NATIONAL ELECTRIFICATION STRATEGY

Government of Mozambique

To the Minister of Mineral Resources and Energy

The National Electrification Strategy represents an important stage of the study "Development of the National Electrification Strategy and Plan", as it aims to provide the necessary elements that will enable Mozambique to achieve the objective of access electricity by 2030.

The Strategy is based on three central pillars, in particular institutional, financial and technical - to determine the necessary activities that will support electrification in Mozambique.

Institutionally, the Strategy assigns clear roles to the institutions responsible for the development of electrification: MIREME, EDM and FUNAE. MIREME must lead the planning process; EDM as the main national electricity company, is the main institution responsible for implementing electrification projects, and will be the leader in extending the electricity service to customers in the grid; the Energy Fund, FUNAE, will be the leader in the implementation of energy solutions in remote rural areas, with an emphasis on off-the-grid technologies such as home solar systems and mini-networks. The Ministry of Economy and Finance will also have an important role to play in allocating funds to projects.

Financially, the Strategy separates electrification efforts from the regular provision of electricity services and proposes flows of funds involving EDM, its clients, FUNAE, a new Electrification Account, donations and loans from International Financing Institutions (IFIs) and the Government of Mozambique (GM). ARENE, as cnelec's successor, must assume the responsibility for adjusting tariffs in order to reflect the efficient costs of providing services. The success of implementing the strategy requires EDM operations to be paid from tariffs charged to consumers while building new connections is funded in several ways, outside the tariff.

Technically, the Strategy requires new means of work designed to build a reliable system economically. New approaches to the creation of technical standards, are combined with improved use of human resources in order to increase their advantage in the design, construction and operation of infrastructures necessary for electrification.

In general, the Strategy presents a new approach to electrification with the potential to address the predictable challenges in achieving this ambitious but necessary programme for the electrification of Mozambique.

This report was prepared by AF-Markets EMI consultants, in cooperation with Estudios Energetic Consultants and Royal Haskoning DHV.

Executive Summary

Traditionally, Mozambique Electricity (EDM) has taken the lead role in the efforts of the Government of Mozambique (GM) to expand access to electricity, complemented by FUNAE in the provision of electrical services in rural areas and centres Community. In the most successful years, EDM was able to connect about 140,000 new customers per year, but this number has declined in recent years, mainly due to the lack of an appropriate business model.

To accelerate electrification and achieve universal access in 2030, the Government of Mozambique, through MIREME and EDM, sought support from the World Bank, which in turn hired a Consultant to help develop a National Electrification Strategy and a complementary plan[1]. The objectives of this activity are:

- Evaluate the current electrification model.
- Propose a new business model to provide commercial and social energy needed to achieve universal access in 2030.

This business model will be part of a new National Electrification Strategy (ENE) for Mozambique. EnE will:

- Focus on developing an implementation framework to accelerate universal access in Mozambique.
- Include institutional, technical and financial considerations, which should be addressed to achieve universal access by 2030.
- Identify the appropriate regulatory framework to facilitate the implementation of the National Electrification Strategy
- Propose the Ministry of Mineral Resources and Energy (MIREME) as the main coordinator of the electrification program and EDM and the Energy Fund (FUNAE) as the main implementation agencies, in close coordination with the Energy Regulatory Authority (ARENE) and with the private sector.

This report corresponds to the Second Task of the project "Development of the National Electrification Strategy and Plan". It is based on the results and recommendations of the First Task, which was the diagnosis report of the sector, discussed with MIREME, EDM, FUNAE, ARENE, other government institutions and cooperation partners.

This report proposes a different approach from the current one to achieve the objectives of access to electricity in Mozambique. This approach, the ENE,

[1] AF-EMI Markets in cooperation with Estudios Energetic Consultants and Royal Haskoning DHV

is organized around the following three pillars: institutional, technical and financial.

This report also benefited from consultations of energy sector cooperation partners in Mozambique, in particular with the active participation of representatives of the World Bank Group, Embassy of Norway, Embassy of Sweden, Delegation of the Union AFD, USAID, DFID, KFW, GIZ and others.

Challenges

The First Task of the Project identified the main challenges that prevent the country from accelerating access to electricity:

1. **Institutional challenges** include mireme's lack of integrated planning and coordination; lack of criteria for prioritizing projects; the need to better coordinate activities between EDM and FUNAE; the need to establish a regulatory body in the sector, including ARENE, increasing its capacity to be the authority responsible for adjusting electricity tariffs.
2. **Financial challenges** include the need for an adequate funding scheme for electrification projects (both on the network and off the grid); reinforcing EDM's finances that are currently operating at a loss as current tariffs do not cover their operating costs; make connecting costs more accessible to households receiving access to electricity; and ensuring that tariffs are accessible to less favoured families.
3. **Technical challenges** include ensuring the reliability of the system that will face a major expansion of its number of customers; developing detailed standards and specifications for building electrical infrastructure; centralizing the acquisition of materials to benefit economies of scale; use the most profitable technologies for electrification on the network; and empowering human resources to rely less on external contractors and consultants.

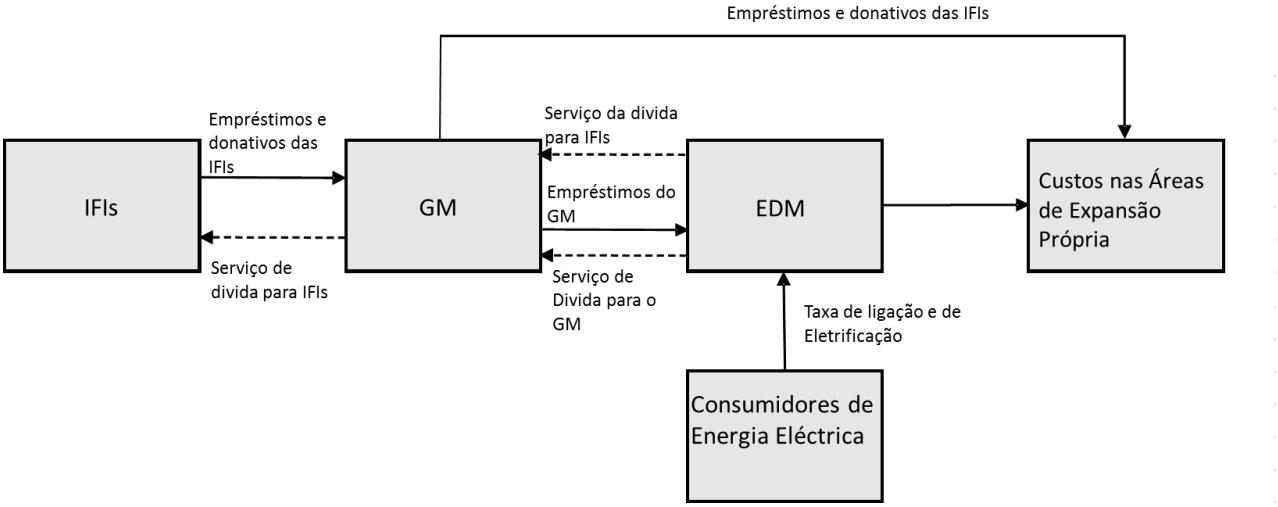
The New Electrification Approach

The strategy to be prepared as part of this study presupposes that electrification includes network connections, both outside the network when the cost of connecting to the network is too high. The strategy focuses on promoting electrification regardless of the locality of customers (rural, urban, peri-urban) and the type of customers (commercial or social).

A new concept to divide responsibility for electrification distinguishes the Self-Expanding Areas (AEP) from subsidized expansion areas (AES). AEP is the area within a 100-meter radius of an existing low voltage line, within which EDM is required to connect any customer requesting service. The cost of binding (a standardized cost defined in the regulation)

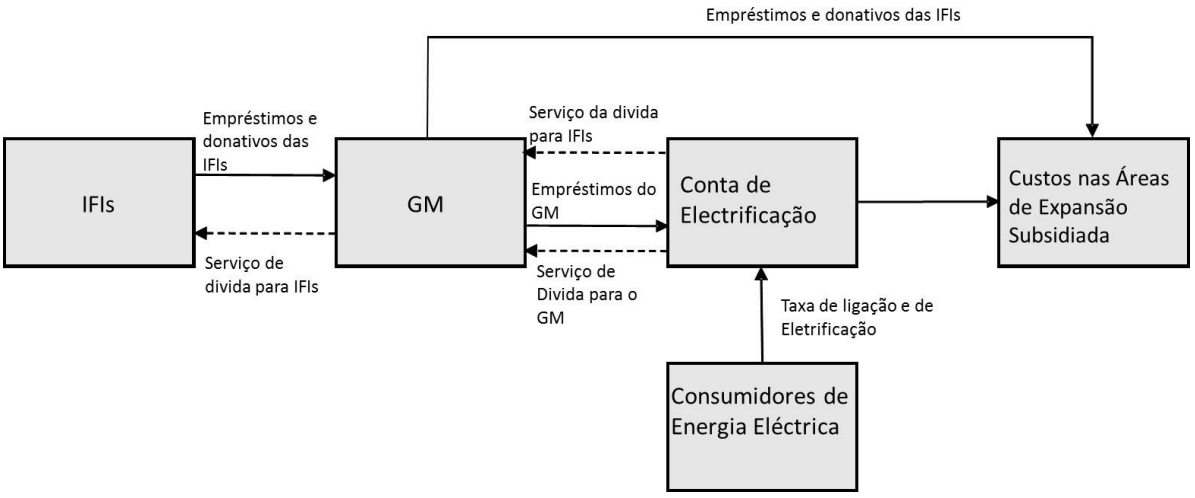
can be paid by the customer in installments incorporated into the approved rate for EDM (even customers in the most favored quintile in Mozambique would have difficulty paying the amount of the total connections without benefits). The distance of 100 meters is defined to minimize edm's financial and technical burden. It could be increased by future regulation, but this step would have to be accompanied by increased tariffs to meet EDM's increased costs, mainly to cover construction costs.

i Electrification program fund flow within the Expansion Areas Of Its Own



A Subsidized Expansion Area (ESA) is any other area in the country where EDM receives government subsidies or cooperation partners to expand the electricity grid. At AES, EDM has no obligation to provide any connection to potential customers, but it can do so if the company decides. The decision can be made around several reasons, such as the presence of a potential large consumer that makes investment profitable and commercial energy. A new instrument, the Electrification Account, will be a rotating fund administered by the Ministry of Economy and Finance, which will finance the capital expenditures of these links. Thus EDM will not have to bear the costs of these connections, however once such connections are made these customers will be integrated into EDM's commercial responsibilities.

ii Flow of funds from the electrification program within the Subsidized Expansion Areas



Building power systems off the grid is funae's responsibility. Once a system is installed, FUNAE will transfer it to EDM for marketing, operations and maintenance, and EDM can outsource the operation to private operators or to the communities involved. FUNAE projects will also be financed by the Electrification Account without the obligation for FUNAE to reimburse them. FUNAE and EDM should coordinate efforts in specific projects where their areas can overlap.

The other characteristics of the new approach are:

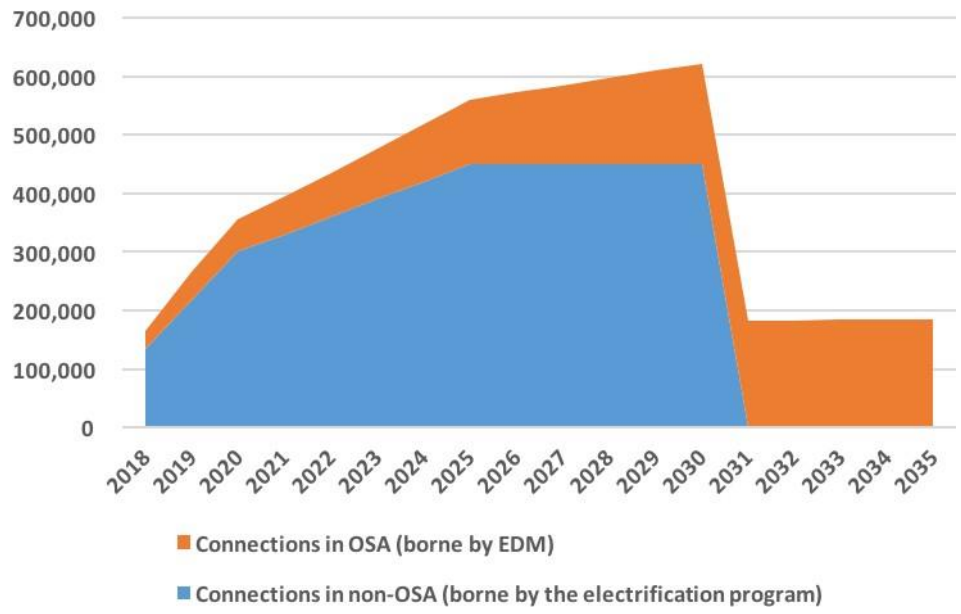
- A planning process, with feasible and short-term results, as a key element for the implementation of the strategy. Only investments resulting from the optimized planning process (both for system expansion and rehabilitation and electrification to connect new consumers) are implemented, following competitive procedures. EDM investments are implemented using the best funding mechanisms available. Investments should not be financed through tariff revenues, as long as IFIs concessional financing is available to Mozambique.
- Implementation of an electrification fee where procedures are intended to finance electrification, including proper fund management.
- Balance of electrification in the network and off the network, in order to take into account social aspects and political priorities for economic development.
- Clarification of the criteria for prioritizing projects identified by the Master plan of the Electrical Sector should be defined:

  - Based on the lowest cost option defined by the Electrical Sector Master Plan

- Priority for projects using existing assets with available capacity, i.e. "densification" of existing networks (other criteria may complement this).
- Financial contributions from local governments.
- Promotion of economic activities in certain areas, attention to areas with lower human development index (HDI) and development corridors.
- Contribution to social inclusion through the acceleration of access to energy.

- Uniform rates for each category of customers. The tariff should be sustainable (reflect the efficient cost of provision of services), but balanced with cross-subsidies suitable for the less favored population.
- EDM's authorized revenue should be sufficient to recover all operating costs (including financing costs). Rates will be periodically adjusted to reflect changes in uncontrollable costs. EDM's operating costs include its own energy production, energy purchases from independent producers and HCB, transmission, distribution and sales costs.

Projection of the number of calls of domestic consumers per year



Projected financing

EDM is currently not only leading, but also funding the electrification effort in Mozambique. Therefore, the fact that tariffs do not reflect the costs hinders the sustainability of electrification projects within the national network.

Regulations and institutional configuration must be ensured to enable EDM to recover the efficient costs of providing electricity services if it provides the service with acceptable quality[2]. The tariff should incorporate mechanisms that reflect costs such as automatic passage of fuel costs related to energy production and adjustments according to exchange rates and inflation. EDM's remuneration should also include depreciation of its assets and a reasonable return on investment. This is necessary to allow EDM to provide an acceptable quality service and finance the replacement of its assets.

In the case of assets financed by the electrification programme (including those financed by the Electrification Account or the donations and concessional loans of IFIs), the property shall be transferred free of charge to EDM[3] and the tariff shall exclude the remuneration of capital used for investment, since it is not financed by EDM, but shall take into account operating and maintenance costs and depreciation (including depreciation of low voltage equipment and depreciation of the customer counter).

It was assumed that the number of connections in the EPA increases due to the increase in the rate of access to electricity, the population and the decrease in the average size of the household. The financing needs of these links were not calculated in this report.

It was also assumed that the number of new connections of residential customers in the Subsidized Expansion Areas will increase from 135,000 in 2018 to 300,000 in 2020 and 450,000 in 2025, when the number of connections was assumed to be constant by 2030. The average number of connections resulting from residential customers to be supported by the electrification program from 2018 to 2030 is equivalent to about 373,000 customers per year (4,852,000 customers in total).

From 2031, when it is assumed that the country will have already achieved universal access to electricity, all new customers were assumed to be linked to AEP and the related financing invested by EDM.

Electricity access projection

[2] This includes a reasonable level of losses; usually a loss reduction programme is agreed with the regulator through a continuous process to achieve the loss-related objectives.
[3] Free of any tax

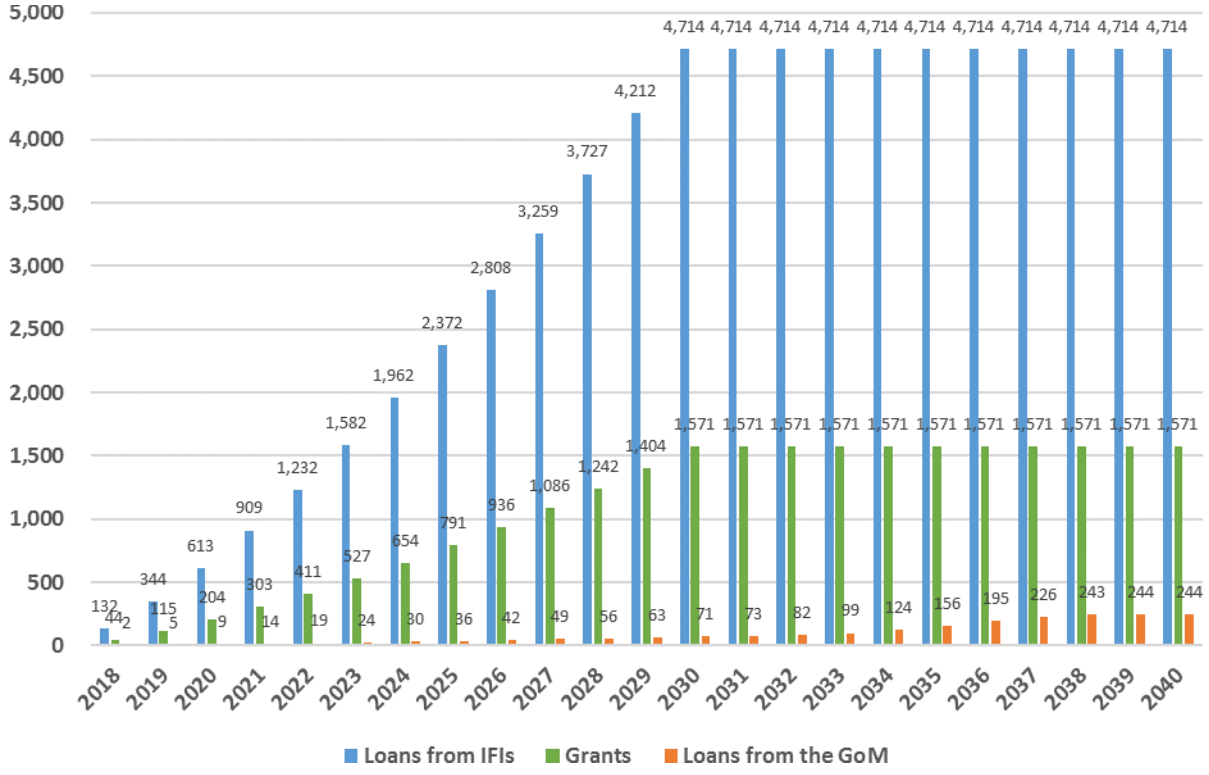
	2017	2020	2030	2040
Population		28,644,358	33,713,497	37,859,444
Population growth rate per year (%)	2.5%	1.9%	1.4%	1.0%
Average size of families	5.0	4.9	4.4	4.0
Decrease in the average size of families (%)	-1%	-1%	-1%	-1%
Access to electricity at the end of the year (%)	26%	38%	100%	100%
In. residential consumers at the end of the year		2,240,413	7,606,967	9,445,610
In. (accumulated 2018)	-	785,206	6,151,760	7,990,403
In. connections in the Self-Expanding Areas (accumulated from 2018)	-	132,706	1,299,812	3,138,455
In. of connections in the Subsidized Expansion Areas (accumulated 2018)	-	652,500	4,851,948	4,851,948

Financing of links and services in the Areas of Subsidized Expansion

Achieving universal access by 2030 requires that about $6.65 billion be provided by IFIs and GM to fund links in Subsidized Expansion Areas[4]. In particular, estimated IFIs loans total about $4.7 billion, estimated IFIs donations total about $1.6 billion and GM loans total about $244 million.

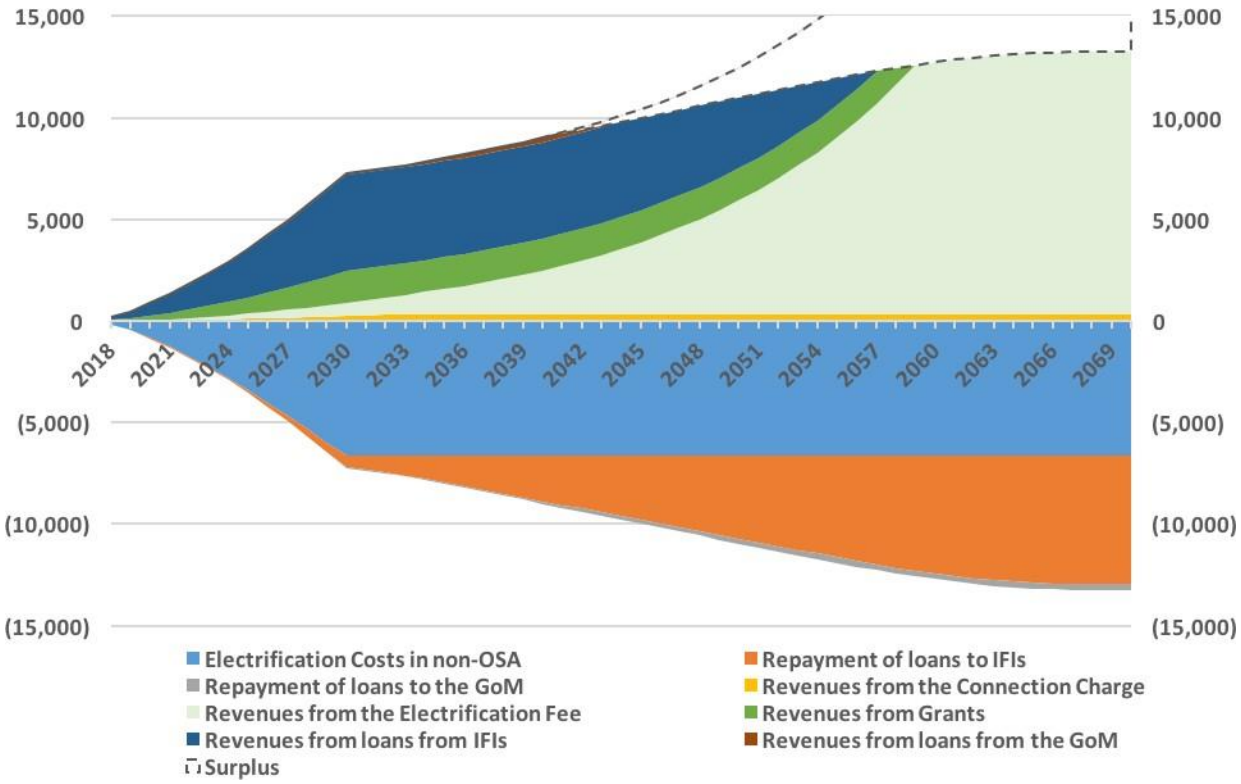
Projections of accumulated financing needs for AES from 2018 of IFIs and GM (million USD)

[4] Financial needs for consumer connections within the Expansion Areas of Own were not calculated in this section.



The Electrification rate is an approximate value of 5% of each consumer's monthly revenue. This fee is deposited in edm's Electrification Account to finance future electrification investments. In 2040, revenues obtained from the electrification rate are high enough to fully cover financing costs, so there is no longer a need for GM resources.

Projections of accumulated annual costs and revenues from the AES electrification program (USD Millions)



The feasibility of the new electrification approach requires sufficient funding, which can come from a combination of external, governmental and utility sources. It also requires the ability to plan, implement and operate electrification projects and maintain services. This means the ability to operate a utility that will have an exponential growth in the number of customers from a technical and commercial point of view, requiring not only expanded financing, but also expanded human resources.

***

Electrification has the potential to transform family and community life. Families with electricity in their homes will have access to lighting, mobile phones, televisions and radios, constituting an improvement with disruptive potential in their quality of life. Communities will benefit from greater conditions of safety, health, education and social services. Existing companies improve their performance and new companies are formed.

The National Electrification Strategy for Mozambique offers a framework for accelerating universal access in Mozambique, it will also identify institutional innovations, regulatory structures for the development and operation of electrification, financial means for the construction and operation and maintenance of a variety of technical solutions, connected to the network and outside the network, in a poor country with adispersed rural population.

Thanks. The authors thank all the participants who provided information, as well as their opinions on this strategy, specifically, we would like to thank the leadership of His Excellency the Minister of the Ministry of Mineral Resources and Energy, the PCA and the BOARD of Directors of EDM, the participation of EDM planning teams, edm project implementation teams, teams of transmission and distribution operations of EDM, CNELEC management, FUNAE and MIREME.

