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THE ELECTRICITY SECTOR IN MOZAMBIQUE

AN ANALYSIS OF THE POWER CRISIS AND ITS IMPACT ON THE BUSINESS ENVIRONMENT

FEBUARY 2015

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ABREVIATION AND ACRONYMS

AGGREKO	Temporary Power Generation Company
CMH	Companhia Moçambicana de Hidrocarbonetos
CNELEC	Conselho Nacional de Electricidade (National Electricity Council)
CPI	Centro de Promoção de Investimentos (investment Promotion Centre)
CTM	Central Térmica de Maputo
CTRG	Central Termica de Ressano Garcia
Discos	Distribution Companies
EDM.EP	Electricidade de Moçambique Empresa Publica
EEP	Eastern Electricity Project
ENMO	Energia de Moçambique
ENH	Empresa Nacional de Hidrocarbonetos
ESKOM	Electricity Supply Commission
EU	European Union
FUNAE	Fundo de Energia
Gencos	Generation Companies
GoM	Government of Mozambique
GSAs	Gas Supply Aggrements
GWh	Gigawatt hour
HCB	Hidroeléctrica de Cahora Bassa
HMNK	Hydroelectric of Mphanda Nkuwa SA
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current

INP	Instituto Nacional de Petrólio
IPP	Independent Power Producer
kV	Kilovolts
KWh	Kilowatt hour
MGC	Matola Gas Company
MOTRACO	Companhia Moçambicana de Transmissão
MOZAL	Aluminium Smelter
MPUP	Master Plan Updated Project
MW	Megawatts
NERC	Nigerian Electricity Regulatory Commission
PETROMOC	Petróleos de Moçambique
PPA	Power Purchase Agreement
PPP	Private Public Partnership
REN	Redes Energéticas Nacionais
SAPP	Southern African Power Pool
SEB	Swaziland Electricity Board
SHER	Sociedade Hidroélectrica Revue
SMAE	Serviços Municipalizados de Águas e Energia
SME	Serviços Municipalizados de Energia
STE	Sistema Nacional de Transporte de Energia
TEM	Transitional Electricity Market
WESTCOR	Western Power Corridor

EXECUTIVE SUMMARY

Although Mozambique is fortunate to have substantial untapped natural energy resources including hydro-power, coal, natural gas, bio-fuels and petroleum, in recent years a failure of planning to provide adequate power for the rapid economic growth which the country is now realizing has today resulted in a situation where many areas experience regular blackouts, and others face the prospect of load-shedding for years into the future.

Government policy has focused on prioritizing the extension of the national grid to rural, economically disadvantaged citizens with the limited resources that have been made available to the national energy utility Electricidade de Moçambique (EDM). This policy objective succeeded by January 2012 in achieving a total number of 1,024,000 connected customers in all regions and provinces of the country. At the same time construction of extensive new power transmission infrastructure was realized, reaching across more than 5360 km with transmission capacity of about 5500 MVA across the national territory.

However, the grid extension effort has left the country with a critically under-maintained legacy network with scant backup provisions and a high degree of reliance on a single energy source, namely hydro power. Natural disaster and operating failures have led to total blackouts for periods of weeks in each of the past two years, with substantial losses to the national economy. In addition, Mozambique suffers from administrative, transmission and distribution losses totaling 27% of power generated which further exacerbate the country's increasingly acute energy shortage.

A situation ripe for investment in generation and distribution by private operators, alone or in conjunction with public entities has been compromised by inappropriate tariff structures and a slow process of legal and regulatory reform that has failed to keep up with the pace of demand growth. The tariff subsidy extended to all customers irrespective of their location entails EDM operating at a loss, a situation compounded by the increasingly frequent requirement to purchase expensive power from a small number of independent power producers (IPPs) or from foreign sources. While several projects are underway or pending approval, there exists an urgent need to accelerate the construction of additional and alternative sources of power and the necessary transmission infrastructures to deliver power to load centers with cost effective rates.

Mozambique's accelerated development zones could be catalysts for an intensified generation effort but require more flexible interpretation of existing incentive regulations to bring forth the necessary supply. Policies aimed at unbundling integrated national power utilities, introduced in other sub-Saharan economies have helped bring forth resources and added a dynamism to national power sectors which their governments had previously failed to provide, although not all such initiatives may be suitable in the Mozambican context. The lack of a developed domestic capital market for potential investors and limited access to overseas finance adds further to the urgent need for government to act.

1. INTRODUCTION

Mozambique is a fortunate country from the perspective of its significant untapped natural energy resources (hydro-power, coal, natural gas, bio-fuels and petroleum), sufficient to assist in meeting energy shortages in neighboring countries of the region.

The bulk power potential represented by known hydropower resources is estimated at 12,000 MW, while resources of offshore gas and coal reserves are estimated at 277 trillion cubic feet and more than 20 trillion tons respectively. Proven onshore natural gas reserves of ± 3.5 trillion cubic feet (Pande, Temane, Buzi) and considerable biomass and biofuels potential exist with the country's more than 30 million hectares of unused arable land, while wind, solar and tidal power potential are still under evaluation.

The power sector thus plays a vital role in the economy of Mozambique and is increasingly becoming as a key component of national production as well as an economic input indicative of the progress of a people.

During the last 10 years the sector has seen remarkable changes with rising electricity supply gaining momentum with expansion and intensification through specific policies and clear targets from the government, for both on and off grid electrification programs.

The Ministry of Energy and Mineral Resources (until January 2015 two separate ministries) is the central organ of the state which according to the mission, vision and tasks set by the government, it guides, plans, promotes and controls the inventory and use of energy resources and the development and expansion of the network supply and distribution of electricity, natural gas and petroleum products.

By January 2012 EDM had attained a total number of 1,024,000 connected customers. Despite the fact that 78% of new connections are through installation of pre-paid meters, new connections have extended into the poorer households, an important policy objective.

2. OBJECTIVES AND METHODOLOGY

The specific objectives of the study are to:

1. Raise public awareness of the continuing national energy deficit and its implications for Mozambique's business environment;
2. Contribute to the discourse around the role of State in the Electricity Sector and the need to stimulate public and private investment in the downstream energy supply;
3. Stimulate activities and suggest measures in order to allow Mozambique to create the necessary capacity to meet growing demand ahead of the rapid development phase in the country's developing natural resources sector.

3. STATEMENT OF THE PROBLEM

Mozambique has a considerable number of investment opportunities in its productive sectors, which makes it an attractive destination for potential investors from all over the world. Nevertheless the lack of sufficient generation, transmission and distribution infrastructure in the electricity sector is currently impeding growth.

In the private sector, the main concern is the inability of EDM to meet electricity demand both in terms of availability as well as reliability of power supply, limiting operational and productive capacity and thus forcing investors to provide their own, universally more expensive sources of reliable power outside the national grid, thereby elevating the cost of investment.

During the same decade when broad national electrification was being improved, industrial development began to emerge but with no significant new accompanying investment in generation and transmission to respond to industry's growing demands. As a consequence, what in 2008 was officially referred to as a capacity surplus [by EDM] became quickly a disturbing capacity deficit that forced the national utility EDM, to contract outside for the provision of expensive energy during peak hours and start load shedding procedures in some areas in the north (Nacala) and center (Beira) of the country, during four peak demand hours per day [EDM].

EDM´s available generation capacity at present comes from the contributions of Corumana, Mavuzi, Chicamba and the HCB hydro power stations, totaling roughly 565 MW. Since 2011, load has exceeded this capacity, giving rise to a new era, characterized by excess power import from the SAPP to satisfy the country's increasing electricity demand. In 2013 available generation capacity was 614 MW including imports of 95MW.

