



Madagascar

Energy and the poor
Unpacking the investment
case for off-grid cleaner energy



SUSTAINABLE
DEVELOPMENT **GOALS**
17 GOALS TO TRANSFORM OUR WORLD



Unlocking
Public and Private
Finance for
the Poor



The Making Access Possible Programme

Making Access Possible (MAP) is a multi-country initiative to support financial inclusion through a process of evidence-based country diagnostic and stakeholder dialogue, leading to the development

of national financial inclusion roadmaps that identify key drivers of financial inclusion and recommended action. Through its design, MAP seeks to strengthen and focus the domestic development

dialogue on financial inclusion. The global project seeks to engage with various other international platforms and entities impacting on financial inclusion, using the evidence gathered at the country level.

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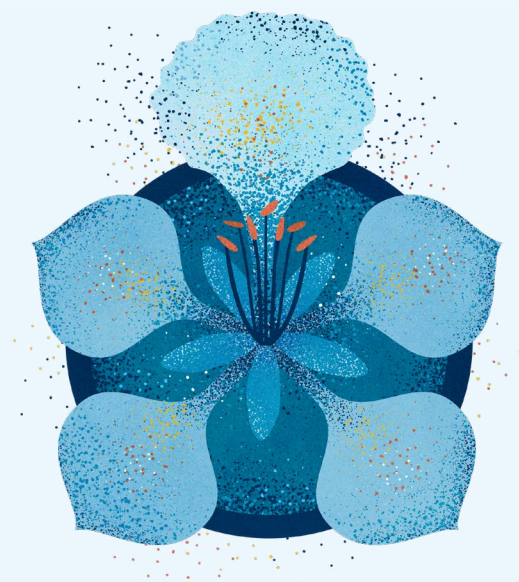
Authors: Kameshnee Naidoo and Christiaan Loots

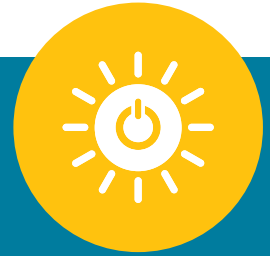
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The cover symbol and artwork

Through the MAP programme, we hope to effect real change at country level and see the impact of financial inclusion on broader national growth and development. The cover graphic features the Poinciana (Delonix regia), a flower synonymous with Madagascar. The flower symbolises growth and development while the circle represents inclusive growth. Each flower is an example of the successful growth in a unique environment. By combining the flower with the currency symbol of Madagascar we represent the characteristics of the country, linking financial inclusion with successful growth.





Working together to support implementation of Agenda 2030

Countries are seeking new ways to address complex and interconnected challenges. Reaching the promise of the SDGs requires multisectoral approaches that brings together expertise from a range of perspectives. By harnessing our comparative advantage and working within the context of our respective mandates, we can collectively make significant progress towards achieving the vision of the Sustainable Development Goals (SDGs).

This diagnostic on access to clean energy is a collaboration with the United Nations Development Programme (UNDP) and the United Nations Capital Development Fund (UNCDF) to jointly address UNDP's Signature Solution 5 that seeks to work with countries to close the energy access gap.

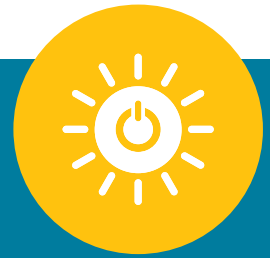
Signature Solution 5 focuses on increasing energy access, promoting renewable energy and enhancing energy efficiency in a manner that is inclusive and responsive to the needs of different sectors of the population, in line with the aspirations of Sustainable Development Goal 7.

This will support countries to transition to sustainable energy systems by working to de-risk the investment environment; attract and leverage private and public-sector resources. In contexts, where energy does not yet reach everybody, it will be necessary to focus on supporting innovative private and public solutions that increase energy access and delivery.

In contexts where energy is already available to most or all people, the focus will be on transitioning to renewable energy and energy efficiency measures and policies.



UNCDF offers “last mile” finance models that unlock public and private resources, especially at the domestic level, to reduce poverty and support local economic development.



Partnering for a common Purpose

By combining inspiration, ideas and resources with our partners, we become more than the sum of our parts.

We are committed to empowering investors—public and private—with the clarity, insights and tools they need to optimize the positive impact of their investments, closing the gap between high-level principles and financial performance to make a positive contribution to society.

FinMark Trust is an independent non-profit trust whose purpose is ‘Making financial markets work for the poor, by promoting financial inclusion and regional financial integration’, by using both the creation and systematic analysis of financial services consumer data to provide in depth insights and following through with systematic financial sector inclusion implementation actions to overcome market level barriers hampering the effective provision of services, thus working to unlock real economic sector development through financial inclusion.

The UNDCF, together with MAP partner FinMark Trust, commissioned Nova Economics to undertake a market assessment of the energy needs, usage and market potential, focusing on the potential for cleaner off-grid energy solutions across five countries in the Southern African Development Community (SADC) region, namely Lesotho, eSwatini, Malawi, Mozambique and Madagascar. The objective of this study is to provide insight into the potential to develop the market for, and promote access to, cleaner off-grid energy solutions in the selected countries. This includes insight into the current programmes and initiatives in each market, to assess the current supply and demand for off-grid cleaner energy solutions and the scope for partnerships and innovative financing models to move forward the clean energy agenda under SDG 7 as it relates to financial inclusion and inclusive growth.

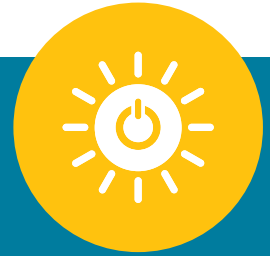
This report represents the country analysis and findings for Madagascar only. A separate report for each country is available, as well as a summary report drawing together the findings for all five countries.

Note on the use of household data

Within this document (unless otherwise referenced), demographic, income and financial usage data is obtained from the 2016 FinScope Consumer Survey undertaken in Madagascar. A summary report and presentation of FinScope is available as a separate deliverable, and the FinScope dataset is available for future research at <https://uncdfmapdata.org>.



The transition to clean and affordable energy helps countries reduce the impacts of indoor and outdoor air pollution, particularly in rapidly developing urban areas.



Our technical response

The MAP target market segmentation model identified four crucial consumption needs that households are regularly fulfilling out of their income. Payments for energy and utility services are consistently highlighted as the single most crucial need. The methodology as applied here seeks to address the need for access to energy as it relates to current usage, affordability and access to infrastructure in order to identify and quantify the financing necessary to accelerate the transition to clean energy.

UNDP's work on Energy

UNDP is the leading United Nations organization fighting to end the injustice of poverty, inequality, and climate change. Working with our broad network of experts and partners in 170 countries, we help nations build integrated, lasting solutions for people and planet.

UNDP's Energy team focuses on clean and affordable energy development; low-emission, climate-resilient urban and transport infrastructure; and access to new financing mechanisms. Learn more at undp.org or follow at @UNDP

UNCDF's work on Energy

UNCDF's energy programme aims to improve access to clean energy finance for poor and low-income people. By partnering with energy and financial service providers and offering capital, data analytics, capacity building and policy advocacy services in the off-grid energy finance markets, UNCDF has scaled energy business models for cleaner, efficient and more effective sources of energy for poor people. As of 2019, UNCDF digital energy finance activities have enabled over 3 million people to benefit from clean energy solutions through micro and PayGo financing.



The methodology as applied here seeks to address the need for access to energy as it relates to current usage, affordability and access to infrastructure in order to identify and quantify the financing necessary to accelerate the transition to clean energy.

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Madagascar at a glance

The island of Madagascar is in the South-West Indian Ocean, adjacent to the Mozambican coast. It has a land area of 587 000 km² and 26.9 million inhabitants (2020 estimate).



Sources: 1) UN population division, World Population Prospects 2019 2) UN World Urbanization Prospects: The 2018 Revision 3) Derived (population/average household size) 4) UN statistics database, household size and composition 5) CIA world factbook 6) Country census, demographic statistics database, 7) IMF, World Economic Outlook database 8) UN Statistics Division 9) IMF, World Economic Outlook database, 2018 The country has the world's fourth-highest rate of chronic malnutrition, with almost one child in two under five years of age suffering from stunting. The country is also highly susceptible to climate shocks such as drought, floods and cyclones (World Bank. "Madagascar Overview."). Inequality is high but moderate — the Gini coefficient was estimated at 42.6 in 2012 by the World Bank ("GINI Index (World Bank Estimate) - Madagascar | Data.").

While the economy has grown at an annual average rate of 2.3 percent over the past decade, and despite having considerable natural resources, poverty has remained persistent and widespread. The country still has among the highest poverty rates in the world. Roughly 74 percent of the population were living on less than USD 1.90 a day in 2019, down only slightly from approximately 78 percent in 2012. This far exceeds the regional average of around 41 percent. Madagascar is the only country in the world that experienced a decline in per capita income between the 1960s and 2010 (that did not experience civil war or violent conflict). According to the World Bank, the average Malagasy person is approximately 42 percent poorer than he or she would have been in 1960.

Energy sector overview

Although Madagascar has vast potential of renewable energy sources (hydro, solar, wind, biomass), national energy consumption and supply is low. The energy sector is characterised by low access to modern forms of energy with only a quarter to a third of adults having access. These adults largely use electricity for lighting, and not for more intensive purposes like cooking. As a result, the majority of people rely on candles and lamps for lighting, and almost all use biomass for cooking. The low level of access is likely a result of affordability issues on the demand side, but also extensive supply side issues. This includes a limited grid infrastructure that is deteriorating due to age and insufficient maintenance.

Rather than one synchronised national electricity grid, Madagascar has three separate high voltage grids: the Antananarivo Interconnected Network (which accounts for 70 percent of electricity consumption), the Fianaratsoa Interconnected Network and the Toamasina Interconnected Network. These three networks are operated by the national electricity company (JIRAMA), but are largely centred around urban areas, and translates to only about 400km of high voltage lines¹.

The majority of the country is therefore not in proximity to the power grid. As a result, the country also has approximately 130 isolated mini-grids that are mainly located in rural areas and powered by thermal diesel units². A substantial portion of electricity in Madagascar is generated through diesel powerplants, with a steady increase in imports of petroleum products to meet road transport and power generation needs. Nevertheless, the majority of power generation in Madagascar is through hydropower. Besides hydro, renewable sources of electricity currently contribute less than one percent to total generation capacity.

The Malagasy electricity grid is dominated by JIRAMA, the country's vertically integrated state-owned water and electricity company. JIRAMA operates



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1 News 24, 2019. <https://www.news24.com/news24/africa/news/in-the-dark-electricity-a-luxury-in-poor-madagascar-20191015>

2 Since 2004, Madagascar has been granting mini-grid concessions to private operators to electrify rural villages

and oversees almost all production, transport and electricity distribution in Madagascar. Mini-grids are operated by both JIRAMA and private operators, of which there are more than ten³ – and who are generating an increasing share of total electricity production⁴. However, the main source for electricity generation remains hydropower, mostly from six aging hydro plants that provide over two thirds of capacity with diesel plants providing the rest. In addition to its deteriorating state, the infrastructure for the generation, transmission and distribution of grid-supplied electricity is insufficient to meet current demand. The total installed capacity of the country stands at 569 megawatts (MW), but the available capacity is only around 60 percent due to maintenance issues. It is estimated that Madagascar has the potential to generate 7,800 MW from hydropower sources⁵.

The cost of thermal generation has consistently increased in recent years due to the impact of expensive, directly negotiated power purchase agreements (PPAs) for new thermal plants signed between JIRAMA and independent power producers (IPPs). JIRAMA must resort to state subsidies to pay for fuel purchase invoices and energy purchases to IPPs, adding pressure on the already resource-starved state.⁶ All petroleum products are imported with the levelised cost⁷ of producing electricity from thermal power stations as high as USD 0.70 to 0.80 per 98 kilowatt hour (kWh). The high tariff rates result in low collection rates and subsequent plant failures due to unfunded maintenance.⁸

Domestic annual electricity consumption in Madagascar per person is among the lowest in Africa, at less than 50 kWh per year. It is also extremely difficult for businesses to access electricity. Madagascar was ranked 185 out of 190 countries in the World Bank's Doing Business survey about the difficulty, delay, and cost of getting electricity, with an average wait time of 450 days.⁹ The lack of adequate and reliable electricity supply has been identified as one of the major constraints to economic growth and development in the country.¹⁰

Other important stakeholders in the energy sector include The Agency for Rural Electrification Development (ADER) who is the government's main implementing agency for all rural electrification activities, and the independent electricity regulator, ORE¹¹ who is responsible for the monitoring and enforcement of quality norms for energy solutions.



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3 Power Africa, 2016. https://www.usaid.gov/sites/default/files/documents/1860/MadagascarCountryFactSheet.201609_FINAL.pdf

4 According to the World Bank, 30 organisations now operate mini-grids providing electricity to around 200 villages, serving approximately 7 000 consumers in total. They generate power using diesel, biomass, or small hydro generators with capacities ranging from 40 kW to slightly more than 200 kW.

5 Power Africa, 2016. https://www.usaid.gov/sites/default/files/documents/1860/MadagascarCountryFactSheet.201609_FINAL.pdf

6 "Madagascar-Electricity Sector Operations and Governance Improvement Project Additional Financing Project Paper."

7 Levelized cost of electricity is a measure of the average net present cost of electricity generation for a generating plant over its lifetime

8 "POWER AFRICA'S ENGAGEMENT IN MADAGASCAR."

9 World Bank, "Comparing Business Regulation for Domestic Firms in 190 Economies."

10 The World Bank Group, "Comparing Business Regulation for Domestic Firms in 190 Economies."

11 Office de Régulation de l'Electricité



Electricity access rate and deficit

Madagascar has a very low electricity access rate compared to other countries in Sub-Saharan Africa. In 2017, only 24 percent of the population had access to electricity (Figure 1). Access to grid-supplied electricity is significantly lower in rural areas. In 2017, only ten percent of the population living in rural areas had electricity compared to an access rate of over 49 percent for urban Malagasy (Figure 1).