The Government of Mozambique would also like to thank the contributions and discussions on ENE with cooperation partners. In particular, we would like to thank the world bank, embassies of Norway, Sweden and Germany, the European Union, AFD, USAID and DFID.

Context. Following the efforts of the Government of Mozambique (GM) to expand access to electricity, Electricity of Mozambique (EDM), the national electricity company, took on the main role, asking the World Bank to review the national electrification situation and to support the identification of appropriate approaches to Mozambique to increase access to electricity services taking account of the financial implications of this investment for the energy sector.

Financing and preparationprocess. Financial support is provided by the World Bank (under the Sustainable Energy for All Trust Fund). Through this support, the World Bank will facilitate discussion and share the lessons learned from other successful electrification programs. The selection of the best approach to electrification for Mozambique is a government decision. The preparation of the strategy included the following phases.

- Terms of Reference verified and approved jointly by MIREME, EDM and FUNAE in June 2016.
- Consultant hired to support the Government in September 2016.
- Internal debate session to share international good practices in October 2016
- Presentation of the initial report to government authorities and cooperation partners and the first visit to assess the progress and challenges of electrification in December 2016.
- Presentation of the scope of work to cooperation partners in December 2016.
- Sector diagnostic report presented and discussed with government authorities in February 2017.

- First draft of the National Electrification Strategy for discussion, including discussions with EDM, government officials and cooperation partners in May 2017.

Purpose of this preliminarydocument. Facilitate discussion among government institutions about the fundamental principles for electrification and to receive guidance from the government on the political decision to be incorporated into the strategy.

Next steps. The National Electrification Strategy is approved by the Minister of Mineral Resources and Energy.

Index

List of Figures

List of Tables

Acronyms used

AAAC, Pennsylvania	Aluminum Conductor (all aluminium alloy conductor)
Abc	*Aerial bundled cables*
Arene	Energy Regulatory Authority
At	High Voltage
CNELEC, New C.C.	National Electricity Council
CTRG	Ressano Garcia Thermal Power Plant
Edm	Electricity Company of Mozambique
Ene	National Electrification Strategy
Eskom	South Africa Electric Power Commission
FUNAE, Pennsylvania	Energy Fund
Gm	Government of Mozambique
Hcb	Cahora Bassa Hydroelectric Power Plant
IFIs	*International Financial Institutions*
IPPs	Independent Power Producer
MIREME, New District	Ministry of Mineral Resources and Energy
Mt	Medium Voltage
MZN, New	Metical - Mozambique currency
Un	United Nations
Pca	Chairman of the Board of Directors
Ppa	*Power Purchase Agreement*
SEC	Swaziland Electric Power Company
SWER, New	*Monopolar* Networks with Return to Earth *(Single*Wire Earth Return)
$200	Us Dollar

Technical terms (electricity)

V	Volt, voltage unit
Kv	Kilovolt, 1,000 volts
W	Watt, active power unit
Kw	Kilowatt, 1,000 watts
Mw	Megawatt, 1,000 kW
Wh	Watt-hour, power unit
Kwh	Kilowatt-hour, 1,000 Wh
Mwh	Megawatt-hour, 1,000 kWh
Gwh	Giga watt-hour, 1,000 MWh
Twh	Terawatt-hour, 1,000 GWh
Va	Volt-ampere, apparent power unit
Kva	Kilovolt-ampere, 1,000 VA
Amm	Megavolt-ampere, 1,000 kVA
Var	reactive volt-ampere, reactive power unit
Bt	Low Voltage, voltage level less than 0.6 kV
Mt	Average Voltage, voltage level greater than 0.6 kV and less than 35 kV
At	High voltage, voltage level greater than 35 kV

Settings

In this report, we adopt the following definitions:

- **Access**: supply of electricity to a home for domestic consumption.
- **Areas of Own Expansion**: for this National Electrification Strategy, these areas are defined as areas close to existing lines where Mozambique's Electricity has an obligation to connect customers when the connection is requested using own resources. These areas are defined in principle based on the capacity of the low voltage infrastructure (BT): 100m for each side of each existing BT line.
- **Subsidized Expansion Areas**: There are other areas in the country where Mozambique's Electricity receives subsidies from the Government or electrification account to expand the electricity grid. In these areas EDM is not required to use its own resources to connect new consumers to the national network.
- **Consumer:** person or entity to whom electricity is supplied for domestic, industrial or commercial use.
- **Conversion to the Power Grid**: The process by which isolated networks (or mininets) are connected to the main network and by which households with Prenet systems are converted to Households connected to the Network.
- **Efficient Cost:** The cost of providing the power service, taking into account efficient network operation and a limited amount of losses in the system.
- **Network Densification:** The process of connecting new households to the existing Power Grid in the area.
- **Electrified**domicile: a domicile with access to electricity.
- **Out-of-grid domicile**: Domicile supplied by electricity from a source that is not connected Network and should not be connected to this network. The sum of pre-electrified and electrified households with systems outside the network represents the total number of households electrified with solutions outside the network.
- **Pre-Electrified Households**: Domicile supplied by a source other than the Power Grid, but which should be connected to the Network soon or on a date defined in the near future as part of the result of the planning process.
- **Network-related households**: a household that receives electricity supplied by the National Electricity Grid.
- **Social Energy:** Energy delivered in areas and/or to customers where there is no commercial viability, considering the efficient performance of the company and the existing tariff level.
- **Commercial Energy**: energy delivered in areas (or to customers) where it is feasible from a commercial point of view, considering the efficient performance of the company and the existing tariff level.
- **Network Extension**: Extension of the lines that leave the National Network to supply new areas with electricity.
- **Equivalent Supply of the Network**: Supply of electricity (through mininets or isolated solutions) capable of supplying a domicile with a

quality of service similar to the electricity of the conventional network. The quality of service varies according to the different areas of load density.

- **Mininet**: Low voltage distribution network (BT) that is isolated from other networks and which has its own sources of electricity production.
- **Electrified village**: a village where most community facilities and more than 50% of its residents can make use of the service without the need to use additional line extensions.
- **Network:** refers to the national electricity grid which is the set of public service facilities for the production, transport and distribution of electricity.
- **Internal reticulation:** refers to electrical installation inside the home
- **Off-network zones**: These are areas that should not be connected to the network in the short and medium term and should be provided as alternatives outside the network.
- **Areas connected to the mains**: Areas supplied by the mains. Depending on the context, this may refer both to the areas currently supplied by the electricity grid and to the areas that must be supplied by the electricity grid in the near future or also to areas that, during the planning process, have been defined as those to be supplied by electricity from the electricity grid.
- **Rural Area**: a district, or area that is not part of a provincial capital or designated municipality. The rural area is characterized by low population density.

1 Introduction

Since the end of the civil war in 1992, Mozambique has had strong and sustained growth, with the economy growing at an average annual rate of 7.4 percent. However, GDP per capita is still low (US$600 in p.p.c. 2016) and approximately 50 percent of the population still lives below the poverty line[5]. In addition, the majority of the population lives in rural areas and only 26 percent were connected to the electricity grid in 2016[6].

Continuing the efforts of the Government of Mozambique (GM) to expand access to the electricity grid, Mozambique's Electricity E.P. (EDM) has played an important role in extending the electricity grid in the country (Tables 1.1 and 1.2). In its most successful years, EDM has managed to connect about 140,000 new customers a year, but this number has been declining considerably over the past few years, mainly due to the lack of funding for the connection of new consumers.

Table 1.1 Number of evolving customers

Customers	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of customers	415667	510848	614732	736085	858108	1010780	1140835	1257809	1377003	1450953
Number of domestic customers	373795	464197	559433	680583	790858	934995	1050735	1156089	1263234	1335207
Number of non-domestic customers	38790	43275	51620	51460	62855	70872	84718	95796	107361	108936
Growth of domestic customers	71580	90402	95236	121150	110275	144137	115740	105354	107145	71973
Growth of non-domestic customers	4981	4485	8345	-160	11395	8017	13846	11078	11565	1575

Source: EDM

Table 1.2 Consumption evolution per customer

Consumption	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Energy Sold [GWh]	1669	1873	2029	2404	2449	2777	3186	3306	3642	3851	4764
Total Energy sold in national territory [GWh]	1307	1375	1506	1734	1935	2197	2517	2978	3381	3691	3902
Energy sold to special customers [GWh]	0	0	15	60	88	96	122	253	310	371	351
Energy sold for distribution [GWh]	1307	1375	1491	1674	1847	2101	2395	2725	3071	3320	3552
Energy sold to domestic customers by distributor [GWh]	481	517	580	648	751	897	1052	1233	1416	1538	1654
Energy sold by distributor to other customers [GWh]	826	858	911	1026	1096	1204	1343	1492	1655	1782	1897
Exports [GWh]	362	498	523	670	514	580	669	329	260	160	862
Average consumption of domestic customers (kWh/year)	1592	1382	1249	1158	1103	1135	1125	1173	1224	1218	1239
Average consumption of non-domestic customers (kWh/year)	24422	22119	21405	21045	23010	20677	20667	20594	20521	20054	20634

Source: EDM

In this context, EDM, being the national electricity company, asked for support from the World Bank, which in turn hired a Consultant[7] to assist in the development of a National Electrification Strategy (ENE) and a complementary plan to accelerate the process of access to electricity in order to achieve universal access in Mozambique until 2030. Among the objectives set for this consultancy, we can mention:

[5] Poverty line defined according to World Bank definition

[6] EDM, Historical Data 2001-2015

[7] AF-EMI Markets in cooperation with Estudios Energetic Consultants and Royal Haskoning DHV

- Evaluate the current electrification model; and
- Propose a new business model to expand both commercial and social energy, both necessary, to achieve universal access by 2030. This business model will be part of a new National Electrification Strategy for Mozambique (ENE).

A ENE:

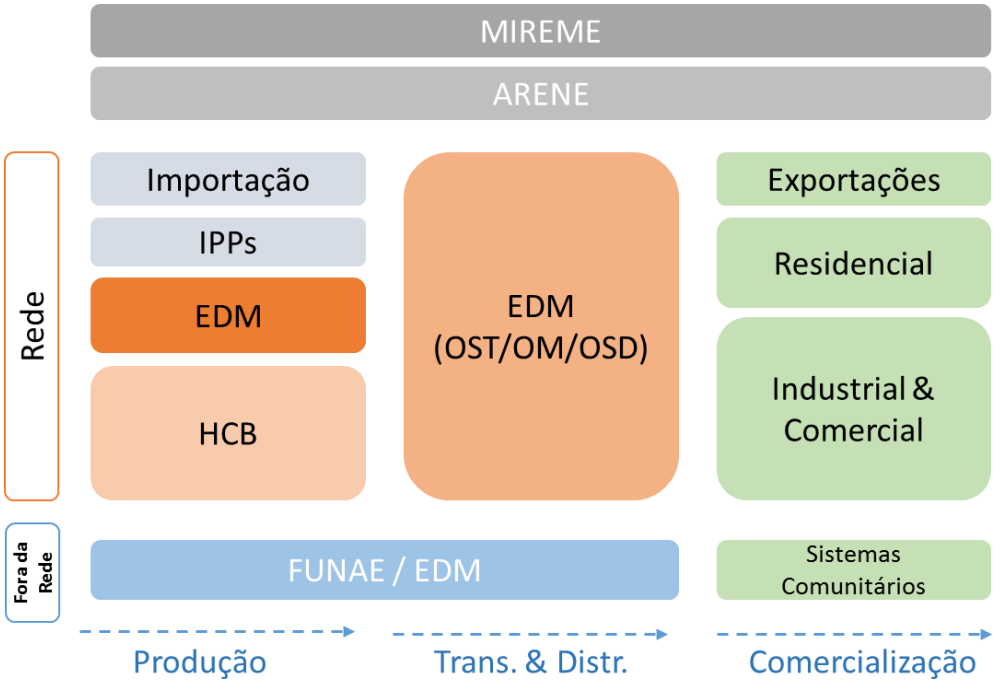
- It will be implemented by EDM and FUNAE in close coordination with the Ministry of Mineral Resources and Energy (MIREME), the new Energy Regulatory Authority (ARENE) and the private sector;
- It will focus on developing a model for electrification that could accelerate universal access in Mozambique;
- It will include institutional, technical and financial considerations that should aim to achieve universal access in 2030; and
- It will identify the appropriate regulatory model to facilitate its implementation.

This report corresponds to the Second Task of the Project "Development of the National Electrification Plan and Strategy" and is based on the results and recommendations of the Sector Diagnostic Report (First Task), discussed with EDM, FUNAE and government authorities in February 2017. The aim of this document is to present a proposal for an approach to achieve the objectives of access to electricity in Mozambique. This approach - the NES - is based on three pillars aspects that are: institutional, technical and financial aspects.

2 Institutional framework of mozambique's electricity sector

The main actors in Mozambique's electricity sector are represented in Figure 2.1:

Figure 2.1 Organization of the electricity sector in Mozambique



MIREME: Ministry of Mineral Resources and Energy; ARENE: Energy Regulatory Authority; EDM: Electricity from Mozambique; HCB: Cahora Bassa Hydroelectric Power Plant; FUNAE: National Energy Fund; IPPs - Independent Producer of Electric Energy; ***OST -*** *Operator of the Transport System;* ***OM -*** *Market Operator;* ***OSD -*** *Distribution System Operator.*

The Government of Mozambique (GM): MIREME

The Ministry of Mineral Resources and Energy (MIREME) is the central body of the state apparatus which, in accordance with the principles, objectives and tasks defined by the Government, directs and ensures the implementation of government policy in the exploitation of energy resources and in the development and expansion of electricity supply infrastructures. MIREME must comply with the following tasks related to the electrical sector and, more specifically, the electrification process:

- Plan and set electrification goals (access);

Regulatory Authorities

Energy Regulatory Authority (ARENE)

The CNELEC was created by the Electricity Act (1997), with the function of protecting the public interest in the provision of electricity services and as an advisory body to advise the Government on conciliation, mediation and arbitration of issues related to the electric sector. Among the functions of CNELEC, we can mention:

- provide information on the policy and objectives of electricity supply;
- Inform and propose regulations for the sector;
- provide information on concession applications to provide electricity, as well as on the proposed tariffs;
- Develop proposals to promote new technologies; and
- Participate in bidding processes when a new capacity is contracted.

In August 2017, Parliament passed a law extinguishing the CNELEC and created the Energy Regulatory Authority (ARENE), focusing on regulating electricity and distributing natural gas and liquid fuels. This amendment gives THE AUTHORITY to:

- Set rates;
- Homologate;
- Ensure quality control of service; and
- Develop regulations.

Electricity from Mozambique E.P. (EDM)

Electricity from Mozambique (EDM) is the vertically integrated state company responsible for the production, transmission, distribution, marketing and import of electricity throughout the country.

Significant progress has been made since its inception in 1977. The installed production capacity of the country is higher than its demand, mainly due to the Cahora Bassa Hydroelectric Power Plant (HCB). About 1,330 MW of installed capacity of 2,075 MW are committed to Eskom in South Africa, which is part of a long-term agreement that ends in 2029. National maximum demand increased from about 320 MW in 2006 to about 900 MW in 2016. The current energy matrix consists of 56% hydropower, 42% gas and about 2% is imported from neighboring countries from various sources. The transmission network went from 3,691 km in 2003 to 5,249 km in 2015. A key priority now is the construction of the National Energy Transport Society (STE) project to connect the country's national network.

EDM has successfully mobilized private and public funding for a series of network-linked production projects over the past 2 years or to be implemented in the next 3 years[8]. The development of these energy production projects allows Mozambique to increase access to electricity and position itself as an important participant in the regional electricity market.

With regard to distribution, EDM increased access to the electricity service from 8% in 2006 to 26% in 2016, thanks to investments in investments for transmission and distribution of energy and management systems that bring improvements in its operations and management activities.

[8] Operational: CTRG (175MW, gas), Gigawatt (110MW, gas), Kuvaninga (40MW, gas). Under construction: MTc (100MW, gas), Mocuba (40MW, solar),. Guaranteed financing: Japanese loan - Temane (100MW, gas), Metoro (40MW, solar)

The Electricity Act of 1997 allows private sector investment, which has been happening only from 2014 and, mainly, production through independent electric energy producers (IPPs). According to the Laws passed by the Government, EDM has an indefinite mandate to provide electricity in the country and, according to Decree 42/2005, acts as manager of the National Transmission Electricity Network, performing the functions of System and Market Operator.

The laws provide for concessions in areas determined to be delivered to private operators. EDM itself could outsource the transaction in an area or part of its assets, provided it informs MIREME and it has no objection to subject [9].

Energy Fund (FUNAE)

Decree 24/97, according to Article 9 of Law 2/87, formally created FUNAE as "a fund". Funae's main objectives are:

- Develop and produce different low-cost energy sources to serve the low-income population, whether in rural or urban areas; and
- Promote the conservation and rational and sustainable use of energy resources.

On the basis of the above mentioned objectives, FUNAE has a mandate at national level and is submitted to MIREME.

FUNAE has been working to obtain funding from the Government and cooperation partners for the implementation of out-of-grid energy supply systems. Significant results were achieved with the electrification of 260 villages, 580 schools,
561 health centers, 74 administrative posts, 3 fish markets and cold storage chambers, construction of a mini-hydro, installation of 19 water pumping systems and distribution of 1,500 stoves. In addition, it has also contributed exceptionally to some electrification projects linked to network[10].

The Law does not give FUNAE the right to operate and provide electricity services to final consumers. However, FUNAE has performed these tasks in some specific cases.

Given the need to expand access to rural areas, funae's mandate is also being updated to meet the challenges of rural energy needs.

Other actors in the electricity sector

Among other relevant partners in Mozambique's electricity sector, we can mention:

[9] Vilanculos mini-networks experience with a private operator lasted only one year because consumers served by the system complained of a higher cost of electrical services compared to consumers connected to the national grid. Although it was not successful in the end, this shows that, from a legal and regulatory point of view, it is possible for a private agent to carry out activities of generation, distribution and operation of electricity grids in Mozambique.

[10] Information provided by FUNAE at a meeting held at FUNAE's premises on 6 October 2016.

- The Cahora Bassa Hydroelectric Power Plant (HCB), which is a hydroelectric power plant
  2,075 MW owned by the Mozambican Government (92.5%) and the National Energy Networks of Portugal (7.5%);
- Independent Electric Power Producers (IPPs). The first large-scale private production connected to the network was a 65MW *Emergency Power Plant (EPP)*emergency powerplant, which was contracted as a temporary arrangement to overcome the energy deficit in 2014. Existing IPPs include the 175 MW Gas-powered Ressano Garcia Thermal Power Plant (CTRG), which started commercial operations in 2014; the 110 MW Gigawatt Thermal Power Plant, powered by gas, operationalized in 2015; and 40 MW Kuvaninga, also powered by gas, which began operations in 2017; and
- The Transmission Company of Mozambique (MOTRACO). MOTRACO is a transmission company owned by EDM, the South Africa Electric Power Company (ESKOM) and the Swaziland Electric Energy Company (SEC). It is responsible for supplying electricity to mozal aluminum plant in Mozambique and for transporting energy to EDM in Mozambique and the Swaziland Electric Energy Company.

3 Challenges to increase access to electricity services

Based on the Diagnostic Report (developed in the First Task of this Project), the following key elements have been identified as challenges to accelerate access to electrical services. These are summarized in three main areas: institutional, financial and technical.

Institutional challenges

- **Lack of comprehensive and coordinated planning:** although plans have been drawn up in the past, planning activity is not a continuous and coordinated activity. From an institutional point of view, there is no organisation responsible for the planning process or a planning procedure. The feasibility of the results of the plan is unclear.
- As far as **human resources**areconcerned, there is not enough qualified technical personnel in MIREME and/or EDM with the necessary capacity for the process of implementing good project planning, implementation and monitoring.
- **Lack of criteria for prioritizing electrification projects:** once projects are identified, there are no clear procedures and criteria for deciding on what order of priority they will be implemented. Currently, however, EDM has established the process and is now working to operationalize it. In principle, EDM follows, or has as a guideline, projects identified in the Sector Master Plan.
- **As part of the intervention of EDM and FUNAE:** although EDM and FUNAE coordinate the areas of intervention, they are based on informal procedures rather than a formally established framework.
- **The role of CNELEC/ARENE in tariff adjustment and cost recognition in tariffs:** THE CNELEC now has only an advisory role in determining tariffs. However, a strengthening of its regulatory capabilities, as a regulatory body, is expected as part of a new Law recently passed by Parliament. However, ARENE will have to substantially increase its internal capacity and rely on the resources needed to effectively develop the necessary tariff studies.

Financial challenges

- **Lack of an adequate funding procedure for developing electrification projects (including network-bound and off-network)**: the lack of a clear vision of the future in terms of projects (lack of appropriate planning process) affects how access is financed (financing planning) and the instruments that can be used to finance projects. However, it was observed the development of an Integrated Steering Plan for the Electricity Sector (2018-2043) which is currently being carried out with the assistance of jica (Japan International Cooperation Agency).

- **EDM Financial Sustainability**: Currently, EDM has to bear the weight of expanding access in a context in which the situation is aggravated by applicable tariffs that do not reflect the efficient cost of providing electrical services and which are below the cost of purchasing energy. Energy losses are very high (26%) and need to be reduced.
- **Bonding rates represent a significant burden:** bonding rates have been a barrier to electrification and more precisely for the densification of electrification in many countries.
- **Tariff accessibility for rural households should be ensured:** it may be that, for some groups, tariffs are very expensive (or the cost of connection, as mentioned above). Therefore, the costs underlying tariffs should be balanced with a subsidy for disadvantaged families.

Technical challenges

- **System reliability:** Adding a large number of customers in a short period of time will affect system reliability sooner or later if the company is not well prepared. Even if new customers have low consumption at first, their growing number and customer consumption growth, once they have the service available, they can affect system reliability. The location of the new demand is another aspect that can affect the reliability and congestion of the system, if not as a whole, at least in some areas.
- **Standards and specifications at the distribution level:** although there are published standards for building distribution infrastructures, they are not sufficiently detailed, resulting in a heterogeneous distribution infrastructure, therefore not benefiting from standardization. In addition, there is a set of patterns that have not yet been approved and that would contribute to standardization.
- **Centralized acquisition of materials:** currently, there is no centralized purchase of materials. The companies contracted in the Modality EPC (Engineering, Supply and Construction) provide all necessary materials. The current model of an "Epcista" can also be modified, creating other alternatives that typically generate considerable savings.
- **Using cost-effective technologies for *network-related*** electrification**:** although more economical technologies such as Earth-back-to-Earth Monopolar type, also known as SWER, are known and implemented by EDM, they are not widely used to reduce electrification costs.
- **Implementation of projects:** currently, the external contractor and supervisor/consultant are hired in the EPC modality. This is usually an expensive alternative to developing network expansion, so the model can be improved to reduce costs.

4 Strategy

Government policies for electrification

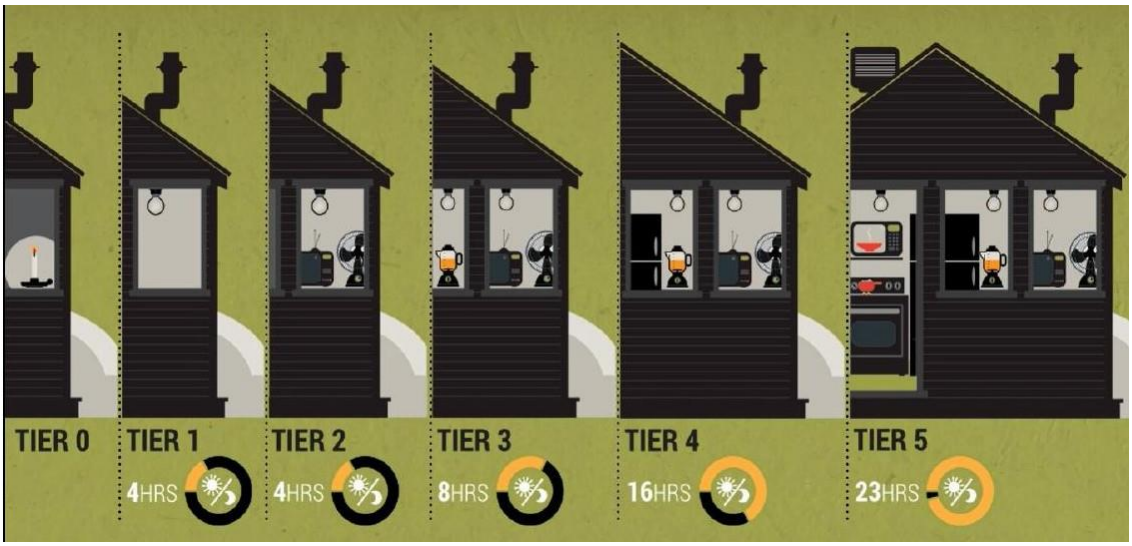
The Government of Mozambique defines the electrification goal that guides the National Electrification Strategy, thus involving the following aspects:

- **Access**: Access has been set to "have electrical service of any kind" in the Settings section. In this regard, the level of electrical service may be different for electrified households (connected to the network and outside the network):
  - In the case of electrification connected to the network, a domicile that is connected to the network is considered to benefit from the full electricity service;
  - In the case of out-of-grid electrification, different levels of electricity service are possible due to the multiple existing alternatives of out-of-grid power systems based on the duration of supply, maximum power and consumption. To address this issue, the World Bank has developed a multi-level structure that allows measuring the different levels of electricity service (Figure 4.1). As shown in the figure below, level 0 represents a house without access to the electricity service that uses traditional energy sources, while the rest of the levels are ordered at increasing levels of electricity service, taking into account delivery hours, maximum power and consumption. Based on GM's statements, although the government's goal is to have a service equivalent to that carried out in a network-connected manner, transitional and alternative solutions that provide a lower level of electricity service during the pre-electrification phase, including Level 2 up to Level 5, will be accepted; and
  - As indicated by GM at the time of preparation of this strategy, access will be considered when there is the presence of a service "equivalent to that of the connected to the network", except for special cases where a low quality of service is accepted as a form of transition to a future service "equivalent to that of that connected to the network ".

