Burundi Market Assessment for Off-Grid Solar and Improved Cooking Technologies for Households

May 2020

LIGHTING AFRICA
Catalyzing markets for modern off-grid energy

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Attribution—Please cite the work as follows:

Lighting Global. 2020. Burundi Market Assessment for Off-Grid Solar and Improved Cooking Technologies for Households. Washington, DC: World Bank.

Acknowledgments

The World Bank Group's Lighting Africa program commissioned this study to assess the off-grid solar and improved cook stove market for households in Burundi. The lead authors are Ed Day (Greencroft Economics), Shahbano Soomro, Suzanne Angliviel (Vivid Economics), Silvia Emili and Marion Denantes (E Co).

The study was supervised by Lindsay Caldwell Umalla and Laurent Durix under the direction of Justin M. B. Beleoken Sanguen and Rhonda Jordan-Antoine (World Bank). The study benefitted from the input and feedback from numerous World Bank contributors, most notably from Umul Awan, Stephanie Nsom, Karen Bazex and Jennifer Lynch.

The Lighting Africa team would like to thank the numerous stakeholders, listed in Appendix 1, from public and private sectors, consulted in person in Burundi or virtually for this study, that gave their time generously and whose insights have made invaluable contributions to this report. We are especially grateful to the SOLEIL/Nyakiriza Project Focal Group which steered this report, led by the Energy Directorate of the Ministry of Hydrology Energy and Mines, and consisting of Burundi Energy Regulatory Authority, the Rural Electrification Agency, the Water and Electricity Production and Distribution Board, the Ministry of Education, Higher Education and Scientific Research, the Ministry of Public Health and the Fight Against AIDS, and the Ministry of Finance, Budget and Economic Cooperation.

Lighting Africa is the World Bank Group's initiative to rapidly increase access to high-quality off-grid solar energy for the hundreds of millions of people in sub-Saharan Africa living without grid electricity. Together with our affiliated program, Lighting Global, Lighting Africa works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market. Our programs are managed by IFC and the World Bank with support from the Energy Sector Management Assistant Program (ESMAP), and funded by ESMAP, the Public – Private Infrastructure Advisory Facility (PPIAF), the Netherlands' Ministry of Foreign Affairs, the Italian Ministry for the Environment, Land, and Sea (IMELS), and the IKEA Foundation.

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Abbreviations

Abbreviation	Definition
ABER	Agence Burundaise de l'Electrification Rurale
API	Agence de Promotion de l'Investissement
ARCC	Agence de Régulation et de Contrôle des Communications
AREEN	Agence de Régulation de l'Eau potable et de l'Energie
B2B	Business to Business
B2C	Business to Customer
BBN	Bureau Burundais de la Normalisation
BIF	Burundian Francs
BQS	Burundi Quality Stoves
BRB	Banque de la République du Burundi
BUREA	Burundi Renewable Energy Association
CDM	Clean Development Mechanism
DALY	Disability Adjusted Life Year
DHS	Demographic and Health Survey
EAC	East African Community
ECVMB	Enquête sur les Conditions de Vie des Ménages au Burundi
EnDev	Energizing Development
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAO	Food and Agriculture Organisation
FENACOBU	Fédération Nationale des Coopec du Burundi
FI	Financial Institution
FSA	Financial Services Associations
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HAP	Household Air Pollution
ICS	Improved Cookstoves
ILF	International Lifeline Fund
IRENA	International Renewable Energy Agency