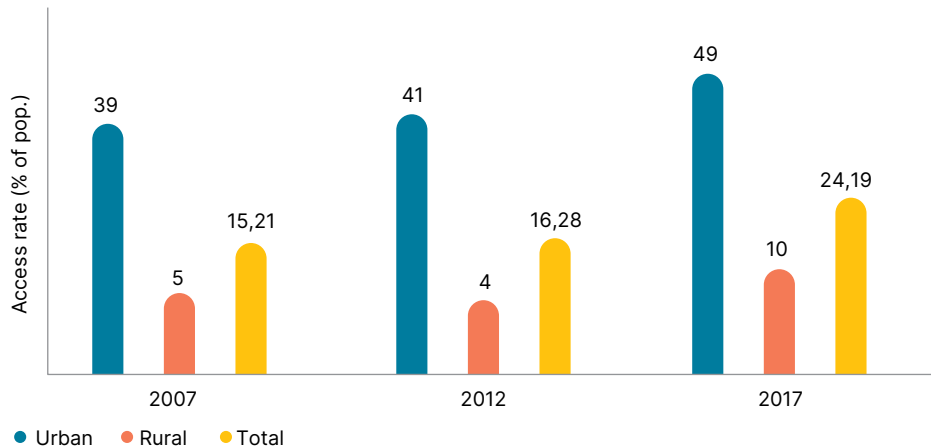


Figure 1: Electricity access, Madagascar (2007, 2012, 2017)

Source: Own analysis based on data sourced from the World Bank development indicators database

FinScope (2016), which measures access only for adults, differ slightly from the above findings in terms of level of access. However, this is largely explained by the skew in age distribution, where a large portion of the population (over 50 percent) is below the age of 18 years. The rate of access to electricity in FinScope is therefore higher at 32 percent of adults. This is largely driven by higher rates of access in urban areas (75 percent), but access in rural areas are also found to be higher at 17 percent. Access to electricity is tied to the locations of the fractured and limited electricity grid, and the locations of mini-grids. The country has 105 districts, that are grouped into 22 regions.

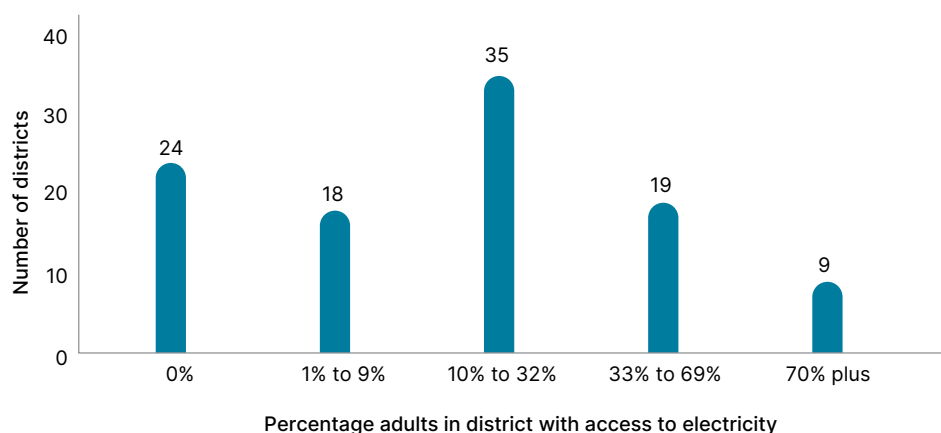


Figure 2: Percentage of adults with access to electricity by district

Source: FinScope Madagascar 2016 survey

These can further be grouped into six autonomous provinces. FinScope provides insight into the levels of access at each of these levels. Only nine districts have electricity access rates of 70 percent for adults, while in 28 districts, only 33 percent of adults have electricity access. There was no reported access to electricity in 24 districts, while 18 districts reported less than ten percent access (Figure 2).

At a regional level, the maximum level of access is 64 percent, and the minimum is three percent, so all regions reported some level of access. There are four regions where access is less than five percent, five regions with access between 10 percent and 15 percent and another five regions between 18 percent and 22 percent. The remaining regions have access between 33 percent and 64 percent. This means that 14 of the 22 (64 percent) regions have access levels lower than the country average. There are nine regions where access is less than 16 percent (half the national average). These nine regions are located in just three provinces. Furthermore, regions where access is below ten percent are located in just two provinces.

Table 1: Regional and provincial access to electricity

PROVINCE	PROVINCE ACCESS	MAXIMUM REGIONAL ACCESS	MINIMUM REGIONAL ACCESS	REGIONS WITH <32% ACCESS	REGIONS WITH < 16% ACCESS	REGIONS WITH < 10% ACCESS	TOTAL REGIONS IN PROVINCE
Antananarivo	53%	64%	19%	2	0	0	4
Antsiranana	34%	35%	33%	0	0	0	2
Toamasina	33%	45%	18%	1	0	0	3
Mahajanga	27%	39%	10%	3	2	0	4
Toliara	23%	41%	3%	3	3	2	4
Fianarantsoa	9%	22%	4%	5	4	2	5
Total	32%	64%	3%	14	9	4	22

Source: FinScope Madagascar 2016 survey

The four regions with the highest rates of access are Analamanga (64 percent), Vakinankaratra (52 percent), Analanjirofo (45 percent) and Atsimo Andrefana (41 percent). Of these, the highest two are in Antananarivo. There are only four other regions where access is higher than the average for the country. These are Boeny (39 percent), Sava (35 percent), Atsinanana (34 percent), and Diana (33 percent).

Madagascar: Energy Access by Province and Region



Regions 22

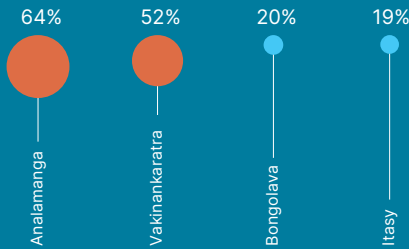


Access 32%



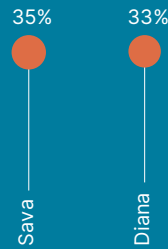
Adults 11.3m

Antananarivo



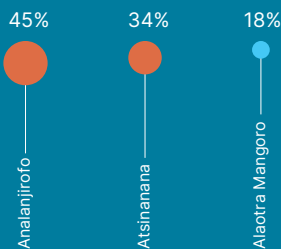
Regions 4 Access 53% Adults 3.5m

Antsiranana



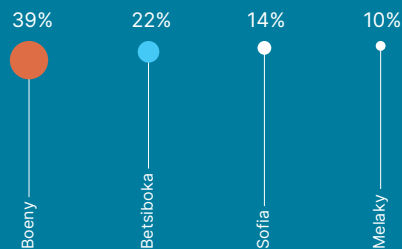
Regions 2 Access 34% Adults 916K

Toamasina



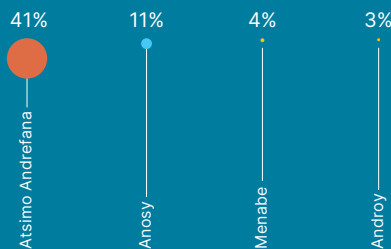
Regions 3 Access 33% Adults 1.8m

Mahajanga



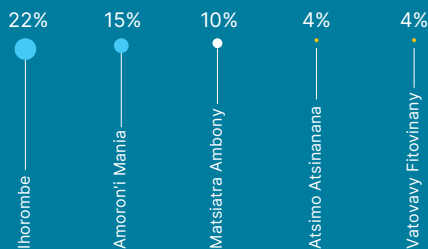
Regions 4 Access 27% Adults 1.3K

Toliara



Regions 4 Access 23% Adults 1.5m

Fianarantsoa



Regions 5 Access 9% Adults 2.2m

● 32% access or more

● 16% to 32%

● 10% to 15%

● Below 10%

Figure 3: Access by region

Source: FinScope Madagascar 2016 survey



Rate of electrification, electrification plans and need for off-grid solutions

While the access rate in Madagascar has improved from 15 percent in 2007, the access deficit (the number of people without access to electricity) has risen as population growth outpaced growth in new connections. In 2017, 19.4 million Malagasy lacked access to electricity, up from 16.5 million in 2007 (Figure 4).

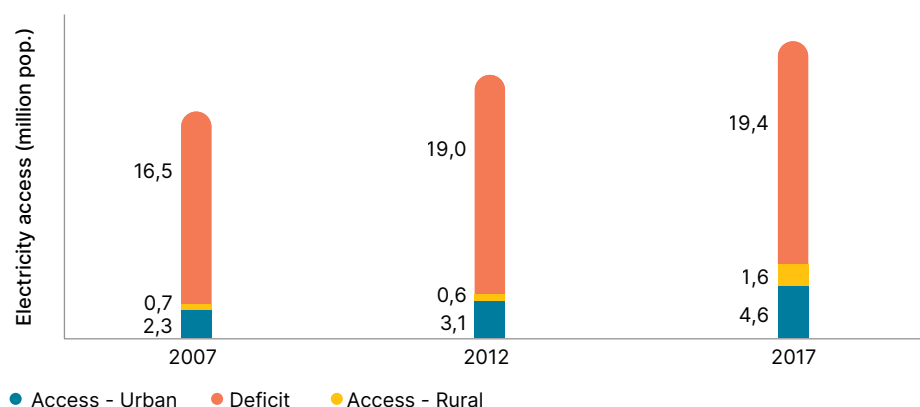


Figure 4: Electricity access, Madagascar (2007, 2012, 2017)

Source: Own analysis based on data sourced from the World Bank development indicators database

To address the targets set by SDG 7, we estimate the likely electricity access deficit in 2030, by extrapolating the current rate at which the government is electrifying households and the increasing need due to expected population growth.¹²

Our analysis shows that between 2012 and 2017, Madagascar connected an average of 500,000 people to the grid annually. Assuming that JIRAMA continues to connect the same number of people annually and that Madagascar's total population increases at an annual average of 2.6 percent,¹³ only 22 percent of the rural population and 52 percent of the urban population will have access to the grid by 2030, far short of SDG7 targets.

Table 2: Nominal change in electrification (average annual), by country

PERIOD	NOMINAL ANNUAL CHANGE IN ELECTRIFICATION
Urban	
2007 – 2012	161 181
2012 – 2017	295 133
2017 – 2030*	295 133
Rural	
2007 – 2012	14 933
2012 – 2017	204 341
2017 – 2030*	204 341

* Projected

Source: Own analysis

¹² See Appendix A for more detail on our electrification projections.

¹³ Based on UN population estimates and projections – medium variant

At the current electrification rate, there will still be 22.9 million Madagascans without access to electricity in 2030 (64 percent of the projected population). The majority of these (15.2 million) would live in rural areas. To achieve universal access to the grid by 2030, the Malagasy government would have to significantly ramp up its current electrification programme. Our analysis suggests that they would have to connect an average of 1.4 million rural people annually, which is 6.7 times the current number and an average of 819,000 urban people annually (roughly three times the current number).

The Government of Madagascar has set itself a more attainable target of reaching a 70 percent access rate by 2030, as outlined in the New Energy Policy (NEP 2015-2030). However, it would have to significantly accelerate its current electrification efforts (roughly two to four times the current number of connections) to reach even this target. Our projections show that only 36 percent of the population would have access by 2030 at the current rate of electrification.¹⁴

According to World Bank projections, based on preliminary geospatial analysis, about 75 percent of new connections under the national electrification plan should be provided through the deployment of off-grid technologies, consisting mainly of mini-grids and standalone solar devices.

64%

At the current electrification rate, there will still be 64 percent of the projected population without access to electricity in 2030. The majority of these (15.2 million) would live in rural areas.

A closer look at access: consumer realities on the ground

In addition to geographic location, access rates are largely driven by income level and factors that correlate with income level (income source, poverty experience, and education). For instance, 28 percent of the population earn MGA 44,000 (USD 14) or less a month with access to electricity at 17 percent. 22 percent of the population earn more than MGA 222,000 (USD 72) per month with access to electricity for this group at 65 percent.

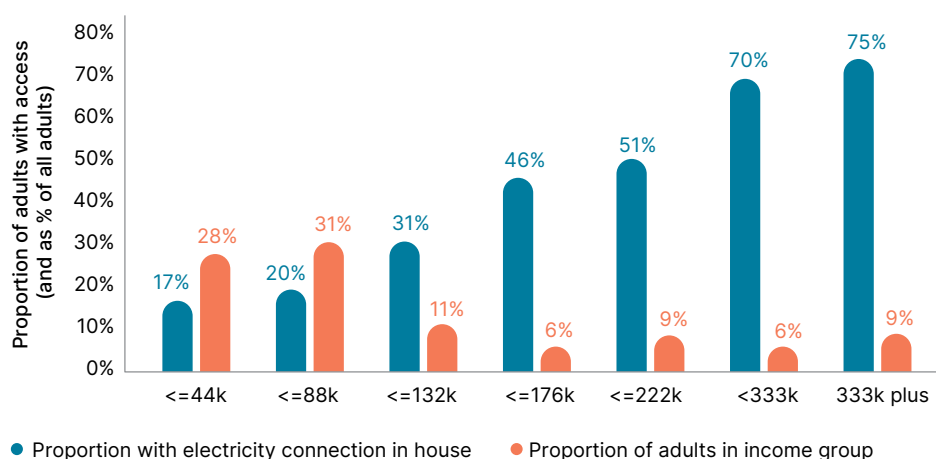


Figure 5: Proportion of income group with access to electricity

Source: FinScope Madagascar 2016 survey

14 World Bank, "Off-grid solar market assessment Madagascar" 2018

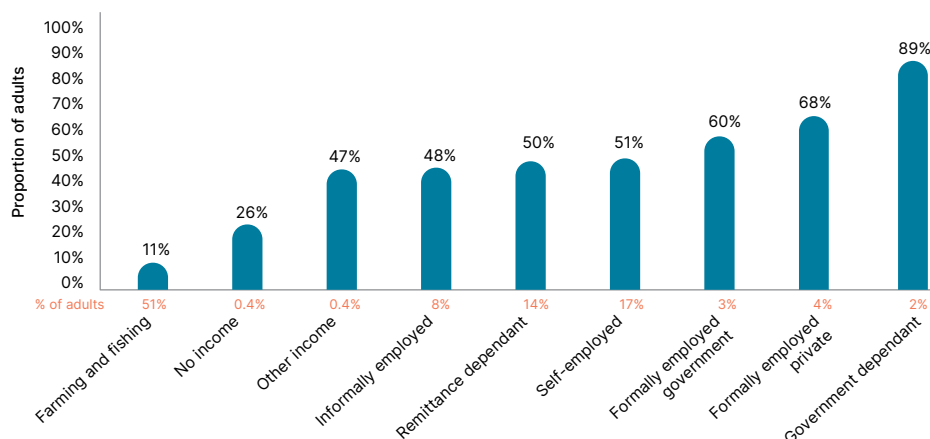


Figure 6: Proportion of income source with access to electricity

Source: FinScope Madagascar 2016 survey

The difference is perhaps most pronounced for education. Eight percent of people with no formal education have access to electricity, versus 86 percent of people with vocational training or a tertiary qualification having access. People whose main source of income is farming and fishing (51 percent of adults) have the lowest rate of access at 11 percent. With half the population deriving their income from agricultural activities, it is worth exploring clean energy and off-grid solutions, both as a climate mitigation response as well as alleviating poverty for those most in need. Government grant recipients have the highest rate of access at 89 percent; however this is only two percent of adults. The second highest is those formally employed in the private sector, at 69 percent (four percent of adults). Access also increases slightly with age, with 29 percent of those between 18 and 30 years having access, versus 40 percent of those aged 51 or older.