- **Intended level**: Access to electricity reached 26 percent in 2016[11]. The official target set is 100 percent for 2030.

[11] EDM, Historical Data 2001-2015

Figure 4.1 Structure, at various levels, developed by the World Bank to measure electricity service [12]



Translation figure 2: *Level 0, 1, 2, 3, 4 and 5*

The feasibility of this goal involves some basic aspects:

- Availability of financing provided by GM, funders or other external sources;
- Planning and preparation of electrification projects;
- Logistics for project implementation;
- Operation and maintenance of electricity services of a rapidly growing system. This means having an ability to operate an electric power company that will have exponential growth in the number of consumers.

New approach to electrification

The strategy to be developed as part of this study presupposes that:

- Electrification will be performed based on a "network equivalent service", except in cases where the cost of connecting the consumer to the network exceeds US$2,000/kVA. In this case the electrification alternatives outside the network should be considered.
- This strategy is focused on the development of electrification in the country (access to the electricity service), regardless of the geographical location of customers (rural, urban, peri-urban) and the type of customers (commercial or social), in order to achieve the desired goal.
- Self-Expanding Areas and Subsidized Expansion Areas. This is a new concept that has been defined to achieve policy targets, clearly passing responsibility to EDM, FUNAE and GM, in addition to ensuring that the concessionaire receives sufficient revenue to perform an efficient operation. Expansion Area Itself: Is defined as the area adjacent to the main lines[13] of BT up to a radius of 100 meters. Within this area; EDM is required to connect any

[12] Supplied by the World Bank.

[13] 0.4 kV: Otherwise, 100m compliance service cables should be adopted.

customer requesting the service. The connection cost is the uniform connection cost defined in the regulation (or by this strategy) and can be paid by the customer in installments. The cost to turn these consumers on and supply is included in the energy tariff charged by EDM. Within this area, revenues from tariffs cover supply costs if there is an efficient operation of EDM (commercial energy).
Initially, it was defined at a short distance of 100 meters to minimize edm's (financial) burden or obligations. This distance can be established by means of regulation and can be modified by it in the future. In any case, if the distance is increased, EDM's overcosts will be included in the rate and will be paid by customers, possibly at higher costs because it is plausible that EDM does not get loans with interest below the market (such as loans from International Financial Institutions [IFIs]) to expand access.

- Subsidized Expansion Areas: Represents all the rest of the territory that is not determined as an Expansion Area of Its Own. In this area, although EDM has no obligation to fulfill any lead requests from potential customers, it can execute projects if it deems it feasible. The Electrification Account is the one who pays CAPEX for any connection made within this area and EDM does not need to refund anything for these CAPEX. However, EDM has an obligation to operate those assets. Households and other network-related consumers are EDM customers and the operating costs corresponding to those assets must be included in the tariff. Within this area, tariff revenues do not necessarily cover costs, even with an efficient operation of the concessionaire (social energy).

In order to achieve the goals of government policies in a more economical, efficient and short-time way, it is necessary to establish clear principles and mechanisms to monitor its implementation. This should also include a future review process to accommodate changes resulting from progress.

When the overall goal is to "increase access to electrical services" (or "access"), the following principles will be considered for the preparation of the strategy:

- The access target is defined by gm's established policy (in line with UN development goals). This decision can be made after evaluating different access scenarios, in terms of level and speed to achieve the goals;
- A planning process with short-term achievable results is a key element for implementing the strategy;
- Electrification will be implemented gradually, as it should take into account social aspects and political priorities for economic development, such as preference for areas with rapid economic growth or areas with higher poverty levels, etc.;
- The electrification connected to the network will be the responsibility of EDM (construction and operation);
- Electrification outside the network will be the responsibility of FUNAE (Construction);
- FUNAE will transfer the built assets (power plants and mininets off the grid) to EDM for marketing, operations and maintenance, and EDM

may outsource the operation of these assets to private operators or to the communities involved;

- EDM and FUNAE will coordinate efforts on specific projects to avoid overlapping intervention areas;
- Clarification of the criteria for prioritizing the projects identified by the Sector Master Plan will be defined, based on:
    - Lower cost options defined by the Electrical Sector Master Plan;
    - Priorities for projects using existing infrastructure with available capacity, i.e. the "densification" of existing networks (other criteria may complement this);
    - Financial contributions from local governments;
    - Promotions of economic activities in certain areas, focusing on areas with lower Human Development Index (HDI); and
    - Contributions to social inclusion through the acceleration of access to energy;
- Geographically uniform rate for each category of customers;
- Sustainable tariffs reflecting service provision costs and balanced with adequate cross-subsidies to facilitate the less favoured population;
- Implementation of an electrification fee in which processes are intended to finance the electrification process, including proper fund management.

These principles are even more detailed below and are grouped in the following main aspects: institutional, financial and technical elements for electrification.

Institutional aspects

Institutional roles and responsibilities

From an institutional point of view, the *proposed* electrification process can be summarized in Table 3. This representation refers exclusively to the ideal involvement of each institution with regard to the electrification strategy, therefore, it is not intended to show all the activities that each institution performs or for which it is responsible.

Figure 4.2 Proposed institutional roles and responsibilities

	Gm	Min of Economics and Finance	MIREME, New District	Edm	FUNAE, Pennsylvania	Arene	Electrification Account	Private Sector
Definition the general objectives of policies	Defines national policy and energy sector policy		Translates GM policy and sets targets, sets intermediate objectives to achieve energy policy objectives					
Planning		Participates	Leads the planning process	Participates	Participates	Participates	Participates	Participates
Plan Approval	Approves	Recommends approval (or not)						
Definition of building standards				Sets standards for integrated system	Sets patterns for isolated areas	Signs standards		
Definition of service quality						Sets quality objectives		
Setting rates				Makes a tariff review request		Proposes and approves tariffs		

Project financing	Provides guarantees to funds lent by IFIs, reimburses IFIs loans, and provides additional funding 	Operationalises the funds received from IFIs and the additional funding decided by gm 					Finance plan projects and repay loans (from IFIs and GM) through fee-picking management	
Implementation of the plan				Builds infrastructure corresponding to network-connected system or off-network 	Builds infrastructure corresponding to off-network systems and transfers to EDM once installed 			Participates as a contractor building assets
Asset operation				Operates and maintains assets 				Operates assets outsourced by EDM (basically off the network) and network-connected IPPs)

Indicates that the institution can carry out the activity with current resources and its experience, at least in the early stages of

It indicates that the institution can carry out the activity with current resources and what its experience, even with some degree of difficulty. However, you need to improve your technical capacity and/or your number of employees for the execution of the activity.

It indicates that the institution cannot carry out the activity with existing human resources and that it needs to seriously develop the capacity of its resources and mobilize additional frameworks.

The Government of Mozambique (GM)

GM sets global targets in terms of energy policy and social objectives. These targets are declared at a high level and should be defined by MIREME and implemented by EDM, FUNAE, HCB and the private sector.

The targets represent the country's national strategy and, with regard to the energy sector, they can address aspects such as:

- Reduction of energy imports and increased exports;
- Increased energy efficiency;
- Development of national resources, including renewable energy;
- Achieve 100% access to electricity by 2030.

At the same time, GM receives funds from IFIs to finance different programmes, including programmes to improve access to electricity in the country, respecting the objectives of the policies set by the Government.

Ministry of Mineral Resources and Energy of Mozambique (MIREME)

In the proposed strategy, MIREME plays a central role in two different aspects related to the electrification process:

- As part of GM, the Ministry communicates to institutions related to the sector the objectives of the sector, develops the strategy and monitors its implementation;
- The Ministry is tasked with developing integrated planning with the following key features:
    - o Planning process carried out continuously as part of the permanent functions of the Ministry;
    - Participatory activity in which all institutions related to the sector contribute, however, the responsible and leader of the process is the Ministry; and
    - "Integral" planning, meaning that production, transmission and distribution are contemplated in the plan. It is necessary to take into account the impacts of rapid increase in access to production and transmission needs.

The planning results are feasible. This means that the projects to be funded are those included in the approved plan. Therefore, EDM can initially assume more responsibilities in the planning process until the necessary capabilities and tools are developed at MIREME. However, in the medium or long term, this activity must become mireme's responsibility. As a result, MIREME must:

- Publish clear national targets for the energy sector and, specifically, for the electrification task;
- Publish electrification objectives and projects arising from planning with a reasonable degree of detail. These projects shall be differentiated in at least in the following categories:
    - Projects for electrification *connected to the network:*
        - Projects (links), of a commercial nature, which are carried out by EDM and paid by tariff (Own Expansion Area);

        - Projects to be carried out by EDM and financed, in whole or in part, with funds from ifis (Subsidized Expansion Area);
        - Projects to be carried out by EDM and financed, in whole or in part, with electrification account resources (Subsidized Expansion Area).
    - Projects for electrification *in areas outside the network:*
        - Projects to be carried out by FUNAE and financed, in whole or in part, with IFIs funds;
        - Projects to be carried out by FUNAE and financed, in whole or in part, with electrification account resources.
- Establish funding for projects (participation), which will come from: from IFIs funds (loans and donations), electrification account and those payable for the tariff (i.e. links in EDM's operating areas).

Energy Regulatory Authority (ARENE)

ARENE was recently created with the typical responsibilities of a regulator (tariff adjustment, homologation, monitoring, definition of service standards, etc.). It is expected that it will soon assume this role as soon as the Law, which has already been adopted by Parliament, comes into force.

The new authority, ARENE, will have the following responsibilities and participation in the electrification process:

- Participate in the planning process: in this respect, ARENE will advise GM (and MIREME) broadly on the issues relevant to the electricity sector;
- Adopt planning standards: this is a relevant point, as the approval of these standards is directly linked to the technologies used and, in turn, the quality of service and the price or tariff;
- Establishing standards and performance indicators that EDM (and, in the future, other operators) must achieve when providing the service. This aspect is key to adjusting the tariff and for establishing the quality parameters of the service to be achieved and, therefore, the building standards. These parameters may (and should) be different, depending on technology and the region or area (rural/urban);
- Enforce network code;
- Determine the tariff, taking into account the above mentioned problems;
- Establish type-approval process.

Electrification Account

The Electrification Account will have the following features and roles:

- It was set up to finance specific projects with the aim of improving access to electricity as soon as possible;
- It is a "specific-purpose" guarantee account administered by the Ministry of Economy and Finance, with the sole objective of financing CAPEX for electrification in Subsidized Expansion Areas;
- Receives resources:
  o Government of Mozambique;

o Of the charges charged on electricity sold (initially calculated as 5% of the invoice, before taxes, for customers who are not considered social tariff).

- It receives applications and funding projects from EDM and FUNAE. These applications receive support from an investment analysis for each project;
- Reviews the requests, verifies the eligibility of each project, prioritizes projects and finances them according to the availability of funds, considering gm's targets, the planning approved by MIREME and the initial categorization of projects; and
- It regularly makes public projects financed by the fund so that account movements are made transparently.

The Electrification Account shall be managed by the Coordination Committee with the following composition:

- MIREME;
- Mef
- Representative of the Partners, as an observer.

Electricity from Mozambique (EDM) – a new "Business Model"

For the successful implementation of the new National Electrification Strategy, EDM must adopt a new Business Model that recognizes and differentiates two key dimensions of electricity supply: commercial energy and social energy. Under this model, EDM is mainly responsible for the electrification linked to the network, in the *Areas of Own Expansion* and the distribution of social energy within the structure of *the Subsidized Expansion Areas,* thus following these strategic principles. In this context, electrification will be carried out within the following principles:

- EDM is required to connect all customers who request a connection in their own expansion area. This area is defined as having a radius 100 meters around the existing main lines of BT;
- The cost for these connections, as well as the supply to these customers, will be included in the rate;
- Outside the expansion area itself, new connections and network extensions, when needed, will not be paid by EDM. They will be paid in full with GM funds (including IFI) and/or the Electrification Account;
- EDM is not subject to reimbursing any of the funds required for such links outside the expansion area itself. These links will be financed by GM, IFIs and the Electrification Account and, finally, it is the Electrification Account that will pay for the investment;
- EDM will operate these new networks commercially, i.e. the cost of its operation will be contemplated and paid in full by the tariff;
- EDM will participate in the planning process as an interested and important institution, initially leading the planning process until MIREME develops sufficient knowledge and capacity and acquires the human resources and tools needed to replace it in these specific functions;
- EDM will receive from the planning process a set of projects and goals, develop projects in detail, carry out feasibility studies and make provisional prioritization of projects;
- The funding request will be made to the Electrification Account, which will review the definition of projects and feasibility studies, and decide on funding according to the plan, with the availability of funds and the GM/MIREME guidelines. Projects can be financed initially with the funds of the

GM/IFIs programs agreed with GM, but in the end this financing will be returned by the Electrification Account;

- Once the Electrification Account decides on the financing procedure and informED EDM, thus making such public decisions, EDM will then implement the approved projects;
- In all cases, funds that finance project capital expenditure (CAPEX) will be disbursed according to predefined construction steps*(pari pasu* with construction);
- When collecting tariffs, EDM should automatically transfer the corresponding rate (5%) for the Electrification Account;
- EDM will be obliged to connect consumers within its expansion area; this is not a deterrent for EDM to be able to address other projects, such as mini-networks outside the network, but this will not be its obligation.

Energy Fund (FUNAE)

FUNAE will be primarily responsible for building electrification infrastructure *in off-grid areas,* focused on remote communities and energy activities for *social purposes.* This electrification will be carried out within the following principles:

- The CAPEX required for the development of off-network electrification will be provided by the Electrification Account and GM (including IFIs);
- FUNAE is not subject to reimbursing the funds needed for systems not connected to the network. These links will be financed by GM, IFIs, the Electrification Account and, finally, it is the Electrification Account that will pay for the investment;
- FUNAE will not operate these assets; once the project has been completed, FUNAE will deliver it to EDM that will, or operate, or outsource the operation to a qualified carrier (named through a competitive process);
- FUNAE will participate in the planning process, being one of the institutions concerned;
- FUNAE will receive a set of projects and targets from the planning process. FUNAE will develop the projects, conduct feasibility studies and make provisional prioritization;
- FUNAE will request funding for the Electrification Account that will examine eligibility, project definition and feasibility studies, and decide on funding according to the plan, availability of funds and gm/mireme guidelines. Projects may initially be financed with gm/IFIs programme funds agreed with GM.
- Once the Electrification Account decides on the financing procedure and informS FUNAE, thus making these public decisions, FUNAE will take the next step: the implementation of approved projects;
- In all cases, the funds that finance capex of the projects will be released according to predefined stages of construction*(pari pasu* with construction); and
- Electrification projects with a capacity of more than 1 MW will need to have special treatment of FUNAE, taking into account that: (i) construction standards should provide for a possible connection to the network in the future; ii) the

coordination with EDM should consider the project as a "pre-electrification" plan.

Cahora Bassa and other IPPs

In the future, as electrification progress is found, greater capacity (and energy) will be needed to meet domestic consumption. This can be obtained from the expansion of the production and/or installed capacity of the Cahora Bassa Hydroelectric Power Plant, as there is the possibility of its use after the closure of the current export contracts.

In other words, once Cahora Bassa's export contracts begin to expire, rather than extending them, providing the same previous capacity volume, part of that capacity can be used to fuel growing domestic demand due to the rapid electrification process.

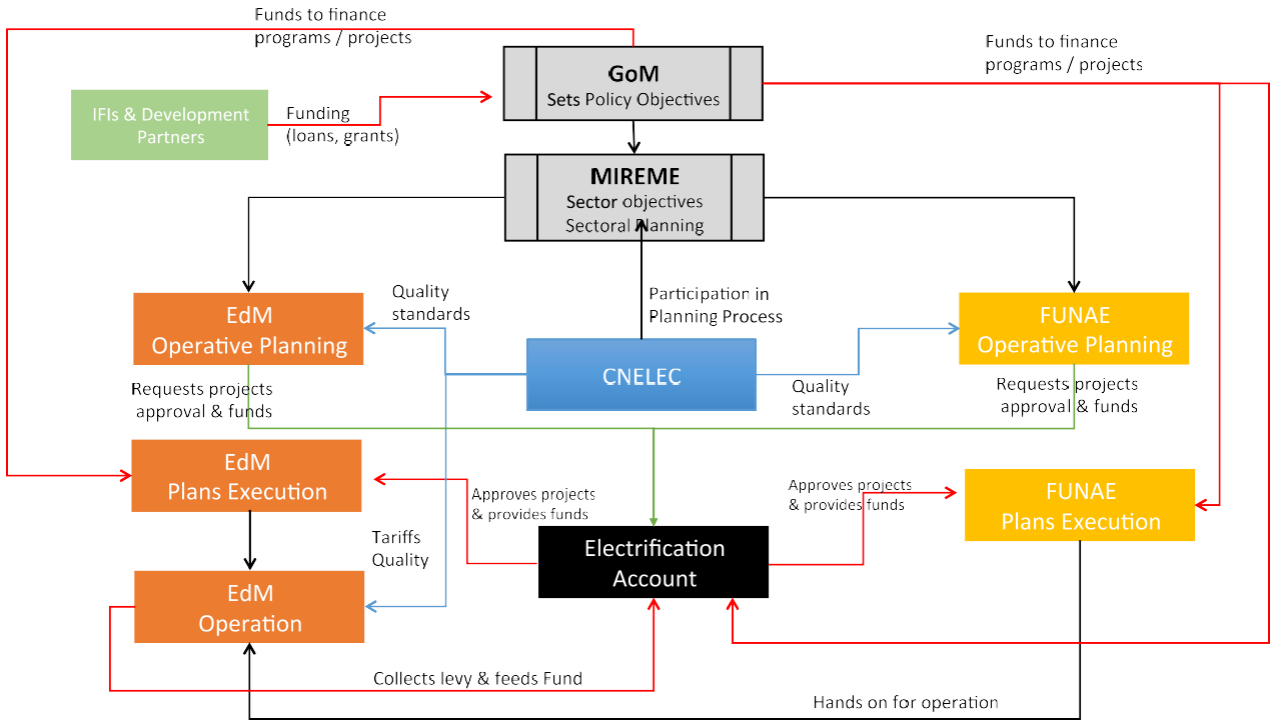
Part of Cahora Bassa's revenue may eventually be used to provide funds for the Electrification Account. However, it is important to point out that it is not recommended to impose any type of rate or taxation on exports, as they can have an effect on the potential of foreign trade.

It should also be borne in mind that it is not recommended to charge any tax or fee on IPPs as a source of revenue from the Electrification Account, since IPPs will pass this tax or fee to the final price of electricity, thereby increasing the price of the account to the final consumer. This would represent a "double charge" for end consumers, as they will already be paying the electrification fee to fund the Electrification Account.

Map of Institutions

In the following figure, the colors indicate: i) red arrows, cash flows, ii) blue arrows, regulations, iii) green arrows, requests for project financing, iv) others. This does not represent the institutional hierarchy, but institutional relations.

Figure 4.3 Roles and institutional responsibilities proposed

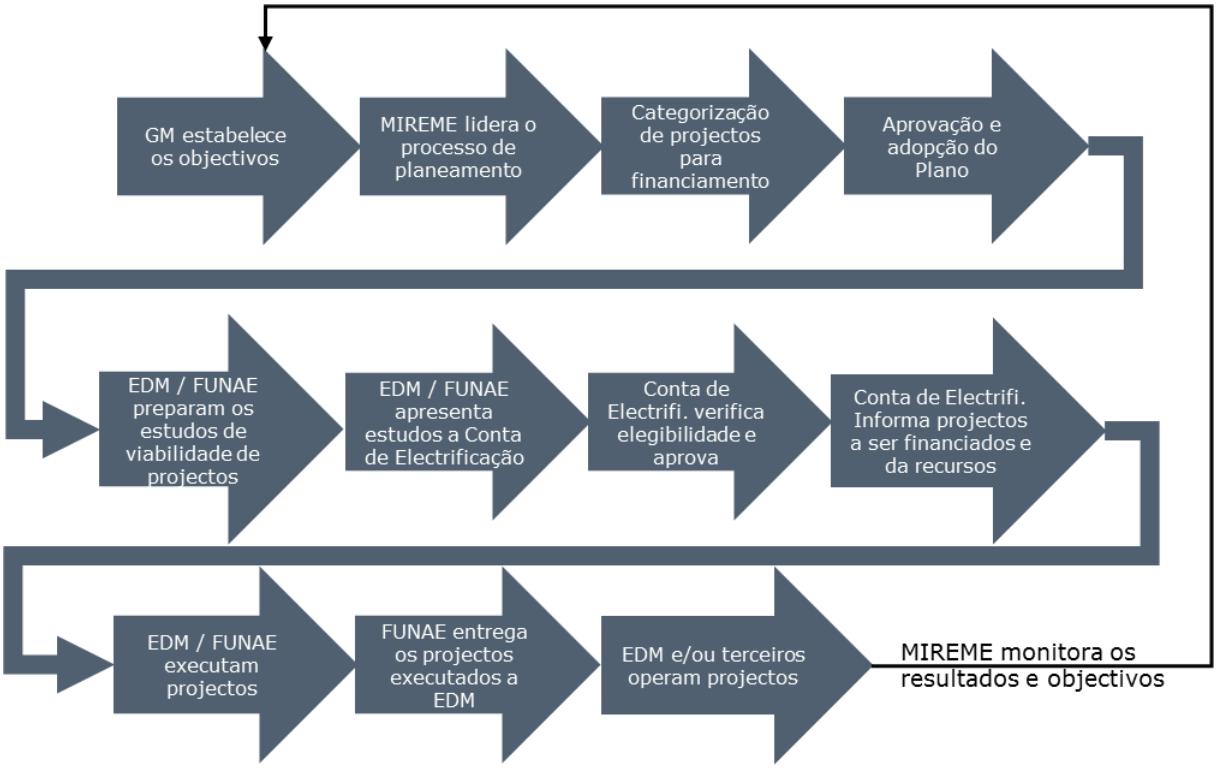


Translation figure 4.4: Organs - in the middle, left and right: *GM (sets policy goals); MIREME (Goals and Planning by sector); CNELEC; Electrification Account; IFIs and Development Partners); EDM (Operational Planning); EDM (Plans Execution); EDM (Operation); FUNAE (Operational Planning); FUNAE (Plans execution);* ***Functions on top-down left:*** *Funds to finance programmes/projects; Financing (loans, subsidies); Quality standards; Requires the approval of projects and funds; Approves the project and provides the funds; Quality on tariffs; Harvest rates and feed the Account;* ***Functions on the top-down right:*** *Funds to finance programmes/projects; Quality Standards; ; Requires the approval of projects and funds; Approves the project and provides the funds; Ready to start the operation.*

The planning process, decision-making, financing and implementation of projects

From the point of view of the electrification process itself (decision on projects and implementation thereof), the process can be represented as follows:

Figure 4.4 The electrification process from the point of view of the participation of institutions



Legal/Regulatory Requirements

The implementation of the described process requires some legal/regulatory instruments.

Legal requirements

From a legal point of view, a new law on the collection of electrification fee would be required to feed to the Electrification Account that it would expose:

- the definition of which consumers will pay this fee;
- the value of the rate;
- the procedure for modifying/exempting the fee;
- the definition of who will charge the fee;
- procedures/penalties, if the fee is not transferred to the Electrification Account;
- the obligation to reserve the funds to finance projects aimed only at improving access; and
- the conditions for exempting the fee, in cases where the rate will no longer apply.