The system peak load in EDM was 709 MW in June 2013 with an energy consumption of approximately 4,538 GWh, within EDM's Northern, Central and Southern grid. According to the load forecast generated in the Master Plan Update 2012-2027, an average growth of 12.5 % is expected over the coming years.

TABLE1: MOZAMBICAN NATIONAL ELECTRIC POWER NETWORK: MEDIUM LOAD FORECAST

Medium Forecast		2012	2016	2021	2026	AAG (%)
Energy	(GWh)	3 255	10 019	12 930	22 753	13.8%
Peak Demand	(MW)	563	1 589	2 075	3 293	12.5%

Considering the rapid load growth being registered in the country, there exists an urgent need on a short, medium and long-term basis to promote the construction of additional and alternative sources of power and the creation of transmission infrastructures to deliver power to load centers with cost effective rates.

EDM sustains technical and administrative losses that amount to 27% of total budget further contributing to its financial problems. These result either through power delivered but unbilled or through thefts (revenue losses) or transmission losses in sections of the network due to lack of reinforcement and maintenance to match growth in load. EDM's stated aim is to reduce losses by 50%, relative to consumption until 2024.

According to the Electricity Master Plan, considering current electricity tariff levels, a substantial increase is required (to about $0.13-14 kWh) to support the development of a new generation of user and the substantial transmission system investments that are necessary to meet the growth and eliminate current limitations on the system.

4. AN OVERVIEW OF MOZAMBIQUE'S ENERGY SECTOR

The Energy Sector, comprising all forms of primary and transformed energy sources involves a number of stakeholders that includes:

- The Council of Ministers with responsibility for setting policies, strategies and regulatory tools to enable the development of natural resources for economic benefits in association with environmental responsibility.

- The Ministry of Energy and Mineral Resources, supervising the electricity portfolio including New and Renewable Energies (NREs) and also in charge of oil and refined oil products (liquid fuels), natural gas, and coal among other mineral resources;

- CNELEC (Conselho Nacional de Electricidade), the electricity independent regulator. Its scope is under revision with the aim of broadening and strengthening its role. It is expected that the outcome will be an overall energy sector Independent Regulator whose scope will be extended to the distribution of natural gas and liquid fuels.

- EDM EP, a state-owned and vertically integrated utility that is responsible for the generation, procurement, transmission, distribution and sale of electricity. A great portion of the rural and peri-urban electrification program via grid extension is being implemented and sustained by the utility.

- Hidroeléctrica de Cahora Bassa (HCB), an IPP owned by The Mozambican state (85%), Companhia Eléctrica do Zambeze (CEZA – 7.5%) and *Redes Energéticas* Mozambique *Nacionais* (REN) of Portugal (7.5%) respectively. HCB owns and operates a hydro power plant with an installed capacity of 2075 MW with a long-term Power Purchase Agreement (PPA) with ESKOM of South Africa, EDM as well as ZESA of Zimbabwe to whom it supplies power via an HVAC line owned by EDM.

- Mozambique Transmission Company – MOTRACO was created as a joint venture transmission company between Eskom, EDM and Swaziland Electricity Board (SEB) with the status of a partnership between public and private entities, with each company owning 1/3 of the shares. In essence MOTRACO operates and maintains the 400 kV network system based on the network's 400 KV transmission parallel lines.

- FUNAE, established as a public institution in charge of developing, producing and making use of different forms of low cost power production and distribution for off-grid rural electrification. It promotes the conservation, rational and sustainable management of power resources.

- INP (Instituto Nacional do Petroleo) sharing a regulatory role in the Oil and Natural Gas Subsectors with the Ministry of Energy and Mineral Resources.

  ENH (Empresa Nacional de Hidrocarbonetos), a state owned company for the development (extraction, transformation and distribution) of hydrocarbon resources. It was established in 1981 as a state company changing to a Public Company in 1997.

- CMH (Companhia Mocambicana de Hidrocarbonetos); a private company in the natural gas sector with a number of projects with SASOL, a South African concessionaire of the onshore gas deposits in Temane and Pande, Inhambane.

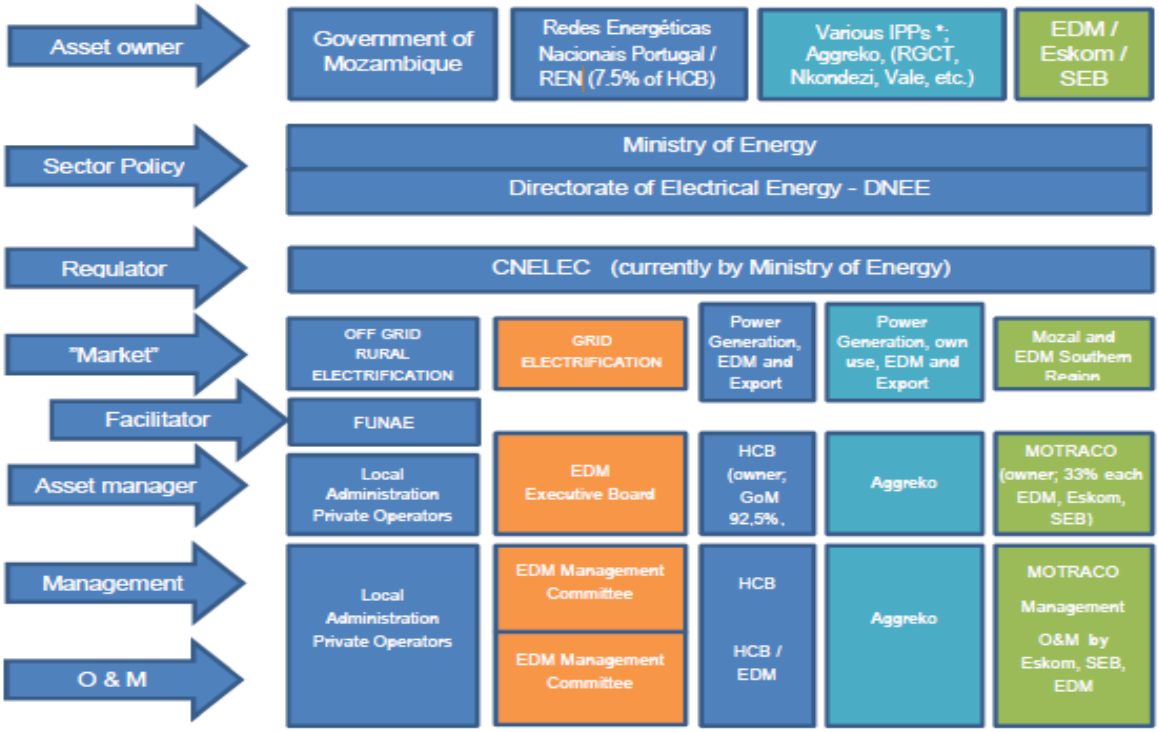
- Independent Power Producers

  The development of IPPs is underway in the power generation sector

  At present Aggreko (100 MW) consisting of multiple prefabricated units operates in a short term contract, while the developments Ressano Garcia Central Termica (CTRG), Nkondezi, Moatize, Vale and others are in varying stages of progress with their respective plans.

- PETROMOC, responsible for the commercialization of refined oil fuel
- MGC (Matola Gas Company), a company distributing gas to industries and transports in the Matola and Maputo areas.

FIGURE 1. INSTITUTIONAL AND REGULATORY FRAMEWORK OF THE ELECTRICITY INDUSTRY, 2014



5. ELECTRICITY SUPPLY - GENERATION

During the year 2013 the total supply of electricity generated in the country excluding consumption by the MOZAL aluminum smelter was 4,538 GWh of which 4,084 GWh was purchased from Cahora Bassa, 251 GWh from own generation, 95 GWh from Thermal IPP and 108.2 GWh from imports, the latter representing 2% of the total.