High levels of poverty in Madagascar, as well as the extensive use of biomass energy for cooking by basically the entire population (see Section 4), highlight that energy usage and expenditure is intrinsically woven into both poverty and climate change. Making progress towards the SDG's requires the ability to deal with both these issues concurrently.

Initiatives to promote the uptake of off-grid cleaner energy

There are several donor and non-governmental organization (NGO) programmes in Madagascar that are focused on off-grid electrification (Table 4). Most of these players, however, are involved with larger rural electrification projects, or specifically focus on mini-grids. Few of the programmes that have been identified focus on reaching the mass low-income segment of the off-grid market or on implementing innovative business models to accelerate the market for solar home systems. Given the low rate of access to electricity in rural areas, these projects should still have a positive impact on access to electricity.

There are however exceptions to this. For instance, KfW Development Bank recently provided a credit line and technical assistance for solar loan product



High levels of poverty in Madagascar, as well as the extensive use of biomass energy for cooking by basically the entire population, highlight that energy usage and expenditure is intrinsically woven into both poverty and climate change.

development at Access Bank. The European Union (EU) financially supports the solar home systems suppliers HERi and Jiro-Ve through grants.

In 2019, the World Bank launched a comprehensive Least-Cost Electricity Access Development (LEAD) project, which focuses on least-cost grid extension and densification but also has a substantial off-grid component. For the off-grid component, LEAD aims to create one of the largest market development funds in Sub-Saharan Africa to engage both private sector companies and financial institutions in accelerating the scale-up of the market for solar off-grid technology.¹⁵ Through the mutually reinforcing design of grid and off-grid components, the project is expected to electrify a minimum of 1.7 million people including 10,000 enterprises and 750 health centres. The project promotes the distribution of certified quality solar home systems with advanced battery technology to reach poor households in remote areas much faster and cheaper than any grid-based solution. This includes scaling the use of mobile payment systems to channel consumer credit for off-grid solar kits to poor households outside the formal banking system.

However, income and expenditure analysis of the current payments for utilities highlights that affordability for consumers would still be the main issue. The affordability analysis, combined with the large-scale use of free biomass energy illustrates that consumers are exceptionally poor and unlikely to switch to a solution that does not make financial sense – regardless of financial product solution. Analysis of current technology solutions available on the market highlights that a large number of the current systems are unaffordable for a substantial portion of the population. Furthermore, in terms of power output, these can only power a few lights, not cookstoves, or a fridge, or other larger appliances.

The LEAD project also aims to better coordinate donor activities in the region to streamline efforts. The programme has recognised that a body or actor that coordinates all donor and NGO work could be beneficial to avoid overlaps in the future. In particular, it is advised to coordinate with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and EU (see Table 4) in promoting the solar Photovoltaic (PV) market in Madagascar, concerning both off-grid and larger PV projects.

In a recent assessment of the off-grid market in Madagascar, the World Bank noted that it intended to draw on the expertise of the Fondation Énergies pour le Monde (FONDEM), Group for Research and Technology Exchanges (GRET), ADER and GIZ in deploying mini-grids. These projects have revealed the high-cost of mini-grid produced electricity and its limited suitability in Madagascar compared to other solutions (such as solar home systems). But, it was noted that mini-grids will still be deployed under certain conditions.

The following table provides an overview of the key programs and projects of other donors active in the off-grid solar sector. The off-grid PV sector has several activities that are already far advanced.



The affordability analysis, combined with the large-scale use of free biomass energy illustrates that consumers are exceptionally poor and unlikely to switch to a solution that does not make financial sense – regardless of financial product solution.

¹⁵ (World Bank 2019)

Table 3: Key donor programmes and initiatives to promote the uptake of off-grid cleaner energy in Madagascar

DONOR	FUNDING	DATES	TECHNOLOGY	OBJECTIVES
World Bank - Least-Cost Electricity Access Development Project - LEAD (P163870)	USD 55 million	2019 to 2024	Solar PV (pico), solar home systems, mini-grids	With its off-grid component, LEAD will create one of the largest market development funds in Sub-Saharan Africa to engage both private sector companies and financial institutions in accelerating the scale-up of the market for solar off-grid technology. Through the mutually reinforcing design of grid and off-grid components, the project is expected to electrify a minimum of 1.7 million people including 10,000 enterprises and 750 health centres.
World Bank - Least-Cost Electricity Access Development Project - LEAD (P163870)	USD 80 million	2019 to 2024	Grid electrification	This component of the project will finance cost-effective investments in grid extension and densification using state-of-the-art planning tools and low-cost technologies to maximize the number of new connections per dollar spent.
African Development Bank	USD 100 million to hydro-power	2019, ongoing	Grid and off-grid electrification, hydro-power	The Sahofika hydro-power project will add 205 MW of renewable energy generation capacity to the national grid, benefiting over 2 million people.
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)		Ongoing	PV (pico) mini-grids	Promotion of rural electrification through renewable energies
European Union (EU)		Ongoing	PV (pico) mini-grids, 10 mini-hydro plants	<p>The EU's support to supplier's HERi's "energy kiosks" attempts to scale-up an appropriate response to electrifying the poorest in Madagascar.</p> <p>The EU's mini-grid projects have provided interesting insights into the limitations of mini-grids as an economically viable solution to electrification, while improving national capacities for their implementation.</p>
KfW		Ongoing	Hydropower plants, mini-grids	<p>KfW is financing and supervising the construction of several MW of hydropower plants and mini-grids in the SAVA region.</p> <p>KfW recently launched a credit line and TA with Access Bank for solar loan product development.</p>
GRET		Ongoing	Solar PV-based multifunctional platforms	<p>GRET's "Café Lumière" project is implementing solar PV-based multifunctional platforms in Vakinankaratra region to enable a range of productive uses.</p> <p>The project is supported through a grant from AFD and technical support from ESF. Six sites have been identified to host the pilot phase. Each platform will have a capacity of 6 to 7 kWp.</p>
Fondem		Ongoing	PV mini-grids	<p>FONDEM is an international energy NGO that has several PV mini-grids, most notably those completed recently under the BOREALE programme, co-financed by the EU.</p> <p>In total, they have four 7.5 kW mini-grids, two 10 kW mini-grids and one 15 kW mini-grid.</p>

Source: Own analysis and the Enclude World Bank report¹⁶

The Embassy of Sweden, through the Africa Enterprise Challenge Fund (AECF), will provide up to USD 6.5 million for private sector companies to access capital and technical assistance. Using matching grants, the initiative aims to accelerate access to low cost, affordable, high-quality off-grid solutions via renewable energy solution providers that will also support mini-grids, solar home systems and clean cooking solutions.

There are a small number of social enterprises distributing solar home systems including Heri, Jiro-Ve, and Nanoe who offer solutions on a rental or pay-as-you-go (PayGo) basis. There is also one well established pan-African microfinance institution (MFI) - Baobab+ (Microcred.) that offers microcredit or loans for the purchase of solar products as well as traditional PayGo modality. They are reportedly selling roughly 200 to 300 solar home systems per month on a loan basis. Baobab+ is in partnership with MVola and Orange, with these mobile providers acting as payment facilitators. Clients who previously were not eligible for loans from MFIs can now become eligible for financial products based on their PayGo credit history. While it is a sound business case with market uptake, at approximately 2400 – 3600 systems a year, this will have negligible effect on expanding wide-scale access to meet SDG7. However, due to its large population size and limited access to grid energy, Madagascar has a large addressable market for basic Tier 1 solar home systems (See table 5). Accessing the last mile through local communities, especially combined with behavioural interventions around the use of biomass energy will be important. The MAP diagnostic in Madagascar highlighted that there are 25 registered MFI's with a combined client base of 1.4 million adults (12 percent of adults) together with a small number of existing social enterprises. Linking these into a coherent scale for private sector initiatives will start to address some of the market bottlenecks, in contribution towards a multi-partner, multi-faceted approach for the country. UNCDF's approach in linking last mile access through MFI and social enterprises with private sector actors will be able to contribute to the larger energy agenda for some market segments.



Due to its large population size and limited access to grid energy, Madagascar has a large addressable market for basic Tier 1 solar home systems

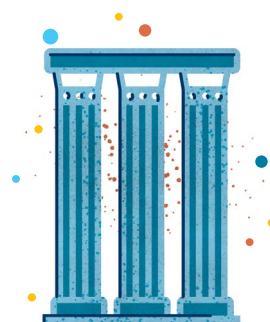
2 / Access to electricity

A framework for access to energy

Typical measures of energy access include the proportion of households that have access to electricity via the national grid. Simple measures like this, however, cannot provide an accurate view of the quality and quantity of energy provided. Our series of reports on the Southern African Development Community (SADC) countries, applies a detailed framework for the evaluation of access to energy, based largely on the ESMAP/SEforALL multi-tier framework.

Access to energy is an enabler of socio-economic development. Universal access to 'modern energy' by 2030 is one of the three key pillars of the Sustainable Energy for All (SEforALL) programme. SEforALL is an initiative co-chaired by the Secretary-General of the United Nations (UN) and the President of the World Bank. The SEforALL multi-tier framework provides three main sources of energy used by households: 1) electricity, 2) solid fuels and 3) modern fuels. Solid and modern fuels are used primarily for cooking and heating. Solid fuels as defined in the multi-tier framework include biomass such as wood, charcoal and dung, as well as coal. Modern fuels include liquefied petroleum gas (LPG), natural gas, kerosene (including paraffin), ethanol, and biofuels.¹⁷

The multi-tier approach measures access to household electricity as a continuum of improvement (as opposed to a binary metric like access vs. no access) by reflecting all attributes of electricity supply that affect the user's experience while being technology and fuel neutral. Different energy services (such as lighting, television, air circulation, refrigeration, space heating, etc.) require different levels and quality of energy. The actual use of energy might be constrained by factors such as capacity, availability, affordability, and convenience amongst others. In terms of the framework, households in Tier 0 are said to have no access to electricity while households in Tier 5 have full access to reliable, safe and good quality electricity. Access to all sources of energy can be measured using multi-tiered standards, including access to *cleaner off-grid electricity*. The relevant ESMAP/SEforALL multi-tier standards for household access to grid-supplied electricity are presented in Table 5.



Access to energy is an enabler of socio-economic development. Universal access to 'modern energy' by 2030 is one of the three key pillars of the Sustainable Energy for All (SEforALL) programme.

¹⁷ Mikul and Angelou, "Beyond Connections - Energy Access Redefined."

Table 4: Multi-tier energy framework to measure access to household electricity supply

ATTRIBUTES	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Power capacity ratings (daily watt-hour - Wh)		Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
Supported appliances		Task lighting and phone charging	General lighting, phone charging & television/fan (if needed)	Tier 2 and medium power appliances	Tier 3 and high-power appliances	Tier 4 and very high-power appliances
Typical supply technologies		Solar lantern	Small solar home systems, Rechargeable battery	Medium solar home systems, Fossil fuel-based generator, Mini-grid	Large solar home systems, Fossil fuel-based generator, Mini-grid, Central grid	Large fossil fuel-based generator, Central grid
Availability (Duration)		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
Reliability					Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
Quality					Voltage problems do not affect the use of desired appliances	
Affordability				Cost of a standard consumption package of 365 kWh/year <5 % of household income		

Source: ESMAP, SEforALL (2015) Energy Access Redefined.

Off-grid technologies such as solar home systems can be used to provide electricity services from Tier 2 to Tier 4, while mini-grids are typically used to provide services from Tier 3 to Tier 4. Table 6 illustrates which energy services can be accessed by households at each tier and which of the services could be met using either solid or modern fuels. While solid and modern fuels can often be

used instead of electricity for cooking, heating and lighting, access to electricity is required for most other energy services.

Table 5: Access to energy services by tier and source of energy

Energy services	ELECTRICITY						MODERN FUELS	SOLID FUELS
	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5		
1. Lighting		✓	✓	✓	✓	✓	✓	✓
2. Entertainment and communication		✓	✓	✓	✓	✓		
3. Space cooling and heating			✓	✓	✓	✓	✓	✓
4. Refrigeration				✓	✓	✓		
5. Mechanical loads				✓	✓	✓	✓	
6. Product heating					✓	✓	✓	✓
7. Cooking				✓	✓	✓	✓	✓

Source: Own analysis based on ESMAP SEforALL. 2015. Energy Access Redefined

Availability, reliability, and quality of grid-supplied electricity

JIRAMA estimates that there were 799 outages due to power breakdowns on the medium voltage network in 2015, more than twice a day on average. Some parts of the capital experience planned power outages of several hours each day, while anticipated power breakdowns are organized in secondary cities. Many residential and commercial establishments maintain diesel generators to compensate for power outages from the grid and purchase equipment to prevent frequent voltage fluctuations.¹⁸ FinScope (2016) finds that 36 percent of adults who have access to electricity do not have continuous access for all hours of the day.

