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The Electricity Sector and Jirama

Constance de Soyres, Joanne Tan and Claude Wendling

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IMF Selected Issues Papers are prepared by IMF staff as background documentation for periodic consultations with member countries. It is based on the information available at the time it was completed on February 11, 2025. This paper is also published separately as IMF Country Report No 25/61.

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African Department

The Electricity Sector and Jirama
Republic of Madagascar

Prepared by Constance de Soyres, Joanne Tan and Claude Wendling

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April 2025

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ABSTRACT: *Madagascar faces significant challenges in electricity access, with only 36 percent of the population connected. The state-owned utility, JIRAMA, struggles with inefficient production, high transmission and distribution losses, and tariffs below recovery costs. These issues create a substantial fiscal burden on the government, hindering social investment and economic growth. The situation negatively impacts business productivity, making the urgent implementation of JIRAMA's recovery plan essential. This plan should aim to enhance efficiency, reduce losses, and shift towards renewable energy, requiring robust support from the government to ensure sustainable development and improved living conditions for the population.*

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Republic of Madagascar

Prepared by Constance de Soyres, Joanne Tan and Claude Wendling

REPUBLIC OF MADAGASCAR

SELECTED ISSUES

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Approved By
The African Department

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THE ELECTRICITY SECTOR AND JIRAMA[1]

While only 36 percent of the population has access to electricity in Madagascar, the state-owned utility company JIRAMA is faced with three major issues: (i) insufficient and inefficient production, (ii) losses during the transmission, distribution and commercialization phases, and (iii) tariffs below costs. It results in a high fiscal cost for the government, diverting resources from much-needed social spending and investment.[2] More generally, it has a negative impact on firms' productivity, on economic growth and development, which makes the finalization of JIRAMA's recovery plan increasingly urgent. Its implementation will require strong support from the executive branch.

A. Background

1. **Around 36 percent of the population has access to electricity, with most of Madagascar's energy provision coming from traditional sources (wood, charcoal)**.[3] According to a report financed by the African Development Bank, 83 percent of energy provision comes from wood and charcoal, which is one of the main drivers of deforestation (average forest reduction by 40,000 ha every year).[4] The remainder of energy provision (17 percent) is from other sources, with around 11 percent coming from hydrocarbons.

2. **Electricity production relies mostly on fossil fuels, in spite of a strong potential for renewable energies and notably hydropower**. In 2023, fossil fuels represented a total of 53 percent of installed capacity, followed by hydroelectricity (33 percent) and solar energy (14 percent), for an installed capacity totaling 718MW.[5] Hydropower was the top source of electricity for most of the last three decades, only recently eclipsed by oil-fueled generation. Economically feasible potential hydroelectric power is estimated at 7,800MW with only 3 percent currently used, and there is also unused potential with solar energy (2,800 hours of sun estimated annually) and potential wind energy, which are estimated at 2,000MW.

3. **The state-owned enterprise JIRAMA is the main operator in urban areas.** JIRAMA, created in 1975 with the state as the unique shareholder, is responsible for the transmission and

[1] Prepared by Constance de Soyres, Joanne Tan, and Claude Wendling. The analysis benefitted from helpful comments from the World Bank.

[2] JIRAMA is a utility company, responsible for both electricity and water activities.

[3] World Bank data, 2022. For comparison, 51 percent of the population on average has access to electricity in Sub Saharan African countries. Other data sources point to an even lower access to electricity in Madagascar, such as the International Energy Agency reporting an access at 27 percent in 2020, lower than the World Bank estimate of 32 percent in the same year.

[4] « Etude sur l'Economie Politique de la réforme du secteur de l'Energie », Dev2E, August 2022.

[5] Source: Climatescope / Bloomberg NEF

distribution of electricity in urban areas.[6] JIRAMA sells the electricity it produces or buys it from private, independent power producers (IPPs). It is under the technical supervision of the Ministry of Energy and Hydrocarbons and under the financial supervision of the Ministry of Finance. While JIRAMA is responsible for both electricity and water-related activities, the focus of this note is on electricity.

Assessment of JIRAMA Issues

4. JIRAMA's electricity service is deficient. While only a third the population has access to electricity (36 percent), there are recurrent outages affecting electricity consumption (an average of 6 hours of outage per day in Antananarivo in October 2024).[7] Additionally, JIRAMA is faced with three main issues: (i) insufficient and inefficient production, (ii) losses during the transmission, distribution, and commercialization phases, and (iii) tariffs below costs.

5. JIRAMA's production is relatively inefficient as the company produces less than what is generally acceptable, and at a higher cost. JIRAMA's electricity production is mostly based on non-renewable energy sources such as heavy fuel and diesel (54 percent), hydroelectricity (45 percent) and other renewable energy sources (1 percent).[8] In thermal power plants, the availability factor, which is the time over a specific period during which a power plant can operate, is evaluated at around 45 percent, which is well below the acceptable range of 80 to 90 percent, reflecting mostly a lack of maintenance. Operational costs tend to be high as consumption of fuel per kWh is higher than in other countries, due to a low thermal efficiency (related to lack of maintenance and investment, especially in rented power plants) and because of high imported fuel costs.[9] For hydroelectricity, the availability factor is higher, at around 75 percent. Three new hydroelectric powerplants projects (Ranomafana, Sahofika and Volobe) are under preparation and could help increase capacity while containing costs, mostly to the benefit of larger cities, but it would take several years before they can be operational.[10] Other solar projects are still under construction (e.g., FINEXPO) and another thermal power plant project is under way. JIRAMA's electricity production reached 1,953 GWh in 2023. It is however difficult to estimate electricity demand as only a small share of the population has access to electricity and it is reported that there is a delay of several years to connect clients to the network.

[6] JIRAMA serves urban areas including urban, peri-urban, and rural areas that are located close to medium and low voltage networks. They consist in three interconnected networks covering the three main economic areas (Antananarivo, Toamasina, Fianarantsoa), representing 80 percent of overall power demand, and around 100 stand-alone urban networks. Rural areas include remaining areas and are served by the rural electrification development agency (ADER). In general, the system is very separated, with larger cities separated from each other and villages having their own generator.

[7] Based on the 2022 World Bank Enterprise Survey for Madagascar, for firms that report experiencing outages (around 52 percent of firms surveyed), there are 6.3 electrical outages in a typical month, which last an average of 3.1 hours.