Although only less than a quarter of its technically feasible potential has been developed, hydropower has been the main source of electricity supply in Mozambique thus far, with as much as 95% of total generation.

FIG.2 - ENERGY MIX IN 2013 [EDM]

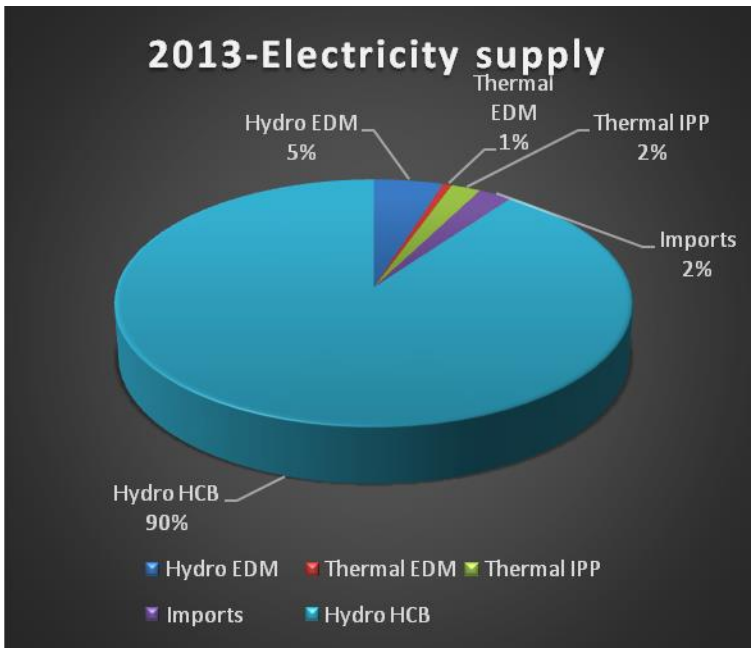
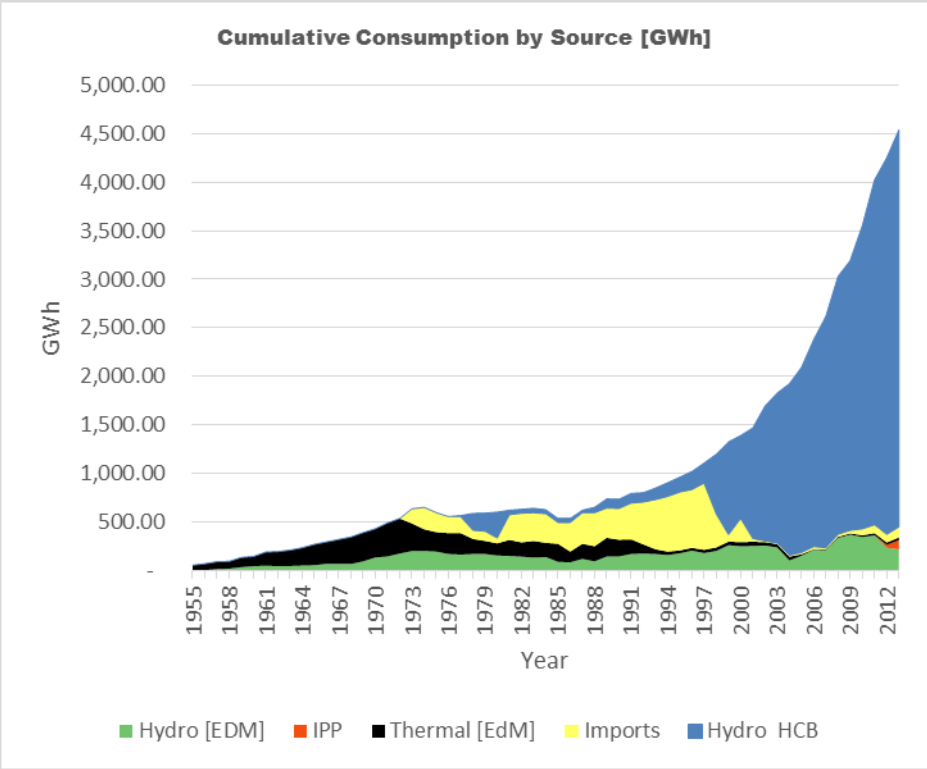


Fig.3 illustrates the evolution of the electricity matrix since 1955 to 2012. It can be noted that during 1955 to 1973 demand was met by the contribution of thermal generation respectively in the south region (CTM supplying Maputo and Matola areas), the contribution of hydro schemes in the center (supplying Chimoio and Beira with a link for emergency supplies to the town of Mutare in Zimbabwe) and scattered diesel generators all over the country.

Commercial operation of HCB started in 1975 contributing significantly to the load diagram up to 1981, until the transmission infrastructure suffered from severe sabotages, thus giving renewed urgency to call for imported energy for Maputo, while generation from coal continued to decrease thanks to ageing, inefficient equipment and logistics problems during the civil war.

After the signature of the Rome Accords peace agreement in 1992, and major reconstruction works on the HVDC link between Songo and Apollo, HCB's

FIG. 3 - ELECTRICITY SUPPLY BY FUEL/SOURCE [EDM]



contribution to the country's energy needs restarted and it soon became the most important power supplier nationwide complemented by two small hydro schemes belonging to EDM.

Only in 2012 came the construction at Gigawatt Park/AGGREKO in the Ressano Garcia area of an emergency containerized power plant installation of 107MW (phase I) and 130 MW (phase II) MW. The facility is fueled by natural gas under a PPA with NamPower, ESKOM and EDM (15+17 MW).

At the same site, Central Térmica de Ressano Garcia (CTRG), a 175 MW power plant using combustion engines will be launched into the grid under a PPA with EDM in the first quarter of 2015. CTRG is a result of a joint venture between SASOL (that owns similar plants in South Africa) and EDM.

Also during the first quarter of 2015 EDM plans to launch the process of selection of an Engineering, Procurement and Construction (EPC) contractor for the construction of one 100 MW gas fired plant located at the Central Térmica *Maputo* (CTM) site, financed by the *Japan International Cooperation Agency* (JICA). In parallel a project to convert diesel to natural gas generation is on-going, where two gas turbines BBC (32MW) and ALSTHOM (25 MW) at the same location are being negotiated with a foreign contractor. The gas supply to the new 100 MW power plant will provide commercial anchors, hence turning feasible the ongoing plans for domestic gas distribution in the Maputo and Marracuene areas.

Following small scale domestic gas distribution undertaken by the Empresa Nacional de Hidrocarbonetos (ENH) in the Vilanculos area, a major project for distributing natural gas in Maputo and Marracuene into households is being implemented by a consortium established between ENH and KOGAS, a South Korean Company.