It may not be necessary to create a Law establishing the Electrification Account, because it is possible to create it through a Presidential Decree. In any case, the following aspects should be considered:

- Electrification Account Objectives;
- Governance;
- Sources of funding;
- Project eligibility;
- Activities/responsibilities;
- Principles for prioritizing projects;
- Conditions for disburseing the funds;
- Monitoring of projects/ disbursement of funds;
- Penalties/procedures in case of non-compliance; and
- Reports/accountability.

Regulatory requirements

The Regulation shall supplement the provisions of the law if necessary. In addition, it must clearly define:

- The detailed pricing methodology, including their calculation formula, procedures for their determination, periodic tariff review (including public hearings), automatic tariff adjustment on key cost determinants, etc.
- The detailed tariff regulation in which it is explicitly established that:
    - o the Government and the Electrification Account pay for CAPEX involved in electrification of customers who are not in EDM's Own Expansion Areas;
    - o the fare is a "national tariff". There is no differentiation that depends on geographical criteria (including a social tariff for inneedy customers that does not contain the fee for the Electrification Account);
    - o the tariff includes the efficient costs of the operation and supply of all customers;
    - o efficient electrification costs in EDM's own expansion area are contemplated in the tariff;
    - o assets transferred to EDM, financed by the Electrification Account, are not part of the regulatory assets base whose objective is to remunerate, however, are taken into account for operating costs, including the provision for depreciation of EDM assets; And
    - o the cross-subsidy mechanism for the operational costs of systems outside the network.

Preparation of institutions to implement the proposed strategy

The different institutions involved in the implementation of the strategy have different preliminary tasks. These tasks are performed before the strategy can be fully implemented as elaborated. The following table shows a number of activities that institutions can do in order to prepare for the implementation of the strategy itself.

Table 4.1 Preliminary activities per institution

Institution	Preliminary Activities
Gm	Review and set access goals Guide the creation of the Electrification Account
MIREME, New District	Prepare an initial set of activities and schedule to regularly plan Create a group/office within MIREME that will be responsible

Institution	Preliminary Activities
	planning and monitoring activity of the Plan Acquire resources for the training of professionals Discuss the agreement with EDM and FUNAE on electrification projects using the available funds Train and train teams
Ministry Economics and Finance	Implement a transitional procedure that allows the use of available IFIs funds while the Electrification Account is not yet established
Edm	Finalize and approve quality standards Select an initial (reduced) list of materials relevant to bulky purchases Develop and implement a procedure for bulky purchases of selected materials Define "standard procedures" for electrification projects. Identify densification projects Coordinate, with MIREME, a set of projects (and schedule) for rapid implementation Prepare a program to strengthen projectplanning and implementation/monitoring capabilities. Start the development of "logistics capabilities" for the implementation of the electrification plan
FUNAE, Pennsylvania	Identify a set of "low cost" projects for off-network areas Coordinate with MIREME projects for rapid implementation (including a schedule) Define "standard procedures" for electrification in areas outside the network Prepare a programme to increase project planning and implementation capacity
Arene	Determine the fare as soon as possible (once the Law is passed) Develop capacity in terms of fare adjustment Analyze and implement the results of the tariff study that is being carried out by EDM.
Committee of Coordination	Develop rules for implementation of the "Electrification Account"

Establishment of the electrification account

Purpose

There is currently no legal framework that clearly establishes the sources of funding to be allocated exclusively to electrification projects, including predefined government funding or an electrification tariff or any hybrid approach. Under the current approach, the availability of funds is heavily dependent on international partners and edm's financial situation, which, as described above, is operating with loss and is not financially sustainable with current tariffs in a macroeconomic environment where access to finance has become extremely complex. The lack of an appropriate funding scheme limits the electrification effort, with several projects having their assessments approved, but not developed, due to the lack of funding.

Activities

International experience has shown that significantly high and isolated funds are needed to support electrification targets as ambitious as those established in Mozambique. An electrification account must be created to provide an appropriate funding scheme for electrification projects in Mozambique. The proposed electrification account is described in detail in the sections below.

General structure and sources of funding of the electrification account

As described above, two different areas were considered in this Strategy:

• EDM's Own Expansion Area (AEP), which is defined as an area near existing lines, where the dealership is required to connect consumers when they request the connection. This area is defined in principle as based on the capacity of low voltage (BT) upstream infrastructure of 100 meters for each side of each existing line. The connection costs at the EPA will be borne by EDM and the tariff will reflect the costs and will be sufficient to ensure reimbursement of this financing.

• EDM's Subsidized Expansion Area (AES), which is defined as the area that is not an AEP. EDM has no obligation to respond to any request to connect potential customers in this area. EDM must fully recover connection costs, which must be borne by the electrification program. There are three sources of funding (Figure 4.7): (1) electricity users, who support electrification through a link rate and an electrification rate, (2) IFIs, which offer loans and grants on favorable terms and (3) GoM, which provides loans and budget.

The Electrification Account shall manage the financial resources obtained from electricity users and gom and finance electrification projects in AES and cover the debt service to IFIs and GoM for electrification projects in AES (see Figure 4.7). Loans and GRANTS from IFIs must be transferred directly to electrification projects (they are never transferred to the Electrification Account), with GoM as the party responsible for covering the resulting debt service.

The sources of funding of the electrification account would be:

• The electrification rate.

• The connection fee.

• GoM loans.

• GoM's annual budget appropriations.

• Any other fees charged to electricity customers.

The disbursements of the electrification account would be:

• Debt service for IFIs in relation to electrification projects in AES.

• Debt service to GoM with regard to electrification projects in AES.

• Electrification costs in AES.

Administration and supervision of the eleCtrification account

The Electrification Account will be a deposit account under the administration of the Ministry of Economy and Finance and under fiduciary administration of a bank or agency.

The Electrification Account must be delimited to protect it: the only outbound flows should be electrification costs in AES and debt services for IFIs and GoM in relation to electrification projects in AES. The legislation should require EDM to transfer all funds from the electrification fee to the electrification account.

All electrification account transactions must be public and must be published regularly by the agency or the bank that manages the account.

No additional institution would be required to finance AES electrification, and the account would be transparent, responsible and appropriate to track money and audit.

Eligibility and prioritization of electrification projects for financial support of the electrification account

All electrification projects at The ESA identified in the planning process to be developed by MIREME would be eligible for financial support from the Electrification Account.

Applications for funding electrification projects would come from EDM and FUNAE to the Ministry of Economy and Finance. The Ministry, considering the goals of the GdM, the planning approved by MIREME, and the initial categorization of the projects, would review the eligibility of each project and finance the selected ones.

- Debt service to GoM with regard to electrification projects in AES.
- Electrification costs in non-AES.

Legal requirements for electrification account creation

The implementation of the Electrification Account requires legal and regulatory instruments.

To create the electrification rate that funds the electrification account, a new law must cover:

- The definition of which consumers will be charged with this fee.
- The value of the fee.
- The procedure for modifying or deleting the levy.
- The definition of who will charge the fee.
- The obligation to transfer all revenue stemming from the fee to the electrification account.
- Procedures and penalties if the fee is not transferred to the electrification account.
- The obligation to allocate resources to finance only projects aimed at improving access.
- Conditions to eliminate the levy because it is no longer applicable.

The creation of the electrification account may not need a law, but may occur through a decree of resolution of the Council of Ministers and should cover:

- Electrification Account Objectives.
- Governance.
- Sources of funding.
- Project eligibility.
- Activities and responsibilities.
- Principles for prioritizing projects.
- Conditions to disburse funds.
- Monitoring of projects and disbursement of resources.
- Penalties and procedures in case of non-compliance.
- Reports and accountability.

Stakeholders and their Roles

MIREME: defines the aspects of the Electrification Rate and the Electrification Account and defines the legal framework for the creation of the electrification rate and the Electrification Account.

GoM: issues the Laws, Decrees or Resolutions of the Council of Ministers required to implement the above mentioned activities.

Ministry of Economy and Finance: Manages the electrification account.

Bank / Agency: Manages the electrification account and publishes all electrification account transactions on a regular basis.

Table 4.2 proposes an example of how electrification projects can be classified. For each of the defined categories, a typical (or basic) technical design must be defined, also benefiting from the standardization of building materials. In this way, it is very simple to implement electrification projects, reducing the time and costs required.

Table 4.2 Example of Electrification Systems

			Project Indicative Parameters		
System	Methodology	Type of settlement	D = EDM network distance	P = Demand for home (kVA)	Population Density
Connected to the Network	Link of new consumers to existing BT network (220 - 400V)	Urban and periurban	D< 10m	3.0 < P< 5.0	High
	Densification (extensions urban bt and of MT)	Urban and periurban	10m < D< Mile	3.0 < P< 5.0	High
	Three-phase rural MT (main and ramifications) and BT extension	Rural	5km < D< 30km	2.0 < P< 3.0	High
	Three-phase rural MT (main), MRT (19kV) for branches and BT extensions	Rural	10km < D< 30km	1.0 < P< 2.0	Average
Off the Network	Mininet: centralized production and BT network	Rural	D > 30km	0.1 < P< 1.0	Average
	Solar system for homes	Rural	D > 30km	0.1	Low

NOTE:In cases where there is a high consumption customer, with a custom connection, the electrification methodology will be evaluated differently.

Financial Aspects

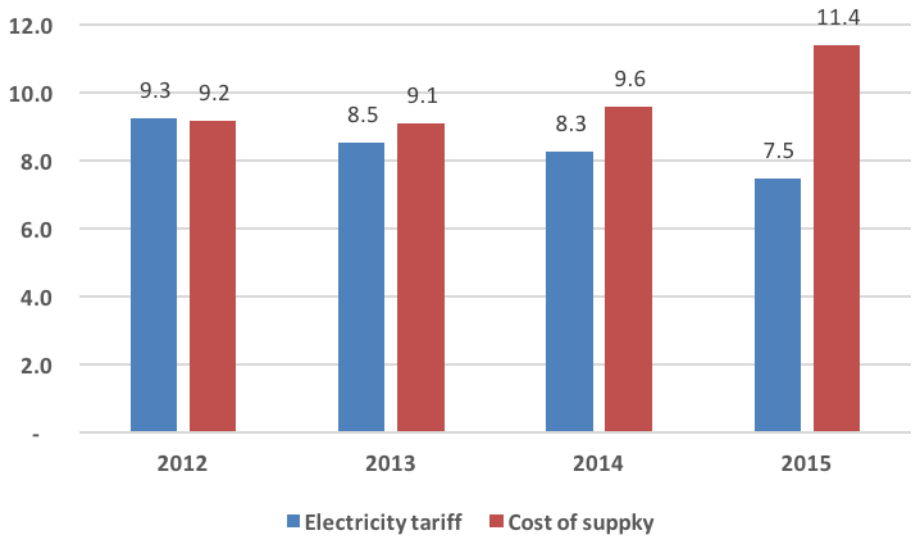
Tariff policies

The following aspects of the current electricity tariff policy should be reviewed:

Tariffs should cover the efficient cost of providing electricity services

Current electrical tariffs do not cover the cost of power supply in Mozambique. As shown in Figure 4.5, the gap between the average electricity tariff and the average cost of supply has increased over the past few years, mainly due to increased energy acquisition costs. The erosion of the tariff was accelerated by the exceptional devaluation of metical[14] and the fact that electricity tariffs have not been adjusted properly for many years. Specifically, the average electricity tariff was estimated at $7.5 cents/kWh in 2015, while the average cost of supply was estimated at $11.4 cents/kWh. As a consequence, EDM is operating with losses and is not financially sustainable with current tariffs. In addition, it adds to the fact that the macroeconomic environment for access to finance has become extremely complex.

Figure 4.5 Evolution of the average tariff and the average cost of supply 2009-2015 (US$ cents/kWh)



Translation figure 4.6: *Electricity tariff; Cost of supply*

Source: EDM, Historical Data 2009-2015

Moreover, EDM is currently not only leading, but is also financing the effort for mozambique's electrification. Therefore, the fact that tariffs are not reflected in costs makes it difficult to sustain electrification projects in network-related systems.

Appropriate regulations and institutional configuration must be ensured to enable EDM to recover the efficient costs of providing electricity services if the company provides services with the indicated quality[15]. The tariff should incorporate mechanisms that allow the reference of associated costs, such as the automatic transfer of fuel costs related to their production, adjustments to

[14] The Metical has depreciated 62% against the U.S. dollar in the last two years (2015-2016). More specifically, the metical devalued 27% against the U.S. dollar in 2015 and 35% additional in 2016.

[15] This includes a reasonable level of losses; the regulator is generally agreed with a loss reduction program that will evolve through a reasonable "route" to achieve the desired loss target.

movements in the exchange rate and inflation. EDM's remuneration should also include devaluation of its assets and a reasonable return on investment. This is necessary for EDM to provide an acceptable quality of service, acting as an electricity supplier and being able to finance the replacement of its assets.

In the case of assets to be financed through the electrification programme, including those financed by the Electrification Account or GM (channeling the donations and loans of IFIs with interest below the market), the ownership of the assets shall be transferred free of charge to EDM[16] and the tariff shall exclude capex remuneration (since it is not financed by EDM). However, account should be taken of operating and maintenance costs and devaluation (including depreciation of low voltage and counter installations).

Policy of standardising tariffs

Electricity tariffs are currently uniform across the country, with consumers in rural areas connected to the network paying the same tariff as users in urban areas connected to the network, although electrification costs are higher in rural areas, as households tend to be dispersed and located in remote and inaccessible areas. In addition, low consumption levels do not allow to take advantage of economies of scale normally present in the electrical sector. While this approach may not be the most financially efficient, it is subject to social and political acceptance around the world. Many developed and developing countries have uniform tariffs (e.g. Spain, Kenya, Vietnam) and this will continue to be the practice in Mozambique as well, implying the existence of a cross-subsidy between rural and urban customers.

In the case of consumers in non-network areas, FUNAE usually charges customers according to edm's tariff, although in some cases FUNAE may charge a fixed tariff (regardless of customer energy consumption). This fare is generally higher than edm's fare, but does not necessarily reflect on costs. It is recommended that the uniform tariff policy be implemented for consumers in areas outside the network, which will result in cross-subsidy between[17] customers connected to the network and outside the network.

In addition, there should be a possibility for EDM to make agreements with third parties for the more efficient operation and maintenance of some systems in off-network areas. These third parties may include private operators or even the local community, who can be trained and involved in the operation and maintenance of the system for a more efficient delivery of the service. However, it is proposed that these customers remain EDM customers and the company should remain the entity legally responsible for the electricity service.

If EDM is the only operator of the network, cross-subsidies between rural and urban customers connected to the network will be implied. On the other hand, cross-subsidies between network and off-network clients are also possible and can be internally managed by EDM. If electricity distribution companies (DISCOs) enter the sector, there should be an explicit cross-subsidy. The permitted revenues of

[16] Free of any tax or fee.

[17] Electricity tariffs are recommended to cover the total cost of supply. It is also recommended that the rate be uniform throughout the country. This implies that there is a cross-subsidy among consumers, because if the tariff is uniform, some users will pay more than the corresponding cost of supply (e.g. urban consumers and connected to the network) and some other users will pay less than the corresponding cost of supply (e.g. rural users and in areas not connected to the network).

private operators should include efficient operating and maintenance costs, asset devaluation, and a reasonable return on investment. To make it possible there will be a need to create a regional tariff subsidies fund, which should be administered by the Energy Regulatory Agency or MIREME.

Tariff accessibility

To assess the issue of tariff accessibility, it is necessary to set a ceiling to determine what would be the acceptable level of expenditure related to public services, such as a percentage of domestic expenditure. By defining this *benchmark,* we will inevitably use a value judgment that can change over time and place. Bearing in mind these complications, many governments and international financial institutions have developed *ad hoc* rules on what constitutes an acceptable level of expenditure related to public services. These are summarized below:

Table 4.3 *Benchmarks* used to measure tariff accessibility (% of total household expenditure)

Source	Electricity	Heating	Water	All consumption accounts
World Bank (2002)	10-15		3-5	
WHO (2004)	10			
IPA Energy (2003)	10	20		
Government of Ukraine (2000)				20

Source: BERD[18]

Although there is no universal *benchmark,* these numbers are indicative. In this case, it is considered that 10% of total domestic expenditure is the highest ceiling for tariff accessibility in relation to the cost of electricity, and that if the percentage in total household expenditure is less than 5%, no concern about tariff accessibility has been identified.

In the expectation of assessing the ability to pay electricity expenditure in Mozambique, estimates of electricity expenditure sper household and quintile were compared with estimates of total expenditure per household and by quintile.

Average household spending per quintile

The estimated averages of monthly household expenditures per quintile are presented in the table below (where the first quintile represents the poorest and the fifth quintile represents the richest). Below we cite the main hypotheses for these estimates:

- The average expenditure per capita and per quintile is based on the 2014-15 household surveys conducted by the National Institute of Statistics of Mozambique [19];
- The average size of a family is 5.0 people, according to the data provided in this same study [19]. It was considered that the average size of the family was slightly lower in the richer quintiles than in the poorest quinttiles;
- The average household expenditure was obtained from the average per capita expenditure multiplied by the average family size; and
- Finally, the final results were adjusted with inflation rates in 2015 and 2016 (2.4% and 16.70%, respectively [20]).

[18] European Bank for Reconstruction and Development, Can poor consumers pay for energy and water? An analysis of tariff accessibility for transition countries, working document No. 92, 2005.

[19] Final Report of the Household Budget Survey 2014/15, National Statistical Institute of Mozambique.

[20] Inflation rates obtained from the site: https://knoema.com/atlas/Mozambique/CPI-inflation

Table 4.4 Estimated average monthly household expenditures per quintis (MZN)

	First Quintil	Second Quintil	Third Quintil	Quintil Room	Fifth Quintil
Average expenditure per capita - 2014	297	538	791	1,223	4,191
Average size of a family	5.50	5.25	5.00	4.75	4.50
Average household expenditures - 2014	1,634	2,824	3,955	5,807	18,861
Average household expenses - Jan 2017	**1,953**	**3,375**	**4,726**	**6,940**	**22,539**

Average expenses with rates per quintile

Table 4.5 Current electrical charges in Mozambique

Monthly consumption (kWh)	Social (MZN/kWh)	Residential (MZN/kWh)	Agriculture (MZN/kWh)	General (MZN/kWh)	Fixed rate (MZN)
0-100	1.07	-	-	-	0
0-300	-	4.04	3.40	5.80	152.37
301-500	-	5.072	4.84	8.29	152.37
>500	-	6.00	5.30	9.07	152.37
Prepaid	1.07	5.14	4.71	8.31	-

Source: EDM in June 2017

Estimates of monthly tariff expenses per quintile are presented in Table 4.6. Below we cite the main hypotheses for these estimates:

- The average consumption adopted for the richest quintile (200 kWh) was obtained from the average consumption of urban consumers in three of mozambique's largest cities (Maputo, Beira, Nampula). The average consumption adopted for the second richest quintile was obtained from the average consumption of peri-urban consumers in the same cities[21];
- The results of the average consumption adopted for the rest of the quinttiles are much more moderate and use as a reference the experience of the effort adopted in the electrification of Kenya;
- The inclusion of the two poorest quinttiles in the socialtariff was considered[22];
- Current electricity tariffs were used for residential consumers (see Table 4.5); and
- It was considered that the variable average rate of residential consumer tariffs of the richest quintile was slightly higher than 4.04 MZN/kWh (4.25 MZN/kWh), in order to simulate that some of these consumers use more than 300 kWh per month.

Table 4.6 Estimated average monthly tariff expenses per household and per quintile

	Unit	First Quintil	Second Quintil	Third Quintil	Quintil Room	Fifth Quintil
Fixed rate of residential rates	MZN, New	0	0	152.37	152.37	152.37
Variable rate of residential rates	MZN/kWh	1.07	1.07	4.04	4.04	4.25
Expected monthly consumption	Kwh	15	30	45	80	200
Monthly tariff expenses	**MZN, New**	**16**	**32**	**334**	**476**	**1,002**

Quintile connection fee expenses

Estimates of monthly link rate expenses per quintile are shown in the table 4.7. We cite here the main hypotheses for these estimates:

[21] These consumption numbers were provided by EDM.

[22] Currently, only consumers with a contracted capacity below 1.1 kVA, consuming less than 100 kWh per month and who prove to be low-income, are eligible for the social purpose rate. The number of residential consumers on the social tariff totaled only 3,596 in 2015, while the number of consumers on the domestic tariff reached 1,259,638

consumers (World Bank, Political Note on mozambique's energy sector, 30 November 2015).

- Although the cost of the connection was estimated at $500 per link in the Master Plan prepared by Norconsult and Vattenfall[23], a bond ing fee of only $72 was adopted to promote its tariff accessibility;
- The current exchange rate of 62.88 MZN/US$[24] was adopted;
- The concept of any richest quintile was adopted to pay the bonding fee in advance; and
- It has been stipulated that the four poorest quintis will pay the bond ing fee on 72 equal monthly instalments to be adjusted for inflation, but no financing costs.

Table 4.7 Advance link rate adopted for the richest quintile and monthly lead rate expenses for the rest of the quintis (MZN)

	First Quintil	Second Quintil	Third Quintil	Quintil Room	Fifth Quintil
Connection fee	63	63	63	63	4,527

Summing up accessibility tariff

Table 4.8 shows the percentage of tariff expenses, the weight of bonding fee expenses and the weight of total electricity expenditure[25] on total monthly expenditureper quintile. Under the hypotheses described above, the results show that:

- No concern was identified with tariff accessibility in relation to total electricity expenditure for the two poorest quintiles (4.0%, 2.8%);
- There were no concerns about tariff accessibility with regard to tariff expenses for the fifth quintile (4.4%). However, total electricity expenditure is more than 5% for the fifth quintile (24.5%), working on the hypothesis that these consumers will be required to pay the connection fee in advance (without benefits). More specifically, the weight of bonding expense represents 20.1% of total monthly expenses alone. If the link rate was compared with total expenditure in three months, the percentage of bond costs would still be higher than 5% (6.7%). This result indicates that concerns about tariff accessibility would be valid if all the richest quintile needs to pay an early bond ing fee of $72. To address this issue and determine the amount of the population that can pay the advance bond ing fee without worrying about tariff accessibility, it would be appropriate to divide the richest quintile into decisions or even percentiles; unfortunately, this information was not available; and
- Finally, concerns about tariff accessibility can be identified with regard to expenditure on tariffs and total electricity expenditure for the third and fourth quintiles (the calculated percentages are more than 5%). However, the resulting expenditure is below the highest threshold for tariff accessibility, considered in international experiences (10%).

[23] Technical Assistance to Strengthen Investment Capacity and EDM Development Network Planning: Master Plan Update Project, 2012 - 2027: Master Plan Update Final Report: Volume III - Main Report of April 30, 2014

[24] Extracted from: http://www.xe.com/currencyconverter/convert/?From=US$&To=MZN. Accessed 05/09/2017.

[25] Total electricity expenditure is calculated from the sum of tariff costs and expenditure on the connection fee.

Table 4.8 Comparison of average electricity expenditures and total household, quintile and monthly expenses

	Unit	First Quintil	Second Quintil	Third Quintil	Quintil Room	Fifth Quintil
Total expenses	MZN, New	1,953	3,375	4,726	6,940	22,539
Tariff expenses	MZN, New	16	32	334	476	1,002
Tariff expenses on total expenditure	**%**	**0.8%**	**1.0%**	**7.1%**	**6.9%**	**4.4%**
Expenses with the connection fee	MZN, New	63	63	63	63	4,527
Connection expenses on total expenditure[26]	**%**	**3.2%**	**1.9%**	**1.3%**	**0.9%**	**20.1%**
Total electricity expenses	MZN, New	79	95	397	538	5,530
Total electricity expenditure on total expenditure	**%**	**4.0%**	**2.8%**	**8.4%**	**7.8%**	**24.5%**

Connection Cost allowance

As demonstrated in the analysis of the tariff accessibility carried out in the section above, concerns about tariff accessibility would be considered if we require the richest quintile of the population to pay an early bond ing fee of US$72[27.] Therefore, for low voltage connections, it is proposed that only customers with a contracted capacity above 3 kVA be required to pay the advance connection fee (or negotiate with EDM more flexible payment terms). For low voltage connections of customers with contracted capacity of less than 3 kVA, it is proposed that these clients are not required to pay in advance, but in 72 equal monthly installments, to be adjusted by inflation (without financing costs). In addition, it is proposed that customers with contracted capacity of less than 250W can apply for a pre-equipped electrical frame (Ready Board) that will be fully subsidized.

For medium voltage connections, it is proposed that these customers be required to pay the advance connection fee or negotiate with EDM more flexible payment terms.