[8] Based on 2021 production numbers. Electricity production/generation is different from installed capacity. Capacity refers to the maximum electric output a power plant or electricity generator can produce under specific conditions, while electricity production is the amount of electricity produced during a specific period of time.

[9] Lack of maintenance and investment have led to a sustained deterioration in production efficiency. Fuel consumption tends to be around 250 grams per kWh, which is above the reference values for similar types of power plants (between 200 and 215 grams per kWh). Furthermore, some of the contracts between JIRAMA and private producers force JIRAMA to pay a fixed amount to buy a declining electricity production.

[10] The two hydroelectric projects are faced with significant delays, due to COVID-19 and to other technical difficulties (e.g. infrastructure).

6. A large share of the electricity produced is lost during the transmission, distribution and commercialization phases.

- **Losses during the transmission phase are moderately higher than industry standards**. 8.2 percent of JIRAMA's production is lost during transmission, which is above the benchmark range of 5 to 7 percent.[11] Measures to reduce transmission losses include improving maintenance as well as constructing and extending transportation network.

- **Distribution losses amount to 22.6 percent, much higher** than the benchmark of 9 to 10 percent. They include both technical and non-technical losses. Technical losses can be related to incidents in the network (connection, rotten pillars, etc.) or to transformers (mostly due to overload), while non-technical losses are generally the result of illicit connections. Losses are mostly due to lack of maintenance, reinforcement and extension efforts, and delays in development projects. They can be reduced by improving selective power cuts, dispatching and controls. In 2016, JIRAMA had set a medium-term objective of 12 percent of distribution losses.[12]

- **Non-collection losses amount to 11 percent,** significantly above the benchmark of 5 percent.[13] They correspond to electricity sold that remains unpaid and can be linked to illicit behaviors (e.g., refusal to let JIRAMA read the meters) or exemptions.

7. Tariffs are far from cost recovery. The tariff structure for households and businesses was last revised in August 2022, but average tariffs remain far below recovery costs. The average price for electricity was 599 ariary per kWh in 2023 (or around US$13 cents per kWh), while the total cost per kWh is twice as high based on JIRAMA's estimations.[14] Costs include fuel expenses (around 56 percent of total costs of JIRAMA's electricity in 2023) as well as electricity purchases from other suppliers (30 percent). An increase in electricity tariffs for businesses was adopted by the Council of Ministers on October 23rd,2024, to be staggered over three years, 20 percent in the first year and 16 percent in the two subsequent years.

8. JIRAMA's 2023 financial accounts are not published yet. While the 2020-22 audited financial accounts were finalized in 2024 with a disclaimer opinion from the audit company, external auditors are still working on the audit of the 2023 accounts. Water and electricity activities are not separated in the statements, which complicates the analysis. Based on the Fund analysis of JIRAMA using the SOE health check tool over 2019-21, JIRAMA is faced with very elevated risks on profitability and solvency, with the net profit margin in negative territory (-40 percent in 2021) and a

[11] There are three main transport networks in Madagascar with a voltage higher than 35 kV for the three major cities. Other isolated centers are spread across the territory, representing around 20 percent of total consumption.

[12] PAGOSE is a project to improve governance and activities with the electricity sector over 2016–21. One of the objectives was to reduce distribution losses to 12 percent by 2030, including through the financing of distribution control centers to improve load shedding and dispatching. It was complemented by the LEAD project to develop electricity access (2019-24). See additional details in Box 1.

[13] More recent data from JIRAMA suggest that non-collection losses have increased to around 20 percent.

[14] Household electricity prices vary across countries in Africa (2023 data from Statista). If we look at other near fragile countries in Sub-Saharan Africa, the price in Madagascar is below that in Togo (US$19 cents per kWh) and Sierra Leone (US$16 cents per kWh), but above the price in Malawi (US$7 cents per kWh).

debt to asset ratio of 160 percent in 2021. Liquidity risks are also elevated, with a ratio of current assets over current liabilities of 85 percent in 2021. Commercial revenue covers only half of exploitation costs – subsidies plug part of the gap, with the rest being financed by debt or resulting in the accumulation of arrears.

9. JIRAMA is also crippled by significant governance issues. There are reports of widespread corruption, misappropriation issues and theft. In May 2024, JIRAMA's former CEO and interim CEO were both sentenced by the Criminal Court of Antananarivo's anti-corruption center (PAC) to ten years of forced labor, on accounts of abuse of office, misappropriation of public funds and money laundering. The governance issues that led to this conviction date back to 2021 when exceptional bonuses of MGA 40 to 180 million were awarded to the company's managers despite the company's financial difficulties.

Box 1. History of Electricity Sector and JIRAMA's Reforms

At JIRAMA's creation in 1975, the electricity sector in Madagascar was governed by law 74-002 (February 4, 1974) which gave the State the exclusive right to intervene in the sector. This right was given to JIRAMA, a state-owned utility facility created in October 1975 by law 75-024. It then controlled most of the production, transportation and distribution processes in the country.

In 1998, Madagascar passed an electricity reform law to privatize the sector and allow the entry of new operators (law 98-032). The goal was to mobilize private financing for electricity infrastructure and to promote better efficiency and service quality through more competition. In this context, the law unbundled the industry and allowed competition in electricity supply using a "concession" approach. A rural electrification agency was set up in 2002 (decree 2002-1550). While the objective was to prioritize local renewable energy sources, several private operators took the opportunity to apply for subsidies to build small mini-grids, mostly powered by diesel-fired generators.

In 2017, a new law was passed to separate the three branches (production, transmission, distribution/commercialization), facilitate reforms aimed at reducing costs and the financing of renewable energy investments to reduce reliance on fossil fuel (law 2017-020). The objective was to attract private capital to finance investments, improve service quality and efficiency and increase self-financing capacity from JIRAMA. In practice, transmission and distribution are still managed by JIRAMA while it is no longer the only electricity producer. However, JIRAMA's status, particularly regarding its public service monopoly in light of the provisions of the law that opened the sector to competition, has not been clarified yet. According to the 2017 Cour des Comptes' report, a new status has been proposed and approved by JIRAMA's Board of Directors but has not been validated by the authorities. Therefore, JIRAMA still operates under its old status.

