa	Lambwe Chomba	Chipili	Bwaiya Mponda
	Mwewa	Kalembe	Lupiya	Luminu	Kapilibila
	Isandulula Peri-urban C	Mukunta	Kasembe	Mukonshi	Kasomalunga
	Miponda	Kafulwe	Mwabu	Mutipula	Konikalila
RGCs by SHS		Sambula	Kampinda		Nsamba
				Mutwewankoko	

Provincial Ranking	16	17	18
Substation	Chipili	Mansa	Mansa
District	Mansa	Mansa	Mansa
RGCs by DL	Munshinga	Ntoposhi	Mulumbu
	Masonde Farming Block	Mutiti	Chintu
	Mano	Kabunda	Mikula
	Kalaba	Kapanda	Kasongwa sub boma
			Milambo
			Kundamfumu
RGCs by SHS			Mulumbi
	Chisunka	Mwanachama	Kasoma lwela
	Mbaso	Bukanda	Lukola
			Kalasa kando
			Mansa Resettlement Scheme
		Kalyongo	
		Chipete	

**Table 14-6 Electrification Priority of Project Packages by Province (5/12)  
Lusaka Province**

Provincial Ranking	1	2	3	4	5
Substation	Kafwe Town	New SS at Chilundu	Coventry	Leopard's Hill	New SS at Chiiundu
District	Kafue	Luangwa	Lusaka	Chongwe	Luangwa
RGCs by DL	Kabweza	Boma	Mwembeshi_mano	Nankaga	Rufunsa
	Manyonyo	Kapoche	Ipongo	Kapongo	Luangwa Bridge
	Tukunka	Mwalilia	Kasupe	Lishiko	
		Katondwe	Kamano	Chinkuli	
		Chitope	Chowa	Katoba	
		Kaunga	Chipapa VC	Shantumbu	
		Mphuka	Chinyongola	Chinyunyu	
		Manuele		Nyamanongo	
		Kakaro		Chiyota	
		Chiriwe		Mwalumina	
		Luangwa Sec		Lwimba	
				Mwachilele	
RGCs by SHS				Nchute	
		Kavalamanja	Muswishi		Nyalugwe Shikabeta

**Table 14-6 Electrification Priority of Project Packages by Province (6/12)  
Northern Province (1/2)**

Provincial Ranking	1	2	3	4	5
Substation	Isoka	Isoka	Kasama 1	Luwingu	Nakonde
District	Isoka	Isoka	Kasama	Luwingu	Nakonde
RGCs by DL	Ntipo	Kafwimbi	Chisanga	Njeke Basic School	Nyela
			Namakwi	Lupili Market	Chitolwa
			Musa	Chiponde Basic School and Chief Chipaka's	Ilendela
				Makolongo Basic School	Wulongo
				Kantongo	
RGCs by SHS	Muliro	Musanya	Lwabwe		Chisanzu
	Chibale	Peleti			Senka
		Kalulu			Shamu
		Kalela			Sumbi
	Chunga			Kayambi	

Provincial Ranking	6	7	8	9	10
Substation	Luwingu 3	Mbala	Luwingu 2	Mporokoso	Luwingu 1
District	Chilubi	Mbala	Chilubi	Mporokoso	Mporokoso
RGCs by DL	Chiwele	Mpungu Central	Mwiima	Nsama Sub Boma	Mukupakaoma
	Kashitu	Isoko	Kantanta	Chishamwamba	Chitoshi
	Chilamba	Chilumba	Chichile	Katutwa	Mulenga M
	Kambashi	Musende	Chitupila	Malama	Menga Basic School and Clinic
	Mule	Pesa, Muzabwera, Mupata (Ib)	Kawasa	Kambobe	Laurenti Chita Basic School and C
	Kapofu	Isunga	Katamba	Mporokoso	
	Mbabala		Chabukasansha	Murwa	
RGCs by SHS		Kasaba Bay			
		Vyamba			
		Tanganyika			
		Mumila			
		Iyendwe			
		Chisha			
	Chitimbwa RHC				

Provincial Ranking	11	12	13	14	15
FIRR Ranking	61	62	66	70	77
Substation	Isoka	Kasama 2	Luwingu 3	Luwingu	Mporokoso
District	Isoka	Mporokoso	Chilubi	Luwingu	Mporokoso
RGCs by DL	Sansamwente	Sikapila	Kawena	Bwalinde	Chalabesa
	Kawngu	Kapatu	Kanama	Tolopa Basic School	Mutotosho
		Malaila	Kanama	Nsanja Basic School	Chewe
		Z Chanda	Nsumbu RH	Chikumanino Market	Kalabwe
			Bukotelo	Chief Tungati's Palace and Scho	Sunkutu
				Kapisha School	
				Ipusukilo Mission	
RGCs by SHS				Chakungubala Basic School	
				Lwena Basic School and Clinic	

Provincial Ranking	16	17	18	19	20
Substation	Luwingu 2	Isoka 1	Isoka 1	Mpika	Luwingu
District	Chilubi	Isoka	Isoka	Mpika	Luwingu
RGCs by DL	Matipa	Thendere	Mulekatembo	Mufubushi Resettlement	Kanfinsa
	Mofu R4				Mufili Basic School
	Mubili				Saili Basic School
	Lwata				Chitofwe Basic School
	Isangano				Lwenge Basic School
					Tungati Basic School and Clinic
RGCs by SHS				Nabwalya	Nsombo
					Musungu
					Kalundu

**Table 14-6 Electrification Priority of Project Packages by Province (7/12)  
Northern Province (2/2)**

Provincial Ranking	21	22	23	24	25
Substation	Chinsali	Kasama	Kasama	Mpika	Mpika
District	Chinsali	Kasama	Kasama	Mpika	Mpika
RGCs by DL	Ketani	Kachuma	Henry Kapata	Katongo Kapala	Katibunga
	Chilanga	Lukulu RR Scheme	Ngoli	Luoembe	
	Mwalala	Chilubula	Mwamba	Kanchibiya Farm Block	
	Nashinga	Chishimba			
	Masongo	Munkonge			
		Chiombo			
RGCs by SHS		Lukulu North			
	Konja		Rosa	Chikakala	Lwanya
	Malekani		Kapolyo	Kopa	Mukwikile
	Kabanda		Chimbola		Mukungule
	Chifulo		M. Mfino		
	Mumba		Chamfubu		
	Nkulungwe		Ndasa		
			Nsampa		
			C. Weyaya		
			Chimba		
			Makasa		
		Chitimukulu			
		Chisau			

Provincial Ranking	26	27	28	29	30
Substation	Mpika 1	Chinsali	Mpika 2	Mpika 1	Isoka 1
District	Mpika	Chinsali	Mpika	Mpika	Isoka
RGCs by DL	Chalabesa Hospital	Kasomo	Muwele	Mbati	Kampumbu (Kamnsu)
	Mpepo HC, Sch, Palace		Mupamadzi Farm Block	Chambeshi Sch, Mkt	
	Mansha Farm Block		Chiunda Ponde	Mayuka	
				Kabinga	
RGCs by SHS				Fube	
		Mbesuma area			
		Chungulo			
		Kampemba			
	Shimwalule				