Electrification financing outside the Expansion Areas of Its Own

As described above, two areas were considered in this strategy:

- EDM's Own Expansion Areas are defined as areas close to existing lines where the dealership has an obligation to connect customers when the connection is requested. This area is defined in principle based on low voltage infrastructure capacity (BT), with a radius of 100m for each existing line side.
- Subsidized Expansion Areas are defined as areas that are located outside the Expansion Areas of Their Own.

This section is intended to determine the financing needs of the electrification program in the Subsidized Expansion Areas. To this end, a financial model estimating the financial needs of the electrification program in the Subsidized Expansion Areas was developed, using several hypotheses about electricity access projections, electrification costs and sources of funding. Both the assumptions and the funding needs arising are described in the sections below.

[26] For the richest quintile, an anticipation of the bond rate was assumed. It has been assumed that the rest of the quintis will be able to pay the link rate in 72 monthly benefits equal to be adjusted for inflation, but without financing costs

[27] This rate is intended to cover part of the costs of low voltage, counter and labor. Although the cost of the connection was estimated at $500 in the Master Plan, a bonding fee of only $72 was considered to promote the fare

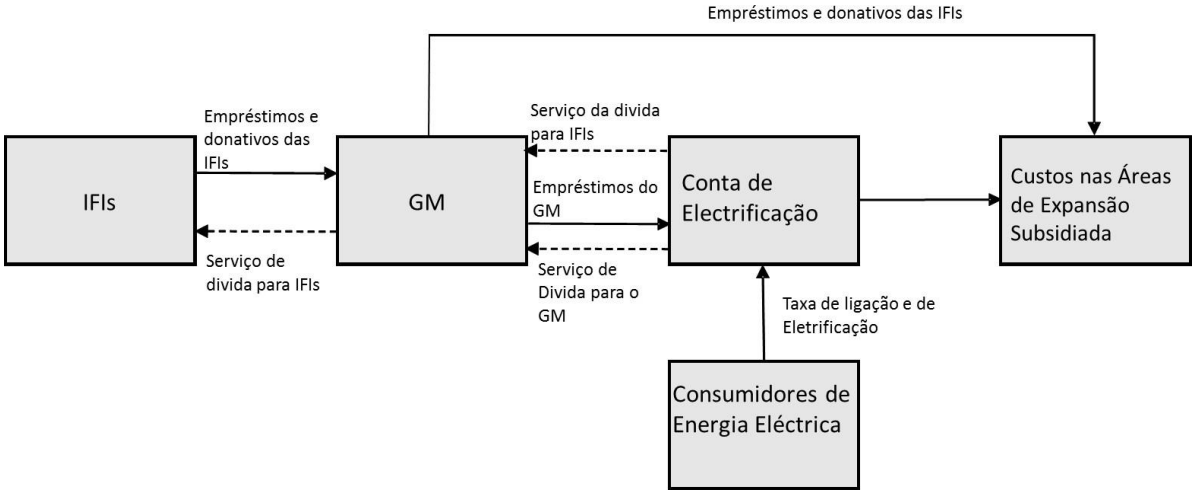
accessibility of the link rate.

Flow of funds to the electrification program

Under the proposed approach to the development of this strategy, EDM is assumed to fully recover connection costs in a Subsidized Expansion Area, which, presumably, were assumed by the electrification program. As shown in Figure 4.6, three sources of funding for the electrification programme in the Expansion Areas of Own: (1) electricity consumers, assumed to finance the electrification programme, were considered through a rate of connection and an electrification rate; (2) IFIs and development partners, taken up to support the electrification programme through loans and donations; and (3) gm, assumed to support the electrification program through loans.

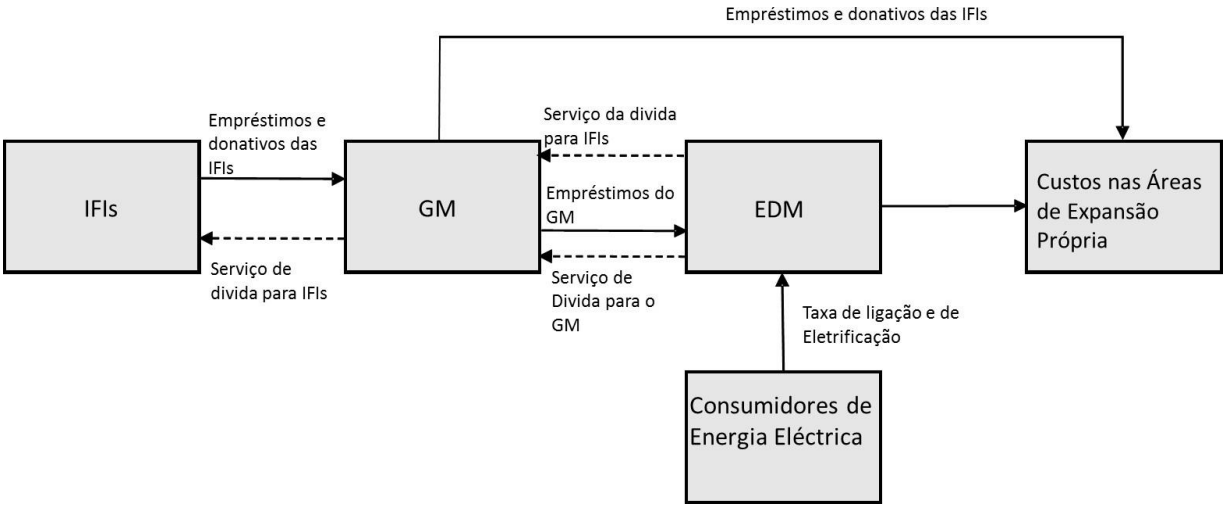
On the one hand, it is assumed that the loans and donations of IFIs should be directly transferred to electrification projects, with GM being the responsible party for covering the resulting debt service. On the other hand, an Electrification Account was simulated as the tool to implement the financial resources obtained from electricity users and GM, which would cover part of electrification costs and debt payment to IFIs and GM.

Figure 4.6 Flow of funds from the electrification program outside edm's own expansion areas



Electrification financing needs in The Expansion Areas of Own have not been modeled in this section. However, the flow of electrification funds in these areas is shown in Figure 4.7. Under the proposed approach to the development of this strategy, IT is assumed that EDM will fully recover the connection costs in the Expansion Areas of Its Own. Electrification costs are assumed by EDM and financed by the cost of connecting electricity users and additional funds from IFIs and GM. It is assumed that the tariff will incorporate these costs and will be sufficient to ensure reimbursement of this Financing.

Figure 4.7 Electrification program cash flow within EDM's Own Expansion Areas



Access to electricity was determined by 26% in 2016, when the number of residential customers reached 1,335,207, the average household size was estimated at 5.0 people and the population was estimated at 25,727,603 people[28].

Access to electricity is estimated to increase slightly to around 26.8% in 2017, according to the following hypotheses:

- Only 120,000 new residential customers were considered in the period 2016-2017;
- The same average size of the families assumed in 2015 was considered;
- A population growth rate of 2.5% per year was assumed according to the annual growth rate in the period 2005-2015.

Assuming that the electrification program will support the electrification effort from 2018, the main hypotheses about electricity access projections after 2018 are:

- It is assumed that the average size of households will decrease at a rate of 0.1% per year, from 5.0 people in 2018 to 4.4 in 2030, 4.0 people in 2040 and 3.3 people in 2060 (considering to be the average family size a constant)[29].
- It was assumed that the annual population growth rate will decrease from 2% in 2018 to 0% in 2060.
- An electrification scenario has been assumed where the country will achieve universal access to electricity by 2030 and where:
    - The number of connections of residential customers in the Subsidized Expansion Areas will increase from 135,000 new connections per year in 2018 to 300,000 in 2020 and 450,000 in 2025, assuming that the number of connections will remain constant until 2030. The average number resulting from connections of residential customers to be assumed by the

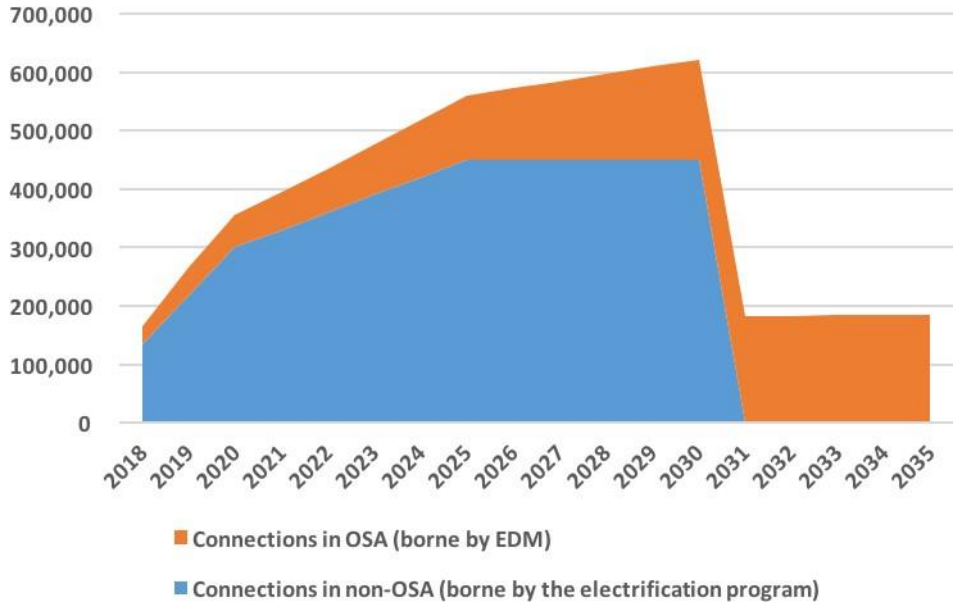
[28] EDM, Historical Data 2001-2015

[29] The consultant took on a decrease in the average family size over time in Mozambique, according to the pattern of decline experienced internationally, due, among other reasons, to contraception (safer and cheaper birth control), the change in women's social position or a geographically mobile workforce. For example, the average family size in South Africa decreased from 4.4 people in 1995 to 4.0 people in 2004 and to 3.6 in 2004 (Restructuring of families in rural South Africa: Reflections on the average size of the family in the Subdistrict of Agincourt from 1992 to 2003, Southern Africa's Research and Labor Development Unit). In Canada, the average family size decreased from 6.2 people in 1851 to 4.3 people in 1941 and 2.5 people in 2011 (http://www.statcan.gc.ca/pub/11-630-x/11-630-x2015008-eng.htm)

electrification in the period 2018-2030 is equivalent to about 373,000 customers per year (4,852,000 customers in total);

- o The number of connections of residential customers in the Own Expansion Areas will increase aligned with access to electricity, with the increase in the population and with the decrease in the average size of families. The financing needs of these links were not calculated in this section, but the number of estimated links in the Own Expansion Areas is also provided in Figure 4.8 and Table 4.9 below;
- o From 2031, when it is assumed that the country will have already achieved universal access to electricity, it has been assumed that all new customers will already be linked to the Own Expansion Areas and their costs assumed by EDM.

Figure 4.8 Number of residential customer connections per year, 2018-2035 - Base scenario



Translation figure 4.8: *Links in the Areas of Own Expansion (assumed by EDM); Links in subsidized expansion areas (assumed by the electrification program)*

Table 4.9 Projections of access to electricity, 2020-2060 - Base Scenario

	2020	2030	2040	2060
Population	28,644,358	33,713,497	37,859,444	41,433,010
Population growth rate per year (%)	1.9%	1.4%	1.0%	0.0%
Average size of families	4.9	4.4	4.0	3.3
Decrease in the average size of families (%)	-1%	-1%	-1%	-1%
Access to electricity at the end of the year (%)	38%	100%	100%	100%
In. residential consumers at the end of the year	2,240,413	7,606,967	9,445,610	12,638,582
In. (accumulated 2018)	785,206	6,151,760	7,990,403	11,183,375
In. connections in the Self-Expanding Areas (accumulated from 2018)	132,706	1,299,812	3,138,455	6,331,427
In. links in the Subsidized Expansion Areas (accumulated from 2018)	652,500	4,851,948	4,851,948	4,851,948

As well as electrification costs, the BT and MT systems required from the delivery point for each service connection, as defined in Annex B to this document, were also considered. Below are the main hypotheses to estimate electrification costs:

- It was assumed that the portion of network-related systems per year accounted for 99% of the new total links from 2018 to 2025, and it was assumed that this portion will decrease to 70% in 2030;
- Three technologies with different costs were considered for network-related systems in subsidized expansion areas (Table 4.10)
- The portion of systems connected to the network by technology is presented in the table
  4.11. It was assumed that 5% of the systems connected to the network per year were made using the most expensive technology (technology 3), while 47.5% of systems connected to the network per year used the cheapest technologies (technologies 1 and 2).
- The costs of off-network systems were initially estimated at about US$2,000 per connection and remain constant during this period (please refer to Annex B to better understand the context). This includes domestic solar systems and represents an average cost, only for areas outside the grid, of the estimated needs of funds at this strategic level.
- The resulting portion of off-network systems during the period 2018 to 2030 would reach 9.8% of total connections in subsidized expansion areas, which would be aligned with the estimated current portion of off-the-network systems required in Kenya to achieve universal access (9.5%)

Table 4.10 Electrification Costs per connection and technology outside edm's own expansion areas (US$/link) - Base Scenario

Area	Technology	Average cost per connection
Off the Network	Not connected	2,000
Connected to the network	Technology 1	1,200
	Technology 2	1,300
	Technology 3	2,300

Table 4.11 Percentage of connections by technology and area (%) - Base Scenario

Technology	2020	2025	2030
Off the Network	1%	1%	30%
Connected to the network	99%	99%	70%
Technology 1	47.5%	47.5%	47.5%
Technology 2	47.5%	47.5%	47.5%
Technology 3	5%	5%	5%

For all scenarios, the resulting electrification costs assumed by the electrification program increased over time in line with the growing number of connections in subsidized expansion areas during the period 2018 to 2025 and the average rising cost per presumed connection during the period 2025 to 2030[30]. From 2031 onwards, no electrification cost will be assumed, since Mozambique will have already achieved universal access and all new customers will already be possibly linked to EDM's Own Expansion Areas;

Table 4.12 Averageelectrification Cefs per link and total accumulated electrification costs from 2018 that will be transmitted by the electrification program (by scenario) - Base scenario

Item	Unit	2020	2025	2030
Average electrification cost per connection[30]	US$/link	1,309	1,309	1,512
Accumulated electrification costs 2018	millions of dollars	854	3,408	6,652

[30] The average annual cost of electrification per connection was calculated using the electrification costs assumed in Table 13 and the portion of the connections assumed in Table 14. The average electrification cost per year increased during the period 2025 to 2030 under the growing portion of systems not connected to the network assumed during this period, as seen in **Error! Reference source not found.** .

Revenues from the connection rate of residential customers in the Subsidized Expansion Areas were calculated as the product of the connection rate and the number of connections in these areas. Here are the key hypotheses for this calculation:

- A $72 link fee was assumed for the connection of residential customers in subsidized expansion areas;
- It has been assumed that the portion of customers who will have to pay an advance of the bond ing fee total 5% of the connections per year, assuming that most customers with a condition to pay the fees are already linked to the system;
- It was considered that the rest of the consumers will pay 72 installments (6 years) without financing costs, i.e. interest. It has been assumed that these consumers will pay 6 monthly instalments in the first and last year, and 12 benefits during the 5 intermediate years in order to model that not all new customers will be linked in January;
- It has been assumed that only 95% of the revenue stemming from the link fee will be transferred to the Electrification Account. It was considered that the remaining 5% of the revenue will be charged by EDM as administrative costs, as the payment of the link fee will be managed by EDM[31].

The resulting trajectory of the revenues obtained from the link rate will be guided by the profile assumed for the number of connections in the Subsidized Expansion Areas and the payment period of 6 years determined for most customers. From 2037 onwards, no revenue from the link rate will be considered, as Mozambique will have possibly reached universal access by the end of 2030 and that the payment period of the last consumers linked in the Subsidized Expansion Areas will have expired in 2036.

Table 4.13 Receitas obtained from the connection rate, 2020-2030 - Base scenario

	Unit	2020	2030	2040
In. links in the Subsidized Expansion Areas (accumulated from 2018)	#	652,500	4,851,948	4,851,948
Connection fee	$200	72	72	72
Portion of the links that must be paid in advance	%	5.0%	5.0%	5.0%
Payment period for the rest of the customers	Years	6	6	6
Portion of revenue transferred to the Electrification Account	%	95%	95%	95%
Accumulated revenues from the link rate (since 2018)	MUS$	11	244	332

The revenues obtained from the electrification rate were calculated and the product of the electrification rate, the average tariff and electrical consumption were calculated. Here are the key hypotheses:

- It was assumed that the implementation of the electrification rate will become effective in 2020[32];
- It was considered that the electrification fee will not be charged on exports, so little of residential consumers who are paying the social tariff;
- The number of residential consumers within the social tariff reached only 3,596 in 2015, which accounted for only 0.3% of total residential consumers[33]. To obtain projections on the number of customers of the social tariff, it was assumed that:

[31] EDM will recover all connection cost through the electrification program. In addition, EDM is proposed to recover ~~the administrative costs of managing~~ the payment fee of all new customers in the Subsidized Expansion Areas when charging a small percentage of revenue stemming from the connection fee (e.g. 5%).

[32] When the account operation is effective.

[33] World Bank, Mozambique Energy Sector Policy Note, 30 November 2015

- There will be 5,000 customers paying the social tariff by the end of 2017;
- The share of new social consumers who will pay the social tariff will decrease from 50% of total calls in 2018 to 15% in 2060;
- 3% of consumers within the social tariff will leave this category each year.

- The 5% rate on the electricity tariff for the rest of consumers (residential and non-residential) is assumed who are not paying the social tariff. It should be noted that the electrification rate is not directly indexed at the exchange rate or the current supply cost, but implicitly at the electrical tariff. It has been assumed that the electrification rate will decrease in the years that total revenues exceed electrification and financing costs.
- Considering the scenario where average tariffs for non-social tariffs increase to MZN 7.55 in 2020 (0.120 US$/kWh[34]), itwas assumed that the average tariff will remain constant in real terms from 2020 onwards;
- Considering that the average annual consumption per capita of the electricity-access population was estimated at around 584 kWh/per capita in 2015[35], it was assumed that average annual consumption will increase to 4,500 kWh/per capita in 2060, when it is expected that[36]. However, in the case of residential consumers, it has also been assumed that average household consumption will increase slightly in the first years of the electrification period (from 2018 to 2030), under the hypothesis that low-income consumers[37] will be electrified during this period;
- It was assumed that 95% of the revenue stemming from the electrification rate will be transferred to the Electrification Account.

The resulting revenues obtained from the electrification rate will increase over the years aligned with the increase in the number of consumers in the short term and the increase in the average per capita electric consumption in the long term.

Table 4.14 Revenue obtained from the electrification rate - Base scenario

	Unit	2020	2040	2060
In. of residential consumers	#	2,062,758	9,354,273	12,575,389
Participation of residential consumers in the tariff for social purposes	%	14%	24%	14%
In. residential consumers in the social ly charged	#	294,534	2,259,239	1,773,211
Average consumer consumption - social lycharged	KWh/month	33	52	100
Consumer electrification rate in social lycharged	%	0%	0%	0%
In. of residential consumers who are not in the rate for social purposes	#	1,768,223	7,095,033	10,802,178
Average consumption per consumer - domestic tariff	KWh/month	109	179	400
Electrification rate of consumers in domestic tariff	%	5.0%	5.0%	5.0%
Electricity consumption per capita	KWh/year	523	994	4,500
Electrification fee - non-residential tariff	%	5.0%	5.0%	5.0%
Average tariff - domestic and non-residential rates	MZN/kWh	7.55	7.55	7.55
Invoice collection fee	%	98.0%	98.3%	98.5%
Participation of revenue stemming from the Electrification Account	%	100.0%	100.0%	100.0%
Revenue obtained from the electrification rate	Millions US$	33	198	136
Electrification rate revenues (accumulated from 2020)	Millions US$	33	2,140	5,861

[34] Assuming the current exchange rate is 62.88 MZN/US$

[35] EDM, Historical Data from 2001to 2015

[36] The average annual consumption of electricity per capita of the population with access to electricity in South Africa reached 4,229 kWh in 2014: http://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC

[37] Than those currently connected to the network.

Additional financial sources of IFIs and GM have been modelled to close the gap between electrification and financing costs on the one hand and revenue stemming from electricity consumers on the other. Specifically, the financial needs of IFIs and GM for a given year have been determined as follows:

- The revenue stemming from electricity consumers (through the link rate and electrification rate) was assumed to cover, first, the amortization of previous loans and then electrification costs;
- Where revenue from electricity consumers is robust enough to fully cover financing and electrification costs, the electrification rate will be reduced so that revenues do not exceed costs;
- It has been assumed that donations or low-interest loans from IFIs will cover the gap between electrification costs and revenues obtained from electricityconsumers[38];
- Gm loans were considered to cover the amortization of new IFIs loans (if any), the deficit between revenues obtained from electricity consumers and the amortization of previous loans (if any), and loans resulting from GM.

Ifis loans were drawn under the following conditions[39]:

- Grace period: 6 years;
- Validity: 38 years;
- Interest Rate: 1.42%;
- Payment of interest during the grace period to 1.42%;
- No other fee was simulated with the intention of maintaining simplicity;
- Currency: Us Dollar (US$).

On the other hand, GM loans to the Electrification Account were drawn under the following conditions:

- No grace period;
- Validity: 20 years;
- Interest Rate: 1.42%;
- No other fee was simulated with the intention of maintaining simplicity;
- Currency: MZN.

Table 4.15 Assumptions about loan terms - Base scenario

	Grace period	Interest during the grace period	Validity	Interest rate	Currency
IFIs loans for electrification projects	6 years old	1.42%	38 years old	1.42%	$200
GM Loans to the Electrification Account	No	-	20 years old	1.42%	Metical

Additionally, it was assumed that:

- The Electrification Account is not protected from the risk of foreign currency;
- Neither revenues nor costs are adjusted for inflation;

[38] It has been assumed that IFISs subsidies will cover 25% of the gap generated and that loans, 75%

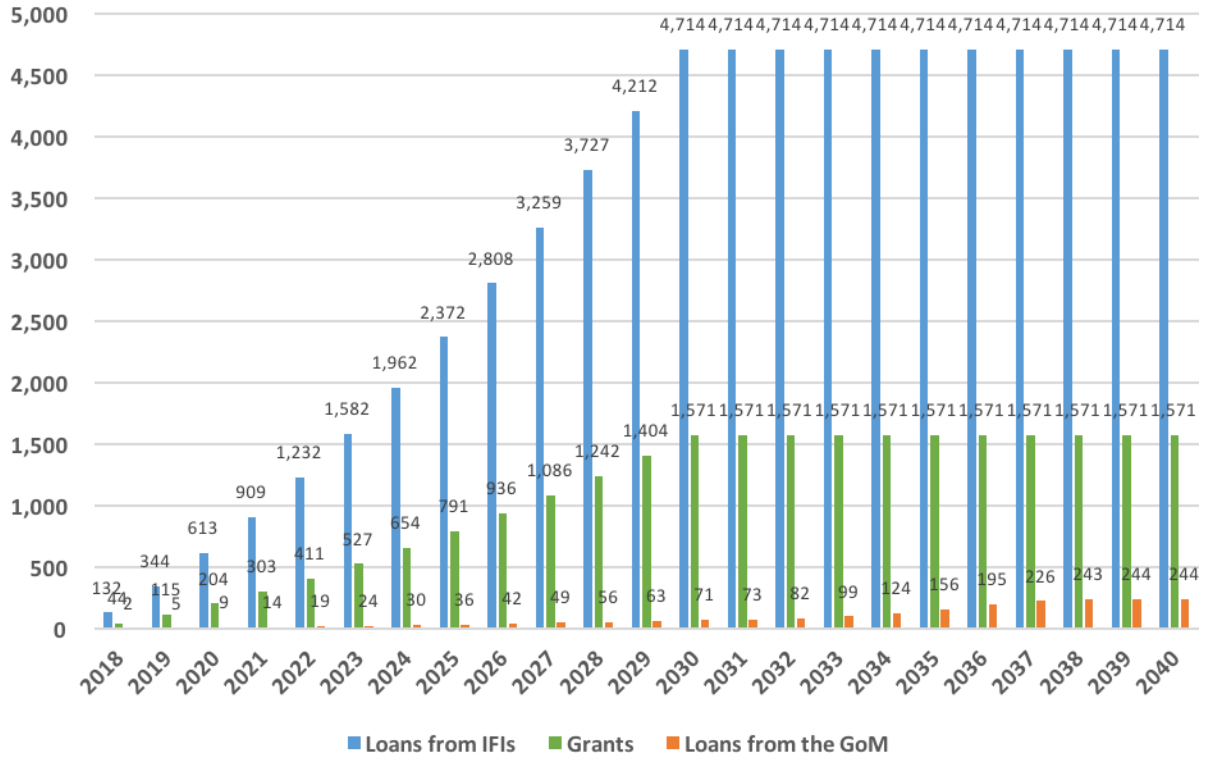
[39] Credit fees and IDA charges, IDA fixed rates for FY17 Q4 (Effective April 1, 2017), extracted from: http://treasury.worldbank.org/bdm/htm/IDACreditPricing.html

- To show u.S. dollar results (US$), an exchange rate of 62.88 MZN/US$[40]wasadopted.