Box 1. History of Electricity Sector and JIRAMA's Reforms (concluded)

JIRAMA's financial difficulties started in the 1980s after the costly installation of two hydroelectric power plants (Andekaleka and Namorona). As a result, lack of maintenance and subsequent investments contributed to a substantial deterioration in the power plants. The financial situation continued to deteriorate in the 1990s, with tariffs set below cost recovery and irregular adjustments. Over 2006-09, the financial situation was significantly improved, notably with tariff increases which helped improve JIRAMA's profitability. However, the situation started to worsen again in 2009 following a sudden reduction in tariffs, after which JIRAMA's profitability continued to deteriorate driven by significant losses (technical, non-technical, commercialization) and the costs associated with the increased use of thermal production to respond to high electricity demand. In this context, JIRAMA resorted to government subsidies to be able to pay for fuel and electricity purchases from private producers.

The PAGOSE program (Project to improve governance and operations in the electricity sector) was launched in 2016 with World Bank support. It aimed at (i) improving planning and financial sustainability, (ii) strengthening JIRAMA's operational performance and governance, (iii) improving electricity reliability, and (iv) improving coordination between JIRAMA and the Ministry. The LEAD project was also launched to increase electricity access for households, businesses, and health centers in Madagascar over 2019-24. The DECIM project (2023 -2028) is financing: (i) the hybridization of JIRAMA thermal power plants supplying these isolated grids with solar PV technology, battery storage, and associated equipment, (ii) the deployment of smart-grid and smart-metering technologies, (iii) strengthening, densifying and extending climate-resilient distribution grids and connecting additional customers, and (iv) feasibility, affordability and other relevant studies. These investments will improve and expand electricity access, contribute to improving JIRAMA's financial situation, increase sustainability of the systems and reduce GHG emissions.

Sources : « Etude sur l'Economie Politique de la réforme du secteur de l'Energie », Dev2E, August 2022 ; 2017 Cour des Comptes report.

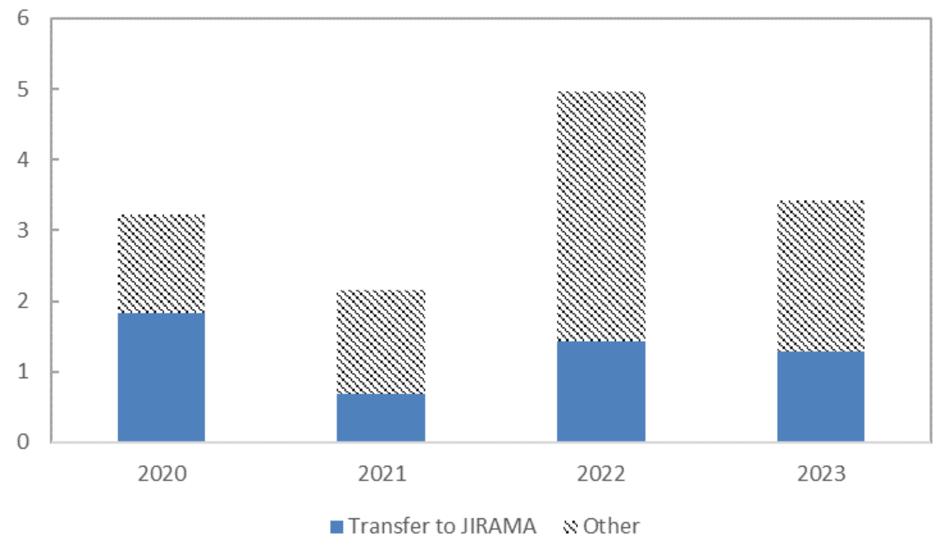
B. Impact on Economic Development

Fiscal Impact

10. JIRAMA represents a high fiscal cost for the government. JIRAMA incurs a deficit every year, which is partly financed by transfers from the government. In 2023, JIRAMA's net cash flow, which is calculated as total revenue inflows minus total cost outflows, amounted to MGA 1,268 billion or 1.8 percent of GDP, while the government's transfers to JIRAMA and selected suppliers reached MGA 895 billion or 1.3 percent of GDP. Other fiscal implications on the revenue side relate to the electricity tariff structure, such as the VAT tax exemption for small consumers, and to the fact that JIRAMA does not pay its taxes (e.g., JIRAMA collects the VAT but does not pay it to the government). As an example, JIRAMA has not paid its taxes due on its employees' wage incomes, which amounted to MGA 13 billion between January and August 2024.

Figure 1. Primary Fiscal Deficit

(In percent of GDP)



Source: IMF Staff Estimates.

11. JIRAMA represents a fiscal risk for the State. JIRAMA's debt to the private sector, including arrears to suppliers, amounted to MGA 1,880 billion or 2.7 percent of GDP at end-2023.[15] In 2022, the government started to issue special T-bills to pay for JIRAMA's fuel requisitions and has been treating those payments as loans from the government to JIRAMA.[16] Taking into account debt to the State, JIRAMA's debt would increase to MGA 5,316 billion or around 7.6 percent of GDP at end-2023.[17]

Impact on Business Competitiveness

12. Electricity is the second biggest constraint to competitiveness reported by businesses in Madagascar, based on the Enterprise Survey conducted by the World Bank.[18] While access to finance is considered as a constraint by 26 percent of the businesses surveyed, electricity is reported as an impediment by 17 percent of them (Figure 4). It is well above other categories such as corruption or informality.

[15] This number is an estimation based on JIRAMA's 2023 non-audited financial accounts. It is derived by adding loans and financial debts from non-current liabilities to short-term debt and accounts payable from current liabilities, excluding debt to the State.

