# Chapter 9 Distribution plan

The Study Team prepared a plan for distribution system expansion by 2020 based on the results of the demand estimates and transmission plan formulation. This chapter is not a master plan for all areas of the Zambia and all distribution facilities as shown below.

## 9.1 Distribution plan subjects

Figure 9.1 and Table 9.1 show the power facilities that are subjects of the preparation of the distribution plan in this study, and definitions of the same, respectively. The specific distribution facilities[23] are as follows.

- 33 kV distribution lines from bulk supply points (BSPs[24]) to 33/11 kV substations.
- 33 kV distribution lines interconnecting 33/11 kV substations
- 33/11 kV substations

The subject areas in the study are Lusaka, Choma, Kafue, Livingstone, Mazabuka, Kapiri/Mkushi, Ndola, and Kitwe. The Kabwe, Chingola, and Luanshya areas, which were initially taken as subjects, were excluded from the subsequently planning because they do not contain any subject distribution facilities.

It was decided to prepare the plan for the period up to and including 2020. The 33/11 kV substations have a capacity of about 20 MVA at the most, and a planning period of about ten years was considered sufficient, as micro situational changes can have a substantial impact on the plan.

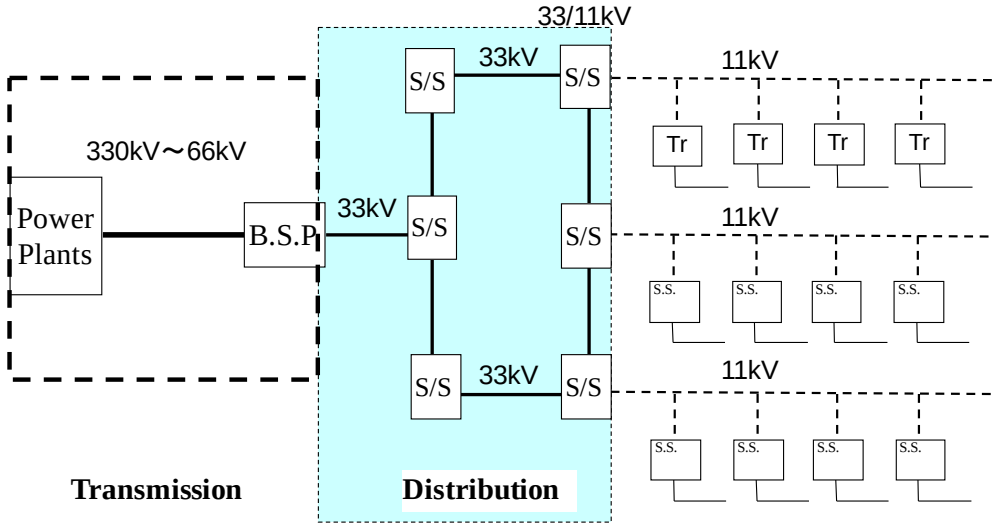


**Figure 9.1 Subject power facilities in the distribution plan**

[23] The list of subjects does not include 33 kV distribution lines directly supplying 33 kV customers, 11 kV distribution lines, and low-voltage distribution lines.

[24] Distribution substations supplying power to 33 kV distribution lines, equivalent to what are called secondary substations in Japan.

**Table 9.1 Definitions of subject power facilities in the distribution plan**

| Power facilities | Definitions |
|---|---|
| distribution line | - 33 kV lines from BSPs to 33/11 kV substations<br>- 33 kV lines interconnecting 33/11 kV substations |
| substation | - 33/11 kV substations |

## 9.2 Distribution plan standard

(1) System plan standard and analytical conditions

Table 9.2 shows the distribution plan standard in Zambia. The N-1 standard is in worldwide use, but is not applied in the distribution system in Zambia at present. The Study Team considered facility measures for satisfaction of the N-1 standard only in the case of the Lusaka area, which is important and has a large load. (The N-1 standard is grounded in the idea of preventing the failure of one of N number of facilities from disrupting the power supply from the remaining (N minus 1) facilities. The failure is assumed to be the failure of one distribution line or one transformer.)

**Table 9.2 System plan standard and analytical conditions**

| | | Description | |
|---|---|---|---|
| Thermal capacity | Normal times | No more than 100% of the normal power flow | |
| | Failure of one unit (N-1) | No more than 100% of the power flow in the event of a one-unit failure (applied only to the Lusaka area) | |
| Voltage | | Drop of no more than 5% at the end of the 33 kV distribution line | |
| System analysis | | System analysis program | PSS/E |
| | | Years of analysis | 2009 - 2020, except the study of single-unit failure (N-1), which will concern only 2020 and the Lusaka area |
| | | Power demand | Assumption of the power demand studied in Chapter 5 |
| | | System plan | Study based on existing ZESCO plans |

(2) Design standards

The study utilized the ZESCO design standards, as follows.

i) Power lines

(a) 33 kV overhead distribution lines

For overhead distribution lines, a selection is made from 50, 100, 150 $mm^2$ ACSR, in accordance with load capacity and the use of trunk and feeder line facilities. In heavy-load areas such as Lusaka, a selection is made of large-capacity conductors (e.g., 200, 300, or 350 $mm^2$ ACSR), in correspondence with the load capacity.

- Trunk lines: 100 or 150 $mm^2$ ACSR (350 $mm^2$ ACSR at maximum)
- Feeder(Branch) lines: 50 or 100 $mm^2$ ACSR

(b) 33 kV underground distribution lines

For underground distribution lines, a selection is made between 70, 120 $mm^2$ PICL, 185, or 240 mm2 XLPE, in accordance with the load capacity and the facility use of trunk and feeder lines. In heavy-load areas such as Lusaka, a selection is made of large-capacity conductors (e.g., 300 - 500 mm2 XLPE), in correspondence with the load capacity.

- Trunk lines: ordinarily 185 or 240 mm2 XLPE (500 mm2 XLPE at maximum)
- Feeder lines: ordinarily 70 or 120 mm2 PICL

ii) Supporting structures

The standard supporting structures in Zambia are wooden poles, which are used in light of their advantages in the aspects of procurement and cost. The standard length is 12 meters, but some poles with a length of more than 12 meters are used if the circumstances in the vicinity of distribution facilities demand it.

- Supporting structures: wooden poles, 12 m (16 m at maximum)

iii) Span distance

The span distances (between supporting structures) are as follows.

- Span distances: urban areas - 100 m, rural areas - 110 m (80 at minimum, 120 at maximum)

(3) Demand estimate results

Table 9.3 - Table 9.6 show the results of the demand estimates for each substation. The estimates of future demand for each substation were based on the demand estimates in Chapter 5. The table does not include an estimate for the demand iin the Lusaka South Multi-Facility Economic Zone (LS-MFEZ), which is slated for development in the southern

part of Lusaka, because it is not certain when this demand will emerge. However, facility formation was studied with consideration of a estimated demand equivalent to a final capacity of 14 MW beginning in 2015.

**Table 9.3 Demand estimate results for each substation (Lusaka area)**

Peak Demand (MW)

| Substation | 2008 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| Shorthorn | 13.8 | 15.0 | 19.4 | 25.3 |
| Makeni | 19.8 | 21.4 | 27.7 | 36.2 |
| Chilanga | 16.1 | 17.5 | 22.5 | 29.5 |
| Barlaston | 1.0 | 1.1 | 1.4 | 1.8 |
| Liverpool | 33.0 | 35.8 | 46.2 | 60.4 |
| Chawama | 16.3 | 17.7 | 22.9 | 29.9 |
| Matero | 41.7 | 45.2 | 58.4 | 76.4 |
| Manda Hill | 11.3 | 12.2 | 15.8 | 20.6 |
| Bublin | 10.5 | 11.4 | 14.7 | 19.2 |
| Birdcage Walk | 20.6 | 22.3 | 28.8 | 37.7 |
| Kafe Road | 46.0 | 49.9 | 64.4 | 84.2 |
| University | 25.1 | 27.2 | 35.1 | 45.9 |
| Chelston | 25.2 | 27.3 | 35.3 | 46.1 |
| Kabulonga | 19.5 | 21.1 | 27.3 | 35.7 |
| Uth | 4.1 | 4.5 | 5.8 | 7.5 |
| Woodlands | 27.1 | 29.4 | 38.0 | 49.7 |
| Waterworks | 18.1 | 19.6 | 25.3 | 33.1 |
| Avondale | 18.9 | 20.4 | 26.4 | 34.5 |
| Ngwerere | 1.6 | 1.8 | 2.3 | 3.0 |
| Chongwe | 4.0 | 4.3 | 5.6 | 7.3 |
| Bauleni | 9.6 | 10.4 | 13.4 | 17.6 |
| Total | 383.4 | 415.6 | 536.3 | 701.6 |

**Table 9.4 Demand estimate results for each substation (Copperbelt region: Kitwe, Ndola)**

Peak Demand (MW)

| Substation | 2008 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| Kansuswa | 2.7 | 2.9 | 3.8 | 4.9 |
| Kafironda | 2.2 | 2.4 | 3.1 | 4.0 |
| Mwambashi | 2.4 | 2.6 | 3.4 | 4.4 |
| Chambishi | 2.7 | 2.9 | 3.8 | 4.9 |
| Chati | 1.4 | 1.5 | 2.0 | 2.6 |
| Katembula | 1.2 | 1.3 | 1.7 | 2.2 |
| Skyways | 40.7 | 44.1 | 56.9 | 74.5 |
| Zambezi Paper Mills | 5.4 | 5.9 | 7.6 | 9.9 |
| Kafubu dam | 2.2 | 2.4 | 3.1 | 4.0 |
| Chilanga | 11.0 | 11.9 | 15.4 | 20.1 |
| Zambezi Portland Cement | 0.5 | 0.5 | 0.7 | 0.9 |
| Swarp Spinning | 0.5 | 0.5 | 0.7 | 0.9 |
| Total | 72.9 | 78.9 | 102.2 | 133.3 |

**Table 9.5 Demand estimate results for each substation (southern region: Livingstone, Choma, Mazabuka, and Kafue)**

Peak Demand (MW)

| Substation | 2008 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| Kafue Town | 12 | 13 | 16.8 | 22 |
| Mazabuka | 8 | 8.7 | 11.2 | 14.6 |
| Magoye | 0.9 | 1 | 1.3 | 1.6 |
| Lochinvar | 0.5 | 0.5 | 0.7 | 0.9 |
| Monze | 2 | 2.2 | 2.8 | 3.7 |
| Chisekesi | 2.1 | 2.3 | 2.9 | 3.8 |
| Gwembe | 0.5 | 0.5 | 0.7 | 0.9 |
| Munyumbwe | 0.4 | 0.4 | 0.6 | 0.7 |
| Chipepo | 0.2 | 0.2 | 0.3 | 0.4 |
| Victoria Falls | 28.0 | 30.4 | 39.2 | 51.2 |
| Zimba | 0.3 | 0.3 | 0.4 | 0.5 |
| Kalomo | 3.0 | 3.3 | 4.2 | 5.5 |
| Choma | 12 | 13 | 16.8 | 22 |
| Itezhi-tezhi | 0.3 | 0.3 | 0.4 | 0.5 |
| Namwala | 0.1 | 0.1 | 0.1 | 0.2 |
| Maala | 0.1 | 0.1 | 0.1 | 0.2 |
| Maamba | 2.5 | 2.7 | 3.5 | 4.6 |
| Sinazongwe | 6 | 6.5 | 8.4 | 11 |
| Total | 78.9 | 85.5 | 110.4 | 144.3 |

**Table 9.6 Demand estimate results for each substation (central region: Kapiri/Mkushi)**

Peak Demand (MW)

| Substation | 2008 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| MTZ | 9.1 | 9.9 | 12.7 | 16.7 |
| Nkumbi Farmers | 2.0 | 2.2 | 2.8 | 3.7 |
| Amajuba Farmers | 1.6 | 1.7 | 2.2 | 2.9 |
| New Boma | 2.1 | 2.3 | 2.9 | 3.8 |
| North East | 1.8 | 2.0 | 2.5 | 3.3 |
| North West | 2.5 | 2.5 | 2.5 | 2.5 |
| Mkushi West | 1.0 | 1.0 | 1.0 | 1.0 |
| Mkushi Central | 1.0 | 1.1 | 1.4 | 1.8 |
| Kapiri Main | 4.7 | 5.1 | 6.6 | 8.6 |
| Total | 22.3 | 24.2 | 31.2 | 40.8 |

**(Note)** For the Mkushi West and North West substations, the final capacity as of 2020 was used because of the existence of improvement plans.

(4) Construction cost integration unit costs

Table 9.7 and Table 9.8 show the unit cost figures were obtained by converting the figures in the 1995 table of unit construction costs prepared by ZESCO into current prices, with consideration of the rate of increase in the cost of commodities over the intervening years.

The tables for removal indicate only the cost of labor and other items directly related to the removal work; the calculation did not take into account profit on sale or reuse of the removed articles, or the cost of disposal accompanying scrapping, because the state of the removed articles is unclear.

**Table 9.7 Unit construction costs for 33-kV distribution lines**

| Description | | | Unit Cost (1000US$) |
|---|---|---|---|
| Installation | Overhead line | 350 $mm^2$ ACSR | 41.8 |
| | | 300 $mm^2$ ACSR | 37.7 |
| | | 200 $mm^2$ ACSR | 33.8 |
| | | 150 mm2 ACSR | 30.6 |
| | | 100 $mm^2$ ACSR | 26.7 |
| | Underground line | 300 $mm^2$XLPE | 200.6 |
| | | 240 $mm^2$ XLPE | 202.4 |
| | | 95 $mm^2$ PILC | 76.8 |
| | | 95 $mm^2$ XLPE | 92.9 |
| Removal | Overhead line | 200 $mm^2$ ACSR | 11.8 |
| | | 150 $mm^2$ ACSR | 10.9 |
| | | 100 $mm^2$ ACSR | 9.7 |
| | | 50 $mm^2$ ACSR | 9.7 |
| | Underground line | 95 $mm^2$ PILC | 27.6 |

**Table 9.8 Unit construction costs for 33/11 kV transformers**

| Description | | Unit Cost (1000US$) |
|---|---|---|
| Installation | 2.5MVA | 75.2 |
| | 5 MVA | 133.9 |
| | 10 MVA | 246.0 |
| | 15 MVA | 375.9 |
| | 20 MVA | 438.7 |
| | 25 MVA | 503.0 |
| | 31.5 MVA | 606.6 |
| | 40 MVA | 731.2 |
| | Primary and secondary point(entrance service and outlet of lines including bus-bar, CB, and so on) | 163.6 |
| Removal | 1MVA | 3.4 |
| | 2.5 MVA | 3.4 |
| | 2.64MVA | 3.4 |
| | 5 MVA | 3.4 |
| | 7.5 MVA | 3.4 |
| | 10 MVA | 4.8 |
| | 11.8MVA | 4.8 |
| | 15 MVA | 4.8 |
| | 20 MVA | 4.8 |

## 9.3 Distribution expansion plan (by 2020)

The Study Team prepared a plan for distribution system expansion by 2020 based on the results of the demand estimates and transmission plan formulation.

### 9.3.1 Lusaka area

The distribution lines in the Lusaka area are heavy-load lines with the highest demand density in Zambia. For the purpose of efficient maintenance and operation of the thermal capacity of distribution lines and substations as well as the distribution line voltage, the distribution system consists of a loop formed by interconnection of some BSPs (Lusaka West : 132/33 kV, Roma : 132/33 kV, Coventry : 132/33 kV, Mapepe : 88/33 kV, Waterworks : 88/33 kV, Chongwe : 88/33 kV) by means of the 33/11 kV substation bus and 33 kV distribution lines.

In 2008, several 33 kV distribution lines and 33/11 kV substations exceeded the tolerable limit of their thermal capacity. Other facilities as well are approaching their tolerable limit. Similarly, on some 33 kV distribution lines, the voltage drop exceeds the tolerable level. At present, the N-1 standard is not met. The results of the demand estimate for 2020 indicate an approximately 1.8-fold increase from 2008. The Study Team prepared a distribution expansion plan to meet this increase.

Figure 9.2 shows the distribution system expansion plan for the Lusaka area as of 2020. The following is an outline of the plan.

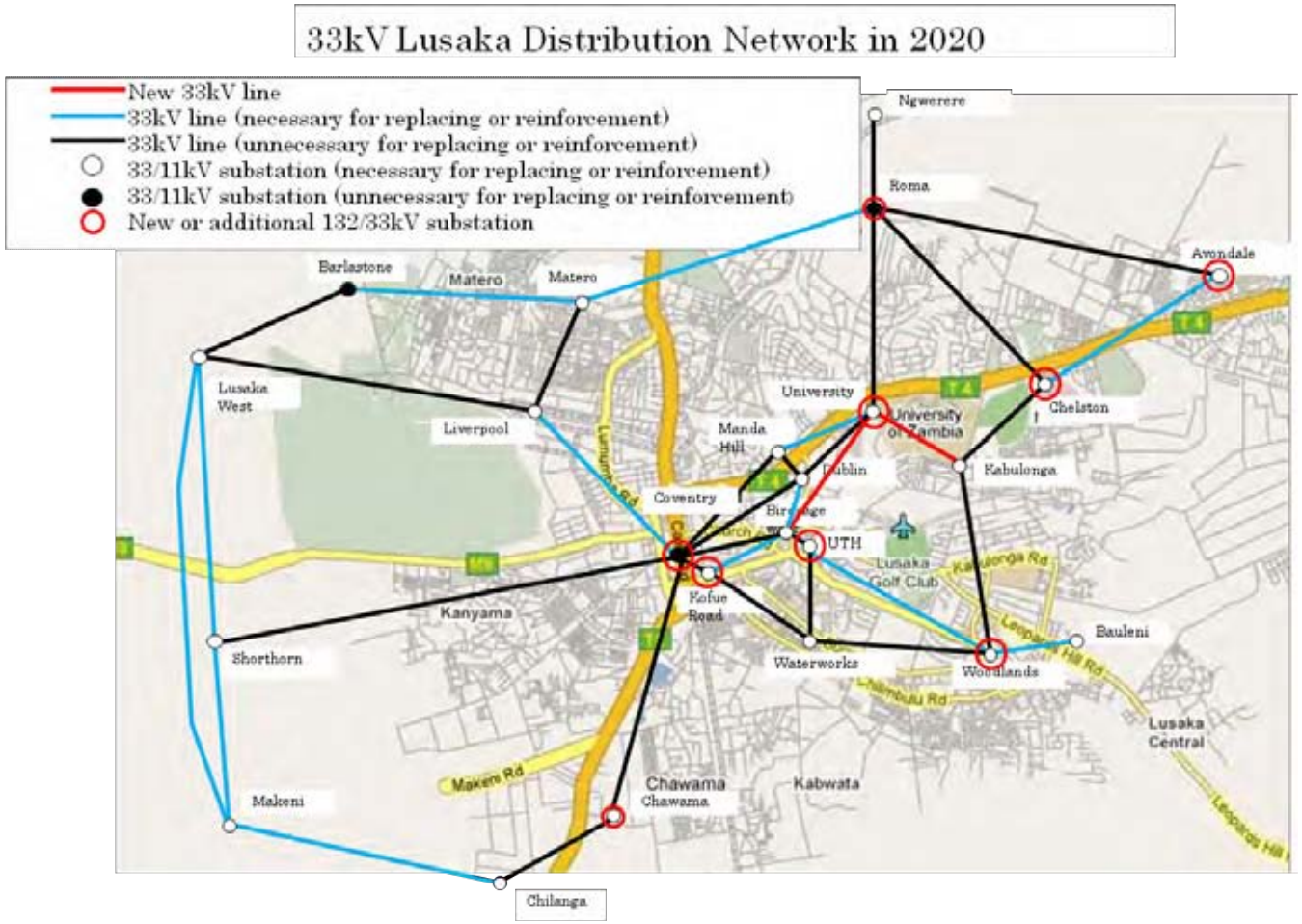


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**Figure 9.2 Plan for expansion of the distribution system in the Lusaka area (by 2020)**

- Expansion of 33/11 kV substations and 33 kV distribution lines (by 2020)

  Almost all of the 33/11 kV substations will be in an overload status along with demand increase. This points to a need for replacement of existing transformers with large-capacity ones, installation of additional transformers, or construction of additional substations. Because almost all 33 kV distribution lines will become overloaded as well and have voltage drops beyond the standard, it is necessary to replace them with large-capacity lines or install additional lines. Because these measures of expansion were studied with a view to meeting the N-1 standard, the system composition as of 2020 would prevent supply interruption even with the failure of a single unit.

- Installation of additional 132 kV transmission lines and 132/33 kV BSPs (by 2020)

  Additional 132 kV transmission lines and 132/33 kV BSPs will be constructed as related in Chapter 8 in order to meet the demand in the Lusaka area.

Table 9.9 and Table 9.10 show the construction for expansion of distribution lines and substations, respectively, required by 2020. Figure9.3 shows the yearly cost of the expansion measures. Figure 9.4 presents the same information for 132 kV transmission lines and 132/33 kV BSPs.

**Table 9.9 Distribution line expansion plan (Lusaka area)**

| From | To | No. | Length [km] | Type of countermeasure | New line | Before replacement | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|---|---|
| Lusaka | Shorthorn | L1 | 2.72 | Replacement | 350ACSR | 100ACSR | 140.2 | 2010-2015 |
| | | L2 | 2.72 | Additional line | 350ACSR | - | 113.8 | |
| | | L3 | 2.72 | Additional line | 350ACSR | - | 113.8 | |
| Lusaka | Makeni | L1 | 13.2 | Replacement | 300ACSR | 100ACSR | 626.1 | 2016-2020 |
| Shorthorn | Makeni | L1 | 6 | Replacement | 300ACSR | 150ACSR | 292.0 | 2016-2020 |
| | | L2 | 6 | Replacement | 300ACSR | 150ACSR | 292.0 | |
| Makeni | Chilanga | L1 | 16.3 | Replacement | 300ACSR | 100ACSR | 773.1 | 2016-2020 |
| | | L2 | 16.3 | Replacement | 300ACSR | 100ACSR | 773.1 | |
| Barlaston | Matero | L2 | 5.6 | Additional line | 200ACSR | - | 189.1 | 2016-2020 |
| Liverpool | Coventry | L2 | 3.8 | Additional line | 350ACSR | - | 158.9 | 2010-2015 |
| | | L3 | 3.8 | Additional line | 350ACSR | - | 158.9 | |
| Matero | Roma | L1 | 8.4 | Replacement | 240XLPECU | 200ACSR | 1799.1 | 2010-2015 |
| | | L2 | 8.4 | Additional line | 240XLPECU | - | 1700.4 | |
| | | L3 | 8.4 | Additional line | 240XLPECU | - | 1700.4 | |
| | | L4 | 8.4 | Additional line | 240XLPECU | - | 1700.4 | |
| Manda Hill | University | L2 | 2.2 | Additional line | 95PICLCU | - | 169.0 | 2010-2015 |
| Dublin | Birdcage Walk | L2 | 2.5 | Additional line | 95PICLCU | - | 192.0 | 2016-2020 |
| Dublin | University | L2 | 2.5 | Additional line | 95PICLCU | - | 192.0 | 2016-2020 |
| Birdcage Walk | Kafue Road | L2 | 3.7 | Additional line | 240XLPECU | - | 749.0 | 2010-2015 |
| | | L3 | 3.7 | Additional line | 240XLPECU | - | 749.0 | |
| | | L4 | 3.7 | Additional line | 240XLPECU | - | 749.0 | |
| Birdcage Walk | University | L1 | 2.5 | Replacement | 240XLPECU | 95PICLCU | 575.1 | 2010-2015 |
| | | L2 | 2.5 | Additional line | 240XLPECU | - | 506.1 | |
| | | L3 | 2.5 | Additional line | 240XLPECU | - | 506.1 | |
| University | Kabulonga | L1 | 5 | Additional line | 300ACSR | - | 0.0 | 2010-2015 |
| | | L2 | 5 | Additional line | 300ACSR | - | 188.6 | |
| Chelston | Avondale | L2 | 5.7 | Additional line | 100ACSR | - | 151.9 | 2010-2015 |
| Uth | Woodlands | L2 | 4.7 | Additional line | 240XLPECU | - | 951.4 | 2010-2015 |
| Woodlands | Bauleni | L3 | 2.8 | Replacement | 200ACSR | 100ACSR | 121.7 | 2010-2015 |
| | | L5 | 2.8 | Replacement | 200ACSR | 100ACSR | 121.7 | |
| **Total Construction Cost [1000US$]** | | | | | | | **16,453.5** | |

**Table 9.10 Substation expansion plan (Lusaka area)**

| Substation | | Type of countermeasure | New Transfomer [MVA] | Before replacement [MVA] | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|
| Shorthorn | T1 | Replacement | 20 | 5 | 442.2 | 2010 |
| | T2 | Replacement | 20 | 5 | 442.2 | |
| | T3 | Reinforcement | 20 | - | 602.4 | |
| Makeni | T1 | Replacement | 20 | 10 | 443.5 | 2010 |
| | T2 | Replacement | 20 | 10 | 443.5 | |
| | T3 | Reinforcement | 20 | - | 602.4 | |
| Chilanga | T3 | Reinforcement | 20 | - | 602.4 | 2020 |
| Liverpool | T3 | Reinforcement | 31.5 | - | 770.2 | 2020 |
| Chawama | T1 | Replacement | 20 | 10 | 443.5 | 2013 |
| | T2 | Replacement | 20 | 10 | 443.5 | |
| | T3 | Reinforcement | 20 | - | 602.4 | |
| Matero | T1 | Replacement | 31.5 | 20 | 611.4 | 2010 |
| | T2 | Replacement | 31.5 | 20 | 611.4 | |
| | T3 | Reinforcement | 31.5 | - | 770.2 | |
| | T4 | Reinforcement | 31.5 | - | 770.2 | |
| Manda Hill | T1 | Replacement | 31.5 | 20 | 611.4 | 2020 |
| | T2 | Replacement | 31.5 | 20 | 611.4 | |
| Dublin | T1 | Replacement | 20 | 7.5 | 442.2 | 2016 |
| | T2 | Replacement | 20 | 7.5 | 442.2 | |
| Birdcage Walk | T3 | Reinforcement | 20 | - | 602.4 | 2020 |
| Kafue Road | T3 | Reinforcement | 25 | - | 666.6 | 2010 |
| | T4 | Reinforcement | 25 | - | 666.6 | |
| | T5 | Reinforcement | 25 | - | 666.6 | |
| University | T3 | Reinforcement | 25 | - | 666.6 | 2020 |
| Chelston | T1 | Replacement | 25 | 7.5 | 506.4 | 2010 |
| | T2 | Replacement | 25 | 7.5 | 506.4 | |
| | T3 | Reinforcement | 25 | - | 666.6 | |
| Kbulonga | T1 | Replacement | 25 | 15 | 507.8 | 2017 |
| | T2 | Replacement | 25 | 15 | 507.8 | |
| | T3 | Reinforcement | 25 | - | 666.6 | |
| Woodlands | T1 | Replacement | 31.5 | 20 | 611.4 | 2016 |
| | T2 | Replacement | 31.5 | 20 | 611.4 | |
| | T3 | Reinforcement | 31.5 | - | 770.2 | |
| Waterworks | T3 | Reinforcement | 20 | - | 602.4 | 2016 |
| Avondale | T3 | Reinforcement | 20 | - | 602.4 | 2020 |
| Bauleni | T3 | Reinforcement | 10 | - | 409.6 | 2020 |
| **Total Construction Cost [1000US$]** | | | | | **20945.9** | |

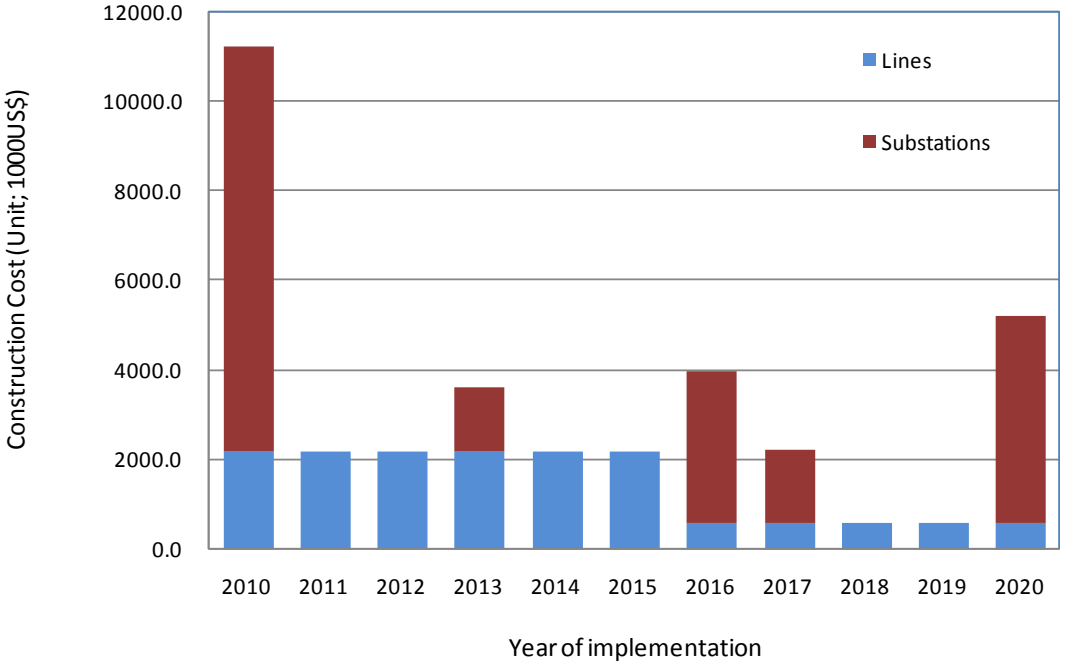



**Figure 9.3 Construction cost (Lusaka area)**

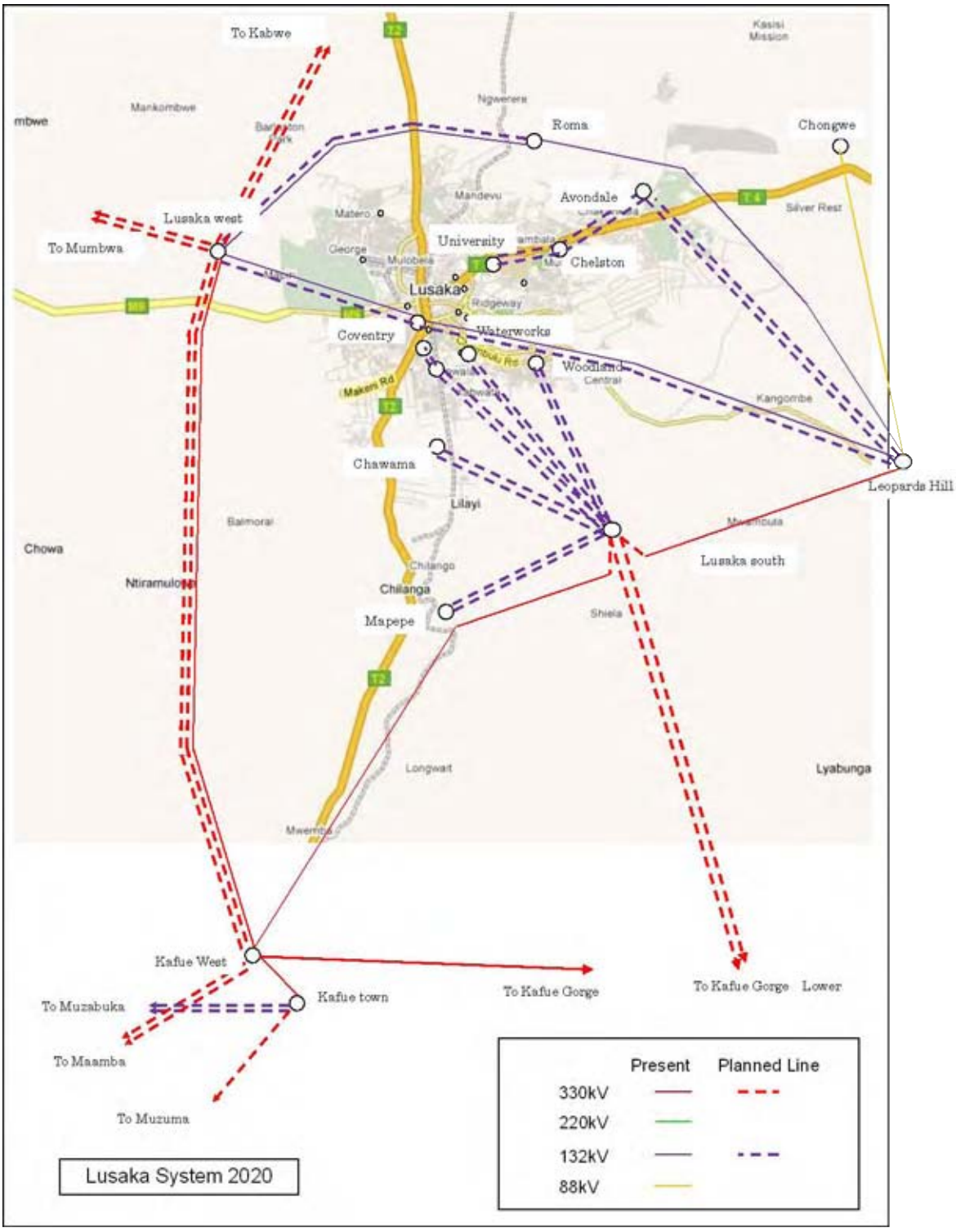



**Figure 9.4 Plan for BSP development in the Lusaka area**

### 9.3.2 Southern region : Livingstone, Choma, Mazabuka, and Kafue

In the southern region, which is characterized by low demand densities and long distribution line legs, measures to prevent excessive voltage drop on the lines are of vital importance. Figure 9.5 and Figure 9.6 shows the plan for expansion in the southern region. The plan is outlined below.