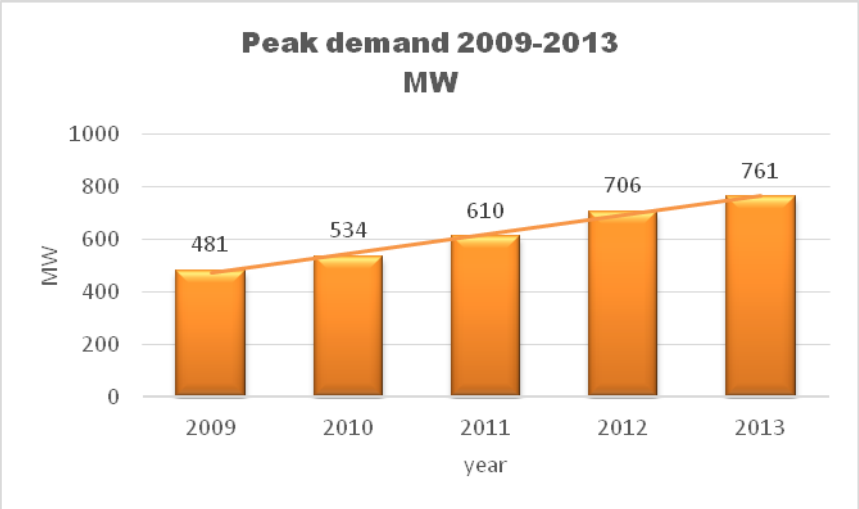
As it can be seen above, natural gas is about to play a significant role within the current energy crisis as a short term response to meeting demand and to addressing the limits of the transmission network in the south region, as a result of:

- Gas availability both from royalty quota and commercial
- Very urgent need of electricity
- Speedy erection
- Operational flexibility and standard technology

Although Electricidade de Mocambique is the entity with responsibility for generation, transmission and distribution of electricity it has fallen short in the task of unlocking the country's potential for generation. Even before 1997 when EDM held the monopoly of the electricity business in the market only Lucheringo (0,680 MW) and Cuamba (1 MW) mini-hydro plants and Corumana hydro plant (16 MW) were developed from greenfield. Temane gas power plant (11 MW) is a result of ENMO's failure to provide power to Vilanculos in 2003 and has been expanded as the load grows. Almost no resources were allocated by EDM during this period for backup power plants.

The current scenario where a rate of increase in peak demand of around 12,5% per annum since 2009, reaching 709 MW in 2013 is obliging the utility to source additional power either from imports (ESKOM at a cost of $0.25/Kwh) or IPPs (AGGREKO at a cost of $0.15/KWh) against the PPA with HCB at a cost of $0.036/ Kwh [EDM] will certainly motivate Electricidade de Mocambique to look for innovative ways to cope with the crisis.

FIG.4 - PEAK DEMAND TREND



In addition to the significant increase in demand, there is insufficient capacity to support the load increase and an ageing and poorly maintained network – resulting in 27% of losses – has begun to impose severe load transfer limits. As a result, the Centre and Centre-North networks are now under load shedding schemes during peak hours resulting in loss of production in the industry.

Emergency power needs in Nacala forced the national utility to reintroduce generation from traditional fuel into EDM's power portfolio, a practice that had been considered outmoded. To this end, it announced the lease of an 18 MW temporary facility to cope with peak demand [www.edm.co.mz]. This highly undesirable but unavoidable scenario is one which might easily have to be repeated in other cities and towns.

6. TRANSMISSION NETWORK

Projects under Implementation

Recognizing that as demand grows, transmission and distribution systems become exhausted with severe economic and social impact, a number of network reinforcements are under implementation or committed for implementation in the short term while others were identified as Priority Projects 2012-2018 within the scope of the Electricity Master Plan. From the ongoing network reinforcement activities the following are worthy of mention:

- Chicamba and Mavuzi Power plants rehabilitation
- Reinforcement of several substations in the Northern grid
- New 275 KV line from Ressano Garcia to Macia
- New 400 KV from Caia to Namialo
- Upgrading of distribution networks

Projects under Proposal

To complement this effort of strengthening the system, the planning Directorate of EDM [Electricity Master Plan] identified the following project proposals (still requiring feasibility studies) as of priority and to be implemented within a time frame of 5 years. Some of these projects are at operational stage while others have to be confirmed via a feasibility study:

Northern Region:

- Rehabilitation of Central Northern Substations and Reinforcement of Nampula city network
- Reinforcement of Pemba City network
- Reinforcement of Nacala city network
- Construction of the Nampula – Angoche line

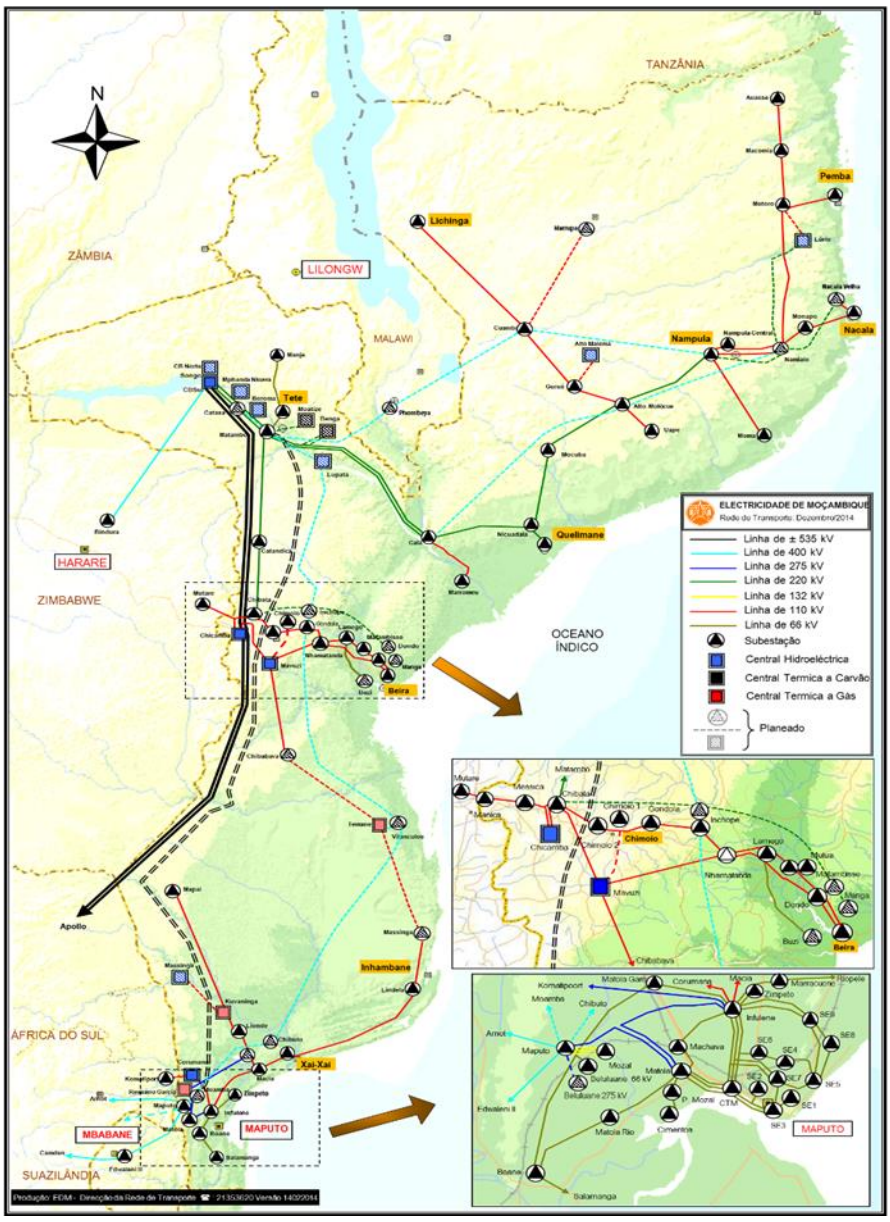
Central Region

- Construction of 220 KV Dondo–Manga line and Reinforcement of the Sofala network
- Rehabilitation and reinforcement of Tete network
- Rehabilitation of Chimoio city network
- Rehabilitation of 11KV Network at Quelimane

Southern Region

- New Beluluane 275/66 Kv Substation project
- Rehabilitation of Infulene Substation
- Reinforcement of the Boane Matola Gare Network
- Rehabilitation of the CTM 66Kv SWGR
- Spare 400/275 KV Substation
- Maputo Infulene 275 KV line

FIG 5 - MOZAMBIQUE'S ELECTRICAL NETWORK [EDM]



The current status of grid extension to rural areas and intensification in peri-urban areas enabled the connection of all provincial capitals by 2007 and 120 district capitals in 2014 increasing the population with access of on grid electricity to 26% in 2013.