Abbreviation	Definition
ISTEEBU	Institut Statistiques et Etudes Economiques du Burundi
KDA	K-Rep Development Agency
LMD	Last Mile Distribution
MFI	Micro Finance Institution
MIS	Malaria Indicators Survey
MTF	Multi-Tier Framework
NGO	Non-Governmental Organisation
OBEN	Observatoire de l'Environnement et de la Nature
OBMC	Office Burundais des Mines et Carrières
OBPE	Office Burundais pour la Protection de l'Environnement
OGS	Off-Grid Solar
PAYGo	Pay-As-You-Go
PND	Plan National de Développement
PO	Purchase Order
QV	Quality Verified
RBF	Results Based Finance
REGIDESO	Régie de Production et de Distribution de l'Eau et de l'Electricité
RISE	Regulatory Indicators for Sustainable Energy
SAFE	Safe Access to Fuel and Energy
SDG	Sustainable Development Goal
SHS	Solar Home System
SSA	Sub-Saharan Africa
TA	Technical Assistance
US$	United States dollars
VAT	Value-added Tax
VSLA	Village Savings and Loan Association
WFP	World Food Program
WHO	World Health Organization
Wp	Watt Peak

Executive summary

Access to clean and modern energy in Burundi remains low; less than 10% of the population has access to electricity and almost all cooking relies on traditional fuels.

Access to electricity and clean cooking technologies in Burundi is extremely low. Only 9% of Burundians have access to electricity nationwide, a rate that is five times lower than the average in sub-Saharan Africa (SSA) of 44%. There is substantial regional variation in access to electricity, with access as high as 60% in the urban capital Bujumbura, but as low as 2% in some (largely rural) provinces. [1] Around 90% of rural households rely on traditional three-stone stoves, while almost 99% of households use solid fuels as the primary fuel for cooking. There has been almost no change in the fuel mix since 2010, with nearly 80% nationwide relying on wood.[2] Outside of Bujumbura Mairie, where charcoal is the main source of cooking fuel, there is limited regional variation.

Penetration of both off-grid solar and improved cooking technologies remains low, reaching less than 5% of the potential market. In recent years, approximately 60,000 to 80,000 improved cookstoves have been distributed to households as part of major programs funded by Energizing Development (EnDev), the European Union (EU) and World Food Program (WFP). Total penetration of quality-verified improved cookstoves (ICS) remains at less than 2% of the population, however. The penetration of quality-verified off-grid solar products is equally low, estimated to be 5% of the potential market of 2.1 million households, or around 100,000 products.[3]

Almost all off-grid solar (OGS) products sold to date have been pico lanterns – typically single light systems, in some cases with mobile phone charging.[4] Among the quality-verified stock reaching Burundi, d.light, Barefoot and Sun King branded lanterns were imported prior to 2016. In the last few years, the most common product type are Sun King single light or multi-light systems. A few companies offer solar home systems, mostly sold to customers in Bujumbura and often as a secondary source of electricity alongside a weak grid connection.

Most stoves are produced locally by artisans, designed to focus on meeting households' affordability needs and providing fuel savings. All the major cookstove initiatives have either used local producers (for example, BQS and Alfaco) and/or have worked directly with local artisanal production of stoves. These initiatives have focused on stoves that generate fuel-savings and can meet households' low purchasing power. EnDev has been working with local manufacturers to sell "Matawi" clay stoves based on a design from Tanzania, which provides a much more efficient (Tier 3) stove in terms of fuel usage, for example.

The policy and regulatory frameworks for off-grid energy are nascent, although the government has a clear commitment to expanding access to modern energy services. Burundi's Vision 2025, the five-year National Development Plan, and the 2011 Energy Policy Letter all underline energy access as a key national priority and prioritize, for example, capacity building, production, and dissemination of improved cookstoves. Sector development plans are currently being created to implement the National Development Plan (Plan National de Développement or PND) and are expected to include a defined role for off-grid energy technologies. However, there is no specific target or implementation plan for either off-grid solar or improved cookstoves.

[1] IEA, IRENA, UNSD, WB, WHO. (2019*) Tracking SDG 7 results.* Available at: https://trackingsdg7.esmap.org/results
[2] ISTEEBU. (2016-2017) *Troisième Enquête Démographique et de Santé au Burundi (EDSB-III).* Available at: https://www.isteebu.bi/images/rapports/eds%20burundi%20%202016-2017%20-%20rapport%20des%20rsultats%20prliminaires.pdf
[3] The population is 11,175,378, with 4.78 people per household on average. The electricity rate is 8.7% on average, meaning 8.7% * 2,336,816 households are off-grid, i.e., 2,133,513 households. The population figures are taken from the UN population database.
[4] Pico products are defined as solar lanterns less than 10 Wp. These enable partial or full Tier 1 electricity access to a person or household, as defined in the World Bank's multi-tier framework for energy access.

