

CHAPTER SUMMARY

TAKING THE PULSE OF ENERGY ACCESS IN MADAGASCAR

Plans by the Government of Madagascar to expand electricity access have been constrained in recent years by slow expansion of the electricity grid. While grid service remains largely unchanged since 2010 at 11 percent, stand-alone solar for households has begun to transform the electricity market in the country, providing electricity to almost 10 percent of households, which represents almost half of the households with energy access. New grid connections are expected to reach an additional 600,000 households by 2030 (increasing grid access by 2.4 percent). The mini-grid sector, currently providing access to less than 1 percent of households, is expected to have a modest impact. The deficit left by grid connections and mini-grids must be addressed by stand-alone solar but moving towards the SDG7 goal of universal access by 2030 will require a solution to the affordability challenge that will constrain stand-alone solar adoption by households with limited willingness and ability to pay.

If Madagascar follows a business as usual (BAU) scenario—allowing markets to continue developing based on current levels of support from the private sector, government agencies and development partners—grid coverage would actually decline to cover 9 percent of households by 2030 since the current pace of grid expansion is not keeping up with population growth. In a forecast scenario, where key stakeholders in Madagascar’s electricity sector commit all resources required to achieve universal access, grid connections would increase to 14 percent of households, representing 600,000 new grid connections between 2020 and 2030. Madagascar has about 160 mini-grids, servicing approximately 24,000 households located primarily in larger urban areas, far from the capital. The growth in mini-grids, particularly in rural areas, has largely been hindered by the ability of Malagasy households to afford this type of electricity service, highlighting the significant importance affordability support will have to play in increasing the deployment of this technology. In the forecast scenario, there is a significant uptick in mini-grid deployment (with 530 new mini-grids built), with the technology delivering electricity access to some 131,000 house-

holds by 2030. A cumulative financing of USD 92 million will be needed for mini-grids in this scenario, necessitating annual commitments averaging approximately USD 8.4 million. By way of comparison, the *Energizing Finance Series’ Understanding the Landscape 2019* report tracked USD 16.6 million in commitments for mini-grids in Madagascar in 2017. In a BAU scenario, stand-alone solar would provide electricity to 25 percent of households. In the forecast scenario, stand-alone solar would deliver access to 84.8 percent of households, representing 7.4 million new connections during the same period. To reach this level of growth, stand-alone solar requires USD 1.8 billion of cumulative financing to address enterprise financing needs (necessitating average annual financing of approximately USD 164 million). When looking at financing flows, the *Understanding the Landscape 2019* report tracked USD 12.7 million in commitments for stand-alone solar in Madagascar in 2017. A further USD 662 million will be required to address affordability constraints.

Madagascar has the largest clean cooking deficit in Africa, with less than 1 percent of households using clean fuels, and a fraction of a percent of households using improved wood or charcoal stoves.¹⁰

Table CS 1

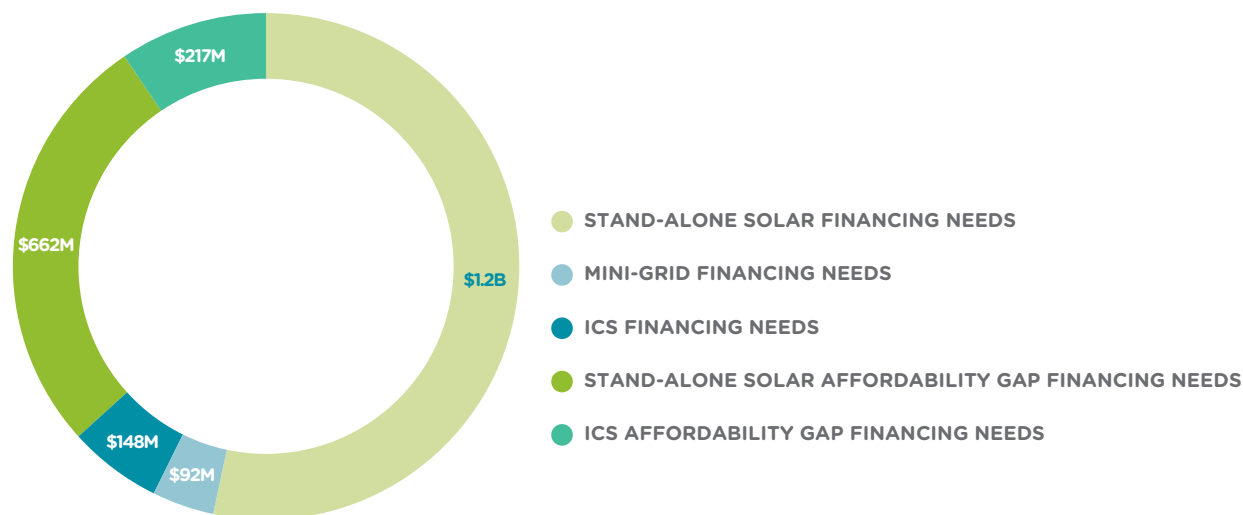
Madagascar: Key Figures

Year end	2018	2030
Population (millions)	26.3	35.6
Households (millions)	6.2	9.5
Grid Access (%)	11.4	13.8
Mini-Grid Access (%)	0.4	1.4
Stand-Alone Solar Access (%)	9.4	84.8
Clean Fuels Use (%)	0.6	5.2
ICS Usage (%)	0.3	100

¹⁰ Key figures in this table reflect, for end-2018, best estimates based on the most up-to-date figures available from various official and unofficial sources, extrapolated by leveraging recent trends. For end-2030, figures reflect model outputs for the forecast scenario, i.e., whereby SDG7 is met for electricity and clean cooking access.

Figure CS 1

Closing the Access Gap in Madagascar: USD 2.3 Billion Required for Off-Grid Electricity and Improved Cooking Solutions



The country’s clean cooking market is dominated by small-scale producers who primarily manufacture charcoal-burning stoves as well as some wood-burning stoves, which are less common. While small-scale improved cookstoves (ICS) producers have a strong presence in the clean cooking sector, there is scarce available data on their activities. In urban areas, charcoal is the source of fuel most widely used whereas, in rural areas, the leading fuel source is wood¹¹ – a trend that is consistent with household income largely determining which type of fuel sources households use. High-income households tend to be located in urban areas, while lower-income households tend to live in rural areas.

Compared to most markets in East Africa, Madagascar’s liquefied petroleum gas (LPG) market is relatively underdeveloped since the country has neither its own oil refineries nor oil products, meaning that most LPG products have to be imported. While the biogas market has benefited from donor support, its residential use remains limited. Ethanol, on the other hand, has demonstrated some uptake, with a few micro-distilleries supplying ethanol fuel to local customers and

¹¹ Per a 2010 household survey, 94.5 percent of households using wood for cooking collect it themselves and do not pay for it.

other ethanol products coming from either South Africa or Mauritius. In the forecast, the use of clean fuels—LPG, biogas, and ethanol—will increase by 5 percentage points (half a million households) with further growth constrained by affordability and logistical challenges. By 2030, over 9 million households (95 percent of households) are expected to continue cooking with wood and charcoal as either a primary or secondary source. Madagascar will need USD 148 million of financing for enterprises and USD 217 million for affordability gap financing to help 90 percent of households afford a basic improved cookstove.

There are a number of supportive actions that will need to be taken to facilitate investment and achieve universal electrification in Madagascar. These are summarized as follows:

For mini-grids:

- Madagascar has an existing regulatory framework that applies to mini-grids thanks to the 2015 public-private partnership (PPP) law. The key to the future growth of the sector lies in this framework being applied in a consistent, transparent way so as to de-risk private sector participation.

- Provide financing that would help de-risk and incentivize the private sector to accelerate mini-grid deployments in Madagascar, including via concessionary public sources of capital.

For stand-alone solar:

- Given the challenging operating context that Madagascar presents to the private sector, improve market intelligence and provide both fiscal and non-fiscal incentives to help them both enter and scale up operations in the market.
- Given Madagascar's profound challenges with household ability to pay, support initiatives that aim to increase household affordability, particularly in difficult to serve areas of the country.
- Although Madagascar's off-grid solar market is already robust, the vast majority of products sold are not quality-verified. As such, the adoption and enforcement of International Electrotechnical

Commission (IEC) quality standards and the operationalization of import duty and value added taxes (VAT) exemptions to these standards is a critical next step to protect consumers and decrease competition from poor quality products.

For improved cooking:

- Madagascar has one of the lowest ICS adoption rates in the world. As such, develop and deliver public awareness campaigns on the benefits of clean cookstoves adoption to encourage behavior change.
- As was the case with stand-alone solar, given Madagascar's ability to pay challenges, support initiatives to enhance household affordability, particularly for the uptake of industrial cookstoves and the use of clean fuels.
- Increase data collection around small-scale producers to obtain a better glimpse into Madagascar's clean cooking market.



PART

1

TAKING THE PULSE OF ELECTRIFICATION IN MADAGASCAR



SECTOR CONTEXT

Government Electrification Strategy

The Ministry of Energy, Water, and Hydrocarbons (*Ministère de l'Énergie, de l'Eau et des Hydrocarbures*, MEEH) is responsible for setting Madagascar's energy policy and providing strategic coordination to its energy sector. MEEH also oversees *Jiro sy Rano Malagasy* (JIRAMA), which is the country's

electric utility and water services company. JIRAMA is a vertically integrated and fully state-owned enterprise that operates the majority of the country's grid infrastructure. It is responsible for transmission, distribution and about half of the country's electricity generation capacity. The utility owns and operates three separate grid networks in the cities of Antananarivo, Toamasina, and Fianarantsoa.

Other players include private sector companies that supply power to JIRAMA either as Independent Power Producers (IPPs) or through rental power agreements. While JIRAMA does not have a legal monopoly over the power market, it is usually the off-taker for all grid-connected generation plants, particularly in areas in which it operates due to long-term concessions.¹² However, JIRAMA has long suffered operational difficulties (e.g. theft, vandalism, hardware failure) and financial shortfalls, resulting in its insolvency in recent years and inability to expand the grid throughout the country. Grid access rates, for example, fell from 15 percent in 2008 to 13 percent in 2015. During that same time period, JIRAMA's operating margins declined by 59 percent, increasing its liability from 1.3 percent of gross domestic product (GDP) in 2008 to 5.6 percent of GDP in 2015.¹³

Other key agencies involved in the energy sector are: (1) the Electricity Sector Regulator (*Autorité de Régulation de l'Électricité*, ARELEC), which regulates tariffs and market entry; (2) the Rural Electrification Agency (*Agence de Développement de l'Électrification Rurale*, ADER), which is tasked with implementing all rural electrification activities, including both on- and off-grid systems, and; (3) the Energy Regulation Office (*Office de Régulation de l'Électricité*, ORE), which is responsible for monitoring and overseeing quality norms. ORE plays a critical role in ensuring that high-quality, stand-alone solar products are entering the Malagasy market, but struggles to fulfill this mandate since its financing comes from JIRAMA, which itself is in financial distress.