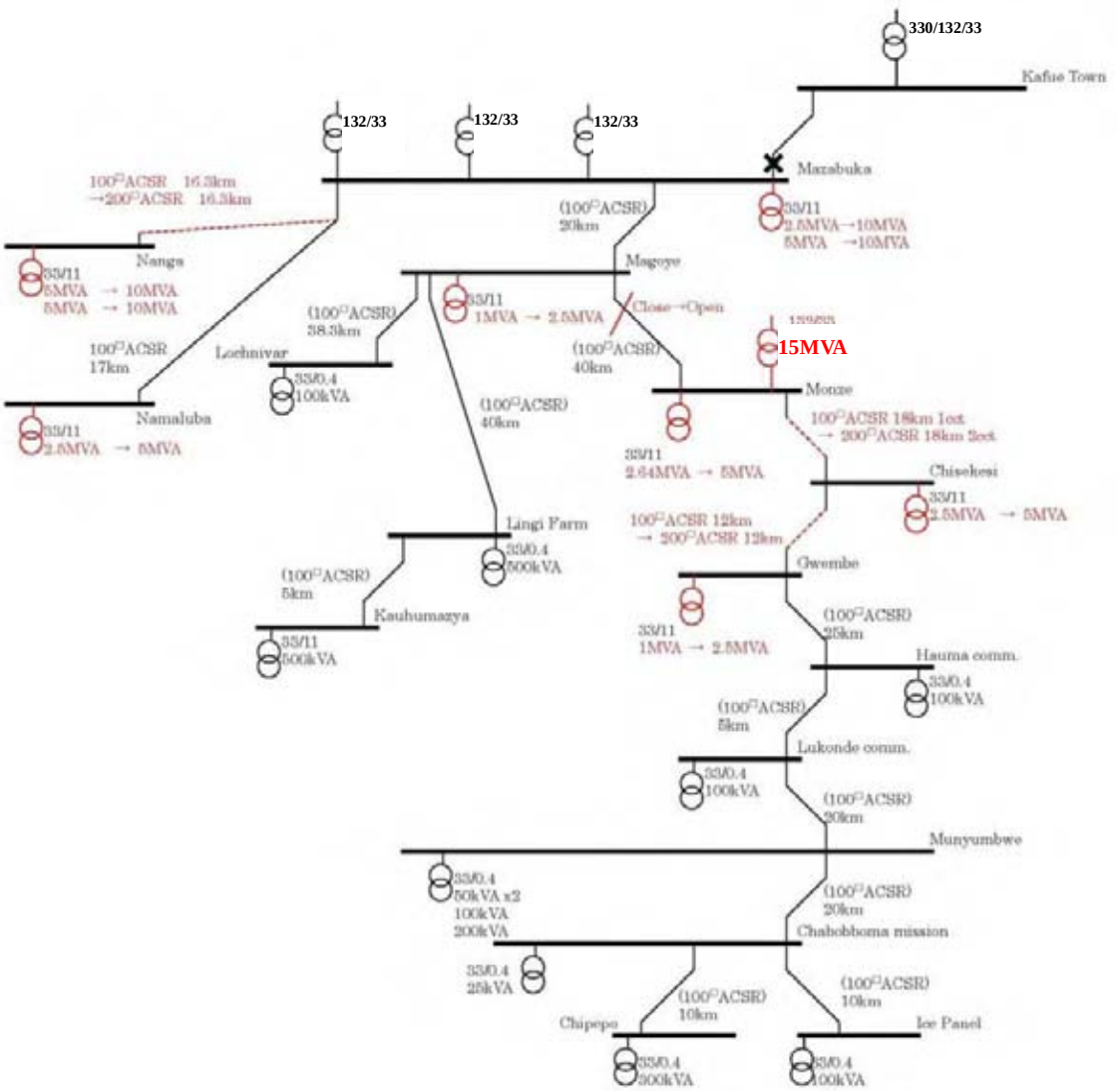



**Figure 9.5 Plan for distribution expansion in the southern region (Mazabuka area)**

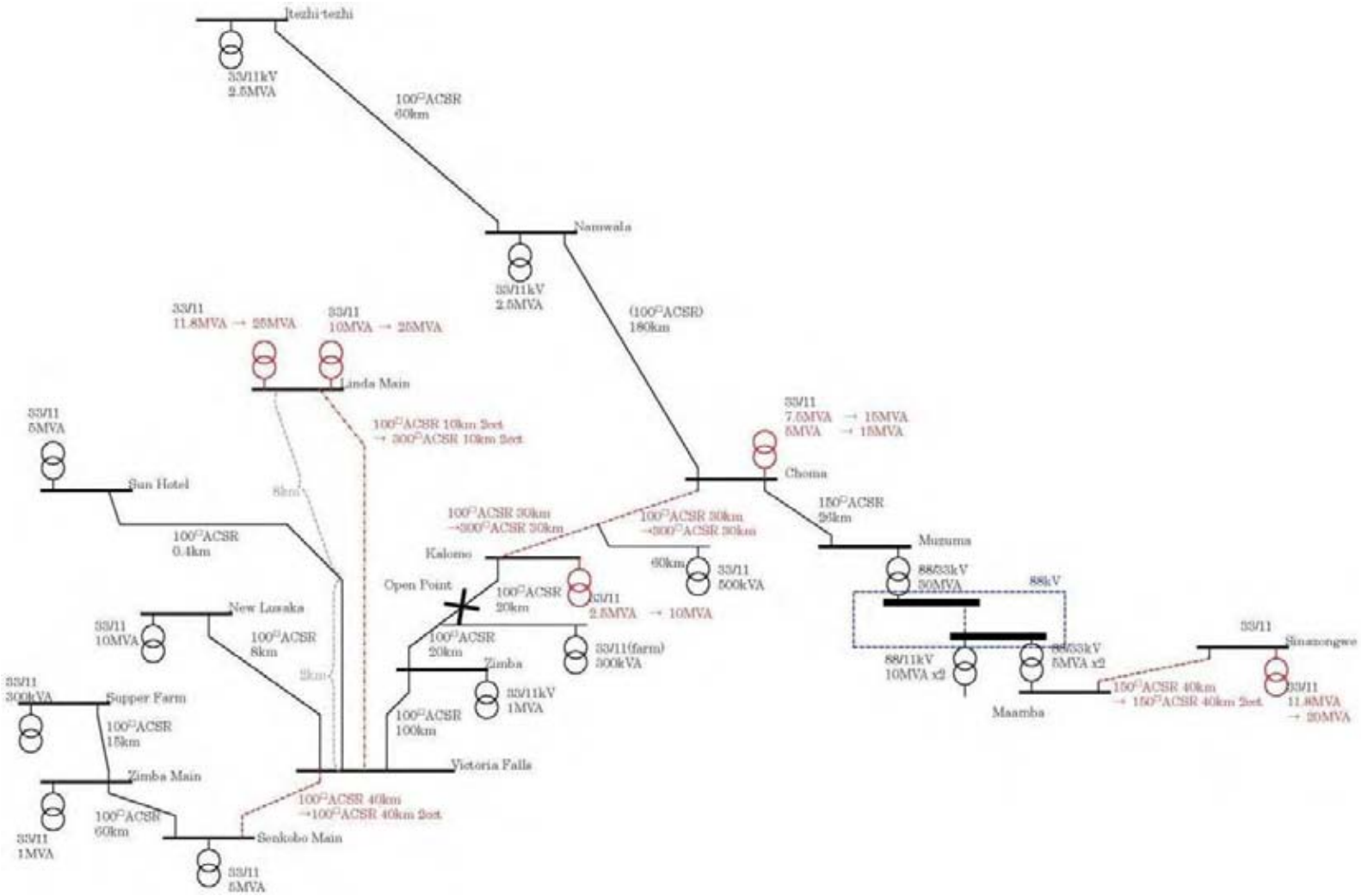



**Figure 9.6 Plan for distribution expansion in the southern region (Livingstone area)**

- Installation of additional 132 kV transmission lines and 132/33 kV BSPs (by 2020)

  In certain areas, the demand increase would make it difficult to supply load through distribution lines. For this reason, the plan calls for installation of additional 132 kV transmission lines and 132/33 kV BSPs, as described in Chapter 8.

- Expansion of 33 kV distribution lines (by 2020)

  Due to demand increase, the voltage drop would exceed the limit on several 33 kV distribution lines. As a result, it will be necessary to replace existing lines with large-capacity ones or install additional lines.

Table 9.11 and 9.12 show the construction for expansion of distribution lines and substations, respectively, required by 2020. Figure 9.7 shows the yearly cost of the expansion measures.

**Table 9.11 Distribution line expansion plan (southern area)**

| From | To | No. | Length [km] | Type of countermeasure | New line | Before replacement | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|---|---|
| Monze | Chisekesi | L1 | 18 | Replacement | 200ACSR | 100ACSR | 782.4 | 2010-2015 |
| | | L2 | 18 | Additional line | 200ACSR | - | 607.7 | |
| Chisekesi | Gwembe | L1 | 12 | Replacement | 200ACSR | 100ACSR | 521.6 | 2016-2020 |
| Mazabuka | Nanga | L1 | 16.3 | Replacement | 200ACSR | 100ACSR | 708.5 | 2010-2015 |
| Victoria Falls | Senkobo Main | L2 | 40 | Additional line | 100ACSR | - | 1066.1 | 2010-2015 |
| Victoria Falls | Linda Main | L1 | 10 | Replacement | 300ACSR | 100ACSR | 474.3 | 2010-2015 |
| | | L2 | 10 | Additional line | 300ACSR | - | 377.2 | |
| Maamba | Sinazongwe | L2 | 40 | Additional line | 150ACSR | - | 1224.7 | 2010-2015 |
| Choma | Kalomo | L1 | 60 | Replacement | 300ACSR | 100ACSR | 2845.7 | 2010-2015 |
| | | L2 | 60 | Additional line | 300ACSR | - | 2263.4 | |
| **Total Construction Cost [1000US$]** | | | | | | | **10871.6** | |

**Table 9.12 Substations expansion plan (southern area)**

| Substation | | Type of countermeasure | New Transfomer [MVA] | Before replacement [MVA] | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|
| Mazabuka | T1 | Replacement | 10 | 5 | 249.4 | 2010 |
| | T2 | Replacement | 10 | 2.5 | 249.4 | 2010 |
| Nanga | T1 | Replacement | 10 | 5 | 249.4 | 2020 |
| | T2 | Replacement | 10 | 5 | 249.4 | 2020 |
| Namaluba | T1 | Replacement | 5 | 2.5 | 137.4 | 2020 |
| Magoye | T1 | Replacement | 2.5 | 1 | 78.6 | 2011 |
| Monze | T1 | Replacement | 5 | 2.64 | 137.4 | 2012 |
| Chisekesi | T1 | Replacement | 5 | 2.5 | 137.4 | 2011 |
| Gwembe | T1 | Replacement | 2.5 | 1 | 78.6 | 2019 |
| Choma | T1 | Replacement | 15 | 7.5 | 379.3 | 2010 |
| | T2 | Replacement | 15 | 5 | 379.3 | 2010 |
| Kalomo | T1 | Replacement | 10 | 2.5 | 249.4 | 2010 |
| Linda Main | T1 | Replacement | 25 | 11.8 | 506.4 | 2011 |
| | T2 | Replacement | 25 | 10 | 506.4 | 2011 |
| Kansuswa | T1 | Replacement | 10 | 5 | 249.4 | 2018 |
| **Total Construction Cost [1000US$]** | | | | | **3837.3** | |

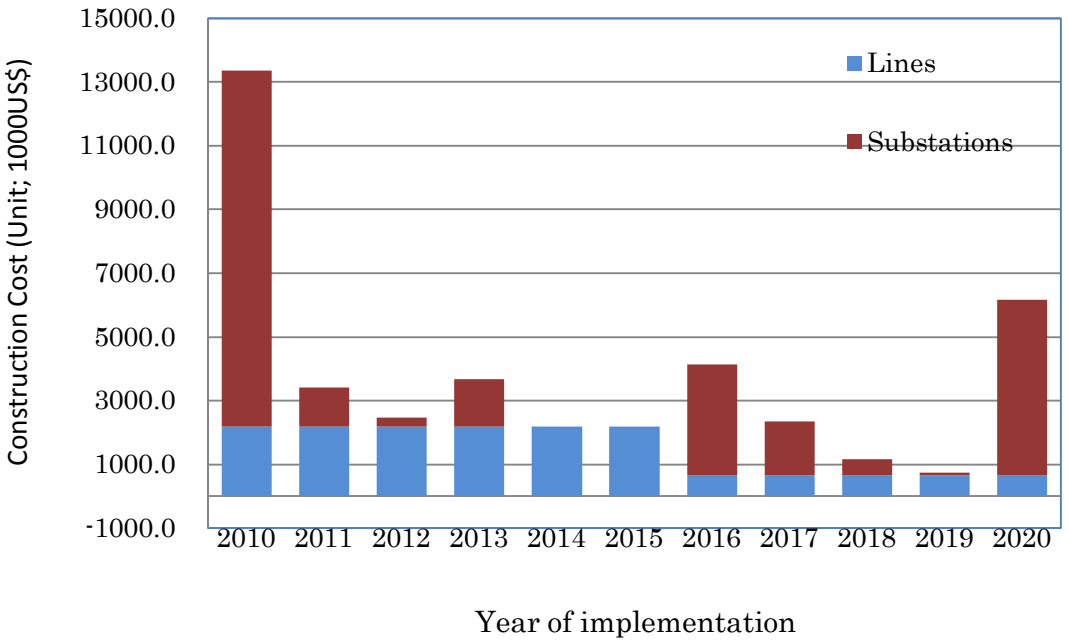



**Figure 9.7 Construction cost (southern area)**

### 9.3.3 Copperbelt region: Kitwe and Ndola

Figure 9.8 shows the plan for expansion in the Kitwe area. (There is no need for expansion in the Ndola area up to 2020.) The expansion is outlined below.

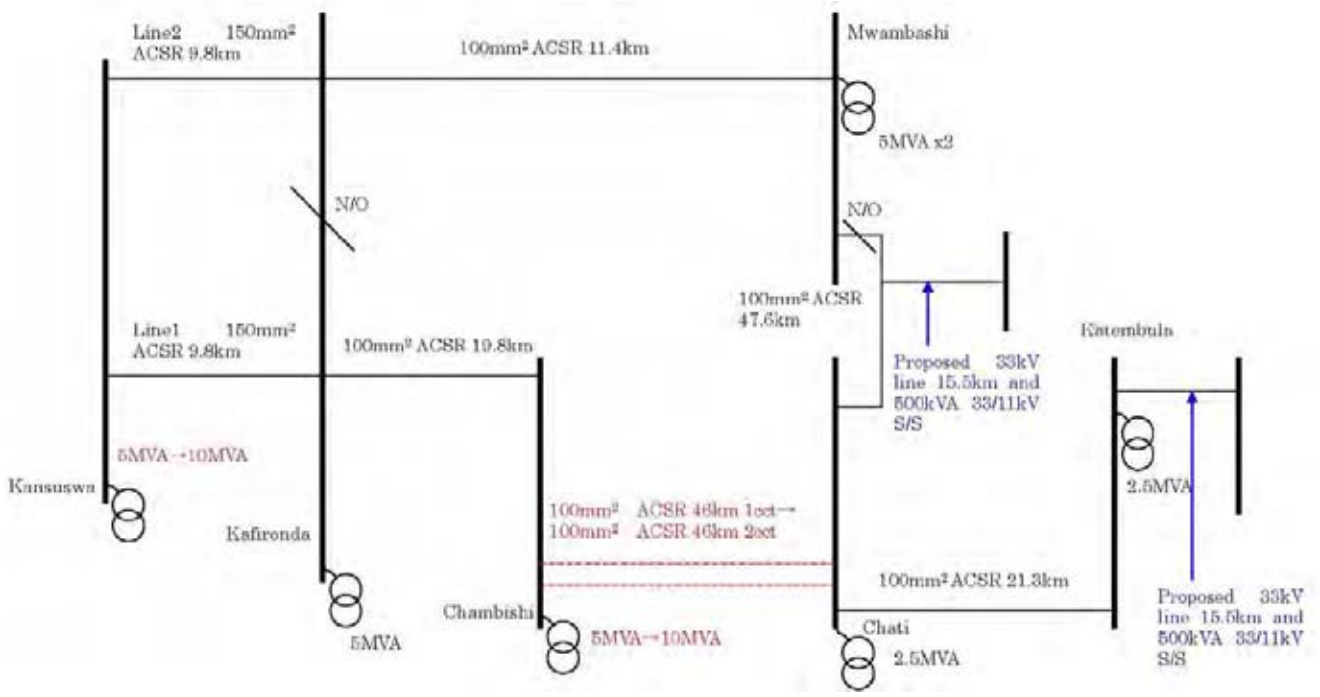



**Figure 9.8 Plan for distribution system expansion in the Kitwe area**

- Installation of additional 66 kV transmission lines and 66/33 kV BSPs (by 2020)

  Additional 66 kV transmission lines and 66/33 kV BSPs will be installed (at Chambishi, Chati, and Katembula) to meet the demand in the Kitwe area.

- Expansion of 33 kV distribution lines (by 2020)

  Due to demand increase, the voltage drop would exceed the limit on several 33 kV distribution lines. As a result, it will be necessary to replace existing lines with large-capacity ones or install additional lines. Table 9.13 and Table 9.14 show the plan for distribution line expansion by 2020, and Figure 9.9, the yearly construction cost.

  In the Ndola region, there is no need for expansion before 2020.

**Table 9.13 Distribution line expansion plan (Kitwe area)**

| From | To | No. | Length [km] | Type of countermeasure | New line | Before replacement | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|---|---|
| Chambishi | Katembula | L2 | 46 | Additional line | 100ACSR | - | 1226.0 | 2010-2015 |
| **Total Construction Cost [1000US$]** | | | | | | | **1226.0** | |

**Table 9.14 Substation expansion plan (Kitwe area)**

| Substation | | Type of countermeasure | New Transfomer [MVA] | Before replacement [MVA] | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|
| Kansuswa | T1 | Replacement | 10 | 5 | 249.4 | 2018 |
| Chambishi | T1 | Replacement | 10 | 5 | 249.4 | 2018 |
| **Total Construction Cost [1000US$]** | | | | | **498.8** | |

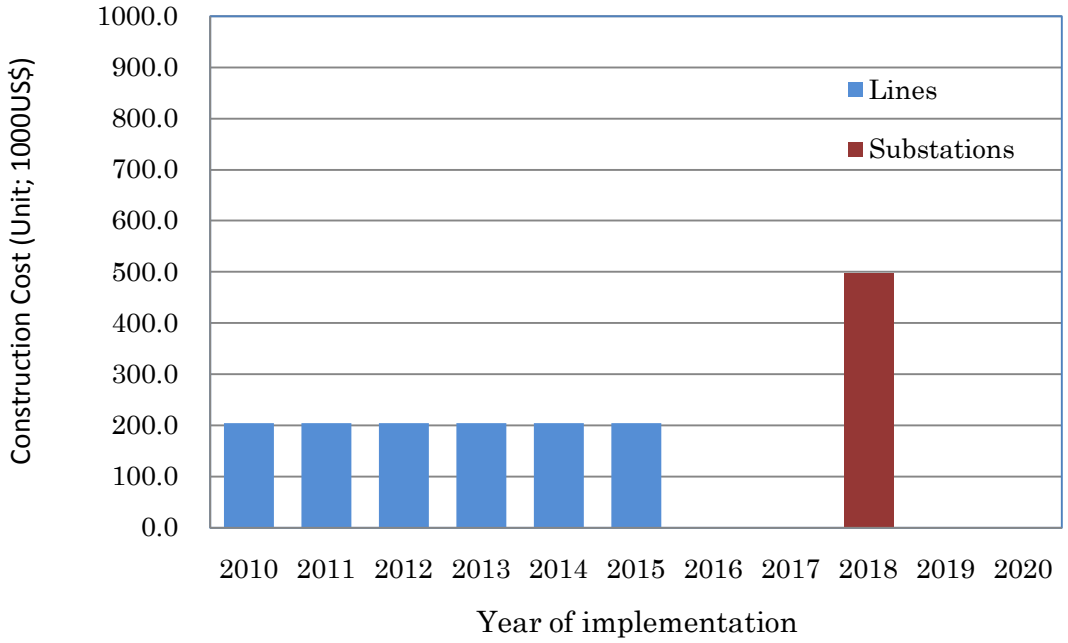



**Figure 9.9 Construction Cost (Kitwe area)**

### 9.3.4 Central region: Kapiri/Mkushi

Figure 9.10 shows the plan for expansion in the central region (Kapiri/Mkushi area).

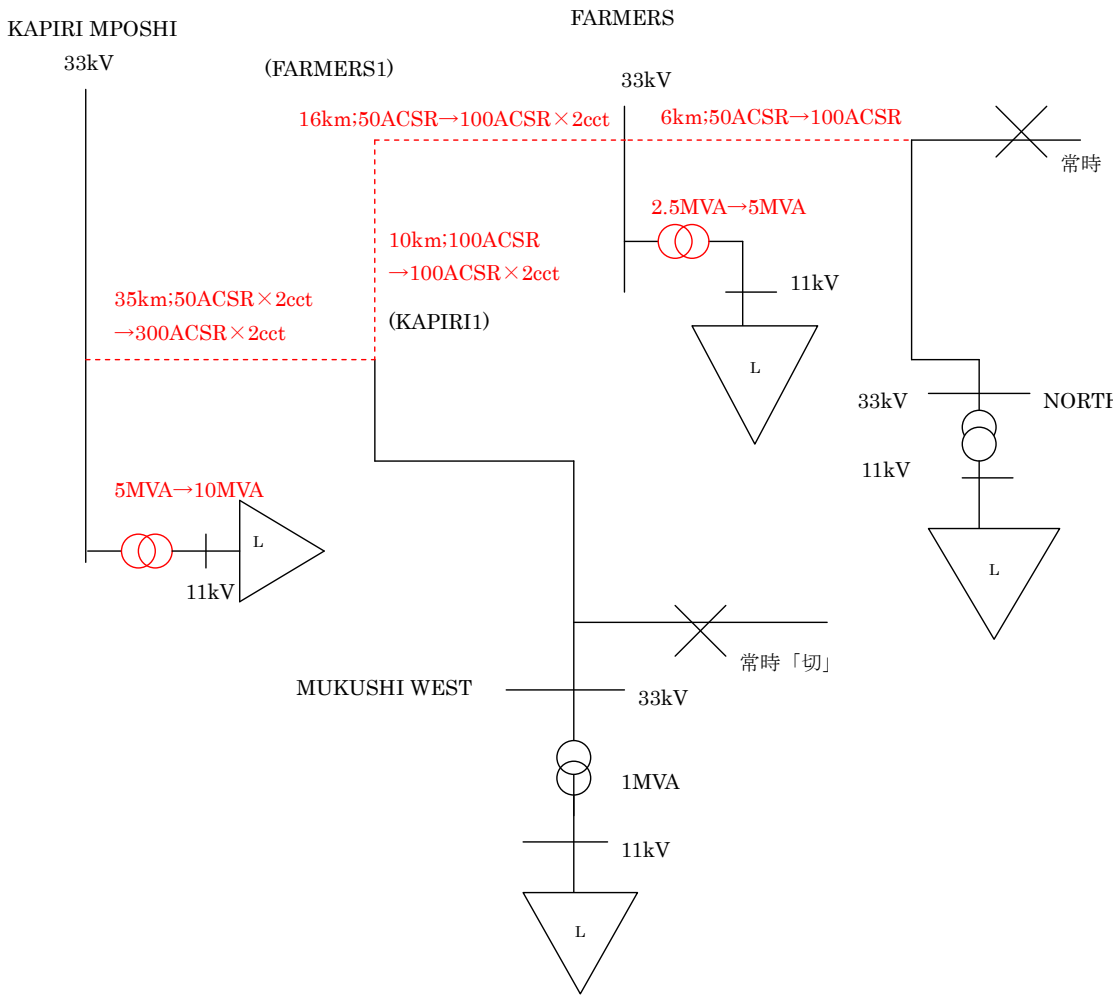



**Figure 9.10 Plan for distribution expansion in the central region**

- Expansion of 33 kV distribution lines (by 2020)

  Due to demand increase, the voltage drop would exceed the limit on several 33 kV distribution lines. As a result, it will be necessary to replace existing lines with large-capacity ones or install additional lines.

Table 9.15 and Table 9.16 show the plans for expansion of distribution lines and substations, respectively, by 2020. Figure 9.11 shows the yearly construction cost.

**Table 9.15 Plan for distribution line expansion (central region)**

| From | To | No. | Length [km] | Type of countermeasure | New line | Before replacement | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|---|---|
| Kapiri | Mkushi | L1 | 35 | Replacement | 300ACSR | 50ACSR | 1660.0 | 2010-2015 |
| | | L2 | 35 | Replacement | 300ACSR | 50ACSR | 1660.0 | |
| Mkushi | Mkushi1 | L2 | 10 | Additional line | 100ACSR | - | 266.5 | 2010-2015 |
| Mkushi1 | Farmers | L1 | 16 | Replacement | 100ACSR | 50ACSR | 581.7 | 2010-2015 |
| | | L2 | 16 | Additional line | 100ACSR | - | 426.4 | |
| Farmers | North West | L1 | 6 | Replacement | 100ACSR | 50ACSR | 218.1 | 2010-2015 |
| **Total Construction Cost [1000US$]** | | | | | | | **4812.8** | |

**Table 9.16 Plan for substation expansion (central region)**

| Substation | | Type of countermeasure | New Transfomer [MVA] | Before replacement [MVA] | Cost [1000US$] | Year of implementation |
|---|---|---|---|---|---|---|
| Kapiri | T1 | Replacement | 10 | 5 | 249.4 | 2010 |
| Farmers | T1 | Replacement | 5 | 2.5 | 137.4 | 2012 |
| **Total Construction Cost [1000US$]** | | | | | **386.8** | |

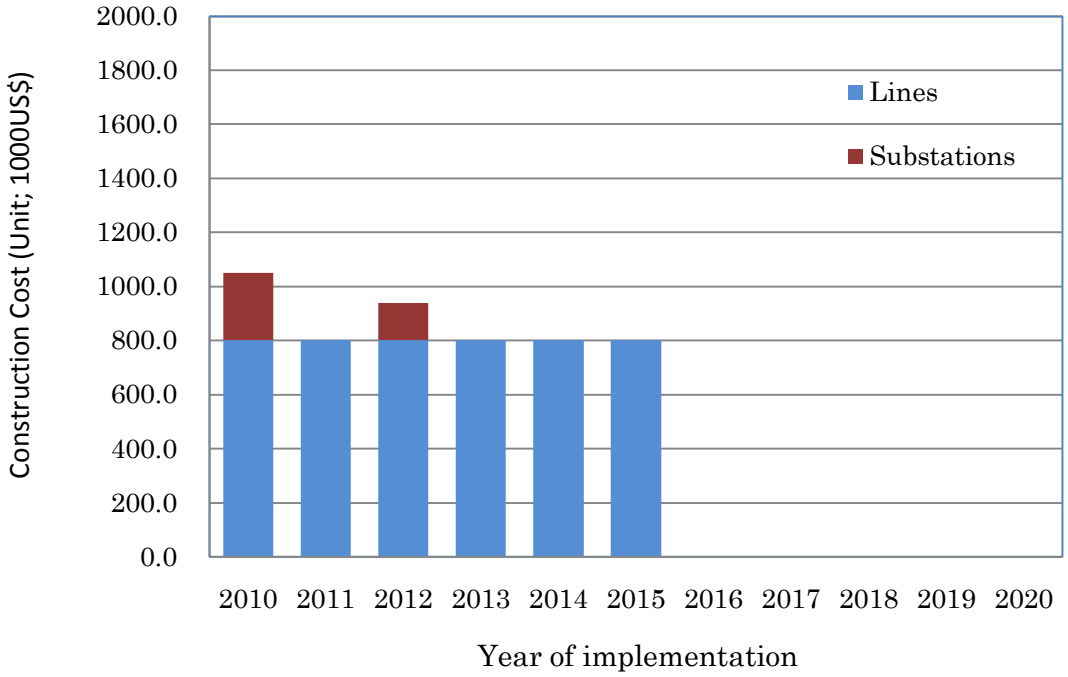



**Figure 9.11 Construction cost (central region)**

## 9.4 Opinions offered concerning reduction of system loss

Zambia government has the objective of reducing the system loss to less than 14% by March, 2010 base on the high system loss (i.e. 19% in 2007).

In this situation, reduction of system loss would appear to be helping to improve the financial dispostion of ZESCO, but the facts in this respect are not necessarily clear. Low-voltage distribution lines in Zambia are characterized by installation of large-capacity distribution transformers at the load center and extension of lines for long distances. This results in a load supply pattern marked by the typical low-load dispersion. Besides lowering the quality of the power supply due to the steep voltage drop, it is thought to be causing a lot of distribution loss. In addition, the use of cable that is of relatively small size for the load current is presumably another factor behind power loss.