About half of the population can afford the upfront cost of a solar lantern, while for cookstoves only around 20% of households are likely to make significant financial savings by adopting more fuel-efficient technologies.

Household expenditure on consumer goods is low, which limits the ability to pay for energy access products. The average (median) household expenditure in Burundi is estimated to be around US$ 67 per month. This is calculated by adjusting estimates of the level and distribution of consumption, from World Bank and the Burundi Office of National Statistics and Economic Studies (ISTEEBU), to reflect available expenditure.

Approximately 50% of households in Burundi could bear the upfront cost of a small solar lantern, at around US$ 10 per unit. It is estimated that rural households could typically spend around US$ 3 to US$ 4 per month on energy access products (around 5% of monthly expenditure). On this basis, by pooling up to three months of expenditure available for energy access products, a small single light – up to 1.5 Watts and providing around four hours of light per battery charge – would be affordable to half of households, whereas systems going beyond basic lighting would remain unaffordable.[5]

Using consumer finance to reduce the upfront cost could bring solar lanterns with phone charging and/or radios within the reach of most households, although multilight systems remain largely unaffordable. By spreading the costs of the off-grid solar (OGS) product over 12 to 18 months, either using a pay-as-you-go (PAYGo) approach or borrowing from micro-finance institutions (MFIs), affordability of OGS products increases considerably. With this approach, a basic single solar lantern could be affordable to all households, while 60% of households could afford a single light with phone charging, and over 40% a light-and-radio system. While spreading the cost helps make each monthly repayment more affordable, it does so at a price. For example, including the cost of consumer finance would raise the cost of a system from US$ 130 to about US$ 160, when repaid over 18 months.

While mobile money is increasingly widespread, rural households still have limited exposure to banking and digital finance. As described above, PAYGo and other forms of consumer finance could help to improve affordability, but rural banking services and mobile money are not widely available. Access to consumer credit is amongst the lowest in the world, with less than 5% of Burundians having borrowed from a financial institution.

Even where households may be able to pay, with limited resources available for purchasing basic goods and services, providers will also need to work to mobilize this potential demand. A significant and growing share of the population own radios (40%) and mobile phones (47%), which could help to drive demand for entry-level off-grid solar products. Rates of mobile phone ownership are lower than in neighboring countries and vary substantially by province from 26% in Karuzi to 86% in Bujumbura. Radio ownership is more consistent across the country between 30% and 40%. Even so, the initial willingness to pay for a new and often "first" off-grid solar device may be limited until products can demonstrate value to households and establish trust.

Providing households partial access to Tier 1 electricity solutions such as solar lanterns will require financial support both to catalyze the market and to bridge the affordability gap. It is also worth noting that while this report focuses primarily on the commercial market potential, access to OGS products could also deliver substantial environmental and socioeconomic benefits. These include reduced CO2-equivalent emissions where they replace fossil-fuel based energy products, lighting for children's education, and improved health and safety.

[5] ESMAP's multi-tier framework for energy access (MTF) classifies a solar lantern as between Tier 0 and Tier 1 if it provides less than 1,000 lmhr per day, or does not provide mobile phone charging. For more information see: ESMAP. (2015) Beyond connections energy access redefined. Available at: https://www.worldbank.org/content/dam/Worldbank/Topics/Energy%20and%20Extract/Beyond_Connections_Energy_Access_Redefined_Exec_ESMAP_2015.pdf

Basic improved efficiency stoves deliver economic benefits through fuel and time savings, which could help to drive consumption. For the 20% of households who currently purchase fuelwood, switching to an improved cookstove could deliver annual fuel savings of approximately US $16. This far outweighs the costs of a simple clay Matawi stove, which has a market price of around US$ 2.50. For the remaining 80% of households who do not pay for fuel wood, substantial time savings can be made, although these may not convert immediately into direct financial savings or additional income generation. More advanced stoves would offer substantial additional environmental and socioeconomic benefits but would also need to be imported which would require access to hard currency. Furthermore, as these environmental and socioeconomic benefits do not translate directly into immediate financial savings, rural households are unlikely to purchase these technologies in the absence of subsidies.