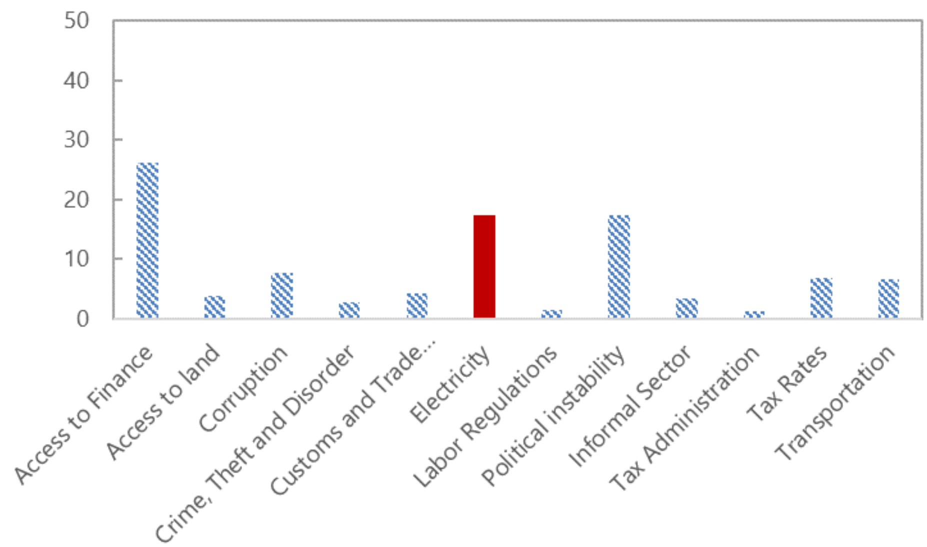
[16] While using special T-bills is an improvement by formally accounting for the contribution of the State to JIRAMA's activities, more transparency would be required, notably on the T-bills conditions and characteristics.

[17] The 2024 Cour des Comptes' report assesses that JIRAMA's debt to its suppliers (including debt to the government) amounted to MGA 2,585 billion at end-2022, with debt to suppliers being one of the components of total debt. JIRAMA's debt to its suppliers is estimated to be lower at end-2023 (MGA 2,371 billion) based on the 2023 non-audited financial statements.

[18] The World Bank conducted an Enterprise Survey for Madagascar in 2022, surveying 386 businesses.

Figure 2. Perceived Constraints to Businesses in Madagascar

(In percent of responses)

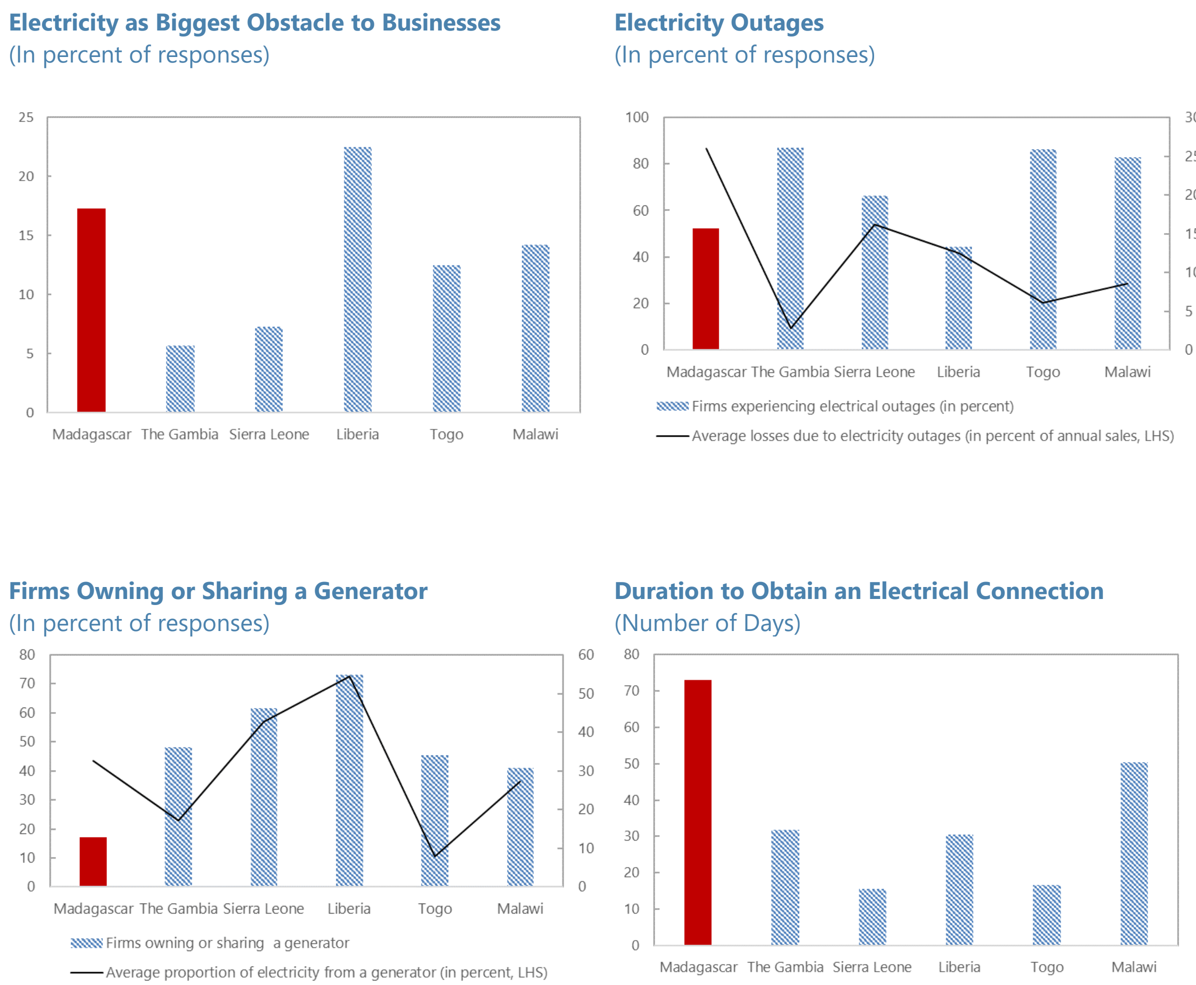


Source: World Bank Enterprise Survey on Madagascar (2022)

13. Madagascar's electricity sector performance is worse than in other similar countries in the region (Figure 5).[19] 17 percent of firms report electricity as their biggest obstacle to doing business, which is well above the average of a comparator group of near fragile countries in Sub-Saharan Africa (SSA, 12 percent). 52 percent of businesses report experiencing electrical outages, compared to an average of 73 percent in the comparator group. However, for those businesses experiencing outages, average losses due to outages represent an average of 26 percent of their annual sales, which is well above all countries in the comparator group. The number of days to obtain an electrical connection upon application is 73 days on average, which is also higher than in all countries in the comparator group. Finally, relatively fewer businesses own or share a generator (17 percent vs. an average of 54 percent in the comparator group).