Against this background, the Study Team advice the reduction of technical and non-technical loss as follows.

### 9.4.1 Outline of distribution loss and measures to reduce

(1) Classification of distribution loss

Distribution loss may be classified as follows.

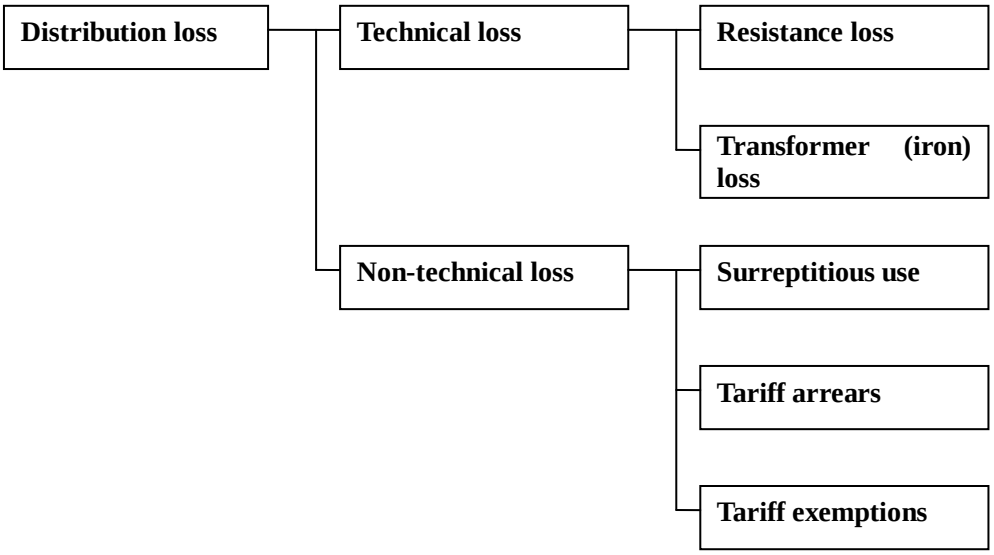



**Figure 9.12 Classification of distribution loss**

i) Technical loss

Resistance loss is caused by the electrical resistance of cable and varies in proportion with the square of current. In developing countries, it is thought to be on a generally high level. This is because, even if the demand increases, there is a tendency to refrain from increasing the capacity of transmission and distribution lines, and consequently to supply power in an overload status as well as to unreasonably extend distribution lines in order to curtail costs.

Transformer (iron) loss arises due to the iron cores of transformers. It varies in proportion

with the transformer capacity, but is unrelated to the size of load. Even though they have the same capacity, transformers built in recent years have less iron loss than those built 30 or more years ago. There have also appeared low-loss models using an amorphous type of iron core.

ii) Non-technical loss

While the definition of non-technical loss varies with the country, the three basic types are surreptitious use, tariff arrears, and tariff exemptions.

The term "surreptitious use" (power theft) refers to illegal use of power by a customer by means of supply that is not routed through the meter. As a result, this use is not included in the amount of power sales measured by the meter. There are two kinds of tariff arrears (non-collection): 1) that from cases in which the power utility cannot collect charges for the amount of power use measured by the meter (i.e., non-payment) and 2) that caused by mistaken measurement by defective meters. The term "tariff exemptions" refers to the practice of supplying power free of charge to governmental agencies as well as for street lights and other public facilities. In some countries, it is not counted as loss. As viewed from the standpoint of power utilities, however, it is equivalent to loss, because they cannot collect tariff charges, as in the case of other types. In some countries, it is even a factor putting a significant strain on utility management.

(2) Measures to reduce transmission and distribution loss

i) Technical loss

Table 9.17 outlines specific measures to reduce technical loss in distribution systems. Distribution loss requires an area-wise implementation of these measures, which can have an enormous effect for reducing loss. Considering the cost-benefit factor, it would therefore be uneconomical to undertake construction aimed solely at loss reduction; it is the normal practice to execute the measures along with other construction. For this reason, it would be more realistic to view measures for reduction of technical loss with a timeframe of about 10 years as opposed to the shorter term.

Table 9.18 presents the findings of analysis and examination in this development study for distribution loss in Zambia. Due to the efficient distribution lines and substations expansion, the loss ratio was decreased.

**Table 9.17 Classification of distribution loss**

| Classification | | Causes | Problem points |
|---|---|---|---|
| Resistance loss | 33- and 11 kV distribution lines | Low demand density | In rural areas, a low-capacity load is scattered over a wide area, and 33 kV distribution lines are extended for long distances (over 100 km) from BSPs. This invites an increase in resistance loss. |
| | | Improper voltage | Distribution lines that ought to have a voltage of 33 kV considering the line span and amperage still have one of 11 kV, and measures have not been taken to increase it. |
| | | Improper conductor size | Thin cables with a sectional area of 25- or 50-mm2 are used for the trunk parts of distribution lines. This is presumably causing a fair amount of resistance loss on trunk lines (in parts where the current is concentrated). |
| | | Triphase imbalance | Considering the send-out current at primary substations, there are thought to be not a few feeders with a triphase imbalance rate of no more than 80 percent. It is estimated that current imbalance is increasing resistance loss. |
| | Low-voltage distribution lines | Long-distance, low-voltage systems | Even in villages with a fairly large number of customers, in some cases there is only one distribution-use substation (secondary transformer), to which are connected only low-voltage lines that extend for distances ranging from a few hundred meters to one kilometer. This is thought to be causing a lot of resistance loss. |
| Transformer (iron) loss | Transformers (secondary) | Large-capacity transformers | In areas electrified under RE programs, there are apparently many cases of installation of transformers with an extremely high capacity as compared to the total demand, even in districts that have a small demand at present and no firm prospects for a major increase in the future. (For example, transformers with a capacity in the range of 100 - 200 kVA are installed for low-voltage systems whose load will probably not exceed 20 or 30 kVA even in the future.) |

**Table 9.18 Results of reducting system loss (example; Lusaka area)**

| | 2008 (before expansion) | | | 2020 (after expansion) | | | Differece 2020 - 2008 | | |
|---|---|---|---|---|---|---|---|---|---|
| | P * | Q * | S * | P | Q | S | P | Q | S |
| Load Demand $P_L$ | 344.9 | 167.3 | 383.4 | 631.4 | 305.8 | 701.6 | + 286.46 | + 138.55 | + 318.20 |
| Power Transmission $P_S$ ** | 352.4 | 204.2 | 407.3 | 644.2 | 372.4 | 744.1 | + 291.80 | + 168.20 | + 336.81 |
| Power loss $P_S$-$P_L$ | 7.5 | 36.9 | 23.9 | 12.8 | 66.6 | 42.5 | | | |
| Loss ratio $1-P_L/P_S$ | 2.11% | 18.09% | 5.88% | 1.99% | 17.88% | 5.72% | -0.13% | -0.21% | -0.16% |
| Loss reduction ratio of 2020's loss ratio to 2008's | | | | -6.06% | -1.16% | -2.71% | | | |

* P: Effective power, Q: Reactive power, S: Apparent power

** Sending power at BSPs

ii) Non-technical loss

Non-technical loss requires specification of causes to determine countermeasures. Surreptitious use can be prevented by switching from bare to covered cable for low-voltage lines to make theft more difficult. It also demands steps in the institutional/systemic aspect, such as a reinforcement of confirmation (detection) by utilities and tougher official penalties for theft. The prospective measures for tariff arrears are a correction of measurement by replacement of defective meters and tighter regulations for collection (e.g., suspension of transmission to customers in arrears). Some African countries are introducing prepaid meters to combat non-payment, and this could help to reduce non-technical loss. In any case, the question of whether or not such measures take immediate effect depends largely on the national circumstances.

## 9.5 (Reference) Area Development Plans

There are five area-development (i.e., Multi-Facility Economic Zone) plans in Zambia.

- Chambishi Multi-Facility Economic Zone (MFEZ)
- Lusaka South MFEZ
- Lusaka East MFEZ
- Lumwana MFEZ
- Ndola MFEZ（Sub Saharan Gemstone Exchange）

In the JICA program of technical cooperation, a master plan study was conducted for the Lusaka South MFEZ, which is the only one of these projects that is promoted by the Government of Zambia (GOZ). The remaining four projects are implemented by the private sector, but Lumwana and Ndola MFEZs are still in planning stage.

As used here, the term "MFEZ" indicates a geographical economic area approved by the Minister of Commerce, Trade and Industry and aimed at attracting siting by high-tech manufacturing industries, in order to develop country's economy and increase its foreign exchange earnings. In return for investment in MFEZ, investors are to receive preferential treatment in taxation, such as tax exemptions.

### 9.5.1 Chambishi MFEZ

The Chambishi project was initiated as a program of governmental economic and trade cooperation between Zambia and China, and was the first MFEZ to be approved.

It is located in the Chambishi Copper Mine zone, which is 70 km from Ndola, the country's second-largest city, and 28 km from Kitwe. China Nonferrous Metal Company (CNMC) is to develop the area in Chambishi Town, on the outskirts of Kitwe (see Figure 9.13). CNMC has pledged to invest US$800 million in the MFEZ and create jobs for 6,000 people.

This area already has copper mines and smelteries. The main objective of the project is to develop industries in copper and, in addition, non-ferrous product (e.g., bars, wires and cables) using copper and cobalt. Furthermore, the project expects to produce chemicals and precious metals using by-products from smelteries.

The Cooperation Zone covers a planning area of 11.58 $km^2$, and consists of the existing mining and metallurgical industrial zone of 3.6 $km^2$ and a new expansion area of 7.98 $km^2$ (see Figure 9.14).

According to the plan, it will take five to eight years to attract siting by smelteries and related industries. Twelve companies have been nominated so far, five of them have already started construction. By the final stage of the project, 50 - 60 companies are expected to come.

Construction of sites by Chambishi Copper Smelter (including access road), Sino Metals Limited and Sino Acid Limited have already begun. A water-supply pipeline from Kafue

River to the MFEZ has already been installed, but the construction of power substation has just started.


(Source) China Nonferrous Metal Mining (Group) Co., Ltd., China Association of Development Zones, Master Plan for the Zambia-China Economic and Trade Cooperation Zone, June, 2007

**Figure 9.13 Site of the Chambishi MFEZ**


(Source) China Nonferrous Metal Mining (Group) Co., Ltd., China Association of Development Zones, Master Plan for the Zambia-China Economic and Trade Cooperation Zone, June 2007

**Figure 9.14 Plot Plan of the Chambishi MFEZ**

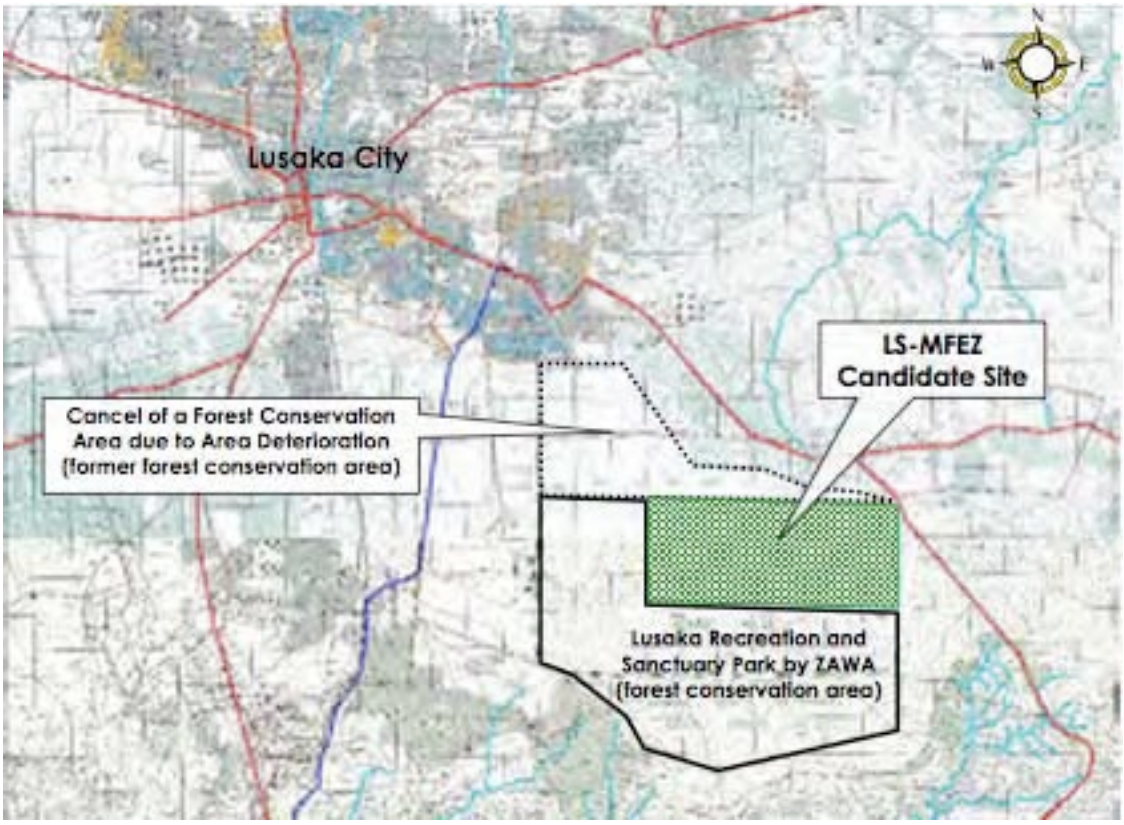
### 9.5.2 Lusaka South MFEZ (LS-MFEZ)

In the master plan, the development area will increase to 1,350ha (13.5km$^2$) by 2007 and 3,530ha (35.3 km$^2$) by 2030.

LS-MFEZ consists of seven zones, and five function modules, i.e., general industry, high-tech park, common service facility, central business district, and housing, are to be allocated.

Construction was started in July 2009, and infrastructural preparation is the first task. The power demand is expected to emerge in the forth quarter of 2010. The GOZ has already allocated 30 million kwacha to construct the access road.

However, it has not yet clarified what kind of industrial siting is targeted. In the Lusaka area, there is another economic cooperation project plan with China, i.e., Lusaka East MFEZ. The GOZ made a comment that it wanted to attract siting by industries of types different from those targeted in other projects.




(Source) JICA 2003

**Figure 9.15 Site of LS MFEZ**

### 9.5.3 Lusaka East MFEZ

As a sub-zone of the Zambia-China Economic Zone, which is developed to economic and trade cooperation between Zambia and China, plans call for development of the area near the

Lusaka International Airport, in the southern part of Lusaka. The Government of China has already allocated 120 million US dollar for the project.

It was announced that the project would soon be launched, but the construction work has not yet started.

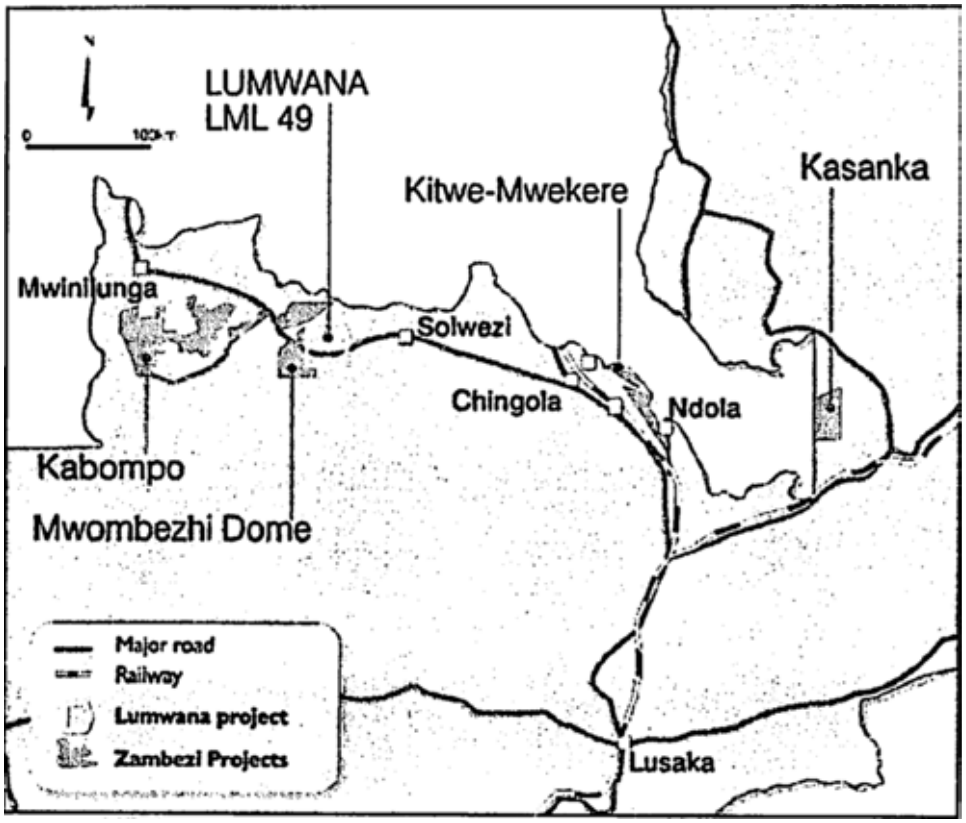
### 9.5.4 Lumwana MFEZ

Lumuwana Minig Company Limited, which is a subsidiary of Equinox Metals Limited (LMC) listed on the stock market in Canada and Australia, is to develop the Lumwana MFEZ in North West Province. It plans to invite participation by manufacturing industries based on a new mining project (i.e., Lumwana Copper Project), but the master plan has not yet been completed (see Figure 9.16).

The site area already contains open pit mining and related facilities and roads. It is equipped with systems for supply of water, including a reservoir with a capacity of 84 million $m^3$, and electrical power. In addtion, a high-voltage transmission line has been constructed between Solwezi and Lumwama. North-western Company, which was established as a regional power company, built a 7km line from ZESCO's 330/33 kV substation to Lumwan and a 33/11 kV substation in the town. LMC's consumption amounts to 50% of the line capacity.

The idea behind the MFEZ is to create a new manufacturing industry, which will surpass the existing Lumwana Copper Project. As an area development supporting the region's economic development, the MFEZ encompasses of industrial, recreational, residential, commercial, agricultural, and fishery development zones. The phases of the development are as follows:

| | |
|---|---|
| Phase 1 (2006-2009): | Development of open-pit mining and preparation of related infrastructure |
| Phase 2 (2010-2013): | Development of Lumwana Town, and education, commercial and medical facilities |
| Phase 3 (2014-2020): | Development and upgrading of road, railway and airport |




Source: Lumwana Minig Company, Lumwana Mult-Facility Economic Zone Master Plan (2006-2020)

**Figure 9.16 Access-road Network to Lumwana MFEZ**

### 9.5.5 Ndola MFEZ（Sub-Saharan Gemstone Exchange）

Ndola MFEZ is a lapidary-based small-size industrial park planned in Cooperbelt. The aim of the project is to heighten the value-added level of the export of the locally mined gemstones by cutting and polishing them. This is the first Zambian-capital industrial park, and 20 companies are to be recruited. Five have already commenced operations and employ around 100 peoples.

# Chapter 10 Case Study

In this chapter, objectives that study team and counterpart accred in the site survey, Itezi tezhi project and Lusiwasi expansion one, were described in Japanese edition,which was informative for strangers to Zambia and should be included in the final report of JICA study. However, most of the information here has less importance to formulate the power system master plan. For this reason, the contents of this chapter were transferred to Appendix C by request from Zambian side.

Sections in this chapter show below for someone's reference.

**10.1** Outline of Case Study

10.1.1 Objective

10.1.2 Project Selection

10.1.3 Methodology of Case Study

10.1.4 Schedule of Case Study

10.1.5 Participants in Case Study

**10.2** Itezhi-Tezhi Project

10.2.1 Examination of Technical Feasibility

10.2.2 Environmental and Social Considerations

**10.3** Lusiwasi Expansion Project

10.3.1 Examination of Technical Feasibility

10.3.2 Environmental and Social Considerations

# Chapter 11 Environmental and Social Consideration

## 11.1 Institutional Framework of Environmental and Social Considerations in Zambia

### 11.1.1 Laws and Regulations related to Environmental and Social Considerations

(1) Legal and Policy Framework related to Environmental Conservation

In Zambia, the Environmental Protection and Pollution Control Act, 1990 (EPPCA) and the relevant regulations constitute the basic framework for environmental conservation. The Act establishes the Environmental Council of Zambia (ECZ) and determines its organizational structure and functions, provides regulatory framework for water and air pollution and waste management, and provides natural resource management system.

Acts and regulations to be taken into account in this Environmental and Social Considerations Study (ESC Study) are listed below.

- Environmental Protection and Pollution Control Act, 1990
- Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997
- Air Pollution Control (Licensing and Emissions Standards) Regulations, 1996
- Water Pollution Control (Effluent and Waste Water) Regulations, 1993
- Waste Management (Licensing of Transporters of Wastes and Waste Disposal Sites) Regulations, 1993
- Hazardous Waste Management Regulations, 2001
- Zambia Wildlife Act, 1998
- Forest Act, 1999, and Forest Act, 1973
- Natural Resource Conservation Act, 1970
- Land Act, 1995
- Electricity Act, 1995
- Land Acquisition Act, 1995
- Electricity Act, 1995
- Zambezi River Authority Act, 1987
- National Heritage Conservation Commission Act, 1989

(2) Laws and Regulations regarding Environmental Impact Assessment

In Zambia, the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 stipulates the framework for Environmental Impact Assessment (EIA) including criteria for categorizing projects that require EIA, and the procedures of EIA. The Regulations require project proponents to produce either Project Brief (PB) or Environmental Impact Statement (EIS), depending on the significance of predicted impacts. PB or EIS is submitted to ECZ and assessed by ECZ. EIS is a report of EIA that is required when significant adverse impacts are predicted, while PB is a report of Initial Environmental Examination (IEE) that is required when the potential adverse impacts are expected to remain low or medium.

When significant impacts are identified as a result of the assessment of PB, ECZ may recommend a project proponent to elaborate EIS. Items to be clarified in EIS are presented below.

(c) a description of the project, reasonable alternatives, which may begin or increase operations to provide materials or services to the proposed project
(d) a description of the proposed site and reasons for rejecting alternative sites
(e) a brief description of the site and the surrounding environment including specifying any information necessary to identify and assess the environmental effects of the project
(f) a description of the raw material inputs into the project and their potential environmental effects
(g) a description of the technology and processes that shall be used
(h) a description of the products and by-products of the project
(i) the environmental effects of the project, and reasonable alternatives, including the direct, indirect cumulative, short-term and long-term effects
(j) the socio-economic impacts of the project such as resettlement of the affected people
(k) an impact management plan containing a description of measures proposed for preventing, minimising or compensating for any adverse impact, and enhancing beneficial effects, and measures to monitor effluent streams or important environmental features which may be affected by the project
(l) an indication of whether the environment of any neighbouring state is likely to be affected

Energy-sector-related projects that are required to produce PB or EIS are presented in the Table 11.1.

**Table 11.1 Energy Sector Projects which Require PB or EIS**

| Projects which require PB | Projects which require EIS |
|---|---|
| - Hydropower schemes and electrification<br>- Projects located in or near environmental sensitive areas | - Electricity generation station<br>- Electrical transmission lines - 220kV and more than 1 km long<br>- Surface roads for electrical and transmission lines for more than 1 km long<br>- Dams and barrages: covering a total of 25 ha or more<br>- All major roads outside urban areas, the construction of new roads and major improvements over 10 km in length or over 1 km in length if the road passes through a National Park, Game Management Area<br>- Clearance of forestry in sensitive areas such as watershed areas or for industrial use 50 ha or more |

(Source) Schedule 1 and 2 of Environmental Impact Assessment Regulations

Environmental Impact Assessment Regulations are basically applied to individual projects, and thus, a Master Plan is out of the scope of the regulations. EPPCA stipulates that ECZ "may identify … plans and policies for which environmental impact assessment are necessary and undertake or request others to undertake such assessments for consideration". However, the detailed procedures for the assessment of such plans and policies are not established at present.

(3) Environmental / emission standards

a) Emission standards for air pollutants

Table 11.2 indicates the emission standards for air pollutants related to power generation, which are specified by the Air Pollution Control (Licensing and Emission Standards) Regulations, 1996.

**Table 11.2 Emission Standards related to Burning Facilities**

| Facility type | Parameter | Emission limits |
|---|---|---|
| Oil fired < 50MW | Dust | 50 - 150 mg/$Nm^3$ |
| | $SO_2$ | 850 mg/$Nm^3$ |
| | CO | 100 mg/$Nm^3$ |
| Coal fired, <10 MW | Dust | 150 mg/$Nm^3$ |
| | $SO_2$ | 2000 mg/$Nm^3$ |
| Coal Fired, 10<50 MW | Dust | 50 mg/$Nm^3$ |
| | $SO_2$ | 1000 mg/$Nm^3$ |
| | CO | 175 mg/$Nm^3$ |

(Source) Third Schedule of the Air Pollution Control (Licensing and Emission Standards) Regulations, 1996

b) Emission standards for effluent and waste water

Standards for effluent and waste water related to power generation, which are provided by the Water Pollution Control (Effluent and Waste Water) Regulations, 1993 are indicated in Table 11.3. In particular, coolant water from thermal power plants should be given due considerations.

**Table 11.3 Relevant Standards for Effluent and Waste Water into Aquatic Environment**

| **Parameters** | **Emission Standards** |
|---|---|
| A. Physical | |
| Temperature (Thermometer) | 40 degrees Celsius at point of entry |
| Colour (Hazen Units) | 20 Hazen units |
| Odour and Taste (Threshold odour number) | Must not cause any deterioration in taste or odour as compared with natural state |
| Turbidity (NTU scale) | 15 Nephelometer turbidity units |
| Total suspended solids (Gravimetric method) | 100 mg/L must not cause formation of sludge or scum in receiving water |
| B. Bacteriological | |
| Algae /100 ml (Colony counter) | 1000 cells |
| C. Chemical | |
| pH (0-14 scale) (Electro-metric method) | 6.0 - 9.0 |
| Chemical Oxygen Demand (COD) (Dichromat method) | COD based on the limiting values for organic carbon 90 mg $O_2$/L average for 24 hours |
| Biochemical Oxygen Demand (BOD) | 50 mg $O_2$/L (mean value over 24 hours period) |
| (Modified Winkler method and Membrane Electrode method) | According to circumstances in relation to the self cleaning capacity of waters |

(Source) Extracted from 3rd Schedule of the Water Pollution Control (Effluent and Waste Water) Regulations, 1993

c) Noise

Environmental standards for noise are not yet established in Zambia, thus, ECZ refers to

international standards when it evaluates an Environmental Impact Statement. The Environmental Quality Standards for Noise in Japan are presented in Table 11.4 as reference. Category C may be appropriate for noise associated with the operation of thermal power plants.

**Table 11.4 Environmental Quality Standards for Noise in Japan**

| Type of Area | Standard Value | |
|---|---|---|
| | Daytime | Nighttime |
| AA | 50 dB or less | 40 dB or less |
| A and B | 55 dB or less | 45 dB or less |
| C | 60 dB or less | 50 dB or less |

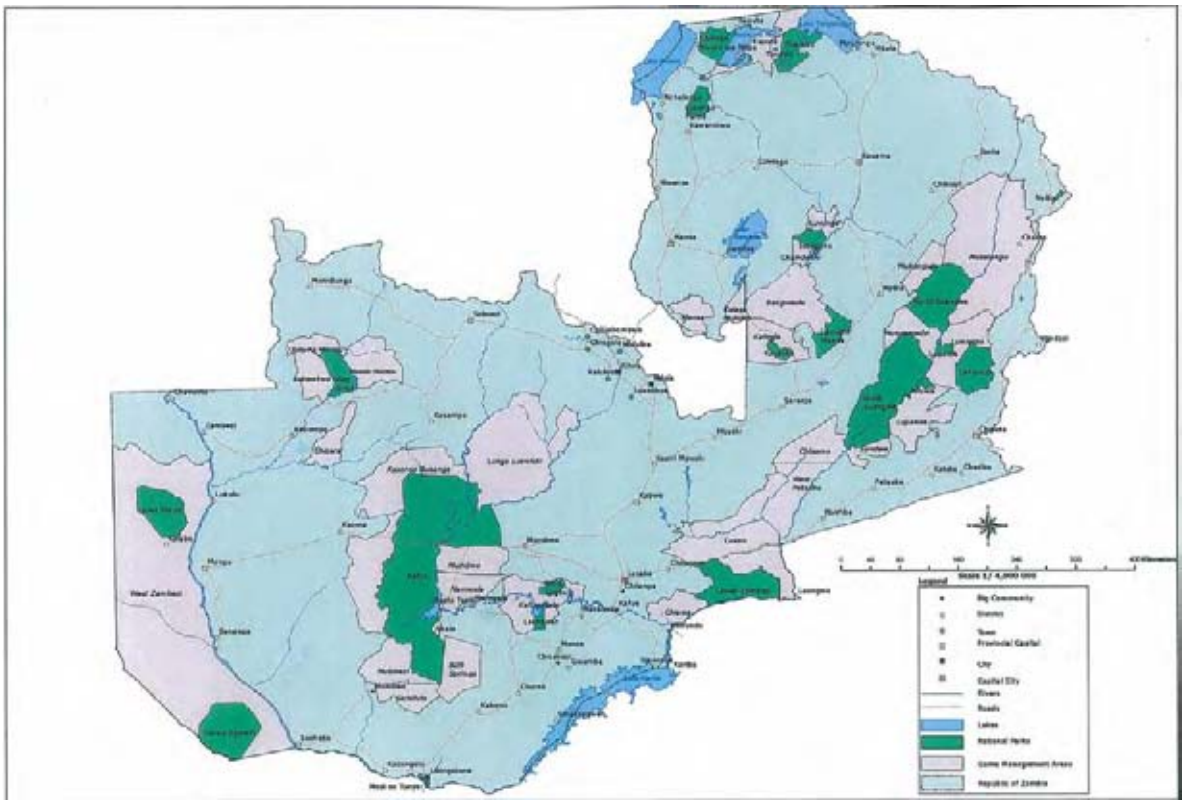
Notes:

1) In terms of the time category, daytime shall be the period from 6:00 a.m. to 10:00 p.m. and nighttime shall be the period from 10:00 p.m. to 6:00 a.m. of the following day.
2) Area category AA shall be applied to areas where quietness is specially required, such as those where convalescent facilities and welfare institutions are concentrated.
3) Area category A shall be applied to areas used exclusively for residences.
4) Area category B shall be applied to areas used mainly for residences.
5) Area category C shall be applied to areas used for commerce and industry as well as for a significant number of residences.

(4) Legal framework for protected areas

The Zambia Wildlife Act, 1998 provides a legal framework for protected areas, such as National Parks and Game Management Areas. The Act stipulates the establishment of Zambia Wildlife Authority (ZAWA), regulations on National Parks and Game Management Areas, protection of wildlife and license for wildlife hunting, permission of sales, import and export of wildlife, and penalties and enforcement provisions. In National Parks and other protected areas, for instance, habitation, hunting of wildlife, and killing and wounding wildlife are prohibited.

There are 19 National Parks, which covers 63,820 $km^2$ or accounts for 8.5% of Zambia's land surface. In addition to the National Parks, 35 Game Management Areas are designated and they account for 22 % of the land surface of Zambia. Three (3) Wildlife Sanctuaries are also designated to protect wildlife. Figure 11.1 demonstrates the distribution of the protected areas.