Despite the range of potential benefits, rural households are highly price-sensitive, and even at relatively low up-front costs, not all households will buy an ICS. There are several market frictions which prevent the uptake of ICS. Labor market frictions, such as relatively high underemployment and subsistence farming, mean time savings do not necessarily translate into increased earnings. Furthermore, rural households are used to cooking with the traditional three-stone fires, and improved clay stoves have sometimes not been durable enough to replace these traditional solutions. There is also relatively low awareness of potential benefits from these cookstoves, and only a nascent supply chain tailoring its services to these customers.

With limited established last mile distribution networks, a mix of leveraging existing networks and establishing new last-mile partnerships will be needed.

Burundi's relatively high population density and reliable sunshine provide potentially attractive supply side conditions for off-grid solar energy. Average hours of direct sunshine typically vary between 4 to 5 hours daily, regardless of the season. Rural Burundi is also relatively densely populated, with less than 10% of the population living in low-density areas. Nonetheless, while there are very few people living in very remote, sparsely populated regions, the population in general is dispersed across a rugged and hilly terrain, with relatively poor road access beyond major towns.

The most successful models for distributing OGS in Burundi build off existing networks of NGOs and community associations. With very few companies operating nationwide distribution networks for fast-moving consumer goods, new last mile distribution networks and partnerships will be necessary. One successful route to market is to leverage existing networks of international NGOs – for example, One Acre Fund's network works with thousands of farmers across five central provinces, including distribution of off-grid solar products. Local NGOs also serve as last mile distributors, for example through UNICEF – FVS-Amade *'Lumière'* program, which sells products both "to" and "through" Village Savings and Loan Associations (VSLAs).

Limited access to forex and all external sources of finance prevent OGS companies from scaling their operations up, even among higher-affordability consumer groups. Access to forex is essential to import products into Burundi, but access to official hard currency is limited to priority companies. This restricts companies' ability to build inventory and can lead to exchange rate volatility risk, as revenue streams are collected in BIF while companies incur up-front costs for hardware in US$. Access to commercial finance is limited, with high collateral requirements and low familiarity among financial institutions of the OGS sector. As a result, most companies rely solely on their own resources to finance operations.

The PAYGo business model is an emerging opportunity, but face challenges to scaling up. Though all providers consulted are looking into establishing PAYGo—reimbursing the products over for example 12 to 18 months – as a core part of their offering, a few additional barriers will need to be overcome. These include managing working capital requirements and managing default risks among a new customer base. This is compounded by low mobile money penetration and familiarity with digital finance in rural areas.

Distribution of improved cookstoves (ICS) has also heavily relied on village-based associations and cooperatives. Cookstoves have to date been distributed through donor-led initiatives, through the support of implementing agencies, such as AVEDEC, FVS-Amade, Croix Rouge and Action Batwa. The availability of partners has been identified as a key factor to ensure a successful production and dissemination of stoves, as these organizations have experience with Village Savings and Loans Associations (VSLAs) and other community-based structures that can support marketing and promotional activities. Charcoal stoves sold in urban areas are an exception, as they are distributed through retail at local markets and shops.

The critical barriers to commercial market development are low consumer affordability, access to hard currency and the small scale of current providers.

Burundi's off-grid solar and improved cookstoves markets face a range of barriers to scaling up. The most critical barrier that will need to be addressed to catalyze private sector investment include:

1. **Low consumer affordability in rural areas nationwide, and low familiarity with technologies.** Low affordability is exacerbated by relatively low consumer awareness, and some mixed experiences with the quality of new technologies (particularly for cookstoves).

2. **Limited access to hard currency, and volatility in the exchange rate.** Access to foreign currency is restricted in Burundi. This severely affects local businesses that require US$ to purchase and import hardware and international companies that wish to repatriate profits.