Total funding for Subsidized Expansion Areas

To achieve universal access by 2030, it will be necessary to make available US$6.530 million from IFIs and GM to finance links in subsidized expansion areas[41]. Specifically, IFIs loans total about $4.714 million, donations total about $1.571 million, and GM loans total about $244 million.

Figure 4.9 Projections of accumulated funding needs from 2018 of IFIs and GM (in millions of US dollars)



Translation figure 9: *Loans of IFIs; Donations; GM Loans*

The projections resulting from the accumulated annual costs and revenues of 2018 of the electrification program in the Subsidized Expansion Areas are present in Figure 10 and Table 19, just below:

- The resulting electrification costs assumed by the electrification programme will increase over time in line with the growing number of links in the Subsidized Expansion Areas, during the period 2025 to 2030, and with the increasing average cost per connection assumed, during the period 2025 to

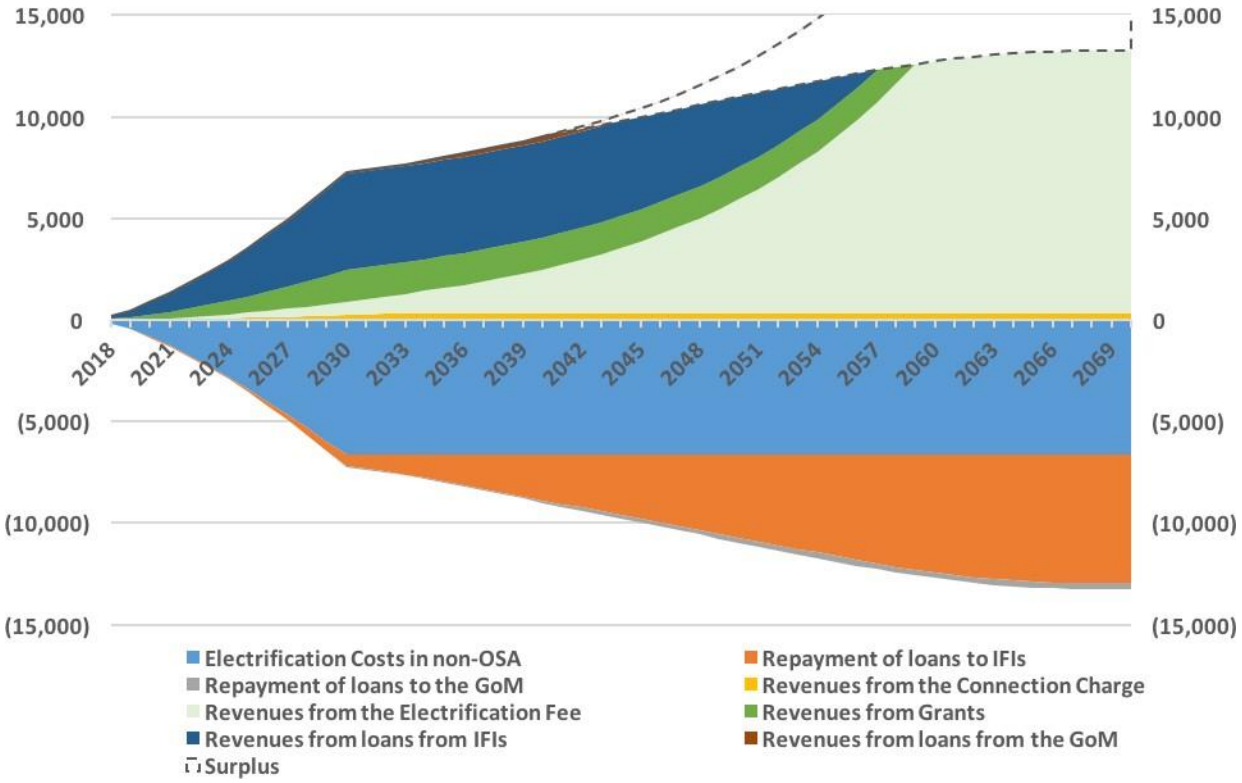
[40] Extracted from: http://www.xe.com/currencyconverter/convert/?From=US$&To=MZN. Accessed 05/09/2017.

[41] The financing needs of customer connections in the Propria Expansion Areas have not been modeled in this section.

2030. From 2031 onwards, no electrification cost will be assumed, since Mozambique will have possibly achieved universal access and all new customers will already be possibly connected within edm's Own Expansion Areas;

- The resulting trajectory of the revenues obtained from the link rate will be guided by the profile assumed for the number of connections in the Subsidized Expansion Areas and the payment period of 6 years determined for most customers. From 2037 onwards, no revenue from the link rate will be considered, as Mozambique will have possibly reached universal access by the end of 2030 and that the payment period of the last consumers linked in the Subsidized Expansion Areas will have expired in 2036;
- The resulting revenues obtained from the electrification rate will increase over the years aligned with the increase in the number of consumers in the short term and with the increase in the average per capita electric consumption in the long term;
- There is a huge gap between electrification costs and revenues from electricity consumers in the early years of the period that needs to be filled by donations and ISIs loans. This also creates the need to provide GM subsidies to cover part of the financing costs. As electrification costs increase during these first years of the period, the financial needs of IFIs and GM also increase (please refer Figure 9);
- There will be no electrification costs in 2031, but revenue stemming from electricity users will not be robust enough to fully cover financing costs. This will create the need for additional funds provided by GM (please refer Figure 9);
- In 2040, revenue stemming from the electrification rate will be robust enough to fully cover financing costs and there will be no need for other funds provided by gm. Consequently, the electricity rate could be reduced by less than 5% for the first time (please see Figure 11), as the revenues obtained from electricity users will exceed the total costs, thus creating a surplus that is represented by the white area in Figure 10;
- In 2058, the latest amortization of GM loans will be made and GM loans will be amortized in its entirety;
- In 2067, the latest amortization of IFIs will be made and ifis loans will be amortized in its entirety;
- In 2068, the Electrification Account may be closed, as all financing and electrification costs will already be covered.

Figure 4.10 Projections of accumulated annual costs and electrification program revenues (millions of US dollars

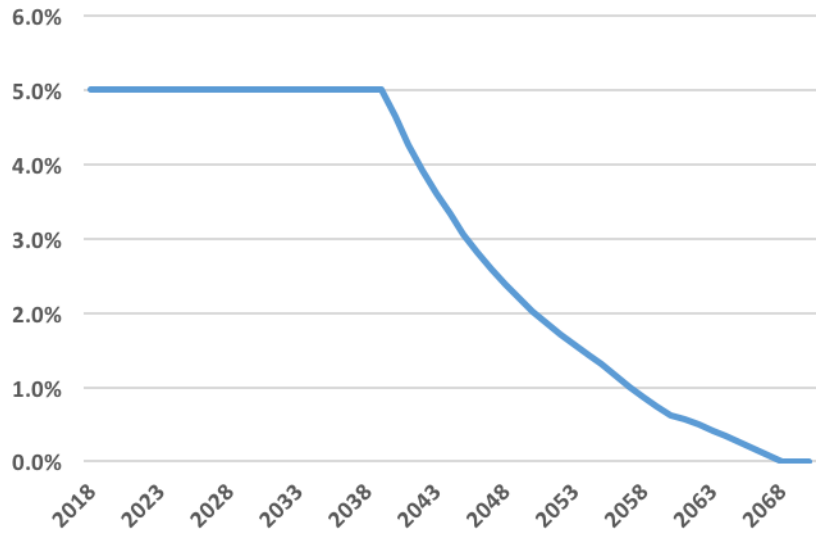


Translation figure 10: Left: *Electrification Costs of Subsidized Expansion Areas; Payment of loans to GM; Electrification Rate Revenues; Revenues from IFIs loans; Excess;* ***Right:*** *payment of IFIs loans, Link Rate Revenue; Income from subsidies; GM loan revenues;*

Table 4.16 Projections of accumulated annual costs and revenues for 2018 electrification program (million U.S. dollars)

	2020	2030	2040	2050	2070
Electrification costs assumed by the electrification program	854	6,652	6,652	6,652	6,652
Amortization of loans to IFIs	15	564	2,229	4,072	6,301
Amortization of loans to GM	1	24	121	238	282
Total costs	**871**	**7,240**	**9,001**	**10,962**	**13,234**
Link rate revenues	11	244	332	332	332
Electrification Rate Revenues	33	639	2,140	4,101	6,373
Donations	204	1,571	1,571	1,571	1,571
IFIS Loans	613	4,714	4,714	4,714	4,714
GM Loans	9	71	244	244	244
Total revenues	**871**	**7,240**	**9,001**	**10,962**	**13,234**

Figure 4.11 Electrification rate projections, 2018-2069 (percentage of residential and non-residential fare)



Additional scenarios

In addition to the Base Scenario, two additional scenarios were designed: a lower electrification cost scenario with respect to the Base Scenario and a scenario of less access to electricity with respect to the Base Scenario. The hypothesis that was made in these scenarios and the results obtained are described in the following sections.

Lower electrification cost scenario with respect to the Base Scenario

It was assumed to scenario that the electrification costs linked to the network would be 30% lower than the Base Scenario, assuming that purchases would be made in the best possible way and that the execution procedures proposed in section 4.5 "Aspects technicians", below, would be implemented.

Table 4.17 Electrification costs per connection and technology outside edm's own expansion areas (US$/link) - Lowest electrification cost scenario

Area	Technology	Average cost per connection
Off the Network	Not connected	2,000
Connected to the network	Technology 1	840
	Technology 2	910
	Technology 3	1,610

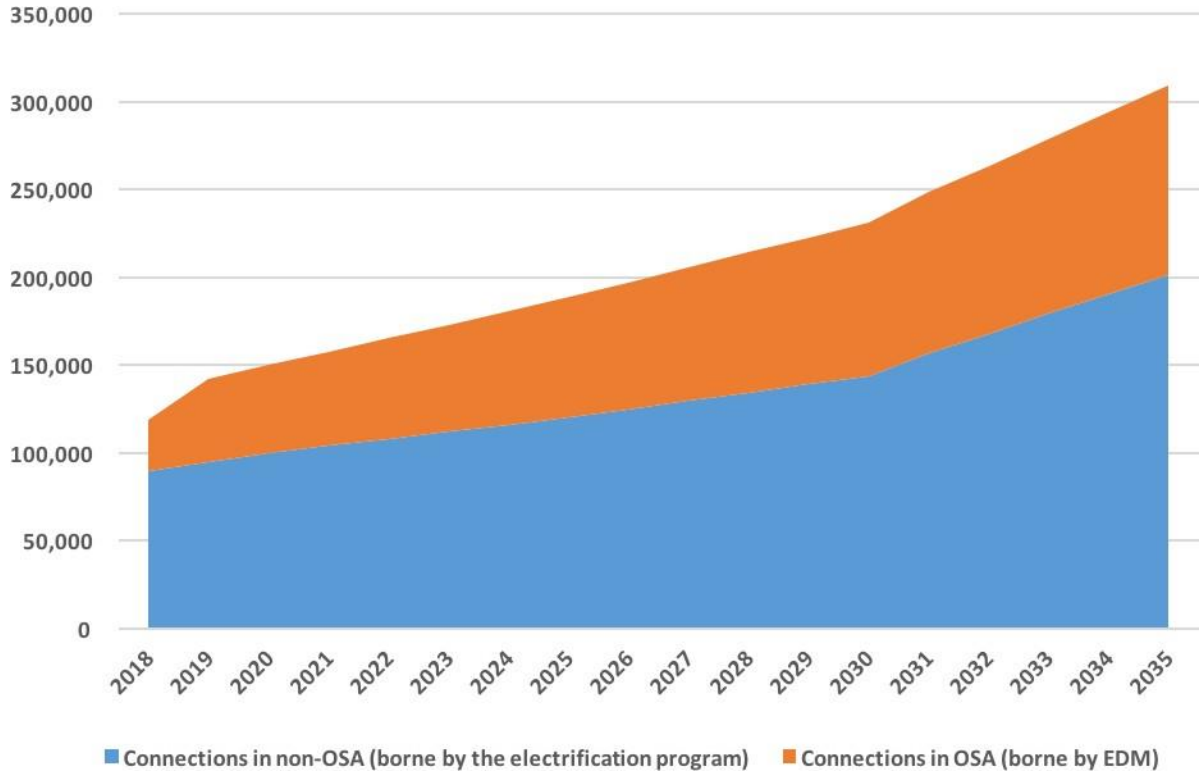
Scenario of lower electricity access target in relation to the Base Scenario

For this scenario, the following paths were taken:

- It was assumed that access to electricity would increase by 50% in 2030;
- It was considered that the country will achieve universal access to electricity by 2055;
- It was assumed that the number of residential customer connections outside edm's Own Expansion Areas would increase from 90,000 new connections per year in 2018 to about 140,000 by 2030 and about 200,000 in 2035, when it was considered that the number of connections would remain constant until 2055. The average number of connections resulting per year of residential customers assumed by the electrification program in the period 2018 to 2030 reached 116,000 customers (1,516,100

customers in total).

Figure 4.12 Hypotheses about the number of connections of residential customers per year - Scenario of less access to electricity



Translation figure 12: *Links in the Areas of Own Expansion (assumed by the electrification program); Links in subsidized expansion areas (assumed by EDM)*

Table 4.18 Projections on access to electricity - Scenario of less access to electricity

	2020	2030	2040	2060
Population	28,644,358	33,713,497	37,859,444	41,433,010
Population growth rate per year (%)	1.9%	1.4%	1.0%	0.0%
Average size of families	4.9	4.4	4.0	3.3
Average decrease in the size of families (%)	-1%	-1%	-1%	-1%
Access to electricity at the end of the year (%)	32%	50%	72%	100%
In residential customers at the end of the year	1,866,617	3,803,121	6,803,875	12,638,594
Number of connections (accumulated from 2018)	411,410	2,347,914	5,348,668	11,183,387
In the connections in the Self-Expanding Areas (accumulated 2018)	126,410	831,814	1,931,983	4,750,532
In the areas of Subsidized Expansion (accumulated 2018)	285,000	1,516,100	3,416,685	6,432,855

The tables below show a comparison of the results obtained in the Base Scenario and in two additional scenarios drawn:

Table 4.19 Comparison of accumulated values for the Base Scenario and the two additional scenarios from 2018 to 2030 (million U.S. dollars)

	Base scenario	Lower costs	Less access to electricity
Electrification costs in subsidized expansion areas	6,652	4,942	2,038
Amortization of loans to IFIs	564	386	167
Amortization of loans to GM	24	17	7
Total costs	**7,240**	**5,344**	**2,212**
User revenues	884	884	648
IFIS Donations	1,571	1,103	387
IFIS Loans	4,714	3,308	1,160
GM Loans	71	50	17
Total Revenues	**7,240**	**5,344**	**2,212**

Table 4.20 Comparison of accumulated values for the Base Scenario and the two additional scenarios from 2018 to the end of the period (millions of US dollars)

	Base scenario	Lower costs	Less access to electricity
Electrification costs in subsidized expansion areas	6,652	4,942	8,802
Amortization of loans to IFIs	6,301	4,421	3,839
Amortization of loans to GM	282	58	50
Total costs	**13,234**	**9,420**	**12,691**
User revenues	6,705	4,960	8,818
IFIS Donations	1,571	1,103	957
IFIS Loans	4,714	3,308	2,872
GM Loans	244	50	43
Total Revenues	**13,234**	**9,420**	**12,691**

The Electrification Account

General Structure and sources of financing of the Electrification Account

According to what has already been described, it is foreseen that the Electrification Account will be responsible for implementing the financial resources obtained from electricity users and GM to cover part of the costs of electrification in the Subsidized Expansion Areas and with the debt service of IFIs and GM (Figure 4.4). It has been assumed that IFIs subsidies and loans will be transferred directly to electrification projects, with GM being responsible for covering the resulting debt service; this means that the sources of funding of IFIs may not be transferred to the Electrification Account.

The sources resulting from electrification account financing would be:

- Electrification rate on electricity sold;
- Connection fee;
- GM Loans;
- Annual budget appropriations by GM[42]; and

On the other hand, electrification account spending would be:

- Payment of debt to IFIs;
- Payment of debt to GM; and
- Electrification costs.

[42] No GM budget allocation was considered in modeling the financing needs of the electrification effort in the Propria Expansion Areas in section 4.3.4

Administration and supervision of the Electrification Account

Within the proposed approach to the development of this strategy, the Electrification Account would be a guarantee account under the management of the Ministry of Economy and Finance and under the fiduciary administration of the bank or agency.

The Electrification Account must be intended for specific purposes. Its only outflows should be the costs of electrification and the payment of debt from IFIS and GM. It is also recommended to specify in law edm's obligation to transfer the defined funds from the electricity rate to the Electrification Account.

Finally, it is also proposed that all electrification account transactions be published. The agency or bank that will administer the account should follow this recommendation regularly.

The main benefits of creating and implementing the account would be: no additional institution would need to be created and the account would provide transparency, accountability and the possibility of tracking resources, and allowing to do so Audits.

Eligibility of electrification projects for financial support of the Electrification Account

All electrification projects outside edm's own expansion areas identified in the planning process to be developed by MIREME are able to receive financial support from the Electrification Account.

The Ministry of Economy and Finance will receive applications for electrification financing projects from EDM and FUNAE. Considering gm's goals, the planning approved by MIREME and the initial categorization of projects, the Ministry of Economy and Finance will verify the eligibility of each project and finance those who are selected.

Electrification Account Revenue and Expenses

Considering the hypothesis and scenarios described in session 4.4.4, in which the financing needs of the electrification effort outside edm's own expansion areas are estimated, the tables below provide annual and accumulated revenues and expenses of the Electrification account in 2020, when it is estimated that the operation of the account will become effective

Notice here again the following:

- The Electrification Account is not protected from foreign exchange risk;
- Neither revenues nor costs are adjusted for inflation;
- To show results in US dollars (US$), an exchange rate of 62.88 MZN/US$[43]wasadopted.

[43] Extracted from: http://www.xe.com/currencyconverter/convert/?From=US$&To=MZN. Accessed on 05/09.2017.

Table 4.21 Accumulated annual revenues and electrification account expenses from 2020 - Base scenario

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050	2060	2070	2080
Electrification costs in subsidized expansion areas	34	72	112	156	201	242	279	310	335	353	363	363	363	363	363	363
Repayment of loans for IFIs	9	22	39	62	93	135	190	259	343	442	558	2,222	4,065	5,782	6,294	6,294
Repayment of loans to GM	1	1	2	4	5	8	10	13	16	20	24	120	238	282	282	282
Total spending	**44**	**95**	**154**	**222**	**299**	**385**	**479**	**582**	**694**	**815**	**945**	**2,706**	**4,667**	**6,427**	**6,939**	**6,939**
Link rate revenues	6	16	30	48	70	95	121	150	179	209	240	327	327	327	327	327
Electricity rate revenues	33	70	110	155	204	260	321	389	464	547	639	2,140	4,101	5,861	6,373	6,373
GM Loans	4	9	13	19	24	31	37	44	51	58	66	239	239	239	239	239
Total revenues	**44**	**95**	**154**	**222**	**299**	**385**	**479**	**582**	**694**	**815**	**945**	**2,706**	**4,667**	**6,427**	**6,939**	**6,939**

Table 4.22 Accumulated annual revenues and electrification account expenses from 2020 - Lower electrification costs [44]

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050	2060	2070	2080
Electrification costs in subsidized expansion areas	36	76	121	171	224	278	331	383	434	482	528	528	528	528	528	528
Repayment of loans for IFIs	6	15	27	42	63	91	129	176	233	301	381	1,541	2,835	4,042	4,416	4,416
Repayment of loans to GM	0	1	2	3	4	5	7	9	11	13	16	44	57	57	57	57
Total spending	**42**	**92**	**149**	**216**	**291**	**375**	**467**	**568**	**678**	**797**	**925**	**2,114**	**3,420**	**4,627**	**5,002**	**5,002**
Link rate revenues	6	16	30	48	70	95	121	150	179	209	240	327	327	327	327	327
Electricity rate revenues	33	70	110	155	204	260	321	389	464	547	639	1,740	3,046	4,253	4,628	4,628
GM Loans	3	6	9	12	16	20	25	30	35	40	46	46	46	46	46	46
Total revenues	**42**	**92**	**149**	**216**	**291**	**375**	**467**	**568**	**678**	**797**	**925**	**2,114**	**3,420**	**4,627**	**5,002**	**5,002**

Table 4.23 Accumulated annual revenues and electrification account expenses from 2020 - Lower access to electricity [45]

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050	2060	2070	2080
Electrification costs in subsidized expansion areas	33	68	107	149	192	237	283	330	381	434	490	1,381	3,588	4,971	4,971	4,971
Repayment of loans for IFIs	4	8	14	21	31	45	62	82	106	133	164	712	1,696	2,768	3,534	3,824
Repayment of loans to GM	0	1	1	1	2	2	3	4	5	5	7	22	40	49	50	50
Total spending	**36**	**77**	**122**	**171**	**225**	**284**	**348**	**416**	**491**	**572**	**660**	**2,115**	**5,324**	**7,788**	**8,554**	**8,845**
Link rate revenues	3	7	12	18	26	33	41	49	57	66	74	192	329	436	437	437
Electricity rate revenues	32	68	106	148	194	244	298	358	423	494	571	1,889	4,954	7,311	8,076	8,367
GM Loans	1	2	3	5	6	7	9	10	12	13	15	34	41	41	41	41
Total revenues	**36**	**77**	**122**	**171**	**225**	**284**	**348**	**416**	**491**	**572**	**660**	**2,115**	**5,324**	**7,788**	**8,554**	**8,845**

[44] Network electrification costs are 70% lower than in the Base Scenario

[45] Access to electricity will be 50% in 2030, and universal access to electricity will be achieved in 2055 (in the Base Scenario, universal access to electricity was expected to take place in 2030)

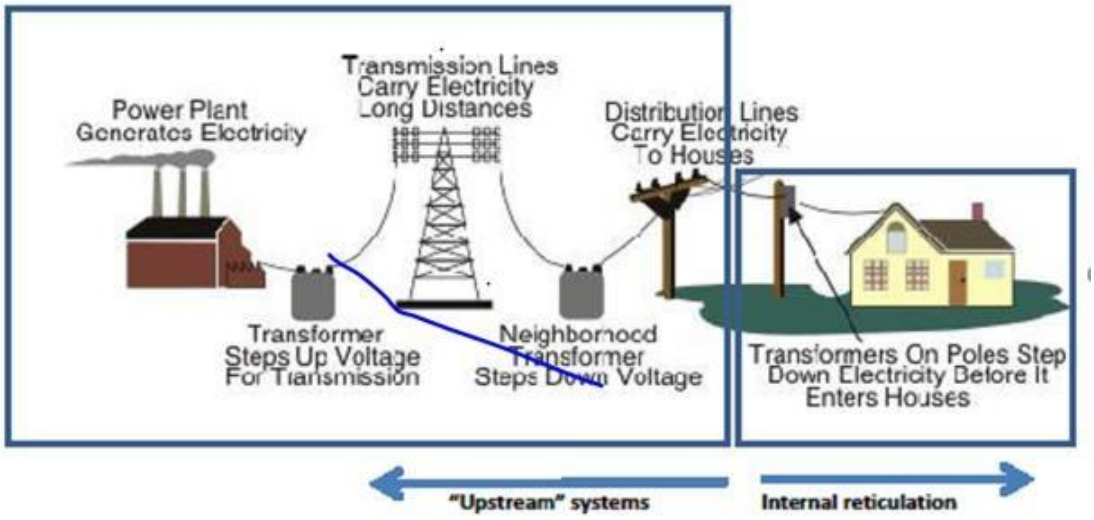
Technical aspects

Universal access to electricity services will have profound impacts on the electrical system as a whole. The incorporation of a large number of new customers, in short periods of time, represents a challenge not only in distribution and commercialization, but also in transmission and production.

Multiplying the number of consumers by five can have major impacts on services[46]. Thus, to deal with five times more customers than the historical quantity, a complete internal "restructuring" of services related to the improvement of management, operations, logistics, technical staff, systems, etc. will be required.