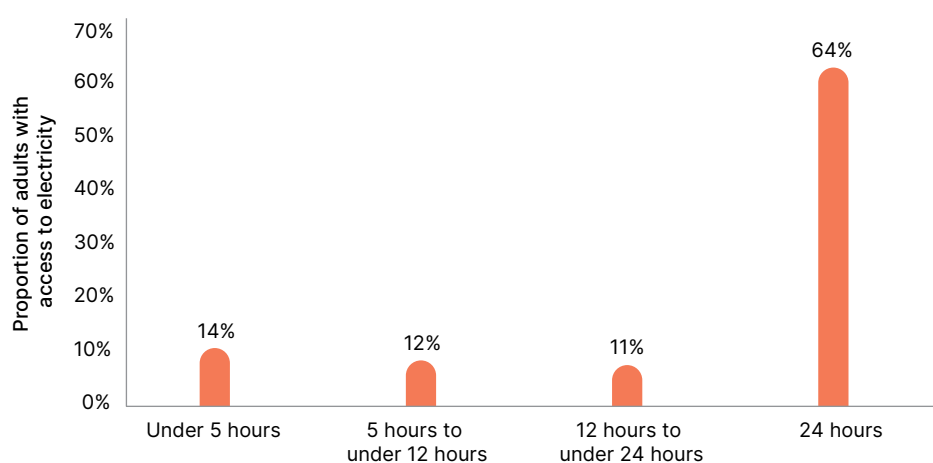


Figure 7: Proportion of population by energy use Tier, based on kWh consumption per day

Source: FinScope Madagascar 2016 survey

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Based on the high frequency of unplanned outages, Madagascar would only meet the Tier 1 to Tier 3 criteria for the availability and quality of grid-supplied electricity. JIRAMA has not published information on whether its supply is affected by voltage fluctuations. Using monthly expenditure on electricity to calculate kWh use per day, FinScope finds that 78 percent of the population falls into Tier 0 (not included in Figure 8). Very few people are therefore either connected to the grid, or use more than 12 watt-hour (Wh) per day if they are connected. Of the remaining population, the majority are in Tier 2 and 3. Most people who have access to electricity therefore use at least 200 Wh per day (min threshold for Tier 2).



JIRAMA estimates that there were 799 outages due to power breakdowns on the medium voltage network in 2015, more than twice a day on average.

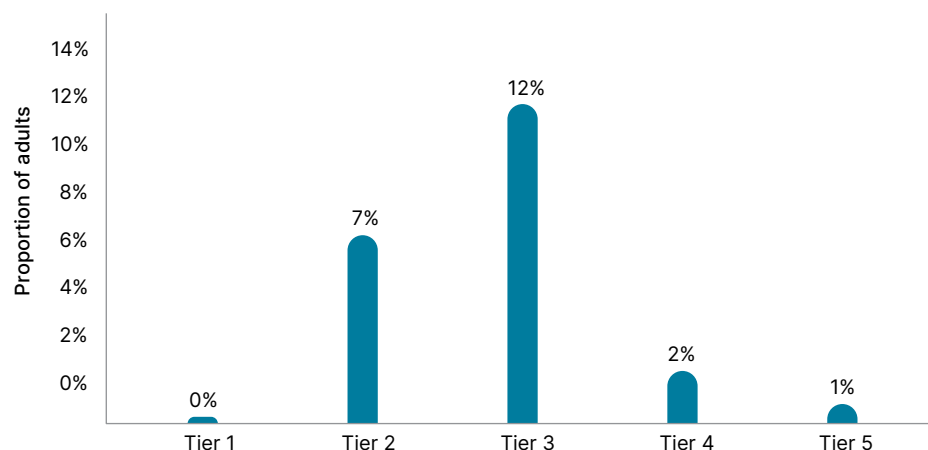


Figure 8: Proportion of population by energy use Tier, based on kWh consumption per day

Source: FinScope Madagascar 2016 survey

Consumer profile of energy needs and usage

In countries where electricity is not yet widely available or reliable, and where affordability is still an issue for the majority of the population, electricity usage is mostly limited to lighting, and not for higher intensity purposes like cooking, fridges, etc. In Madagascar, most people actually rely on non-electrical means of lighting because electricity access overall is so low. Electric lighting is therefore still uncommon with 58 percent of households relying on paraffin lamps or candles (Figure 9). 98 percent Malagasy households are heavily reliant on biomass for cooking (Figure 10), with firewood being the predominant fuel source (64 percent), as well as charcoal (35 percent).

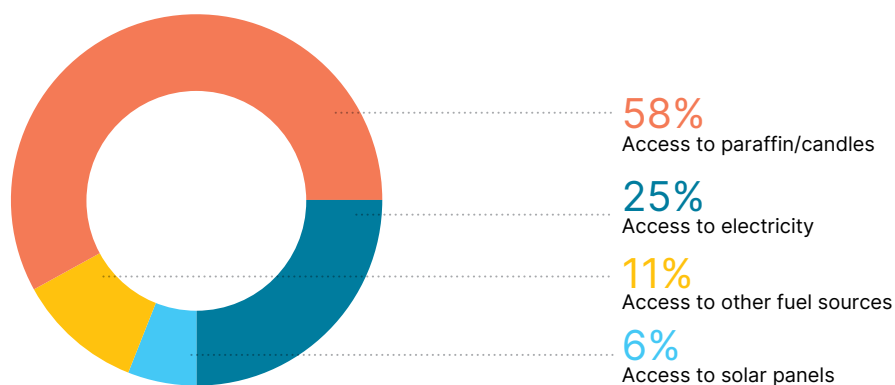


Figure 9: Access to clean fuels and technologies for lighting, Madagascar (% of households)

Source: Own analysis based on data sourced from the World Bank development indicators database

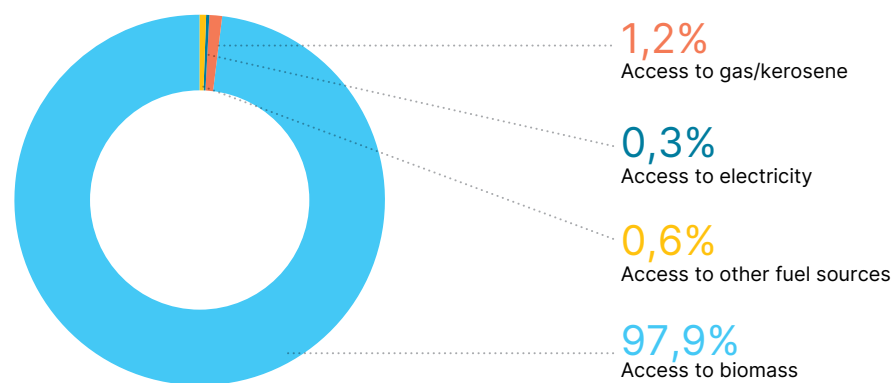


Figure 10: Access to clean fuels and technologies for cooking, Madagascar (% of households)

Source: Own analysis based on data sourced from the World Bank development indicators database

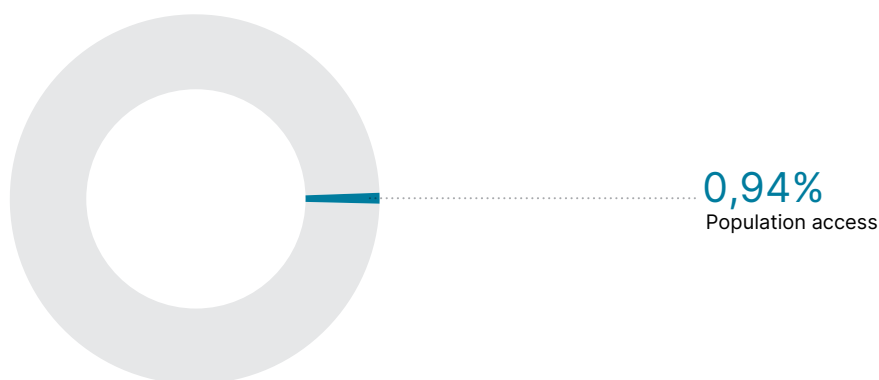


Figure 11: Access to clean fuels and technologies for cooking, Madagascar
(% of the population)

Source: Own analysis based on data World Bank, Sustainable Energy for All (SEforALL) database and from the WHO Global Household Energy database

In terms of the World Health Organization (WHO) definition, only one percent of the population accessed clean fuels and technologies for cooking in 2016 (Figure 11).

16 percent of households with access to electricity (or five percent of all households) report that their source of electricity is a solar panel (Figure 12). Similarly, six percent of adults report that they use solar panels for lighting.

The largest drivers of using electricity for lighting is geographic location, income, income source, and education. This is similar to the factors that contribute the most to having access to electricity overall. For instance, in urban areas, 73 percent of adults report using electricity for lighting, but only 9 percent in rural areas do the same. In rural areas, oil (or paraffin) lamps account for 64 percent of lighting, while 8 percent use solar panels. In urban areas, only two percent use solar panels for lighting.

Similarly, for income, 59 percent of the population earn MGA 88,000 (USD 28) or less a month. For this group, only 14 percent use grid electricity as a source of lighting while 63 percent of those who earn MGA 333,000 (USD 107) or more

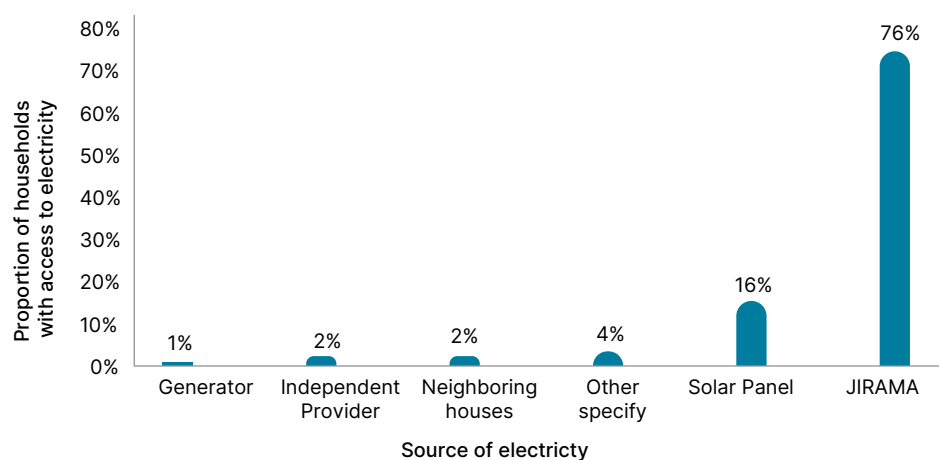


Figure 12: Access by source as proportion of households who have access to electricity

Source: FinScope Madagascar 2016 survey

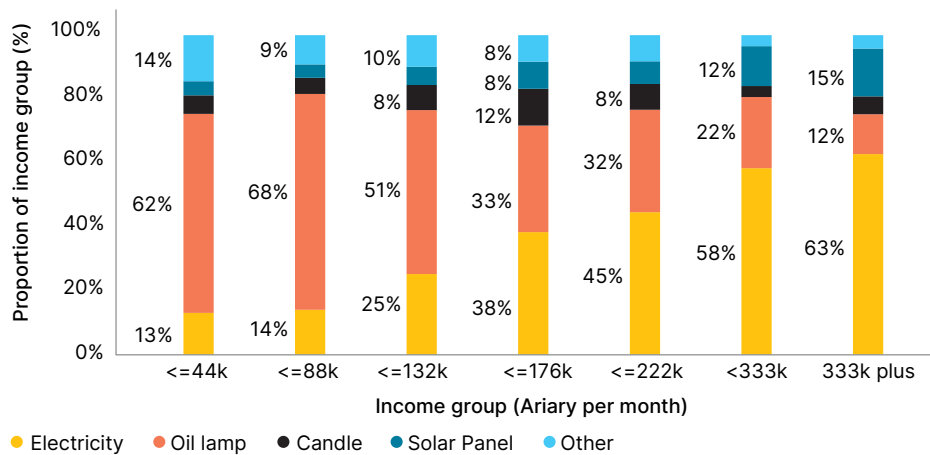


Figure 13: Energy use for lighting by income source

Source: FinScope Madagascar 2016 survey

(nine percent of adults) use electricity for lighting. 53 percent of those who are formally employed (eight percent of adults) also use electricity for lighting, versus only 24 percent of those who are not formally employed. Perhaps the biggest impact is education with 78 percent of those who have vocational training or a tertiary education using electricity for lighting, versus only five percent of those who do not have any education.