(Source) Zambia Wildlife Authority

**Figure 11.1 Distribution of the Protected Areas of Zambia**

Zambia became a contracting party of the Ramsar Convention[25] in December 1991. There are eight (8) wetlands registered under the Ramsar Convention, covering 4,030,500 ha, as indicated in Table 11.5. Electronic maps showing the distribution of these wetlands were not available.

**Table 11.5 List of Ramsar Sites in Zambia**

| Wetland | Area (ha) | Location | Description |
|---|---|---|---|
| Bangweulu Swamps | 1,100,000 | About 100 km east of Mansa, Northern Province | Bangweulu Swamps provides a breeding ground for birds, fish and wildlife (e.g., the African Elephant *Loxodonta africaca*, the buffalo *Syncerus caffer*, and Sitatunga *Tragelaphus spekei*, and Black Lechwe *Kobus leche*). It is home to the threatened Wattled Crane (*Grus carunculatus*), and the threatened Shoebill (*Balaeniceps rex*). The swamp is a natural flood controller and important for groundwater recharge. |
| Busanga Swamps | 200,000 | About 60 km south of Kasempa, Northwestern Province | A wide variety of ecosystem types such as swamps, lagoons, woodlands, rivers and large grassy plains are found. It hosts the vulnerable Wattled crane (*Grus carunculatus*), Cheetah (*Acinonyx jubatus*), and Lion (*Panthera leo*), and supports significant numbers of migratory birds and other fauna such as the Blue Duiker (*Cephalophus silvicultor*), Wildbeest (*Connochaetes gnou*) and Zebra (*Equus burchelli*). |

[25] The Convention on Wetlands of International Importance especially as Waterfowl Habitat

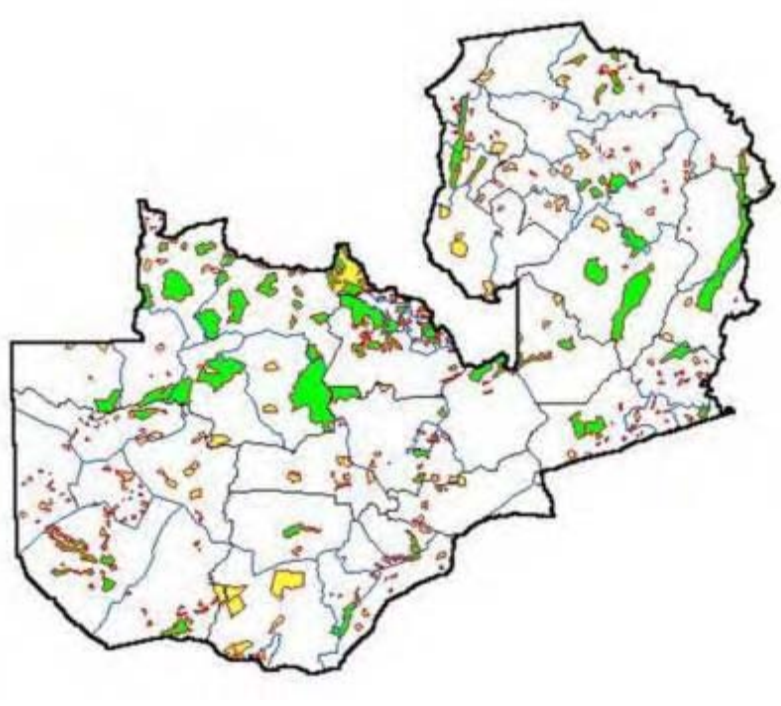
| Wetland | Area (ha) | Location | Description |
|---|---|---|---|
| Kafue Flats | 600,500 | About 60 km southwest of Lusaka, and about 50 km south of Mumbwa, Southern & Central Provinces | A vast expanse of floodplains, grasslands, woodland zones and geothermal areas of high biodiversity in a complex patter of lagoons, oxbow lakes, and river channels. The site supports many endangered and endemic species such as the endemic Kafue lechwe (*Kobus leche kafuensis*), and Wattled crane (*Grus carunculatus*). It hosts migratory birds such as the White pelican (*Pelecanus onocrolatus*) and the Cattle Egret (*Bubulcus ibis*), as well as 67 fish species. The site provides clean and plentiful water and acting as a natural sink for nutrients and other micro-elements |
| Luangwa Flood Plains | 250,000 | About 100 km Northwest of Chipata, and about 90 km of southeast of Mpika, Eastern Province | Representative of the major wetland types of Southern Africa, the site is dominated by rivers that recharge many springs, freshwater lakes, lagoons, marshes and streams. The main habitats include evergreen miombo woodlands (with wild mango, African ebony, fig, and Natal mahogany) and the alluvial zone which sustains riverine vegetation. The plains host over 50 mammal species, including the African wild dog (*Lycaon pictus*) and the critically endangered Black Rhino (*Diceros bicornis*). It is an important breeding ground for birds like *Merops nubicoides*, *Merops bullockoides*, and *Hirundo paludicola.* |
| Lukanga Swamps | 260,000 | About 45 km West of Kabwe, Central Province | The largest permanent water body in the Kafue basin, comprising generally shallow swamps. They are a suitable habitat for birds and wildlife, hosting a number of threatened species such as the Wattled Crane, the Red Lechwe, African python, and the sitatunga. The area is also an important breeding ground for fish, the most abundant of which is Tilapia, with *T. rendalli* and *T. sparmani.* |
| Mweru wa Ntipa | 490,000 | About 70 km Northwest of Mporokosa, Northern Province | The main features are rivers, swamps, and the Lake Mweru wa Ntipa basin, which is surrounded by flat wetland plains with itigi thickets and miombo woodlands. Evergreen forests on the river and lake shores are a home to more than 390 bird species such as the Wattled crane, Shoebill, Black stork, and Goliath's Heron. Other species found here include the slender-snouted crocodile (*Crocodylus cataphractus*), wild dog (*Lycaon pictus*) and Elephant (*Loxodonta Africana*). The Mweru wa Ntipa lake records a number of indigenous fish species like the Green-Headed Bream (*Oreochromis macrochir*), Sharp Toothed Barbel (*Clarias mossambicus*), Cat Fish (*Auchenoglanis occidentalis*), and Mweru sardine (*Poecilothrissa moeruensis*). |
| Tanganyika | 230,000 | North of Mpulungu, Northern Province | Includes the Zambian part of Lake Tanganyika. The Zambian shoreline (about 238km) is steep and rocky, with some areas of shallow swampy land and limited stretches of sandy beaches. The site has a rich diversity of vegetation and hosts the African elephant, lion, and wild dog. It also hosts endemic reptiles like the Lake Tanganyika Water Snake (*Lycodonomorphus bicolor*) and Water Cobra (*Boulengerina annulata*). The Zambian part of the lake hosts over 252 fish species, 82 of which are endemic (e.g., *Neolamprologus brichardi* and *Altolamprologus compressicep*). |
| Zambezi Floodplains | 900,000 | West of Mongu, Western Province | The second largest wetland in Zambia, chiefly riverine wetland consisting of the Zambezi River and its naturally formed floodplains. There is sparse riparian vegetation, small stands of *Acacia albida* in the floodplains, *Syzygium guineens* along the main river channel and patches of *Diplorhynchus* scrub and *Borassus* forest in the northern areas. Semi-evergreen woodlands have economically important species like *Baikiaea plurijuga* and *Pterocarpus angolensis*. The site hosts the Lion (*Panthera leo*), several endemic reptiles, the Blue Wildebeest (*Connochaetes taurinus*), and many water birds. It is an important spawning ground for about 80 different fish species. |

(Source) Website of the Ramsar Convention <http://www.ramsar.org/index.html#top>

(5) Forest

Forests in Zambia are managed by the Forest Act. Although the Forest Act 1999 was already approved by the Parliament, the Act 1999 is not yet in force since relevant regulations and guidelines are still in preparation. The Act 1973 is currently used for the forest administration. The Act 1973 consists of several provisions such as the establishment of the National and Local Forests, regulations in the National and Local Forests, licenses for tree-cutting, management of forest produces, and relevant regulations.

There are two categories of forests, namely the National Forest and the Local Forest. One hundred eighty (180) National Forests are currently designated covering 5,145,162 hectares or 6.8 % of the total land surface, and there are 307 Local Forests covering 2,076,062 hectares or 2.8 %.



[Legend] : National Forest : Local Forest

(Source) Forestry Department

**Figure 11.2 Distribution of Forest Reserves in Zambia**

(6) Legal framework for land tenure

Land in Zambia can largely fall into state land or customary land. The customary land constitutes more than 90 % of the total land of Zambia. The rights over the customary land are governed by the respective customary laws that can vary from region to region. The rights over the customary land are protected by the Land Act. It is, therefore, important to pay due attention to the customary laws governing a region where land acquisition for an undertaking will take place.

In terms of electricity projects, it is necessary to follow the provisions of the Electricity Act as

well as those of the Land Acquisition Act. The Land Acquisition Act stipulates the procedures for land acquisition in general, including preliminary investigation, notice of intention to acquire property, principles for assessment of compensation, establishment of the Compensation Advisory Board. The Electricity Act provides the land acquisition procedures of electricity-related project. In particular, the Act stipulates detailed provisions for transmission projects, including compensation for land and properties beneath transmission lines, right of entry into land beneath the lines, and removal of trees and buildings interfering with transmission lines.

(7) Legal and Policy Framework regarding Cultural Heritages

The National Heritage Conservation Commission Act provides the functions of National Heritage Conservation Commission (NHCC), and its organizational structure. In addition, the Act stipulates the declaration of national monuments, prohibition of alterations, removal and destruction, and protection measures for discovered ancient heritages and relics. The national heritages include both cultural and natural heritages, and they are officially designated by the recommendation of NHCC.

International Council on Monuments and Sites (ICOMOS), an international NGO engaging in the protection of cultural heritages, reported in 2001 that NHCC listed about 3,000 heritage sites such as archaeological and anthropological sites, historic and architectural buildings, engineering industrial structures, geomorphological, geophysical and ecology sites.

Zambia ratified the Convention concerning the Protection of the World Cultural and Natural Heritage in June 1984. "Mosi-oa-Tunya / Victoria Falls" is currently registered under the Convention, and four (4) properties are included in the tentative list (Table 11.6).

**Table 11.6 List of World Heritages of Zambia**

| Property Name | Status | Adjacent District, city |
|---|---|---|
| Mosi-oa-Tunya / Victoria Falls | Inscribed | In the vicinity of Livingstone, Southern Province |
| Mwela and adjacent areas rock art site (rock paintings) | Tentative List | 7 km east of Kasama, Northern Province |
| Dag Hammarskjoeld Memorial (crash site) | Tentative List | 10 km south-west of Ndola, Copperbelt Province |
| Kalambo falls archaeological site (prehistoric settlement site) | Tentative List | 30 km north-west of Mbala, Northern Province |
| The Barotse Cultural Landscape and Kuomboka Ceremony | Tentative List | In the vicinity of Mongu, Western Province |

(Source) UNESCO World Heritage Website <http://whc.unesco.org/>

### 11.1.2 Overview of Relevant Organizations

(1) Environmental Council of Zambia (ECZ)

ECZ was established based on the Environmental Protection and Pollution Control Act, 1990. The major functions of ECZ are the following:

- Identify projects or types of projects, plans and policies for which environmental impact assessment are necessary and undertake or request others to undertake such assessments for consideration by ECZ;

- Advise the Government on the formulation of policies relating to sustainable management of natural resources and environment;
- Conduct studies and make recommendations on standards relating to the improvement of the environment and the maintenance of a sound ecological system; and
- Consider and advise on all major development projects at an initial state and for that purpose ECZ may request information on the major development projects.

The Environmental Protection and Pollution Control Act, 1990 stipulates the organizational structure of ECZ and the council members. The Council consists of relevant ministries and government agencies, university researchers, representatives of the industrial sector and NGOs, and the chairman of the Council, who is appointed by the Minister, is responsible for the management of the Council. ECZ has four sections dealing with practical affairs, i.e., Pollution Control Inspectorate, Planning Environmental and Management, Human Resources, and Accounts and Finance. In addition, there are three regional offices at Ndola, Livingstone, and Chirundu Border.

(2) ZESCO

ZESCO has its own environmental policy (ZESCO Environmental Policy) comprising of the following five statements.

- ZESCO's ambition is to satisfy customers' demand for efficient, safe and environmentally friendly supply of electric energy.
- The natural resources on which our operations depend shall be harnessed with utmost possible care.
- In our effort to achieve environmental excellence in our operations, we shall continuously train and motivate all employees to perform their duties in an environmentally responsible manner.
- Facing our responsibility to enhance environmental protection, we shall take the interest of future generations into consideration when carrying out our development projects.
- In openness and with commitment to environmental issues related to power development, we shall endeavor to create and enjoy the confidence of our customers and other stakeholders in our actions and operations.

ZESCO established the Environmental and Social Affairs Unit (ESU) under the Engineering Development Directorate in 1996, aiming at effectively handling environmental and socio-economic issues related to the operations of ZESCO. ESU consists of fifteen (15) staff members, including the Manager, Environmental Information Specialist, Social Scientist, Environmental Scientist, Soil Scientist, Ecologist, Hydrologist and other technological and assistant staff. Thirteen (13) staff members are assigned as of February 2009. The main functions of ESU are described below.

- Ensuring that ZESCO operates in accordance with Zambian environmental regulations
- Developing environmental guidelines and environmental operational plans for ZESCO on various aspects
- Advising engineering and other ZESCO staff on environmental and social issues
- Training ZESCO staff in environmental and social issues

- Developing baseline environmental and socio-economic database for catchment areas where ZESCO operates
- Conducting environmental impact assessments for ZESCO projects to identify the impacts, recommend mitigation measures and monitoring implementation of recommended mitigation measures
- Supervising consultants hired to do environmental work for ZESCO projects pertaining to power generation, transmission and distribution
- Managing land acquisition, resettlement programmes and compensation related to implementation of ZESCO projects
- Conducting public meetings in project areas to ensure that the public understands the project being undertaken by ZESCO and to get their input on various aspects of the project.

(3) Zambia Wildlife Authority (ZAWA)

ZAWA was established by the Zambia Wildlife Act No.12 of 1998. ZAWA is responsible for controlling, managing and protecting protected areas, National Parks, Game Management Areas and Wildlife Sanctuary, designated based on the Act. It is also in charge of issuing all licenses and permits regarding the capture, hunting, import and export of wildlife. ZAWA consists of five major departments: Finance and Administration; Commercial; Operations; Research and Planning; and Game Management Areas.

## 11.2 Principles and Methodology for Environmental and Social Considerations

### 11.2.1 Basic Principles

This study formulates a master plan for power development extending to the year 2030. Although the formulation of the master plan does not directly cause any adverse environmental and social impacts, sub-projects included in the plan will cause such impacts. This study, therefore, conducted environmental and social consideration (ESC) study in accordance with the JICA Guidelines for Environmental and Social Considerations.

The objectives of ESC study at the master plan stage are to identify potential impacts at an earlier stage, and to mitigate or avoid serious adverse impacts by taking necessary measures against the impacts when determining detailed locations and specifications of facilities. Identifying environmental and social impacts prior to the determination of the details of sub-projects will make it possible to take appropriate measures at an earlier stage. In addition, clarifying points to consider at the master plan stage will contribute to the smooth implementation of EIA at the subsequent stages, i.e. a feasibility study (F/S) stage or a detailed design study (D/D) stage.

This ESC Study, based on the above views, conducts an Initial Environmental Examination (IEE) on environmental and social impacts anticipated at the master plan stage. It is at the F/S or D/D stage that environmental and social impacts can be appropriately assessed taking into account the site-specific conditions and detailed specifications.

The study pays due attentions to the following points.

1) Implementation of the ESC study incorporating the perspective of Strategic Environmental Assessment (SEA)

This ESC study identifies points to be noted prior to the determination of detailed locations and sub-project components by predicting potential environmental and social impacts and considering necessary measures. The result of the ESC study is incorporated into the master plan.

2) Clarification of points to consider at the F/S stage

This ESC study clarifies points to consider and necessary procedure in an environmental and social assessment at the F/S stage. It is also expected to be utilized as a preliminary assessment in the F/S.

### 11.2.2 Methodology for Environmental and Social Considerations Study

This ESC study carries out the IEE on impacts predicted at the master plan stage. Potential impacts and necessary mitigation measures were examined based on literature reviews, surveys on sampled power facilities, and interviews to stakeholders. The sample facilities are presented in Table 11.7.

**Table 11.7 List of Sampled Power Facilities**

| Facility Type | Location/ Name |
|---|---|
| Hydropower Plant | - Kafue, Lusaka Province: Kafue Gorge<br>- Kariba, Southern Province: Kariba North<br>- Livingstone, Southern Province: Victoria Falls<br>- Central Province: Lusiwasi |
| Substation | - Chongwe, Lusaka Province: Leopards Hill<br>- Mazabuka, Southern Province: Mazabuka<br>- Choma, Southern Province: Choma |
| Transmission | - Transmission lines around Lusaka<br>- Transmission lines around Kafue<br>- Transmission lines around Kariba |

(Source) JICA Study Team

The Study Team, in collaboration with officials of DOE and ZESCO, conducts the scoping of potential environmental and social impacts of sub-projects, and elaborates mitigation measures. The scoping result was then consulted with ECZ and other related institutions, and finalized.

## 11.3 Environmental and Social Impacts

### 11.3.1 Components of Master Plan

This study aims at formulating the master plan extending to the year 2030, which covers the following three (3) components.

1) A plan for optimal generation
   An optimal generation plan for hydropower development and coal-fired thermal power development

2) A plan for the transmission and distribution system
   An optimal transmission and distribution plan with the view of the conformity with the optimal generation plan and consideration for voltage grades

3) A plan for international power interchange
   An international power interchange plan based on the rough calculation of power export and import, and verification of the interconnection capacity

In terms of the plan for power development, seventeen (17) hydropower projects were identified in the Study as presented in Table 6.31. Of these, Ten (10) projects are shortlisted since their feasibilities are considered higher.

### 11.3.2 Examination of Alternatives

Possible alternatives to be examined in this ESC study are the following.

1) Comparison of power development scenario
2) Site selection for hydropower development
3) Zero-option scenario

The basic stance on the examination of the above three (3) alternatives in this ESC study is presented below.

1) Comparison of power development scenario

   The master plan study proposes two scenarios, 1) a base case or Scenario 1-1; and 2) a scenario to encourage private investment in coal thermal power plants or Scenario 1-2. Sub-projects included in the respective scenarios are described in Chapter 8. The main differences between the two are the following: 1) Scenario 1-1 includes only one coal thermal power plant, i.e., the Maamba power plant, while Scenario 1-2 proposes additional three coal thermal plants; and 2) Scenario 1-2 does not refer to two hydropower plants included in Scenario 1-1, i.e., the Batoka Gorge and Mambilima Falls I, though the scenario includes a total of four coal thermal power plants. In terms of the three coal thermal plants proposed in Scenario 1-2, the detailed locations are not yet determined.

   Table 11.8 compares major potential impacts of the two scenarios.

**Table 11.8 Comparison of Power Development Scenarios: Environmental and Social Impacts**

| Impacts | Scenario 1-1 | Scenario 1-2 |
|---|---|---|
| Involuntary Resettlement | Significant (Creation of a Reservoir) | Minor |
| Local Economy and Land Use | Significant (Creation of a Reservoir) | Minor |
| Infectious Diseases (HIV/AIDS) | be in the same range | be in the same range |
| Hydrology | Significant (Creation of a Reservoir, Water Intake from Rivers) | Minor |
| Biodiversity | Significant (Creation of a Reservoir) | Minor |
| Air Pollution | Minor | Significant ($SO_2$, $NO_2$, SPM, etc.) |
| Soil Contamination | Minor | Significant (Fly Ash, Coal Ash) |
| Waste | Minor | Significant (Fly Ash, Coal Ash) |

Note 1: "Significant" and "Minor" indicates relative significance between the two scenarios.
Note 2: Items in brackets are main cause of adverse impacts
(Source) JICA Study

Comparison of Scenario 1-1 and 1-2 demonstrates that Scenario 1-1 involves impacts whose extent depends largely on the location of a project site, while Scenario 1-2 involves impacts related to pollution. The former includes involuntary resettlement and biodiversity, and the latter includes air pollution and wastes.

2) Site selection for hydropower development

The main component of the master plan is hydropower development. Hydropower development projects, in general, involve impacts whose extent greatly varies according to their location such as impacts on ecosystem and involuntary resettlement. Such impacts may cause significant adverse and irreversible impacts, and thus it is critical to consider alternatives when selecting the sites.

This master plan study will roughly indicates locations of new hydropower development projects, though the locations will not be determined in detail. The details of many projects are not determined yet, but will be determined in or prior to the F/S stage. This study therefore tries to confirm the distribution of protected areas, densely populated areas and cultural heritages, adjacent to the project sites based on available map information and other sources. The study then clarifies points to consider when selecting respective project sites.

3) Zero-option scenario

A zero-option scenario means a case without the power system development master plan. In considering the zero-option scenario, the environmental and social impacts of the zero-option scenario are compared with those caused by sub-projects included in the master plan.

Even in the zero-option scenario, power system development is expected to be carried out to meet the increasing power demand. However, the development will not be conducted in a planned manner without the plan, and as a result, serious impacts on peoples'

lives and economic activities will be unavoidable such as frequent power cuts and increase in electricity tariff. In addition, it will become hard to achieve the national targets for poverty reduction, i.e., increasing the rural electrification rate from 2 percent to 50 percent, and the urban electrification rate from 48 percent to 90 percent by 2030.

The case where power development is conducted in a planned manner is deemed more desirable than the case where power development is unplanned in order to avoid or mitigate potential environmental and social impacts. This is because the former case will enable project proponents and other stakeholders to predict potential impacts, and to prepare and take necessary measures. The former therefore will cause less significant impacts than the latter.

Based on the above considerations, an alternative pursuing the zero-option scenario is not considered in this ESC study.

### 11.3.3 Scoping Result

Formulation of the master plan per se does not cause any environmental and social impacts. Sub-projects included in the master plan, however, are expected to cause certain adverse impacts. This ESC study therefore identifies potential adverse impacts in general, but it does not refer to detailed or site-specific impacts since the master plan does not determine the candidate sites or project components in detail. Impacts may vary from sub-project to sub-project, and thus, the sub-projects with more significant impacts are featured during the scoping of potential impacts. Points to consider in conducting the scoping at the F/S phase are also described. Table 11.9 demonstrates the scoping result of the sub-projects included in the master plan.

**Table 11.9 Scoping table for potential impacts of sub-projects**

| Impacts | Hydro | | Thermal | | Transmis-sion | |
|---|---|---|---|---|---|---|
| | Construc-tion | Operation | Construc-tion | Operation | Construc-tion | Operation |
| Involuntary Resettlement | A | A | B | B | B | B |
| Impacts on Local Economy (employment and livelihood) and Land Use | A | A | B | B | B | B |
| Impacts on Local Social Institutions such as Decision-making Institutions | B | B | C | C | C | C |
| Impacts on the Livelihoods of Indigenous Peoples and Ethnic Minorities | C | C | C | C | C | C |
| Local Conflict of Interests and Inequality | C | C | C | C | | |
| Water Usage and Water Rights | B | B | | C | | |
| Sanitation and Infectious Diseases such as HIV / AIDS | B | B | B | C | B | C |
| Cultural Heritage | C | C | C | C | C | C |
| Topography and Geological Features | C | | C | | C | |
| Soil Erosion | C | B | C | C | C | C |
| Local Hydrology and Groundwater | C | A | | C | | |
| Flora and Fauna, and Biodiversity | A | A | C | C | B | C |
| Landscape | B | B | C | C | B | B |
| Global Warming | | | | C | | |
| Air Pollution | | | | B | | |
| Water Pollution | C | C | | C | | |
| Soil Contamination | | | | C | | |
| Waste | B | B | B | A | B | |
| Noise and Vibration | C | | C | C | C | C |
| Ground Subsidence | | C | | C | | |
| Offensive Odor | | | | | | |
| Bottom Sediment | | B | | C | | |
| Accident and Safety | B | C | B | C | B | C |

[Legend] A: Significant impacts expected B: Certain impacts expected
C: Impacts unknown D: Negligible impacts

The current environmental and socio-economic conditions of Zambia and the detailed anticipated impacts are described in the following sections.

(1) Involuntary Resettlement

**[Hydropower]** The master plan recommends the construction of hydropower stations. If villages are found in the vicinity of a proposed dam site, large-scale involuntary resettlement will take place. In terms of hydropower development projects, possibility to cause involuntary resettlement is considered high because many of them involve the construction of new dams except for projects using existing dams such as Kariba-North Extension and Itezhi-Tezhi. In particular, reservoir-type projects which require large reservoirs, such as the

Batoka Gorge and Mpata Gorge, will cause large-scale involuntary resettlement. On the other hand, run-off-river type projects, which require relatively small reservoirs, may cause certain impacts depending on the scale of planned facilities. The scale of involuntary resettlement will also vary depending on the distribution of villages. For instance, the Kafue Gorge Lower Project will not cause involuntary resettlement or will cause minor scale of involuntary resettlement since there are few villages in the sites to be submerged. Impacts of involuntary resettlement on local residents' livelihoods will continue after the operation of the facilities starts.

At the F/S phase of individual projects, it is necessary to conduct surveys on the distribution of villages around the proposed project sites and the areas to be submerged, and to identify the scale of the impacts.

**[Thermal Power]** A plan for the construction of a coal-fired thermal power plant in Maamba of Sinazongwe District is currently under consideration. Maamba Ward is a relatively large ward in the District with the population of approximately 10,000[26]. In addition to the Maamba project, three (3) coal thermal projects are proposed in Scenario 1-2. Sites around Kitwe and Kapiri Mposhi are tentatively proposed as the candidate sites for these projects. Although the possibility that the thermal power plant is constructed in the densely populated area is low, small-scale involuntary resettlement may be required if some households are found in the vicinity of the planned construction site. Impacts of involuntary resettlement on local residents' livelihoods will continue after the operation of the power stations starts.

**[Transmission]** The master plan will recommend the construction of transmission and sub-transmission lines. A way-leave size of a transmission line is 25m wide from the centre of the line on either side, and trees in this area will be regularly cut for maintenance. Although densely populated areas are in general to be avoided when determining the route of transmission and sub-transmission lines, small-scale involuntary resettlement may be required depending on the selected routes. Impacts of involuntary resettlement on local residents' livelihoods will continue after the completion of the civil works.

(2) Impacts on Local Economy (employment and livelihood) and Land Use

**[Hydropower]** The construction of a hydropower station with a reservoir may cause changes in land use pattern due to the submersion of agricultural and forestry land, and other types of land. It may also cause the relocation of the whole of or part of villages, the acquisition of land, and the loss of livelihood means due to the submersion of land and buildings. Impacts on local residents' livelihoods will continue after the operation of the facilities starts.

**[Thermal Power]** The construction of thermal power stations may cause the relocation of households and commercial buildings, and the restriction of agricultural land use, and the acquisition of land. This may have certain adverse impacts on local economy. Impacts on local residents' livelihoods will continue after the operation of the power plants starts.

**[Transmission]** The construction of transmission and sub-transmission lines may cause land

[26] Central Statistical Office. (2003) *Census of Population and Housing*

acquisition, the temporary restriction of land use, and the relocation or closing of stores. Entry into the land beneath transmission lines is restricted because the areas of either side of power lines are set as "Right of Way" for the purpose of maintenance and safety. Impacts on local residents' livelihoods will continue after the completion of civil works.

(3) Impacts on Local Social Institutions such as Decision-making Institutions

**[Hydropower]** If the whole or considerable part of villages is submerged as a result of the construction of hydropower stations, some impacts such as loss or malfunction of local institutions may be predicted. Reservoirs to be constructed may cause separation in local society due to the creation of barriers for passage.

**[Thermal Power]** It is prohibited for local residents to enter into the site of power stations, thus social separation might be caused due to the passage obstruction depending on the layouts of power stations. Occurrence/ nonoccurrence of such impacts is unclear at present since it relies heavily on the contents of individual project plans.

**[Transmission]** Passage under transmission / sub-transmission lines may be restricted due to the Right of Way for maintenance and safety, thus social separation might be caused depending on the routes of the lines. Occurrence/ nonoccurrence of such impacts is unclear at present since it relies heavily on the contents of individual project plans.

At the F/S phase of individual projects, it is necessary to consult with chiefs and local residents around proposed project sites to identify social institutions to be given due considerations, and impacts to be caused by the proposed projects.

(4) Impacts on the Livelihoods of Indigenous Peoples and Ethnic Minorities

**[Hydropower, Thermal, Transmission]** Designated habitats for indigenous peoples and ethnic minorities were not identified in this master plan study. However, if such habitats are found in the vicinity of generation facilities, reservoirs and the routes of transmission lines to be constructed, certain impacts may be predicted such as the relocation of houses and the loss of livelihood means. Existence/ nonexistence of habitats of indigenous peoples and ethnic minorities should be investigated at the F/S phase.

(5) Local Conflict of Interests and Inequality

**[Hydropower]** In terms of damages such as the submersion or relocation of houses and other adverse impacts, the specific groups of local residents may suffer more than others depending on the location of reservoirs and facilities. This may cause a sense of inequality among the local residents.

**[Thermal Power]** Misdistribution and inequality such as concentration of pollution on a particular area may take place depending on the location or specification of planned power stations.

Occurrence/ nonoccurrence of the above impacts is unclear at present since it relies heavily on the contents of individual project plans. At the F/S phase of individual projects, it is necessary to pay due attention to whether proposed projects cause local conflicts of interests and inequality.

(6) Water Usage and Water Rights

**[Hydropower]** Water resources of rivers to be developed for hydropower generation are already developed for other uses than power generation, such as irrigation. Water intake for power generation may cause conflicts with water intake for irrigation and other usage. In particular, international river basins such as the Zambezi basin require due coordination, otherwise conflicts over water may take place.

**[Thermal Power]** Thermal power stations require the considerable amount of coolant water, and thus the intake of the coolant water may affect local water usage and water rights. It is therefore necessary to confirm the required amount of coolant water, and to conduct surveys on local water usage and water rights related to water bodies where coolant water is taken.

(7) Sanitation and Infectious Diseases such as HIV/ AIDS

HIV-infection rate in Zambia is estimated 15.2 % of the adult population according to the report of UNAIDS[27].

**[Hydropower]** HIV/ AIDS could spread as a result of the long-term inflow of construction workers into construction sites. Risk of malaria, chistosomiasis and other water-borne diseases may increase as a result of the creation of reservoirs. If a project causes large scale involuntary resettlement, problems of sanitation and infectious disease may be caused in relocation destinations.

**[Thermal Power]** The risk of HIV/ AIDS spread may increase due to the inflow of construction workers into construction sites. Problems of sanitation and infectious diseases might be caused in relocation destinations since involuntary resettlement may take place even though the resettlement will be small scale. Occurrence/nonoccurrence of such impacts in relocation destinations is unclear at present.

**[Transmission]** The construction of transmission/ sub-transmission lines will not require large-scale civil engineering works compared with power generation development, and the number of construction workers will smaller in many cases, but the possibility of HIV/ AIDS spread is undeniable. Problems of sanitation and infectious diseases might be caused in relocation destinations since involuntary resettlement may take place even though the resettlement will be small scale. Occurrence/nonoccurrence of such impacts in relocation destinations is unclear at present.

(8) Cultural Heritage

As described in **Table 11.6**, one heritage is registered with the World Heritage Convention, and four are submitted on the tentative list. Furthermore, the National Heritage Conservation Commission listed about 3,000 cultural and natural heritages. When planning power development projects, due considerations should be given to such heritages, though all of them are not designated as national cultural heritages.