7. INTERNATIONAL EXPERIENCE

Other countries in Sub Saharan Africa and beyond have faced similar power crises at corresponding critical take off moments in their development and from their experience there is a rich body of examples both positive and negative, as well as lessons learned, which Mozambique can draw on today. The section below gives an overview of recent international experience.

Kenya

In Kenya, a Master Plan for the entire economy has been developed, known as “Kenya Vision 2030” and within it is contained a very definite strategy for the power sector. Currently with an electricity generation capacity similar to Mozambique’s at around 1700MW, but a population almost twice our size, Kenya nevertheless has largely avoided the systemic power shortages that are at this stage endemic in many parts of Mozambique.

Although population growth is above 3% annually, to date per capita power demand has until recently not risen significantly; nevertheless, within the Kenya national energy plan, it is aimed to approximately triple generation capacity in just over three years in a strategy that national utility KenGen’s chief executive Simon Ngure describes as avoiding a “load following” strategy, but rather anticipating, planning and building for more rapid future growth.

To that end Kenya has embarked on a multi-faceted programme of capacity expansion, that initially relies on industry having to resort to expensive temporary power solutions but which is intended to result, over the medium term in an annual reduction in average retail and industrial consumer rates from the currently near-prohibitive average tariff of around $0.18/kWH.

The capacity expansion goal is to be achieved through expansion of a mix of sources, including new coal-fired generation plants, some expansion in the current unreliable domestic hydroelectric power resource, and including a joint venture to allow access to neighbouring Ethiopia’s much larger hydro resources via the Eastern Electricity Project (EEP), and from a bold pioneering expansion in geo-thermal power generation – a source which is one of the most expensive options to build in terms of initial capital outlay but which then yields some of the cheapest electricity available once operational.

Sourcing the necessary finance and creating a suitable climate for investment, both public and private, for the future power sector investment needs of the country are critical elements in Kenya’s route to capacity expansion. By comparison with other countries in the East Africa

region, including Mozambique, Kenya is fortunate to have a relatively mature indigenous financial sector including active domestic equity and debt markets, with links to capital markets internationally as well as sources of public and multilateral finance.

In 2010 KenGen embarked on a partial privatization program which led to the sale of 30% of the company's shares to the public. In a radical structuring of the sector, transmission, generation and distribution were unbundled, with IPPs participating most actively in generation while transmission and distribution were devolved into through the development of the Private Sector Power Generation Support Program, funded in part by the World Bank. Kenya now has seven IPPs up and running and contributing some 20% of total national generation capacity. In 2013 the IPP sector played a major role in bringing an additional 668 MW on stream into the national grid through development of new generation projects.

Due to the rapid connection of urban and commercial consumers to the grid, Kenya Energy Regulatory Commission (ERC) now estimates a growth in national demand of some 11% annually. However, according to Kenya Power, the national power distribution entity, the cost of connecting an additional consumer has gone up from $823 to $1,176 due to the huge capital needed to invest in new transmission infrastructure.

Importantly, however, despite the large capital investment needed to improve and extend transmission infrastructure, which remains in the hands of the Kenya Electricity Transmission Company, generation capacity has been expanded greatly with the partial devolution of operations to the private sector, while the very different financing needs and long term investment time horizons of the transmission sector are not holding back delivery of additional power supply in the shorter term due to competition for scarce resources within the same entity.

Nigeria

The power generation shortfall in Nigeria at the outset of the country's recent privatization process can be described as nothing short of catastrophic, with an estimated 5GW or less being delivered to a country of 170 million inhabitants via the national grid, as against a global average of approximately 1 GW per million inhabitants. In addition it was estimated that as of 2013 an additional 25GW was being generated in the country by captive industrial sources and by commercial users independently of the national grid.

In terms of its resources and indeed its massive power shortfall at the time of the plan's implementation, the similarity with the Mozambican situation can be seen at least in nature if not in scale. While the Kenyan Vision 2030 strategy seeks to avoid load following, seeking instead to plan for future needs, the Nigerian situation more resembles our own in the sense that long

term planning is not sufficient, while still necessary, as the shortfalls inhibiting growth, employment and human development are already present and pressing and requiring urgent solutions today.

Financed initially by the country's local banking sector and private investors, by the end of 2013 a total of five out of the existing six power generation companies (gencos) had been privatized and 10 out of the 11 distribution companies (discos) had also been sold off into private ownership. The clear mandate given to the new operators was to focus on delivery of capacity to the grid intended for the residential customer, with industry regarded as the second priority given its ability to source captive power, as well as likely political considerations going into the country's 2015 elections.

In addition, Nigeria secured a contract for the upgrade of the transmission infrastructure of its national power grid, at the same time signing a three-year contract with Manitoba Hydro International to operate its power transmission network for a three-year period.

Investment required in new transmission equipment was estimated at $2.4 bn. much of which was raised locally, giving the banking system considerable exposure to Nigeria's reforming power sector. Further funding was sought from foreign institutions, which proved more challenging due to problems at the regulatory level as well as the obstacle of local currency volatility – gencos and discos earnings in naira would have to be used to service debt normally denominated in dollars.

The scale of the funding required later proved too great for an already overstretched Nigerian banking sector, and recourse to Development Finance Institutions became the preferred option, where funding availability was however also limited.

Another serious issue encountered has been the mismatch of appropriate funding tenor availability with the needs of the sector: whereas power asset investments often involve purchases of equipment with a life of 20 years or more, the availability of funding in the Nigerian market rarely goes beyond loans of a few years maturity, further complicating funding for operators.

The government announced a transitional regime for tariffs and off take arrangements which was to be brought in after an initial phase, to provide security of revenues and contract enforceability for operators under a Transitional Electricity Market (TEM).

TABLE 2: POWER GENERATION PER CAPITA, VARIOUS COUNTRIES, ROUNDED TO 0.1 GW

Country/ Region	2011 Total Electricity Installed Capacity (GW).	Population (m.)	2011 Electricity per Cap. (GW)
Africa	137.7	1,000.0	0.1
Brazil	119.1	202.7	0.6
Egypt	27.8	87.0	0.3
Ethiopia	2.1	96.6	0.0
Europe	1,024.3	509.4	2.0
France	130.4	66.3	2.0
India	237.9	1,236.3	0.2
Kenya	1.7	44.6	0.1
Mozambique	2.2	24.6	0.2
Nigeria	5.9	177.2	0.0
Russia	231.6	142.5	1.6

South Africa	44.3	48.4	0.9
Turkey	57.0	81.6	0.7
United Kingdom	93.2	63.7	1.5
United States	1,052.9	318.8	3.3
Average	--	--	1.1

Revenue collection nevertheless proved more challenging than initially expected, with a shortfall of paying customers, amid widespread bribery of technical staff allowing customers access to non-metered electricity supply.

After considerable delay, in late 2014, TEM was announced by the Nigerian Electricity Regulatory Commission (NERC), establishing PPAs and Gas Supply Agreements (GSAs) between gencos and their customers within a regulated market structure.

The system has continued to encounter problems however, not only in financing but also in the delivery of power across the country's woefully inadequate infrastructure. One issue that contributed was the deferral of capital spending plans and maintenance activities by formerly state operating entities in the transmission sector ahead of the asset sales, leaving the quality and operability of infrastructure impaired at handover.

