Dual Plenary Session I
Electricity Access in Emerging and Developing Countries

The case of Mozambique

Monday, June 19\textsuperscript{th}
11:15 a.m. - 12:30 p.m
Rationale for Universal Access

Access to reliable and unlimited electricity supply is a human right!

Mozambique has accepted the challenge to reach Universal Access in 2030

EDM has incorporated this challenge as one Key Strategic Objective

No development can occur without electricity!

Access was defined as “having electricity service of any kind”

“The future is electric”
Contents of the Presentation

• Introducing Mozambique and EDM

• Statistics of access

• Challenges and Opportunities

Question: can EDM, as an utility, meet the goal of sustainable access to all by 2030?
Universal Access by 2030

Electrification of Districts finished in 2015

To achieve universal access by 2030, EDM will need to connect between 300 and 400 thousand households per year, at a cost of approximately 500 USD per connection. EDM is targeting to reach 3.7 million new connections on-grid and 1 million new connections off-grid, through mobilization of development funding and through partnerships with the private sector for innovative supply solutions.

154 district capitals, of which 147 connected

Residential access in 2016: 26%
Power Corridors link resources and markets

**The African Challenge:** 1) Power infrastructure is underdeveloped, 2) Electricity supply is often unreliable, 3) Power costs are high, 4) Cost reflective tariffs are difficult to implement, 5) Access to electricity is low and unequal, 6) Large Markets distant from Sources

Mozambique has the following strengths:

- Diverse and large energy resources: hydro, coal, gas
- Border with 6 countries and narrow east-west territory, enabling the three main trading and power corridors
- Fast growing demand – mines and industries

Power Deficit in SAPP of about 7 GW
EDM’s Investment Portfolio 2018-2030 (8+ bUSD)

Light up Mozambique!

Past
3 Provincial Capitals connected to RNT
1977
688 km

Present
All 11 provincial Capitals and 146 (96%) District Capitals connected to REN
2015
5,367 km

Future
New Power Stations and new Transmission Lines to respond to Demand growth
2020
9,849 km
Conceptual approach / vision of growth

- **Design and structure investment programs** to ensure security and quality of supplies, the widening of access and the regional role as a generator and wheeler in SAPP.

- **Promote and strengthen the domestic and regional energy markets**, to anchor the large investments needed to explore and utilize the natural resources and to industrialize the country and the region.

- **Differentiate between social and commercial energy**, in order to explore the profitability components of the electricity business to the benefit of the company and the public sector, and focus public funding directly into the segments of society that need welfare assistance.

- **Develop standards, procedures and regulations**, both within the company and in the sector, in order to achieve the highest quality and optimal management of resources, thus ensuring the highest possible affordability in the supplies for social and economic driven consumption.
• Introducing Mozambique and EDM

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• Challenges and Opportunities

**Question:** can EDM, as an utility, meet the goal of sustainable access to all by 2030?
Residential Access: higher in urban settings

Moz Residencial: 91% Clients, 48% Energy

Residential Access

2016

12.8% 12.3%
10.9%
21.3%
31.8%
18.3%
41.6%
76.2% Provincia 92.7% Cidade

90% Pre-paid

The lowest access rate in cities is 65%

To reach Universal Access 2030, a total of 5.4 million households must be connected to an electricity source
Total 431 Administrative Posts, 258 (60%) are electrified, other 14 electrification underway. 159 Administrative Posts (37%) remain, cost estimated at 650 MUSD
Proximity is not Access
The case study of Macaneta Beach

It is confirmed that:
- HHs headed by women are generally worse off than male’s
- There is desirability of electricity as a lighting and modern source of energy
- Cooking energy is still mostly biomass.

A modern thermal source must be found!

- Time-to-connect after network “arrives” is longer for women than for men. Reasons:
  - Cost of new connection
  - Funds to build the wiring in the house
  - Capital to acquire electrical appliances
- Micro-credit too expensive
- Limited supply of affordable materials and services
Consumption per Household (grid-electrified)

<table>
<thead>
<tr>
<th>Region</th>
<th>kWh/HH.year</th>
<th>Access Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>1,369</td>
<td>858</td>
</tr>
<tr>
<td>Center</td>
<td>2,309</td>
<td>1,235</td>
</tr>
<tr>
<td>South</td>
<td>2,611</td>
<td>1,607</td>
</tr>
<tr>
<td>EDM</td>
<td>2,339</td>
<td>1,382</td>
</tr>
</tbody>
</table>