In 2015, the Government of Madagascar launched its New Energy Policy (NEP 2015-2030) targeting electrification of at least 70 percent by 2030 through grid and off-grid energy solutions. As a continuation of the NEP 2015-2030, the recently approved *Stratégie Nationale d'Électrification* aims to achieve 70 percent energy access by targeting the following areas for service delivery:

¹² Include BV. "Off-Grid Solar Market Assessment Madagascar" July 2018.
¹³ Ibid.

- Extension of the grid
- Development of mini-grids (using such electricity sources as small hydro, solar, biogas from rice bales, and diesel)
- Extension of stand-alone solar, including solar home systems and solar lanterns.

More recently, in 2019, the MEEH identified two new strategic objectives for the energy sector:¹⁴

1. Ensure that 50 percent of the population will have electricity access at a "socially acceptable" price by 2023
2. Double the country's electricity generation capacity in five years, achieving approximately 800 megawatt (MW) by the end of 2023.

To achieve these two strategic objectives, the government has identified five areas that require attention: (1) reducing load shedding and controlling the price of electricity; (2) bringing electricity access to the largest number of people; (3) identifying energy supply development zones; (4) reducing the environmental impact of energy (e.g., accelerate clean cooking), and; (5) developing and implementing a NEP in case of emergencies (e.g., deployment of solar kits and generators during natural disasters).

Stand-Alone Solar

At the end of 2018, it was estimated that nearly 10 percent of households had electricity access delivered through stand-alone solar systems.

The slow expansion of the public electricity service in Madagascar has enabled the private sector to play a more prominent role in filling the energy access gap.¹⁵ Stand-alone solar companies that distribute and oper-

¹⁴ Ministère de l'Énergie, de l'Eau et des Hydrocarbures. 2019. "Ministère de l'Énergie, de l'Eau et des Hydrocarbures : Contrat de Performance 2019".

¹⁵ The World Bank. 2019. "International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project".

ate stand-alone solar systems are estimated to serve almost as many households as the grid system.¹⁶ They offer solar lanterns or solar home systems products to customers on a cash sale, lease-to-own, or rental basis. By the end of 2018, nearly a million stand-alone solar products had been sold in the country, mostly in the preceding three to five years, although the majority of these were of low quality and sold through informal channels, such as roadside vendors.¹⁷ No quality standards are currently in place, a factor contributing to poor quality and after-sale service in an already underdeveloped sector.¹⁸

The majority of rural Malagasy households are more likely to pay for off-grid technology (e.g., pico-solar

and stand-alone solar systems) than mini-grids or grid connections since they are oftentimes cheaper and provide the same, or better, electricity service.¹⁹ The main distributors of stand-alone solar services and products are Jiro-ve; HERi; Baobab+; Orange, Majinco; Power Technology; SQVision; MadaGreen, and WeConnex. Only four of the distributors are identified as selling Lighting Global quality-verified (QV) products²⁰, and only four out of the nine companies listed and operating in the country offer pay-as-you-go (PAYG) and/or credit services to their customers. However, the two largest mobile telecom companies in Madagascar (Orange and Telma) have launched or are in the process of launching their own stand-alone solar PAYG pilots.

Table 1.1

Overview of Stand-Alone Business Models in Madagascar²¹

Formal Distributors	Product Types	Business Model(s)	Credit/PAYG Offered
Jiro-ve	Non-QV solar lanterns	Small solar lanterns rented to customers through 31 franchisees	Yes
HERi	QV solar lanterns	Variety of solar lanterns rented to customers through 110 kiosks; PAYG sales to be launched soon	Yes
Baobab+	QV pico-PV (pico-photovoltaic) systems	Pico-PV products sold through MFI top-up loans and through agent network	Yes
Orange	QV pico-PV and stand-alone solar	Pico-PV and stand-alone solar products rented to consumers through a subset of Orange agent network	Yes
Majinco	Non-QV, QV pico-PV, stand-alone solar	Pico-PV and stand-alone solar products sold on a cash basis through store network	No
Power Technology	Non-QV stand-alone solar	Stand-alone solar sold on a cash basis through single outlet and 20-person sales agent network	No
SQVision	Non-QV stand-alone solar	Stand-alone solar sold on a cash basis through a network of sales agents; PAYG sales being investigated	No
MadaGreen	Non-QV stand-alone solar	Stand-alone solar sold on a cash basis to wealthier households and small- and medium-enterprises (SMEs)	No
WeConnex	Non-QV stand-alone solar	Stand-alone solar sold through partner outlets on a cash basis	No

¹⁶ Ibid.

¹⁷ Enclude BV. "Off-Grid Solar Market Assessment Madagascar" July 2018

¹⁸ The World Bank. 2019. "International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project".

¹⁹ Ibid.

²⁰ Lighting Global, the World Bank Group's platform to support sustainable growth of the global off-grid lighting market, sets standards for quality, durability, and truth in advertising.

²¹ The World Bank. 2019. "International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project".

Table 1.2**Major Development Partners and their Main Programs**

Development Partners	Key Programs
The World Bank	<ul style="list-style-type: none"> • Financing grid extension and densification • Financing off-grid electrification • Technical support for electrification planning • Improving utility performance • Financing feasibility studies for hydro mini-grids
African Development Bank (AfDB)	<ul style="list-style-type: none"> • Providing legal support to MEEH • Financing interconnection between Antananarivo and Tamatave
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	<ul style="list-style-type: none"> • Financing PV mini-grids • Technical support to MEH and ADER
European Union (EU)	<ul style="list-style-type: none"> • Financing PV mini-grids • Financed 10 mini-hydro plants

Many international development partners are supporting a wide range of programs to advance energy access through stand-alone solar solutions, cultivating market growth and stimulating capital investment, as noted in the World Bank's 2019 project appraisal document for Least-cost Electricity Access Development (LEAD) project.²² Key development partners and their programs that are actively supporting OGS are outlined in Table 1.2 above.

The Malagasy stand-alone solar market is still nascent and continued market growth will depend on increased consumer awareness, a rigorous quality assurance framework, and financing to help companies access hard-to-reach rural areas. Affordability gap financing will also be required to address affordability concerns. Households in the bottom third of the income pyramid will have particularly acute affordability issues without financial support from third parties.²³ The affordability challenge is discussed in more detail later in this chapter.

²² The World Bank. 2019. "International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project".
²³ Ibid.

Mini-Grids

Modern mini-grid developers are at a nascent stage in Madagascar with many fundamentals of the business model still to be worked out. While Madagascar has about 30 different organizations providing electricity via more than 100 mini-grids, the majority of the grids are powered by 40 kilowatt (kW) to 200 kW diesel or hydropower generation and are heavily government subsidized. JIRAMA itself also owns and operates a further 50 isolated mini-grids, serving cities and villages out of reach of its three larger grids.²⁴ Together, these mini-grids serve approximately 24,000 households, primarily in areas far from the capital. The government has granted mini-grid concessions to private operators to electrify rural villages since 2004. However, their contribution to the mini-grid sector has been minor.²⁵ The majority of these private contracts have been obtained through ADER via ad-hoc proposals and were accompanied by significant (capital expenditure)

²⁴ Ibid.
²⁵ The World Bank. 2019. "International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project".

CAPEX subsidies.²⁶ One company noted that subsidies were expected to account for at least 50 percent of CAPEX to be able to support lower tariffs.²⁷

Mini-grid growth has been constrained by the ability of Malagasy households to pay for electricity service (i.e., their low purchasing power). According to one interviewee, mini-grids tariffs can sometimes be three times higher than services offered by JIRAMA, making it harder for private sector companies to operate profitably if grants are not readily available to subsidize the low tariffs imposed in the country.²⁸ Additionally, Madagascar's rugged landscape, particularly in rural areas, makes the installation, operation, and maintenance of mini-grids challenging. Despite the falling price of technology, construction of new mini-grids is still hampered by the high and often prohibitive cost of connections.²⁹

Several international development partners are supporting the development of mini-grids in Madagascar. GIZ has been supporting a number of PV mini-grids in close collaboration with ADER, providing technical assistance and developing mini-grid concession schemes, as well as providing overall logistical and financial support. The EU has also been actively engaged in the development of mini-grids, providing subsidies to small hydro mini-grids through its Energy Facility. It has also supported and financed some stand-alone solar companies operating in the country, such as HERi and Jiro-VE.³⁰ Fondem, an international nongovernmental organization (NGO), has been one of the most active mini-grid supporters within Madagascar, focusing primarily on solar PV mini-grids. Fondem has already deployed four 7.5 kW mini-grids, two 10 kW mini-grids and one 15 kW mini-grid, some of which were co-financed by the EU through the Best Options for Rural Energy and Access to Light and Electricity (BOREALE) program.³¹

²⁶ Ibid.

²⁷ Based on in-country interviews.

²⁸ Based on in-country interviews.

²⁹ Ibid.

³⁰ Ibid.