[19] For the purpose of this analysis, we define a comparator group of "near fragile" countries, which are no longer "fragile" countries according to the World Bank's classification, but continue to exhibit fragilities, similar to Madagascar. Comparator countries in the region were surveyed by the World Bank in 2023 for The Gambia, Sierra Leone, and Togo, in 2017 for Liberia and in 2014 for Malawi. The average numbers reported in the text are computed by averaging over countries in the comparator group.

Figure 3. Electricity as Impediments to Businesses, Cross-Country Comparison



Source: World Bank Enterprise Surveys

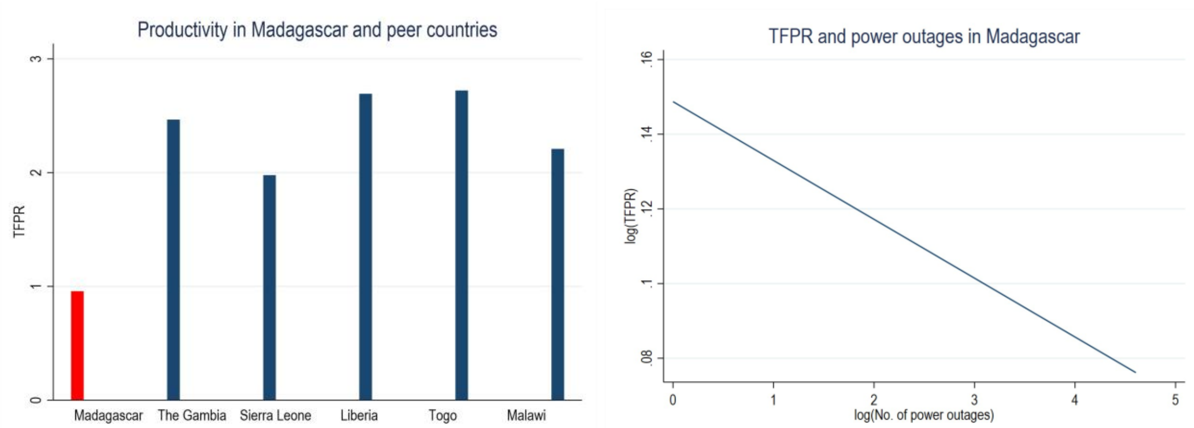
14. Unreliable electricity supply dampens firm productivity, particularly among smaller firms without generators. Using revenue-based total factor productivity (TFPR) estimates at the firm-level derived from the World Bank Enterprise Surveys, we find that Madagascar's average TFPR is lower than that of peer countries (Figure 6).[20] In addition, descriptive evidence from the Enterprise Surveys suggests a negative relationship at the firm level between TFPR and the frequency of power outages.[21] Rigorous empirical analysis based on richer firm-level panel datasets for other developing countries corroborate our findings. For example, using manufacturing plant-level panel data and state-level information on electricity outages in India, Allcott et al. (2016) find that, for the average plant, electricity shortages lowered productivity by 1.5 percent, a statistically significant result.

[20] Estimates of TFP based on the World Bank Enterprise Surveys are constructed by Francis et al. (2020). Using a translog production function with capital and labor as inputs, the authors obtain estimates of revenue-based TFP (TFPR) at the firm-level for establishments represented in the survey.

[21] Causality is difficult to establish based on cross-sectional data.

Similarly, using panel data on Chinese firms, Fisher-Vanden et al. (2015) find that electricity shortages raised production costs by 8 percent on average.

Figure 4. Total Factor Productivity and Power Outages



Source: World Bank Enterprise Surveys and IMF staff estimates.

Impact on Economic Growth

15. More broadly, lack of electricity is a constraint on economic growth. As a factor of production, electricity availability directly impacts economic growth.[22] In addition, by facilitating commercial activity at night, reducing indoor air pollution from substitute energy sources, and reducing the uncompensated time spent collecting firewood, electrification also has a positive indirect impact on growth. Yet, reliable estimates of the impact of electricity access on economic growth vary across existing studies due to endogeneity issues. Best and Burke (2018) find that the elasticity of GDP growth with respect to electricity access varies substantially by econometric specification and by choice of controls.[23] Using a panel regression of average annual GDP per capita growth on measures of electricity access and lagged GDP per capita over 2006-16, the authors find that a 10 percentage point increase in electricity capacity per capita could significantly increase GDP per capita growth by anywhere between 0.6 and 1.1 percentage points over a ten-year period.[24] Using a simple back-of-the envelope calculation, their results imply that were Madagascar's electricity capacity 10 percentage points higher, annual GDP per capita could have been 9 percent greater after a ten-year period.

[22] Lee et al. (2020) provide a useful overview of the literature on the growth impact of reliable electricity access.

[23] The authors measure electricity access in several ways, including electricity consumption per capita in kilowatt hours, electricity capacity per capita, as well as electricity transmission and distribution losses.

[24] Electricity capacity is measured as the total electricity installed capacity in million kilowatts. Depending on the specifications, other controls include other non-electric energy consumption per capita, life expectancy, consumer price inflation, corruption, trade openness, regional fixed effects, time effects and country fixed effects.

16. **Adopting a similar empirical strategy with more recent data, we estimate the impact of raising electricity access on GDP per capita growth.**[25] As presented in Box 1, a ten-percentage point rise in electricity access raises annual per capita GDP growth by between 0.4 and 0.9 percentage points. Using these estimates, our back-of-the-envelope calculations suggest that if the share of population with electricity access in Madagascar were to increase from the current 35 percent to the objective of 70 percent by 2030 targeted in the PGE, GDP per capita would be anywhere between 13 and 28 percent higher relative to the baseline after 10 years.