Consumption per HH reduces, as access rates increase

POVERTY LEVELS IN MOZAMBIQUE
From 18.4% Single Male to 59.4% Divorced Female

Challenges specific of Mozambique at Utility Level:
- All areas are Obligatory Supply Areas
- Uniform tariff system does not differentiate geographically
- Tariff reviews are subjected to Gov approval
- Centralized planning is insensitive to local particularities
- New connections are unprofitable for the first 2-5 years
- Poor urban planning facilitates losses and energy theft
• Introducing Mozambique and EDM

• Statistics of access

• Challenges and Opportunities

**Question:** can EDM, as an utility, meet the goal of sustainable access to all by 2030?
What are the hurdles?

What models will EDM take to provide access

“grid equivalent service” except for the cases where the connection cost per consumer and per kVA exceeds 2,000 USD/kVA, in which case off-grid electrification alternatives shall be considered.

Average Electrification Connection Cost: 1,300 – 1,500 USD per connection

<table>
<thead>
<tr>
<th>On-Grid Urban</th>
<th>On-Grid Rural</th>
<th>Off-Grid Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient expansion corridors. &lt; 5km</td>
<td>Large electrical losses &lt; 30 km</td>
<td>Slow decision in individual small solutions. &gt; 30 km</td>
</tr>
<tr>
<td>Expensive insulated aerial and subterranean cables</td>
<td>Mostly residential clients</td>
<td>Dispersion and diversity of consumers</td>
</tr>
<tr>
<td>Fast growth of Offices and Services loads</td>
<td>Low consumption customers</td>
<td>Slow decision in individual small solutions</td>
</tr>
<tr>
<td>High quality requirements</td>
<td>Long expensive aerial lines</td>
<td>Funding is too diverse and in small amounts</td>
</tr>
</tbody>
</table>
Planning and Financing issues

National Electricity Network

Master Plan for Electricity Infrastructure

• Project Finance for Large Gx & Tx Projects
• Public-Private partnerships structured as SPVs for large investments
• Concessional funding for critical infrastructure
• System reliability cannot be compromised
• Densification is preferred
• Vulnerability to currency fluctuations
• Strengthen Moz industry/services to anchor investments for access

Electrification for Access

National Electrification Strategy

• Set up an Electrification (Escrow) Account
• Levy on electricity consumption to levy electrification – 5%
• Connection Cost subsidy – pay in installments
• Maintain Uniform Tariff (no geographic differentiation) on low voltage “small” consumers
• Maintain tariffs at cost reflective levels
• Enforce compliance with Energy Efficiency and Saving measures

Achieving universal access by 2030 for 33+ million people, outside 100 m radius of the existing national electrical network, will require about 6,530 Million USD
Processes: Nationwide versus Local
Utility operates with some centralized processes

- Integrated planning allows for a selection of sites where off-grid solutions are cheaper: it is made based on the proximity of the national electricity network.

- Private sector operators cannot offer off-grid solutions with competitive prices: public sector investments and leadership is needed to establish the “skeleton” of the supply chains and reference prices.

- Local markets for materials, equipment and services are small and limited: the economy of scale of large companies can bring electrification costs down.

- Normalization of services to clients reduces costs and increases predictability to customers: the widespread customer service stations or conventional supplies can also serve off-grid and alternative solutions to access.
EXTRA SLIDES IF NEEDED
Between 2006 and 2016

- Number of Clients increased from 415 thousand to 1.5 million
- Operational Cost Reduced from 242 to 114 USD per Client
- Export revenue increased from 5.4 to 219 MUSD
- Cost of Sales Increased from 26% to 77% (it is suffocating the company)
### Technology: Solutions for Access

The utility has diverse technological resources

<table>
<thead>
<tr>
<th>Off-grid Connections</th>
<th>On-grid</th>
<th>Mini-grid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centralized Medium size or Large size source</strong></td>
<td>• Centralized Medium size or Large size source</td>
<td>• Dedicated Small size source</td>
</tr>
<tr>
<td><strong>HV / MV networks</strong></td>
<td>• HV / MV networks</td>
<td>• LV network and connection wires</td>
</tr>
<tr>
<td><strong>LV network and connection wires</strong></td>
<td>• LV network and connection wires</td>
<td>• Meter</td>
</tr>
<tr>
<td><strong>Meter</strong></td>
<td>• Meter</td>
<td>• Centralized or dedicated commercial management and controls</td>
</tr>
<tr>
<td><strong>Centralized commercial management and controls</strong></td>
<td>• Centralized commercial management and controls</td>
<td></td>
</tr>
</tbody>
</table>