³¹ Fondem. 2017. PROJET BOREALE. <http://www.fondem.org/projets/boreale/>

CURRENT STATE OF ENERGY ACCESS

Defining Energy Access

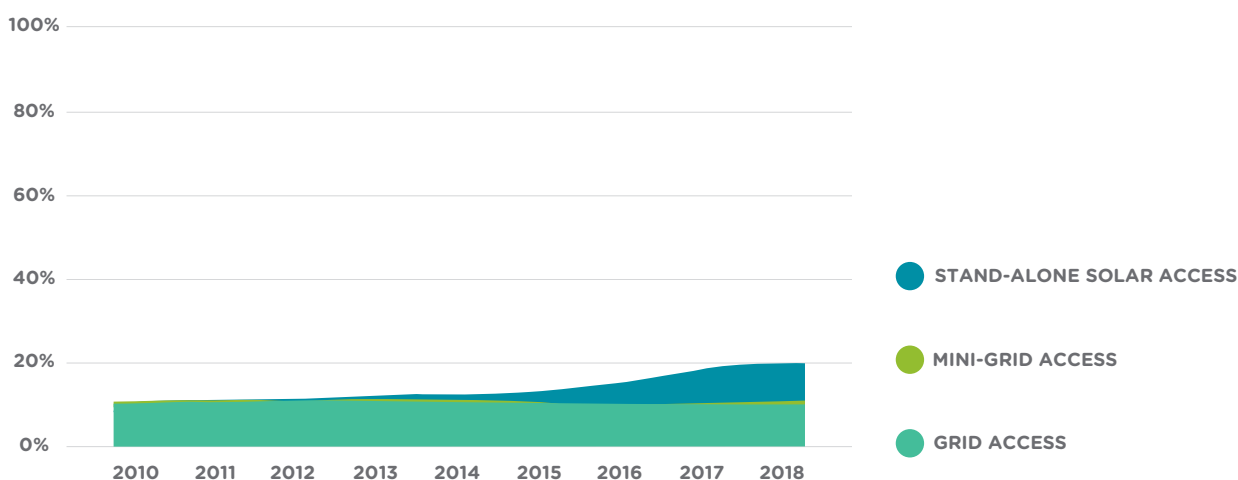
Taking the Pulse uses the globally accepted Multi-Tier Framework (MTF) to define energy access.³² The MTF establishes five “tiers” of household electrification that are based on capacity, duration, reliability, quality, affordability, legality and health and safety impacts. The MTF is often referred to as the “energy access ladder”, whereby households may graduate from one level of service to another depending on what sources of electrification they have access to, what they need, and what they can afford. Tier 0 represents a household that uses stopgap measures to meet their basic electrification needs, often using fuel-based lighting (e.g. kerosene lanterns, candles) or battery-operated flashlights for lighting needs, and relying on third-parties to power their devices (most notably cell phones). Tier 1 and 2 services are most often delivered by “stand-alone solar solutions”, frequently in the form of single or multi-light point systems that derive their power via solar PV panels. Tiers 3 through 5 are most typically met by connections to a centralized or localized grid (i.e. a “mini-grid”). However, it is important to note that having a grid connection can also qualify as Tier 1 (or as low as Tier 0 if power is available for less than four hours per day) if the MTF duration criteria are not met. More details on the MTF can be found in the *Taking the Pulse* methodology chapter.

Tier 1 stipulates either a certain level of installed capacity (in terms of power and capacity) or a level of service, which is expressed in lumen hours. Lumen hours is the unit of measure for the brightness of light. *Taking the Pulse* establishes the minimum level of electricity service based off the MTF service metric in lumens. It stipulates that fractional Tier 1 access counts toward the SDG7 goals. This means a single-light-point solar lantern that has the functionality to charge phones (one of the MTF service criteria) counts toward access goals. However, since the lumen output of most solar lanterns is less than the MTF Tier 1 requirement of 1,000 lumen hours per day, this contribution is “fractional” given that the lantern does not deliver full service to all mem-

³² Bhatia, M. & Angelou, N., 2015. Beyond Connections – Energy Access Redefined, Washington: Energy Sector Management Assistance Program.

Figure 1.1

Historical Electricity Access in Madagascar³³



bers of a typical household. *Taking the Pulse* assumes in its modeling that a lantern delivers sufficient lumen output to provide access to 60 percent of household members—in line with the capabilities of the typical modern lantern. As such, households would need to have two lanterns in order to achieve full Tier 1 access. This is a critical methodological point, as lanterns are often more affordable than multi-light point systems. As such, this impacts the overall financing needs required to achieve universal access in a given market. The methodology chapter discusses how levels of service are derived in the model, and the assumptions that underpin them.

State of Electricity Access in Madagascar

Based on outputs from the model developed as part of this report (see the methodology section), at the end of 2018, 21 percent of households in Madagascar had Tier 1³⁴ equivalent or higher electricity access per the MTF.

Grid access in Madagascar stands at 11.4 percent, roughly the same level as in 2010—as seen in Fig-

ure 1.1 above. This electrification rate is among the lowest in Africa.³⁵ Access through stand-alone solar, which was negligible at the start of the decade, now accounts for 9.4 percent of Malagasy household connectivity. This figure includes households with fractional Tier 1 access from a solar lantern that provides access to a share of the household.³⁶ Mini-grid access as a share of total electricity access in Madagascar, covering approximately 24,000 households of the country's 6.2 million, is minor, equal to less than 0.5 percent of households.

As seen in Figure 1.2, the model outputs show that if Madagascar continues to expand grid access at the pace seen in recent years, following a business as usual (BAU) scenario, grid coverage will actually fall relative to current levels (given that it is not keeping pace with population growth), and will stand at 9 percent in 2030. In contrast, stand-alone solar access, following its current trajectory, can be expected to reach 25 percent. This projection assumes an annual net increase of 150,000 households with Tier 1 equivalent access through 2030. With the low

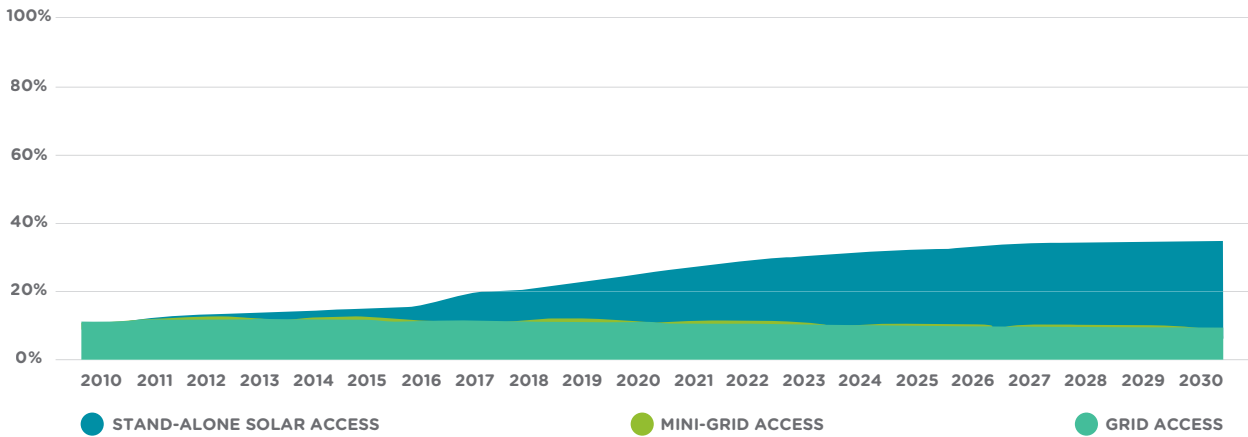
³³ Authors' analysis.

³⁴ Tier 1 is the most basic level of electricity access, providing task lighting and phone charging for at least four hours a day, including at least one hour in the evening.

³⁶ A lantern will often not provide the 1,000 lumen-hours required to provide Tier 1 access to all members of a household. Therefore, it is possible to instead determine the share (or number of members) of a household that effectively gain access from the ownership of a lantern. This fractional household access allows for the positive impacts of smaller lanterns to be captured in total access figures.

Figure 1.2

Madagascar BAU Electricity Access Scenario



number of current connections, extrapolating forward the BAU mini-grid scenario would be near-imperceptible (0.3 percent – just over 30,000 total households with access). In the aggregate, the BAU scenario shows that Madagascar would provide energy access for 34 percent of households in 2030, leaving an energy access gap of 66 percent.

CLOSING MADAGASCAR'S ELECTRIFICATION ACCESS GAP

Achieving universal energy access in Madagascar by 2030 will require acceleration across both on-grid and off-grid technologies. The forward-looking projections modeled in Figure 1.3 below illustrate the target for Madagascar to achieve universal energy access by that time. The key assumptions driving this scenario are as follows:

- Grid connectivity would increase to 14 percent, supported by grid connections to reach an additional 2.4 percent of households. A total of 600,000 new grid connections would be realized between 2020 and 2030, fueled in the first half of the decade primarily by a World Bank grid extension and densification program. In later years, it is assumed that ad-

ditional financing from development partners would support further grid electrification efforts.

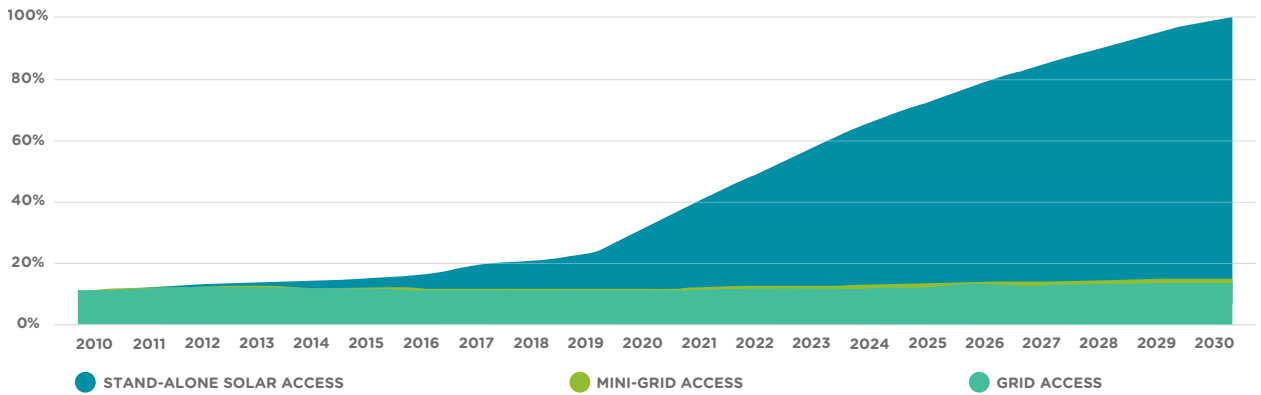
- The relatively limited growth in grid coverage would leave significant opportunities for mini-grids in the forecast scenario. As such, a significant scale-up in support for mini-grids from development partners and the private sector would yield over 100,000 new mini-grid connections, thereby yielding a mini-grid access rate of 1.4 percent.

Once grid and mini-grid contributions are derived, the model assumes that the remaining electrification access deficit will need to be filled by off-grid solar (OGS). As a result, Madagascar will be counting on stand-alone solar to deliver access to the remaining 85 percent of households in order to achieve universal access by 2030.