Provincial Ranking	31	32
Substation	Chinsali	Mbala
District	Chinsali	Mpulungu
RGCs by DL	Lundu	Kavumbo
	Chitimba	Uningi
	Chikanda	Chalele
	Chimbwese	Chimula
	Lameck	Kaka
	Chimbele	St-Pauls
	Lufila	Kawimbe
	Musonko	Mwamba
	Kabangama	
	Chilombo	
Shiwan'gandu area		
Mulakupikwa		
RGCs by SHS		Kalukanya
		Matanga
		Kaluluzi
		Mwiluzi
	Mpande	



**Table 14-6 Electrification Priority of Project Packages by Province (8/12)  
North-western Province**

Provincial Ranking	1	2	3	4	5
Substation	Solwezi	Mwinilunga 1	Solwezi	New SS at Kabompo	New SS at Zambezi
District	Solwezi	Mwinilunga	Solwezi	Kabompo	Zambezi
RGCs by DL	Mushnoomo		Kimsala	Kaifa	Chinyingi
	Turva		Kamalamba	Kawanda	Liyovu
			Kangwena	Nilunga	Kashona
			Kibanza	Kashinakapi	Kakoto
			Chikoa	Lusona	
			Manyinga		
			Chiteve		
RGCs by SHS		Salujinga			Lukuni
		Jimbe			
		Nyakasenga			
RGCs by Mini-Hydro		Kafweku			
		Ikelenge			

Provincial Ranking	6	7	8	9	10
Substation	Zambezi 1	New SS at Mwinilunga	New SS at Mwinilunga	New SS at Zambezi	New SS at Mwinilunga
District	Zambezi	Mwinilunga	Mwinilunga	Zambezi	Mwinilunga
RGCs by DL	Matondo	Nambu		Dipalata	Kawiku
	Milombo	Samuteba		Likungu	Mukangala
	Muyembe	Chisengiseng		Chitololoki	Lwakela
	Mwanze			Ishima	
				Mpidi	
			Kakeki		
			Nyakulena		
			Lwatembo		
RGCs by SHS	Nguvu	Tomu		Lunywe Basic School	
	Kavenge	Lumwana		Chiseng	
			Katoru		
			Chizuzu		
RGCs by Mini-Hydro		Kanyama	Mwinilunga BOMA		
		Kakoma			

Provincial Ranking	11	12	13	14	15
Substation	New SS at Mwinilunga	New SS at Mufumbwe	Kasempa	Solwezi	New SS at Mumbezi
District	Mwinilunga	Mufumbwe	Kasempa	Solwezi	Solwezi
RGCs by DL	Chiwika	Mushima	Mateko	Kapi	Mukumbi
	Mudunyama	Kikonge	Nselauke	Musaka	Mumbezi
	Kanongesha	Lakafuta	Dengwe	Mulonga	Musele
	Kampenba	Matushi	Kamakuku	Kalilele	Shienda
	Chwoma	Kashima W	Kalengwa	Sanda	
	Kamapanda	Kamnzeke	Kashima E	Mujima	
		Munyambala	Kalombe	Mumena	
		Miluj			
		Musonweji			
		Shukwe			
	Kakakasa				
	Chowe				
	Kamabuta				
RGCs by SHS		Myamaduka	Miyombe		
			Lunga		
RGCs by Mini-Hydro					

Provincial Ranking	16	17	18
Substation	New SS at Chavuma	New SS at Kabompo	Kasempa
District	Chavuma	Kabompo	Kasempa
RGCs by DL	Sanzongo	Sakandingo	Kabele
	Kakhoma	Samende	Kantenda
	Kalombo	Mukolo	Shivuma
	Lingundu	Nyangwali	Mpungu
	Lukolwe	Chinkonkwelo	
	Kamsamba	Dongwe	
	Chiwandumba	Chiyengele	
	Kambuya		
Mandalo			
Chambi			
RGCs by SHS	Chivombo		Kalongwa
	Mukelangombe		Maako
	Nyathanda		Kamakochi
		Lubofu	
		Kanogo	
RGCs by Mini-Hydro			

**Table 14-6 Electrification Priority of Project Packages by Province (9/12)  
Southern Province (1/2)**

Provincial Ranking	1	2	3	4	5
Substation	Muzuma 2	Victoria Falls	Muzuma 1	Muzuma 3	Muzuma 1
District	Kalomo	Livingstone	Namwala	Namwala	Namwala
RGCs by DL	Kauwe	Sinde	Baambwe	Mbeza	Moobola
		Mulala	Ngabo	Niko	Namakaka
		Sakurita		Ichila	Itapa
		Majeledi		Bweengwa	Muchila
	Katubia			Chilala	
RGCs by SHS		Smachuma	Kalundu		Namusenga
		Chilzya	Shapopa		Luchena
		Kananga	No.57 (Lubanda)		Mbila
		Inonge	Itumbi		Mabombo
		Zimba Hills Settlements			
		Napenzi			
		Malimba			
	Nyawa Central				
	Simango				

Provincial Ranking	6	7	8	9	10
Substation	Mazabuka	Muzuma 3	Mazabuka 1	Chilundu	Mazabuka 1
District	Mazabuka	Namwala	Monze	Siavonge	Monze
RGCs by DL	Ngwezi	Nakamboma (Namakaka)	Njola Camp	Chiawa Central	Namakube
	Nwanachmgurela	Makaba	Kaumba	Mafungautsi	Bbombo
	Naluama	Simaubi	Ntambo Agricultural Camp	Mugula mano	Hakasenke
	Maggobo	Nalutanga	Mujiika	Mulila Nsolo	Namilongwe
	Neganeqa	Kachenge	Chisuwu Agric Camp	Chisakila	Haatontola
		Mangonza	Manungu A	Mulangwa	Malende
			Manungu B		Kazungula
			Lweeta Agric Camp		Hufwa
			Chiyobola Agricultural Camp		Katimba
			Muzuri (Kamuzya East)		Simeweendengwe
			Namateba Agricultural Camp		Silwili
					Hamusankwa
RGCs by SHS	Mbaya Musuma Upper Kaleya			Kanyangala	
					Sikalinda Resettlement Hamapande

Provincial Ranking	11	12	13	14	15
Substation	Muzuma 2	Sinazongwe	Muzuma 1	Mazabuka 1	Victoria Falls
District	Kalomo	Sinazongwe	Namwala	Monze	Livingstone
RGCs by DL	Nkandanzovu	Chipepo	Kantengwa	Kayuni	Makunka
	Darphan	Sinakaimbi		Keemba	Ma Hundred
	Kinnertone	Munyati		Chungu Agric Camp	Sekute
	Bbilibi	Siacheka		Nteme	Mubalu
	Simakakata	Chiyabi		Malundu	Mambova
	Mutala	Sinamalima		Bankaila	Mahelituna
	Chikoli	Chabulabwambe			Mandia
		Siabwengo			Mayumbelo
		Siambabala			
		Mudonki			
		Mwaledede			
		Nangombe			
		Siamejele			
		Hangoma			
	Siampande				
	Malyango				
	Siangwaze				
RGCs by SHS	Nguba	Mwerya	Muwezwa		Sinde
		Mundoza	Makunku		Ngwezi Matakai
		Simulongo	Banamwaze		
		Nzala			
	Chaposwa				