### Energy Appliances

<table>
<thead>
<tr>
<th>On-grid</th>
<th>Off-grid is simpler and modular</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dedicated source &amp; self contained utility</strong></td>
<td>• Dedicated source and connection wires</td>
</tr>
<tr>
<td><strong>Distribution chain</strong></td>
<td>• Distribution chain</td>
</tr>
<tr>
<td><strong>Retail</strong></td>
<td>• Retail or Centralized/dedicated commercial management and controls</td>
</tr>
</tbody>
</table>
Vision for Transformation of EDM

THE PILLARS OF TRANSFORMATION

People

Reorganization, training and institutional capacity programs, motivation, incentives, culture and ethics

Processes

Reengineering of processes, quality standards, tools for monitoring and controls, result-oriented

Technologies

Connectivity and communication, automation and controls, modernization and innovation

Growing Demand in Moz and in SADC

Commitment to extend Access

Large Energy Resources

THE PILLARS OF TRANSFORMATION

The transformation is based in ethical and professional principles, such as transparency, team work, good performance, etc.

Vision of Transformation

Turn Mozambique into a Regional Hub and Reach Universal Access by 2030

20
Energy resources are vast and competitive

Mozambique’s energy resources potential include:

- **HYDROPOWER** - 18,000MW;
- **NATURAL GAS** - over 200 TCF,
- **COAL** - 23 billion tonnes;
- **RENEWABLES** - 7,100MW, of which:
  - Micro, mini and small hydropower - 4,700MW;
  - Wind Power - 1,100MW;
  - Solar Power - 1,200MW;
  - Biomass Power - 130MW

Mozambique has concluded a detail mapping of renewable potentials, the Renewable Energy Atlas
The Model of Growth under review

The Master Plan

- Upgrade the transmission and distribution networks expansion plans to accommodate new vision of a regional energy hub
- Include generation in the Master Plan
- Simulate for high stability and least cost solution
- Keep concept of power corridors as structural developments for a long term future

The National Electrification Strategy and Plan

- Develop the solutions to separate commercial from social energy
- Ensure off-grid component can be developed without compromising limits of affordability and quality of supplies
- Off-grid model is a transitional solution to future on-grid electrification
- Mobilize Government support to social energy component
# EDM in partnership with AfDB on the New Deal on Energy for Africa (Mozambique)

<table>
<thead>
<tr>
<th></th>
<th>From current energy situation in Mozambique</th>
<th>To Universal Access by 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population, <em>M</em></td>
<td>27 x 1.3</td>
<td>36</td>
</tr>
<tr>
<td>GDP, $ bn</td>
<td>15 x 3.4</td>
<td>50</td>
</tr>
<tr>
<td>Electrification rate, %</td>
<td>27% x 3.7</td>
<td>97%</td>
</tr>
<tr>
<td>Households connected, <em>M</em></td>
<td>1.4 x 5.0</td>
<td>6.9</td>
</tr>
<tr>
<td>Grid</td>
<td>1.4 x 3.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Off-grid</td>
<td>0 x</td>
<td>1.7</td>
</tr>
<tr>
<td>Grid capacity, GW</td>
<td>2,957 x 3.0</td>
<td>8,931</td>
</tr>
<tr>
<td>Consumption kWh/capita</td>
<td>154 x 3.5</td>
<td>544</td>
</tr>
</tbody>
</table>

### Power
- +3.7 M new on-grid connections
- +1 M new off-grid connections
- +6,000 MW of new capacity

### Clean cooking
- Households using clean cooking, *M*  

### Renewable Share
- 447 MW small hydro and solar PV
- 2,745 MW large hydro
Strategic Investments: up to 8+ bill USD

Critical $227 M 1-2 Years
- Avoid fatal collapse of the electric system and secure supply of electricity

Emergency: Avoid fatal collapse of the electric system and secure supply of electricity

Short term $386 M 2-3 Years
- Security of supply and safety operation

Stabilization: Security of supply and safety operation

Medium term $2,398 M 3-5 Years
- Priority and structural projects (Redundancy and Industrialization)

Expansion: Priority and structural projects (Redundancy and Industrialization)

Long term $5,097 M 5-10 Years
- Infrastruture GX, TX e DX (Markets, including exports)

Leadership: Infrastruture GX, TX e DX (Markets, including exports)

- Infrastructure damage by accidents
- Infrastructure in risk of collapse
- Infrastructure due to risk of collapse there is a consequence of collapse of supply of electricity (emergency/urgent need to repair transformers and networks to unlock power evacuation)

Strategic Investments: up to 8+ bill USD

- Infrastructure which are being operated below technical and safety operating standards
- Infrastructure which ensures the supply to all major Capital of the Country (New transformers & new lines to enable evacuation and new path/corridors of power)