The following sections will discuss the Malagasy mini-grid and stand-alone solar sectors in more detail, including providing an overview of key actors, their challenges, and the detailed financing needs each will require to make its respective contribution toward achieving SDG7.

Figure 1.3

Forecast Electricity Access in Madagascar (All Technologies)



Mini-Grid Contributions Toward Achieving SDG7

The forecast model projects that 530 new mini-grids will be built during the period 2020-2030, resulting in 106,000 new household mini-grid connections. This represents a 330 percent increase in connections compared to the BAU scenario. Although this is a substantial increase from the base case observed in 2019, it still means that mini-grid contributions to the SDG7 challenge will remain modest, at 1.4 percent of total connections.

Mini-Grid Financing Needs

Taking the Pulse establishes that mini-grids will deliver a minimum of Tier 3 electricity services.³⁷ The model therefore includes assumptions around the cost of delivering this level of service. This is a minimum and does not preclude the development of mini-grids that are capable of delivering Tier 4 or 5 access. However, if either of these levels of service were to be considered the minimum, the overall costs of delivering

³⁷ Based on the MTF; see the methodology chapter for additional detail on the MTF.

Figure 1.4

Mini-Grid Electricity Access Forecast in Madagascar

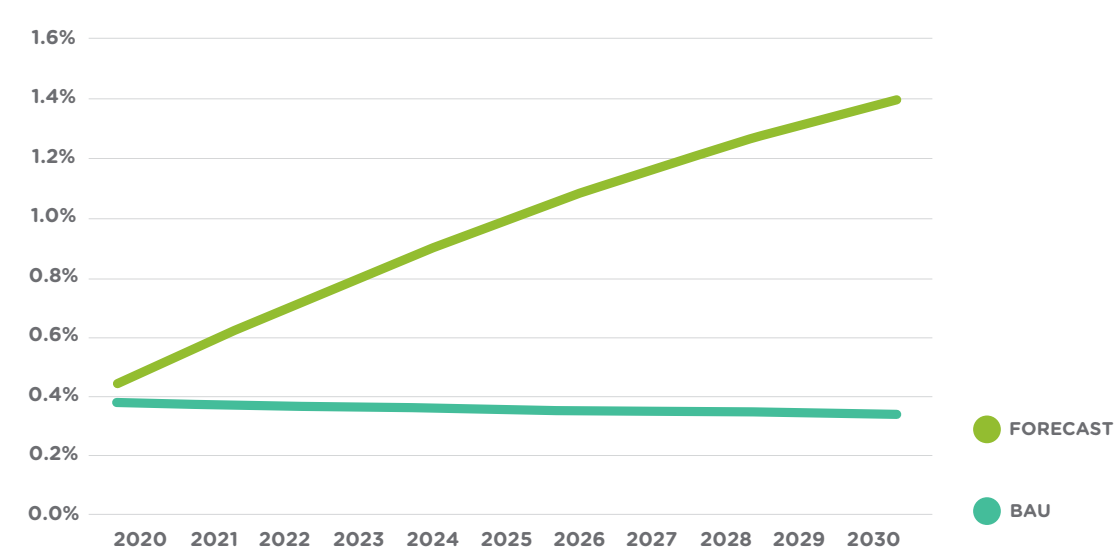
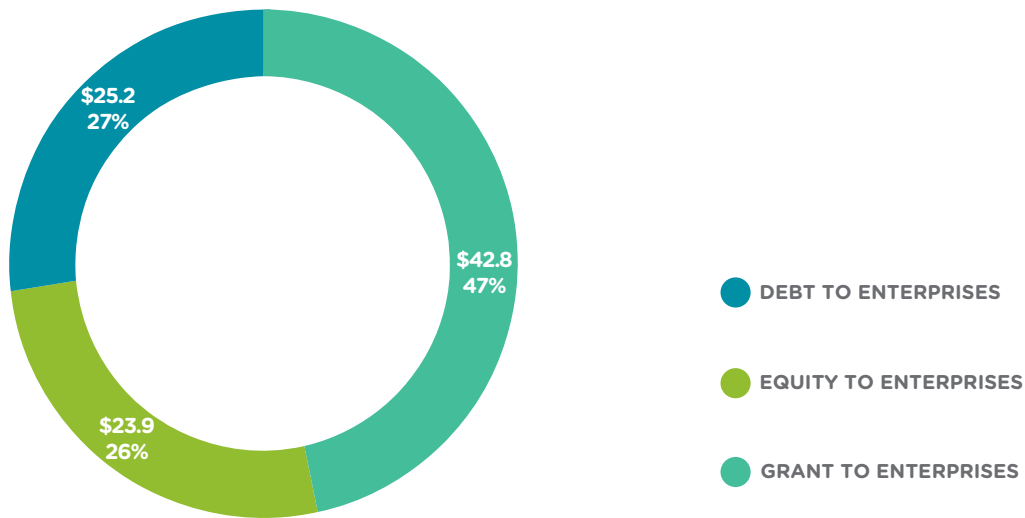


Figure 1.5

Cumulative Financing Need for Mini-Grid Enterprises in Madagascar (Million USD)



energy access via mini-grid solutions would increase considerably. New mini-grid development envisaged in the forecast scenario above will require a cumulative financing need of USD 92 million, as seen in Figure 1.5 above. The model assumes each mini-grid will support 200 households and two large anchor clients that consume at least one-third of the mini-grids' generated electricity and that connections will cost between USD 650-1,050 per connection, depending on the maturity of the mini-grid developer. A mature developer, by virtue of experience deploying at least 25 mini-grids, is expected to be able to develop new mini-grids at lower upfront cost than its peers. In reality, the mature developer is also more likely to ensure that mini-grids are efficiently exploited and thus more economically viable going forward.

Mini-grid projects rely on a blend of grants and equity to finance early-stage development costs, operational costs, and leverage for the additional debt financing needed to build and maintain infrastructure. Due to challenges regarding sustainability and sector growth, the analysis of financing needs for mini-grid development assumes that international development agencies, local government agencies, trusts and foundations, and other investors will provide grants to cover

47 percent of enterprise financing, while venture capital, private equity, impact funders, and other equity investors will contribute 26 percent. The remaining 27 percent of enterprise financing would come from debt.

Affordability of Mini-Grids

Project developers have difficulty setting cost reflective tariffs that recoup installation costs and operating expenses while staying within a rural household's willingness and ability to pay for electricity. One company noted that the government's inability to mobilize and deploy grants quickly to companies could hinder the scale-up of mini-grids in rural areas at low and affordable rates.³⁸ In the absence of an anchor customer with substantial energy needs, such as an agricultural facility, a cottage industry, or a mobile phone tower, mini-grid projects require subsidies to offset the tariff charged to energy users or buy down the connection cost.

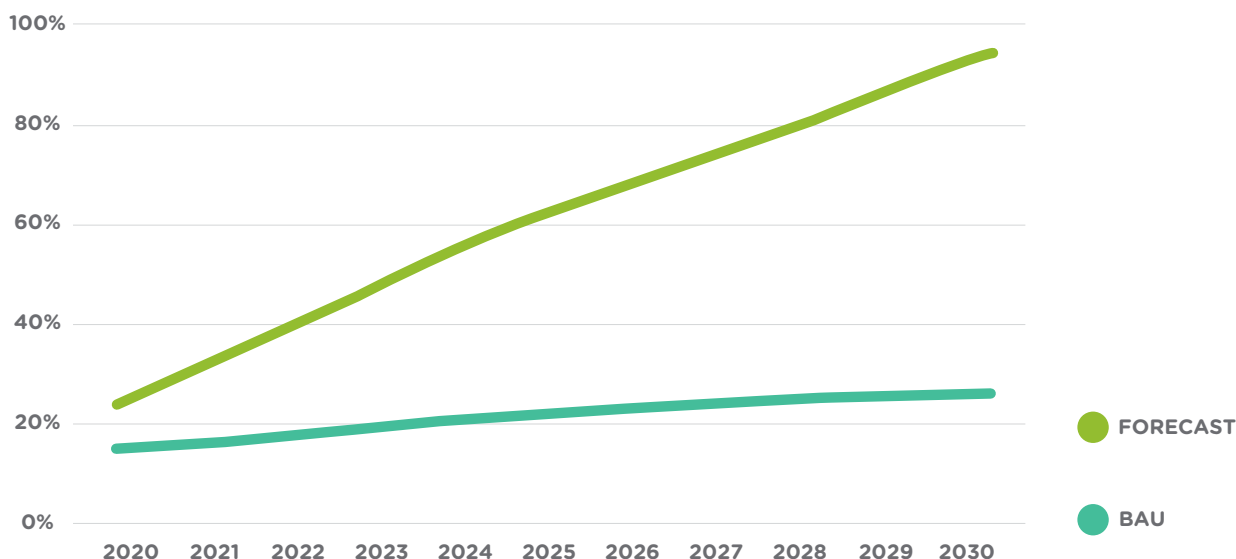
Key Challenges and Opportunities Relative to MGs Delivering on SDG7 Targets

The Malagasy mini-grid sector faces various challenges including but not limited to high cost of connections,

³⁸ Based on in-country interviews.

Figure 1.6

Stand-Alone Solar Electricity Access Forecast in Madagascar



policy bias towards grid and fear of intrusion in mini-grid service areas due to the lack of a central registry for new electrification projects. Not being able to access financing, including financing in the local currency, makes it difficult for companies to scale-up mini-grids, particularly since the country’s energy ecosystem is not yet mature nor is its political climate stable, according to one interviewee.³⁹

Mini-grid operators in Madagascar are providing electricity to around 200 villages, serving approximately 24,000 customers. On the plus side, the industry has slightly benefited from the decline in the cost of solar PV hardware, battery storage, and metering technology over the past decade. However, despite falling technological costs, the construction of new mini-grids is still significantly hampered by the high and often prohibitive cost of connections resulting from the need to build expensive distribu-

tion networks for small numbers of poor customers living in sparsely populated regions.⁴⁰ In addition, the policy bias and vested interest of stakeholders in the power sector, including JIRAMA, power producers and others invested in the status quo may weaken the development of mini-grid and stand-alone solar solutions, as both are perceived as a threat to their business.⁴¹

Moreover, the lack of a central registry for new electrification projects has led to conflicts at certain attractive hydroelectric sites between planned vertically-integrated mini-grid projects and planned generation only projects. To address this, in December 2015, the Government of Madagascar passed a law on PPPs to provide a legal definition for the roles, obligations, and the rights of private partners. This new law improves Madagascar’s concessions processes and energy policies.^{42 43}

³⁹ Based on in-county interview.