3. **The small scale and limited track-record of OGS and cookstoves providers, which is insufficient to attract international finance.** The private sector remains small and reliant on its own financial resources, with very limited access to local or international sources of external finance.

4. **Limited experience and capacity among policy and regulatory agencies.** The policy and regulatory framework is nascent, and while there is a clear drive among government agencies to facilitate development of off-grid energy technologies, this will need to be translated into clearly defined targets, with a clear (and resourced) implementation plan.

There is a growing awareness of the benefits of off-grid energy and a developing entrepreneurial ecosystem to take advantage of opportunities, which can be catalyzed by both of financial and non-financial support.

To catalyze what is currently a young – but growing – private sector ecosystem in Burundi, and to crowd in international finance and expertise will require a series of phased interventions to accelerate growth of the market.

In a first phase, consumer awareness, seed funding for providers, and adoption of quality standards will be essential. Increasing familiarity among households on the benefits and usage of standalone solar and improved cookstoves will be critical to mobilizing demand. To meet this demand, companies will need to access patient capital – including initially grant finance – to trial and test products and business models. In the case of cookstoves, this should include testing a range of product designs for rural and urban customer segments. At this time, to develop the enabling environment the priority will be to adopt internationally recognized quality standards and test methods, both to ensure consumers get a high-quality product that they trust, and to define qualifying products for results-based finance in the second phase described below.

In a second phase, training and skills development can maximize the value of solar and cooking technologies for households, while results-based finance can incentivize companies to reach scale. Technical assistance

should help households and farmers make the most of these new technologies, both in terms of time savings and in terms of income generating potential. Indeed, financial support accompanied by technical assistance to move from ideation through to achieving scale is critical to developing a sustainable commercial market in the medium term. At this stage, results-based finance should be used to incentivize qualifying companies to increase the volume and reach of sales of defined, quality-verified products.

Finally, as the market matures, companies should prioritize profit, and tightly targeted demand side subsidies may be used to ensure access for the poorest and hardest to reach. To reach scale and establish commercially sustainable operations, companies will have to identify technologies, business models, and a target customer base – which will not serve the whole population. However, once companies can demonstrate a track record of sales and sustainability, demand side subsidies could be used effectively to provide affordable access for the poorest and hardest to reach households.

1 Introduction

1.1 Context

Burundi is a small land-locked country in East Africa, of just over 11 million people living across a land mass of 27, 830 km^2.[6] With close to 500 inhabitants per square km, it is the second most densely populated country in mainland Africa, after neighboring Rwanda. However, just 13% of this population live in urban areas – mostly in the capital Bujumbura – and most of the population (around 80%) remains primarily dependent on the agriculture sector.

The Republic of Burundi has seen some positive signs of economic and social development over the past decade, but much of its potential remains untapped. Since 2010, its GDP has grown at around 4% per year, albeit experiencing a downturn following the elections in 2015. The country is endowed with physical and human resources which could unlock greater development potential.

Most of the population live in poverty, with an estimated 60% of Burundians living below the food consumption poverty line in 2014. The average per capita income in Burundi is US$ 210 per annum,[7] nearly 90% lower than the average across sub-Saharan African countries.[8] Education and health outcomes are poor, with the country ranking 185 out of 189 countries on the 2019 Human Development Index.[9]

A major inhibitor to socioeconomic development is the lack of access to energy services; the vast majority of Burundians do not have access to electricity and remain reliant on traditional wood and charcoal based cooking technologies. The rate of access to electricity in Burundi remains at just 9%,[10] and has only recorded modest year-on-year improvement in access of 0.6% since 2010.[11] This is at the lower end of access levels and one of the slowest rates of improvement across the continent.