**Table 14-6 Electrification Priority of Project Packages by Province (10/12)  
Southern Province (2/2)**

Provincial Ranking	16	17	18	19	20
Substation	Muzuma	Muzuma	Chilundu	Victoria Falls	Muzuma
District	Choma	Choma	Siavonge	Livingstone	Choma
RGCs by DL	Luyaba	Kanchomba	Munyama	Manyemunyemu	Kasukwe
	Kanchele	Moyo	Sikoongo	Siadazya	Kabimba
		Singani	Gwena	Kasiya	
		Mukamunga	Chaanga	Zangala	
		Manyati	Siaryoolo	Siambebele	
		Gamela	Namoomba	Natebe	
			Malengo	Katapazi	
			Ibbwemunyama	Sichilore	
RGCs by SHS			Syangwemu	Simwizi	
			Dibbwi		Nachanowe

Provincial Ranking	21
Substation	Maamba
District	Sinazongwe
RGCs by DL	Kabanga
	Napatizya
	Muuka
	Siameja
	Dengeru
	Masuku
	Mweemba
	Kafwambila
	Siansalama
	Namafulu
Siatwiinda	
Chilele	
Sulwegonde	
RGCs by SHS	Ngoma

**Table 14-6 Electrification Priority of Project Packages by Province (11/12)  
Western Province (1/2)**

Provincial Ranking	1	2	3	4	5
Substation	Senanga	Mongu 2	Mongu 2	Mongu	Senanga
District	Senanga	Senanga	Senanga	Mongu	Senanga
RGCs by DL	Lui-mwemba	Sinunga	Nalolo	Nangula	Ngundi
	Liangati	Liliachi	Nangucha	Ikabako	Silumbi
		Nasilimwe	Kataba	Kaande	Songa
		Nasilimwe	Sianda	Mawawa	
				Mweeke	
			Siwa		
			Namitone		
RGCs by SHS		Sumi	Nangoma		

Provincial Ranking	6	7	8	9	10
Substation	Senanga 3	Kaoma	Kalabo	Mongu	Senanga 2
District	Senanga	Kaoma	Kalabo	Mongu	Shangombo
RGCs by DL	Nande	Kazabami	Makuku	Kasheke	Mulele
	Sitoti	Kalumwange	Sishekanu	Likutwe	Mutomena
	Beshe	Shitwa	Lwanda	Ikwiichi	
	Matebele	Namaloba	Mbanga	Ushaa	
	Namatoya		Nangili	Sitoya	
			Mombo		
			Sikusii		
RGCs by SHS		Kabapupu	Malasha		
			Liuwa		
			Mishuwundu		
			Kuuli		
			Munde		
		Mulinga			
		Likapai			

Provincial Ranking	11	12	13	14	15
Substation	Senanga 3	Kalabo	Senanga 2	Mongu 1	Kaoma
District	Senanga	Kalabo	Shangombo	Mongu	Kaoma
RGCs by DL	Likondwana	Ndau	Nangweshi	Mukangu	Shinono
	Kalengola	Kama	Kaania	Luandui	Namilaugi
	Kaunga Lueti	Ngangu	Sioma	Nalikwanda	Longe
	Keyana	Tapo	Palace	Nakato	Mukandamina
	Namono	Mulundumano		Kalundwans	Kankwanda
			Lukweta	Nkeyama	
			Simulumbe		
RGCs by SHS		Mwandi		Litawa	Shishamba
		Lulambo		Liande	Kalale
				Namengo	Lombelombe
					Chiluli
					Mimpongo
				Kandende	
				Nionjolo	

Provincial Ranking	16	17	18	19	20
Substation	New SS at Lukulu	Mongu 1	Senanga	Sesheke	New SS at Lukulu
District	Lukulu	Mongu	Senanga	Sesheke	Lukulu
RGCs by DL	Lukulu Township	Kaba Hill	Namabuka	SITULU	Simakumba
	Mwanambuyu	Kaungeta	Mata	Mwandi	Namayula
	Mwito	Lukalanys	Mwanamwalye	Katima	Mitete
	Lishuwa	Miulwe	Sibukali	Mabumbu	Kakulunda
	Winda	Nalwei		Lusinina	
	Muyondoti	Ndondo		Lipumpu	
	Kawaya	Nasange			
	Lukau	Nandombe			
	Naimbu	Loona			
	Ndanda				
RGCs by SHS					Watopa
					Kakwacha
					Lupui
				Chinorwe	

**Table 14-6 Electrification Priority of Project Packages by Province (12/12)  
Western Province (2/2)**

Provincial Ranking	21	22	23	24	25
Substation	Senanga 1	Kaoma	Kalabo	Kaoma	Sesheke 1
District	Shangombo	Kaoma	Kalabo	Kaoma	Sesheke
RGCs by DL	Shangombo	Luamba	Tuuwa	Mayukwayukwa	Magumwi
	Kaunga Mashi	Kahokoto	Sikongo	Kapili	Sichili
	Sipuma	Kafunda	Liumba	Mangango	Loazamba
	Natukoma	Mushiwala	Liumena	Naliele	Bwina
	Nambolomoka	Mbanyutu	Siluwe	Lukena	Mulobezi
		Nkenga	Kalumbu	Lyamunale	
		Namasheshe	Loke West	Nyango	
		Mukunkiki	Salunda		
		Lubuka	LULANUNYI		
		Lui	Nyengo		
RGCs by SHS		Nyambi 2	Mbalala		Senamba
		Afumba	Muyumbana		Mushukula
		Nakayembe	Namatindi		Kasompa
		Namando	Kalenga		
		Mulwa	Lutwi		
			Sihole		
		Lueti			

Provincial Ranking	26
Substation	Sesheke 2
District	Sesheke
RGCs by DL	Nawinda
	Luampungu
	Siniembela
	Lusu
	Imusho
	Ngweze
	Mazaba
	Silumbu
Kalobolelwa	
RGCs by SHS	

Table 14-9 Annual Project Phases by 2030 (1/2)