Box 2. Economic Growth and Electricity Access at the Country Level

Following Best and Burke (2018), we adopt the following econometric specification to measure the impact of electricity access on long-term growth at the country level:

$$\frac{log(y_{it}) - log(y_{it-10})}{10} = \rho_0 + \rho_1 Electricity_{it-10} + \rho_2 log(y_{it-10}) + X_{it-10}\beta + \psi_i + \delta_t + \epsilon_{it}$$

Where the left-hand side of the equation refers to average annual growth of GDP per capita of country i, y_{it}, over a decade and $Electricity_{it-10}$ refers to the percentage of the population with electricity access. We also control for growth convergence (y_{it-10}), other time varying country-level controls (X_{it-10}), country fixed effects and year effects. Standard errors are clustered at the country level. We run the regression with data over two decades over a set of 168 countries, from 2001 to 2010, and 2010 to 2019.[1/]

	Per capita GDP growth (annual average)		
log(GDP per capita)	-1.42***	-1.60***	-9.62***
	(0.21)	(0.19)	(0.70)
Electricity access (% of population)	0.04***	0.05***	0.09***
	(0.01)	(0.01)	(0.03)
log(life expectancy)	3.66	2.59	-5.08
	(2.72)	(2.48)	(5.35)
CPI	-0.13***	-0.04***	0.01
	(0.01)	(0.01)	(0.01)
Trade (% of GDP)	0.01***	0.01***	0.02**
	(0.00)	(0.00)	(0.01)
Country FE	No	No	Yes
Year FE	No	Yes	Yes
R^2	0.58	0.65	0.89
N	312	312	312

Country-level economic growth and electricity access

From the regression table above, a one percentage point increase in the share of population with electricity access significantly raises average annual per capita GDP growth anywhere between 0.04 and 0.09 percentage points.

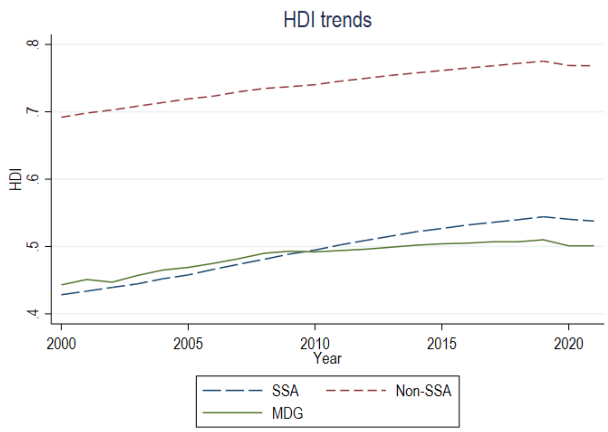
1/ Data are from the World Development Indicators. They can be accessed here.

[25] Electricity access is measured as the percentage of the population with access to electricity at the country level. Data is taken from World Development Indicators.

Impact on Human Development Index (HDI)

17. **Madagascar's HDI has stagnated between 0.49 and 0.50 for the last ten years**, placing the country in the category of "low human development", according to the United Nations Development Program (UNDP).[26] Madagascar has increasingly lagged behind its peers in SSA (Figure 6). Electricity access is expected to impact all facets of HDI by affecting the duration and type of economic activity, education, and health outcomes. Indeed, electricity access is deemed by the UNDP to be a necessary condition for development and is one of the Sustainable Development Goals (SDG 7).

Figure 5. HDI Trends in Madagascar and SSA[1]



1/ The figure is constructed using country-level HDI data from the Global Data Lab. Mean HDI is calculated for each of the relevant country groups by year.

18. **Substantial variation in HDI is observed across districts within Madagascar (Box 2).** Applying machine learning methods to satellite data, Sherman et al. (2023) estimate HDI at the district level for all countries including Madagascar. While wealthier districts around the capital and the northeast such as Toamasina I on the east coast had levels of HDI at just under 0.66 in 2019, close to the average among emerging economies (0.75), other districts in the central south, such as the district of Benenintra, face much lower levels of development of around 0.37. Moreover, there is no evidence of convergence in development across districts, with less developed districts in the southwest for instance experiencing a decline in HDI over time. Overall, the gap in HDI between the most and least developed districts in Madagascar has stagnated at around 0.34 since 2013.

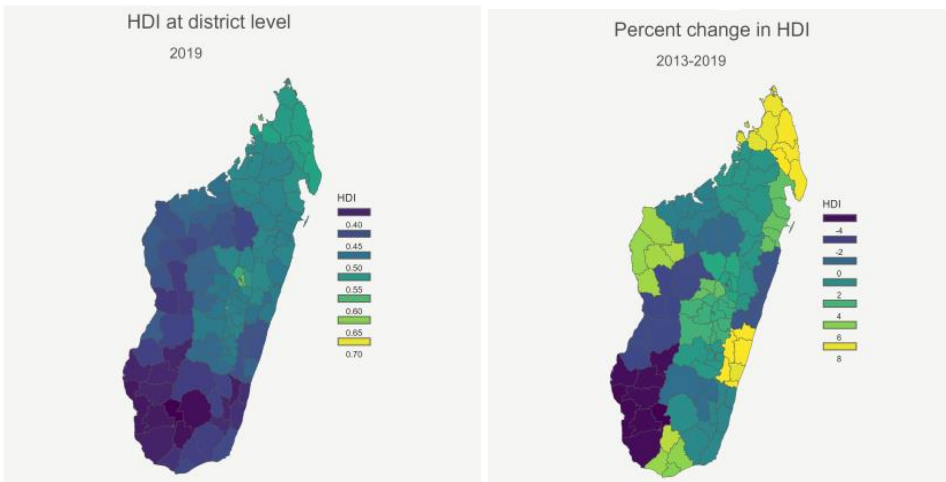
19. **Improving electricity access would significantly raise HDI in Madagascar.** To avoid endogeneity concerns that could arise in the relationship between HDI and electricity access, we adopt the instrumental variables strategy of Dinkelman (2011), which hinges on the assumption that the land gradient of a locality correlates with the cost of electrification but does not otherwise

[26] The HDI is a composite measure of 3 indicators of development: (i) life expectancy at birth, (ii) expected years of schooling, and (iii) GNI per capita (PPP$). It ranges from 0 (least developed) to 1 (most developed).

correlate with the unobserved factors that affect HDI.[27] Exploiting the variation in development and electricity access across districts in Madagascar, we find that a 10-percentage point increase in the share of households with reliable electricity access would raise HDI at the national level significantly, by 1.3 percentage points (Box 3).