Access to electricity is only 9% across Burundi and in rural areas it remains even lower, at less than 2%, with an average per capita consumption of electricity of 23 kilowatt hours per year. [12] This is among the lowest in sub-Saharan Africa where the regional average is 480 kWh/year.[13] Even in major urban centers such as Bujumbura, Ngozi, and Gitega, planned and unplanned electricity outages remain common. The vast majority of rural – and often urban – households rely primarily on wood for cooking, using traditional three-stone fires. There is limited access to alternative sources of energy for cooking or improved cook stoves both of which could be more efficient and would reduce the environmental and health impacts of cooking with wood.

A lack of reliable energy not only affects livelihoods but is also a major constraint on businesses and on the provision of public services. Some 22% of Burundian firms identify poor electricity access and reliability as major barriers to investment, compared to an average 15% across sub-Saharan Africa,[14] and 85% of Burundian firms experience frequent electricity outages. Health clinics are subject to frequent power outages – if they have power at all – even in major urban centers such as Bujumbura. Important public institutions such as schools, and regional / central government agencies often lack access to reliable electricity.

[6] World Bank. (2019) *The World Bank Data.* Available at: https://databank.worldbank.org/home.aspx
[7] At PPP and constant 2010 rates
[8] World Bank. (2019) *The World Bank Databank.* Available at: https://databank.worldbank.org/home.aspx
[9] UNDP. (2019) *Human Development Report.* Available at: http://hdr.undp.org/sites/default/files/hdr2019.pdf
[10] IEA, IRENA, UNSD, WB, WHO. (2019*) Tracking SDG 7: The Energy Progress Report 2019.* Available at: https://trackingsdg7.esmap.org/
[11] Ibid
[12] Implementation Completion and Results Report on a Global Environment Facility Grant to the Republic of Burundi. World Bank, June 2016.
[13] World Bank. (2019) *The World Development Indicators*. Electric power consumption (kWh per capita), 2016. Available at: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC
[14] World Bank. (2014). *Enterprise Surveys.* Available at: http://www.enterprisesurveys.org

1.2 Objectives, scope and methodology

The objective of this market assessment is to describe the current state of energy access among households in Burundi, and to explore the market potential for off-grid solar and improved cookstove technologies. It serves as a point of reference for local companies at various points in the off-grid energy value chain, for international companies exploring entry or expansion into Burundi, for financiers who may be looking for expansion opportunities in a relatively young market, and for development partners and the Government of Burundi seeking to understand how best to catalyze the market and provide long term support to customers a commercial market may not reach.

The consultancy team spent three weeks in January 2020 interviewing over 40 representatives of government, private sector, financiers, and civil society organizations. These consultations were used to gather data, reports, supporting quantitative and qualitative information, and stakeholder views across four main topic areas: (i) potential household demand for OGS and ICS technologies, (ii) current supply chains for these technologies, (iii) local sources of finance and the financing needs of OGS and ICS providers, and (iv) key barriers to sustainable commercial market development.

A wide range of data sources are used in this report – and while they provide a rich overview of the market context they are in some cases dated and should be interpreted with caution. Much of the data on affordability and poverty levels trace back to the *'Enquête sur les conditions de vie des ménages du Burundi'* (ECVMB) from 2013-14, or to the *'Demographic Health Survey'* (DHS) last published in 2016.[15] In all cases this data has been compared to and adjusted for information received in consultations and represents the best and most up-to-date available evidence, but nonetheless is somewhat dated.

The forthcoming Multi-Tier Framework (MTF) household survey will generate much more granular primary information. Data collection in Burundi is expected to commence in the second half of 2020. The MTF surveys provide a detailed snapshot of energy consumption, with Energy Access diagnostic reports already published for nine countries, with a further six country studies underway.[16]

Finally, consultations with around 20 international stakeholders were used to test the hypotheses generated from in-country consultations and data analysis. Views from international companies and investors helped shape recommendations to reflect the main barriers identified by actors active in the region, and to identify what it might take to catalyze entry from established players into the Burundian market.