**[Hydropower]** If the whole or part of villages is submerged as a result of hydropower

[27] UNAIDS. (2008) *Report on the Global HIV/ AIDS Epidemic 2008.*

development, the loss of local heritages such as cultural and religious facilities, cemeteries and traditional buildings is inevitable.

**[Thermal Power and Transmission]** If local heritages such as cultural and religious facilities are found in the vicinity of the planned construction sites and routes of transmission/ sub-transmission lines, certain impacts on the local heritages may be caused including the loss or relocation of the heritages, and impacts on the local landscape.

Occurrence/nonoccurrence of the above impacts is unclear at present since it relies heavily on the contents of individual project plans. At the F/S phase of individual projects, it is necessary to confirm existence/ nonexistence of cultural heritages around project sites, and to predict impacts caused by proposed projects.

(9) Topography and Geological Features

**[Hydropower, Thermal Power and Transmission]** Submersion of land caused by the creation of reservoirs and land formation for the construction of power facilities and transmission lines may cause loss or damage of valuable topography and geological features. Although such topography and geological features are not identified in this master plan study and occurrence/nonoccurrence of such impacts is unclear, it is necessary to conduct surveys on such features around project sites at the F/S phase.

(10) Soil Erosion

**[Hydropower]** Soil erosion may occur due to the construction of power facilities and dams. Soils around reservoirs may be eroded.

**[Thermal Power]** Soil erosion may occur during construction works, depending on the site selection of power plants.

**[Transmission]** If the routes of transmission/ sub-transmission lines are set on hilly lands, soil erosion may occur during civil works.

Although occurrence/nonoccurrence of the above impacts is unclear at present except soil erosion at newly created reservoirs, it is necessary to predict the possibility of soil erosion and the extent by surveying the topographic and geological conditions of project sites at the F/S phase of individual projects.

(11) Local Hydrology and Groundwater

**[Hydropower]** Water intake from rivers and the creation of reservoirs or low-water section will affect the hydrology of the rivers to be developed. Such impacts on local hydrology will also affect the distribution and amount of nearby groundwater.

**[Thermal Power]** The intake of coolant water for the operation of thermal power plants may have some adverse impacts on local hydrology. Although occurrence/nonoccurrence of such impacts is unclear at present since it depends heavily on individual project plans, it is necessary to predict impacts of coolant water intake on local hydrology and groundwater at the F/S phase of individual projects, based on the characteristics of water bodies from which coolant water is taken and the amount of water to be taken.

(12) Flora and Fauna, and Biodiversity

The distribution of protected areas and reserved forests are indicated in Figure 11.1 and Figure 11.2 respectively. If power development projects are planned in the vicinity of these protected areas and forests, impacts on flora and fauna are of concern.

**[Hydropower]** Hydropower development will have adverse impacts on floras and faunas such as the habitat loss of wildlife by reservoir creation, impacts on water creatures caused by changes in river flow, and clearance of trees for land formation. Many hydropower development projects included in the master plan are planned within or in the vicinity of National Parks and Game Management Areas. In particular, most of the shortlisted projects are planned in or around protected areas, namely Itezhi-Tezhi, Lusiwasi Expansion, Mutinondo, Luchenene, Lunsemfwa, Mkushi, Kabompo Gorge, Kabwleume Falls, Kundabwika Falls, and Kafue Gorge Lower. These projects may cause significant impacts on local ecosystems by the creation of reservoirs or extraction from nearby rivers.

**[Thermal Power]** There are no protected areas and forest reserves around Maamba where a coal-fired thermal generation station is planned to be constructed. Land formation for the construction of thermal power stations, however, might cause certain ecological impacts by the clearance of forests and loss of wildlife habitats. The other coal thermal plants are proposed to be constructed in the vicinity of Kitwe and Kapiri Mposhi. No protected areas are found around these sties, but certain ecological impacts such as vegetation clearance might also be anticipated like the Maamba project. Although occurrence/nonoccurrence of the above impacts is unclear at present since it relies on the contents of individual project plans, it is necessary to conduct surveys on the possibility of vegetation clearance and its extent at the F/S phase.

**[Transmission]** Forest clearance will be necessary for the construction of transmission/ sub-transmission lines. If the lines pass through protected areas and forest reserves, some impacts on flora and fauna are anticipated. Certain areas of either side of the lines are “Right of Way” where trees are regularly cleared for maintenance. Of the urgently needed projects proposed in the master plan, Improvement of Transmission System in North-East Area may pass through areas dotted with many protected areas, such as Lavushi-Manda National Park and Kasanka National Park located several tens of kilometers north of Serenje and Isangano National Park located in 100 km south of Kasama. Development of Transmission Line from Itezhi-Tezhi Power Station to Lusaka is expected to go through Kafue Flats and nearby protected areas. It is therefore required to carefully survey impacts on vegetation and wildlife animals of protected areas, when selecting the routes of these transmission lines.

(13) Landscape

**[Hydropower]** Local landscape may be significantly changed due to the construction of hydropower stations and creation of reservoir. At the F/S phase of individual projects, it is necessary to identify the extent of impacts on local landscape based on opinions of local stakeholders.

**[Thermal Power]** Buildings and high stacks may affect local landscape depending on the location of a power plant. At the F/S phase, it is necessary to conduct surveys on existence/ nonexistence of the impacts, taking into account the topography of project sites and opinions of local stakeholders.

**[Transmission]** In Zambia, towers of transmission lines are about 20 m high for 132kV lines, while more than 20 m for 330kV lines, hence local landscape may be affected. At the F/S phase, it is necessary to identify the extent of impacts on local landscape based on opinions of local stakeholders.

(14) Global Warming

**[Hydropower and Transmission]** Small amount of greenhouse gases (GHG) will be emitted from heavy machinery and construction vehicles for civil-engineering works, forest clearance for construction works, and submersion of forest by reservoir creation. However the impacts on climate change are negligible.

**[Thermal Power]** Heavy machinery and construction vehicles emit small amount of GHG, but the contribution of the GHG to global warming is negligible. Combustion of coal for power generation will continuously emit a certain amount of GHG. The degree of the impacts is unclear at present, thus it is necessary to predict the emission amount of greenhouse gases at the F/S phase based on the capacities and specifications of power plants, and the qualities of fuels.

(15) Air Pollution

**[Hydropower and Transmission]** Negligible amount of air pollutants will be emitted from heavy machinery and construction vehicles.

**[Thermal Power]** Heavy machinery and construction vehicles emit negligible amount of air pollutants. Combustion of coal for power generation will emit some amount of air pollutants such as sulfur dioxide and nitrogen dioxide.

(16) Water Pollution

**[Hydropower]** Construction works may cause the inflow of muddy water into rivers to be developed, and the creation of reservoirs may deteriorate the water quality of the rivers. Occurrence/nonoccurrence of water pollution is unclear at present since it depends heavily on the components of individual projects and the locations of related facilities. At the F/S phase of individual projects, it is necessary to predict the level of water pollution by surveys on water flows and volume of nearby water bodies and pollution sources around project sites.

**[Thermal Power]** Coolant water discharged from a thermal power plant may affect the water quality of a nearby water body depending on its quality and temperature. If chemicals are used to prevent water creatures from adherence to the inside of coolant pipes, such chemicals may cause water pollution. Occurrence/nonoccurrence of water pollution is unclear at present since it depends heavily on the components of individual projects and the locations of related facilities. At the F/S phase of individual projects, it is necessary to confirm the

disposal process of coolant water, and to predict occurrence/ nonoccurrence of water pollution and its level.

(17) Soil Contamination

**[Thermal Power]** There is a slight concern about soil contamination associated with the inappropriate disposal of coal ash and fly ash. Although the occurrence/nonoccurrence and its degree of soil contamination are unclear at present, it is necessary to confirm the disposal process of coal ash and fly ash when determining the detailed specifications of facilities.

(18) Waste

**[Hydropower and Transmission]** The construction of hydropower facilities, transmission/ sub-transmission lines and substations will generate waste soil and construction wastes. The operation of thermal power plants and transmission lines will also generate wastes. In terms of transmission projects, waste transformer oils contaminated by Polychlorinated Biphenyl (PCB) may be discharged associated with the replacement of old transformers.

**[Thermal Power]** Construction of power stations will generate wastes such as waste soils and construction wastes. Coal ash and fly ash will be continuously generated during the operation of coal thermal power stations. Coal ash and fly ash are strong alkaline materials and may contain heavy metals depending on the quality of coal fuels, thus, if improperly disposed of, they may cause soil contamination and groundwater pollution.

(19) Noise and Vibration

**[Hydropower, Thermal Power and Transmission]** The construction of hydropower facilities, transmission/ sub-transmission lines and substations will cause a certain level of noise and vibration. In particular, if there are villages in the vicinity of construction sites, a certain level of noise impacts on local residents' livelihoods is anticipated. Operation of a thermal plant will cause a certain level of noise. Transformers with high capacity will discharge low-frequency noise that can reach tens of meters. Whether a project causes noise impacts on neighboring communities is unclear since it relies heavily on the layout plans of individual projects. At the F/S phase of individual projects, it is necessary to predict the level and extent of noise and vibration based on the distribution of villages around project sites and layout plans of individual facilities.

(20) Ground Subsidence

**[Hydropower]** Ground subsidence may occur depending on the ground stability of the construction sites for dam of sub-projects. Occurrence/nonoccurrence of ground subsidence is unclear at present, but it is necessary to conduct a geologic survey, when the detailed plan is determined, to identify possibility of ground subsidence and the degree.

**[Thermal Power]** If coolant water is taken from groundwater, operation of thermal power stations might cause ground subsidence. Occurrence/nonoccurrence of ground subsidence is unclear at present since it depends on individual project plans. For projects that plan to extract coolant water from groundwater sources, it is necessary to predict the possibility of

ground subsidence by surveying the quantity of groundwater at the F/S phase.

(21) Bottom Sediment

**[Hydropower]** Deposited materials may flow into reservoirs. At the F/S phase of individual projects, it is necessary to predict the level of bottom sediment by surveying expected amount of the inflow of deposited materials.

**[Thermal Power]** Coolant water discharge might cause adverse impacts on the bottom sediments of nearby water bodies. The occurrence/nonoccurrence of the impact is unclear at present since it depends on individual project plans. At the F/S phase of individual projects, it is necessary to survey on quality of discharged water based on the planned disposal system for coolant water.

(22) Accident and Safety

**[Hydropower]** Accidents during construction works may take place. Water discharge from dams might cause damages of local residents.

**[Thermal Power]** Accidents during construction works and unintended leaks of hazardous coal ash may take place.

**[Transmission]** In addition to accidents during construction works, transmission/ sub-transmission lines may be broken down or hang down to the ground by disasters.

Occurrence/nonoccurrence of impacts related to the operation of power facilities is unclear since it relies on the components and locations of individual projects. At the F/S phase of individual projects, it is necessary to confirm the safety measures based on the topography and geology of project sites, the distribution of nearby villages, and planned civil works and construction schedule.

### 11.3.4 Mitigation Measures for the Potential Impacts

(1) Considerations at the master plan stage

The basic policy of the environmental and social considerations at the master plan stage is to identify sub-projects with potential significant impacts, and then to avoid such impacts in planning sub-projects or to elaborate necessary mitigation measures at earlier phases. In particular, impacts whose significance depends on the location such as involuntary resettlement and impacts on the protected areas and wildlife need to be taken into consideration when selecting sub-project site.

The Study team tried to identify areas with potential significant impacts based on map information and other available information, in consultation with relevant institutions, and then tried to avoid the areas in elaborating the master plan.

(2) Mitigation measures at project implementation stage

Project implementation stage can be divided into a feasibility study (F/S) phase, a basic design study (B/D) phase or a detail design study (D/D) phase, and a construction phase. Environmental Impact Assessment (EIA) is in general carried out at the F/S phase, and mitigation

measures identified in the EIA are further elaborated at the B/D or D/D phases, then the measures are put into practice at the construction phase. This section aims to clarify points to consider for the convenience of the future preparation of EIA at the F/S phase.

1) Involuntary resettlement

When selecting sub-project sites, it is necessary to consider the possibility of alternatives to avoid involuntary resettlement as much as possible. Project proponents need to ascertain the physical and social conditions of candidate sites through field investigations and consultations with local representatives, such as chiefs, opinion leaders and district council members. Based on the information, sites with the high possibility of involuntary resettlement should be avoided. If involuntary resettlement is unavoidable, it is important to hold sufficient consultations with affected people and local representatives to obtain their agreement. A sub-project-specific resettlement plan, including the amount of compensation, support for restoring income and livelihoods, system for accepting and processing complaints and monitoring mechanism of the livelihoods of relocated households, shall be formulated and implemented. It should be noted that the monitoring needs to be continued, as appropriate, after the completion of construction works. The following items should be included the sub-project-specific resettlement plan at least.

1. Scope of land acquisition and resettlement
   - Scope of land acquisition and resettlement and the necessity
   - Alternative options to minimize land acquisition and resettlement
   - Key effects in terms of land acquired, assets lost, and people displaced from homes

2. Socioeconomic information
   - Definition and number of people to be affected
   - Impacts on people to be affected, taking into account social, cultural and economic parameters
   - Identification of all losses for people to be affected
   - Impacts on the poor, indigenous peoples, ethnic minorities, and other vulnerable groups and any special measures needed to restore/ enhance their economic and social base

3. Objectives, policy framework, and entitlements
   - Objectives of land acquisition and resettlement
   - Key national and local land, compensation and resettlement policies, laws, and guidelines
   - Eligibility of people who receive compensation and other supports

4. Consultation, and grievance redress participation
   - Identification of stakeholders
   - Mechanisms for stakeholder participation in planning, management, monitoring, and evaluation.
   - Identification of local institutions or organizations to support people affected, and potential role of NGOs
   - Procedures for redress of grievance by people affected

5. Relocation of housing and settlements
   - Options for relocation of housing and other structures, including replacement housing, replacement cash compensation, and self selection
   - Measures to assist with transfer and establishment at new sites
   - Options for developing relocation sites
   - Plan for layout, design, and social infrastructure for each site
   - Means for safeguarding income and livelihoods, and measures for planned integration with host communities
   - Special measures for addressing gender issues and those related to vulnerable groups

6. Income restoration strategy
   - Income restoration strategy
   - Job opportunities, including provisions for income substitution, retraining, and self-employment
   - Plan to relocate and restore businesses, including income substitution

7. Institutional framework
   - Tasks and responsibilities in planning, negotiating, consulting, approving, coordinating, implementing, financing, monitoring and evaluating land acquisition and resettlement
   - Review of the mandate of the land acquisition and resettlement agencies
   - Provision of capacity building, including technical assistance

8. Resettlement budget and financing
   - Identification of land acquisition and resettlement cost
   - Preparation of an annual budget and a plan of timing for release of funds

9. Implementation schedule
   - Time schedule showing start and finish dates for major resettlement task
   - Specification of timing for support prior to demolition of housing and other structures

10. Monitoring and evaluation
   - Plan for internal monitoring, key indicators of progress, mechanisms for reporting
   - Evaluation plan with provision for external and independent evaluation
   - Participation of people affected in monitoring and evaluation

(Source) Modified from *ADB Handbook on Resettlement: A Guide to Good Practice* and ZESCO Draft Resettlement Policy for Transmission and Distribution Projects

During local stakeholder meetings held in this study, participants stated that compensations were not sufficient under the projects implemented in the 1970's. Although legal and policy frameworks and their execution status in the 1970's are unclear, any projects to be implemented in the future shall provide project-affected-persons (PAPs) with sufficient compensations and supports for the restoration of their livelihoods.

The ESU of ZESCO formulated a Draft Resettlement Policy for Transmission and Distribution Projects in January 2003. Although the draft policy is not formally authorized, the recent project-specific resettlement plans for transmission and distribution projects were formulated in accordance with the policy. The policy covers almost all items listed above, and provides basic principles of each item, and thus satisfies the requirements of the JICA Guidelines for Environmental and Social Considerations. When implementing individual projects, a project-specific plan should be formulated, in accordance with the basic principles indicated in the draft policy, according to the natural and socio-economic characteristics of project sites.

ZESCO has several experiences in formulating project-specific resettlement plans for transmission projects, based on the draft policy. In the plans, the following costs were budgeted, and they are considered to pay due attention to the restoration of relocated people's livelihoods.

- Cost for building a new house that is slightly better than the current one
- Relocation cost, including transportation cost
- Funds to acquire land and buy inputs for the first agricultural season

In addition, costs to construct social facilities including schools and clinics are also

budgeted where it is considered necessary. Such plans are deemed to take into account the restoration of livelihoods in relocation destination. These precedents can be referred to as good practices in formulating a resettlement plan.

2) Impacts on Local Economy (employment and livelihood) and Land Use

It is necessary to explain the content of a sub-project to local residents at the F/S stage or earlier stage. If a project may affect the livelihood means of local residents, the plan should be explained well in advance so that they have enough time to find alternative income generating means. In addition, a land acquisition plan including an income restoration program needs to be formulated, in case impacts of land acquisition on the economic bases of affected persons are unavoidable. The plan should be based on sufficient consultations with local people to be affected, and it is critical to reach an agreement with the people. The framework of the plan should cover items specified in section 1). It is also necessary to monitor their livelihoods and income restoration, as appropriate, even after the operation starts.

3) Impacts on Local Social Institutions such as Decision-Making Institutions

It is necessary to explain the content of a sub-project at the initial phase of the F/S stage, and confirm whether there are formal or informal decision-making institutions and other social institutions in the sub-project site. Informal decision-making institutions here include a local meeting held based on a traditional custom. If such institutions are identified, agreement with the institutions on the project implementation, and mitigations measures of potential impacts, and support for reorganizing the institutions needs to be obtained.

4) Impacts on the Livelihoods of Indigenous Peoples and Ethnic Minorities

It is necessary to consult with local governments and local representatives to confirm whether there are habitats of indigenous peoples and ethnic minorities. In case such habitats are identified, it is critical to hold a consultation with them, and make careful considerations to ensure that they will not experience unfair treatment.

5) Local Conflict of Interests and Inequality

It is necessary to consult with local governments, local representatives, and other stakeholders to confirm whether there are any concerns that may cause the local conflict of interests in the vicinity of sub-project sites. Specifically, it shall be highlighted whether adverse impacts concentrate on particular groups of local people, or whether there were troubles in the past in the vicinity of the sub-project site. If some impacts are anticipated, it is necessary to hold sufficient consultations with stakeholders, and to reach an agreement.

6) Water Usage and Water Rights

It is necessary to coordinate with water right holders at the planning stage of sub-projects, and to reach an agreement with them on the amount of water intake and its pattern. In case of international rivers, negotiations with relevant nations on water rights shall be highlighted.

7) Sanitation and Infectious Diseases such as HIV/ AIDS

Construction workers and local people should be provided with basic information on infectious diseases including HIV/ AIDS to prevent the spread of such diseases due to the inflow of construction workers. Mitigation measures such as the distribution of condoms shall be undertaken. ZESCO has collaborated with the Ministry of Health to conduct activities to prevent infectious diseases. It is effective and efficient to seek for the collaboration with outside resources such as the Ministry of Health and NGOs.

It is also necessary to undertake necessary measures, including the construction of drainage and information provision, to prevent sanitation and infectious disease-related problems in relocation destinations.

8) Cultural Heritage

It is necessary to explain the content of a sub-project, at the initial phase of F/S stage, to local governments, local representatives and local residents, and National Heritage Conservation Commission (NHCC) to confirm existence or non-existence of cultural heritages to be considered. If cultural heritages to be affected are identified, it is critical to hold consultations with local representatives, NHCC and other stakeholders, and elaborate mitigation measures including the modification of part of the sub-project plan and relocation of the heritages.

9) Topography and Geological Features

It is necessary to explain the content of a sub-project, at the initial phase of F/S stage, to local governments, local representatives and local residents, NHCC, and academic expert to confirm existence or non-existence of valuable topography and geological features. In case some valuable topography and geological features are identified, sufficient consultations with the stakeholders should be made, and necessary mitigation measures, including the modification of part of the sub-project plan, shall be elaborated.

10) Soil Erosion

Measures against soil erosion, including the construction of drainages, and avoidance of construction works during the high water and rainy season, shall be effectively implemented. With respect to hydropower development, the conservation of vegetation around reservoir and the minimization of the adverse effects of soil erosion should be given high priority. If transmission lines are constructed on hilly areas, soil conservation measures such as the conservation of vegetations and re-vegetations shall be undertaken.

11) Local Hydrology and Groundwater

The amount and pattern of water intake from rivers should be based on the results of surveys on river flows and local hydrology to avoid significant impacts on local hydrology. It is necessary to monitor the water amount and quality of nearby water bodies and wells, and to adjust the amount to be taken in case some impacts are observed such as the depletion of groundwater.

12) Flora and Fauna, and Biodiversity

It is necessary to conduct a detailed survey on flora and fauna in a sub-project site, and the distribution of their habitats, protected areas and forest reserves. Endangered or valuable species should particularly be detailed. The surveys, which should cover both the rainy and dry seasons, will require long time, and the surveys, therefore, should be conducted at the earlier stage of the F/S. More specifically, the surveys should follow the steps below.

- At the earlier stage of the F/S, it is necessary to confirm the existence/nonexistence of ecological survey data conducted in the vicinity of project sites, which can be a baseline data of the projects. Institutions which implement the ecological surveys or manage the survey data should also be confirmed.
- If ecological data is not available, it is necessary to consult with ZAWA and ECZ about the necessity and contents, including survey items, survey duration, frequency, etc.) of the ecological survey, and to conduct necessary surveys.
- If the project site is located around the border, it is also necessary to confirm the existence/nonexistence of agreements on wildlife protection with neighboring countries.

The environmental conservation measures should be considered, based on the above ecological survey results and agreements with neighboring countries, in line with the following priority.

- At first, it is necessary to avoid the alteration of valuable species' habitats and the clearance of forests as much as possible, based on the ecological survey results, when determining the facility layout and the route of access road.
- If some impacts are unavoidable, it is necessary to minimize the impacts by adjusting construction schedule and method such as the suspension of civil works during breeding period, the adjustment of working hours and construction schedule, and the setting of velocity limits of construction vehicles.
- If significant impacts are still predicted, environmental compensation measures should be undertaken. The compensation measures should be appropriately determined as per the degree and nature of potential impacts. They include the establishment of new protected area to create alternative habitats for wildlife, reforestation in the neighboring areas, and the installment of fish-way.

It is also necessary to elaborate effective mitigation measures for wildlife protection, referring to the precedents of infrastructure development projects.

13) Landscape

It is necessary to explain the content of a sub-project, at the initial phase of F/S stage, to local governments, local representatives and local residents to confirm whether impacts on local landscape can be significant. In case some impacts are predicted, it may be necessary to modify

the sub-project plan including the route change of transmission lines, and to develop mitigation measures such as reforestation after the completion of civil works and coating with landscape-conscious colors.

14) Global Warming

Greenhouse gas emissions should be reduced by installing energy-efficient facilities in the thermal power plant to be constructed.

15) Air Pollution

It is necessary to ensure compliance with the Emission Standards specified by the Air Pollution Control (Licensing and Emission Standards) Regulations, 1996. The thermal power plant should be designed to reduce air pollutants by the reduction of sulfur concentration through coal pretreatment, or the installment of devices for flue desulfurization and denitration, and electrostatic precipitator.

16) Water Pollution

To prevent muddy water from flowing into rivers, it is necessary to make considerations such as the construction of temporary dams and the suspension of civil works during high water or rainy season.

Discharge of coolant water from the thermal power plant shall be in accordance with the Emission Standards specified by the Water Pollution Control (Effluent and Waste Water) Regulations, 1993. In particular, temperature shall be less than 40 degrees Celsius at point of discharge. In addition, it is crucial to reduce difference in temperature between the intake and outflow. In Japan, for instance, the difference in temperature is controlled within seven (7) degrees Celsius in general.

17) Soil Contamination

Coal ash from the thermal power plant should be appropriately disposed of to prevent the leakage into soil.

18) Waste

Waste soil and construction waste, coal ash from the thermal power plant, and other wastes discharged during the operation of facilities shall be disposed of in compliance with the Waste Management (Licensing of Transporters of Wastes and Waste Disposal Sites) Regulations, 1993. In the contract with sub-contractor, it is necessary to incorporate an article regarding the appropriate disposal of wastes into the contract with sub-contractors.

In Zambia, a system for properly disposal of PCB wastes is not established. It is therefore crucial to properly store PCB wastes oil to prevent the leakage into the environment. The followings are the standards to store PCB wastes specified by Japanese Waste Management Law. ZESCO needs to properly store PCB waste in reference to the standards.

1) Take necessary measures to prevent the volatilization of PCB such as putting PCB oil into sealed containers, and to prevent exposure of PCB oil to high temperature.
2) Take necessary measures to prevent the decay of containers of PCB waste.
3) Set fences around storage sites.
4) Put a board indicating the followings in a prominent part of storage sites.
   a) That PCB waste is stored here
   b) Name of personnel or organization responsible for the storage and its contact information
5) Take necessary measures to prevent splash, leakage, and infiltration into the ground of PCB waste, and emission of offensive odors from PCB waste.
6) Take necessary measures to prevent rats, mosquitoes, flies and other harmful insects.

19) Noise and vibration

In case there are villages in the vicinity of the planned sites, prior notification of civil work hours and duration is necessary to reduce the impacts of noise and vibration.

It is necessary to make considerations on the layout and design of power facilities, referring to the international standards described in 11. 1.1 (3) c, to prevent noise and vibration.

20) Ground Subsidence

It is necessary to monitor groundwater level at the site where coolant water can be extracted by the thermal power generation plant. If some impacts are identified, the amount and pattern of the water intake should be adjusted.

21) Bottom Sediment

It is necessary to conduct regular dredging activities and the construction of sediment pool dam to prevent sedimentation within reservoirs.

22) Accident and Safety

Safety education to prevent accidents should be provided to construction workers, facility operators, maintenance and management staff and other relevant persons. It is necessary to inform local residents of the schedule of dam water discharge well in advance to ensure safety of downstream livelihoods. Regular patrols on the conditions of transmission lines are also necessary to prevent accidents.

### 11.3.5 Environmental Management Plan and Monitoring Activities

(1) Environmental Management Plan

In the Environmental Impact Statement of sub-projects, an Environmental Management Plan to ensure the smooth implementation of proposed mitigation measures is required. The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 requires project proponents to formulate an Impact Management Plan including environmental conservation measures against adverse impacts and indicators for environmental monitoring (Regulation 11). Although the regulations do not specify the detailed contents of the plan, the Environmental Management Plan should cover the following items at

least.

1) Mitigation measures against potential adverse impacts
   - Clarification of necessary mitigation measures
   - Implementation mechanism and responsibility of mitigation measures

2) Monitoring of adverse impacts
   - Monitoring of the implementation status of mitigation measures, and their effectiveness (monitoring items and methodology)
   - Monitoring of environmental quality such as air, water, and noise (monitoring items and methodology)
   - Monitoring of unexpected impacts (monitoring items and methodology)
   - Measures to be taken based on the monitoring results

3) Implementation mechanism of the Environmental Management Plan
   - Appointment of staff in charge of environmental management, and clarification of his/her responsibilities
   - Training for staff and contractors

4) Disclosure and public participation
   - Disclosure of the progress of projects
   - Disclosure of the implementation status of mitigation measures and monitoring results
   - Setting of stakeholder meetings
   - Procedures for processing complaints

5) Implementation schedule
   - Implementation schedule by individual task

The monitoring of adverse impacts is in particular important in the Environmental Management Plan. Through the monitoring activities, it can be confirmed whether mitigation measures proposed in EIA are appropriately implemented, and whether adverse impacts unexpected by EIA are observed. In addition, it is critical to increase the effectiveness of mitigation measures by reflecting the monitoring results to the contents of Environmental Management Plan.

Main monitoring items for sub-projects included in the master plan are identified in Table 11.10, based on the scoping results and considerations of mitigation measures.

**Table 11.10 Major Environmental Monitoring Items**

| Project type | Key impacts | Monitoring items |
|---|---|---|
| Hydropower Development | Involuntary Resettlement/ Land Acquisition | - Occurrence/ nonoccurrence of involuntary resettlement and land acquisition<br>- Appropriateness of process to reach agreements with people affected<br>- Appropriateness of property value assessment and compensation<br>- Appropriateness of resettlement process<br>- Progress of resettlement and land acquisition<br>- Progress of support for the rebuilding of livelihood of relocated people |
| | Local Economy/ Land Use | - Occurrence/nonoccurrence of impacts on local people's livelihood means |
| | Water Usage/ Water Rights | - Occurrence/ nonoccurrence of any impacts on local water usage and water rights |
| | Sanitation/ Infectious Diseases | - Progress of the proposed mitigation measures such as the distribution of condoms<br>- Understandings of construction workers about infectious diseases |
| | Soil Erosion | - Status of soil erosion around construction sites<br>- Progress of mitigation measures to prevent soil erosion such as re-vegetation |
| | Local Hydrology/ Groundwater | - Transition of water flows of nearby rivers and wetlands<br>- Water levels of adjacent wells |
| | Flora and Fauna, and Biodiversity | - Existence/nonexistence of impacts on protected areas and valuable ecosystem (changes in number of indicator species, etc.)<br>- Appropriateness and sufficiency of mitigation measures |
| | Cultural Heritage, Local Landscape | - Existence/nonexistence of impacts on cultural heritages and local landscapes<br>- Appropriateness and sufficiency of mitigation measures |
| | Waste | - Appropriateness of the disposal of construction wastes |
| | Ground Subsidence | - Status of ground subsidence of a proposed new dam |
| | Bottom Sediment | - Status of sediment in a new reservoir |
| | Safety Measures | - Implementation of safety measures during civil works<br>- Maintenance and inspection of facilities, and prevention of fire breaking |
| Thermal Power Development | Involuntary Resettlement/ Land Acquisition | Same as "Hydropower development" |
| | Local Economy/ Land Use | Same as "Hydropower development" |
| | Sanitation/ Infectious Diseases | Same as "Hydropower development" |
| | Flora and Fauna, and Biodiversity | Same as "Hydropower development" |
| | Cultural Heritage, Local Landscape | Same as "Hydropower development" |
| | Water Pollution | - Temperature and quality of discharged coolant water |
| | Air Pollution | - Quality of emission gas |
| | Waste | - Appropriateness of the disposal of construction wastes<br>- Appropriateness of disposal of coal ash and fly ash |
| | Noise | - Noise level at site boundary |
| | Safety Measures | Same as "Hydropower development" |
| Transmission Development | Involuntary Resettlement/ Land Acquisition | Same as "Hydropower development" |

| Project type | Key impacts | Monitoring items |
|---|---|---|
| | Local Economy/ Land Use | Same as "Hydropower development" |
| | Sanitation/ Infectious Diseases | Same as "Hydropower development" |
| | Flora and Fauna, and Biodiversity | Same as "Hydropower development" |
| | Cultural Heritage, Local Landscape | Same as "Hydropower development" |
| | Waste | - Appropriateness of the disposal of construction wastes<br>- Status of disposal and/or storage of PCB waste oil |
| | Noise | Same as "Hydropower development" |
| | Safety Measures | - Implementation of safety measures during civil works<br>- Maintenance and inspection of facilities, and prevention of fire breaking<br>- Prevention of electric shock |
| Common Issues | Mitigation Measures | - Implementation status of proposed mitigation measures and their appropriateness |
| | Unexpected Impacts | - Existence/nonexistence of unexpected impacts |
| | Complaints | - Establishment of system for accepting complaints and records of complaints<br>- Appropriateness of processing complaints |

(Source) JICA Study

The monitoring items of individual sub-projects can vary depending on the location and other conditions. For instance, if a sub-project is planned around the Ramsar sites, it is necessary to monitor impacts on waterfowls inhabiting in the sites. In addition, monitoring methodologies such as monitoring sites, frequency and duration, and indicator species shall be determined according to the characteristics of projects. Detailed monitoring methodologies and items should be adjusted, in consultation with relevant institutions including ECZ and ZAWA, as per potential environmental and social impacts of individual sub-projects.