Box 3. Sub-National Data on Development and Electricity Access

Due to lack of official data, information on economic growth, development, and electricity access in Madagascar must be gleaned from other sources. Using a range of features from world-wide satellite imagery and machine learning applied to sub-national units for which official data is available, Sherman et al. (2023) estimate the Human Development Index (HDI) for all countries at the sub-national level. We use their HDI estimates at the district-level as a measure of development in Madagascar.[1/]

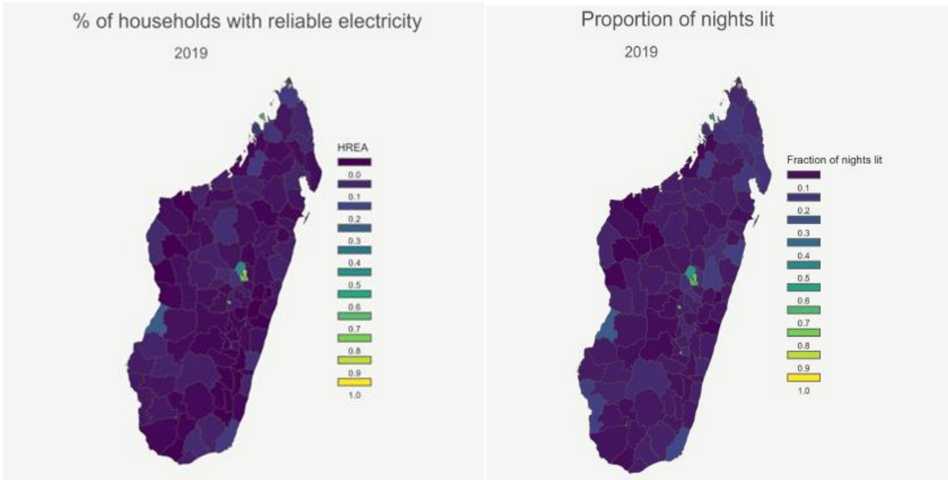


For electricity access, we rely on estimates from Min et al. (2024), based on average yearly measures of luminosity at night.[2/] We aggregate these settlement-level estimates and calculate the percentage of households with electricity access, as well as the fraction of nights lit at the district level for Madagascar.[3/]

1/ The sub-national HDI data can be found here. For our analysis, we focus on the period from 2013 to 2019, to abstract from the pandemic years.
2/ From this night light information, the authors derive estimates of the percentage of households with reliable access to electricity (HREA) in each settlement, as well as the proportion of nights a settlement is observed to be lit each year.
3/ The use of satellite data to measure electricity access or outages has also been explored in Min et al. (2017) and Shah et al. (2022).

[27] The impact of electrification on development has also been explored by papers including Lipscomb et al. (2013), in which the authors exploited exogenous topographical variation to estimate the development effects of electrification in Brazil.

Box 3. Sub-National Data on Development and Electricity Access (concluded)



Box 4. Estimating the Impact of Electricity Access on Development

We adopt an instrumental variable strategy to estimate the causal impact of electricity access on development, following Dinkelman (2011), with the following econometric specification:

$$HDI_{drt} = \alpha_0 + \alpha_1 Electricity_{drt} + X_{drt}\beta + \mu_{rt} + \underbrace{\psi_{drt} + \epsilon_{drt}}_{v_{drt}}$$

$$Electricity_{drt} = \delta_0 + \delta_1 Slope_{drt} + X_{drt}\Gamma + \mu_{rt} + v_{drt}$$

Where HDI_{drt} and $Electricity_{drt}$ refer to HDI and some measure of electricity access in district *d*, region *r*, at time *t* respectively. X_{drt} is a vector of observed time-varying controls, while μ_{rt} and ψ_{drt} refer to regional time-varying effects and unobserved time-varying district-level effects respectively. The coefficient of interest is α_1, which measures the impact of greater electricity access on HDI.

	OLS	OLS	IV (Mean slope)	IV (Max slope)
HREA	0.16***	0.13***	0.13***	0.13***
	(0.02)	(0.01)	(0.03)	(0.01)
Distance to road (100km) -0.02**	-0.00	0.00	-0.00	
	(0.01)	(0.00)	(0.01)	(0.00)
Annual irradiation (100kWh/m2)	-0.01	-0.01***	-0.01***	-0.01***
	(0.01)	(0.00)	(0.00)	(0.00)
Distance to grid (100km)	-0.27	4.81*	4.06	4.26*
	(5.88)	(2.59)	(2.62)	(2.39)
Population (100,000s)	0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Region FE × Year FE	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.42	0.98	0.88	0.88
N	760	760	760	760

Impact of reliable electricity access on HDI

Box 4. Estimating the Impact of Electricity Access on Development (concluded)

Since electricity access in a district is likely endogenous to HDI, such that

$$\mathrm{E}[\upsilon_{drt}|\mathrm{Electricity}_{drt}] \neq 0,$$

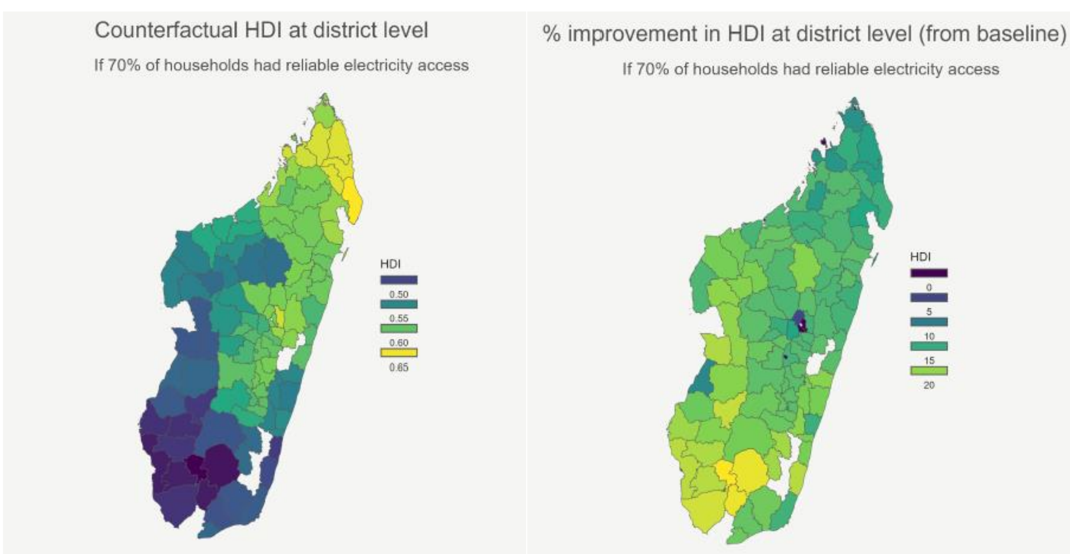
we use the land gradient of a district as an instrument for electricity access, following Dinkelman (2011).[1/] We find that a 10-percentage point increase in the share of households with reliable electricity access would raise HDI by 1.3 percentage points.

