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Monograph:
Salite, Daniela Lidia Jacob, Cotton, Matthew David and Kirshner, Joshua Daniel (2020) Electricity access and social sustainability in Mozambique. Working Paper. Energy Insight . Oxford Policy Management , Oxford, UK.

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Energy and Economic Growth
Applied Research Programme

Electricity access and social sustainability in Mozambique

Energy Insight

Daniela Salite
Matthew Cotton
Joshua Kirshner

December 2020

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Introduction

The demand for access to electricity in developing countries is rapidly increasing as intergovernmental organisations, national governments, and business leaders recognise the social and economic value of infrastructure investment. The institutions that govern energy investment and planning recognise a 'trilemma' of system development: low-carbon energy sources are needed to meet global climate change mitigation goals, while also meeting service reliability demands and energy security measures alongside maintaining service affordability, particularly for residents on the lowest incomes in rural, urban, and peri-urban communities. Integrating traditional, centralised grid networks based upon large-scale generation technologies (in the case of Mozambique, this includes hydropower from the Cahora Bassa Dam) with decentralised off-grid renewables such as solar projects in rural communities is a significant technical and governance challenge. Energy providers are tasked with a social mandate to deliver good quality electricity at an affordable price to consumers while widening access to underserved populations.

Providing access to clean and reliable energy sources is embodied in Sustainable Development Goal 7 as one of the preconditions for socioeconomic development, poverty reduction, and human wellbeing (Pueyo and Maestre, 2019; UN Energy, 2005). International development practitioners and policy networks recognise the tangible benefits of electricity as a form of energy service provision. These tangible benefits include lighting and powering appliances at domestic, private, and institutional levels and increased telecommunications coverage, which collectively provide new personal and business development opportunities, healthcare and food safety benefits, and improved leisure and night-time education prospects (UN Energy, 2005). They also minimise the health risks and ecological impacts associated with black-carbon fuels such as charcoal, which diminish air quality within residential buildings (Anenberg, 2017) and lead to deforestation (Sedano *et al*., 2016).

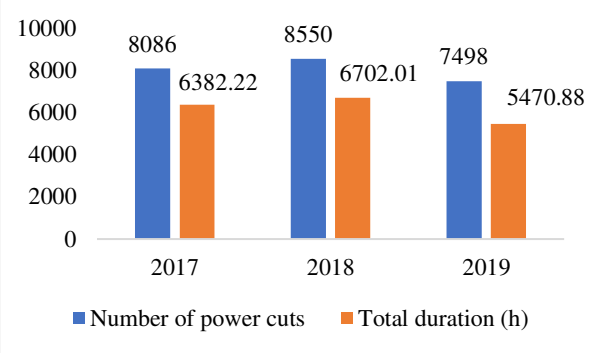
In order to enhance electricity sector performance, many sub-Saharan African countries have implemented significant governance reforms. It is necessary, however, to evaluate whether such reforms facilitate expanded social access to electricity, whether they improve service quality, public utility, and financial stability, and whether they lead to broader social and environmental sustainability goals. In this policy brief, we assess these dimensions related to the case of Mozambique, a country where major progress has been made to increase population-wide access to electricity from around 6% in 2004 (Chambal, 2010) to 32% in 2019 (EDM, 2020a). Though policy progress is significant, challenges remain, particularly in rural areas, where only around 6% of the population have electricity access (EDM, 2018a).

Electricity reliability and affordability challenges

In Mozambique, electricity is provided through the national Electricity Supply Company (*Electricidade de Moçambique* E.P. (EDM)). EDM is a vertically integrated public company established in 1977, charged with the generation, transmission, distribution, and commercialisation of electricity (Arthur and Cockerill, 2019). It has a social mandate to expand access to electricity for consumers across urban and rural regions, though it continues to face multiple challenges in meeting this goal (Nhamire and Mosca, 2015).

Though advancements have been made in terms of expanding grid connections, with major Mozambican cities such as Matola, Maputo, Nampula, and Beira having 80%, 98%, 89%, and 88% electrification rates respectively (EDM, 2020a; b), grid reliability and service quality remain ongoing technical challenges. Despite a decrease of 12.3% in the number and a decrease of 8.5% in the duration of power cuts nationwide between 2018 and 2019 (Figure 1), Mozambique still registered roughly 7,500 power outages with an average duration of around 43 minutes (EDM, 2020c). Unreliable electricity supply, exacerbated by extreme weather events and peak loads (usually during the 18:00–23:00 timeframe), cause problems for domestic users due to associated financial and emotional costs. Poor-quality and intermittent electricity cause disruption to domestic energy services such as refrigeration and lighting, leading to external costs (e.g. spoiled food or damage to household appliances), disruption to social and economic activities, and the supply of associated secondary energy services such as clean water provision. Under conditions of uncertainty over when electricity will be restored, citizens are forced to revert to solid and liquid fuel energy sources such as candles, oil lamps, and charcoal to meet acute lighting and heating needs.