(2) Implementation Mechanism of Environmental Management Plan

The Environmental Management Plan should be appropriately implemented. It is therefore critical to secure human resources and budget needed to implement the plan, and to establish an implementation mechanism.

Project proponents are responsible for the implementation of the Environmental Management Plan. Proponents of power development projects to be developed in Zambia include private companies as well as ZESCO.

In terms of ZESCO projects, the Environmental and Social Affairs Unit (ESU) will implement the plan in collaboration with relevant department. In the ESU, experts are appointed who cover broad environmental and social issues such as environmental management, ecosystem, involuntary resettlement and land acquisition. The ESU has practical experiences in the Environmental Impact Assessment, thus, it can be concluded that the ESU has already developed basic capacity to implement the Environmental Management Plan effectively.

With respect to private projects, the developers should appoint personnel in charge of the implementation of the Environmental Management Plan. They also need to establish a mechanism to supervise consultants dealing with environmental and social issues.

### 11.3.6 Environmental and Social Considerations in Case Study

Stakeholder meetings conducted in this study are largely categorized into two types: 1) local stakeholder consultation meetings including local interviews at case study sites; and 2) a stakeholder meeting at Lusaka. The former aims to identify potential environmental and social impacts and understand local residents' perceptions on the ground. It also contributes to the extraction of points to consider in environmental impact assessments at subsequent phases. The latter consulted with relevant government agencies, NGOs, and academe. It aims to learn the lessons of past projects, and to clarify points to consider at planning level.

(1) Local Stakeholder Meeting at Case Study Sites

In this master plan study, PAPs cannot be identified since the master plan will not specify the exact locations of individual sub-project. This ESC study, therefore, holds a series of alternative meetings with stakeholders including local farmers, traditional chiefs and district assembly members at the two case study sites. The meetings aim to identify potential impacts of sub-projects in advance, and to clarify points to consider at the F/S stage.

The perceptions of local governments, local representatives and traditional chiefs on the environmental and social impacts associated with the hydropower development projects were investigated through the alternative stakeholder meetings.

**Table 11.11 Stakeholder Meetings at Case Study Sites**

| Date | Location | Participants |
|---|---|---|
| 5 June 2009 | Serenje District, Central Province | Serenje District Development Coordination Council: Extension offices of government agencies, district officers, police, representatives of farmers, representatives of commercial and industrial sector, NGOs, etc. |
| 3 June 2009 | Mailou Community, Central Province | Chief Mailou who governs the area where the Lusiwasi Extension Project is proposed |
| 9 June 2009 | Itezhi-Tezhi District, Southern Province | Itezhi-Tezhi District Development Coordination Council: Extension offices of government agencies, district officers, police, representatives of farmers, representatives of commercial and industrial sector, NGOs, etc. |
| 10 June 2009 | Kaingu Community, Southern Province | Chief Kaingu who governs the area where the Itezhi-Tezhi Dam is located |

(Source) JICA Study

The major points that were clarified through the stakeholder consultation meetings are presented below.

1) Consultation with District Development and Coordination Committees

**[Positive Impacts]**

- Hydropower development projects will create job opportunities associated with the construction and operation of a power station.
- Infrastructures such as roads are developed and improved, and local communities can enjoy many benefits through improved infrastructures.
- Hydropower projects will increase income generation due to the enhancement of local

economic activities.

- Rural electrification will be promoted. This will contribute to the improvement of living standards, and reduction in the use of wood fuels and thereby conservation of forest resources.
- Other multiple positive economic impacts are anticipated due to the enhancement of economic activities.
- Revenue increase of local governments and associated improvement of government service delivery are also expected

**[Negative Impacts]**

- Hydropower development projects may cause the submersion of land, which will reduce the availability of agricultural and other use of land. The anticipated influx of new settlers will increase the competition over land.
- Involuntary resettlement may occur. Loss of livelihood sources may affect persons to be affected.
- The influx of new settlers may inhibit timely delivery of social services such as education and health.
- Risks of infectious diseases may increase due to the influx of new settlers. Hydropower development projects may also cause the increase of mosquitoes due to the creation of a dam lake and hygienic related diseases such as diarrhea and cholera due to poor sanitation.
- The influx of people may lead to increase in deforestation, loss of wildlife habitats, and resultant conflicts between humans and animals.
- Valuable natural and cultural heritages may be affected.
- Change in river flow regimes due to the creation of a dam, water intakes from rivers, and controlled releases of water may affect water usage of local communities.

**[Involuntary Resettlement and Land Acquisition]**

- Involuntary resettlement and land acquisition will be inevitable, but they are only acceptable where sufficient consultations are held, and resettlement and acquisition conditions, including the amount of compensation, are agreeable with affected parties.
- All the concerned people should be involved in the process of consultations. Various facets of society including chiefs and other related residents should also be consulted.
- Compensation should be based on the appropriate evaluation on the properties and assets to be affected. Psychological compensation will be necessary when relocation of houses is required. In addition, project-affected people should be given new skills in case they are forced to change their livelihood means.
- The amount of compensation should be determined so that affected people can lead the same life as or slightly better life than before.

**[Points to Consider]**

- It is necessary to learn from what has been done in the past development project in or in the vicinity of the proposed sites.

2) Interviews with Chiefs

**[Impacts of Power Development Projects]**

- Many people affected by the construction of the existing Itezhi-Tezhi Dam in the 1970's or the Lusiwasi Power Station in the 1960's to 1970's could not obtain proper compensation. With respect to future projects, proper compensation should be given to the affected people.
- Lifestyle of local residents may change drastically after the completion of a power development project, since such a project will bring about economic development.

**[Points to Consider]**

- The necessity of power development project is understandable, so the chiefs will not oppose the projects in principle. However, it is necessary to have sufficient consultations in advance.
- Consultation with local residents should avoid harvesting time when farmers are busy working.
- When constructing power stations, villages around the construction sites should be given high priority for electrification. There are un-electrified villages where transmission lines pass through, but such situation is not acceptable.
- Sufficient consultations will be necessary to avoid significant impacts on traditional and cultural sites, such as graves, shrines, and sites for rain-making rituals.

(2) Stakeholder Meetings at Lusaka

A stakeholder meeting on environmental and social considerations for power development projects was held in Lusaka, inviting concerned government agencies, NGOs, and academe.

**Table 11.12 Stakeholder Meeting at Lusaka**

| Date | Location | Participants |
|---|---|---|
| 18 June 2009 | Conference room of Department of Energy (DOE) | DOE, ZESCO, Forestry Department (FD), Zambia Wildlife Authority (ZAWA), National Heritage Conservation Commission (NHCC), Integrated Water Resources Management Center of the University of Zambia, WWF, Wildlife and Environment Conservation Society of Zambia (WECSZ) |

(Source) JICA Study

The brief outline of the consultation meeting is indicated below.

**[Potential Impacts]**

- ZESCO developed the draft resettlement policy since there is no national resettlement framework program so far. Sufficient compensation should be provided to people affected in a timely manner.
- For the mitigation measures against involuntary resettlement, re-establishment of livelihoods of resettled persons in the new settlements and support to the re-establishment should be given high priority.
- Construction of sanitation and health facilities and schools should be completed prior to

the resettlement of people affected.

- It is necessary to avoid fragile and/or sensitive ecosystem when selecting the location of power development projects.
- Studies on dam construction impacts tend to focus much on flood related issues by newly created reservoir, but downstream ecosystem is also equally important.
- How to determine an environmental flow is critical when constructing a dam. In general the flow will be determined based on surveys on river flows and key species, however, consultations with broad range of stakeholders are necessary in the process of the determination.
- Cultural heritages tend to be given less considerations. It is necessary to consult with local residents to identify cultural heritages that should be given due attention.
- There should be mechanisms to minimize the loss of tourist attractions such as the beauty of nature.

**[Points to Consider]**

- Strategic Environmental Assessment (SEA) should be given due attention to have a bigger picture of the project. It is necessary to ensure the consistency with government policies and programs of various sectors by reviewing them.
- It is necessary to consider the alternatives to the proposed development projects.
- In terms of consultations, it is necessary to identify with whom, when and how to consult. In particular, prior consultations with relevant chiefs are critical.
- When consulting with local residents, it is important to facilitate income generating activities by referring to likely positive impacts as well as negative ones.
- Stakeholder consultations should be regularly held after the process of Environmental Impact Assessment, and this should be required for a project developer.

(3) Stakeholder Meetings at Subsequent Phases

Sub-projects in the master plan will be further elaborated and the locations and specifications will be determined in the subsequent F/S, B/D, and D/D phases. Although an environmental impact assessment is in general conducted at the F/S stage, however, regardless of the study name, local stakeholder consultations shall be held prior to the determination of project sites and specifications, and the developer shall obtain agreement from the stakeholders.

The following points shall be noted for the local stakeholder consultations.

1) Stakeholders to be Consulted

The following stakeholders should be consulted at least.

- Local residents whose lands and other properties are acquired, and/or those who are forced to be relocated, including those without land title
- Local residents affected by projects
- Chiefs
- District Council and other local government institutions, in particular those in

which a variety of stakeholders participate, such as District Development and Coordination Committee

- Extension or regional offices of ZAWA, ECZ, and Forestry Department and other central government agencies

In particular, agreements from chiefs as traditional authorities as well as PAPs are critical to initiate projects. In addition, a District Development Coordination Committee is institutionalized in each district in Zambia. A variety of stakeholders take part in the committee, including local officers of central government agencies, district government officers, NGOs, representatives of farmers and private businesses. In selecting a project site, it is effective for developers to consult with the committee members. In addition, consultations with regional offices of ZAWA, Forestry Department, and ECZ are expected to be effective to ascertain the distribution of protected areas and natural ecosystem.

2) Topics of Stakeholder Meeting

The following impacts should be taken into account in the stakeholder meetings at the F/S stage since the impacts can be significant.

- Involuntary resettlement
- Impacts on agricultural activities and other economic activities due to land acquisition
- Infectious diseases such as HIV/AIDS
- Impacts on cultural heritages
- Hydrological conditions and groundwater
- Flora and fauna, and biodiversity
- Impacts on local landscapes
- Noise and vibration
- Air pollution

It should be noted that local residents tend to focus on issues directly related to their livelihoods, such as involuntary resettlement and land acquisition. Biodiversity and landscape may not be given enough attentions. It is therefore necessary to hold individual meetings with local officials of ZAWA and Forestry Department.

### 11.3.7 Points to Consider at Project Implementation Stage

The master plan aims to identify potential projects, including power development projects, transmission projects and distribution projects, for the next 20 years. The master plan does not specify the exact locations of individual projects, and thus, ESC studies for the projects should be carried out when the locations are determined at the project implementation stage. This section presents points to consider in conducting ESC study at the project implementation stage.

(1) Execution of Necessary Procedures

Environmental Impact Assessment Regulation, 1997 requires certain categories of power

sector projects to formulate and submit PB and EIS, as indicated in Table 11.1. It is, therefore, critical for developers to take necessary procedures for the projects in consultation with ECZ.

(2) Environmental and Social Consideration Study according to Project Locations

When ESC Study is conducted at the F/S stage, it is necessary to re-consider the scoping presented in 11.3.3 according to the individual conditions of project sites and the specifications. When carrying out the scoping, environmental and social impacts should be thoroughly examined in reference to the conditions of proposed locations and the specifications. In particular, if sites for dams and reservoirs and transmission line routes are specified, developers will be able to conduct detailed investigations on involuntary resettlement and land acquisition, and impacts on protected areas and biodiversity.

In the ESC study at the F/S phase, it is necessary to reconsider mitigation measures taking into account the local characteristics, in reference to mitigation measures described in 11.3.4. If impacts related to land acquisition and involuntary resettlement are predicted, stakeholder meetings should be properly carried out, properly taking into account the stakeholders and points to consider indicated in 11.3.6. Developers shall also give due considerations to consultations with traditional authorities such as chiefs, and obtain their agreement.

(3) Considerations for alternative locations

In elaborating mitigation measures, the first priority should be put on seeking the alternative locations to avoid potential impacts. In case of unavoidable impacts, measures to minimize the impacts, or mitigation measures such as compensations should be taken into account. With respect to projects included in the master plan, it is essential to avoid locations where serious impacts are predicted, such as areas with high population density, protected areas and valuable landscapes. F/S should prepare more than one option regarding location selection, and determine the final location taking into account environmental and social impacts of respective options.

(4) Environmental Management System

If projects included in the master plan are expected to have certain impacts, it is necessary to establish an Environmental Management Plan that addresses environmental measures and monitoring at the operational and maintenance phase as well as environmental measures at the construction phase. In terms of hydropower development projects, monitoring activities on involuntary resettlement process and unexpected impacts on ecosystem are critical. In particular, monitoring on ecosystem is critical since impacts on ecosystem cannot be thoroughly assessed in advance.

The reinforcement of the environmental management system of project developers can be considered important. ZESCO has the Environmental and Social Affairs Unit, which is deemed to have basic capacity of environmental management. On the other hand, private developers' environmental management system cannot be judged in this study in which the development plans are not yet detailed. It is essential for such developers to establish an effective

environmental management mechanism that can handle the whole environmental management cycle, including the formulation, implementation and evaluation of environmental management plans. Furthermore, providing training courses of environmental and social considerations to individual engineers and technical staff is also critical.

# Chapter 12 Economic & Financial Analysis and Private Investment Promotion

## 12.1 Economic & Financial Analysis

### 12.1.1 Financial Analysis

It is critical for the timely implementation of the investment plan to confirm the scenarios for financial resources that guarantee the future investment plan. Since the large size of the investment naturally requires the significant amount of the borrowings, the capital injection by the government and/or the private capital. Therefore, it is very important to confirm the forecast of the financial plan that includes the payment for the purchase of the private power and the repayment of the debt guaranteed by the government. The investment plan was discussed with the various stakeholders in Zambia, and the future projection of the financial position of ZESCO was carried in order to assess the future outlook of the finances of the power sector.

The major objectives for the financial analysis in the JICA Study are to (i) highlight the long-term financing needs for ZESCO in comparison with the scenarios that ZESCO initially planned and (ii) confirm the tariff adjustment possibility to finance the ZESCO's operation. In particular, since ZESCO filed the tariff adjustment to ERB in February, 2009, the JICA Study tried to compare with the ZESCO's original plan on the same ground and to highlight the difference. Therefore the Study basically used the ZESCO financial model and share most assumptions with the ZESCO original analysis. This will also benefit ERB and other decision makers to refer the results to the ZESCO analysis and compare the consequences of the study outputs.

The report basically discuss the result of the financial analysis based on the scenario 1-1 even though the analyses were made for both the scenario 1-1 and 1-2 because the scenario 1-1 imposes more severe conditions for ZESCO finance. The difference in the both results were also very marginal.

(1) Assumptions for Analysis

The study period is from Year 2009/10 to 2030/31.

a. Assumptions for Revenue

(i) Macroeconomics

The exchange rate is assumed to be US$1 = ZMK4700. The inflation rate in Zambia is assumed to be 15% in 2008, 12% in 2009 and 10% in 2010 and thereafter. The producer price inflation is assumed to be 3.5% in 2008 and 2009, and 2.5% in 2010 and thereafter.

(ii) Demand and Annual Sales

The electricity sales for the base case is expected to follow the below table.

**Table 12.1 Projected Demand Growth and Annual Sales (GWh)**

| Year | 2009 | 2019 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Energy Sent Out | 11,022 | 12,477 | 14,566 | 15,299 | 15,736 |
| Distribution Loss | 1,508 | 1,529 | 1,561 | 1,325 | 1,378 |
| Transmission Loss | 331 | 374 | 437 | 459 | 472 |
| Projected Sales | 9,184 | 10,574 | 12,567 | 13,516 | 13,885 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Energy Sent Out | 16,542 | 16,855 | 17,188 | 17,539 | 17,908 |
| Distribution Loss | 1,433 | 1,472 | 1,512 | 1,554 | 1,599 |
| Transmission Loss | 496 | 506 | 516 | 526 | 537 |
| Projected Sales | 14,613 | 14,878 | 15,160 | 15,458 | 15,771 |
| **Year** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Energy Sent Out | 18,297 | 18,754 | 19,238 | 19,751 | 20,293 |
| Distribution Loss | 1,646 | 1,702 | 1,761 | 1,823 | 1,888 |
| Transmission Loss | 549 | 563 | 577 | 593 | 609 |
| Projected Sales | 16,101 | 16,490 | 16,901 | 17,336 | 17,796 |
| **Year** | **2024** | **2025** | **2026** | **2027** | **2028** |
| Energy Sent Out | 20,867 | 21,474 | 22,117 | 22,797 | 23,517 |
| Distribution Loss | 1,958 | 2,032 | 2,110 | 2,192 | 2,279 |
| Transmission Loss | 626 | 644 | 664 | 684 | 706 |
| Projected Sales | 18,283 | 18,798 | 19,344 | 19,921 | 20,532 |
| **Year** | **2029** | **2030** | | | |
| Energy Sent Out | 24,279 | 25,086 | | | |
| Distribution Loss | 2,372 | 2,470 | | | |
| Transmission Loss | 728 | 753 | | | |
| Projected Sales | 21,179 | 21,864 | | | |

(Source) Compilation by JICA Study

The above figures are the projected supply data, which are calculated by the demand forecast and the supply capacity based on the development plan.

(iii) Power Tariff

ERB made the decision on the tariff adjustment for 2009 and 2010 on July 20th, 2009. The ERB board decision allows that with effect from 1st August, 2009, the average tariffs for the 2009/10 and 2010/11 have been increased by 35% and 26% respectively. The revised tariffs are as follows.

**Table 12.2 Revised Electricity Tariffs**

| Customer Category | 2009 to 2010 | 2010 to 2011 |
|---|---|---|
| Residential | Increase: 40%<br>New Tariff: K170.97/kWh | Increase: 33%<br>New Tariff: K264/kWh |
| Large Power (MD3 & MD4) | Increase: 42%<br>New Tariff: K110.19/kWh | Increase: 33%<br>New Tariff: K264/kWh |
| Small Power (MD1 & MD2) | Increase: 40%<br>New Tariff: K170.97/kWh | Increase: 33%<br>New Tariff: K264/kWh |
| Commercial | Increase: 40%<br>New Tariff: K170.97/kWh | Increase: 33%<br>New Tariff: K264/kWh |
| Services | Increase: 40%<br>New Tariff: K170.97/kWh | Increase: 33%<br>New Tariff: K264/kWh |
| Average | Increase: 40%<br>New Tariff: K170.97/kWh | Increase: 33%<br>New Tariff: K264/kWh |

(Source) Board Decision, Energy Regulatory Board (2009)

ERB states that the tariff revision falls within the current three-year multi-year tariff framework from 2008 to 2011. Thus the tariff revision in 2009 runs up to March 2011. Then after that a new tariff framework will be considered.

While the current tariffs are still below cost, ERB finds that ZESCO's service quality has generally deteriorated and that ZESCO needs to increase the budget allocation for maintenance costs. It has also been identified that ZESCO needs a recapitalization in strengthen the financial basis. The efforts for improving management performance needs to be continued such as the high staff costs, trade receivables, and billing/collection. The discussions on the restructuring issue of ZESCO have also been recommended to the government by ERB.

Based on the ERB decision, ZESCO announced the detailed tariff adjustment on July 20$^{th}$ 2009 as follows.

**Table 12.3 ZESCO Revision of Electricity Tariffs**

| | | Current Tariffs | Approved Tariffs |
|---|---|---|---|
| **1. METERED RESIDENTIAL TARIFFS** | (Capacity 15kVA) | | |
| R1-Consumption up to 100kWh | Energy Charge/kWh | K77.00 | K107.80 |
| R2-Consumption above 101 to 400kWh | Energy Charge/kWh | K127.00 | K177.80 |
| R3-Consumption above 401kWh | Energy Charge/kWh | K207.00 | K289.80 |
| | Fixed Monthly Charge | K7, 411.00 | K10, 375.40 |
| Pre-paid | Energy Charge/kWh | K141.00 | K197.40 |
| **2. COMMERCIAL TARIFFS** | (Capacity 15kVA) | | |
| C1-Consumption up to 700kWh | Energy Charge/kWh | K165.00 | K209.55 |
| | Fixed Monthly Charge | K29, 607.00 | K37, 600.89 |
| **3. SOCIAL SERVICES TARIFFS** | | | |
| Schools, Hospitals, Orphanages, Churches, Water pumping, Street Lighting | Energy Charge/kWh | K144.00 | K180.00 |
| | Fixed Monthly Charge | K24, 972.00 | K31, 215.00 |
| **4. MAXIMUM DEMAND TARIFFS** | | | |
| MD1-Capacity between 16 - 300kVA | MD Charge/kVA/Month | K8, 068.00 | K10, 165.68 |
| | Energy Charge/kWh | K116.00 | K146.16 |
| | Fixed Monthly Charge | K79, 018.00 | K99, 562.68 |
| MD2-Capacity between 301-2000kVA | | | |
| | MD Charge/kVA/Month | K15, 094.00 | K19, 018.44 |
| | Energy Charge/kWh | K99.00 | K124.74 |
| | Fixed Monthly Charge | K158, 035.00 | K199, 124.10 |
| MD3-Capacity between 2001-7500kVA | | | |
| | MD Charge/kVA/Month | K24, 973.00 | K35, 461.66 |
| | Energy Charge/kWh | K80.00 | K113.60 |
| | Fixed Monthly Charge | K346, 808.00 | K492, 467.36 |
| MD4-Capacity above 7500kVA | MD Charge/kVA/Month | K25, 112.00 | K35, 659.04 |
| | Energy Charge/kWh | K66.00 | K93.72 |
| | Fixed Monthly Charge | K693, 615.00 | K984, 933.30 |

NOTE:
The above tariffs are:
(a) Exclusive of 3% Government excise duty
(b) Exclusive of 16% Value Added Tax (VAT)

Notice is hereby given that the Energy Regulation Board has approved revised electricity tariffs from

1st August 2009. This notice is being given in accordance with the requirements of section 8 subsection 2 of the Electricity Act CAP 433 of the Laws of Zambia. The fixed, energy, and demand charges will be as given below. Electricity bills based on the new charges should therefore, be received by our customers in August 2009.

(Source) ZESCO (2009)

The above tariff increase would allow ZESCO to proceed to the cost reflective tariffs towards the year 2011. The JICA Study analysis took the announced new tariffs in the financial analysis.

The power tariff was set each year to accommodate the revenue requirements to sustain the power sector business including (a) operating expenses, (b) depreciation, (c) financial costs, (d) taxation, and (e) return on net fixed assets. The allocation by business unit and by customer group is also considered. It is also assumed that the power tariff will be adjusted at the beginning of ZESCO fiscal year to reflect the full cost of services.

The analysis model for JICA Study is modified from the ZESCO model. The basic assumptions are also shared in the Study. ZESCO and ERB can benchmark the outputs with the existing tariff study.

b. Assumptions for Cost

(i) Depreciation

The ZESCO's financial accounting estimates of asset life as follows.

- Generation civil works and all the buildings: 50 years
- Generation plant and machinery: 30 years
- Transmission system: 25 years
- Distribution system: 20 years
- Others: 5 years

(ii) New Generation Plants

The development schedule for major generation plants is as shown in the following table that has been discussed in the previous section of the report.

**Table 12.4 New Generation Plants**

| COD | Project | Province | Type | Developer | Capacity (MW) | Annual Energy (GWh) | Project cost (m US$) |
|---|---|---|---|---|---|---|---|
| 2013 | Kariba North (ext) | Southern | RES | ZESCO | 360 | 380 | 358 |
| | Itezhi Tezhi | Southern | RES | ZESCO/TATA | 120 | 611 | 170 |
| 2014 | Lusiwasi (ext) | Central | ROR | ZESCO | 10<br>40 | 40<br>160 | 134 |
| | Maamba Coal | Southern | Thermal | Private | 200 | 1,536 | 240 |
| 2015 | Mutinondo | Northern | ROR | Power Min | 40 | 188 | 77 |
| | Luchenene | Northern | ROR | Power Min | 30 | 139 | 75 |
| 2016 | Kabwelume Falls | Luapula & Northern | RES | LPA | 62 | 324 | 140 |
| | Kumdabwika Falls | | RES | LPA | 101 | 533 | 226 |
| | Lunsemfwa | Central | RES | LHPC | 55 | 462 | 271 |
| | Mkushi | Central | RES | LHPC | 65 | 223 | 141 |
| 2017 | Kafue Gorge Lower | Lusaka | RES | n.y. | 750 | 2,400 | 1,745 |
| 2018 | Kabompo Gorge | North Western | RES | CEC/TATA | 34 | 176 | 115 |
| 2019 | Devil's Gorge | Southern | RES | ZRA-ZESCO | 500 | 2,802 | 1,808 |
| 2021 | Mumbotuta Falls | Luapula | RES | n.y. | 301 | 1,449 | 510 |
| 2023 | Mpata Gorge | Lusaka | RES | ZRA-ZESCO | 543 | 3,785 | 2,442 |
| 2025 | Mambilima Falls II | Luapula | RES | n.y. | 202 | 1,003 | 708 |
| 2027 | Batoka Gorge | Southern | RES | ZRA-ZESCO | 800 | 4,373 | 1,828 |
| 2029 | Mambilima Falls I | Luapula | RES | n.y. | 124 | 609 | 481 |
| | | | | | **4,337** | **21,116** | **11,469** |

(Source) Compilation by JICA Study

(iii) Key Performance Improvement

The efficiency improvement and cost reduction projections are assumed to achieve in accordance with the performance agreement with ERB. These would include (a) customer

metering, (b) cash management, (c) staff productivity, (d) quality of services, and (e) system loss.

Particularly the number of the employees will be reduced to achieve the ratio of customers per employee. After the confirmation of the achievement, the employees in generation, transmission and distribution can be allowed to increase based on the business base expansion such as the ZESCO installed capacity, the energy sent out in GWh and the distribution system expansion. Other operating expenses are assumed to increase reflecting the general inflation. The costs of fuel, lubricants and water charges are linked to the energy generated in GWh and escalated for Zambian inflation.

(iv) Taxation

The taxation rate is 35% for ZESCO. Available tax losses from previous periods are considered for the subsequent years.

(v) Power Purchase Tariff

The major power purchase tariffs are based on the cost estimation of the generation plants that are going to provide energy to ZESCO. The import power tariffs are also based on the current trade arrangement with the related organizations and the engineers' estimates of the JICA Study. The current power purchase price is estimated at 7.00 US cents /kWh, and will be adjusted in the subsequent years based on the price escalation projection.

c. Assumptions for Cash Flow

(i) Investment Needs

The assumed investment amounts are based on the least cost power system planning and transmission line system analysis by the JICA Study.

**Table 12.5 Power Sector Investment Program Overview**

| | | Scenario1-1 | | | Scenario1-2 | | |
|---|---|---|---|---|---|---|---|
| | | Installed capacity (MW) | Energy (GWh) | Investment (MUSD) | Installed capacity (MW) | Energy (GWh) | Investment (MUSD) |
| -2015 | **Total** | **800** | **3,054** | **1,054** | **800** | **3,054** | **1,054** |
| | Hydro | 600 | 1,518 | 814 | 600 | 1,518 | 814 |
| | Coal | 200 | 1,536 | 240 | 200 | 1,536 | 240 |
| 2016-2020 | **Total** | **1,567** | **6,920** | **4,446** | **1,667** | **8,726** | **3,358** |
| | Hydro | 1,567 | 6,920 | 4,446 | 1,067 | 4,118 | 2,638 |
| | Coal | 0 | 0 | 0 | 600 | 4,608 | 720 |
| 2021-2025 | **Total** | **1,046** | **6,237** | **3,660** | **800** | **4,991** | **2,168** |
| | Hydro | 1,046 | 6,237 | 3,660 | 500 | 2,687 | 1,808 |
| | Coal | 0 | 0 | 0 | 300 | 2,304 | 360 |
| 2026-2030 | **Total** | **924** | **4,982** | **2,309** | **844** | **5,234** | **2,952** |
| | Hydro | 924 | 4,982 | 2,309 | 844 | 5,234 | 2,952 |
| | Coal | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **Total** | **4,337** | **21,193** | **11,469** | **4,111** | **73,059** | **9,532** |
| | Hydro | 4,137 | 19,657 | 11,229 | 3,011 | | 8,212 |
| | Coal | 200 | 1,536 | 240 | 1,100 | 8,448 | 1,320 |

(Source) JICA Study

(ii) Borrowing

90% of the future capital expenditure is assumed to be financed by debt and the rest of 10% will be by equity. The assumption on the debt financing is that 85% is in US dollars and 15% is in Zambian Kwacha. The interest rates for US dollars and Zambian Kwacha are assumed to be 12% and 25%, respectively. These conditions are the same of those ZESCO applied in the financial projections.

(2) Findings from Financial Analysis

(i) Overall Financial Performance

The salient features for the ZESCO financial performances are as indicated in the following table.

**Table 12.6 ZESCO Financial Performance**

| Year | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Operating Margin (%) | 34.5% | 38.8% | 34.2% | 32.1% | 35.9% |
| Margin after Dividends (%) | 15.8% | 16.8% | 11.2% | 10.0% | 12.3% |
| Retained Profit (K mil.) | 307,594 | 404,753 | 395,933 | 494,245 | 690,204 |
| Return on Fixed Assets (%) | 15.9% | 13.4% | 12.6% | 14.4% | 16.4% |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Operating Margin (%) | 34.8% | 34.5% | 34.5% | 31.4% | 29.5% |
| Margin after Dividends (%) | 12.2% | 12.3% | 12.6% | 11.7% | 11.5% |
| Retained Profit (K mil.) | 778,594 | 857,987 | 956,356 | 919,553 | 950,246 |
| Return on Fixed Assets (%) | 16.5% | 16.4% | 17.6% | 16.4% | 16.0% |
| **Year** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Operating Margin (%) | 26.6% | 23.7% | 21.2% | 21.6% | 19.6% |
| Margin after Dividends (%) | 10.5% | 9.5% | 8.6% | 6.8% | 8.1% |
| Retained Profit (K mil.) | 897,562 | 853,834 | 819,779 | 694,908 | 887,765 |
| Return on Fixed Assets (%) | 14.7% | 13.6% | 12.4% | 13.1% | 12.1% |
| **Year** | **2024** | **2025** | **2026** | **2027** | **2028** |
| Operating Margin (%) | 18.8% | 17.6% | 17.3% | 16.5% | 15.5% |
| Margin after Dividends (%) | 6.6% | 7.0% | 6.8% | 6.7% | 6.3% |
| Retained Profit (K mil.) | 771,725 | 874,063 | 921,366 | 970,132 | 970,900 |
| Return on Fixed Assets (%) | 11.9% | 11.5% | 12.1% | 12.3% | 12.2% |
| **Year** | **2029** | **2030** | | | |
| Operating Margin (%) | 14.1% | 12.8% | | | |
| Margin after Dividends (%) | 6.7% | 6.3% | | | |
| Retained Profit (K mil.) | 946,611 | 921,629 | | | |
| Return on Fixed Assets (%) | 11.7% | 11.3% | | | |

(Source) Compilation by JICA Study

The analysis results of the margin show the sound financial performance. The asset return is also generally more than the expected level of eight percent.