⁴⁰ The World Bank. 2019. “International Development Association Project Appraisal Document on a Proposed credit in the amount of SDR 107.9 Million (USD 150 Million Equivalent) to the Republic of Madagascar for the Least Cost Electricity Access Development (LEAD) Project”.

⁴¹ The World Bank. 2015. “Evaluation of Rural Electrification Concessions in sub-Saharan Africa (Detailed case Study: Madagascar)”.

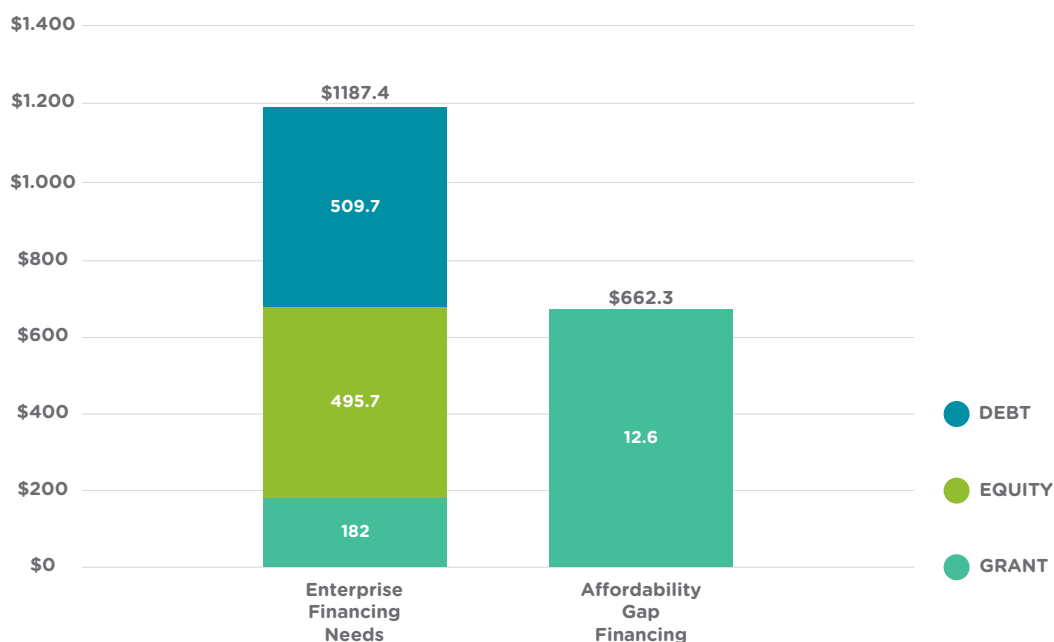
⁴² Ibid.

⁴³ The African Legal Support Facility (ALSF). Profil Pays PPP – Madagascar <http://www.afsf.org/sites/default/files/PPP%20Country%20Profile%20-%20Madagascar.pdf>



Figure 1.7

Cumulative Financing Needs for Stand-Alone Solar Enterprises in Madagascar (Million USD)



STAND-ALONE SOLAR CONTRIBUTIONS TOWARD SDG7

In a BAU scenario, stand-alone solar for households is expected to reach 25 percent, whereby net new systems deployed (gross additions minus retirements) range from 110,000-190,000 Tier 1 equivalents per year through 2030. This scenario reflects the general slowdown in stand-alone solar product sales witnessed across many solar markets in recent years as affordability and accessibility constraints become more acute as the sector moves into more remote, less well-off areas of the country. As one company noted, one of the biggest barriers in scaling-up stand-alone solar solutions is customer affordability, where the target market is earning around USD 1.66 a day.⁴⁴

The forecast model, however, projects that stand-alone solar will provide 7.3 million new households with access in the period 2020-2030 (84.8 percent of electrified households by 2030). This is a 240 percent increase from the BAU scenario and

⁴⁴ Based on in-country interview.

will require tremendous financing and execution capability to achieve. One company operating in the industry noted that the government’s ability to efficiently support and facilitate the development of private sector enterprises in the country will have significant implications on how quickly stand-alone solar will take off in the next five years.⁴⁵

Stand-Alone Solar Financing Needs

To reach the additional 7.3 million households envisaged in the forecast scenario outlined above, stand-alone solar enterprises in Madagascar have a cumulative financing need of USD 1.19 billion, as seen in Figure 1.8 below. This figure is driven by three key assumptions:

- PAYG companies require long-term, up-front financing to accommodate the payment schedule of their customers—which is often 12 to 18 months but can extend to three years or more. This means that the initial financing challenge resides with the solar enterprises themselves. Debt

⁴⁵ Based on in-country interview.

is the most appropriate form for this financing to take, as it will enable stand-alone solar companies to import inventory, and in some cases, extend loans to their customers. As those systems are purchased, loans can be repaid.⁴⁶

- Stand-alone solar systems are assumed to have a lifetime of four years and, as such, households purchasing a system in a given year are projected to require a new system to maintain access fully four years later. A country with a high rate of stand-alone solar access more than four years prior to 2030 is therefore likely to have higher proportional financing needs than a country that makes rapid gains in OGS access closer to 2030.
- Madagascar will also require USD 662 million in affordability gap financing to achieve universal electricity access. A more detailed explanation of consumer affordability is provided below.

The model assumes that stand-alone solar enterprises are at different stages of maturity during the forecast period (pilot, validation, scale-up, mature). The blend of capital associated with these stages varies, as summarized in Table 1.3 below. Early-stage enterprises will be more reliant on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure

⁴⁶ Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".

significant debt that will finance their consumer receivables and inventory finance needs.

Stand-alone solar projects benefit from increasing access to debt, limiting the need for grants in the financing mix. As noted in Figure 1.7, grants are expected to provide 15 percent of total enterprise financing through 2030, largely due to the need to incentivize companies to establish sales channels in underserved rural areas. Equity finance covering 42 percent of enterprise needs will support ongoing operational activities, while debt will contribute the remaining 43 percent of enterprise capital needs.

Affordability of Solar Home Systems

The estimated affordability constraints outlined above were determined by leveraging the World Bank PovCal tool to create Malagasy household consumption curves, i.e., charting the percentage of households with consumption at or below specific dollar amounts. Then, by assuming that households are willing to allocate no more than 5 percent of their monthly expenditure on electricity access (a threshold often used by practitioners to define electricity affordability), it is possible to determine the percentage of households that can afford the USD 3.30 that is modeled out as a proxy for what the monthly cost for a PAYG lantern would be. Prompt 1 on Figure 1.8 illustrates that approximately 60 percent of households could afford this, while the remaining 40 percent would require some sort of support to be able

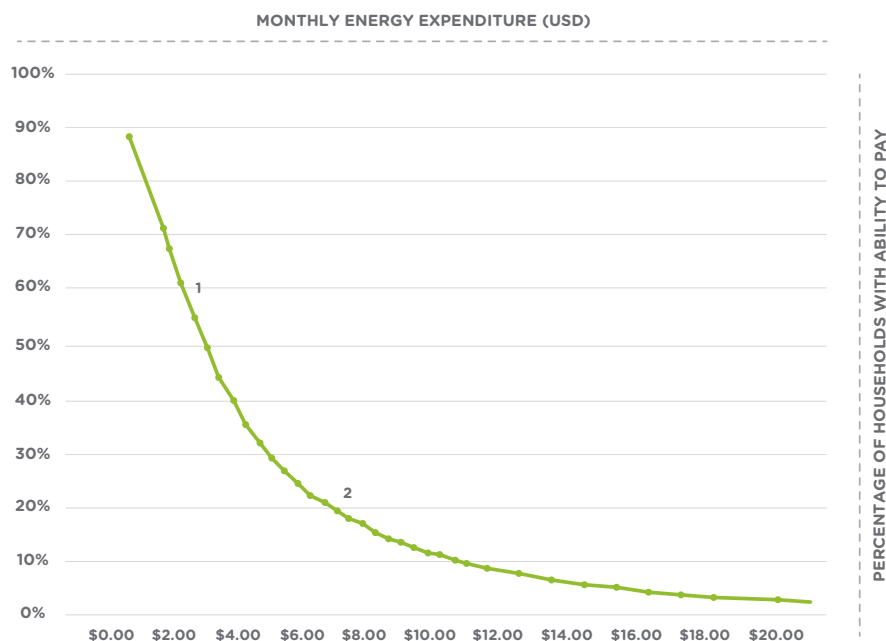
Table 1.3

Model Assumptions of Capital Blend by Stand-Alone Solar Company Maturity

	Pilot	Validation	Scale-Up	Mature
Grant	20%	30%	10%	5%
Equity	80%	55%	45%	15%
Debt	0%	15%	45%	80%

Figure 1.8

Madagascar’s Ability to Pay at 5% of Monthly Consumption on Electricity Access



to pay this amount. Along similar lines, Prompt 2 on Figure 1.8 illustrates that only 20 percent of households could afford the USD 7.50 that is modeled as a proxy for the cost of a multi-light point stand-alone solar system that delivers Tier 1 electricity services. The *Taking the Pulse* methodology chapter provides a more detailed discussion of how affordability was estimated.

Key Challenges and Opportunities Relative to Stand-Alone Solar Delivering on SDG7 Targets

Stand-alone solar has immense potential to deliver energy access in Madagascar, with most regions receiving over 2,800 hours of sunshine per year.⁴⁷ The country’s low population density makes the extension of the grid extremely costly, while the population’s affordability challenge—particularly in rural areas—constrains the mini-grid sector’s ability to grow quickly. These challenges, combined with JIRAMA’s financial woes, make it all the more imperative to scale up stand-alone solar solutions in Madagascar to deliver on SDG7.

⁴⁷ Get Invest. Mobilizing Renewable Energy Investments. Madagascar Renewable Energy Potential at: <https://www.get-invest.eu/market-information/madagascar/renewable-energy-potential/>

The sector faces major challenges which affect both customers (demand side) and private sector enterprises (supply side). These include lack of quality and after-sales services, weak distribution network for solution providers, low purchasing power among consumers, including lack of access to SMEs financing for solar distributors, high costs of rural distribution due to Madagascar’s relatively large size, lack of government incentives and the lack of local human capital to fill management and key technical positions.⁴⁸ By way of a start, the government is working to tackle the issue of low-quality products by adopting the Lighting Global standards for stand-alone solar systems and tying import duty and VAT exemptions to these standards. It will be equally as important for the GoM to enforce the use of higher-quality products – once the standard is adopted – to address these challenges.