Annual Project Phase	FIRR Ranking	Substation	Province	Feeder & Package	Project Package Cost (US\$)	Cumulative Cost (US\$)	Project Package FIRR	Project Package FIRR
2009	1	Isoka	Northern	1 - 1	1,663,395	1,663,395	22.0%	59.9%
	2	Azele	Eastern	2 - 2	1,899,936	3,563,331	20.6%	57.5%
	3	Kapiri Mposhi	Central	2 - 2	2,701,298	6,264,627	18.1%	50.2%
	4	Kansunswa	Copperbelt	1 - 8	4,522,824	10,787,451	13.2%	35.1%
	5	Azele 2	Eastern	2 - 1	2,598,212	13,383,663	12.1%	34.1%
	6	Azele	Eastern	1 - 2	1,808,120	14,991,783	12.0%	33.9%
	7	Azele 3	Eastern	1 - 2	3,388,392	18,380,175	11.5%	32.4%
	8	Isoka	Northern	2 - 1	1,991,449	20,371,624	11.0%	29.5%
	9	Azele 1	Eastern	1 - 5	3,800,612	23,972,236	11.0%	31.1%
	10	Ndola 1	Copperbelt	1 - 4	3,875,872	27,847,908	10.8%	29.5%
	11	Lundazi	Eastern	3 - 2	2,733,588	30,381,496	9.5%	26.1%
	12	Chipata	Eastern	2 - 2	4,897,181	35,078,677	9.2%	26.3%
	13	Mbereshi	Luapula	1 - 3	3,243,548	38,322,225	9.1%	22.2%
	14	Azele 5	Eastern	1 - 3	7,189,452	45,511,677	8.7%	25.6%
	15	Kasama 1	Northern	1 - 2	4,821,185	50,132,862	8.7%	24.9%
2010	16	Senanga	Western	1 - 1	2,148,932	52,279,794	8.5%	23.3%
	17	Mbereshi	Luapula	2 - 1	1,854,468	54,134,262	8.4%	23.9%
	18	Kitwe	Copperbelt	1 - 3	2,637,930	56,772,192	8.2%	22.6%
	19	Azele 2	h	1 - 3	4,538,180	61,310,352	8.2%	23.8%
	20	Luwingu	Northern	3 - 3	1,395,468	62,705,820	7.7%	23.2%
	21	Mpongwe	Copperbelt	3 - 2	2,129,151	64,834,971	7.6%	22.8%
	22	Mongu 2	Western	2 - 3	6,104,929	70,939,900	7.5%	22.1%
	23	Nchelenge	Luapula	1 - 4	2,452,620	73,392,520	7.5%	19.1%
	24	Azele 3	Eastern	2 - 1	2,509,598	75,902,118	7.5%	22.6%
	25	Azele 1	Eastern	2 - 2	4,684,662	80,586,778	7.1%	21.9%
	26	Mongu 2	Western	1 - 3	4,321,732	84,908,511	7.1%	20.9%
	27	Mumbwa	Central	1 - 3	2,718,738	87,627,248	7.0%	21.3%
	28	Nchelenge	Luapula	2 - 4	4,452,947	92,080,198	6.8%	19.1%
29	Nakonde	Northern	1 - 2	4,141,237	96,221,433	6.7%	16.6%	
30	Mongu	Western	1 - 4	3,890,700	100,112,133	5.9%	19.0%	
2011	31	Muzuma 2	Southern	2 - 1	3,703,968	103,816,101	5.6%	17.7%
	32	Luwingu 3	Northern	2 - 5	4,202,498	108,018,597	5.5%	17.4%
	33	Samfya 2	Luapula	2 - 2	2,752,596	110,771,193	5.0%	14.4%
	34	Luano	Copperbelt	1 - 3	2,671,892	113,443,084	4.9%	15.5%
	35	Mbereshi 1	Luapula	2 - 5	6,873,037	120,316,122	4.9%	15.2%
	36	Mbala	Northern	2 - 4	7,860,327	127,976,449	4.8%	17.1%
	37	Pensulo	Central	1 - 1	599,616	128,576,065	4.6%	13.7%
	38	Msoro	Eastern	1 - 1	1,486,296	130,062,361	4.6%	14.4%
	39	Azele 4	Eastern	2 - 3	5,708,616	135,770,977	4.6%	16.4%
	40	Kabwe 1	Central	1 - 3	4,443,228	140,214,205	4.5%	16.0%
	41	Solwezi	North-Western	1 - 1	3,196,692	143,410,897	4.5%	16.3%
	42	Senanga	Western	3 - 3	4,424,004	147,834,901	4.4%	15.6%
2012	43	Luwingu 2	Northern	2 - 5	6,526,008	154,360,909	4.4%	16.3%
	44	Victoria Falls	Southern	3 - 1	3,027,377	157,388,288	4.4%	16.0%
	45	Kabwe 2	Central	1 - 2	5,905,008	163,293,294	4.3%	15.9%
	46	Luano	Copperbelt	2 - 4	3,294,598	166,587,893	4.3%	13.8%
	47	Senanga 3	Western	1 - 2	5,513,598	172,101,311	4.2%	15.2%
	48	Ndola	Copperbelt	1 - 3	4,725,756	176,827,067	4.1%	14.6%
	49	Kitwe	Copperbelt	2 - 3	3,237,335	180,064,402	4.0%	11.9%
	50	Samfya 1	Luapula	2 - 3	4,234,788	184,299,190	3.9%	13.2%
	51	Samfya	Luapula	1 - 1	1,580,313	185,879,504	3.7%	14.6%
	52	Muzuma 1	Southern	2 - 1	4,833,777	190,713,281	3.6%	14.0%
	53	Mwinilunga 1	North-Western	1 - 0	5,725,580	196,438,861	3.6%	14.5%
2013	54	Mporokoso	Northern	2 - 8	7,404,372	203,843,233	3.6%	14.3%
	55	Kawambwa Tea	Luapula	1 - 6	5,397,673	209,240,908	3.5%	10.4%
	56	Mbereshi 1	Luapula	1 - 3	5,025,126	214,266,031	3.4%	12.7%
	57	Samfya 2	Luapula	1 - 3	4,748,220	219,014,251	3.3%	12.4%
	58	Kaoma	Western	4 - 2	3,789,420	222,782,671	3.2%	13.4%
	59	Nampundwe	Central	1 - 5	6,848,699	229,631,370	3.1%	13.2%
	60	Luwingu 1	Northern	1 - 5	7,400,916	237,032,288	2.9%	13.2%
	61	Isoka	Northern	3 - 2	4,738,824	241,771,110	2.9%	12.9%
	62	Kasama 2	Northern	1 - 4	7,680,980	249,452,070	2.8%	12.3%
2014	63	Kalabo	Western	1 - 3	6,835,774	256,287,844	2.7%	13.0%
	64	Muzuma 3	Southern	1 - 3	4,332,980	260,620,804	2.7%	12.1%
	65	Pensulo 1	Central	2 - 5	5,348,756	265,969,560	2.7%	12.5%
	66	Luwingu 3	Northern	1 - 3	3,819,528	269,787,088	2.6%	13.0%
	67	Lundazi	Eastern	1 - 2	4,265,265	274,052,353	2.3%	11.5%
	68	Mongu	Western	2 - 5	7,319,376	281,371,729	2.3%	12.3%
	69	Nchelenge 1	Luapula	1 - 3	4,821,120	286,192,849	2.3%	10.1%
	70	Luwingu	Northern	1 - 4	7,722,972	293,915,821	2.2%	12.3%
	71	Senanga 2	Western	2 - 2	2,739,744	296,655,565	2.2%	11.8%
2015	72	Kabwe	Central	2 - 5	6,458,570	303,114,135	2.1%	11.5%
	73	Senanga 3	Western	2 - 3	7,618,538	310,732,671	2.1%	11.6%
	74	Kapiri Mposhi	Central	1 - 6	5,897,794	316,630,374	2.0%	11.0%
	75	Kalabo	Western	2 - 1	3,560,455	320,180,829	1.8%	11.4%
	76	Senanga 2	Western	1 - 3	3,328,452	323,509,281	1.8%	10.2%
	77	Mporokoso	Northern	1 - 5	4,094,712	327,603,993	1.7%	10.6%
	78	Muzuma 1	Southern	1 - 4	7,543,883	335,147,858	1.7%	10.1%
	79	Mongu 1	Western	1 - 4	9,228,684	344,376,540	1.6%	11.1%
	80	Lundazi 1	Eastern	1 - 3	4,215,024	348,591,564	1.5%	10.8%
2016	81	Kaoma	Western	1 - 2	5,340,384	353,931,948	1.5%	8.5%
	82	Mazabuka	Southern	1 - 3	4,470,646	358,402,594	1.5%	3.5%
	83	Luwingu 2	Northern	1 - 5	7,825,988	366,028,582	1.5%	11.0%
	84	Mfuwe 1	Eastern	1 - 5	4,998,989	371,025,571	1.5%	10.7%
	85	Solwezi	North-Western	2 - 4	2,863,712	373,889,283	1.5%	10.4%
	86	Kafue Town	Lusaka	1 - 3	1,582,832	375,271,915	1.5%	9.2%
	87	Mumbwa	Central	3 - 4	6,012,576	381,284,491	1.3%	10.2%
	88	Lundazi	Eastern	2 - 7	8,256,276	389,540,767	1.2%	9.1%
	89	Isoka 1	Northern	1 - 1	4,828,988	394,369,755	1.2%	8.5%
	90	Muzuma 3	Southern	2 - 6	5,251,284	399,421,039	1.1%	8.4%