For cooking, 64 percent of adults report using firewood, while 35 percent report using charcoal. Less than two percent of adults report using anything else, and only 0.5 percent use electricity for cooking (57,000 adults, or 23,000 households). The largest trade-off between energy source is also between firewood and charcoal, with those having a higher income, formally employed, urban, and higher educated using more charcoal than firewood. For instance, 78 percent of adults in urban areas versus only 19 percent in rural areas use charcoal, and 75 percent of those with vocational training or a tertiary education versus only 12 percent of those with no education. Although overall use of gas remains low for cooking (at only one percent), there is a slight increase in use

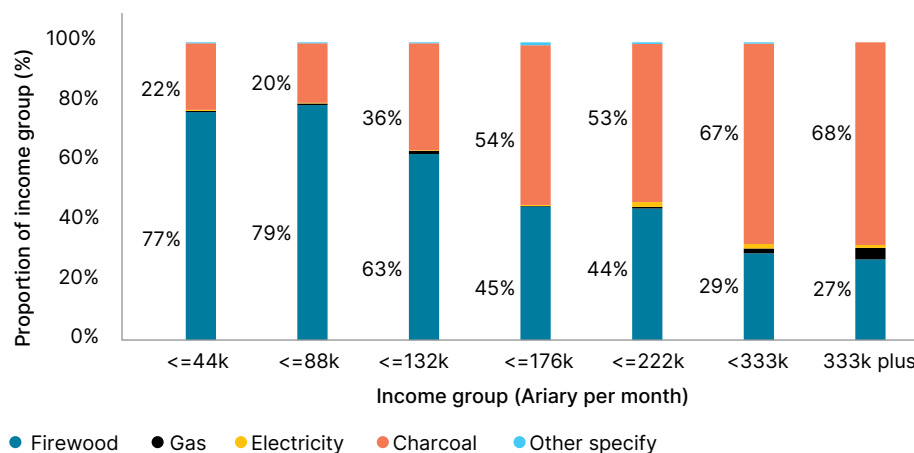


Figure 14: Energy use for cooking by income level (MGA)

Source: FinScope Madagascar 2016 survey

of gas for higher income groups (three percent for those earning more than MGA 222,000/USD 72), location (two percent of urban adults), and education (five percent of those with the highest education). Similarly, use of electricity for cooking is less than one percent, but is slightly higher for richer individuals (1.4 percent of those earning more than MGA 222,000/USD 72), the formally employed (1.3 percent), urban adults (1.5 percent), and the highest education group (2.1 percent).

Fuelwood is the predominant fuel for those who earn less than MGA 133,000 (USD 43) per month, while charcoal is the principal fuel for those earning more than this, especially those earning more than MGA 332,000 (USD 107). Only a small minority (one percent) have access to cleaner cooking fuels including electricity, natural gas and kerosene. The vast majority of biomass used in Madagascar is burnt without any means for optimising energy extraction from the fuel, such as improved fuelwood cookstoves. The source of traditional biomass (fuelwood) is from indigenous forests, where the trees are harvested without following sustainable management practices.

Less than 25 percent of the total land area of Madagascar is covered in forest. An estimated 80 percent of its natural forested areas have been lost, and an estimated 200,000 hectares more is lost annually (source: Clean Cooking Alliance in 2011). Nearly 12,000 deaths per year in Madagascar are attributed to respiratory infections caused by inhalation of Household Air Pollution (HAP) from traditional cooking with biomass.¹⁹

FinScope allows us to quantify the total amount spent on electricity, gas, and other energy sources (not disaggregated) in Madagascar, by adding up the individually reported expenditure on these, and weighted for the overall population. Annually, people in Madagascar report to spend USD 626 million on all energy sources. Of this, 58 percent is spent on other energy sources such as charcoal, oil, or candles (USD 364 million), and 38 percent is spent on electricity (USD 238 million). Only four percent is spent on gas (USD 24 million). The average monthly expenditure (by all adults) on other sources is just under USD 3, while it is just under USD 2 for electricity.



Less than 25 percent of the total land area of Madagascar is covered in forest. An estimated 80 percent of its natural forested areas have been lost, and an estimated 200,000 hectares more is lost annually.

Table 6: Annual total expenditure on electricity in Madagascar

SOURCE	ANNUAL EXPENDITURE (USD)	PROPORTION OF TOTAL EXPENDITURE	AVERAGE MONTHLY (USD)
Gas	23 743 740	4%	0,2
Electricity	238 308 735	38%	1,8
Other	363 954 372	58%	2,7
ALL energy	626 006 847	0%	4,6

Source: FinScope Madagascar 2016 survey

19 Clean Cooking Alliance, "Ethanol as a Household Fuel in Madagascar.

Affordability of grid-supplied electricity and cost-reflectivity of tariffs

JIRAMA's current tariff for single-phase domestic electricity is MGA 431 (USD 0.14) per kWh while the lifeline supply (which JIRAMA defines as the use of less than 20 kWh per month) is discounted to MGA 141 (USD 0.05) per kWh (Table 8).²⁰ The allotted 20 kWh per month covers only 300 of the 365 kWh of an annual standard consumption package (SCP)²¹. The effective tariff for the full 365 kWh is roughly MGA 252 (USD 0.08) per kWh, with an SCP costing MGA 91,960 (about USD 30). At the standard residential tariff, an SCP costs MGA 157,315 (about USD 51).

Table 7: Cost of grid-supplied electricity, Madagascar (2020)

	CURRENCY	COST PER KWH	COST OF SCP (365 KWH)
Lifeline tariff, prepaid	MGA	251.95	91 960.00
	USD	0.08	29.69
Residential tariff, prepaid	MGA	431.00	157 315.00
	USD	0.14	50.75

Source: Own analysis based on tariff data from <http://www.jirama.mg/>

The ESMAP/SEforALL multi-tier framework measures the affordability of grid electricity by comparing the cost of a standard consumption package (SCP) of 365 kWh per year to a maximum energy expenditure threshold, set at five percent of total household expenditure (Figure 15).²² According to this metric, and dividing the population into five equal quintiles, households in the bottom three expenditure quintiles (Q1, Q2, and Q3) would struggle to afford a SCP at

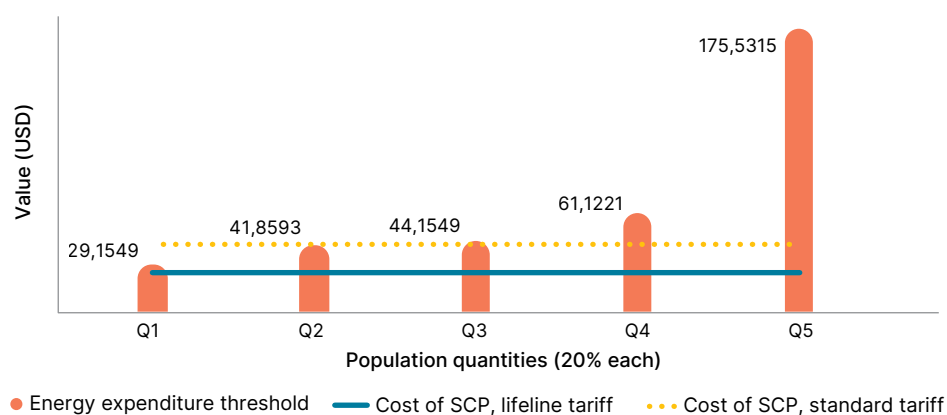


Figure 15: Affordability of grid electricity, Madagascar (2020)

Note: Cost of standard consumption package (SCP): Lifeline tariff = USD 29.69; Standard tariff = USD 50.75

Source: Own analysis.

²⁰ "Electricity Prices- JIRAMA.

²¹ We used an SCP of 1 kWh per day, or 365kWh per year as a cross country comparable minimum usage benchmark

²² Our estimates of mean annual household consumption expenditure are provided in Error! Reference source not found.

the standard residential tariff. Households in the bottom quintile (Q1) are barely able to afford an SCP at the lifeline tariff. Nevertheless, at the lifeline tariff, all five quintiles should theoretically be able to afford a SCP of electricity in Madagascar.

However, FinScope (2016) provides information for total monthly expenditure, as well as monthly expenditure on gas, electricity, and other energy sources. This allows for a detailed analysis on actual expenditure on a more granular basis across the population, and given the known cost of electricity, calculate electricity use. Although affordability (expenditure on electricity as percentage of all monthly expenditure), does not change drastically across income groups, there is a substantial difference in the proportion of people in each income group that spends money on electricity each month. It starts as low as eight percent for the lowest income group, and rises to 58 percent of the highest income group. Furthermore, the nominal amount varies just as much, with as little as USD 0.3 spent per month for those who buy electricity in the lowest income group, to almost USD 7 for those in the highest income group (Figure 16). The same trend can be observed for the formally employed, urban, educated and older adults where a larger proportion of each of these groups spend money on electricity, and they spend a larger nominal amount each month.



Although affordability does not change drastically across income groups, there is a substantial difference in the proportion of people in each income group that spends money on electricity each month.

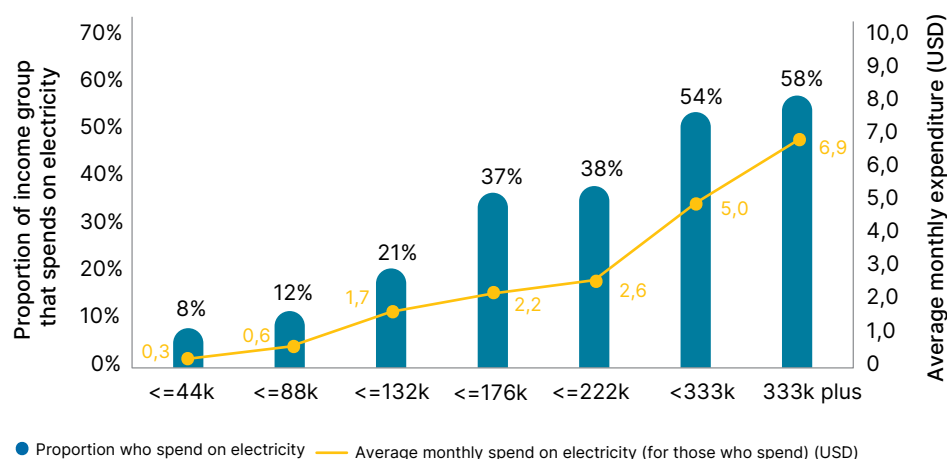


Figure 16: Monthly expenditure on electricity by income group

Source: FinScope Madagascar 2016 survey

However, when looking at expenditure on energy across all sources (including electricity and gas), the proportion of people in each income group that spends money on a monthly basis increases dramatically. In this case, the lowest proportion of people who spend is still in the lowest income group, but it is now 60 percent (compared to only eight percent for electricity alone). This rises to 85 percent for the highest income group. The nominal amount spent increases across all income groups as well, but increases by a smaller factor for higher income groups (factor of two), compared to lower income groups (factor of 5). Clearly, most people do spend on energy sources, but if you are richer, more of

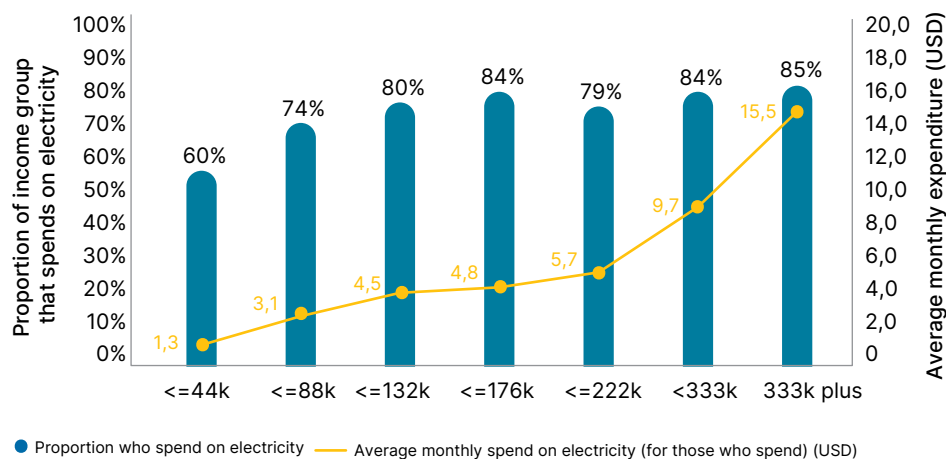


Figure 17: Monthly expenditure on all energy sources by income group

Source: FinScope Madagascar 2016 survey

your energy requirements are fulfilled by electricity. Energy overall is not that affordable in Madagascar though, as the proportion of expenditure on all energy sources (as a proportion of all monthly expenditure) is between 14 percent (lowest income group) and 18 percent (second highest income group), which is far above the five percent affordability threshold used for the SCP.

The proportion of adults who spend on all energy sources, the average amount spent, as well as the proportion of monthly expenditure is the highest (although again not substantially higher) for urban adults, as well as adults with vocational training or a tertiary degree. Almost all electricity and gas is bought on a monthly basis. Other energy sources (charcoal, oil, candles, etc.) is bought on a daily and weekly basis, with 28 percent and 21 percent, respectively, of all adults buying

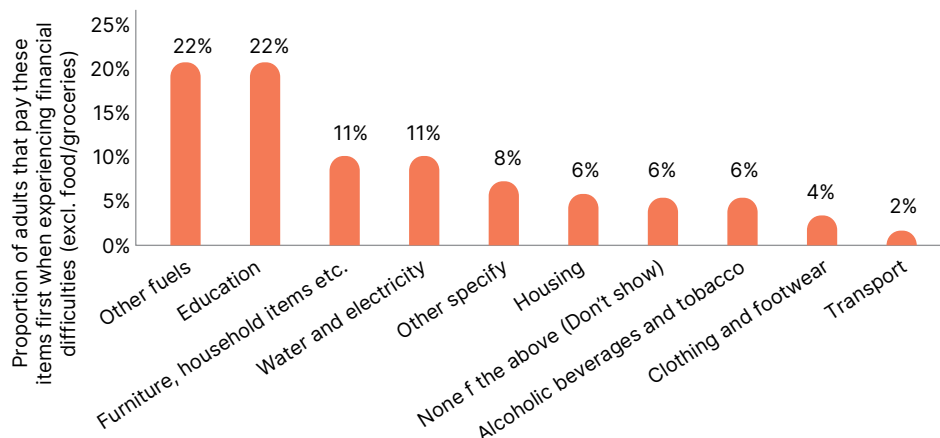


Figure 18: What people spend money on first when experiencing financial difficulties (excl food and groceries)

Source: FinScope Madagascar 2016 survey

Electricity tariffs in Madagascar are not fully cost-reflective. Revenue from the tariff does not cover the full costs of producing power plus a market-related return on capital invested.

Electricity tariffs in Madagascar are not fully cost-reflective. Revenue from the tariff does not cover the full costs of producing power plus a market-related return on capital invested.