Figure 1: Total number and duration of power cuts registered between 2017 and 2019 (source: EDM, 2018c; 2020c)



The issue of electricity reliability is compounded by a range of socioeconomic and political constraints. Mozambique has an ageing grid infrastructure across the asset base (i.e. substations, transmission, and distribution lines). The majority of currently operating infrastructure was constructed under colonial rule, prior to independence in 1975. This infrastructure is both inefficient and poorly maintained in some regions, leading to a reduction in the installed capacity of existing lines and substations (World Bank, 2020) and comparatively high rates of electricity loss (around 30%, amounting to up to US$ 100 million). Geographic distance from power generation and distribution sources, along with high summer temperatures, increases transmission losses, and further reducing energy efficiency and increasing cost.

Deteriorating and fragmented infrastructure and power interruptions are exacerbated by Mozambique's increasing vulnerability to extreme weather events such as flooding, droughts, and cyclones, which are currently increasing in both frequency and intensity as a result of ongoing anthropogenic climate change disruption. A notable recent example is Cyclone Idai, which struck near the coastal city of Beira in March 2019 and affected more than 1.5 million people, killing 603 civilians, and internally displacing over 400,000 (UNDP, 2019). The cyclone also damaged existing infrastructure and forced the city to operate with only one of two existing transmission lines. Residents then experienced supply loses due to an overloaded grid network. The ongoing challenge of insufficient electricity infrastructure capacity is spread across Mozambique; when combined with policy strategy to increase the number of grid connections and urban/peri-urban electricity distribution networks, this leads to transmission system overload and damage to existing infrastructure assets.

The Mozambican government has set ambitious targets to connect 300,000–450,000 new customers annually to the centralised grid. This policy initiative aims to meet universal access goals by 2030 and fulfil political promises (EDM, 2018a). This puts considerable political and financial pressure on EDM and strains the operating capacity of the already-overloaded transmission infrastructure. EDM is concurrently suffering from financial insolvency, which limits its capacity to invest in upgrading and extending the grid network to areas that are considered financially unviable given the lack of return on investment. The growing public sector electricity bill debt (currently standing at US$ 42 million) alongside increased provision of public lighting (Figure 2), sometimes even during daylight hours, compounds EDM's financial insolvency (EDM, 2020a; Nhamire *et al*., 2019).

Figure 2: Street lighting switched on in the morning at the National Road 4 (N4) (source: author, May 2020)

In key urban and peri-urban areas, residents may engage in electricity theft by bypassing meters or patching into illegal connections (Baptista, 2015). This informal electricity market activity is in part a response to problems of energy affordability for domestic consumers. However, this creates a self-perpetuating cycle of low investment and poor-quality service access. Electricity theft further destabilises electricity connections and reduces EDM's profit, further hindering its capability to maintain a low price-point for consumers. Ordinary urban residents may also build structures such as residential extensions and commercial buildings that require larger power transformers without previously consulting EDM: this threatens to overload transmission and distribution assets, potentially endangering public safety and damaging property. Grid instability is further exacerbated by vandalism and theft of equipment and infrastructure (e.g. theft of electrical cables for producing cooking pans) (Figure 3).

Across Mozambique's diverse geography, the largest cities of Maputo, Matola, Nampula, and Beira have registered an increase in the number of overloaded

substations and distribution lines, causing more brown-outs. EDM's capacity to upgrade, monitor, and maintain its infrastructure to support growing demand in all parts of the country (south, centre, and north) is limited, in part due to the distance between electricity generation sources (including, but not limited to, the Cahora Bassa Hydrodam) and sites of energy demand. Moreover, EDM lacks sufficient technical staff to make necessary maintenance, upgrade, and repair work to the ageing infrastructure assets (the company has 3,327 employees, compared to more than 2 million total customers) (Figure 3) and is often unable to respond to customer access needs within the promised three-hour period.