**Table 14-9 Annual Project Phases by 2030 (2/2)**

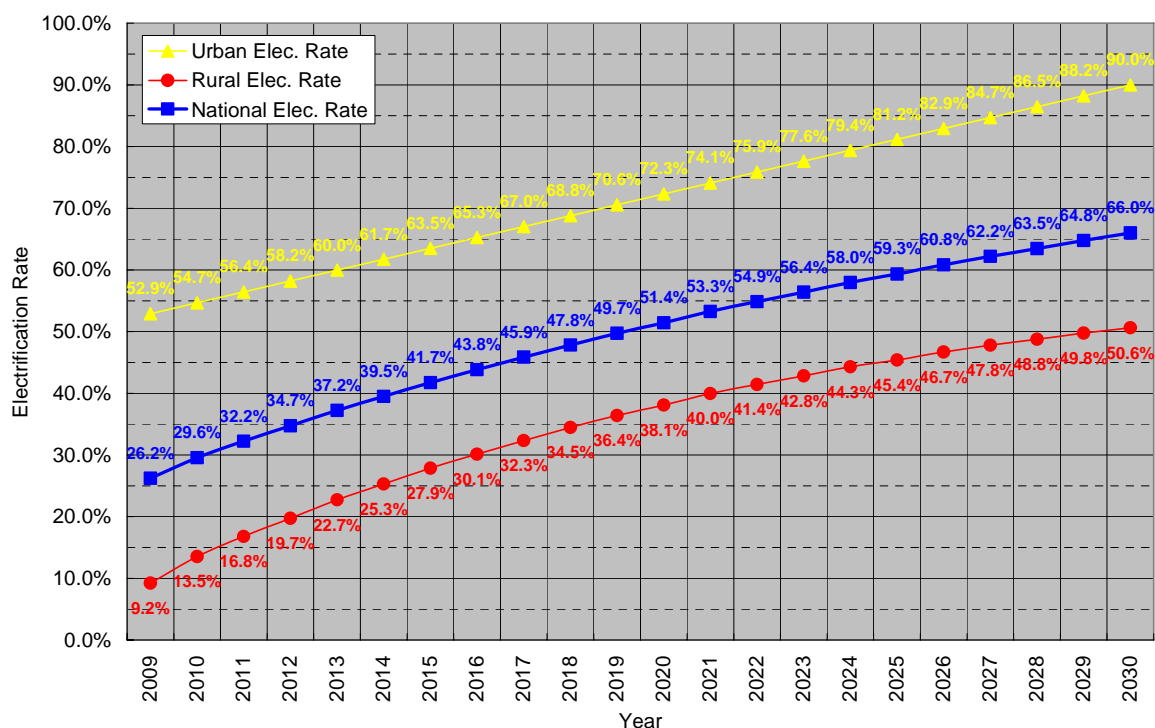
Annual Project Phase	FIRR Ranking	Substation	Province	Feeder & Package	Project Package Cost (US\$)	Cumulative Cost (US\$)	Project Package FIRR	Project Package EIRR
2017	91	Luano 2	Copperbelt	1 - 5	6,576,303	405,999,342	1.1%	6.8%
	92	Isoka 1	Northern	2 - 1	4,419,792	410,419,134	1.1%	9.8%
	93	Azile 4	Eastern	1 - 4	11,500,056	421,919,190	1.0%	10.1%
	94	New SS at Lukulu	Western	1 - 5	6,474,976	430,394,166	1.0%	6.9%
	95	Mongu 1	Western	2 - 6	10,201,660	440,595,848	1.0%	10.2%
	96	Mpika	Northern	1 - 1	1,760,200	442,356,048	0.9%	9.6%
	97	Mkushi	Central	1 - 7	6,928,735	449,284,783	0.6%	7.1%
2018	98	Nchelenge 1	Luapula	2 - 4	7,165,648	456,440,438	0.6%	8.3%
	99	Luwingu	Northern	2 - 5	7,468,756	463,909,194	0.7%	9.7%
	100	Mhuve	Eastern	1 - 3	7,816,826	471,726,020	0.6%	9.8%
	101	Mazabuka 1	Southern	2 - 6	6,056,668	477,782,688	0.6%	7.7%
	102	Maposa	Copperbelt	2 - 4	3,617,136	481,400,824	0.4%	8.1%
	103	Chinsali	Northern	2 - 1	2,330,585	483,731,411	0.4%	6.3%
	104	Senanga	Western	2 - 3	5,619,172	489,350,583	0.4%	9.7%
2019	105	Kasama	Northern	2 - 6	7,077,132	496,427,715	0.4%	8.5%
	106	Kasama	Northern	1 - 3	5,713,510	502,141,225	0.3%	8.7%
	107	Mpika	Northern	2 - 3	5,137,329	507,278,554	0.3%	8.4%
	108	Mpika	Northern	3 - 1	3,998,616	511,277,170	0.0%	8.2%
	109	Azile 0	Eastern	2 - 2	3,700,780	515,000,000	0.0%	8.4%
	110	Maposa	Copperbelt	1 - 6	9,191,420	524,191,420	-0.3%	7.3%
	111	Chipili	Luapula	1 - 4	4,431,563	528,622,983	-0.4%	6.4%
2020	112	Mumbwa	Central	2 - 3	4,442,904	533,065,887	-0.5%	5.7%
	113	Mpika 1	Northern	1 - 2	7,672,860	540,738,747	-0.5%	7.3%
	114	Kitwe	Copperbelt	3 - 6	7,121,331	547,860,078	-0.7%	4.7%
	115	Sesheke	Western	1 - 4	8,665,009	556,525,087	-0.7%	6.4%
	116	Chilundo	Southern	1 - 3	3,654,055	560,179,142	-0.8%	6.1%
	117	Azile 6	Eastern	1 - 3	7,260,641	567,439,783	-0.8%	7.3%
	118	Mkushi Farm Block	Central	1 - 5	7,627,920	575,067,703	-0.8%	6.1%
2021	119	Chipata	Eastern	1 - 4	6,646,664	581,714,367	-0.8%	6.8%
	120	Fensulo 1	Central	1 - 4	5,382,160	587,096,527	-0.9%	7.1%
	121	Mazabuka 1	Southern	3 - 9	6,448,246	593,544,773	-1.0%	6.1%
	122	Muzuma 2	Southern	1 - 4	7,909,413	601,454,186	-1.0%	7.0%
	123	Chinsali	Northern	3 - 1	1,624,740	603,078,926	-1.0%	6.4%
	124	New SS at Kabompo	North-Western	2 - 6	11,871,020	615,000,017	-1.1%	6.7%
	125	New SS at Lukulu	Western	2 - 2	7,012,140	622,012,157	-1.2%	6.1%
2022	126	Sinazongwe	Southern	1 - 8	6,081,434	628,093,591	-1.3%	4.6%
	127	Kabwe	Central	1 - 7	6,667,012	634,760,603	-1.3%	6.1%
	128	New SS at Zambezi	North-Western	2 - 2	5,702,795	640,463,398	-1.6%	6.3%
	129	Zambezi 1	North-Western	1 - 4	6,833,935	647,297,333	-1.6%	6.3%
	130	New SS at Mwinilunga	North-Western	4 - 0	8,688,211	655,985,544	-2.0%	4.6%
	131	New SS at Zambezi	North-Western	1 - 6	11,189,609	667,175,153	-2.2%	4.7%
	132	Luano 1	Copperbelt	1 - 4	4,613,690	671,788,843	-2.4%	3.4%
2023	133	Samfya 1	Luapula	1 - 6	6,764,040	678,552,883	-2.4%	4.1%
	134	Muzuma 1	Southern	3 - 1	3,025,234	681,578,117	-2.4%	4.6%