The strategy focuses only on customer connection, system needs up to voltage of 33kV (medium voltage) and solutions outside the conventional network, although we recognize that additional efforts may be required in production and transmission (as mentioned previously). The following scheme presents, in a simplified way, the area of intervention of the study.

Figure 4.13 Project intervention area



***Legend figure 4.14**: Power plant generates electricity; Transformers raise the voltage level for transmission; Transmission lines carry electricity over long distances; Intermediate transformers lower the voltage level; Distribution lines carry electricity to homes; The transformers on the poles lower the tension before entering the houses;* Upstream systems; Internal network;

Technical considerations

As this study deals with the strategy to achieve the government's electrification target, the main technical parameters, the restrictions, the projects scheduled and ongoing are presented in two documents prepared by Norconsult/Vattenfall:

- Technical Assistance to strengthen EDM's Capacity in Investment and Network Development Planning - Project Updated Master Plan, 2012 - 2027. Updated final report of the Master Plan, Volume III - Main Report of 30 April 2014 (referred to below in this document as the Master Plan).

[46] The consultant estimates that the current number of consumers is close to 1,550,000 and that by 2030 it reaches 7,800,000, assuming full access to electricity.

- Distribution Network Project Manual (referred to below in this document as project manual).

The Integrated Master Plan report includes the unit cost for various types of lines, transformers, and substation components. In order not to create different cost databases, these values are used in this report, but readjusted at 2.5% per year in order to be updated to reflect 2017 values. Note that the absolute accuracy of cost estimates is not seen as essential in determining values for alternative systems.

From a strategic perspective, the technical aspects considered in this report deal with the following issues:

- Rationalization of the standards that impact:
  - In the reliability of systems for contingency criteria in network projects (in addition to the standards already proposed: N-1, for urban locations, and N-0, for rural places);
  - In the comments on the possibilities for reviewing project standards, as proposed in the Norconsult/Vattenfall Project Manual, specifically to look for ways to streamline and simplify standards in a context of mass electrification.
- Systematic selection of technologies;
- Definition of guidelines for the selection and prioritization of projects based on continuous planning focused on low cost, consumer types and network availability parameters;
- Proposed procurement strategies that will help meet the targets through:
  - Standardization of projects and project criteria;
  - High volume purchases of basic system components.
- Organizational capacity, including:
  - Comments on issues related to human resources and other resources necessary to meet the targets related to project planning, construction acquisitions and operational levels.

The Integrated Master Plan focuses on aspects of production, transmission and distribution, and considers the standards associated with the components of these systems. They will therefore not be discussed in this report. This report focuses on electrification, that is, on networks derived from large medium voltage suppliers that extend to residential areas.

Rationalization of standards

EDM has been carrying out projects for many years and, over time, has developed some standards. They are apparently not largely properly documented and differences between projects and construction practices can happen due to the fact that detailed designs are left to contractors, contracted under the *turnkey* regime for certain projects.

Sometimes projects can be influenced by their funders, and may impose some of them geographical limits on the acquisition of materials.

To create a higher degree of standardization, Vattenfall Power Consultants/Norconsult was indicated to compile the Distribution Network Project Manual. The last revision of this manual was released in September 2009. This comprehensive document still needs to be

edm approved[47] for mandatory application in all new electrification projects.

In general, it is suggested that all distribution standards be reviewed by EDM, or by an external consultant appointed by it, with the following key objectives:

- The designs and specifications of components and equipment of lines and cables will be carried out with the aim of maximizing the level of standardization. Items, such as structures for lines, must have a higher level of detail. More complex items in plants, such as switches, transformers, circuit breakers, etc., must have dimensional details (especially fixing details).
- Designs should be consistent in order to eliminate divergent interpretations by contractors. This includes the level of technical guidance that should be given to designers.
- A set of construction specifications should be provided to contractors in a simplified manner to ensure that most of these companies can be trained in the use of these specifications.

These objectives will, in turn, require EDM:

- Provide, or search externally, qualified teams to develop detailed drawings according to requirements, and that it review the Distribution Network Project Manual.
- List the most appropriate material and equipment suppliers that sign multiannual supply contracts (this aspect is covered in more detail in the following section, which deals with acquisitions).
- Provide, or search externally, network project teams that, prior to supply processes, will detail all aspects of the project currently left in charge of contractors.
- Provide local work teams to become able to make decisions, reducing the management of construction contractors with regard to line studies, selection of structures, selection of foundation types, electrical resistance of the ground and grounding projects of the site;

All this should, however, be preceded by prior organisation, which presupposes the establishment of appropriate planning criteria, recruitment and training of staff, or the hiring of external personnel, and obtaining software licenses of planning and project, including a properly integrated GIS to deal with the planning and recording of data. These aspects are covered in more detail in the sections dealing with resources, training and acquisitions.

The Distribution Network Project Manual is a document consisting of seven volumes and is a solid foundation for general applications. The sections below aim to add value to the document, presenting ways to apply it to its fullest and to develop it so that it becomes useful to the challenge of achieving 100% of electrification in Mozambique by 2030. With this in mind, the following steps are designed to support the development of a set of standards:

- Investigate whether the general guidelines of the Distribution Network Project Manual can be further streamlined with regard to the permitted number of structures and variations in mechanical conductors and accessories (i.e. reducing the set of possible options to an easier-to-manage subset);

[47] Until November 2016.

- Add details of structures and network components to streamline acquisitions and construction;
- Divide the rules into:
    - Design and supply standards and
    - Construction standards.
- Review the project criteria present in the Distribution Network Project Manual, seeking to identify possible areas where stricter standards facilitate mass electrification. The aim could consist of planned updates within limited periods (i.e. initially building a provisional network and, as the load grows over time, the final network);
- Review the project criteria present in the Distribution Network Project Manual with the aim of identifying what may not be appropriate for mozambique's climate, resources, working regime and other conditions;
- Consider other aspects that may require an independent review in order to support the review given by EDM itself on the proposed standards.

Review of current standards

The following sections aim to raise awareness of standards compilers about aspects requiring regular review.

There is a need to reduce the number of options for structures in 11kV and 33kV, since ten types of structures, for each voltage level, are currently specified. Although applied on a small scale in Mozambique, it is recommended that voltage levels 22/24kV are not used as a distribution voltage, due to the existence of extensive infrastructure in 11kV and 33kV. However, there is the possibility (if considered favorable) of construction of MT lines at 22/24kV, due to the negligible cost difference between mechanical accessories for lines at 11k and 22kV.

The Distribution Network Project Manual allows project contractors to provide additional details for each type of structure to be used, i.e. detailed design and construction are under the responsibility of a relatively companies contracted and have a certain level of experience in projects.

This, however, discards the use of small local contractors who could be trained to take over construction, but probably lack some capacity in projects. By centrally carrying out the project, and only once, through competent resources under the project (from within EDM or through external consultants), a duplicate effort can be avoided. This approach also allows the use of less experienced contractors (without capacity in project development), which can become exclusively labor suppliers for construction. To achieve a maximum degree of electrification within a limited time, there is a much greater need for contractors specialized in construction (without experience in project) of all sizes.

This also applies to aspects, such as: investigation of line routes, selection of structure and foundation types, and placement of poles. Independent teams with experience in this respect can perform them more effectively and at a lower cost than construction companies, especially in the case of small contractors who need to subcontract other companies for such services. With regard to these studies, a decision matrix needs to be developed to determine the level of study required in each case. In simpler cases, tasks may be limited to determining coordinates for poles via GPS. At the other end, the project may require a complete study using LIDAR*(Light Detection and Ranging)*technologywith equipment on land or using

aircraft to obtain data needed to power the project software, such as PLS-CAD/POLE, used for the positioning of towers and transmission lines.

If the structures are well detailed, this will allow EDM:

- Fully standardize projects and equipment and
- Provide kits for all mechanical accessories, insulators and fastening devices for each type of structure, reducing costs and avoiding the effort of contractors to compile their own quantity maps and to purchase all components individually, in general, from different suppliers. Provisioning for the construction of lines thus becomes a matter of requesting a required number of each kit.

In general, it is suggested that the broader aspects of project, supply of materials and construction be simplified, so that relatively inexperienced contractors can be trained to take on simple construction activities related to the distribution of energy. Therefore, the most complex activities of project, supply, selection and allocation of structures and foundations will be carried out centrally.

Consideration should be given to the general reorganisation of standards in the Project Manual for Separate Distribution Networks in the Project and Supply and Construction sections to allow:

- an adequate level of technical support that enables designers to produce projects and specifications compatible with established standards, preventing construction contractors from taking over any project design activities;
- access to a large number of relatively inexperienced contractors who deal with simple specifications, letting them deal only with construction aspects.

The rules of the Project Manual for Distribution Networks do not deal with systems outside the network. This aspect requires the elaboration of appropriate specifications, which should be added to the distribution standard and that are able to fully integrate with the specifications for network connections, present in the aforementioned standard.

Maximum demand studies (at the level of the distribution transformer, the delivery point in TM and substation in ATI) should be established. This includes the possibility of projecting initial systems that grow according to increased load and consumption per consumer.

Distribution planning standards should feed Transmission Planning. The interaction between planning functions requires special attention and can be addressed in network code.

Determining the best technological option for each program

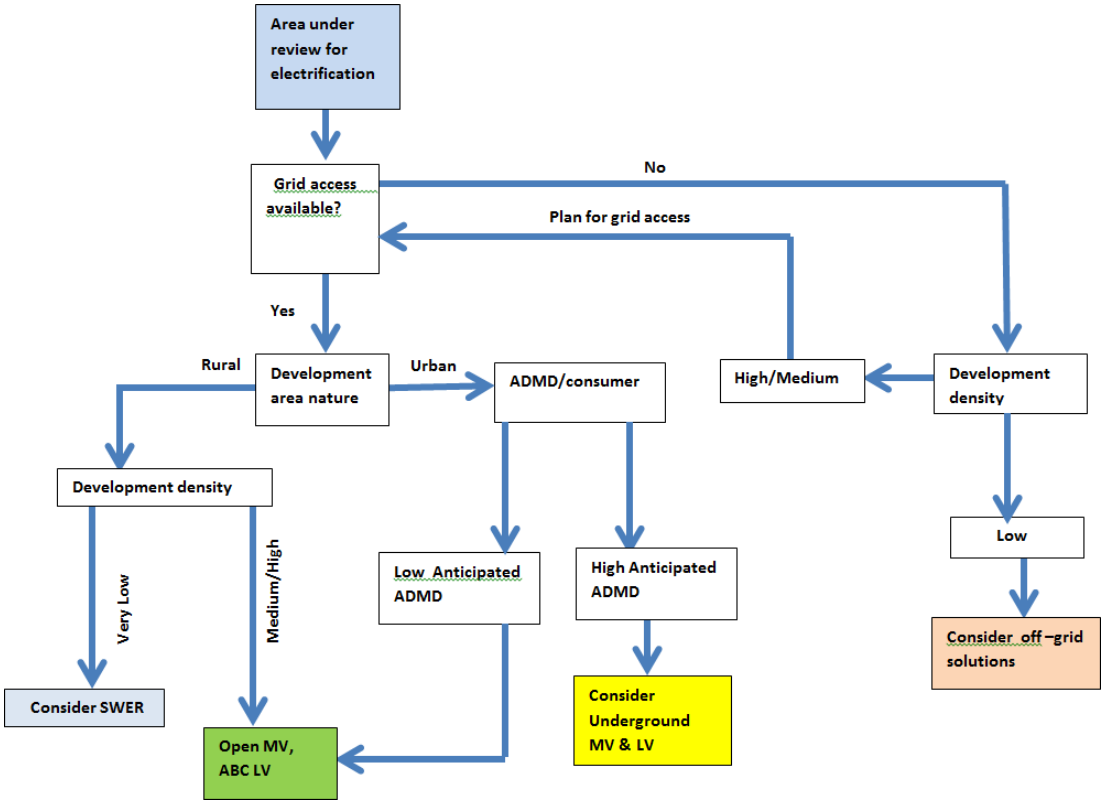
Areas must be selected for electrification according to the following priority order:

- Urban areas, well built, where MT, BT or both systems already exist and have the ability to accommodate additional connections.
- Urban areas with high population density, with high demand, where revenues generated through bonds can justify capital investment and where MT systems already exist and have capacity.

- High-density urban areas with low demand, where MT systems already exist and have capacity.
- High density rural areas, where the supply of MT still needs to be provided;
- Low density rural areas, where electrification would be low priority and where alternative and off-network systems can be indicated.

The types of systems to be installed can be selected, considering the following criteria:

Figure 4.14 Criteria for determining the best technological option in each program



Translation figure 15: *Area under review for electrification; Available network access?; Nature of the development of the area; Rural/Urban; Development density; Very low - Consider MRT (Monopolar with Return for Earth); Medium/High - Open MT, BT with ABC drivers; Plan for network access; Maximum diversified/consumer demand; Low forecast of diversified maximum demand; High forecast of maximum diversified demand; Consider MT and BT underground; High/medium; Development density; Low; Consider off-network solutions*

Table 4.24 Indicative design parameters for electrification systems

			Project Indicative Parameters		
System	Methodology	Type of Settlement	D = EDM network distance	P = Demand for home (kVA)	Population Density
Connect To ed Network	Connection of New consumers to BT network (220 - 400V)	Urban and peri-Urban	D< 10m	3.0 < P< 5.0	High

	Densification	Urban and peri-	10m<D<5km	3.0 < P<	High

	(extensions urban bt and of MT)	Urban		5.0	
	Three-phase rural MT (main and ramifications) and BT extension	Rural	5km<D<30km	2.0 < P< 3.0	High
	Three-phase rural MT (main), MRT (19kV) for the branches and BT extensions	Rural	10km<D<30km	1.0 < P< 2.0	Average
Out Of Network	Mininet: Production centralized and BT network	Rural	D > 30km	0.1 < P< 1.0	Average
	Solar system for residences	Rural	D > 30km	>0.1	Low

Purchasing procedures

Currently, the construction of electrification infrastructures with network connection is carried out by contractors hired by EDM. The standards used for projects are included in the Distribution Network Project Manual compiled by Vattenfall Power Consultants and Norconsult in September 2009. The sections of the Distribution Standard, which would deserve a review, were discussed in the sections above. That way, there will be no additional discussions about them. However, there is still room for improvement and cost reduction in material acquisition activities for projects.

At the moment, the contractors responsible for the project buy all the materials used in the construction, i.e. EDM does not provide any material to contractors. The rationalization proposed in the standards will result in the reduction in materials intended for the work.

EDM should prepare fixed-term contracts for the provision of the main materials, including the following:

- Naked conductors for MT (standardized measures).
- ABC drivers to BT (standardized measures).
- Drivers for service connection.
- Distribution transformers (standardized sizes).
- Switches for MT and BT.

- Insulators for MT.
- Mechanical accessories in general for MT lines.
- Mechanical accessories in general for bt lines.

- Fixing accessories for MT and BT.
- Counters for prepayment.
- Ready distribution frames with internal components.

To simplify the purchase of materials, different materials must be included in the same contract; for example, all associated drivers and accessories must be in the same contract. This will also ensure compatibility between accessories for lines and conductors.

Materials purchased through the contract will be free of charge for contractors, based on the approved project and installation schedule.

There are materials that must be purchased, in advance and in large quantities, for the execution of the electrification program. As EDM currently does not purchase or maintain significant quantities of these materials, it is proposed that, during contract preparation, manufacturers/suppliers are responsible for the organisation and maintenance of storage locations selected and spread throughout the country (the locations will be determined by the proposed program). Thus, EDM will not be responsible for the logistics of materials to the construction sites,nor for the storage of warehouses. Payment for materials provided in this way will need to be negotiated with manufacturers/suppliers, taking into account the risk assumed by all parties. This will be a temporary solution until EDM feels able to manage logistics.

To ensure compliance with existing national electrification standards, it is imperative that EDM develop great capacity to approve electrification projects. It is proposed that, initially, this be done by an experienced external consultant, with the training of EDM staff and the creation of EDM's internal capacity being specific conditions of the contract. Standardized drawings for elaboration will simplify the process and all drawings will be approved by this mechanism before construction begins

Due to the size of the task to be carried out, it is proposed, in addition, that initially electrification projects be assumed by external consultants. Training and skills development within EDM should also be requirements for these initial commitments. Once this competency is established as edm's task, the use of external consultants can be reduced or completely eliminated. Although the current practice of hiring contractors is extensively used in EDM, there is a major problem in this type of contract: changes can occur during construction without the approval of the client (EDM) or its representative.

For construction supervision, this activity is also proposed once again by external consultants, who must also carry out construction training within EDM. To ensure the quality of external projects, it is proposed that construction monitoring be carried out by different resources from project managers. This will help ensure that project changes are not carried out by an external consultant during construction, in accordance with the contracted company. Some project changes may be necessary during construction, but this will be limited if the project is carried out independently of construction.

The identification and registration of future consumers*(premarketing/marketing),*as well as route studies for MT lines, must be performed by external parts. As long as EDM can choose to have some of these resources, the establishment of such large-scale competence within EDM will not be necessary once the 2030 target is reached.

With the monitoring of the project and construction to be carried out by external parts, there is the opportunity to develop companies focused only on construction. Initially

contractors designated to take over construction must be hired to develop emerging local companies with specific capabilities for each contract. For example, an emerging company can be indicated as a subcontractor in the first project to provide more basic services such as digging holes and installing poles under the supervision of the main company and, in the next project, the same emerging company can be appointed to launch drivers and so on, until all aspects of the project have been covered in this learning process. Upon successful completion of all tasks, the emerging company can be indicated to take on complete construction projects, with smaller work, at first, and larger, as they increase their skills. It is essential that a development programme for emerging companies be conducted by EDM or an appropriate government agency (possibly the Ministry of Labor).

The overall management of projects from identification to installation should be carried out internally by EDM as implementing the strategy and electrification plans. While additional assistance can be obtained, a priori, through external consultants, it is strongly recommended that such activity, as far as possible, be carried out internally. Existing project implementation resources can be used for this purpose.

Regarding the supply for off-network constructions, the standards used should be similar to those used for network-related projects because, in due course, they may end up being connected to the network and therefore will need to comply with EDM standards. This will also allow common materials and the above-mentioned supply mechanisms to be used. The adequacy of the use of external consultants will need to be discussed with FUNAE to establish the most effective implementation solution, which is dependent on the required approach to electrification outside the network;

While the 100% electrification target by 2030 is considered to be achieved at the lowest cost, the focus is likely to be on consumers connected to the network, to the detriment of remote communities and off-grid.

Human Resources

EDM indicated that network growth exceeded the growth of support resources, causing significant restriction of these resources. This situation can be severely aggravated by electrification in large quantities, as intended.

With regard to the development of human capital within EDM, it is proposed that it be considered the recruitment of a significant group of young newly qualified technicians, who will benefit from training and training proposed in the supply sections, referring to the monitoring of projects and construction. Once trained as designers through an external contract with consultants, the new recruited group will continue to monitor the construction of the same project and will then be trained as an operation and maintenance resource, to be used after the installation and end of the project. In this way, the final requirement for field personnel will be addressed from the planning phase and will be scaled according to the development of projects. The added benefit is the comprehensive understanding that field personnel will participate in the design philosophy, construction methods and standards and factors relevant to network operation and maintenance.

All contracts assigned to designers, project managers and construction contractors must include provisions for the training of EDM personnel.

The following areas require attention:

- Consumer service centers. Current practices are based on each center being able to handle about 80,000 consumers, 1 substation and 100 distribution transformers. This includes all technical and administrative staff;
- All aspects of project;
- Training of personnel able to assume route selection exercises and studies;
- Compilation and maintenance of all project standards;
- Supply and warehouses.

Implementation of the Strategy

Short-term stocks

The full implementation of the "strategy" can take a certain time because the strategy needs to be approved by GM and there are actions that need to be implemented before being in full operational capacity and in perfect agreement with the decisions made (for example, the implementation of the Electricity Fund, capacity building, approval and implementation of standards and processes such as purchases of materials in large quantities); and it all takes time.

However, you can immediately start the electrification process using the already available IFIs funds while final decisions are made and the different tasks required for the implementation of the strategy are carried out.

It is suggested that EDM assume sums up the responsibility for implementation at an early stage until MIREME acquires the necessary capabilities and instruments. The following activities will allow the start of electrification projects in a short period of time while the rest of the activities will continue in their implementations:

- o Decision on the allocation of available funds: network-linked electrification and off-network. **Responsible: MIREME**
- Identification of "densification projects": EDM can quickly identify densification projects where infrastructure already is available and some consumers are already connected. These projects are considered low cost since the goal is to make use of existing MT infrastructure (or even BT infrastructure) in areas where the population has not been connected to the service. **Responsible: EDM**
- Agreement between EDM and MIREME on the prioritization of these projects linked to the network and outside the network, considering the availability of financing. **Responsible: MIREME and EDM;**
- Identification of "low cost" electrification projects connected to the network and off the network. **Responsible: FUNAE**
- Agreement between MIREME and FUNAE on the prioritization of these projects linked and not connected to the network, considering the availability of financing. **Responsible: MIREME and FUNAE**
- Finalize and approve the standards necessary for construction (projects linked to the network and off the network). **Responsible: EDM**
- Develop "electrification procedures" or a standard for network-connected or off-network electrification projects to reduce engineering costs. **Responsible: EDM**
- Develop "electrification procedures" or a standard for network-connected or off-network electrification projects to reduce engineering costs. **Responsible: FUNAE**
- Develop transitional arrangements for the use of IFIs funds. **Responsible: Ministry of Economy and Finance / MIREME**
- Implementation, within MIREME, formation of a small group to coordinate and conduct these initial efforts to "initiate" the electrification strategy. This group will be the origin of the "cell" within which a

office that will be responsible for planning and monitoring electrification efforts. **Responsible: MIREME**

- Implementation of large purchases for at least a few items needed for project construction. **Responsible: EDM**.

Execution Plan

In the section "Preparation of institutions to implement the proposed strategy", a number of activities were presented that each institution should address in order to begin the implementation of the proposed strategy. You can propose a high-level "execution plan" for its implementation, assuming that the strategy, when approved, will not be much different from the current one. The following table summarizes a sequence of activities that each institution must adopt:

Table 4.25 Strategy Implementation Plan

Institution	Activity
Preliminary Internship	
Gm	Set policy objectives
GM - Ministry of Economy and Finance	Implement /create the Electrification Account Implement a charge to foster the Electrification Account
Edm	Define building patterns Define and implement purchase procedures in large quantities Establish "procedures" for electrification projects Strengthen monitoringand planning capacity department
FUNAE, Pennsylvania	Establish "procedures" for electrification projects Strengthen monitoringand planning capacity department
MIREME, New District	Establish an "electrification group" to deal with planning and monitoring plans Develop skills
Early Stage	
Ministry of Economy and Finance	Operationalize the Electrification Account
MIREME, New District	Set objectives for planning activity Establish criteria for prioritizing projects Monitor electrification projects
Edm	Initially conduct the planning activity Finalize the implementation of the process of purchasing material in large quantities Implement projects linked to the network following the criteria for project prioritization and electrification procedures Finalize theprocess of training professionals for implementation and monitoring of projects Improve the company's general systems and procedures Prepare the standard procedure to outsource the operation of isolated systems
FUNAE, Pennsylvania	Proceed with the preparation of projects following the plans and standards established
Arene	Implement pricing methodologies and calculations
Final Stage	

Gm	Establish ing electrification-related policies
MIREME, New District	Set goals

	Conduct the planning process once the professional team, tools and training are achieved Monitor the implementation of the plan
Edm	Build infrastructure and connect customers to the network
FUNAE, Pennsylvania	Build infrastructure and connect customers outside network Deliver installed (active) projects to EDM
Arene	Setting rates Monitor service quality
Ministry of Economy and Finance	Manage the Electrification Account Manage the relationship with IFIs
Private Sector	Participate in asset construction and operation of systems Outsourced

Annex A: Cost estimates

Estimated cost of alternative distribution technologies based on network connection

Two aspects should be considered, namely: distribution costs (costs of making available an appropriate supply point nearby, or within the area to be electrified) and electrification or network costs (MT and BT systems required from the supply point to each service connection). This section deals only with aspects relating to electrification costs (or reticulated/network). Transmission and distribution costs will be addressed in the Master Plan report.

The costs of electrification per connection will vary substantially from project to project, based on certain factors. The factors, considered as most important in cost determination, are:

- Development density, expressed in number of households per km²;
- Maximum Diversified Demand of the project by domicile;
- Quality level of service, expressed in annual availability;
- Reliability inherent to the technology employed;
- Nature of the land: rocky, mountainous or similar terrain will increase costs;
- Location of facilities: ease of access, transportation cost etc.
- Project size or number of connections made per contract: smaller contracts will result in higher relative costs per connection.