The highly profitable diesel supply and individual generator companies played a part in delaying the transition as well, unwilling to cooperate fully in the dismemberment of the large and long-standing market for their products.

An additional issue has been the pricing and availability of gas for generation. At present, the tariff is too low to bring forth the investment needed privately to secure supply for generation. While Nigeria has access to plentiful natural gas, much of it is not in the areas where generation has to take place, necessitating costly pipeline investment.

The impaired and inadequate transmission infrastructure is a further problem, with upgrading failing to keep pace with new generation despite the demands of the end user and the ability in principle to pay for supply. This results in so-called 'stranded' generation, serious problem in many countries and one which in Nigeria has already reached an estimated 1500 MW of generation, across a network which can ill afford to see power wasted through lack of deliverability.

Nevertheless, new gas supply projects are coming on stream in the near future, encouraged by the government's commitment to dedicate a 75% share of production to the power generation sector.

Angola

Angola, the second largest oil producer in Sub Saharan Africa after Nigeria, is beset with infrastructure deficiencies across the board, much of which, in common with Mozambique, is the legacy of an extended period of civil warfare in the late twentieth century. Despite concerted efforts in recent years to rectify the situation, power shortages compound the overall infrastructure and logistics environment impeding progress in all areas of the Angolan economy.

The macroeconomic and business environment also has similarities with Mozambique's with a volatile current account exacerbated by dependence on oil revenues as well as a concentration of trading partners internationally, with the EU and Portugal in particular playing a major part. According to the World Bank Angola ranks 181 out of 189 countries for overall ease of doing business, while Angola's power sector can be considered as one of the least efficient in Africa. Access to electricity, which is generated two-thirds from hydroelectric plants and the remainder from thermal plants is challenging.

Nevertheless, the government's investment program includes expenditure of USD18bn over the 2009-16 period to expand hydroelectric and thermal generating capacity to 7,000 MW and to extend the country's transmission network. Longer term, plans exist to link Angola's national grid to the Southern African Power Pool (SAPP) and the Inga III project, part of the DRC's Western Power Corridor (WESTCOR).

Mozambique's recent experience and current challenges cannot be directly compared with developments in its regional African peers outlined above, as differences in resources available as well as priorities for the future exist. Two of the three, Nigeria and Angola, are major hydrocarbon producers, while Kenya, with a relatively mature and diversified economy by regional standards is also in the process of developing offshore oil and gas potential.

Thus, while similarities to Mozambique exist in all three of these countries, measures taken thus far by governments to address critical power deficits have varied enormously. Willingness to relinquish economic management to domestic and international private sector actors, the chosen route in Kenya and Nigeria, has by no means been embraced, to the same extent, as yet, in Mozambique and Angola.

Nevertheless, there is an increasing realization by all that efficiencies are to be gained in the unbundling of functions, notably of splitting off generation operations as well as distribution to the consumer, while transmission network development and maintenance, due to the nature of the investments involved, for the most part has been an area where all governments have sought to retain maximum possible control.

In general, Mozambique comes to this process at a relatively late stage compared to the regional partners surveyed above, whether in respect of policy implementation or in the maturity of the major sectors of the economy which the national power capacity will need to service. Overall, as far as policy formulation can benefit from the outcomes realized by others and in as much as lessons can be learned from outside, some common elements are valuable in recommending a way forward in the Mozambican environment.

8. DISCUSSION AND ANALYSIS

Intermittent and inadequate supply of electricity impacts the industrial sector in particular since production has to be interrupted if no (expensive) alternative sources are located.

Generation devolved closer to the regions of consumption is surely a valid approach to achieving a less vulnerable electricity supply system. The existing potential and the growing demand should naturally fuel entrepreneurship in the development of new sources of supply. Why is this not happening?

A retarded reform process evidenced by e.g. the revision of the electricity law which started in 2011 and is not yet completed and the grid code which is still to be approved are factors negatively impacting investor interest. These shortcomings can be seen as an institutional lack of commitment to sector reform

The oil and gas law should be a useful tool in governing this emerging sector. Business Monitor International was recently cited by *Jornal o Pais* as having said that excessive “resources nationalism” would refrain investors’ enthusiasm due to its clearly stating that a quarter of all production of oil and gas products has to be used to spur domestic industries and consumption.

In our view, while the intention of the law is to ensure direct benefits to the country from these resources, what will actually determine the amount of oil and gas for domestic use will be the internal market itself and its ability to perform.

To date 27 MGJ +9 MGJ (royalty) is available from SASOL’s production at Temane for the national market. According to Law 21/2014, 45 MGJ out of 183 MGJ/a produced by SASOL are readily available at a price to be defined by the government (art. 35 nr 2).

9.Electricity cost of supply versus tariff charged

The policy of universal standardized price access to electricity means an increased overall unit cost of supply with no corresponding positive impact on revenue as the majority of new consumers lie below the social tariff level. As per Energy Policy Directives electricity suppliers are expected to commit to serve the customer with high quality and low cost electricity to ensure the human right to development which is not achievable without access to sustainable energy. The differentiation in tariff is set by consumer categories and by consumption levels rather than the cost of supplying power.

As in any business the cost of production and unit sales price determines performance. In Mozambique every citizen has the right to enjoy the benefits of electricity at the same rate no matter his location. Irrespective of the fact that the same principle is not applied to e.g. sea food or indeed liquid fuels for that matter, it is an acceptable philosophy that avoids the arbitrary approach.

PPP Investments

The Government of Mozambique, mindful of its lead role in enabling economic activity, has approved a number of investment incentives and set up a facilitating institutional framework to operationalize this objective. Government bodies were set up with CPI in investment promotion, and Gazeda, the Office for Economic Free Trade Areas with Accelerated Development, designed to promote rapid development clusters with preferential fiscal regimes and strategically located across the country. Beluluane Industrial Free Trade Area, the location of the aluminum smelter Mozal, together with the Special Economic Zones of Nacala, Beira, and Mocuba in Zambezia are examples of areas enjoying a number of incentives with the aim of promoting the industrial production of goods both for export and domestic consumption.

Normally the special economic zones are confined to pre-determined geographic locations.

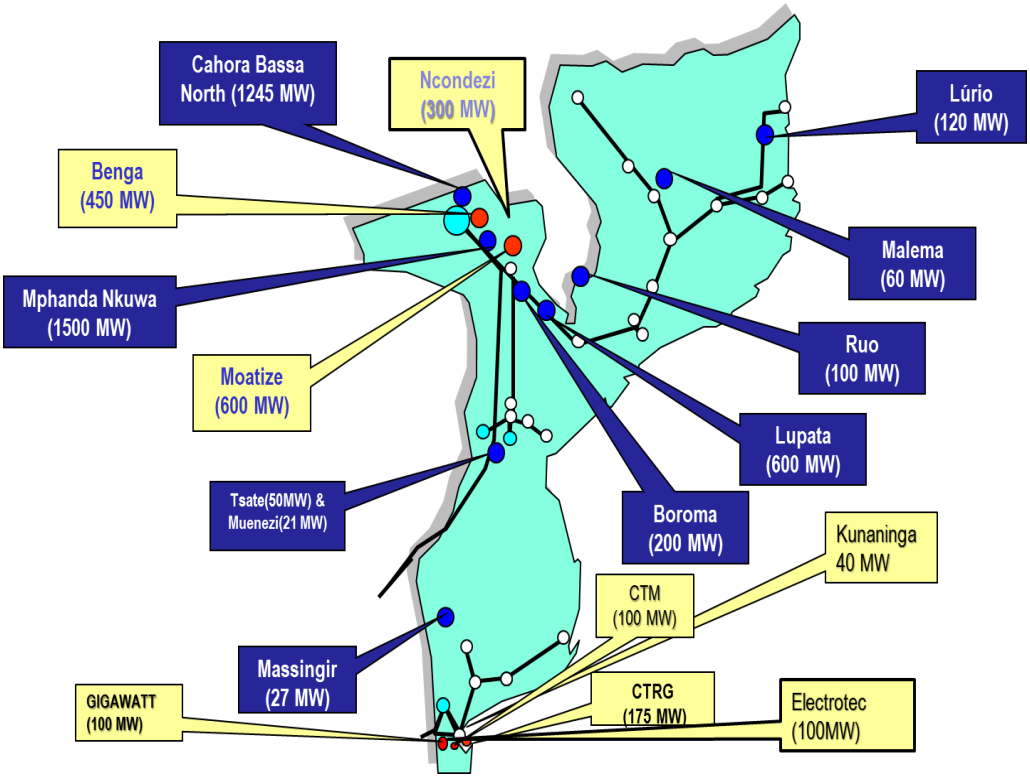
As inter-institutional planning is still a challenge for economic management in the country, often the electricity (and water) suppliers for example are not present at the negotiating table nor involved in the licensing process. The result is regular project backlogs due to the lack of those institutions' inputs.