Low-quality products have led to lower consumer confidence. Currently, only four businesses have been identified as consistently selling Lighting Global quality-verified products, Baobab+, HERi, Orange

⁴⁸ Ibid.

and Majinco. As noted by a private sector company that operates in that sector, higher-quality stand-alone solar products with longer warranty and better service oftentimes fail to attract new customers because lower-cost products remain more attractive for the Malagasy consumer.⁴⁹ The lack of differentiation of fiscal incentives between low- and high-quality products also discourages private sector enterprises from selling high-quality products. On the distribution side, the footprint of stand-alone solar pro-

⁴⁹ Based on in-country interview.

viders in remote areas of the country is extremely limited (most systems are sold to higher-income households in cities and rural towns). This makes purchasing those products even more expensive for rural customers as they must travel to cities to buy them.⁵⁰ The GoM could explore other fiscal incentives that would encourage private sector enterprises to sell more products in harder to reach locations, such as rural areas, as a means to reduce cost for rural consumers.

⁵⁰ Ibid.



PART

2

**TAKING THE PULSE
OF CLEAN COOKING
IN MADAGASCAR**



INTRODUCTION

Government Initiatives

The Government of Madagascar (GoM) has a relatively robust clean cooking policy guided by the country's overarching energy policy.⁵¹ Under this policy, the country has established several cooking-related targets to achieve by 2030, including:

⁵¹ Madagascar's primary energy policy is called 'La Nouvelle Politique de l'Énergie 2015-2030'.

- 70 percent access to energy-efficient cookstoves.
- 50 percent of wood to be sourced from legal and sustainable forest resources.
- 20 percent of charcoal to be 'green' having been produced efficiently and from legal and sustainable forest resources.

The government has established a tracking framework to measure achievement in clean cooking and standards to assess efficiency, emissions, and safety of clean cooking solutions.⁵² As of 2018, Madagascar had a score of 50 (out of 100) in robustness of its clean cooking policy framework according to the Regulatory Indicators for Sustainable Energy (RISE) score.⁵³ The government is also actively promoting ethanol as a household cooking fuel to reduce the use of firewood and charcoal. In July 2014 the government set forth a decree to promote ethanol cooking through the following means: i) exemption of heavy alcohol tax for ethanol fuel production and exemption of import tax on imported ethanol stoves; ii) setting performance and quality standards for ethanol fuel; and iii) designation of the Ministry of Industry (MoI) to be technically responsible for approving Ethanol Micro Distilleries (EMDs) and promoting ethanol clean cooking. Since the decree was passed, private-sector interest in ethanol cooking has increased; the MoI received applications from four distilleries, and 528 stoves have been sold in the Malagasy market.⁵⁴

The government has begun to partner with international organizations and NGOs active in the cooking space. One example of this is the financial support GoM provided to ADES (the *Association pour le Développement de l'Énergie Solaire*), a Swiss-Malagasy energy NGO. Through its financial support, ADES is able to sell solar box cleaners⁵⁵ at a subsidized price of USD 20, with a local production price of USD 46.⁵⁶

CURRENT SECTOR ECOSYSTEM

Defining Clean Cooking

Taking the Pulse uses the MTF⁵⁷ to establish the minimum definition of “improved cooking” that

⁵² Regulatory Indicator for Sustainable Energy (RISE). 2017. Madagascar <http://rise.worldbank.org/country/madagascar#modal-container-web-link-doc>

⁵³ The RISE scores highlight a country's policies and regulations in the energy sector organized by four pillars: energy access, energy efficiency, renewable energy and clean cooking. The scores are out of 100 and a lower score indicates poor performance whereas a high score indicates good performance.

⁵⁴ The World Bank. 2016. “Project Information Document (PID) Appraisal Stage: MG ethanol clean cooking climate finance program (P154440)”.

⁵⁵ Solar box cookers are the most popular type of solar cookers. They are made of any material such wood, air plastic, cardboard). They can reach a maximum temperature of 1500 C. (Source: (Solar Cooker n.d.).

⁵⁶ Fandom. 2019. Solarcooking. <https://solarcooking.fandom.com/wiki/Madagascar>

⁵⁷ Bhatia, M. & Angelou, N., 2015. Beyond Connections – Energy Access Redefined, Washington: Energy Sector Management Assistance Program.

counts toward the SDG7 goal of universal access. The MTF measures household access to cooking based on indoor air quality, cookstove efficiency and convenience, and the safety, affordability, quality and availability of the primary fuel.

Taking the Pulse has two main ways in which it defines access to improved cooking solutions. The first, which is the primary focus of the report, centers on moving households away from traditional cooking solutions (typically using a three-stone fire or artisanal or semi-industrial cookstove) which do little to improve cooking efficiency and/or reduce emissions. As such, the report models the cost of what it would take for these households to adopt improved “industrial” cookstoves, which typically entail centralized, large-scale production that uses quality components, manufactures with precision tools and employs considerable levels of automation. The focus is typically on rocket stoves, which have an insulated, L-shaped combustion chamber that improves combustion efficiency and reduces emissions. However, it is important to note that use of these stoves necessitates the continued use of either wood or charcoal as a fuel source. *Taking the Pulse* defines the minimum level of improved cooking access as ICS that meet International Workshop Agreement (IWA) minimum standards on fuel efficiency and emissions.

Related to clean fuels, the report focuses on three primary ones that are considered to have significant potential. These are a sub-set of cooking solutions that deliver high performance in terms of reducing household air pollution—often (although not always) regardless of the type of cookstove used: biogas, LPG, electricity, ethanol, natural gas, and solar cookers, collectively called “BLEENS”⁵⁸. Given that *Taking the Pulse* only focuses on biogas, LPG, and ethanol, it adopts the term “clean fuels” in discussing them. The report forecasts the expected uptake of clean fuels over time, but does not cost out the financing that would be required to achieve these forecasts. This is because it was not in the scope

⁵⁸ Ibid.

of this report given the complexity surrounding the costing of delivering clean fuels for cooking.⁵⁹

Clean Cooking in Madagascar

Madagascar has the largest clean cooking deficit in Africa, with less than 1 percent of households using clean fuels and a fraction of a percent of households using improved wood or charcoal stoves.⁶⁰ Madagascar's cookstove market is dominated by small-scale producers that are scattered around the country, producing mostly artisanal stoves. Many of these producers manufacture charcoal-burning stoves, while a few produce wood-burning stoves. Although production is small scale, stove manufacturers are still quite uniform in the materials they use to produce stoves. These materials include clay, concrete, sheet metal, sand, and/or dung. Despite this uniformity, there is considerable innovation, especially in stove design.⁶¹ There is scarce available data on the number of these small-scale producers.

Malagasy households predominantly use solid fuels irrespective of geography. However, in urban areas, charcoal is the most widely used fuel source whereas, in rural areas, the leading fuel source is wood. Other solid fuels used by roughly 1 percent of households or less include coal, straw, branches, grass, and agricultural residues. Household income also affects cooking fuel in Madagascar, as high-income households tend to use charcoal while those with lower household income tend to use wood.

Semi-industrial ICS production is nascent in Madagascar. NGOs and international organizations play a significant role in filling this gap in the market. ADES—one of the prominent stakeholders and an implementing partner of Energising Development (EnDEV)—has been producing efficient wood, charcoal, and solar cookstoves in Madagascar since 2002 and selling them at a reduced price to local

households.⁶² Before ADES started its work, there were hardly any market channels for semi-industrial cooking solutions in Madagascar. Since its inception, it has sold over 170,000 stoves and created some 400 jobs.⁶³

Other cookstove programs have commenced operations in the wake of ADES. One of them is Clean Cooking Madagascar (CCM) which is fully funded by Green Development AS, a Norwegian company which aims to reduce household air pollution by increasing access to modern energy solutions at household level. With this goal in mind, CCM and Green Development AS are currently promoting the use of ethanol stoves for cooking. CCM promotes three ethanol-based stoves which are produced outside of Madagascar.⁶⁴ Another local nonprofit organization called Zahana has developed an easy to build cookstove which can reduce the need for firewood by half using simple technologies such as bricks and mud. This organization follows an incremental approach to the promotion of ICS by starting with environmentally-friendly wood burning stoves. Its long-term goal is to introduce modern technologies such as solar cooking.⁶⁵

LPG Market

Compared to other markets in East Africa, the LPG market in Madagascar is also relatively under-developed. Since Madagascar does not have its own oil refinery, oil products such as LPG must be imported. The main LPG companies include a few major oil companies, such as Total, which sell LPG cylinders at some of their petrol stations, and a few local players such as Jovena, Galana, and Vito Gaz. Vito Gaz is a private company in Madagascar that has been in operation since 2001 as an independent importer, distributor, and retailer of LPG.⁶⁶ The company currently has two storage sites and its own import terminal, as well as two re-fill-

⁵⁹ In addition to the financing needs for distribution and/or installation of the cooking hardware, scaling LPG and ethanol uptake requires the build-out of large-scale distribution infrastructure, particularly related to shipping, storage, and processing of fuels.

⁶⁰ Energy Sector Management Assistance Program. 2015. "Beyond Connections: Energy Access Redefined".

⁶¹ Klug, Thomas. 2018. "Understanding the Impacts of Traditional Cooking Practices in Rural Madagascar and a Way Forward with Improved Cookstoves".

⁶² My Climate. 2017. My Climate. <https://www.myclimate.org/information/climate-protection-projects/detail-climate-protection-projects/show/Project/madagascar-efficient-cook-stoves-solar-7116/>

⁶³ ADES. 2019. adesolaire. <http://www.adesolaire.org/en/ades-in-madagascar-en/our-program-en>

⁶⁴ Clean Cooking Madagascar. 2017. Madagascar Ethanol Stove Program <http://madagascarethanolstoveprogram.org/clean-cooking-madagascar/>

⁶⁵ Zahana. 2019. Zahana.org. https://zahana.org/Site_With_Pix/Cookstove.html

⁶⁶ VITOGAZ. 2019. <http://www.vitogaz.mg/presentation.php>

ing stations, one in the northwest in Mahajanga and one in the capital city, Antananarivo. Vito Gaz currently has 14 accredited distributors as well as 640 individual retailers throughout the island. The company's main cannister sizes include 9-kilogram (kg), 12.5kg, 25kg, and 39kg. Its total storage capacity is 2,850 tons of LPG, which is sufficient to meet the annual needs of between 104,000 and 126,000 households.^{67 68}

The company's current customers also include a substantial share of commercial and industrial clients, including bakeries, roasteries, restaurants, hotels, and a range of others, which means that household consumption represents only a portion of total sales.⁶⁹ Growth in the market has been stable, rather than exponential, and there are currently no incentives or government programs to support the adoption of LPG as a clean cooking fuel.