	135	Fensulo 2	Central	2 - 2	13,040,814	694,618,931	-2.5%	4.8%
	136	Mpongwe	Copperbelt	2 - 1	1,797,786	696,416,717	-2.6%	4.1%
	137	Senanga 1	Western	1 - 4	17,644,170	714,060,887	-2.6%	4.6%
	138	Fensulo 2	Central	1 - 6	10,138,284	724,200,171	-2.6%	4.4%
	139	Luano 1	Copperbelt	2 - 4	6,293,806	730,493,977	-2.9%	3.0%
2024	140	New SS at Chilundo	Luapula	2 - 1	12,035,162	742,529,139	-2.9%	2.9%
	141	Covertry	Lusaka	1 - 4	5,693,913	748,223,052	-3.0%	2.2%
	142	Mpika 2	Northern	1 - 3	9,631,704	757,854,756	-3.1%	4.0%
	143	Kaoma	Western	2 - 3	9,098,247	766,953,003	-3.1%	3.4%
	144	Mpika 1	Northern	2 - 3	11,880,690	778,833,693	-3.4%	3.2%
	145	Mazabuka 1	Southern	1 - 4	4,611,924	783,445,617	-3.5%	2.4%
	146	New SS at Mwinilunga	North-Western	3 - 2	3,620,916	787,066,533	-3.5%	3.1%
2025	147	New SS at Mwinilunga	North-Western	2 - 4	9,069,892	796,136,425	-3.6%	3.1%
	148	New SS at Mwinilunga	North-Western	1 - 1	20,302,796	816,439,221	-3.9%	0.4%
	149	Fig Tree	Central	1 - 6	7,550,211	823,989,432	-3.9%	1.6%
	150	Leopard's Hill	Lusaka	1 - 11	12,060,904	836,050,336	-4.0%	2.5%
	151	Senene	Central	1 - 3	7,325,532	843,375,868	-4.2%	2.4%
	152	Victoria Falls	Southern	2 - 4	5,482,320	848,858,188	-4.2%	0.9%
	153	New SS at Mufumbwe	North-Western	1 - 7	13,926,801	862,784,989	-4.5%	1.4%
2026	154	Kalabo	Western	2 - 5	16,693,051	879,478,040	-5.0%	2.1%
	155	Kaoma	Western	3 - 3	10,689,516	890,167,556	-5.1%	0.8%
	156	Mpongwe	Copperbelt	1 - 6	6,733,023	896,900,579	-5.1%	1.7%
	157	Muzuma	Southern	2 - 2	4,124,629	901,025,208	-5.3%	1.5%
	158	Kasempa	North-Western	2 - 4	6,904,406	907,929,614	-5.3%	0.2%
	159	Chipili	Luapula	2 - 2	6,344,891	914,274,505	-6.0%	0.7%
	160	Solwezi	North-Western	3 - 5	10,115,604	924,390,109	-6.0%	0.5%
2027	161	Isoka 1	Northern	3 - 1	5,762,340	930,152,449	-6.0%	0.7%
	162	Sesheke 1	Western	1 - 5	13,319,639	943,472,088	-6.0%	0.1%
	163	Muzuma	Southern	1 - 5	5,251,740	948,723,828	-6.1%	-0.7%
	164	Mansa	Luapula	2 - 3	1,822,519	950,546,347	-6.1%	-2.5%
	165	Chilundo	Southern	2 - 8	6,734,500	957,280,847	-6.5%	-0.2%
	166	Victoria Falls	Southern	1 - 5	3,954,312	961,235,159	-6.6%	-3.1%
	167	New SS at Mufumbwe	North-Western	1 - 2	5,636,492	966,871,651	-6.8%	0.0%
2028	168	New SS at Chavuma	North-Western	1 - 8	6,768,591	973,640,242	-7.0%	-1.7%
	169	Muzuma	Southern	3 - 1	3,063,260	976,703,502	-7.0%	-0.6%
	170	New SS at Kabompo	North-Western	1 - 4	11,623,500	988,327,002	-7.0%	-1.9%
	171	New SS at Chama	Eastern	2 - 5	11,377,600	1,000,000,000	-7.0%	-0.1%
	172	New SS at Chama	Eastern	1 - 3	14,667,712	1,014,667,712	-7.6%	-1.3%
	173	Chinsali	Northern	1 - 4	9,725,076	1,024,392,788	-7.6%	-2.6%
	174	New SS at Chilundo	Lusaka	1 - 1	5,826,784	1,030,219,572	-8.1%	-1.1%
2029	175	New SS at Nyimba	Eastern	1 - 6	6,670,917	1,036,890,489	-8.2%	-4.4%
	176	Kasempa	North-Western	1 - 4	3,434,849	1,040,325,338	-8.7%	-3.0%
	177	Maamba	Southern	1 - 8	15,171,571	1,055,496,909	-9.6%	-3.6%
	178	Sesheke 2	Western	1 - 4	21,645,000	1,077,141,909	-10.2%	-2.7%
	179	Mansa	Luapula	1 - 5	9,269,414	1,086,411,323	-12.6%	-5.6%
	180	Mbala	Northern	1 - 2	6,590,154	1,092,999,228	-13.1%	-4.2%