Specifically, to ensure availability of power and thus viability of the accelerated development zones, the lead institutions should estimate needs in electricity (and water) in the early planning stages by involving the utilities.

Following this stage the utility should choose the best possible way to supply the special zone via a designated source that would be developed under the same incentives as if it were located **within the limits of that specific special zone** including the transmission component.

Instead of subsidizing consumption of power, incentives would effectively subsidize the **generation of power** to promote the productive use of electricity at an affordable rate reflected in the final price of goods.

FIG 6. - GENERATION PROJECTS (HYDRO & THERMAL) BY LOCATION



Thermal Power burning Natural gas will play a capital role in the south (Maputo and Ressano Garcia areas) as it can be seen in the next table illustrating some generation projects under implementation:

TABLE 3 - GENERATION PROJECTS UNDER IMPLEMENTATION

Generation Projects under implementation (at different development stages)						
		Expected Commissioning year				
Project	Fuel	2015 (MW)	2016 (MW)	2017 (MW)	2018 (MW)	2019 (MW)
CTRG	Gas	175				
Kuvaninga	Gas	40				
Electrotec	Gas		100			
Gigawatt	Gas		100			
Moatize	Coal			50		
ENI	Gas			75		
Benga	Coal				300	
CTM	Gas				100	
Nkondedzi	Coal					300
Total/ year		215	200	125	400	300
Total Cumul		215	415	540	940	1240

Such an approach would act as an enabler for projects such as Lurio (Hydro 120 MW + water to Nacala Special Economic Zone), gas power plants at Ressano Garcia, and Massingir Hydro for the Beluluane Industrial Free Zone; Tsate and Mwenezi (Hydro 60 MW at Revue basin for the Manga Special Economic Zone at Beira), Mutelela (60 MW) or Malema (60 MW) hydro projects for the Mocuba Special Economic Zone.

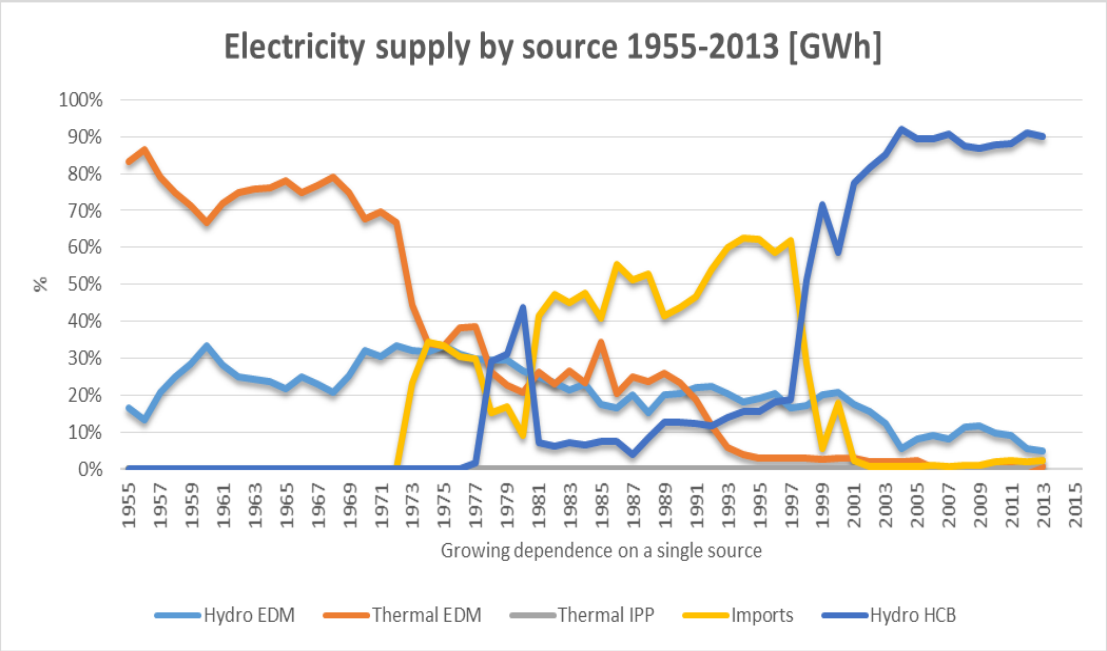
The full adoption of the incentive mechanisms already in place could motivate developers in a more expeditious way than through the PPA route and a cost reflective tariff might be ensured on long term basis.

Several power projects in the coal mining areas at Tete are now on hold awaiting roll out of the STE project while neighbouring Malawi starves for electricity and even the new railway linking Moatize to Nacala could have been realized through electric traction by using the electricity produced from abundant thermal coal available locally.

This sort of arrangement would result in the following immediate advantages:

- Energy matrix diversification
- Network stabilization due to the existence of several generation connections to the grid
- System flexibility and avoid high levels of vulnerability as shown in Fig.7
- Improve the available clean electricity for exportation, thus contributing to mitigate regional carbon footprint.

FIG. 7 - ELECTRICITY SUPPLY DEPENDENT ON SINGLE SOURCE OR NEAR-SINGLE SOURCE [EDM]



10. CONCLUSIONS AND RECOMMENDATIONS

Electricity consumption growth in urban, peri-urban and rural residences, industries and other commercial enterprises are key contributors to a country's socio-economic growth. Availability of electricity will be a catalyst for industrial growth, employment, productivity and development of related business and commerce. Agro–industries will be important catalysts in the rural areas associated with productivity and income dynamics, informal and formal goods and service suppliers to the large industries. Industries will continue evolving and new business will be attracted to set up in Mozambique.

The analysis presented above and the discussion which follows, together with the benefit of comparable experiences of regional peers, demonstrate that creating an environment that investors can feel comfortable with, whether through appropriate levels of unbundling of state-owned assets or otherwise, setting workable cost-reflective tariffs, outsourcing of management in the short term while developing local skills for the long term, are all priorities to be addressed in policy formulation.

At the same time, raising performance and ensuring maintenance of existing assets, controlling costs while monitoring distribution and ensuring better contract enforcement are elements

where improved implementation has featured in the above countries' experience. Each of these components is common to Mozambique's situation and need to be addressed within future overall power sector strategy.

Unbundling of upstream and downstream operations

How can energy stakeholders best promote successful large-scale change in the electricity and electrification business? Unbundling of operations at the generation and distribution levels have been clearly shown to offer superior alternatives in comparable situations and have yet to be given free rein to flourish in the Mozambican context.