- Infrastructure which enables redundancy, reliability of supply, including Industries
- Infrastructure for Development corridors (Nacala, Beira, Mocuba, Pemba) and Industrial Hubs (New generation, new transmission lines, including redundancies)

- Infrastructure to sustain rapid demand and energy consumption growth
- Evacuate power from new generation to load centres, including exports (Expansion of generation and transmission to connect loadas and markets)

Generation [M$]
- $2,005 M

Transmission [M$]
- $3,584.8

Distribution [M$]
- $2,501.6

ELECTRICIDADE DE MOÇAMBIQUE, E.P.
com energia construímos futuro
400 kV HVAC and 500 kV HVDC

Two major generation Centers in the North (Palma/Nacala) and West (Tete)

The West to North Power Corridor, in a loop, which will flow power into Tanzania and the Eastern Africa Power Pool (EAPP)

The Western Power Corridor, in a loop, which will flow power into Zimbabwe and Zambia, and the West African Power Pool (WAPP)

The North to South Power Corridor, in a loop, which will flow power into Maputo Metro, South Africa and the Southern African Power Pool (SAPP)
## Monitoring and measuring results
### Results from surveys 2011 - 2014

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surveyed</strong></td>
<td>446</td>
<td>484</td>
</tr>
<tr>
<td>% Female (head of HH)</td>
<td>24%</td>
<td>28%</td>
</tr>
<tr>
<td>Age (20-60)</td>
<td>88%</td>
<td>84%</td>
</tr>
<tr>
<td>None or Primary Education only (head of HH)</td>
<td>89%</td>
<td>85%</td>
</tr>
<tr>
<td>Activity: fishermen/agricult. tourism commerce</td>
<td>30%+18%</td>
<td>39%+19%</td>
</tr>
<tr>
<td>Monthly Cash Earnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 5 kMT</td>
<td>42%</td>
<td>28.6%</td>
</tr>
<tr>
<td>&gt; 5 kMT</td>
<td>47%</td>
<td>60.8%</td>
</tr>
<tr>
<td>Monthly Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5 kMT</td>
<td>87.5%</td>
<td>60.7%</td>
</tr>
<tr>
<td>&gt; 10 kMT</td>
<td>3.06%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Monthly Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no expense</td>
<td>79%</td>
<td>&lt; 100 or blank</td>
</tr>
<tr>
<td>100 – 5 kMT</td>
<td>3%</td>
<td>48%</td>
</tr>
<tr>
<td>Use Kerosene</td>
<td>95%</td>
<td>42%</td>
</tr>
<tr>
<td>Use Grid Electricity</td>
<td>5.5%</td>
<td>55%</td>
</tr>
<tr>
<td>Use Charcoal</td>
<td>58.2%</td>
<td>58%</td>
</tr>
<tr>
<td>Use LPG</td>
<td>6.2%</td>
<td>3%</td>
</tr>
</tbody>
</table>
## Monitoring and measuring results

### Male x Female in 2014

<table>
<thead>
<tr>
<th></th>
<th>Male 2014</th>
<th>Female 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surveyed</strong></td>
<td>339</td>
<td>134</td>
</tr>
<tr>
<td><strong>Age (20-39)</strong></td>
<td>37.5%</td>
<td>47%</td>
</tr>
<tr>
<td><strong>(20 – 60)</strong></td>
<td>85%</td>
<td>84%</td>
</tr>
<tr>
<td><strong>None or Primary Education only (head of HH)</strong></td>
<td>84%</td>
<td>87%</td>
</tr>
<tr>
<td><strong>Activity: fishermen/agricult. tourism commerce</strong></td>
<td>37%+17%</td>
<td>44%+27%</td>
</tr>
<tr>
<td></td>
<td>14.5%</td>
<td>9.7%</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Monthly Cash Earnings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 5 kMT</td>
<td>25%</td>
<td>34%</td>
</tr>
<tr>
<td>&gt; 5 kMT</td>
<td>61%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Monthly Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5 kMT</td>
<td>90.5%</td>
<td>98%</td>
</tr>
<tr>
<td>&gt; 10 kMT</td>
<td>3.06%</td>
<td>0.7%</td>
</tr>
<tr>
<td><strong>Monthly Electricity expense</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 – 5 kMT</td>
<td>55%</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Use Kerosene</strong></td>
<td>37.5%</td>
<td>51.5%</td>
</tr>
<tr>
<td><strong>Use Grid Electricity</strong></td>
<td>54.6%</td>
<td>42%</td>
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<td>60.5%</td>
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<td>3%</td>
<td>0.8%</td>
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