29 Consumer profile of energy needs and usage

4

MSME energy use for productive uses

Small business profile

The micro, small, and medium size enterprise (MSME) sector in Madagascar is dominated by the timber, agricultural, construction, tourism. Most businesses are in agriculture, which accounts for 30 percent of gross domestic product (GDP) and employs about 75 percent of the workforce. Most agriculture in Madagascar is small-scale subsistence farming.²⁴ The country's non-agricultural private sector is dominated by self-employment and family businesses with about 42 percent of the employed work in their own business while 18 percent help in their family's businesses.²⁵

FinScope finds that there are 5.3 million adults whose main income source is agriculture. An additional 1.6 million are self-employed in the informal sector (not registered), and 383,000 are self-employed and registered (formal sector). However, people also have multiple income sources, and in total, there are 6.5 million people who derive income from agriculture, and 2.1 million who earn an income being self-employed (but not registered). A total of 440,000 people are self-employed and registered. Accounting for overlaps between these three



There are 5.3 million adults whose main income source is agriculture. An additional 1.6 million are self-employed in the informal sector, and 383,000 are self-employed and registered.

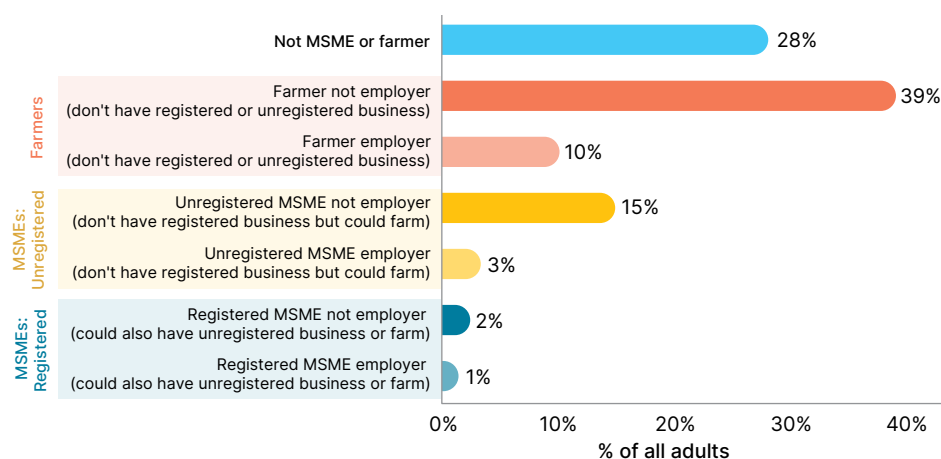


Figure 19: Proportion of adults who farm or are self employed, including their employment status

Source: FinScope Madagascar 2016 survey

24 World Bank, "Off-grid solar market assessment Madagascar" p.7

25 World Bank, "Off-grid solar market assessment Madagascar" p.2

sources, a total of 8.1 million people are self-employed (agriculture or MSME), and a total of 2.5 million are self-employed when excluding farmers. This accounts for 72 percent of all adults in Madagascar. Only 28 percent of adults are therefore neither a farmer, nor self-employed (business owner). Using these criteria, along with information on whether the business employs someone else, six unique segments can be constructed, which is used for further understanding the MSME landscape and their energy use in Madagascar (Figure 19).

Registered MSMEs in particular (440,000), are fairly concentrated geographically, with 50 percent found in just one province, and 68 percent in only two provinces. This is despite these provinces only accounting for 51 percent of all adults. At a regional level, only three regions account for 59 percent of all registered MSMEs, two of which is in Antananarivo. For at least half of registered MSMEs, geographic location should therefore not be a barrier to access to electricity. For unregistered MSMEs, there is only one region (Analamanga) with a disproportionate portion of MSMEs (in relation to population share), at 23 percent (or almost one in four unregistered MSMEs), compared to a population share of only 16 percent.

In addition to provincial and regional concentration, registered MSMEs are also the most urban, especially those who employ someone else (68 percent versus 53 percent if not an employer). This is followed by unregistered MSMEs (32 percent urban). Only nine percent of those who farm (and don't own a business) are located in urban areas. Of the entire adult population, only 27 percent are urban.

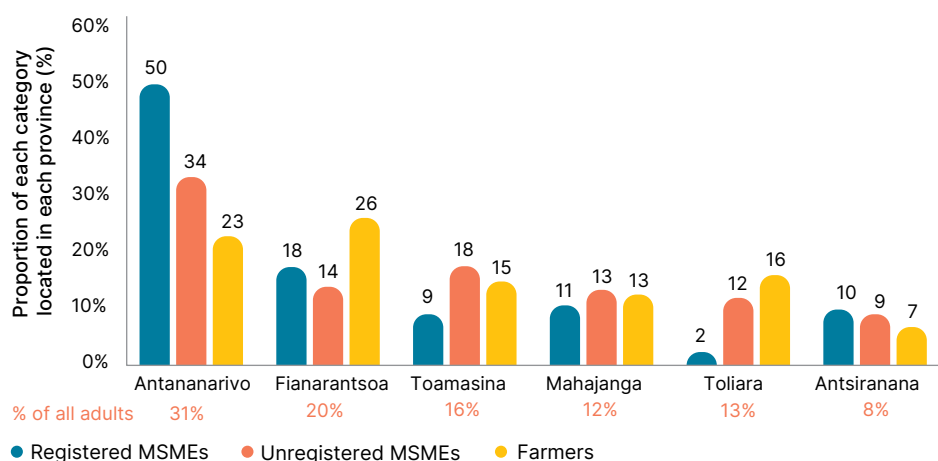


Figure 20: Proportion of self employed in each province by category

Source: FinScope Madagascar 2016 survey

MSME access to electricity

FinScope Madagascar (2016) provides information on access to electricity for MSMEs and farmers as consumer groups. Registered MSMEs have the highest level of household access to electricity, followed by unregistered MSMEs. However, it is only registered MSMEs who also employ someone who have fairly saturated levels of access (83 percent). This is remarkable given that only 68 percent of these MSMEs are urban – meaning that a substantial proportion get

their electricity either from the grid in rural areas (less likely), or from off-grid sources (most likely mini-grids). Farmers who do not own a business have the lowest levels of access. Even for registered MSMEs though, their actual energy use per month is so low that around half these businesses fall in Tiers 0 to 2 (mostly Tier 0). Therefore, not even MSMEs are using electricity sufficiently to unlock broad-based productivity.

In terms of expenditure on electricity as a proportion of all expenditure, and expenditure on all energy sources (also as proportion of all expenditure), there is scope to increase the electricity use of MSMEs, given their geographic concentration. For instance, the minimum and maximum expenditure on all energy sources across the groups are nine percent (farmers who do not employ someone) and 17 percent (registered MSMEs with employees) as a proportion of all expenditure. The expenditure on electricity is much lower at one percent and seven percent, respectively. MSMEs and farmers therefore spend a much higher portion of their overall expenditure on energy than they do for electricity.

The World Bank's 2013 Madagascar Enterprises Survey report highlights that electricity is perceived as the second most important barrier to doing business

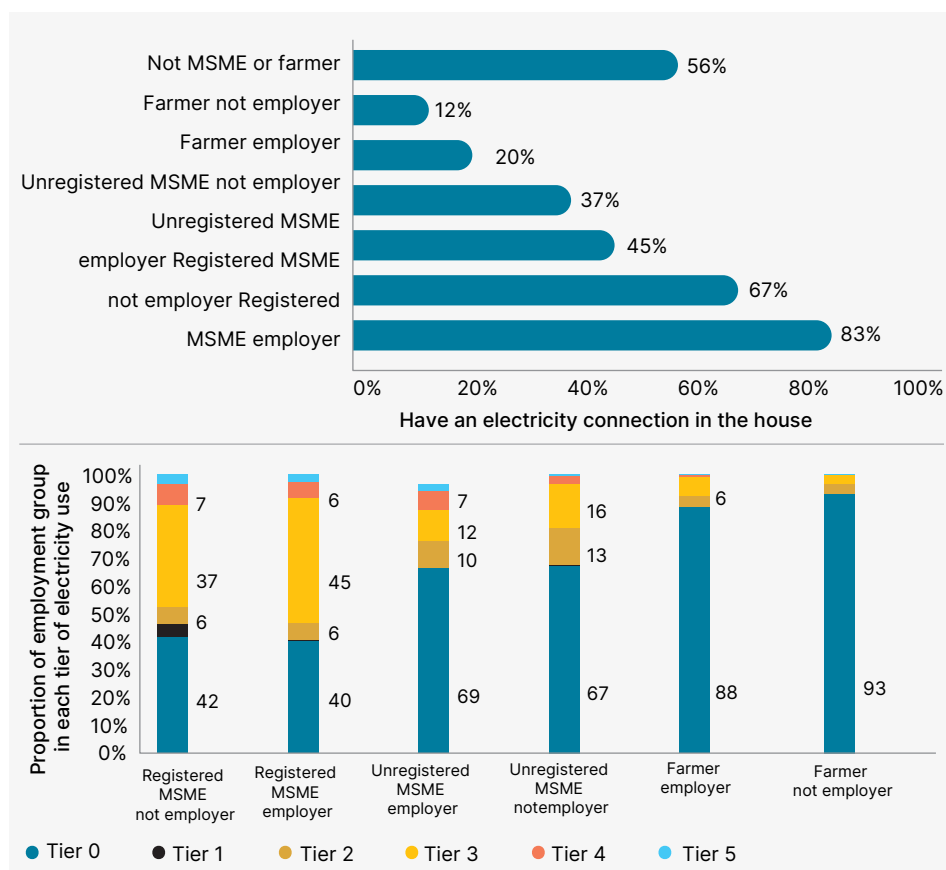


Figure 21: Electricity access and use by employment group

Source: FinScope Madagascar 2016 survey

after political instability, especially for small and medium-sized firms (SMEs).²⁶ SMEs experience an average 6.7 power outages per month with an average duration of 1.5 hours each (about 2.5 hours per week). The impact on business profitability is significant with the average firm losing the equivalent of seven percent of its sales because of power outages.

Furthermore, results from the Madagascar Enterprises Survey indicate that high connection fees make grid electricity unaffordable for many small businesses. While JIRAMA offers lifeline tariffs for the first 20 kWh per month, the upfront connection fees (USD 165 on average) represent a major barrier to grid access for most households and small businesses. SMEs that can afford grid electricity have to wait up to 18 months to get connected, which is unfavourable for the development of productive uses.²⁷ In the survey, ten of the 17 SMEs reported that they use a generator, two companies had grid-power and three companies used solar products. The average monthly consumption of electricity was 1,000 kWh (or 33 kWh per day on average – much higher than typical household usage). Rice mills, carpenters, and car repair garages required the most energy.

However, FinScope, which includes micro enterprises, finds much lower usage for MSMEs as a group. The average kWh estimated use per month for the highest group (registered MSMEs with employees) who report buying electricity is only 144 kWh per month. Except for farmers, unregistered MSMEs who do not employ anyone have the lowest use at 58 kWh per month. However, this may not include electricity for business purposes, as FinScope consumer does not distinguish this.

Interviews with the World Bank highlight that SMEs electricity expenditure can account for up to 70 percent of total operating costs (including connection fees and maintenance). Businesses using generators (and thus petrol or diesel) reported the highest energy costs, with over 80 percent of their total operating costs going to energy. Actual operating costs ranged between MGA 90,000 per month (about USD 29) for a small shop or garage, and about MGA 2 million per month (about USD 645) for a rice mill or carpenter.²⁸

All enterprises surveyed expressed interest in investing in alternative energy sources. The average investment priority score given to energy was 8.3 out of ten. The interviewed SMEs were willing to invest an average of MGA 10 million (USD 3,226). Over half of the interviewed SMEs (nine of 17) were open to taking a loan to finance the investment, but seven of these nine businesses had never dealt with a financial institution before. Similarly, FinScope finds that only 39 percent of registered MSMEs are banked, and only 15 percent have any type of formal credit. Similar to reports in other countries, access to appropriate financial products for a severely income constrained country would be a central part of an off-grid energy adoption strategy in Madagascar.



All enterprises surveyed expressed interest in investing in alternative energy sources. The average investment priority score given to energy was 8.3 out of ten.

26 World Bank, "Doing Business Survey: Madagascar, 2013-2014" p.7

27 World Bank, "Doing Business Survey: Madagascar, 2013-2014" p.9

28 World Bank, "Doing Business Survey: Madagascar, 2013-2014" p.9

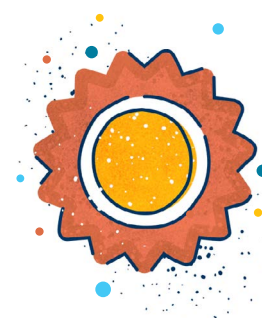
Potential to deploy off-grid power solutions for productive applications

The market for off-grid solar for productive use is determined by the affordability and accessibility of these solutions. The World Bank study recommended that solar-powered or hybrid solar and diesel multi-functional platforms (MFP), as is common in West Africa, be introduced to equip small business in Madagascar.²⁹ However, at the levels of use found for SMEs, these would have to be high capacity Tier 5 solutions, and even at levels found for MSMEs in FinScope, it would have to be Tier 4 and 5 solutions. These systems cost significantly more than Tier 1 to 3 solutions, which can mostly just be used for lighting and charging phones.