The detail level cost estimates required by the Electrification Strategy can therefore deal only with approximate relative costs between projects executed under different conditions and circumstances.

The most common systems or schemes will typically allow:

- Three-phase/single-phase distribution systems and standardized service connections;
- Use of naked conductors on MT airlines;
- Isolated conductors grouped in beam for BT;
- Distribution transformers for pole installation;
- Use of wooden poles;
- Street lighting - low power;
- Prepaid type meters;
- Maximum diversified project demand in the range of 0.5-0.6kVA/household, measured by the distribution transformer for rural consumers, and 2.5-3.5 kVA for low-income urban and periurban consumers. [48]

This is cited in more detail in the "default" schema.

With regard to maximum diversified project demand, it should be noted that the Master Plan marks current domestic consumption of 1,128 kWh. This refers to electricity used, almost exclusively, in low-power lighting applications, i.e. a maximum diversified project demand in the range of 1.0-1.2 kVA per

48 These figures refer to low-income consumers in urban and periurban areas. In the case of electrification of middle and high class residential areas, maximum diversified project demand needs to be reviewed on a case-by-case basis. At the moment, it should be assumed that there are no middle and upper class residential areas that are not electrified (possibly incorrect premise).

(measured by the distribution transformer) will be sufficient for most applications.

The following table is considered a high-level guide in the applied project criteria, but it should be verified whenever possible and compare it to the data obtained, through field research, on the viability, the needs of consumers and the experiences with similar consumer groups in other areas:

Table A.1.- Indicative parameters for maximum diversified project demand

Typical description of the area to be electrified	Main sources of income of residential consumers	Maximum diversified demand expected for the next 5 years after electrification (kVA)	Maximum diversified demand expected for the next 15 years after electrification (kVA)
Housing in rural groups	Subsistence agriculture, pensions, immigrant work	0.35	0.5
Rural villages	Some local industries, agriculture, pensions	0.7	0.9
Informal settlements near an urban area.	Informal trade, in general, jobs in cities	1.0	1.4
Formal municipal area	Formal jobs, in general, semi-qualified	1.7	2.4
Middle-class urban residential areas	Formal jobs, working class	2.7	3.5
High-class urban residential areas	Professional and semi-professional work, entrepreneurial types	4.0	6.0

Impact of different factors on cost per link: standard single-phase and three-phase network systems

Table A.2 below is indicative of the impact that some of the factors above the cost of downstream electrification systems, a supply point in the vicinity, or from within the served area, imply:

Table A.2 - Impact of several factors on the cost of "standard" distribution systems, single phases and three-phases [49]

Type of construction, assuming, in a reasonable way, easy access and good conditions of the land	Maximum diversified demand project	Density of households	Relative cost[50]	Relative failures expected per year
MT with naked drivers, BT with grouped aerial conductors (ABC)	1.0 - 1.2 kVA	More than 2,500/km²	0,8	1
		750 - 2 500/km²	1	
		Less than 750/km²	1,4	
	3.0 kVA	More than 2,500/km²	1,3	
		750 - 2 500/km²	1,5	
		Less than 750/km²	2,0 - 2,2	
MT with naked drivers, BT with naked conductors	1.0 - 1.2 kVA	More than 2,500/km²	0,8 - 0,85	4-6
		750 - 2 500/km²	0,85 - 0,95	
		Less than 750/km²	1,2 - 1,3	
	3.0 kVA	More than 2,500/km²	1,2 - 1,3	
		750 - 2500/km²	1,4 - 1,5	
		Less than 750/km²	1,9 - 2,0	
Underground cables	3.0kVA	More than 2,500/km²	1,5	0,8
		750 - 2 500/km²	2,2 - 2,5	
		Less than 750/km²	2,7 - 3,5	

Comparative cost estimates arising from the configurations of alternative network systems

The final cost of any electrification project is entirely dependent on a number of factors such as the Maximum Diversified Project Demand, the technology employed, the terrain, the costs of connecting to the network, among others. At programme level, only an opinion is issued on the typical costs to serve as the basis for initial budgets. Estimates for each project need to be determined in detail after specifying the number of connections, project criteria, technology and availability of network connection in the planning phase of each project.

The general planning criteria for system configurations, as defined in the Master Plan, are:

- the normal MT system will be a three-phase three-wire system.
- if the load powered by a connecting branch does not require a three-phase system, a two-wire biphasic feeder can be employed by feeding one or more single-phase transformers.
- due to their limited load capacity, MRT systems (both conductive and shielding) should only be considered where the total load is low (up to about 200kVA) and the lines are relatively long (more than 10km).
- to provide an indication of the relative costs for alternative system configurations, the following options are priced, and in order not to create duplicity of typical unit cost rates, the (increasing) rates presented in the Master Plan are used.
- in the initial calculations and to maintain a reference of previous studies (and subsequently evaluate potential savings compared with this case), we consider

49 These are only relactive costs. Table 5 contains the assumptions made for a hypothetical project, based on unit rates, according to norconsult's Master Plan

50 Based mainly on Eskoms values and discussions with other (municipal) distributors in South Africa

a "price scenario" compatible with previous studies. The following alternatives [51]were investigated:

- Three-phase MT naked conductors, three-phase transformers and MT networks with ABC grouped aerial cables (no single-phase circuits);
- Three-phase and biphasic MT conductors, biphasic transformers, single-phase secondary and biphasic MT nets with ABC cables (with a 1:2 split between monophase and BIPhasic BT by simplicity);
- Three-phase MT networks and in the MRT system, insulating transformers and essentially no BT network in the rural surroundings with scattered dwellings in an informal layout.

An MRT system with *shield* and provision through AT transformer will only be feasible in exceptional circumstances where the cost of regular networks would normally be much higher, but this is a less relevant factor in the decision to provide the service. Edm's current practice of designing MRT systems and subsequently *upgrading* to three-phase systems is consistent and should be maintained.

To compare the relative costs of alternative systems, a typical hypothetical case that presents the following parameters is considered:

Table A.3 - Composition of the hypothetical electrification project used to compare alternative technology costs

Total number of service connections	Maximum diversified project demand /link	Number of connections	Estimated area demand (kVA)
Rural villages	0,7	5.000	3.500
Rural housing groups	0,35	1.200	420
Total connections		6.200	
Estimated total load on MT (kVA) lines	3.920		
Average maximum demands diversified/lead (kVA)	0,63		

As mentioned, the cost of alternative systems is based on unit ary fees as found in the Master Plan and on various assumptions relating to unit prices and other factors:

- The cost/km of two-wire MT lines is considered to be 75% of the equivalent cost of a three-phase line;
- The prices of single phase and three-phase transformers are considered as 90% of a three-phase unit.
- The costs of DRIVERS of type ABC (three or two wires) and the similar ABS conductor of 4 cores are considered as 80% and 65%, respectively.
- The Master Plan allows a cost of a $500/link single-phase service connection, which probably includes an appropriate meter, connection of air conductors and additional poles, drivers and mechanical accessories at points where the connection crosses a street from the BT line.

51 It should be noted that the nature of the land and access conditions can increase these estimates by more than 50%.

("National Electrification Plan in 10 Years"), is fully developed (as mentioned before, it is a price scenario that maintains coherence with these studies).

- The 2014 Director Plan report and estimates, based on unit rates in the report, increased by 2.5% per year that creates a cost base date for April 2017;
- The Master Plan allows, in a correct way, that contingencies, project and other costs, spare costs and mobilization can go beyond basic network costs, and this is reflected in estimates. It should be noted that no interest or loan allowance is included during construction.
- These assumptions result in the following estimates for the alternative systems investigated:

Table A.4 - Estimated costs of alternative secondary internal network systems in MT and BT for hypothetical design (US$)

Cost component	4-wire (BT) and 3-wire (MT) three-phase	Mixed 2 and 3 wires in MT and 4, 3, and 2 wires in BT	Mrt housing in rural groups
Costs of internal MT lines	157	137	184 [52]
Transformer costs	220	198	187
BT line costs	212	181	143
Subtotal for basic network scheme, excluding service connections and street lighting, based on the unit rates of April 2014	**589**	**516**	**515**
Single-phase customer connections	500	500	500
Street lighting	75	75	75
Total costs per connection of the construction of internal systems, based on the rates of April 2014	1.164	1.090	1.089
Growth in unit rates by April 2017, based on growth of 2.5% p.a.	7,7%	7,7%	7,7%
Total costs per connection of the construction of internal systems, based on the rates of April 2017	**1.253**	**1.174**	**1.173**
Reserve for spare parts at 1.5%	19	18	18
2% mobilization costs	25	23	23
Contingencies at 10 %	125	117	117
10% draft, bidding and supervision	125	117	117
Compensation for MT lines at 4 % of line costs	6	5	7
PROPOSED TOTAL BUDGET/CONNECTION FOR INTERNAL NETWORK COSTS	**1.554**	**1.455**	**1.456**

While the costs of similar projects may mislead, as is not always clearly defined which is exactly taken into account, many sources show a wide range of costs (from 600 to 2,300 US$/link).

52 Unit costs for MRT networks ($/km) are lower. However, it was assumed, for the hypothetical project, that an increase in the average costs for lines/connections will be required due to the dispersed nature of development, with an economy in the length of BT networks.

Table A.5 - Electrification cost data

Company/Service	Estimated costs – April 2017 (US$/link)	Comments
Eskom, South Africa	1.660	Exclusion of street lighting, density country's average population of 42/km²
Major metropolitan areas in South Africa	2.310	Inclusion of street lighting, residential density about 2 000/km2, maximum diversified project demand of 3.5 kVA
Major metropolitan areas in South Africa	1.550	Inclusion of public lighting, residential density ofabout 2 000/km2, maximum demand diversified project of 1.5 kVA
Cambodia	592	Without public lighting, average population density of 82/km2, maximum diversified demand for undefined project
Ethiopia	1.400 – 1.600	Without public lighting, average population density of 83/km2, maximum diversified demand for undefined project

1. RSA Dept. de Energia - National National Electrification Program - feedback report, June 2013.

2. Data received on an informal basis from the corresponding project managers.

3. Cambodia's Strategic Rural Electrification Plan, December 2009.

4. Final Report of ethiopia's National Electrification Strategy, June 2016. There are comments in the report on high costs and suggestions on how they can be significantly reduced.

Based on previous cost estimates, it is proposed that the following values be used as a price profile for strategic budgets and as initial estimates adjusted in the next reports as more data are being gathered:

- High density urban and periurban areas, close to the main centers, on land with easy relative access and in good topography and soil conditions, presenting average diversified maximum demands of 3kVA/link: US$ 2,300.
- Low density rural areas and urban areas of high density and low purchasing power, close to the main centers, in land with easy relative access and in good conditions of topography and soil, showing average diversified maximum demands of 0.6-0.8 kVA /link: US$ 1,200 - US$1,300.

These are the total network costs assumed to determine the financial needs of electrification efforts in section 4.4.4.

At the top of these network costs, would be the cost of upstream network components, which includes the costs of transmission and distribution systems and the costs of systems at medium voltage upstream to supply the hypothetical project[53]. As a high initial indication of budget forecasting, the consultant estimates the additional cost per connection of upstream network components at about $600/link. A more detailed context for this estimate is given in Annex II to this report.

Cost of off-network systems

The cost of systems not connected to the network will vary dramatically according to technology, and are influenced by reliability and availability parameters. As

53 The hypothetical design will require the installation of an AT/BT transformer in an existing substation. Additionally, a 30km trunk line, in 33kV, will need to be built from the substation mentioned to a point at the site of the hypothetical project.

for example, while a fixed photovoltaic plant can be fed at a cost less than 1,000 US$/kVA for 0.6 – 0.8 kVA, using batteries for full availability will cause the estimate to fold.

Both unconnected systems and MRT can only be considered when the load requirements and population density are low, electricity supply is a necessity and the costs with standard systems are excessive.

Different alternatives for non-connected systems (solar home systems with storage, mininets, etc.) were considered and an average cost of US$2,000/bonding was assumed as representative of these technologies. This will be prepared in more detail in the next report (Implementation of the National Electrification Strategy).

Annex B: Cost estimate of alternative systems technologies

Table B.1 serves to detail the estimates of the hypothetical project, such as summarized in the report body.

Table B.1 - Line costs in medium internal voltage with alternative systems in medium voltage

Cost of lines in medium voltage	Junction point feeder branch to area to be electrified	Junction point feeder branch to the area to be electrified	MRT for housing in rural groups, three-phase MT in the city
Total internal length of the MT line (km)	44	44	65
Length/link (m)	7,1	7,10	10,48
Length of 3-wire system lines	44	20	20
Length of 2-wire system lines	0	24	15
Length of lines of MRT systems	0	0	30
Conductors on three-phase circuits	Pin	Pin	Pin
Cross section area of conductor	72mm2	72mm2	72mm2
3-wire system current driving capability	175A (10 MVA)	175A (10 MVA)	46A (1.5MVA)
Conductors on MRT circuits	N/A	N/A	Bantam
Cross section area of conductor	N/A	N/A	16mm2
Cost/km (US$/km) for 3-wire lines	21,000	21,000	21,000
Cost/km (US$/km) for 2-wire lines	16,800	15,750	15,750
Cost/km (US$/km) for MRT system lines	14,500	14,500	14,500
Cost of MT lines (US$/km)	924,000	798,000	1,091,250
Line reconnecting and insulator on shunt	49,500	49,500	49,500
MT /link line costs (US$)	**157**	**137**	**184**

Table B.2 - Costs of distribution pole transformers

Transformer power	Unit price (US$/traffic)	Total	Total cost (US$)	Total installed capacity
32kVA	17.200	15	258.000	480
50 kVA	22.600	10	226.000	500
100 kVA	26.800	22	589.600	2.200
160 kVA	29.200	10	292.000	1.600
Total		57	1.365.600	4.780
Average transformer /connection cost			**220**	
Average load				82.0%

Table B.3 - 4-wire three-phase low voltage distribution systems with ABC conductors

Description	Rural villages	Housing in rural groups	BT Unit Line Cost (US$)	BT Line Costs (US$)
Average length/consumer	9	22		
Total length	45	26		
Mixed ABC-type conductors - average				
4x95mm2 +25mm2	15	5	25.000	500.000
4x50mm2 +25mm2	20	9	18.900	548.100
4x25mm2	10	12	12.000	264.000
Total cost of BT lines				1.312.100
Average cost per BT line per connection				**212**

Table B.4 - Low voltage distribution system, biphasic and three-phase mixed 3 and 4 wires, with ABC conductors

Description	Rural villages	Housing in rural groups	BT Unit Line Cost (US$)	BT Line Costs (US$)
Average length/consumer	9	22		
Total length	45	26		
Mixed ABC type conductors - average				
4x95mm2 + 25mm2	6	2	25.000	200.000
3x95mm2 + 25mm2	6	3	20.000	180.000
2x95mm2 + 25mm2	3	2	16.250	81.250
4x50mm2 + 25mm2	8	3	18.900	207.900
3x50mm2 + 25mm2	8	5	15.120	196.560
2x50mm2 + 25mm2	4	3	12.285	85.995
4x25mm2	4	1	12.000	60.000
3x25mm2	4	4	9.600	76.800
2x25mm2	2	2	7.800	31.200
Total cost of BT lines				1.119.705
Average cost per BT line per connection				**181**

Table B.5 - Low voltage distribution systems with MRT distribution in medium voltage in rural areas

Description	Rural villages	Housing in rural groups	BT Unit Line Cost (US$)	BT Line Costs (US$)
Average length/consumer	9	10		
Total length	45	12		
Mixed ABC-type conductors - average				
4x95mm2 + 25mm2	6	0	25.000	150.000
3x95mm2 + 25mm2	6	0	20.000	120.000
2x95mm2 + 25mm2	3	0	16.250	48.750
4x50mm2 + 25mm2	8	2	18.900	189.000
3x50mm2 + 25mm2	8	2	15.120	151.200
2x50mm2 + 25mm2	4	1	12.285	61.425
4x25mm2	4	2	12.000	72.000
3x25mm2	4	2	9.600	57.600
2x25mm2	2	3	7.800	39.000
Total cost of BT lines				888.975
Average cost per BT line per connection				**143**

Table B.6 - Summary of costs with internal network of alternative systems (US$)

Cost component	Three-phase 4 wires and 3 MT wires	Mixed 2 and 3 wires and 4.3 and 2 BT wires	MRT for housing in rural groups
Costs of internal MT lines	157	137	184
Transformer costs	220	198	187
BT line costs	212	181	143
Subtotal for basic network scheme, excluding service and street lighting connections at unit rates in April 2014	589	516	515
Single-phase consumer connections	500	500	500
Street lighting	75	75	75
Total cost/connection of construction of internal systems based on april 2014 rates	1.164	1.090	1.089
Growth in unit rates by April 2017 of 2.5% p.a.	7,7%	7,7%	7,7%
Total cost/connection of construction of internal systems based on april 2017 rates	1.253	1.174	1.173
Reserve for spare parts at 1.5%	19	18	18
2% mobilization costs	25	23	23
Contingencies at 10%	125	117	117
10% draft, bidding and supervision	125	117	117
Compensation for MT lines at 4% of line costs	6	5	7
PROPOSED TOTAL BUDGET/CONNECTION FOR INTERNAL NETWORK COSTS	**1.554**	**1.455**	**1.456**

Table B.7 - Costs of the main feeders of medium voltage lines

Costs of medium voltage lines	Existing MT distribution station main feeder up to a derivation point
Supposed length (km)	30
Length/link (m)	4,84
Driver	Mulberry
Cross section area of conductor	250mm²
Driving capacity of Current	275 A (15 MVA)
Cost/km (US$/km)	32.000
MT line costs (US$)	960.000
Line reconnecting and insulator on shunt	49.500
Cost /connection of MT lines	**155**

Table B.8 - Average voltage substation costs (assuming extensions to an existing substation)

Item	Cost (US$)
New lines and *transformer bays* @ 60,000 US$/bay	120.000
Additional 5MVA transformer and associated costs	71.250
Total substation costs	191.250
Substation extension cost/connection	31

Annex C: Cost of upstream network components

The cost of infrastructure to an appropriate point of delivery at the project site is entirely dependent on the size of the load and location in relation to the existing production and transmission infrastructure. The total cost estimated per connection may therefore be indicated without any degree of accuracy. The following is marked as an indication only of the upstream costs for an appropriate AT/MT substation, based on a series of premises:

- The hypothetical project will require the installation of an AT/MT transformer in an existing substation.
- A 30km section of the trunk line in 33kV will need to be built from the existing substation to a location in the hypothetical project.

Table C.1 - Indicative of systems costs in medium upstream voltage to power a hypothetical project (US$)

Cost component	Unit ary rate	Total
30 km of lines in 22kV using 250mm^{2} conductor) CAL	32,000/km	960.000
New 33kV lines and transformer *bays* in existing AT/33kV substations	60,000/bay	120.000
Additional 5MVA AT/33kV transformer and associated costs	71.250	71.250
Total costs assumed of upstream distribution systems based on unit rates present in the 2014 Master Plan		1.151.250
Cost updates @ 2.5% p.a. april 2017 base		1.240.000
Contingency and project costs		1.538.000
Alleged cost per consumer connection of upstream MT networks for the hypothetical project		**248**

The infrastructure created in this way will likely exceed its capacity, which will have to be financed as part of the project, but which will serve to reduce subsequent costs with the same line and substation.

As an initial high-level indication of budget requirements, it is proposed that it be used as set out in the following table:

Table C.2 - Total CAPEX suggested for budget typical service connections

System level	Cost per service connection (US$, April 2017 base)
Transmission system	150
Distribution system	200
Distribution system/medium voltage to the point of supply of a project site	250
Average mt distribution system and internal BT, including service connection, meter and street lighting (low average density/high density areas)	1.800
Total per average service connection	**2.400**

These suggested costs should be used only as a reference in initial budgets. With the continued construction of a more comprehensive and detailed cost ratio, the costs will be based on the actual assignments of the contract.

Annex D: Technical considerations for electrification

Supply reliability

Supply reliability needs to be considered to ensure the quality of electricity services, either through the grid or by isolated systems. The reliability of supply to consumers depends on a number of factors, including:

- Aspects of system design.
  - The basic technology employed has an impact on the reliability of the service; for example, fully underground systems would be subject to much less disruption than aerial distribution systems with naked conductors;
  - Project criteria, incorporating aspects such as safety factors, will impact reliability;
  - Geographical and environmental factors at the site of the installation: population, population density, terrain, lighting levels, etc.
  - Redundancies criterion, i.e. the extent to which system elements are duplicated to allow continuous supply, even under certain conditions of absence;
- The quality of the initial construction.
  - Quality of materials used
  - Quality of construction works
- Operational aspects: response time to supply interruptions, which, in turn, is dependent on several factors, such as:
  - Location, accessibility, spare availability and features and nature of failure;
  - Availability of maintenance personnel and number of failed locations to be met;
- Continuous maintenance.

Some indexes are used to measure the reliability of the supply. The most common are:

- frequency of Interruption per Unit Consumer (FIC), which measures the average annual number of interruptions per consumer;
- interruption duration per Consumer Unit (IHD), which measures the average annual number of hours during which a consumer's supply is interrupted;
- Maximum Continuous Interruption Duration (DMIC), which measures the maximum continuous interruption time of electricity in a consumer unit.

Reliability, therefore, cannot be quantified through the technology used only at the distribution level. This, however, does not imply that goals for FIC and IHD should not be established. Targets should be set taking into account what is considered acceptable for a specific consumer base. The following data were extracted from a 2014 Distribution Report:

Table D.1 - Indicative Reliability Indices for EDM BT and MT systems

Area	Fic (Failures/consumer)		Dic (duration of interruption of supply, in hours)[1]		System Restore Time (DMIC in hours)[1]		Failures in MT lines (No./ 100km) [1]	Number of BT Interrupts
	MT system	BT[Systems 2]	MT system	BT[Systems 2]	MT system	BT[Systems 2]		
Maputo	0,3		0,31		1,02		100	
All EDM	2,01	0,44	1,01	3,51	0,51	8,0	64	609.844

1. Edm Distribution Network Performance Report 2014, with BT data extracted from the report's comments.
2. EDM report above with data calculated from the report texts.

Based on the information provided, a customer is likely to experience about 2.5 interruptions per year per consumer, each lasting 8.5 hours due to problems in primary/secondary distribution networks. This indicates that improvements should be made to the infrastructure and distribution network management with the addition of new clients to the network.

The definition of supply reliability differs between urban and rural distribution systems. Reliability, in turn, will be measured by the average monthly or annual consumption of residential consumers: users with high electricity consumption for lighting, heating, refrigeration, cooking and communication demand greater reliability than consumers using electricity only for lighting. The decision to select the most appropriate technology in each particular project can be guided by the relative reliability values of the technology that will be presented in this report (see Table 3, section 6.2.1.2).

Review of project criteria with the aim of easing certain standards

What will be presented below was mentioned as an example of issues that will be best investigated during the preparation of the plan (Task 4):

- Use of arrangements with vertical conductors staggered in 33kV, 11kV and low voltage bare cables where loads allow the use of smaller gauge conductors. Supply costs and construction in general can be reduced at the expense of a small increase in the length of the poles. It should also be noted that, in this regard, there is the potential danger that larger birds (vultures, eagles and other birds of similar size) will use structures that have configurations with horizontal naked conductors;
- The exclusive use of conductors with aluminum alloys. Steel-souled aluminum conductors (ACSR) are adequate and economical in indoor areas, but the cost of maintaining alternative reserves for both drivers and the needs to be met must be assessed.
- It may seem that the use of connections, handles, anchoring devices, and other preformed components is not allowed in standards, however, the use of these devices could generate cost and construction benefits.
- Delivery-specific reliability criteria (availability) may require review. A lower level of reliability can be acceptable in return

especially in low-demand installations, where use can be limited only to lighting.

- The specified ground distance for airlines can be reconsidered. Specified distances of 6.0 m (within urban areas) and 7.0m (at highway crossing) for 11kV and 33kV lines may experience some reduction. This could, in turn, allow the use of configurations with staggered vertical conductors without increasing the length of the poles. It is necessary to know the regulatory environment in which these changes would happen.

  o High wind speed in design (40m/s) may not be a good premise in some areas;
  - Increased disruptive atmospheric impulse stresses in lines in the MRT system in 33kV, 11kV and 19kV through simple *gaps* in descent drivers would bring benefits with high lightning intensity;
  - The elimination of crosses, where possible and advisable, as defined above.
- The document of the Project Manual for Distribution Networks that handles Environmental Protection Requirements should be reviewed and approved by the relevant Mozambican authorities.

The adequacy of references to issues related to work, health and safety practices needs to be reviewed by the respective government authorities responsible.