There is also disparity of access provision between commercial and domestic users. The spatial concentration of customers in the country's largest cities creates a challenge for EDM in balancing household connections with the needs of expanding high-energy use businesses, considering EDM only has the capacity to generate approximately 12% of total electricity needs (EDM, 2020a). Under peak load conditions, the existing electricity supply is usually insufficient to meet all user needs (World Bank, 2015); large energy-user private enterprises are often prioritised for electricity service provision due to their reliable payment schedules compared to the public sector or to private households.

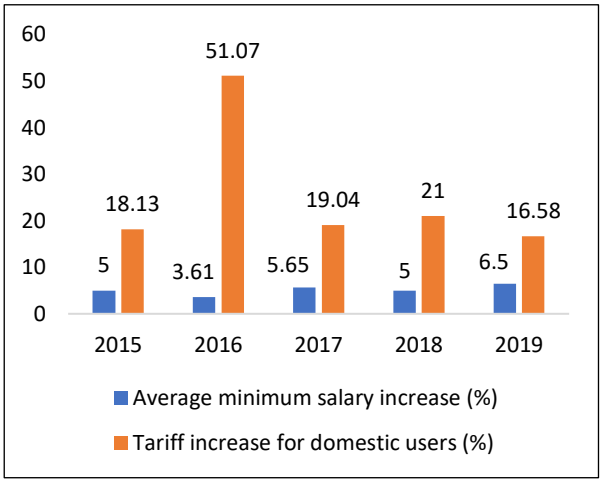
Figure 3: Vandalised power tower (top) and grid network lacking maintenance (bottom) (source: *Jornal Noticias*, 2020; author, August 2020)

On the energy supply-side, capacity deficiencies have exacerbated customer affordability problems. EDM now purchases up to 88% of its total electricity needs from outside sources. Some 36% (2,491MW) of this electricity comes from independent power producers (IPPs) at prices that are three to four times higher than those charged by the state-owned company Cahora Bassa Hydroelectric (US$ 0.036/kWh), which manages the country's largest hydroelectric dam, a key source of generation and export (Sebitosi and de Graça, 2009). EDM spends millions of dollars annually buying electricity from the IPPs (Nhamire *et al.*, 2019) for US$ 0.09–0.10 per kWh, which it then sells at loss for an average of US$ 0.076 per kWh amid the company's growing operational costs and financial restrictions (EDM, 2020a). The negotiation between state actors and IPPs is fraught with the problem of *rent-seeking* – the agreed electricity prices bring in state wealth without any reciprocal contribution of productivity (Nhamire et al., 2019), this results in inefficient pricing within electricity markets. Unfortunately, rent-seeking and enrichment of ruling party-allied elites to secure a portion of the growing revenue from natural resources (including energy generation and supply) is deeply embedded in Mozambican political history (Nuvunga and Orre, 2019; Orre and Rønning, 2017). In practice, rent-seeking means providing favourable purchasing agreements for IPPs, ultimately limiting EDM's capacity to negotiate lower and fair electricity purchase prices and harming the company's social mandate, as well as consumer affordability.

Across a broader regional perspective, Mozambique has one of the highest electricity tariffs in southern Africa (US$ 0.1058/kWh) (SAPP, 2019). However, these tariff rates do not reflect EDM's operational and investment costs, despite the substantial increase in tariffs by 126.4% since 2015 (Figure 4). This tariff conundrum has been created by EDM's increasingly unsustainable debt with suppliers (upwards of US$ 1

billion), such as power generation companies and contractors (EDM, 2018a). Though tariffs increase incrementally to cover supply and investment costs and debt servicing, these increments exceed annual minimum salary increments for most workers, as shown in Figure 4. As a result, electricity costs absorb up to 59% (2,512 MZN/month) of monthly household budgets—compounding the problem of energy poverty for the poorest people.

Figure 4: Comparison of the annual increase in the average minimum salary and tariffs (source: SAPP, 2015–19; Wage Indicator, 2020)



EDM's planned actions to secure the supply of reliable electricity

EDM's investment in grid infrastructure is subject to continuing financial restrictions and growing dependence on external funding from donors, private investors, and the government. These funding avenues are subsequently influenced by the broader national political and economic instability Mozambique faces, notably a financial crisis driven by the uncovering of US$ 1.2 billion of undisclosed government loans, which resulted in the International Monetary Fund and foreign donors rapidly cutting off support. This triggered a currency collapse and a default on the country's sovereign debt (Hanlon, 2016). With dwindling public sector and donor financial support as a result of the financial crisis, raising domestic revenue through cost-reflective tariffs is a key area of policy concern. EDM asserts that growing the customer revenue base is the solution to the financial challenges it faces – and that such revenue would be reinvested to improve service quality through infrastructure improvements, and thus allow the company to respond to growing electricity demand and further increase household access nationally (Arthur and Cockerill, 2019; EDM, 2018a).