(ii) Operating Costs

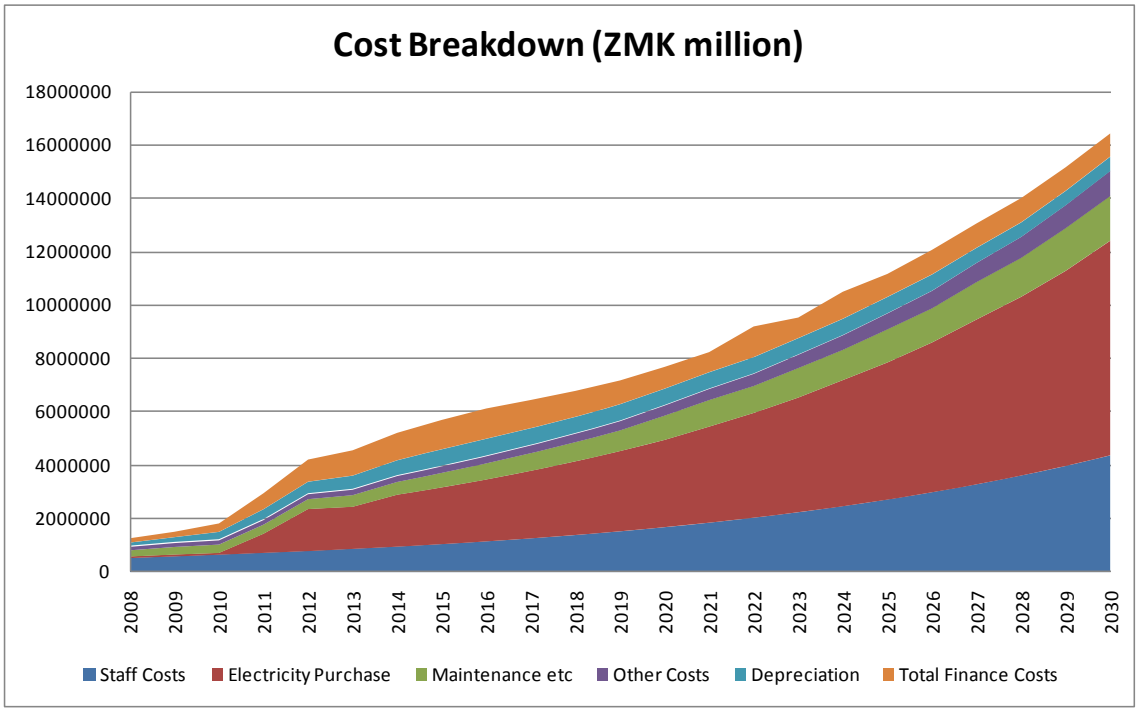
The operating costs of ZESCO for each customer group will change over the next twenty years as follows.

**Table 12.7 Breakdown of Operating Costs 2009-2030 (% of total)**

| Year | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Power Purchase | 5.0% | 4.1% | 24.8% | 37.7% | 34.9% |
| Payroll | 40.3% | 36.6% | 24.6% | 18.9% | 19.2% |
| Fuel & Maintenance | 19.3% | 17.6% | 11.7% | 8.9% | 9.7% |
| Depreciation | 11.9% | 15.3% | 12.5% | 10.3% | 10.9% |
| Financing | 13.6% | 17.6% | 20.5% | 19.8% | 20.9% |
| Others | 9.8% | 8.8% | 5.8% | 4.4% | 4.5% |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Power Purchase | 37.5% | 37.5% | 38.0% | 39.3% | 40.8% |
| Payroll | 18.5% | 18.6% | 18.9% | 19.7% | 20.6% |
| Fuel & Maintenance | 9.3% | 9.5% | 10.0% | 10.5% | 10.5% |
| Depreciation | 10.7% | 10.9% | 10.1% | 9.6% | 9.1% |
| Financing | 19.8% | 19.2% | 18.7% | 16.4% | 14.3% |
| Others | 4.3% | 4.3% | 4.3% | 4.5% | 4.7% |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| **Year** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Power Purchase | 41.9% | 42.6% | 43.7% | 42.7% | 45.1% |
| Payroll | 21.4% | 22.0% | 22.6% | 22.2% | 23.6% |
| Fuel & Maintenance | 10.9% | 11.9% | 12.1% | 11.0% | 11.7% |
| Depreciation | 8.5% | 7.9% | 7.4% | 6.6% | 6.4% |
| Financing | 12.4% | 10.6% | 9.2% | 12.5% | 8.1% |
| Others | 4.8% | 4.9% | 5.0% | 4.9% | 5.2% |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| **Year** | **2024** | **2025** | **2026** | **2027** | **2028** |
| Power Purchase | 45.0% | 46.0% | 46.5% | 47.2% | 47.7% |
| Payroll | 23.5% | 24.3% | 24.8% | 25.2% | 25.8% |
| Fuel & Maintenance | 10.8% | 11.2% | 10.6% | 10.8% | 10.5% |
| Depreciation | 5.8% | 5.4% | 5.0% | 4.3% | 3.9% |
| Financing | 9.6% | 7.7% | 7.6% | 7.0% | 6.5% |
| Others | 5.2% | 5.4% | 5.4% | 5.5% | 5.6% |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| **Year** | **2029** | **2030** | | | |
| Power Purchase | 48.1% | 48.8% | | | |
| Payroll | 26.2% | 26.6% | | | |
| Fuel & Maintenance | 10.6% | 10.2% | | | |
| Depreciation | 3.6% | 3.3% | | | |
| Financing | 5.8% | 5.3% | | | |
| Others | 5.7% | 5.8% | | | |
| Total | 100.0% | 100.0% | | | |

(Source) JICA Study Team (2009)

The actual cost breakdown is also shown in the below figure.




(Source) JICA Study (2009)

**Figure 12.1 Cost Breakdown**

The staff costs show a moderate increase compared with the total cost but a slightly higher than other costs such as maintenance and depreciation. On the other hand, the electricity purchase is expected to increase substantially over the period due to the increase of the purchase from IPPs.

(iii) Cost of Service

The projected cost of services for each category can be summarized in the following.

**Table 12.8 ZESCO Cost of Services (in ZMK/kWh)**

| Year | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Mining | 151 | 205 | 284 | 324 | 332 |
| Residential | 358 | 451 | 549 | 598 | 629 |
| Large Power | 172 | 224 | 304 | 360 | 380 |
| Small Power | 178 | 228 | 317 | 382 | 407 |
| Commercial | 313 | 393 | 490 | 544 | 576 |
| Overall Ave. | 207 | 266 | 344 | 388 | 407 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Mining | 360 | 384 | 399 | 406 | 416 |
| Residential | 678 | 723 | 752 | 765 | 780 |
| Large Power | 414 | 447 | 467 | 474 | 483 |
| Small Power | 444 | 480 | 501 | 505 | 512 |
| Commercial | 623 | 670 | 702 | 718 | 737 |
| Overall Ave. | 440 | 472 | 494 | 505 | 518 |
| **Year** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Mining | 424 | 436 | 451 | 479 | 489 |
| Residential | 795 | 817 | 842 | 894 | 904 |
| Large Power | 491 | 505 | 521 | 560 | 563 |
| Small Power | 518 | 531 | 546 | 589 | 587 |
| Commercial | 757 | 780 | 806 | 859 | 870 |
| Overall Ave. | 531 | 549 | 570 | 610 | 621 |
| **Year** | **2024** | **2025** | **2026** | **2027** | **2028** |
| Mining | 513 | 531 | 552 | 575 | 592 |
| Residential | 948 | 975 | 1,009 | 1,045 | 1,074 |
| Large Power | 595 | 612 | 634 | 658 | 675 |
| Small Power | 621 | 636 | 658 | 682 | 698 |
| Commercial | 916 | 944 | 981 | 1,019 | 1,050 |
| Overall Ave. | 657 | 680 | 709 | 740 | 765 |
| **Year** | **2029** | **2030** | | | |
| Mining | 615 | 640 | | | |
| Residential | 1,111 | 1,149 | | | |
| Large Power | 699 | 724 | | | |
| Small Power | 721 | 745 | | | |
| Commercial | 1,090 | 1,131 | | | |
| Overall Ave. | 797 | 830 | | | |

(Source) Compilation by JICA Study

The supply costs of services of ZESCO will increase for all the customer categories. The residential customer will have a large increase until 2012. The increase after 2012 however is a moderate because the tariff will achieve the cost-reflective level by the time. The overall average cost shows the increase from 207 ZMK/kWh in 2009 to 830 ZMK/kWh in 2030. The increase can be translated to approximately seven percent per year. The increase would be a little lower than the assumed average domestic inflation rate which is ten percent per year.

(iv) Cash Position

The projections for the cash flow statements are as shown in the below.

**Table 12.9 Cash Flow Statements (in ZMK million)**

| Year | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Cash Flow from Operation | 649,700 | 897,527 | 975,238 | 1,190,880 | 1,554,744 |
| Net Cash Outflow from Financial Services | (160,729) | (271,095) | (551,092) | (778,242) | (892,192) |
| Net Cash Flow from Capital Expenditure | (390,190) | (634,891) | (879,941) | (969,825) | (1,142,049) |
| Adjust. Income Tax Paid | (165,627) | (217,944) | (213,195) | (266,132) | (371,648) |
| **Increase(Decrease) in Cash** | (66,846) | (226,402) | (668,990) | (823,320) | (851,145) |
| **Accumulated** | 246,482 | 455,968 | 213,368 | (77,689) | (185,537) |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Cash Flow from Operation | 1,754,516 | 1,941,708 | 2,090,446 | 2,031,269 | 2,075,971 |
| Net Cash Outflow from Financial Services | (965,753) | (1,023,689) | (1,068,511) | (970,043) | (880,164) |
| Net Cash Flow from Capital Expenditure | (1,290,891) | (1,439,710) | (1,453,013) | (1,464,084) | (1,478,018) |
| Adjust. Income Tax Paid | (419,243) | (461,993) | (514,961) | (495,144) | (511,671) |
| **Increase(Decrease) in Cash** | (921,371) | (983,684) | (946,038) | (898,002) | (793,882) |
| **Accumulated** | (268,423) | (328,121) | (244,237) | (151,952) | 77,508 |
| **Year** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Cash Flow from Operation | 1,992,404 | 1,922,582 | 1,869,175 | 1,677,077 | 1,973,790 |
| Net Cash Outflow from Financial Services | (789,786) | (705,627) | (632,151) | (1,018,650) | (625,083) |
| Net Cash Flow from Capital Expenditure | (1,471,492) | (1,407,336) | (1,285,530) | (1,185,413) | (1,149,665) |
| Adjust. Income Tax Paid | (483,303) | (459,757) | (441,420) | (374,181) | (478,028) |
| **Increase(Decrease) in Cash** | (752,177) | (650,138) | (489,925) | (901,168) | (278,985) |
| **Accumulated** | 291,937 | 561,312 | 954,226 | 801,421 | 1,478,491 |
| **Year** | **2024** | **2025** | **2026** | **2027** | **2028** |
| Cash Flow from Operation | 1,795,229 | 1,952,661 | 2,025,445 | 2,055,417 | 2,038,614 |
| Net Cash Outflow from Financial Services | (852,181) | (686,609) | (726,866) | (700,117) | (675,073) |
| Net Cash Flow from Capital Expenditure | (1,136,734) | (1,123,938) | (1,033,843) | (1,045,385) | (1,057,935) |
| Adjust. Income Tax Paid | (415,544) | (470,649) | (496,120) | (522,379) | (522,792) |
| **Increase(Decrease) in Cash** | 221,859 | 612,764 | 760,855 | 832,293 | 828,399 |
| **Accumulated** | 1,700,349 | 2,313,113 | 3,073,968 | 3,906,261 | 4,734,660 |
| **Year** | **2029** | **2030** | | | |
| Cash Flow from Operation | 1,997,072 | 1,958,650 | | | |
| Net Cash Outflow from Financial Services | (624,929) | (583,437) | | | |
| Net Cash Flow from Capital Expenditure | (1,043,864) | (1,030,404) | | | |
| Adjust. Income Tax Paid | (509,713) | (496,262) | | | |
| **Increase(Decrease) in Cash** | 837,993 | 841,071 | | | |
| **Accumulated** | 5,572,652 | 6,413,724 | | | |

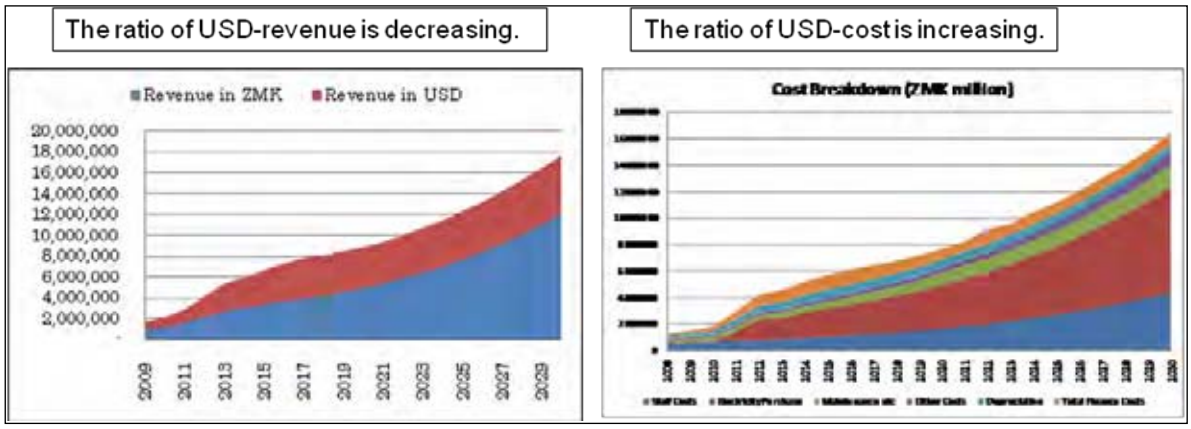
(Source) Compilation by JICA Study

The cash arrangement for ZESCO would be an issue during the period when the large amount of investment would be made, particularly from 2012 to 2017. The cash requirement will be mostly due to the projected expansion of the transmission network. After the year 2018, ZESCO will have a sound cash position.

(v) Tariff Adjustment Framework

Due to the investment needs in the future, the cost denominated in US dollars will increase

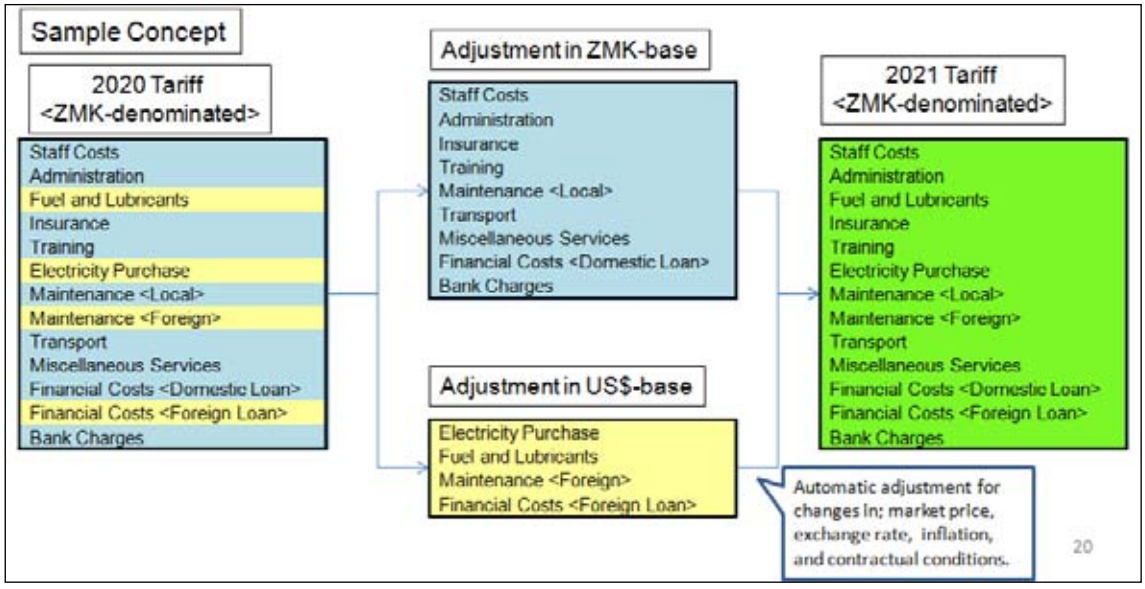
over the next twenty years. On the other hand, the revenue in US dollars, which is currently paid by the mining customers, may not increase as much as the revenue increases in US dollars. Therefore there is a concern that the gap may take place in the foreign-currency accounts.




(Source) JICA Study (2009)

**Figure 12.2 Revenue and Cost in USD**

The sample concept for disintegration of the cost items is shown in the following chart.



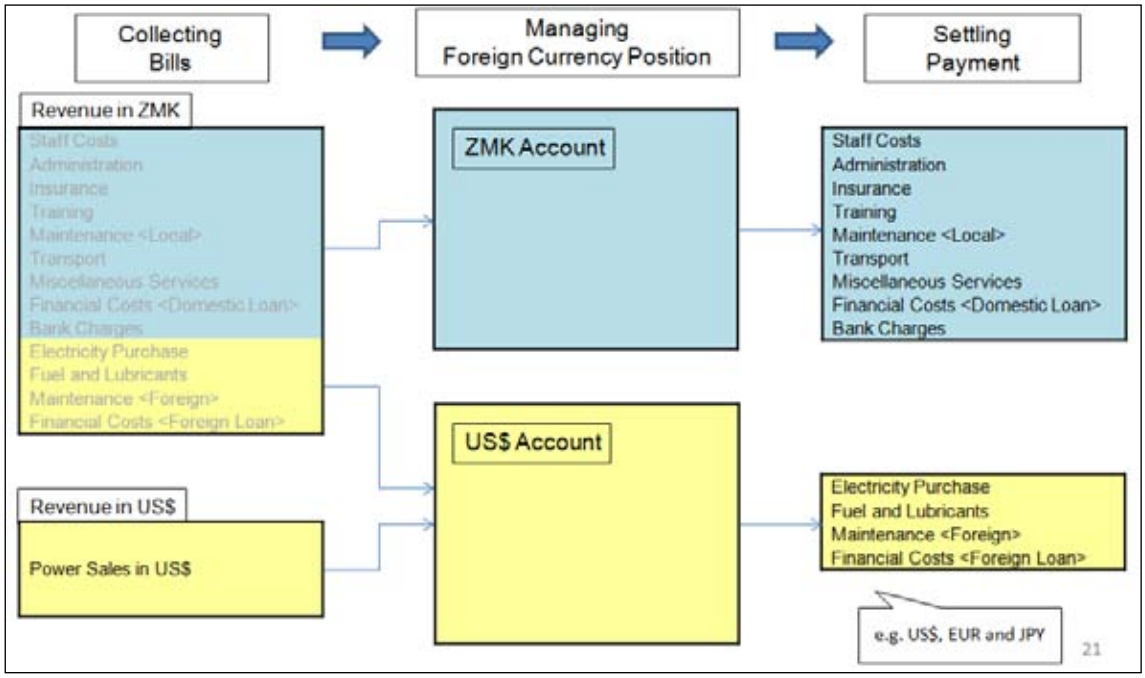

(Source) JICA Study (2009)

**Figure 12.3 Disintegration of Tariff Structure**

Most of the cost items are based on the Kwacha whereas some items are foreign currency based such as fuel, electricity purchase, maintenance cost for imported equipment and financial expenses for foreign loans. Therefore it is preferable to disintegrate the two portions of Kwacha and foreign currency for tariff adjustment. The two portions will have different ratios and increase rates in the cost breakdown and hence the different needs for tariff adjustment. An

automatic adjustment scheme would also benefit the timely cost recovery and adjustment.

Once the two-part tariff adjustment is introduced, it would be easy to manage the foreign currency accounts to settle the payments. The flow diagram is as illustrated in the following.




(Source) JICA Study (2009)

**Figure 12.4 Foreign Currency Management**

The revenue of the foreign currency denominated portion, which is still paid in Kwacha by the retail customers, can be exchanged to the foreign currencies depending on the payment needs such as USD, EUR an JPY. The bank account of foreign currency base can be managed separately from the domestic currency account**.**

### 12.1.2 Recommendation on Economic and Financial Issues

ZESCO aims to continue the improvement of management including the reduction of personnel costs. The Study has found some important factors and future perspectives on the management of power sector. The following items are critical for the economic and financial matters on the power sector master plan.

(1) Future Perspectives for Capital Expenditure

The development plan shows the optimum scenario for future capital expenditure. The study expects that the sequential development will be conducted according to the proposed schedule. However if the development plan faces any slippage in the schedule, ZESCO would need to procure power from neighboring countries and may need additional funds for the purchase. The delay in the project schedule wo*uld therefore cau*se another increase of the power tariff.

The study proposed an alternative measure to address the issue by considering the coal-fired thermal power plants by imported coals. Although the additional study needs to be carried out to assess the feasibility and bankability, it is recommended to look into the alternative scenarios at an early stage in order to prepare for the unexpected situations.

(2) Financing for Future Investment

As the investment plan shows, the large amount cash expenditure projects are planned in the coming years, particularly from around 2012 to 2016. While the power tariff is expected to achieve the economic tariff that reflect the cost of power services, the funds to invest in the additional infrastructure still remains an issue to ZESCO. The study assumed that ninety percent of the fund would be contributed by the debt financing that would presumably guaranteed by the government. However the discussion on the financial issue needs to be carried out with the Ministry of Finance and National Planning.

(3) Cost of Services

The cost of services will increase due to the factors such as the inflation, the additional development requirements, the investment to improve the efficiency and reliability of power supply, and the payment obligation to IPPs. On the other hand the efficiency gain is also expected including the system loss reduction, the operation cost reduction in real term, and the overall cost saving from the scale of economy. The supply costs could also be further reduced by the utilization of the SAPP interconnection. It is recommended that ZESCO would take various initiatives to improve the management performance in a proactive manner and demonstrate the achievements to the concerned parties including ERB.

Moreover, it is expected that ZESCO would improve the service efficiency and performance in terms of the services from metering, billing, and collection. These would include the overall service level improvement for customers as well as the reduction of the receivables.

(4) Foreign Currency Position

ZESCO has basically two currencies for revenue such as Zambian Kwacha and US Dollars because the payment from mining customers is made in the foreign currency and the retail customers pay in the local currency. ZESCO then utilize the revenue in foreign currency to settle the payment for the debt services in foreign currency, the import equipment, the power purchase, and goods, and others. Currently ZESCO has s surplus in the foreign currency account balance due to the revenue from the power sales in foreign currency. However it is expected that the payment in foreign currency will increase over the period due to the increase of the power purchase from the private power producers. Therefore given the potential depreciation of the local currency against the foreign currency, the foreign currency management is increasingly important and critical for ZESCO. Even at this point, the exchange fluctuation causes the impact on the profit of ZESCO. In terms of the management of the foreign currencies, ZESCO's account will face the cash shortage in the future due to the increase of the foreign cash payment to the IPPs. Therefore the asset and liability management will be important to ZESCO.

(5) Power Tariff Adjustment

As shown in the financial analysis, the regular tariff adjustment will be inevitable even if the performance of ZESCO will improve due to the power supply cost increase. Therefore ERB should adjust the power tariff in a continuous and timely manner based on the ZESCO's performance and the economic and business situations. The consideration on the power tariff continues to be critical because it would have a significant impact on the ZESCO finance. In addition, the foreign currency portion in the power tariff should also be adjusted in a timely manner to reflect the changes in foreign exchange to address the settlement needs for foreign currencies.

### 12.1.3 Current Status and Issues

The private investment will be an important vehicle for the power sector development in Zambia because the public funding would not be sufficient to sustain the continued and increasing needs for investment. However the current framework and environment for private investment are not always attractive for private investors even though some legal bases have been established. This section will review the current status and issues on the private investment promotion.

(1) National Public Private Partnership (PPP) Policy

National Public Private Partnership (PPP) Policy has been formulated in November, 2008 by the Ministry of Works and Supply. The objectives of the policy are to facilitate the PPP development to ensure the economic growth through enhanced productivity, improved competitiveness and wealth creation. The aims will also be applicable to the power sector for maximizing the benefits of private sector participation such as (i) Accelerated implementation of infrastructure projects, (ii) Efficient services to the public, (iii) Opportunities for business for local entrepreneurs, (iv) Access to infrastructure and services by the public, (v) Positive impact on social and economic welfare. The power sector has already identified some specific projects for private participation. All the private investment projects are expected to produce the above-mentioned benefits.

The PPP policy stipulates the guiding principles for undertaking the PPP projects including (i)Feasibility, (ii)Affordability, (iii) Bankability of Projects for Financiers and Developers, (iv)Value for Money, (v)Appropriate Risk Allocation, (vi)Economic and Social Benefits, (vii)Citizens Empowerment, (viii)Decentralization and (ix)Corporate Social Responsibility.

The PPP Policy has also identified wide-ranging arrangements for PPP such as service contract, management contract, lease, concession, build operate transfer (BOT)/ build own operate transfer (BOOT), and divestiture (privatization). Thus it is expected that the Government would seek appropriate form of contract and encourage innovation in project formulation.

The PPP policy will be implemented by a PPP Unit to be established in the Ministry of Finance and National Planning as an Independent Statutory Body. The unit is expected to

coordinate, administer and monitor PPP in Zambia. The contracting ministries and local authorities will play a lead role in project implementation with the assistance of the PPP unit. It is not however clear how the PPP unit will work with OPPPI in the case of power sector. Therefore it is strongly encouraged that the clear legal and regulatory framework is put in place by a new PPP legislation that will cover all the relevant sectors and organizations.

(2) The Framework and Package of Incentives for Private Participation in Hydropower Generation and Transmission Development (FPI)

The Framework and Package of Incentives for Private Participation in Hydropower Generation and Transmission Development (FPI) was published by the Government. The framework has not been revised for the last ten years, and would need to be updated based on the current economic and technical development.

(a)Finance

The financial resources are expected to be mobilized in the development concept of FPI. Thus project sponsors need to secure the sufficient revenue from the power sales in order to serve loans. Nevertheless the power tariff level appears to be low to achieve the sector goals of private sector participation. It is also noted that GRZ was not in a position to provide any types of government guarantees on the power sector projects including the partial guarantees due to the conditions of the debt relief package under the Highly Indebted Poor Countries (HIPC) Initiative. However the Study Team was notified that GRZ is now in a position to provide the government guarantees on power sector. Therefore sovereign guarantees can be considered to future projects in consultation with the Ministry of Finance and Planning.

The corporate tax may be exempted on incomes from sales or transmission of power according to FPI. The custom duties, value-added tax and other charges may be exempted. In addition, the provision states free repatriation of dividends and equity for private power projects. These tax and fiscal incentives should be aligned to prevailing laws and regulations.

(b)Power Tariff

Power tariff is administered by ERB including generation and transmission prices. The procedure to determine and approve the tariff for private power projects would follow the current methodology as far as the tariff would have significant impacts on ZESCO and hence public. The electricity costs for large consumers would be much lower than other consumers such as domestic and small commercial uses. However ERB would consider the social impacts on the private investment projects and may intervene in the tariff approval even in the case of power purchase agreements between private companies.

The procedure for application of bulk power tariff will be reviewed by ERB based on the application by project sponsors that need to provide a year-wise tariff profile for the first 30 years of the project. However except the four major tariff components, detail procedure and data requirements are not provided. ERB therefore need to provide a guidance and sample

applications for project sponsors to clarify the basis for the regulation.

The transmission service charge is also described in FPI. The framework states that the sponsors will be paid service charges covering capital and maintenance cost including return on equity. ERB needs to develop and provide a detail methodology to estimate the charges. The Study Team identified a potential for international and domestic transmission line development by private sector particularly when ZESCO may not have a sufficient credit to mobilize the capital for long-distance transmission line development.

(c)Water Rights

Water rights are another issue for hydro project development. First, there is a mismatch between the duration of the water right approval of five years and the project life of hydropower, which is usually more than 30-50 years. Second, the hydropower use is not prioritized in the law. The draft water resources development act prioritizes the domestic use, environmental purposes, and agricultural purposes more than industrial use including hydropower. Therefore, there is always a risk not to have the water rights renewed if other prioritized needs emerge after the commissioning of hydro projects since the water rights for hydropower generation is not guaranteed by the relevant law. FPI provide a misleading message in this aspect.

(d)Institutional Framework

Office for Promoting Private Power Investment (OPPPI), which is established in MEWD is mandated to coordinate and lead the private investment in the power sector and the implementation of FPI. OPPPI needs to coordinate with various organizations to achieve the tasks such as ZDA, Ministry of Finance and Planning, Treasury Office, Ministry of Justice, and ERB in addition to private sector.

PPP Policy also aims to establish a PPP unit. Since the future private investment will have various modalities such as PPP, concessions and service contract, the coordination would be critical. Therefore the coordination by OPPPI will be increasingly important.

According to FPI, Government will support sponsors in the following actions for large hydropower projects including (i) appointment of an independent panel of experts from the start, (ii)extensive evaluation of site alternatives, and (iii)resolution of upstream and downstream issues. GRZ needs to specify and distinguish what would be regulatory and approval aspects to secure the environmental matters and what would be supporting aspects for project sponsors that may not have expertise on the matters. The conditions for development imposed by GRZ should be articulately provided to project sponsors. Otherwise the government interventions could be used for political measures.

(e)Open Access

While the grid code has been established in Zambia, it is not yet put into operation because of no or limited transactions in the country. However the demand for open access will be larger in the near future due to the increasing demand for diversified, cheaper and more reliable electricity.

An independent system operator has not yet been put in place. Thus the regulator has not established an effective monitoring and regulatory system to ensure the efficient and fair trade of electricity.

The Study Team also learned that the revision of the grid code is being discussed by a committee led by ERB. The members of the committee include ERB, MEWD, CEC, other private firms and other stakeholders in the power sector. The discussion at the committee would lead to a possible structural reform of the power sector because the issues include the roles and responsibilities as well as the organizational setup for the system operator.

The current FPI assumes that ZESCO is to identify, describe and recommend the least-cost blocks of capacity and related infrastructure services required for the national grid. The function involves the forecasting of the future demand scenario and the planning of infrastructure investment. However the future role of ZESCO on the future planning will be changing because the independent system operator, if once established, may take over the function and ZESCO would be one of the power utility companies in addition to other generation and transmission utilities. ZESCO will however remain a major vertically integrated power company in Zambia, and need to plan its power system development.

(3) Key Issues

This section aims at identifying and analyzing the current status and issues for private investment. The major issues related with the private investment in the power sector in Zambia can be analyzed from the following viewpoints such as (i) finance, (ii) generation tariff, (iii) water rights, (iv) institutional framework, and (v) open access.

(1) Finance

Some of the articles in FPI are not supported by legislations. Good samples of these issues are the corporate tax and custom duties. Even though the concept has been included in the policy paper, no clear legal documents appear to be provided. Thus private investors are not really sure how to proceed. These conditions should be put into statutory orders.