Biogas Market

Biogas has benefited from donor and other support over the last decade but remains very limited in scope. The sector has been mainly supported by development aid from the Norwegian Missionary Society (NMS) and the People's Republic of China,⁷⁰ which collaborated on a biogas partnership from 2009 to 2015. The most recent figures available (2015) indicate that 492 household biodigesters have been built in Madagascar, using a standard 10m³ fixed-dome design and a solid concrete dome as a mold, as well as eight institutional digesters (between 30m³ and 40m³).⁷¹ Such systems can last twenty years or more provided adequate maintenance is conducted. An earlier model based on a plastic, tubular design was used from 2005-2007, as they were more affordable, but the systems were not sufficiently reliable and only lasted three years on average. Aside from these efforts, there is currently little notable activity in the residential biogas market, although the program mentioned above

⁶⁷ This is based on field research in Sub-Saharan Africa indicating annual household LPG consumption of between 22.6 and 27.3 kg.

⁶⁸ Economic Consulting Associates, The Global LPG Partnership. 2017. "Econometric analysis of potential LPG Household cooking market in Ghana".

⁶⁹ VITOGAZ. 2019. <http://www.vitogaz.mg/presentation.php>

⁷⁰ Oméga Razanakoto, Lars Kåre Grimsby, Guo Jing, Elisabeth Rabakonandrianina. 2015. "Final Evaluation of the International NMS Biogas Partnership Program".

⁷¹ Ibid.

appears to have raised sufficient awareness for biogas to be included as a priority in the Ministry's guidance for activities to be undertaken in 2019.

The main constraint on the supply side is the lack of companies equipped and trained to install systems. Market activity has been dependent on the presence of active donor support, and once this support and technical assistance has lapsed, so too has demand. As such, although Madagascar has about 492 biogas installations country-wide, the potential for future growth appears limited in the absence of further interventions. On the demand side, the main barrier remains the high upfront cost of the systems, along with the lack of companies and workers trained to build the systems well. The cost of constructing biogas systems ranges from between USD 500-800. Given that average GDP per capita in Madagascar is currently around USD 450 per year, the upfront cost of a biogas system is beyond the reach of the vast majority of households.

Ethanol Market

Although the ethanol market is fledgling, there are a few signs of activity. There are currently three ethanol micro-distilleries in operation supplying ethanol fuel to local customers. In addition, a number of suppliers have begun importing ethanol as well, mainly from South Africa and Mauritius. A few different stove models are also available on the market ranging from USD 20-30 each. According to a recent feasibility study conducted for the World Bank, ethanol can be produced in the range of USD 0.50-0.60 per liter, but due to the early stage of development of the current distilleries, their production costs are approximately twice as high. The current sales price for domestically produced ethanol is roughly USD 1.50 per liter. On the portion that is imported, companies pay sizeable import duties, which in some cases (depending on the countries from which one is importing) can more than double the price of the fuel.

Another key driver of the ethanol market to date has been the work undertaken as part of the World Bank's Carbon Initiative for Development (Ci-Dev), which is a development-focused trust fund set up by the World

Bank that uses carbon credits to help accelerate market transformation and spur the adoption of clean technologies. Ci-Dev signed an “emissions reduction purchase agreement” in 2016 with Green Development AS, a company focused on carbon financing. The agreement involved the purchase of 1.1 million certified emission reductions (CERs) that are to be generated through the end of 2024 through a range of activities, including ethanol cooking.

The aims of the initiative are to make ethanol cookstoves more affordable to end-users, to support establishment of two pilot ethanol micro-distilleries (including a training center), and to provide capacity building and technical assistance to private sector and government partners.

In light of the relatively low-price of charcoal compared to ethanol, the main impetus for the market’s development has been institutional and donor support focused on creating a local ethanol industry. Within the ethanol industry, the view of many donors and other activities

in the sector is that if the cost of the stoves can be brought down, then demand will come. If the price of ethanol could be brought down to between USD 0.80-0.90 cents per liter, one local interviewee with deep knowledge of the local market estimates it would be within the range of affordability (between USD 10-15) required to drive demand.⁷²

In recent months, the newly elected Government of Madagascar has signaled interest in promoting ethanol cooking; this could help build on NGO and donor-funded efforts to advance the sector.

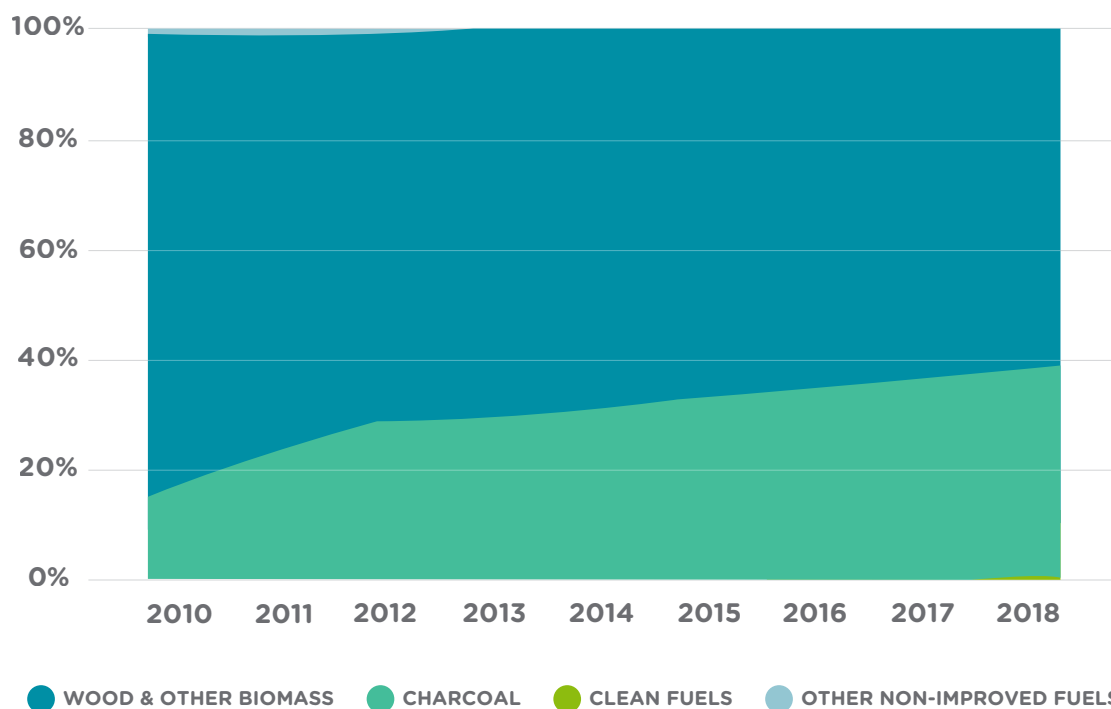
Current State of Clean Cooking Access

By the end of 2018, approximately 0.6 percent of Malagasy households were using clean fuels and just 0.3 percent of the households cooking with charcoal, wood or other biomass were thought to be using ICS. A staggering 99 percent of households still do not employ clean cooking solutions.

⁷² Based on in-country interviews.

Figure 2.1

Historical Cooking Fuel Breakdown in Madagascar



Based on outputs from the model developed as part of this report (see methodology chapter for details), it is estimated that at the end of 2018 some 38 percent of households cooked with charcoal, and a further 61 percent cooked with wood or other biomass. Of the less than 1 percent of households that cook with clean fuels, approximately 0.4 percent cook with LPG, 0.1 percent with electricity, and 0.2 percent with ethanol. The remaining households (fully 99 percent) use a three-stone fire or an artisanal or semi-industrial cookstove that does not improve cooking efficiency and/or emissions enough to be deemed an ICS. All Malagasy households report that they cook at home, according to survey data.

CLOSING THE CLEAN COOKING ACCESS GAP IN MADAGASCAR

Figure 2.2 illustrates the scope of the clean cooking challenge in Madagascar. The model projects that households using clean fuels will increase to a total of just 5 percent, equivalent to 0.5 million households from the low existing rate of 0.6 percent, however, a considerable share of these are expected to engage in fuel stacking. Over 9 million households are expected to continue to cook with wood and charcoal as either a primary or secondary source. The challenge will be to shift all of these households away from traditional cooking technologies (namely three-stone fires and lower-quality semi-industrial stoves) and onto higher-quality industrial improved

wood and charcoal stoves, as illustrated by the white line representing required penetration of ICS over the period 2020-2030.

Wood and Charcoal ICS Contributions Toward Achieving SDG7

The analysis now focuses on the forward-looking projections through to 2030 and modeling what it would take for Madagascar to achieve universal clean cooking access by that time. Figure 2.3 below illustrates the model outputs through to 2030. The key assumptions are as follows:

- The minimum definition of access is high-quality industrial ICS that meet international minimum standards on fuel efficiency and emissions.
- The assumed retail price is USD 25 for an industrial wood stove and USD 36 for an industrial charcoal stove.
- Going forward, urbanization is expected to drive higher rates of charcoal use in Madagascar.
- The penetration of clean fuels is expected to be limited to just over 5 percent of households due to affordability constraints, and also logistical issues. Madagascar is 90 percent the size of France (with less than half the population) and its internal road systems are unreliable, particularly during the rainy season.