### 14.6. Targeting Electrification Rate in 2030

As shown in Table 14-10, the household electrification rate in 2006 is 20.4% nation-wide, being 47.6% in the urban areas and 3.1% in the rural areas (data from *Living Conditions Monitoring Survey Report 2004, Central Statistical Office, December 2006*). As of 2006, the number of households in 1,217 RGCs targeted in the master plan is 535,717, accounting for 23.4% in the national total, and this will be 1,067,729 in 2030. By 2030, DoE, REA and ZESCO aim to achieve household electrification rate 90% in the urban areas, 100% in 1,217 RGCs in the Master Plan, and 20% in the rural areas outside the 1,217 RGCs. Based on these targets, a household electrification rate of 66.0% in the nation-wide will be achieved in 2030, in which the rural electrification rate will be 50.6%. The growth of household electrification rates in urban areas, rural areas, and nation-wide during the Master Plan period are shown in Figure 14-4. The cumulative number of electrified RGC and rural electrification rate by 2030 are also shown in Figure 14-5. Figure 14-6 shows the rural electrification map of 1,217 RGCs with their electrification modes.

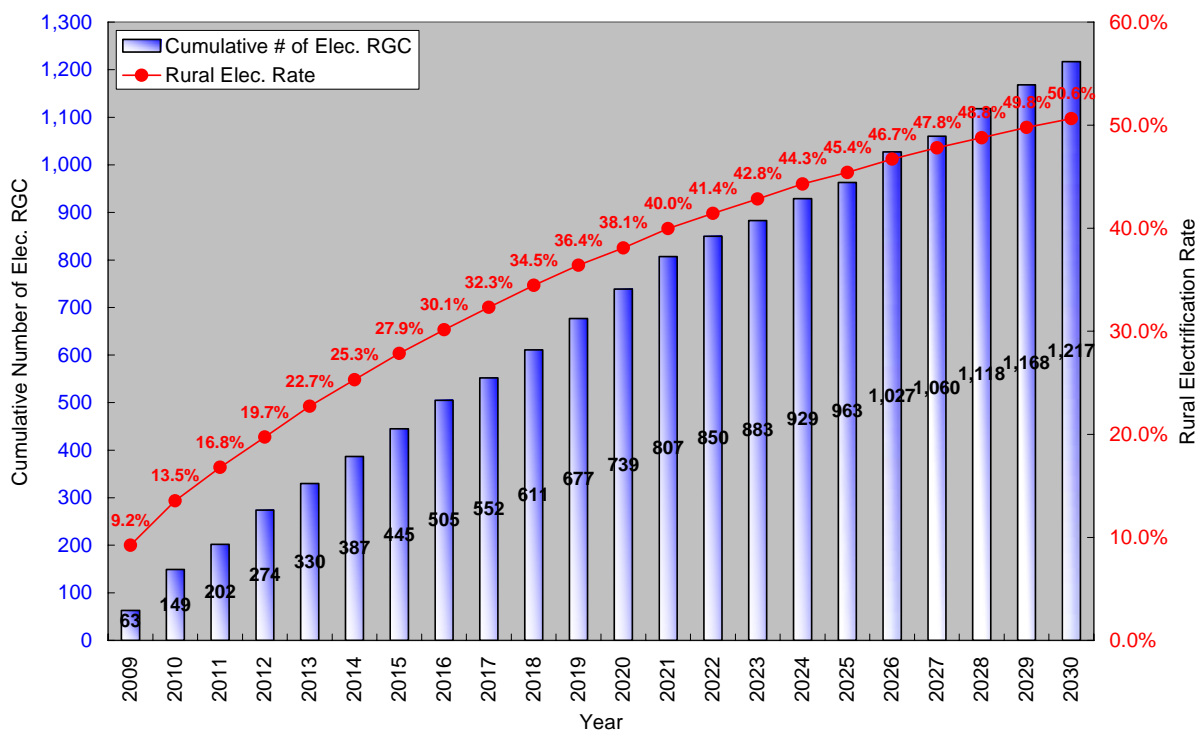
**Table 14-10 Targeting Electrification Rate in 2030**

	2006				2030		
	# of HH	HH Ratio	# of Elec. HH	Elec. Rate	# of HH	# of Elec. HH	Elec. Rate
Urban	896,234	(39.0%)	426,608	47.6%	1,779,880	1,601,892	90.0%
Rural	1,403,408	(61.0%)	43,506	3.1%	2,787,102	1,411,604	50.6%
a) 1,216RGCs	535,717	(23.4%)	0	-	1,067,729	1,067,729	100.0%
b) Others	867,691	(37.6%)	43,506	3.1%	1,719,373	343,875	20.0%
<b>Total</b>	<b>2,299,642</b>	<b>(100.0%)</b>	<b>470,113</b>	<b>20.4%</b>	<b>4,566,982</b>	<b>3,013,496</b>	<b>66.0%</b>

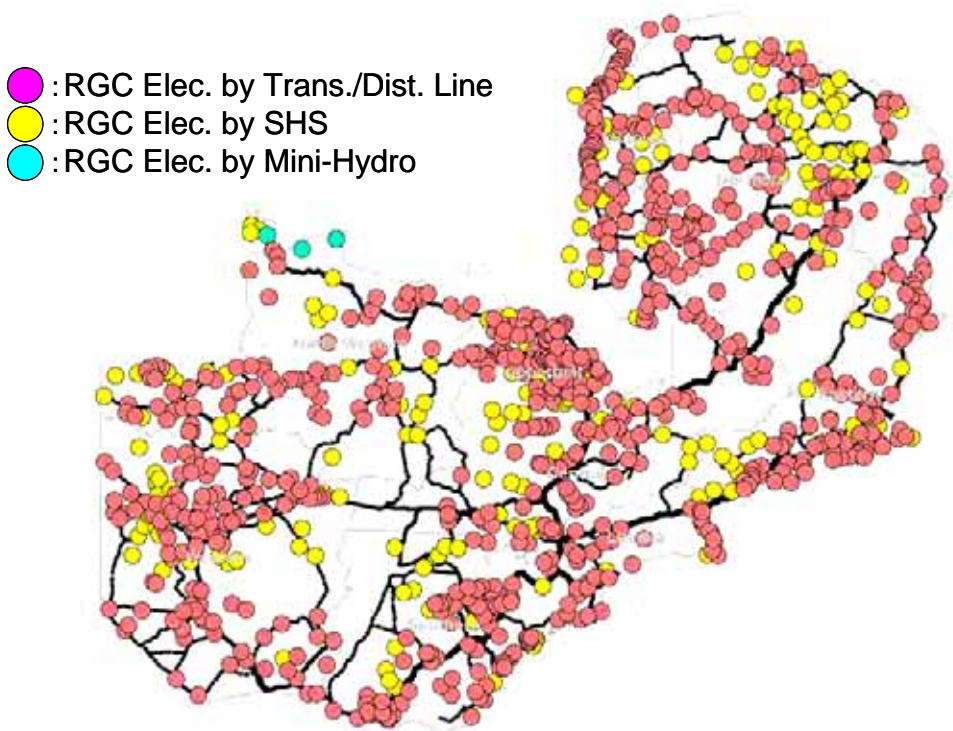


**Figure 14-4 Transition of Household Electrification Rates by 2030**





**Figure 14-5 Transition of Cumulative Number of Electrified RGCs and Rural Electrification Rate by 2030**



**Figure 14-6 Rural Electrification Map in 2030**

## **Chapter 15**

### **Conclusion and Recommendation**

## Chapter 15. Conclusion and Recommendation

### 15.1. Conclusion

In this Study, the Rural Electrification Master Plan up to 2030 was developed. In the process of “Technical Aspect Analysis”, the “Decentralized Planning Process” was adopted to identify 1,217 RGCs in rural areas as the electrification target. Next, “Demand Criteria (or potential daily maximum demand in each RGC)” and “Supply Criteria (or the “Unit Life Time Cost in Net Present Value”)” were used to cluster (or group) 1,217 RGCs into 180 Project Packages, and to select the optimal electrification mode (among transmission/distribution extension, SHS, mini-hydro, and diesel generator) for each of the 1,217 RGCs. Then, based on the estimated cost for each Project Package, the final electrification priority of 1,217 RGCs in 180 Project Packages was determined by Financial Indicator (FIRR). Finally, these 180 Project Packages were grouped into 22 Annual Project Phases up to 2030, by the uniform annual project cost.