The funding for private projects will also be an issue for some project sponsors. Even though FPI proposes the establishment of Private Sector Infrastructure Development Fund and Hydro Planning Fund, no successful actions appear to be taken to materialize the funds. With the global financial crisis in 2008, the fund mobilization will be increasingly difficult for any private companies to develop hydropower in particular. Thus the public funding can be revisited to facilitate the timely development.

(2) Power Tariff

The current power tariff level in Zambia is still less attractive to project sponsors if the current tariff level is applied to their generation project. In addition, ERB will need to take into considerations the financial and social impacts on the domestic consumers if the off-taker of the

power is not a private firm but ZESCO.

ERB will need to establish a methodology for determining a tariff profile for project life in consideration of the profitability of the project and the economic and financial impacts on the current stakeholders including the domestic, commercial and industrial consumers as well as the power utilities.

(3) Water Rights

The water rights have been a big concern and issue for hydropower project sponsors. In the Draft Water Resources Development Act, the priority for hydropower use is lower than the domestic purposes, the environmental purposes, and the agricultural use. The actual application of the law to the hydropower projects would not be clear for the long-term project life of hydropower in particular. Since OPPPI cannot make decisions on the water rights issue, OPPPI will need to closely coordinate with other organizations.

(4) Institutional Framework

Even though OPPPI has a mandate to coordinate the private sector participation, the legal instruments have been weak to support the articles in FPI and the activities of OPPPI. The specific incentives for example should be entrenched in the specific law in order to protect the rights and profits of project sponsors. Therefore the FPI should be strengthened to increase the credibility and the instruments for administrative directions should be institutionalized in OPPPI.

The several initiatives and activities in government organizations need to be streamlined and strengthened. The private investment in the power sector entails comprehensive approach on cross-cutting matters in order to assist in investment. For instance while ZDA is supposed to be a one-stop office for investment projects, OPPPI will need to exchange information and coordinate the advisory and administrative services with ZDA. The tax issue can also be clearly explained and instructed by OPPPI on behalf of other government offices.

The Public Private Partnership (PPP) unit has been established in the Ministry of Finance and National Planning (MOFNP). The detailed inter-ministry arrangement for coordinating the PPP projects is not however still yet established, particularly on the coordination on financing and incentives issues. As discussed the private investors are sensitive to the financial an fiscal conditions associated with the investment such as the corporate income tax, import duty, and VAT. The future prospects and directions on the provision of the government guarantee are not under the discussion in the government departments including the guarantee for debt financing and power purchase agreement.

(e)Open Access

Open access has not been secured yet in Zambia even though the grid code has been established. GRZ will need to establish a appropriate legal and regulatory structure to implement open access, and develop/secure adequate capacity to plan and regulate the transmission line services. ERB's capacity to upgrade the grid code and enforce the regulation

will need to be improved in order to achieve the efficient system development.

The discussions on open access will touch on a possible restructuring of the power industry. In fact international practices imply that the transparent and efficient operation of power system should be secured by an independent system operator. Since the function is currently undertaken by ZESCO, the introduction of system operator would result in the organizational restructuring of the incumbent power utility. The Study however does not originally intend to examine the sector reform methodology but aims to study the measures to successfully promote the private investment projects. Therefore the discussion would focus on the effective measures to introduce and expedite private investment projects.

## 12.2 Private Investment Promotion Plan

### 12.2.1 Needs Assessment and Financial Capacity

The Study conducted a series of interviews with the possible private investors in Zambia. The interviewee companies included the following.

**Table 12.10 Possible Investors in Power Sector in Zambia**

| No. | Name of Company | Name of Project | Method of Selection | Capacity (MW) | Status of Project |
|---|---|---|---|---|---|
| 1 | Lusemfwa Company | Lusemfwa/ Mkushi River | Negotiation | 147 | F/S to be completed by June 2010 |
| 2 | Mwinilunga Power Co. | West Lunga | Negotiation | 3 + 3 | PPA under negotiation with ZESCO |
| 3 | CEC/TATA | Kabompo Gorge | Bidding | 34 | F/S ongoing. PPA negotiation will be started in 2009. |
| 4 | Lunzua Power Authority (Olympic Milling) | Kalungwishi | Bidding | 62 + 101 | I/A under negotiation |
| 5 | Power Min Co. | Mutinondo/ Luchenene | Negotiation | 40 + 30 | No F/S has been completed. |
| 6 | TATA | Itezhi Tezhi | Negotiation | 120 | D/D ongoing. |

Even though the other promising generation projects will also be undertaken by private firm, those projects have not identified and/or selected project sponsors. It is also not easy to discuss those projects when the project formulation and arrangement are ongoing. Therefore the Study will eliminate those projects from the examination such as Kafue Gorge[28], Lusiwasi Expansion, and Maamba Project.

(1) Lusemfwa Company

Lusemfwa Company is currently the only independent power producers in Zambia that has a 18MW capacity. The majority shareholder is Eskom, the South African power utility. Lusemfawa intends to develop Lusemfwa/ Mkushi River Project.

[28] Kafue Gorge Project is currently being studied and prepared by IFC. The pre-qualification of the project sponsor will be completed by 2009, and the construction is planned to be started in 2011.

The proposed project has three power plants with the capacity of 55MW, 60MW and 32MW. The generated power is expected to be sold primarily to ZESCO. The feasibility study is going to be completed by 2010 including geological survey. The information memorandum is also expected to be finalized by the end of 2009. At the moment Lusemfwa is negotiating with financial institutions on funds. Information has also been sent to ERB for review on the license application and environmental clearance.

Lusemfwa identified a few viewpoints for GRZ to improve the environment for private investment in the power sector.

- A guideline by GRZ can be easy to understand for private investors including FPI.
- Water Act should be aligned with other laws such as Electricity Act and Energy Policy
- ERB should be operationalized on the open access issue.

The company anticipates necessary funding for the project from the corporate bond and financial institutions such as DBSA and IFC. Even the project requires a transmission line of 15km, the company intends to upgrade the existing substation of ZESCO and to construct the transmission line on behalf of ZESCO in order to accelerate the project implementation.

(2) Mwinilunga Power Co.

Mwinilunga Power Co. runs a small hydropower plant (1MW) in the isolated area of the northwest region of Zambia. The company intends to develop West Lunga Project in Mwinilunga district with the capacity of 6MW in total. The two sites include Kakokakaw and Kanyikomboshi.

The feasibility study has been completed and the letter of intension for development has been sent to OPPPI. The environmental brief has also been sent to the environmental council. The negotiation with ZESCO is ongoing on the PPA. Since the project area is in the rural area, the project may be able to tap the subsidy fund from REA. Given the power cost for the area is about 41 US cents/kWh due to the high cost of diesel generation, the project will be a economical solution for the region.

The company is expected to sell the generated power to ZESCO and the region will be provided the power. A concession contract is also another option for the project whereby the Mwinilunga Power Co. will generate the power and operate the isolated distribution system on behalf of ZESCO. If the concession is materialized and successful, the regional investors and local government can demonstrate a proven business model and increase the confidence in rural development by a private company.

(3) CEC/TATA

Kabompo Gorge Project is currently being developed by the joint venture of CEC and TATA. The project was advertised for public bidding and three bids were submitted approximately two

years ago. The joint venture of CEC and TATA was selected in October 2008 as a successful bidder. The feasibility study will take twelve months and the application of license will be submitted after the feasibility study is completed.

The project sponsor identified a few issues on the project and the private development in general.

- The cost of F/S is borne by private sector, which may be a bottleneck for some investors.
- The project needs an access road including the 34km government road that needs a repair and upgrade. Since the road is managed by the road development agency, the timely construction with sufficient budget is extremely important to the project.
- The hydrological data is critical for improving the estimates of energy generation and the project viability. The government and the water board can assist in the data acquisition.
- The government process for the project application should be shortened, simplified and streamlined. It takes too much time.
- Tax benefits have not been adequately spelt out in the laws.
- The tariff regulation by ERB[29] should not be applicable to a direct PPA agreement with industrial consumers. The cap regulation on the project return does not make sense to private projects.
- GRZ can consider financing for the infrastructure necessary for the implementation of private projects such as access roads.

(4) Lunzua Power Authority

Luzua Power Authority is a subsidiary company of Olympic Milling Company. Luzua Power Authority is a project sponsor for the Kalungwishi Project (173MW). The company was selected by an open bidding in 2007. The company and GRZ are currently negotiating the implementation agreement. The feasibility study was carried out by Harza in 2000.

Since the project requires a 510km transmission line to evacuate the generated power, the total project cost would exceed US $600 million. While the primary off-taker of the power is expected to be ZESCO, there is a possibility to supply the power to the other private companies in Zambia as well as other countries.

Luzua Power Authority has pointed out issues associated with the private power development in Zambia.[30]

- Water right issue remains a large concern for private investors.
- Hydrological risk is also a big concern due to the limited, reliable data available for estimating the energy production.
- The environmental issues are also getting more and more critical in addition to relocation due

[29] ERB mentioned that Electricity Act is also applicable to private investment projects. ERB would also review the import tariff by private companies.
[30] Luzua Power Authority did not raise the mobilization of funds for project implementation as an issue for the project.

to the project. GRZ states that these risks should be borne by private project sponsors by nature.

- The incentive programs by the government should also be strengthened such as fiscal incentives.

(5) Power Min Co.

Power Min Company identified the Mutinondo/ Luchenene Project themselves on an unsolicited basis unlike many other private investment projects in Zambia. The feasibility study is being considered and the company is looking for financial sources for the F/S. The implementation agreement is also under preparation. The discussion on the off-taking arrangements and PPA is also a future task as well.

The company has identified the following issues on the private investment projects.

- Funding is an issue for Power Min even for the feasibility study cost. The mobilization of funds for implementation will also be an issue.
- The assistance by OPPPI is expected in terms of project formulation and implementation. Especially the water right and environmental clearance can be facilitated by OPPPI.
- The pricing conditions on the project implementation are not clear to the company.

Since the company has just started the preparation for the necessary study for the project, it is suggested that the company get in touch with OPPPI and obtain necessary information.

(6) TATA

In addition to Kabompo Gorge Project, TATA is participating in the hydropower development for Itezhi Tezhi Project (120MW). The joint venture of ZESCO and TATA[31] is currently finalizing the formulation of the project implementation arrangement. The project cost is estimated to be US$150 million.

The feasibility study has been completed and approved. The project sponsor has already forwarded the PPA proposal to ZESCO. At the same time, the proposals for EPC contract are expected to be submitted in 2009. Currently the project sponsor is supported by the transaction adviser in the discussion on PPA.

Debt financing for the project may be provided by the international financial institutions such as EIB, DBSA and AfDB. The government guarantee for the debt finance has not been discussed yet. The issues on the project may be the operation of the three power plants including Itezhi Tezhi Plant, where the dispatch function would be managed by a system operator. The company wishes to have a concession agreement with the government that would include the financial conditions such as tax benefit, holding tax, import duty, VAT and others.

Since the project is expected to be one of the most promising projects in the near future, GRZ

[31] The participation rates for the joint venture are ZESCO (50%) and TATA (50%).

should demonstrate a showcase to other private investors by the successful implementation of Itezhi Tezhi Project. In particular, since the project sponsor is the joint venture of ZESCO and TATA, this is the first major initiative for the public private partnership. The financial institutions are also reported to show interests to support the project implementation by a concessional financing.

### 12.2.2 Recommendation on Private Investment Promotion

The environment for private investment promotion can be improved and enhanced from the viewpoints that are already identified as bottlenecks for development.

(1) To provide clear framework and system for encouraging private investment

The framework should be updated and strengthened by necessary statutory instruments on the issues such as incentives for tax/duty, grid code/open access, environmental matters, and other legislations and regulations.

Many investors' concerns do not rest in the profitability and the technical risks of the specific projects but in the unclear legal situations and surrounding regulatory circumstances. If the conditions for the investment such as various taxes and import duties are certain to the investors, the investors will be more confident on the project implementation.

(2) To accelerate processes for the review and approval of private investment project

There are already some projects in the pipeline that are waiting for administrative guidance and clearance. The instruction and support by GRZ are critical for implementation of projects because the advices of the government would drive the directions of the projects. The critical aspects on the projects include (i)environmental issues, (ii)licensing for project development, (iii)power tariff and PPA negotiation, (iv)design and construction, and (v)water rights matters.

The process should also be simplified and clearly understood by private investors. Some private investors also complain the slow processing by the government organizations and the complexity of clearance procedures. Since some of the investors could be new to the power market in Zambia, the facilitation by the government experts would lower the barriers to enter the market.

(3) To enhance the capacity for coordination and review of the applications of the private power development

ERB appears to be occupied with the burning issues at hand such as the tariff issues, the monitoring of the performance agreement with ZESCO, and the revision of the grid code. ERB can take the lead in establishing the standard and good practice for regulating the private investment projects. FPI can also be upgraded to reflect the recent changes in the power sector and articulate the scope of works and the methodology for the regulation of the private power development by ERB. The tariff negotiation will be increasingly important when dealing with the diverse needs of different private investors and projects.

OPPPI will continue to be a focus and critical point for private sector participation in the power sector. It is significant for OPPPI to establish a credible position in coordinating the power projects. In addition to establishing a clear legal framework for the activities by OPPPI, the capacity and human resources need to be mobilized and developed in terms of the contract matters, project planning and coordination with various stakeholders both within and outside of GRZ.

(4) To increase the government support to fund the project preparation and implementation by the private sector

Funds to support the private sector initiatives need to be revisited. There would be certainly needs and benefits for the intervention by the government for instance to mobilize the domestic capitals by local investors even though the number of the domestic investors would be less than the international players.

GRZ has already prepared several financial and fiscal incentives for the implementation of the private investment. These benefits should be realized and enjoyed automatically upon initiating the project implementation so that they can contribute to attracting more succeeding investment projects.

The hydrological data can also be collected and accumulated by public institutions such as the water board in order to use for future projects. The reliability of information will reduce the investment risks and hence increase the welfare of the consumers.

The government funds for infrastructure development that are related with the power projects also play a significant role in the project implementation. These would include the access road construction, the substation and other facilities for evacuating power, the information and communication facilities, and the other social services. These public facilities and services should not be a bottleneck for the implementation of private investment projects. The coordination by OPPPI is also critical in this aspect. The proposed PPP unit in the Ministry of Finance and Planning should also work with OPPPI to resolve the budget issues.

# Chapter 13 GIS Database

## 13.1 GIS introduction

Geographic information systems (GIS) perform comprehensive management, processing, and visual display of data with position-related information (spatial data) based on geographical location, to facilitate sophisticated analysis and prompt decision-making. The construction of a GIS database from the results of the master plan study for power development in Zambia will not only facilitate confirmation of results but also be of extensive use in future studies.

In the master plan study for rural electrification in Zambia implemented from May 2006 to January 2008, data for the medium-voltage distribution system and rural growth centres (RGC) were added to the existing GIS data in such forms as geographical information in the possession of Zambian administrative institutions.

This study will add data collected through the Study Team activities to the existing GIS data upon a review of the latter and consultation with the C/P.

## 13.2 GIS utilization and existing databases

### 13.2.1 GIS utilization

Although there is no GIS in the DOE, the counterpart institution in this study, there is one in the Department of Planning and Information (DOPI), which is also attached to the Ministry of Energy and Water Development (MEWD). In addition the Rural Electrification Agency (REA), the counterpart institution in the aforementioned RE master plan study, has Arc View and employs a GIS expert (a GIS officer engaged in management of design and construction for the medium-voltage distribution system). Similarly, DOE staff received training in Arc View and therefore basically know how to operate it.

Outside the power sector as well, GIS are in extensive use. Table 13.1 lists cases of GIS utilization in JICA schemes.

Effective use of combinations of these GIS databases (baseline information) could make possible various planning applying GIS.

**Table 13.1 Examples of JICA schemes related to GIS databases in Zambia**

| Name of scheme | C/P | Productive of the scheme |
|---|---|---|
| Study for compilation of information on geology and mineral resources to promote investment in the mining sector | -Ministry of Mines and Minerals Development | -Map of mineral resource distribution<br>-Geological map |
| Lusaka primary health care project | -Ministry of Health<br>-Lusaka department of health (LDHMT) | -Map of health facilities<br>-Places of residence of people with cholera |
| Capacity-building program for decentralization of power | -Cabinet Office<br>-Ministry of Finance and National Planning<br>-Ministry of Local Government and Housing | -Urban planning maps |

(Source) JICA Study team

* GIS utilization in the REA

The work of RE promotion in the REA provides good examples of effective use of GIS databases. This use is outlined below because it is thought to furnish useful information for the transition to actual implementation of the master plan.

* Examples of RE promotion work

(1) Work flow

1) On-site visits to areas slated for RE

2) Use of GPS to plot routes for extension from power supply points (ends of existing distribution lines or substations if the lines are newly installed) on electrification routes
The GPS plot points are as follows.

-- Power supply points
-- High-voltage (HV; 33- or 11kV) feeders and line ends to be extended
-- Locations of pole transformers
-- Medium-voltage (MV; 400 V) feeders and line ends
-- Bridges on extension routes (for determination of river crossing locations)
-- Receiving customers
-- Locations of other items (route curves and other items whose location must be determined for route planning)

3) Preparation of GIS data
Use of GIS to map extension routes based on the plot points noted in section 2) above. Plots are not made for the points slated for pole erection (these points are generally determined from the prepared maps, on the basis of a 50-m span as the standard)

4) Preparation of design drawings

Charts are prepared by CAD based on the GIS data noted in Item 3).

5) Preparation of integration (addition) tables for materials used

Preparation of a bill of quantity (BOQ) required for extension work based on the design drawings noted in Item 4), and calculation of the requisite number of poles by dividing the route distance by the standard span

6) Determination of contractors

a. Submission of design drawings and BOQs to the Zambia Public Power Authority (ZPPA)

b. Announcement of the construction work to construction companies upon ZPPA approval of the drawings etc.

c. Determination of the construction company through performance of tenders or other procedures

7) Execution of the construction

Execution of the construction upon conclusion of the contracting agreement

8) Hand-over to ZESCO

Inspection of the facilities by the REA upon completion of the construction and hand-over to ZESCO

(2) Tool software used in this work

- GIS: Arc GIS Ver.9 (Arc View)
- GPS: eTrex Venture HC manufactured by Garmin (incorporated into the Arc GIS using the GPS interface)
- CAD: AutoCAD Ver.7

(3) Requisite manpower for the work

Ordinarily, one REA staff member visits each site to perform the work noted in items (1)-1) and -2) (employment of up to 8). This work can be completed within a period of 0.5 - 1.0 days per site.

The GIS officer prepares the GIS database and performs other work involving slips (work for 25 sites within 3 - 4 weeks)

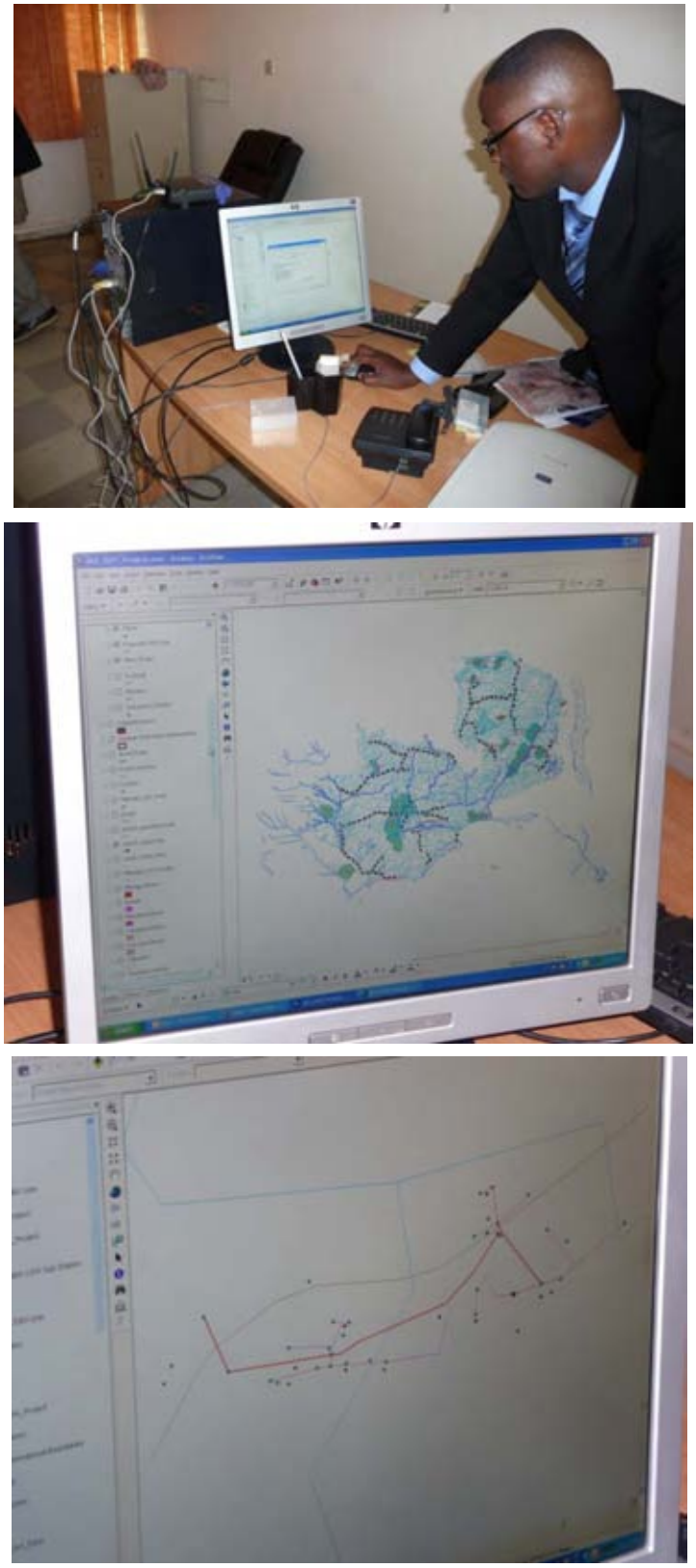


**Figure 13.1 GIS environment in REA (photo)**

### 13.2.2 Existing GIS databases

Table 13.2 shows the GIS databases based on information obtained from the concerned institutions through the field survey. These databases were built with data collected from the RE master plan study. They are managed in units of administrative institutions, and contains information on major infrastructure and other elements in Zambia.

However, they contain some information that uses different coordinates and consequently lacks a conformance of scale as well as other information not particularly needed for this study. In addition, they lack some requisite information, such as topographical data.

Therefore, it is necessary to compile requisite information through further study work (including re-collection and in-depth study).

**Table 13.2 GIS databases at present**

| Administrative institutions | Databases |
|---|---|
| — | Map of Africa, national borders in Africa, provincial and county borders in Zambia |
| Ministry of Agriculture and Cooperatives | Farming districts, farms |
| Ministry of Education | Primary schools (electrified/unelectrified/without water), junior high schools, village centers, trunk roads, ordinary roads, national parks, railways, rivers, wetlands, dams, drainage conduits |
| Ministry of Energy and Water Resources | Transmission line routes, hydropower stations, diesel power stations, substations |
| Ministry of Environment, National Resources, and Tourism | Forests, grasslands, roads, railways, rivers |
| Department of National Statistics | Electoral districts, roads |
| Ministry of Health | Medical facilities, primary schools |
| REA | RGC, distribution line routes |

(Source) Prepared by the Study Team based on information from the RE master plan

## 13.3 Construction of the GIS database

### 13.3.1 Selection of GIS applications

Of the GIS application software currently available in the market, the Study Team selected Arc View for the GIS in this study. Arc View has one of the major shares of the GIS market, and has also been adopted for the RE master plan in Zambia. In addition, it has many users who are oriented toward studies of expansibility through data exchange with other GIS software, and is steadily evolving as a result.

Furthermore, DOE staff were trained in Arc View in connection with the RE master plan study.

### 13.3.2 Guidelines in conditioning of the GIS environment

Efforts were made to prepare the survey results into a GIS database that would match the needs of the C/P and concerned institutions.

More specifically, the prerequisites included avoidance of a situation in which the database could not be easily updated and go out of use if the product exceeded the skills of users, and the need for sure database management (swift data revision, smooth data provision, and management of amplified versions) into the future.

The Study Team ascertained the needs among the C/P and other concerned institutions, and made judgments on the types of role that could be played by each.

In consideration of the above, the following is a proposal of the type of involvement with the GIS database on the part of the concerned institutions.

* DOE:

The DOE is the central organization charged with directing the master plan, and in a position to exercise leadership for the power system development in this study. It must interlink the GIS databases that are at the concerned institutions and specialized for their work, and direct the power system development in multiple aspects, including environmental considerations, locations of mineral resources, and city planning. Because the collection of information related to power systems spans a wide range, it would be unreasonable to expect the DOE to perform all the collection and database construction itself. Therefore, the DOE should seek provision of information from the concerned institutions, check the content, and perform the conversion processing for input into the GIS database (the specific procedure for this processing is contained in the related manual).

* REA:

As the administrative institution promoting rural electrification, the REA desires to be constantly supplied with the latest information on the progress and orientation of power system development. It is presumably most interested in the location and demand situation at bulk supply points involved in the extension of medium-voltage distribution lines, and supply points, whose installation expands from bulk supply points. A check with the REA revealed that, at present, it does not make proposals on matters such as the establishment of supply points and is engaged solely in design for extension from the existing points. However, the projection of a change of demand in the retail division as suggested by plans for development of provincial cities indicates a need for coordination of views with the Ministry of Local Government and Housing, ZESCO, and other concerned entities. Knowledge of micro-grid system demand represented by solar home systems (SHS), micro hydropower, and other such sources constituting potential demand as viewed from the perspective of the on-grid system would also be important for dealing with future demand increase and system planning. The REA would be suitable for leading collection of information on such items.

* ZESCO:

ZESCO is on the front lines of power system development and management, and the primary principal for technical promotion of the master plan. It has the most information on plans and actual data regarding the power system. As such, ZESCO would, properly speaking, be best qualified to act as administrator in connection with this environment. Nevertheless, this would pose the risk of detraction from information accuracy, as ZESCO also performs the development design and management itself. For this reason, it would be advisable for ZESCO to perform design and production of related GIS databases on its own initiative, and to construct an operational routine for periodic inspection by the DOE as the administrative body. (As used here, the term "production" does not refer to the production of run-format files for GIS software; details of such production are contained in the related manual.)

* CEC

The CEC ranks alongside ZESCO as an enterprise supporting the power system in Zambia. It possesses information on the mining sector, which largely determines the trend of power demand. In addition, in formation of its own system facilities, it must pay attention to changes in the demand of the distribution system of ZESCO, which supplies power through its own facilities. As a result, like ZESCO, it must be a GIS database builder. GIS database design (framework design), however, should be unified, and ought to be led by ZESCO. In other words, the CEC would be a database builder and party that refers to data. Other private enterprises (Lunsemfwa etc.) may be treated in the same way as the CEC.

Augmentation of GIS databases by the approach outlined above would enable more in-depth and progressive power development. As a secondary benefit, it would also refine the GIS databases of other concerned governmental institutions and thereby contribute to Zambia's advancement.

### 13.4 Deliverables

Following figure shows the deliverable of this study regarding GIS database. We would aspire to accept it and revising, managing and growing it by each ministry.

**Table 13.3 Configlation of GIS database**

| Super Class | Sub Class | GIS data | Attribute |
|---|---|---|---|
| Root | 0_World landscape | Operational Navigation tool | Layer |
| | | World Shade relief | Map Document |
| | 1_Zambia landscape | Zambia map UTM35 | Shape file |
| | | Zambia photo map UTM35 | Raster data set |
| | 2_Recent data | 330kV transmission | Shape file |
| | | 220kV transmission | Shape file |
| | | 132kV transmission | Shape file |
| | | 88kV transmission | Shape file |
| | | 66kV transmission | Shape file |
| | | Hydro power stations | Shape file |
| | | Substations | Shape file |
| | | Diesel stations | Shape file |
| | | Proposed hydro power stations | Shape file |
| | | Proposed thermal power station | Shape file |
| | | Network facilities | Map Document |
| | | Point facilities | Map Document |
| | 3_Recommendation | Plan in 2015 | Map Document |
| | for Scenario 1-1 | Plan in 2020 | Map Document |
| | | Plan in 2025 | Map Document |
| | | Plan in 2030 | Map Document |
| | | Related data | Shape file |
| | 4_Rcommendation | Plan in 2015 | Map document |
| | For Scenario 1-2 | Plan in 2020 | Map document |
| | | Plan in 2025 | Map document |
| | | Plan in 2030 | Map document |
| | | Rlated data | Shape file |
| | 5_Reference 1 | | |
| | (PEMP data) | | |
| | 6_Reference 2 | | |
| | (misc. in PMP) | | |

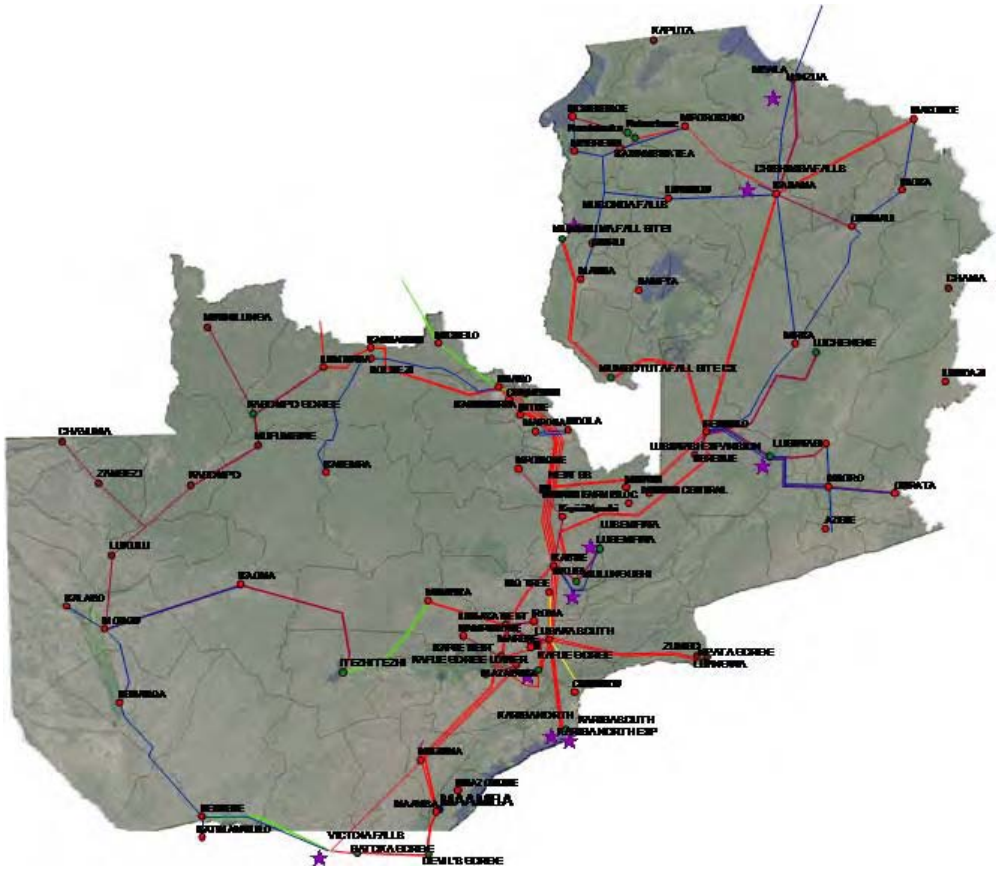



**Figure 13.2 Example of the objective regarding GIS**