In order to mitigate the continuing crisis situations in a short term basis, this study recommends interventions in three distinctive areas: generation by opting for alternative sources of power, transmission infrastructures to deliver the power thus eliminating bottlenecks and distribution by introducing a rational use of power (including demand side management).

Although operators are still shy of the Mozambican market, private initiatives are appearing at the upstream level. Several generation projects promoted by private entities are in the pipeline. At the transmission level the sole exception of non-public intervention is the Motraco case which is nevertheless a valuable precedent and a clear sign that the transmission monopoly assigned to EDM by law can be bypassed in the face of strong imperatives. What then should happen at the downstream level?

Energy together with people, need to be recognized as key ingredients for development. Therefore, the Ministry of Economy and Finance through CPI, GAZEDA and other institutions must design clear action-oriented programs toward the goal of transforming Mozambique into a regional energy giant.

A complete Master Plan for gas including a specific program of transforming Gas to Power is highly recommended. To promote distributed generation for network stabilization, lower the vulnerability of long distance loads and enhance local content of distributed power special geographical incentives should be mapped

PPP Mini-Grids

To ensure efficient distribution of electricity at a local level it seems that the establishment of local private-public distribution entities ("mini-grids") to service the network within clear terms of reference and targets for new connections would help.

The profit made by such entities would mirror and substitute savings in costs currently incurred by EDM's operating inefficiencies. Such on-grid to mini-grid transmission would be achieved by buying bulk electricity from EDM to be distributed to consumers. To maintain standards all expansion projects – normally subsidized by the government and partners – would be implemented by EDM. In theory however, future local generation e.g. from domestic solar units could also be re-sold back into the network as could any surplus generation from the mini-grid be re-sold to the national grid.

How best to define, regulate and manage such private-public mini-grids?

In a pilot stage every distribution load up to e.g. 10 MW could be considered. Appropriate management e.g. retired skilled employees from EDM or from other comparable experience internationally should be motivated to take over such entrepreneurship in partnership with municipalities. Pre-paid metering - still managed by the utility - could be maximized to collect revenue and transparently share costs and revenues.

The relationship between electricity (water or gas) suppliers with municipalities is a natural one as urban planning and development require in one way or another the cooperation of those entities. As a historical reference, before independence the electricity supplier to Maputo city was SMAE (Servicos Municipalizados de Agua e Electricidade) an entity that sourced its bulk electricity from Sonefe, the company that owned and operated a coal-fired power plant.

Similarly, the company that distributed electricity in Beira was named after SME (Servicos Municipalizados de Electricidade), which in turn bought its power from SHER (Sociedade Hidrolectrica do Revue) a private company that erected the Mavuzi and Chicamba power stations. Across the other provincial capitals both generation and distribution were also run by the municipalities or local administrations.

Furthermore, across the border in South Africa, Citi Power is the electricity provider for Johannesburg, not ESKOM. There is thus a wealth of examples both domestically and internationally for the exploitation of such private-public structures to maximise supply and reduce cost of local transmission and distribution.

Some years ago EDM initiated a process named "Separacao de Contas" by creating business centres which were to clearly specify the requirements for every operational activity while identifying inefficiencies as accurately as possible. If fully implemented, such projects could lead to more municipalized electricity distribution through private business participation, leaving public entities available to focus their upstream capabilities in excelling at generation, sourcing and provision of electric to power the economy.

Such an unbundling of EDM's generation, transmission and distribution is presented as the way forward to greater efficiency together with leaner operational structures requiring effective, skilled and committed manpower.

The load forecast produced in the MPUP dictates an exponential growth that will be reflected within the country in a short, medium and long term basis, mainly as a result of the GoM's ambitious electrification program and of the large appetite from local/international investors willing to develop large commercial/industrial activities to accommodate the recent coal mining and natural gas exploration.

Therefore if no major interventions are made in the Electricity Industry in Mozambique, bearing in mind the current power shortage, the load growth will have negative consequences creating two major impacts:

- Possible rolling blackouts as supply fell behind demand which will force the utility to run with load shedding schedules, similarly to Eskom's 2007 event; and
- Retardation of the country's socio-economic growth due to unreliable and non-security of supply

Demand side management

It is recommended that EDM exerts efforts to change consumer behavior in demand of electricity through a variety of methods including financial incentives and improving awareness of supply constraints to aid load use optimization, as a short term solution.

This can be performed by allocating load (especially industrial sector load) from the evening peak hours to be consumed at off-peak hours. The advantage of this approach is to improve the use of available capacity in the power system and to save or postpone further investments until resources become available.

Demand Side Management awareness education can be implemented in the following areas:

- Interruptible Supply; during emergency hours contracting large customers should cut their consumption.
- Energy Efficiency: means of reducing customers' total consumption at all times. e.g. low energy lamps, solar power geysers, etc.
- Strategic allocation of load in the system: measures to encourage additional load in the system during off-peak hours. e.g. agriculture irrigation, etc.
- "No go" this method is to deny/retard introduction of new loads into the system, a technical approach resulting from the unavailability of power capacity to meet with demand. Note however that this procedure contradicts the development goals of the GoM.

APPENDIX: LEGAL FRAMEWORK

The table below shows the legal framework that governs Investments, Special Industrial Zone establishment and the power sector in general.

TABLE 3. LEGAL FRAMEWORK GOVERNING INVESTMENTS, SPECIAL INDUSTRIAL ZONES AND THE POWER SECTOR.

Legal instrument	Subject	Observation
Law 3/1993	Investments law	
Decree 43/2009	Regulation of the Investment law	
Decree 4/2009	Code of Fiscal Benefits	
Decree 56/2009	Regulation on Fiscal Benefits Act	
Minis. Diploma 14/2002	Regulation on Custom Regime on the free Industrial Area	
Decree 75/99	Labor regime for the Industrial Free Zones	
Decree 75/2007	Organization chart for the Special Economic Zones Office	
Decree 28/1995	Creates EDM - EP from EDM EE created in 1977	
Law 21/1997	Approves Electricity Law and creates CNELEC	Under revision (MoE)
Decree 24/1997	Creates FUNAE to spur off grid access to modern energy	
Decree 8/2000	Regulates the Electricity Law	
Decree 25/2000	By laws of CNELEC	
Decree 3/2001	Crude oil law	
Decree 42/2005	Rules for industrial Electrical installations. (Gen, Tran. Distrn.)	
Decree 43/2005	Nominates EDM as the RNT concessionaire	
Decree 44/2005	Natural gas	

Resolution 5/1998	Approves Energy policy	
Resolution 10/2009	Approves Energy34 strategy	
Decree 1/2010	Tariff for electricity used in agriculture	
Law 15/2011	Private, Public Partnership	
Decree 12/2012	Regulation of the PPP law	
Law 21/2014	Oil and Gas Law	

Laws 15/2011 (The PPP law and its regulation), 21/97 (Electricity Law, still under revision) and 21/2014 (Oil and Gas Law) may, in association with the existing investment regulations and the special economic zones, be the key to establishing an unified incentive framework for the power sector integrated at all levels of the economy and cost in a manner consistent with maximizing overall benefits to society as well as long term development needs.

The recently approved law governing oil and gas activities (Law 21/2014) is challenging to the country as whole as it has to draft ways to maximize the use of the 25% of all produced gas in the domestic market.

The Electricity law - 21/97- is under ongoing review apparently to strengthen and enhance the role of the regulatory entity CNELEC certainly including natural gas and liquid fuels distribution in its scope and to improve sector efficiency to encourage greater private investments.