As a part of the Technical Aspect Analysis, Case Study (or pre-feasibility study level survey) was carried out. Among 29 potential mini-hydro development sites explored in Northern, Luapula, North-western, and Western Provinces, the Case Studies were executed at 2 sites: Chilambwe Falls Site in Northern Province and Mujila Falls Lower Site in North-western Province. At these two mini-hydro Case Study sites, Socio Environmental Surveys were also executed and Project Briefs were prepared. The Case Studies for transmission/distribution extension were also executed at 3 sites: Kabwe in Central Province, Luangwa in Lusaka Province, and Mazabuka in Southern Province.

In addition, Socio Economic Survey was carried out, in the process of “Social Aspect Analysis.” In the Socio Economic Survey, data were collected more than 1,300 interviewees in 90 RGCs: 71 unelectrified and 19 electrified RGCs. Based on the data collected in the Socio Economic Survey, the ability to pay, willingness to pay, and prioritized property for electrification were analyzed, and these results were used as basic information to elaborate policy recommendation with the involvement of Stakeholders.

The Study combined the outputs from the Technical and the Social Aspect Analysis, to develop a Comprehensive Rural Electrification Program. The development process of the Master Plan was subject of discussion with International Development partners, such as Japanese Bank for International Cooperation (JBIC), African Development Bank (AfDB), Development Bank for Southern Africa (DBSA) and World Bank (WB). As a result, the Development Partners have shown interest in financing the rural electrification projects in Zambia, and JBIC started considering providing Yen-Loan as a co-finance with WB, to realize this Master Plan.

Initial findings, results and outputs of this Study are as follows:

- 1) 1,217 Unelectrified RGCs were clustered (or grouped) into 180 Project Packages. The electrification priority order of 180 Project Packages, the optimal electrification mode for each of 1,217 RGCs, and the 22 Annual Project Phases up to 2030 are shown in Table 14-5, 14-6, and 14-9 respectively.
- 2) Although not many Project Packages’ FIRR are attractive, considerable number of Project Packages show reasonable EIRR.
- 3) US\$ 1,103 million is required to realize all 180 Project Packages (including 1,217 RGCs) by 2030. This means approximately US\$ 50 million per year is needed from 2008 to 2030.
- 4) The target household electrification rate is set as 66.0% nation-wide, requiring a rate of 50.6% for the rural areas. This is achievable if DoE, REA and ZESCO success to increase the household electrification rate at 90% in the urban areas, 100% in 1,217 RGCs in the Master Plan, and 20% in the rural areas other than 1,217 RGCs by 2030 (refer to Table 14-10). It is essential that the Zambian Government makes appropriate investment to the rural electrification projects in the

Master Plan to meet these targets.

- 5) Since the annual amount of Rural Electrification Fund (REF) is much less than the required project cost to realize the Master Plan, in addition to making effort to increase the REF, utilization of the low interest loan from the international donors should be necessary.
- 6) In the nation wide, 241 RGCs are identified as Solar Home System Market.
- 7) Although a lot of mini-hydro potential sites exist in Zambia, only 3 sites (Mujila Falls Lower, Upper Zambezi, and West Lunga in North-western Province) were financially feasible.
- 8) Unelectrified households and business entities pay considerable amount of money to meet their needs using alternative energy sources (K59,141 and K75,315 respectively). In 2006, the estimated ability to pay for electricity monthly bill for households and business entities are K35,485 and K60,252 respectively.
- 9) The connection fee charged in rural areas by ZESCO (K2,873,000 for 1 Phase and K4,887,000 for 3 Phase) was much higher than the rural households' ability to pay (average monthly income by K910,757) and willingness to pay (K2,508,483).
- 10) Duration (usable daily hours of electricity) was the most important factor for unelectrified residents, compared to Urgency (years until electrified), Monthly Fee, and Connection/Initial Fee. Although 24 hours usage per day was the most preferred, unelectrified residents were eager to use electricity even for 5 hours per day (such as by SHS).

## **15.2. Recommendation**

### **15.2.1. Practical Use of Master Plan**

Although the final electrification priority of Project Packages were determined by Financial Indicator (FIRR) in the Master Plan, the priority should be modified in practice and updated by taking into account the opinions of Zambian Government and Financial Organization, such as in the financial coordination with International Development Partners. For example, Zambian Government may wish to pay attention to the balance of development among areas/Provinces. Some of Financial Organizations may also wish to apply some project selection criteria as their loan conditions. Therefore, the staff members of DoE and REA need skills to merge the new criteria with the original Master Plan in a flexible way. Such skills and techniques could be transferred under the JICA Technical Cooperation Project scheduled to commence in 2008.

Since financial evaluation for SHS portion in each Project Package was excluded in the Master Plan, International Donors may not be willing to provide financial assistance for SHS projects. They may, for instance, wish to finance a Project Package with high priority ranking but excluding RGCs electrified by SHS in a Package. Even in such a case, however, maintaining an electrification priority order of SHS portion according to the priority of a Project Package, by providing subsidy utilising Rural Electrification Fund (REF) for SHS installation to households and business entities, is suggested. Regarding public facilities (such as school and hospital/clinic) in RGCs electrified by SHS, the installation cost is assumed to be provided from the Government Authorities (such as Ministry of Education and Ministry of Health).

### **15.2.2. Management of Rural Electrification Fund**

The REF as currently funded is not sufficient to implement the Master Plan, and thus measures are needed to increase REF and methods of efficient and effective utilization of funds need to be considered. Firstly, the Zambian Government should allocate an adequate budget every year toward the REF as it does for other infrastructures, such as health and road sector. Secondly, the Rural Electrification Levy should be charged to the mining sector (which consumes 50% of the national total) and to the export of electricity. At the time of writing, it was uncertain what percentage of

levy should be charged to the mining sector, other industries and electricity export, but the Zambian Government was considering 5% electricity levy for them as a measure towards social responsibility, while the levy by the domestic consumers would remain at 3%. Thirdly, the REF needs to be efficient and effective in its management in order to ensure that the program runs smoothly. Such measures are also likely to attract the interest of Development Partners. Therefore, more transparency, accountability and efficiency are required in the process of electrification project selection and utilization of the REF. Fourthly, the electrification levy should be paid directly to REA, not through the Ministry of Finance and National Planning. Otherwise, the possibility remains that the rural electrification levy will be used for other purposes by the Government (such as a general account budget). Finally, electrification facilities funded by the REF (such as mini-hydro, but exclude SHS) should be owned by either REA or ZESCO, and leased to other private companies or local communities for O&M, if necessary.

#### 15.2.3. Increase of Electricity Access Rate

A high initial connection fee is one of the hindrances to increase electricity access, even in areas where distribution line has been extended. The tariff charged by utility companies should be capital cost reflective and thus reduction of the initial connection fee should be considered. In addition, the payment of initial connection fee by the consumers to the electricity network should be spread over a period of 3 to 5 years.

Setting up a technical standard for appropriate low cost electrification method could also contribute to increase the electrification rate in rural areas. Moreover, exemption of import tax for equipments used for rural electrification gives the advantage of reduced project cost and connection fee.

Finally, to create a price competitive market, supporting capacity development and formation of new companies to undertake rural electrification business, such as construction and operation & maintenance is recommended.

#### 15.2.4. Supporting Sustainable Electrification Business in Rural Area

Development of local capacity in simple operation and maintenance of electricity systems, such as SHS and mini-hydro, through a mobile training program provided by DoE and REA could contribute to making the rural electrification business sustainable. Development of the mobile training programs could be supported by JICA Technical Cooperation Project scheduled to commence in 2008.