The MFP is a village-level energy solution (mini-grid), built around a diesel or solar-diesel hybrid electrical generator.³⁰ A typical MFP comprises of a ten horsepower (HP) diesel engine, capable of driving different ancillaries such as a grain mill, a de-huller, an oil press, and even an electric alternator to power 250 light bulbs. Several thousands of MFPs have gone into operation in West Africa in the last 20 years, creating local jobs and adding value to local production. GRET, an international NGO active in Madagascar in the agricultural and energy sectors, is implementing a project based on the construction of solar PV based MFPs. These MFPs will support a range of productive uses including husking, drying, cold storage, print shops, small metal and woodwork, and small shops in the region of Vakinankaratra, mainly in Antsirabe.³¹

The Project, called “Café Lumière”, is based on the principle of co-financing. Agence Française de Développement (AFD) provides seed capital in the form of a grant, a volunteer from *Electriciens Sans Frontières* oversees the technical implementation, and GRET manages the project and develops the capacity of local enterprises that manage the platforms.³² The project was initiated in 2015 and six sites have been studied to host the pilot phase. Each platform will have a capacity of six to seven kW, which, when combined can serve up to 1,000 inhabitants. The cost of the platform is EUR 52,000 per unit. The local enterprise must invest in its production equipment and machinery which will run off the power source.³³

With the decreasing costs of solar PV hardware, battery storage and metering technology, the World Bank foresees an opportunity to hybridize and densify existing systems and build new solar-powered mini-grids that could promote both rural economic development and electricity access. However, even with decreasing technology costs and upfront capital expenditures, the business case for mini-grids remains tenuous because of limited ability to pay, and the high cost of supply. The World Bank has suggested that mini-grids servicing both



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29 World Bank, “Doing Business Survey: Madagascar, 2013-2014” p.8

30 World Bank, “Doing Business Survey: Madagascar, 2013-2014” p.8

31 World Bank, “Doing Business Survey: Madagascar, 2013-2014” p.12

32 World Bank, “Doing Business Survey: Madagascar, 2013-2014” p.12

33 World Bank, “Doing Business Survey: Madagascar, 2013-2014” p.12

A stylized illustration of a hand holding a blue banknote. The hand is orange with a blue sleeve. The banknote is blue with a white circle in the center. There is a burst of small blue dots and confetti around the banknote.

Access to finance is a more pressing constraint to operating or growing a small business than electricity access.



5

Access to financial services, availability and cost of credit

A large proportion of Malagasy does not have access to formal financial services (Figure 22). In 2016, FinScope found that only 29 percent of people in the country have access to formal financial services, while more than two-fifths do not use any form of financial services. Only 12 percent of the population have bank accounts. An additional 16 percent use formal financial services (including mobile money and MFI credit) while 26 percent use other formal services. A total of 41 percent use informal financial services, but only 30 percent use informal services but no formal services.

Access to electricity is influenced by access to finance. The banked population has the highest levels of access (74 percent), followed by those who use other formal services (62 percent). Those who use informal services have low levels of access to electricity, similar to those of the excluded (24 percent). However, even for groups with high levels of access to electricity (those using formal financial services), a large proportion remain in Tiers 0 to 2, with less than half of this group in Tiers 3 to 5. The use of electricity for lighting is quite high for the banked population (66 percent) and those who use other formal financial services (55 percent). However, even these groups do not use electricity for cooking – only five percent of the banked use gas or electricity to cook, and only two percent of other formal financial services users. Interestingly, solar panels as a source of electricity is the highest for those who use informal

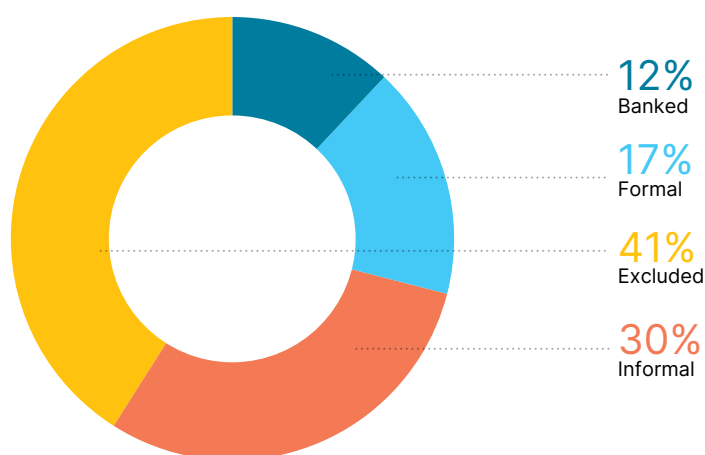


Figure 22: Access to financial services, Madagascar (% of population)

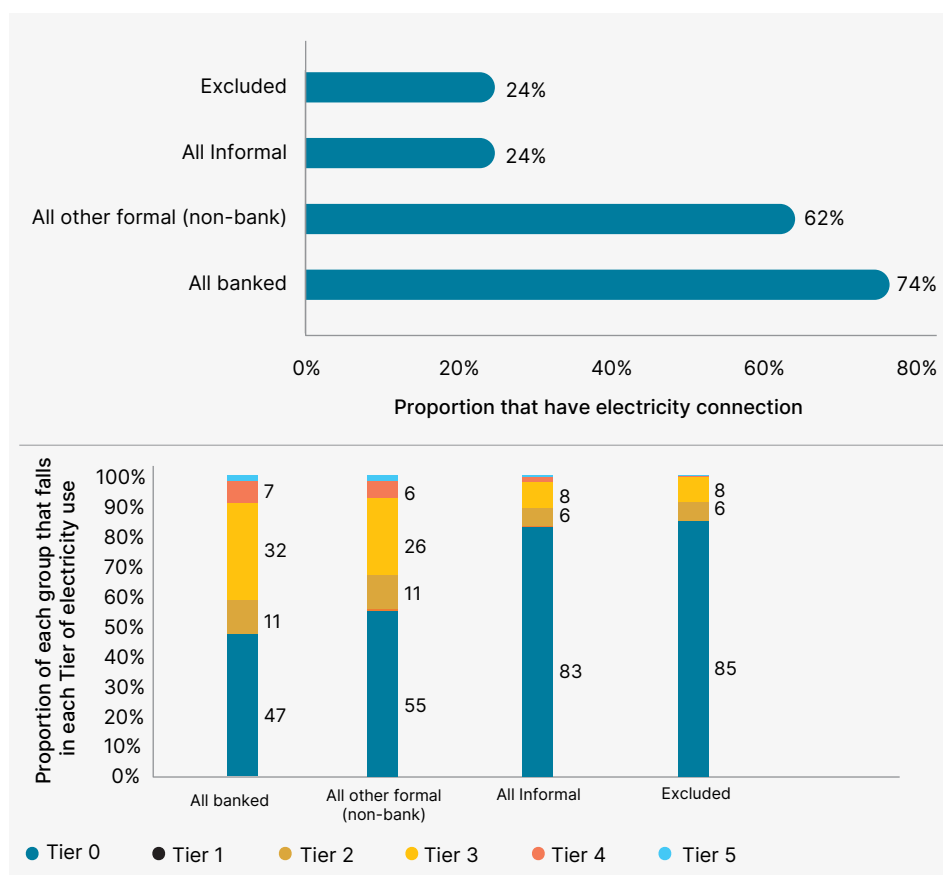


Figure 23: Financial inclusion versus electricity access and use

Source: FinScope Madagascar 2016 survey

services (19 percent) as well as those who use only informal services (25 percent) – surpassing formal financial services at 10 percent for banked and 12 percent for other formal services, likely because a higher proportion of formal financial service users are using electricity for lighting purposes.

There are 11 banks in Madagascar. Banks in the country operate across all four financial service product markets (payments, savings, credit, and insurance). MFIs also play a significant role in the market for credit, savings and insurance, notably in rural areas and in providing financial services for smaller amounts than those serviced by banks. In 2017, there were 25 registered MFIs.

According to the MAP diagnostic for Madagascar, the microfinance sector operates in four different ways.

1. Niche MFIs specialise in agricultural or MSME loans in specific sectors.
2. Retail MFIs focus on large-scale deposit collection and lending and operate as quasi banks. This type of MFI serves more than half of MFI consumers.
3. Donor-funded MFIs are primarily impact orientated, rather than profit-orientated.
4. Most large MFIs are mutual organisations and often have a specific mandate to serve lower-income and rural consumers.

Lending in Madagascar, both to businesses and individuals, is very risky. Credit cooperatives have an explicit mandate to serve lower-income Malagasy based in rural areas. Operating costs are high, and many ledgers have significant non-performing loans. Low-value loans to poor people have a high credit risk, and as a result, MFIs charge high interest rates. Despite this, MFI loans remain attractive as they have a wider branch network than banks and lower eligibility requirements.

Access Bank, Microcred (Baobab+), and CECAM have established loans and PayGo for solar home systems for the household-level consumer. Most of these energy lending activities have enjoyed moderate uptake and have shown early signs of success. They offer solar home systems through classical loans for existing Microcred clients or through PayGo models for those that do not qualify. For existing Microcred customers the programme developed a top-up loan with a maximum value of 50 percent of the customer's original loan. In terms of outreach, the Baobab+ programme seems to have reached, together with CECAM, the highest numbers in terms of solar loan uptake. For Microcred, this amounts to the sale of approximately 200-300 RE or solar loans a month, which is comparable to the better performing MFIs that provide solar loans in the Sub-Saharan Africa region.³⁴ Clients who previously were not eligible for loans from MFIs can become eligible for financial products based on their PayGo credit history.³⁵

Credit risk is increased by institutions' inabilities to access adequate information on their clients via an up-to-date credit bureau. The World Bank Ease of Doing Business report (2019) finds that debt recovery rates are approximately 11 percent of the debt value, and that the recovery process can take up to three years. The quality of credit bureau reporting is poor, and less than seven percent of the adult population is reported on by credit registries. Difficulties in debt recovery and high information asymmetry give rise to collateral requirements up to 600 percent of the loan value.³⁶



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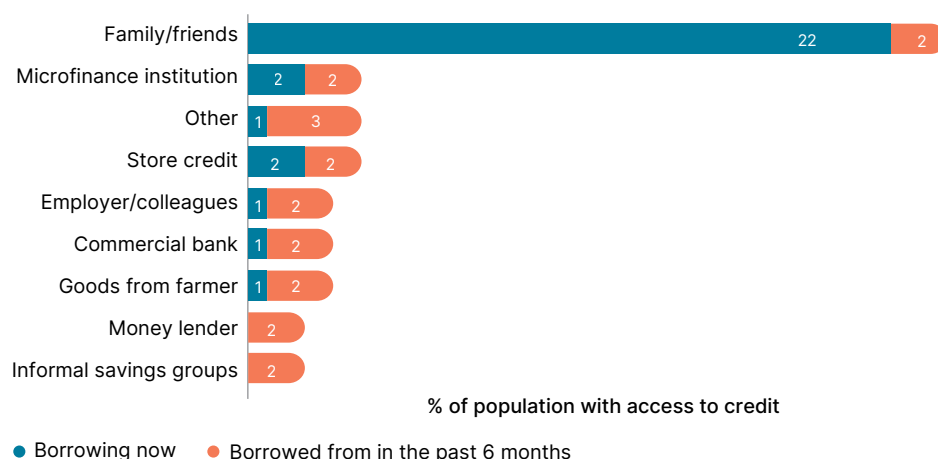


Figure 24: Source of credit, Madagascar, 2018

Source: Own analysis based on FinScope survey for Madagascar, 2018.

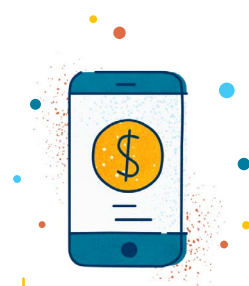
34 World Bank, "Off-grid solar market assessment Madagascar"

35 <https://www.baobabplus.com/?lang=en>

36 The World Bank Group, "Comparing Business Regulation for Domestic Firms in 190 Economies."

The financial services sector is segregated heavily by income and location. Extremely poor, rural people tend to be fully financially excluded or rely on informal options and friends and family (Figure 24). The MAP diagnostic estimates that 300,000 people in Madagascar belong to informal savings societies. Large MFIs are often mutual organisations and tend to have a specific mandate to serve lower-income and rural consumers. They tend to reach deeper rural and lower-income customers than mobile money services and formal banks, which typically service urban, middle-income and wealthy customers.

The use of mobile money in Madagascar is still limited where only 35 percent of the population own mobile phones³⁷ (although access is higher at 75 percent if mobile phone sharing is taken into account) and 13 percent of the population use mobile money. The country has five mobile network operators. Mobile network coverage statistics are unclear, but coverage maps from the GSMA suggest that, while coverage is good in urban areas, it is patchy in remote rural areas. Mobile money payment channels exist but are underutilised. While FinScope suggests that approximately 69 percent of adult citizens have heard of mobile money, only 13 percent of them are current users of mobile money solutions. This makes PayGo models challenging. Mobile money, however, is rapidly developing, with four providers currently active in this market: Orange, MVola (Telma), Airtel, and BIP.



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³⁷ Using FinScope, MAP found that Madagascar has an estimated mobile phone penetration rate of 35% of the population, while the ITU reports that, according to the Madagascan telecommunication regulator, there are 41 mobile network subscriptions per 100 inhabitants.

The investment case for cleaner off-grid solutions



Given the low level of access to electricity, and the substantial dependence on off grid and clean energy solutions, there is massive potential for off-grid and clean energy products to serve the needs of households and small businesses.

As a first step to address and achieve the government's objectives of increasing electricity access to households, we have attempted to size the market, based on two typical standalone solutions currently available in the market. These solutions focus on the need for energy for lighting, charging phones, and running small appliances. Given that 78 percent of the population is currently in Tier 0, and that 75 percent don't use electricity for lighting, a Tier 1 clean energy product could contribute significantly to expanding basic access to energy.



Option 1: Tier 1 solar home systems solution or 'pico-solar' solution

Assumed costs USD 60 per annum, providing a low-end solution with a single light and charging solution. This is typically sold for cash but we have assumed it could be sold on an instalment basis over a maximum repayment period of 12 months.

Option 2: High-end Tier 1 solar home systems

Package includes two to three lights, a mobile device charger, and possibly a low power appliance (e.g. radio) with an assumed purchase price of USD 150 per year over a 24 to a 30 month repayment period.