1/ The assumption is that the slope of a district affects the cost of reliable electricity access, but not other unobserved factors that also affect economic development. Since it is possible that in-migration to districts with flatter gradient is larger, which would affect HDI, we control for time-varying population at the district level. We experiment with average and maximum slope of a district and confirm that the IV results are similar for each of the two instruments. We also use both instruments jointly and conduct a Durbin-Wu-Haussman test of overidentifying restrictions to check for exogeneity. We do not reject the null hypothesis that the instruments are exogenous.

Regional Disparities

20. If the authorities' aim of 70 percent household electricity access by 2030 were achieved, Madagascar's national HDI would rise by 16 percent and the HDI gap between the most and least developed district would narrow by 29 percent.[28] Using the regression estimates in Box 3, we calculate the counterfactual HDI for all districts in Madagascar, presented in Figure 7. We find that for the least developed districts in the south, district-level HDI would rise by close to 25 percent if the electricity access objective were achieved. At the national level, this would translate into a rise in HDI to 0.58, placing Madagascar on par with countries such as Cameroon. [29]

Figure 6. Development Gains from Rise in Electricity Access



Source: IMF staff estimates

C. Possible Way Forward

[28] The authorities' energy strategy plan can be found here.

[29] As of 2023, Madagascar's HDI stood at 0.49, ranking 177th out of 192 countries. A HDI of 0.58 would move the country up by around 25 places in the global HDI ranking, everything else constant.

Comparison with Other Countries

21. In SSA, one third of electricity utilities encounter financial difficulties. Work done by the World Bank's Energy Sector Management Assistance Program (ESMAP) through its Utility Performance and Behavior in Africa Today (UPBEAT) framework illustrates the difficulties faced by electricity utilities in SSA.[30] Based on 2012-2018 data, it points to the precarious financial situation of most power companies and explains that only one in three utilities in SSA recover their operating and debt-servicing costs (one in four if subsidies are excluded). It notes that financial performance correlates with reporting on performance management, making the link between better financial performance and improved transparency and accountability. Fewer than half the utilities surveyed published their audited financial statements and fewer than one in three had unqualified audit opinions.

22. Improvements in cost recovery tend to result from reductions in non-technical losses or from sharp increases in capacity. The UPBEAT survey also points to some success story in terms of improvement of cost recovery through reduction of non-technical losses such as fraud and other unmetered consumption (Côte d'Ivoire) or in terms of improvement of reliability of electricity supply (Rwanda). In Rwanda, a drastic reduction in System Average Interruption Duration Index was linked to a vast increase in generating capacity (from 76 MW in 2009 to 225 MW in 2020) and to the rehabilitation, upgrade, and extension of the transmission and distribution infrastructure to better serve existing customers and expand electricity access (from 6 percent in 2009 to 54 percent in March 2020). Rwanda was also able to significantly reduce system losses through better monitoring of the consumption of large customers and state-of-the-art information systems.

23. Successful electricity sector reforms are correlated with the presence of an electricity law, a sector regulator, vertical unbundling, and private participation. A 2022 paper analyzes the performance of electricity sector reforms in 37 SSA countries between 2000 and 2017.[31] It indicates a positive correlation between reforms and installed generation capacity per capita, plant load factor, and reduction of technical network losses. The presence of an electricity law, a sector regulator, vertical unbundling, and private participation in the management of assets are all positively correlated with reform performance. The paper points notably to the performance of Côte d'Ivoire, with an early engagement (1994) in IPPs for power generation and a successful privatization through a concession contract of the vertically integrated Compagnie Ivoirienne d'Electricité, in charge of generation (partly), transmission and distribution of power.

Recommendations

24. A recovery plan is currently under preparation by the new JIRAMA management. While a first objective is for JIRAMA to reach financial sustainability and no longer be dependent on

[30] Balabanyan, A., Y. Semikolenova, A. Singh, and M. A. Lee. 2021. Utility Performance and Behavior in Africa Today (UPBEAT): SUMMARY REPORT. ESMAP Papers. Washington, DC: World Bank.
[31] Asantewaa, A.; Jamasb, T.; Llorca, M. Electricity Sector Reform Performance in Sub-Saharan Africa: A Parametric Distance Function Approach. Energies 2022, 15, 2047. https://doi.org/10.3390/en15062047

government transfers, other important objectives relate to electricity access and a shift of the production mix towards more renewables.[32] Recommendations include:

- **Increase production capacity and efficiency and expand access to electricity**. While it is difficult to estimate the size of electricity demand, it is estimated that electricity production should be at least doubled by 2030. Improving production efficiency involves reducing the amount of fuel needed to produce electricity, including through a better monitoring of fuel stocks (geo-filling).

- **Shift the production mix**. The expansion of production capacity should take place through an increase in renewable energy to reach 85 percent of the production mix (75 percent hydroelectricity, 5 percent wind energy and 5 percent solar energy). In this context, the share of thermal production (using fossil fuel) could be decreased to 15 percent for both cost and environmental reasons. Potential hydroelectric power is estimated at 7,800MW but a large share of hydroelectric power plants has little storage capacity, which means that it cannot be a substitute to thermal energy during peak hours. There is also unused potential with solar energy (2,800 hours of sun estimated annually), but it is more expensive than hydroelectricity production and tends to supply electricity outside peak hours. Finally, potential wind energy is estimated at 2,000MW.

- **Reduce losses**. Losses could be reduced to around 20-25 percent of production (transmission, distribution, and commercialization phases). This would require a broad use of smart and prepaid meters to better control consumption and fully extend the use of prepaid meters in all administrations. Investments in maintenance to improve the quality of the network would also be crucial.

- **Review the tariff structure**. Tariffs should be in line with recovery costs, including operational, distribution, commercialization, and investment costs. A first-best approach is to have one single household tariff and compensate most vulnerable households with targeted transfers. When targeted transfers are difficult to implement, the second-best approach is a tariff structure by consumption brackets. Going forward, an automatic indexation mechanism is needed to keep prices in line with costs.

[32] The objectives are presented in the national Energy Policy 2015–2030. One goal is to increase electricity access to 70 percent of households by 2030.

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