As such, tariffs will continue to increase annually for the next 22 years in line with the consumer price index and total electricity supply costs (EDM, 2018b). This will happen despite several plans for the construction of more power generation sources, including renewable energies that are cheaper, cleaner, and more sustainable. These projects aim to increase EDM's capacity to supply electricity and to collect revenue both domestically and regionally (e.g. in Malawi, Tanzania, and Zimbabwe) (see Box 1 and EDM, 2018a). Additionally, the government has televised promises to reduce tariffs by 10% in response to the COVID-19 pandemic, which could undermine existing EDM's plans for a tariff increase.

Box 1. Priority infrastructure projects carried out by EDM (EDM, 2018a)

Donor, private investor, and government funding all play a role in the national electrification strategy 2018–28. EDM is carrying out multiple projects to improve the grid network, the quality and quantity of electricity supply, and its financial viability, including the following:

- the Power Efficiency and Reliability Improvement Project (PERIP), 2018–23;
- power generation projects through the construction of more hydropower (4), solar (1), wind (2), coal-fired (5), and gas-fired (4) power plants, for the next seven years (until 2027);
- regional grid connection projects with Malawi, Tanzania, Zambia, and Zimbabwe, 2018–24;
- national grid connection projects, Caia-Nacala and Maputo-Temane, 2019–24; and
- digitisation to transform the company into a Smart Utility (over the next five years).

Transparency and fairness in tariff formulation

A significant challenge in electricity service provision in Mozambique is that, although rising and cost-reflective tariffs may improve EDM's financial position, they present a prohibitive cost for consumers, particularly when prices rise at a faster rate than wage inflation. Under conditions of financial stress, this may lead consumers to cut electricity demand by reducing appliance usage or by fractioning electricity purchase into smaller units (such as weekly rather than monthly payments through pre-paid metering systems) and rationing electricity use by reverting to perceived cheaper alternatives, such as charcoal or bottled gas for cooking. The former has negative environmental impacts due to deforestation and biodiversity loss, as well as to human health from indoor air pollution, leading to respiratory and heart disease. Price increases may also create a perverse incentive for illegal connections, which would have negative impacts on

EDM's revenue-raising approach. If conditions are not created to address consumer affordability through, for example, salary increases or income generation opportunities, universal access to electricity will be stifled and the policy position of the Mozambican Government to meet national Sustainable Development Goals will fail. The analyses above show that, besides non-cost-reflective tariffs, several interlocking factors contribute to EDM's lack of financial solvency to invest in operations and to provide quality services. Greater exploration of these interrelated factors is needed by energy policy authorities within government, donor organisations, and EDM itself.

As a major steward of Mozambique's energy system and as a provider of public energy services EDM must urgently review its business strategy to balance between addressing financial insolvency risks, improving its asset performance and customer service, and addressing the longer-term social sustainability goal. We therefore argue that:

- further transparency is needed regarding tariff formulation for consumers and how this influences EDM's capacity to meet social sustainability goals for the Mozambican people;
- the same way consumers have an obligation to provide all the necessary information to EDM for billing purposes, as enforced by the Electricity Law 21/97; EDM must also provide information to consumers regarding pricing and supply levels. Enforcement of consumer information provision is needed through stronger regulatory compliance and enforcement; and
- the Energy Regulatory Authority (ARENE, or *Autoridade Reguladora de Energia*), created in 2017, should revise the current tariffs prior to EDM's intervention into electricity supply markets in order to ensure consumer affordability interests are met before cost schedules are fixed. The revision process should be fair, transparent, and public.