Table 8: Typical standalone Tier 1 solar home systems solution

SOLUTION	BENCHMARK PRICE (USD)	FUNCTIONALITY
Pico-solar (low-end)	60	Single light and mobile device charging 
Basic SHS (high-end)	150	Three lights, mobile device charging, low power appliance (e.g. radio) 

Source: Own analysis

To estimate the affordability of solar home systems solutions, it is necessary to calculate the monthly instalment, based on the repayment terms, as well as the affordability threshold of different segments. Assuming a favourable interest rate of ten percent, the 'pico-solar' solution (USD 60) has a monthly instalment of MGA 16,000 (USD 5) given a repayment period of 12 months. For the same interest rate, the high-end Tier 1 solar home systems solution (USD 150) would have a monthly instalment of MGA 21,000 (USD 7) over 24 months, but this drops to MGA 18,000 (USD 6) over 30 months. Using these assumptions and FinScope (2016) data, we can look at the proportion of adults which can afford to repay these instalments on a monthly basis. Given the already high proportion of expenditure on energy, which presumably could to some extent be offset if a solar solution is obtained, we take 15 percent of monthly income as an affordability threshold. Accordingly, we find that 67 percent, 71 percent, and 67 percent of adults, respectively, do not earn enough to afford these payment terms.

It is clear that lower cost solutions need to be found, or the financing models have to change drastically in order to make these products more accessible. Lowering the cost to USD 40, a Tier 1 system, at ten percent interest over 12 months, will have a monthly instalment of MGA 11,000 (USD 3.5) and over 18 months, MGA 7,000 (USD 2). However, even at this reduced cost, this exceeds the affordability threshold for 54 percent and 29 percent of adults respectively. However, the least cost option would open the market to 71 percent of the population, which is substantial.

A capitalised loan model may therefore not be the best option for the Malagasy market, which is perhaps why some providers are opting for a rental model –



see for instance Sunking “Pico 200” lamp example in section 6, which rented out solar lighting devices for MGA 4,800 (USD 1.5) per month. At this price, it exceeds the 15 percent of monthly income threshold for only 20 percent of the population.

Madagascar has a fairly low mobile ownership rate (35 percent), but usage of mobile phones is much higher at 75 percent, so PayGo models could be a feasible way to collect revenue efficiently from rural customers for either mini-grid or solar home systems energy services, if monthly payments can be kept affordable.

A market assessment by the World Bank³⁸ notes some of the social businesses that currently serve the Madagascan market:

Heri and Jiro-Ve rent the smallest solar lanterns (such as SunKing Solo) for approximately MGA 100 to 300 (USc 3.22 to 9.68) per day (this is not a rent-to-own model). These two companies reach thousands of customers daily. Heri has set up 100 active kiosks where lamps are charged and rented out by local entrepreneurs. The company typically rents out 33,414 lamps per day, or roughly 330 lamps per kiosk.

Jiro-Ve offers a cash-based PayGo solution; fully charged solar lights are delivered to consumers for a price of MGA 250 (USc 8.06) per day, payable on delivery. Jiro-ve estimates that it can reach 65,000 Madagascans, with 13,000 daily active customers.

Both Heri and Baobab+ offer pico-solar solutions, such as the Sunking “Pico 200” lamp, on a PayGo basis. Both companies make use of the PayGo solution provider Angaza.³⁹ Heri focuses on the central and eastern portions of the country, which are areas that are already served by the grid. The SunKing Solo, which is rented for MGA 4,800 (USD 1.55) per month was initially popular, but following a price increase to MGA 6,000 (USD 1.94) per month, customers switched to the SunKing Pico, a smaller and dimmer product which is priced at MGA 4,000 (USD 1.29) per month.

Baobab+ is a pan-African MFI headquartered in France that grew out of Microcred. Baobab+ is developing access to energy in West Africa (Senegal, Ivory Coast, Mali) and Madagascar through classical loans for existing Microcred clients or via a PayGo model. They offer Tier 1 Greenlight Planet Sun King systems to consumers on a PayGo basis. For existing Microcred customers, the programme developed a top-up loan with a maximum value of 50 percent of the customer's original loan. In terms of outreach, the Baobab+ programme seems to have reached, together with CECAM, the highest numbers for solar loan uptake. For Microcred, this amounts to the sale of approximately 200-300 solar loans a month, which is comparable to the better performing MFIs that provide solar loans in the Sub-Saharan Africa region.⁴⁰ Baobab+ is in partnership with MVola and Orange, mobile providers that act as payment facilitators. Clients who were previously not eligible for loans from MFIs can now become eligible for financial products based on their PayGo credit history.⁴¹

Nanoë is a social enterprise that operates in the relatively wealthy northern region. It offers ‘nano-grids’ which are collective solar home systems that can deliver power to four to six households. Consumers use mobile prepayments to purchase daily access to an electrical service adapted to their needs. The modular panels can be connected to provide a larger solar home solution. Nanoë installs solar home systems of between 100 watt-peak (Wp) to 500 Wp, providing basic energy services (Tier 1 to 3) to approximately five households at the cost of MGA 500 to 2,000 (USc 16 to 65) per customer per day, depending on energy consumption, which is comparable to the cost of electricity from the grid. In contrast, Heri rents out 1 – 2 Wp pico-solar lanterns, where customers pay MGA 150 to 300 (USc 5 to 10) daily. Hence, the maximum amount that the average Heri customer is willing to pay is equivalent to the starting amount of the Nanoë customer in the North.⁴²

38 World Bank, “Off-grid solar market assessment Madagascar.” 2018

39 <https://www.baobabplus.com/pay-as-you-go?lang=en>

40 World Bank, “Off-grid solar market assessment Madagascar”

41 <https://www.baobabplus.com/?lang=en>

42 World Bank, “Off-grid solar market assessment Madagascar.” 2018



The market for off-grid cleaner energy solutions

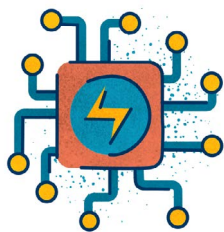
The off-grid market in Madagascar is still in its infancy. Current rates of solar home system ownership are low.

1. Companies that install large PV systems for commercial applications. These firms serve a small number of institutional clients, high-income households or commercial clients (e.g. hotels, agricultural processors). They have the professional capacity to respond to calls for proposals to design, build and operate mini-grids.
2. Social businesses that sell or rent pico-solar⁴⁴ products on a cash, MFI or PayGo basis. There are a few social enterprises including Baobab+, Heri, Nanoë, and Jiro-Ve. Most of them initiated their businesses with external grant funding and none have reached the break-even point.
3. Retailers selling low to average quality products mainly on cash or credit on a case-by-case basis. The most favourable terms of sale are generally only available to friends and family of distributors. There is a large number and they overlap significantly with electronics and appliances retailers. In Antananarivo, some of the shops include Madawatt, Sanifer, Confortech, Solair, and Baoialai.

The market for solar home systems solutions remains constrained by ability and willingness to pay with the largest demand for solutions currently for Tier 0 - 1 products (See Box 1). Financing solutions are required for even the most inexpensive of products such as daily rental.

44 A small solar product providing a low-end solution, usually with a single light and charging solution

Regarding cleaner cookstoves, the vast majority of the population relies on biomass fuelled inefficient three-stone cookstoves. The Swiss-Madagascan organization Association pour le Développement de l'Energy Solaire (ADES) is the main player in the clean cooking market in Madagascar. They have been locally manufacturing both solar cookers and more efficient biomass cookers in country. ADES offers a portfolio of nine different solar and efficient cookstove models for households as well as for institutional and commercial clients such as schools, children's homes, and hospitals. The Clean Cooking Alliance estimates that 170,000 cleaner cookstoves have been sold by 2017, which has benefited 900,000 people.⁴⁵ This represents less than four percent of the Malagasy population.



Madagascar is a fairly large country, but has low population density. The three regional grids do not penetrate far outside three urban areas in central and eastern Madagascar. There are efforts to incorporate more clean energy into the grid, including a 20 MW solar project near the capital city, but most rural areas are off-grid



The government is supportive of programmes to promote off-grid solutions, both smaller market-led solutions (such as Tier 1 to Tier 3 solar home systems and lanterns) and mini-grids (Tier 3 to Tier 5). A national strategy for off-



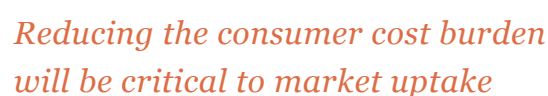
differentiate between levels of quality in applying for exemptions. This contributes to a large supply of low-quality solar products and equipment, damaging the product image for solar home systems in the Malagasy market. The VAT exemption is inconsistently applied and fines are inconsistently handed out. The World Bank is working with the bureau of standards⁴⁶ to put quality standards in place.

The market sizing addresses the governments access to energy goal but it specifically only caters to lighter use cases like lighting. It does not address the broader needs around substituting cooking with biomass fuels, switching

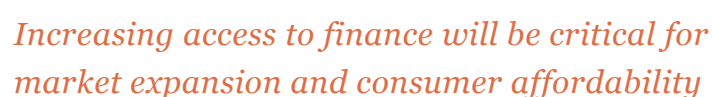
46 Bureau de Normes de Madagascar



there is an opportunity to extend off-grid solutions to households for lighting and use of appliances by providing certain isolated rural communities with access to electricity from hybrid mini-grids. This can provide electricity services at the capacity and reliability that is comparable to the grid (Tier 4 or Tier 5) as a more cost-effective alternative to a grid connection. Given the potential for hydropower in Madagascar, there is also scope to support hydro mini-grids further, which is already being done to some degree.



unaffordable for most adults. Further expansion of the electricity grid and infrastructure has to be balanced with improving the affordability and type of access to energy, through alternative financing models, clean energy, and off-grid solutions. This requires differentiated solutions from the private sector, reducing the burden on government for financing infrastructure, and sharpening the focus on pro-poor solutions, that also focuses on the financing solution. However, government can support this push through appropriate pricing models, quality control of equipment, consumer protection around equipment, and universal access policies around clean energy for the poor, combined with incentives to support provision.



than electricity access. This has implications for the way development agencies should approach the design of projects that are aimed at deploying off-grid energy solutions for productive uses. Particularly, it highlights the need for them to be aware of the broader (non-energy related) constraints facing businesses and to understand the way in which these constraints can affect the adoption of off-grid solutions. This may require partnership with donors and NGOs outside of the energy space to ensure the successful deployment of off-grid energy solutions for productive applications. Given that the government is supportive of programmes to promote off-grid solutions, a more comprehensive sector development approach may also be considered.



Acronyms and abbreviations

ADER	Agency for Rural Electrification Development
ADES	Association pour le Développement de l'Energy Solaire
AECF	The Africa Enterprise Challenge Fund
AFS	Agence Française de Développement
ESMAP	The world Bank Energy Sector Management Assistance Program
EU	The European Union
FNED	Fonds National de l'Énergie Durable
FONDEM	Fondation Énergies pour le Monde
GDP	Gross domestic product
GEF	The UNDP Global Environment Facility
GIZ	the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GRET	Group for Research and Technology Exchanges
Gwh	Gigawatt hours
HAP	Household Air Pollution
HDI	Human Development Index
HP	Horsepower
IPP	Independent power producer
kWh	Kilowatt-hour
LDC	Least Developed Country
LEAD	Least-Cost Electricity Access Development
LPG	Liquid petroleum gas
MAP	The UNCDF Making Access Possible programme
MEH	The Ministries of Water, Energy and Hydrocarbons
MFI	Microfinance institution
MFP	Multi-functional platforms
MGA	Madagascar currency (Ariary)
MSME	Micro, Small and Medium sized enterprise
MW	Megawatts
NCE	Nature, Climate and Environment
NEP	New Energy Policy 2015-2030
NGO	Non-governmental organization
PayGo	Pay-as-you-go
PPA	Power purchase agreements
PPP	Purchasing Power Parity
RETs	Renewable energy technologies
SACCO	Savings Credit Corporative
SADC	Southern African Development Community
SCP	Standard consumption package
SDGs	Sustainable Development Goals
SEforALL	The Sustainable Energy for All Programme
SHS	Solar home systems
SME	Small and medium sized enterprise
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
USc	Unite States cent
USD	Unites States Dollar
VAT	Value-added tax
Wh	Watt-hour
WHO	World Health Organization
Wp	Watt-peak

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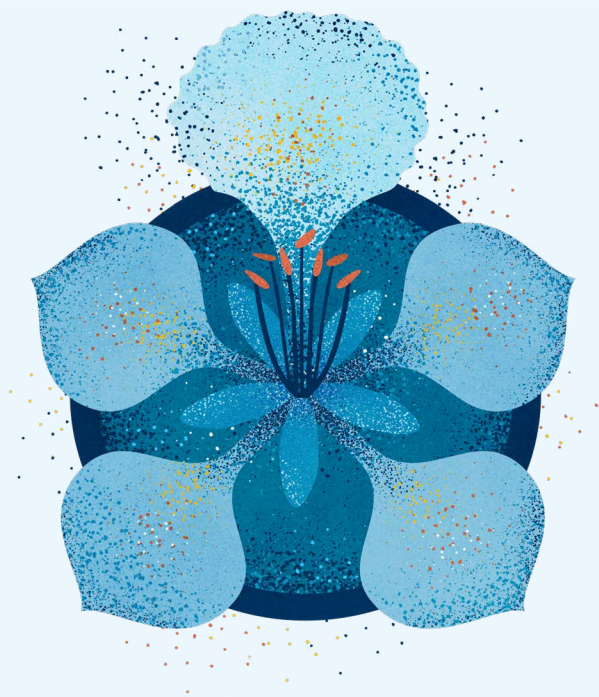
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About the UNCDF

The UN Capital Development Fund makes public and private finance work for the poor in the world's 47 least developed countries (LDCs). UNCDF offers "last mile" finance models that unlock public and private resources, especially at the domestic level, to reduce poverty and support local economic development. UNCDF's financing models work through three channels: (1) inclusive digital economies, which connects individuals, households, and small businesses with financial eco-systems that catalyze participation in the local economy, and provide tools to climb out of poverty and manage financial lives; (2) local development finance, which capacitates localities through fiscal decentralization, innovative municipal finance, and structured project finance to drive local economic expansion and sustainable development; and (3) investment finance, which provides catalytic financial structuring, de-risking, and capital deployment to drive SDG impact and domestic resource mobilization.



7 Affordable and Clean Energy