Figure 2.2

Cooking Fuel Breakdown and ICS Penetration Forecast in Madagascar

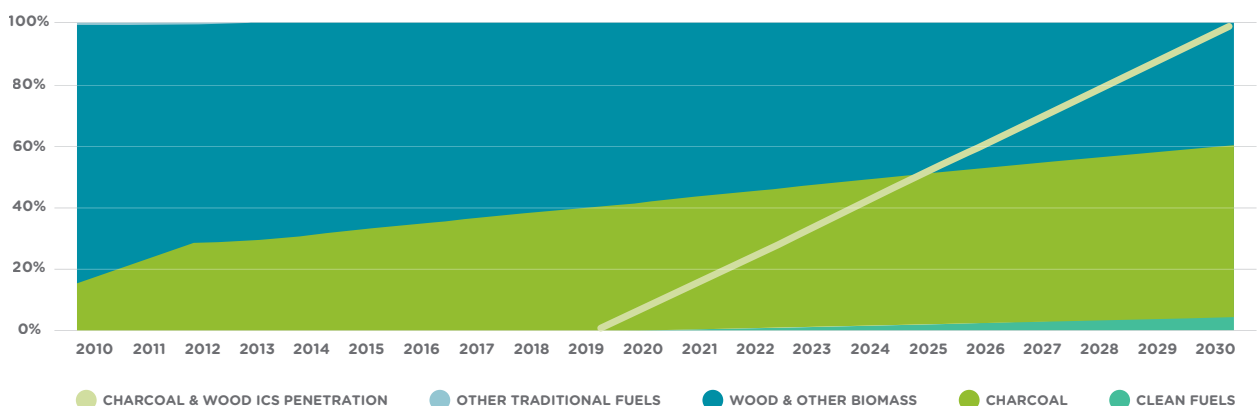
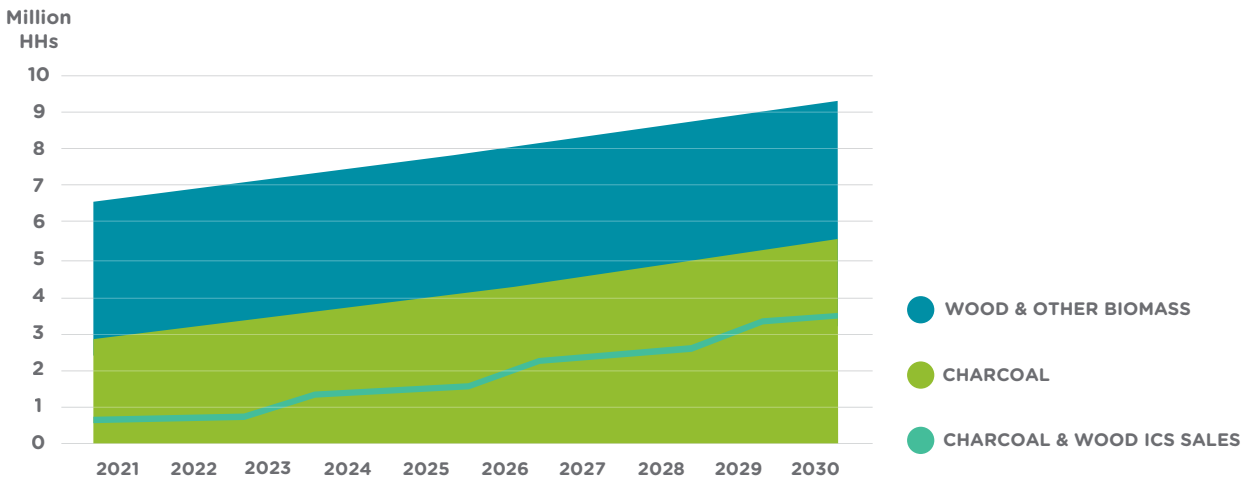


Figure 2.3

Traditional Cooking Fuel Use & ICS Sales Forecast in Madagascar



This makes considerable clean fuel uptake outside of the capital and port cities rather unlikely by 2030.

- Electricity use in cooking is unlikely to increase significantly due to both the lack of grid reliability and the high cost of electricity.
- Clean fuels households are likely to continue to fuel stack in considerable numbers and will thus also need to purchase charcoal ICS.

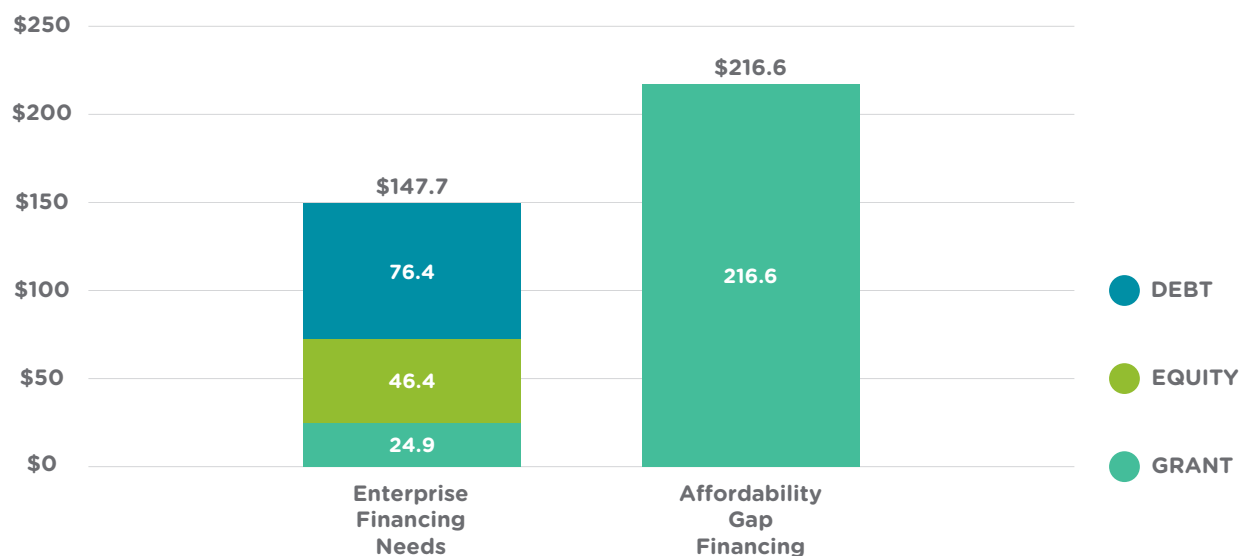
The model assumes that the population will grow at a rate of 2.6 percent per annum. It also assumes that stoves must be replaced at three-year intervals.

Financing Needs of ICS (Charcoal and Wood)

To achieve the scenario in Figure 2.3 above, ICS have a cumulative financing need of USD 148 million for enterprises and USD 217 million for affordability gap financing, with the breakdown of the former illustrated in Figure 2.4 below.

Figure 2.4

Cumulative ICS Enterprise Finance Needs in Madagascar (Million USD)



Grants to enterprises represent 17 percent (USD 24.9 million) of the capital mix used to lower costs associated with proving out the business model and displacing additional equity financing needs. Another 32 percent (USD 46.8 million) of financing needs will be in the form of equity investments in businesses that turn profitable at the scale-up phase, wherein they have sold about 5,000 ICS units. Debt financing accounts for 52 percent (USD 76.4 million) of the capital mix. This is inventory finance to enable retailers to purchase stock of stoves and then repay those loans once sales are completed. The model assumes that all stoves are sold on a cash sale basis.

Consumer Affordability

According to the forecast scenario, Madagascar will require up to USD 217 million in affordability gap financing to help the 90 percent of households that cook with wood but cannot afford an industrial cookstove. The model assumes that households save an amount equivalent to 2 percent of total monthly household consumption for a period of three months in order to buy an ICS. The model also assumes that if a household can afford to buy charcoal, then there is no affordability gap in buying a stove. Since charcoal is expensive—relative to firewood—and the charcoal stove enhances efficiency, purchasing an improved stove should be a selling proposition and compelling to consumers.

KEY CHALLENGES AND OPPORTUNITIES: MADAGASCAR'S SDG7 COOKING TARGETS

Organizations involved in production and marketing of ICS technology in Madagascar face considerable challenges including, but not limited to: lack of customer awareness, limited capacity due to lack of financing, consumer affordability challenges, and a lack of data.

Changing centuries-old cooking habits is not easy. Many cookstove projects in Madagascar have reasonable success while their representatives are still on-site supervising installation and use, but find that soon after their departure the stoves are repurposed

as flower pots or doorstops, and people return to their original cooking methods.⁷³ To address this, many organizations have customer awareness creation at the core of their programs. ADES, for example, conducts training to inform local communities on how to use energy-efficient ovens as well as awareness raising initiatives regarding environment and climate protection.⁷⁴ However, small local producers do not have the resources for such programs, and the responsibility falls to the government and other engaged stakeholders to support them through campaigns showcasing the economic and health argument of clean cookstoves as well as the positive gender impact. As noted above, the lack of available data regarding small-scale producers in Madagascar is another major impediment in reaching clean cooking targets. The government and other engaged stakeholders would be better equipped to reach clean cooking targets with improved data collection on small-scale producers and consumer preferences, predominantly from women, for solutions and approaches that will be sustainably adopted.

Most local producers are incapable of producing semi-industrial let alone industrial-level cookstoves. According to a survey conducted among local producers in the Sava region, most produce largely uniform products, which are charcoal-burning stoves. They have limited business capability as they do not employ additional workers and are very localized with no distribution network outside of their existing market.⁷⁵ On the financing side, many organizations are also utilizing innovative financing schemes such as carbon financing to support their ongoing programs including user training, cooking demonstrations, and school programs that guarantee long term usage and adoption of new cooking technologies.

As illustrated in Figure 2.4, affordability of cookstoves is a major challenge in Madagascar. The relative price

⁷³ Becker, Elena. 2015. "Malagasy Cookstove Use and the Potential for Alternative Models: A Case Study in Madagascar's Vakinankaratra region." Academia.edu.

⁷⁴ ADES. 2019. [adesolaire.org/en/ades-in-madagascar-en/our-program-en](http://www.adesolaire.org/en/ades-in-madagascar-en/our-program-en)

⁷⁵ Klug, Thomas. 2018. "Understanding the Impacts of Traditional Cooking Practices in Rural Madagascar and a Way Forward with Improved Cookstoves".

of charcoal compared to other substitute fuels is cheap. However, rising firewood and charcoal costs over the past few years are making ICS more appealing.⁷⁶ One way to improve affordability is to introduce

duty exemptions on cookstoves and cookstove components. Another option would be to impose taxes on charcoal and firewood, to the extent possible, to decrease deforestation and wood use. The government is currently providing subsidies for solar cookers; extending this subsidy to other ICS solutions is another option to increase affordability.

⁷⁶ Fondem. 2017. PROJET BOREALE. <http://www.fondem.org/projets/boreale/>