Energy governance and enforcement

While the Electricity Law comprehensively addresses the duties and the rights of the electricity company and of consumers, enforcement lags behind the rhetoric. Considering the pivotal role played by the state in the formulation of policies, strategies, planning interventions, and the legal and regulatory framework of Mozambique's energy sector, the state should be the first to enforce their implementation. As such, it is pertinent to:

- depoliticise consumer electricity prices as a political campaign issue, such that democratic candidate claims to ensure low-cost service provision are transparently costed and tariff rates are divested from election cycle promises;
- avoid political rent-seeking and to allow public companies to be administrated independently with a private management system. A strong anti-corruption policy and strategies such as those implemented in Tanzania to tackle discretionary authority in awarding legitimate or illegitimate benefits to clients such as IPPs (Rahman, 2019) can be successful in addressing rent-seeking behaviour;
- provide stronger enforcement on grid disconnections due to electricity debts for public authorities, followed by high financial penalties for non-payment within 30 days of warning;
- design clear legal guidance regarding how energy supply companies should exercise the right to disconnect non-paying public institutions from supply services;
- focus on processes to liberalise the electricity supply market to increase competition and diversify the electricity market, thus building financial resilience into electricity supply services. Market diversification will encourage greater market efficiency in tariff-setting and reduce domestic financial and political uncertainty. Liberalised markets will require accompanying regulatory oversight to ensure cost efficiency, engagement between electricity supplier and stakeholder networks for investment planning, and protection of consumer interests on grounds of cost and reliability. The existing body, ARENE, can be adapted to strengthen regulatory governance by independently exercising its roles and competencies over the energy sector to ensure its proper functioning and safeguarding all stakeholders' interests, including the right of consumers to have reliable electricity at a fair price; and
- encourage a more favourable investment environment to allow private investors to expand low-carbon electricity supply businesses, for example through reduction or exemption from renewable energy equipment import taxes, while addressing the needs of consumers and the national and international goal of universal access to electricity.

Conclusions

The state electricity provider EDM has four primary goals. The first is to improve the social sustainability of electricity service provision for Mozambican consumers by providing reliable access that meets user demands and reduces social disruption from brown-outs and equipment failure. The second is to expand access across the diverse geography of the Mozambican urban and rural regions, providing 'last-mile' access to rural communities and connecting urban centres to remote sites of electricity generation. The third is to maintain system reliability and service maintenance/upgrades under conditions of internal and external financial pressures. The fourth is low-carbon generation and meeting Sustainable Development Goals towards clean energy generation and supply. Managing this set of competing social, economic, and environmental objectives remains challenging under current commercial and political circumstances. EDM suffers from poor revenue-raising capacity, given its unpaid bills and mounting debt, political pressure to keep tariffs low, and a growing funding gap that is bridged through raising tariffs to consumers. It is important that EDM should articulate the social need for raising revenue to relevant stakeholder networks, thus garnering political support from consumer groups, donors, public sector organisations, and high-energy use commercial sector organisations. Raising revenue must be shared equitably across the network supply chain: improving invoicing and bill payment from public sector organisations, cracking down on illegal connections, and improving supply services to reduce the need for informal electricity markets will provide a sustainable asset base.

Where tariffs are raised to better reflect the costs of supply, maintenance, and network upgrades, it is important that EDM should be allowed greater leverage in negotiations over electricity pricing from IPPs and other private organisations. The overall price structure of the electricity system requires greater market liberalisation combined with robust regulatory oversight from ARENE to facilitate fair cost-sharing between suppliers, EDM, and consumers, while allowing a schedule of network investments to improve access rates and services reliability as a matter of long-term system planning.

Acknowledgements

This policy briefing is an output of the project 'A political-economic analysis of electricity grid access histories and futures in Mozambique (POLARIZE)', funded by UK Aid through the UK Foreign, Commonwealth, and Development Office and the Energy and Economic Growth Applied Research Programme administered by Oxford Policy Management Ltd. In POLARIZE, the authors examine the socioeconomic, spatial, and political factors contributing to the challenges faced by the national EDM to provide reliable and affordable electricity in Mozambique. We present findings from qualitative interviews with 120 households and 87 public, private, and donor-level stakeholders in four major Mozambican cities (Matola, Maputo, Nampula, and Beira) conducted in 2019 and 2020. Comments in this policy brief are related to the authors' own analysis and are not reflective of positions taken either by the Foreign, Commonwealth, and Development Office or by Oxford Policy Management Ltd.

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About the authors

Dr Daniela Salite is a Postdoctoral Research Associate at the University of York, UK, daniela.salite@york.ac.uk
Prof. Matthew Cotton is Chair of Public Policy in the School of Humanities and Social Sciences at Teesside University, UK, m.cotton@tees.ac.uk
Dr Joshua Kirshner is a Senior Lecturer in Human Geography at the University of York, UK, joshua.kirshner@york.ac.uk

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