The report's findings are structured as follows:

- Section 2 sets out the current state of access to electricity and cooking technologies, highlighting the organizations and market structures in place today and the national policy landscape.
- Section 3 analyses the potential demand for off-grid solar and improved cooking solutions.
- Section 4 analyses the supply chain for off grid solar and cooking technologies.
- Section 5 sets out the role of financial institutions in the provision of commercial and consumer finance for off-grid solar and cooking sectors.
- Section 6 sets out the key financial, technical, and regulatory barriers to market growth.
- Section 7 sets out recommendations to catalyze increased investment and uptake of off-grid solar and clean cooking technologies.

[15] Translated as the "Burundi Household Living Conditions Survey"

[16] The MTF country diagnostic reports complete at the time of writing include: Bangladesh, Cambodia Ethiopia, Kenya, Myanmar, Nepal, Rwanda, São Tomé and Príncipe, and Zambia

2 The current state of access to electricity and cooking technologies and enabling environment

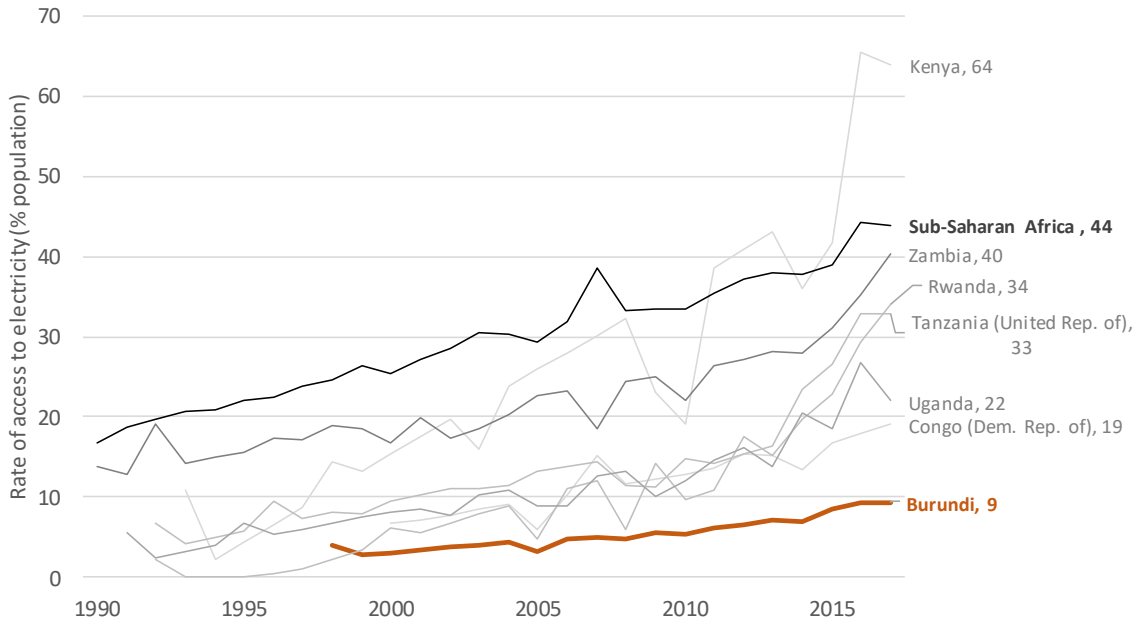
2.1 Access to electricity – baseline

- The vast majority of Burundians do not have access to electricity – with under 10% having access to electricity nationwide.
- There have been a few initiatives to roll out off-grid solar products, yet still only around 1% of the population use off-grid solar solutions.

The vast majority of Burundians do not have access to electricity – with under 10% having access to electricity nationwide

Under 10% of Burundians have access to electricity, although there is substantial regional variation with much higher rates of electricity access in urban areas. This national rate is low compared to neighboring East-African countries and is five times lower than the sub-Saharan African (SSA) average of 44% (Figure 1). In rural areas the energy access deficit is particularly stark with an energy access rate at around 2%, which is 13 times lower than the SSA average, although In urban areas access to electricity has improved gradually over the last decade, up from 49% in 2010 to 60% by 2016.[17]

Figure 1 Burundi's national rate of access to electricity is extremely low compared to neighboring East African countries and to the sub-Saharan Africa average



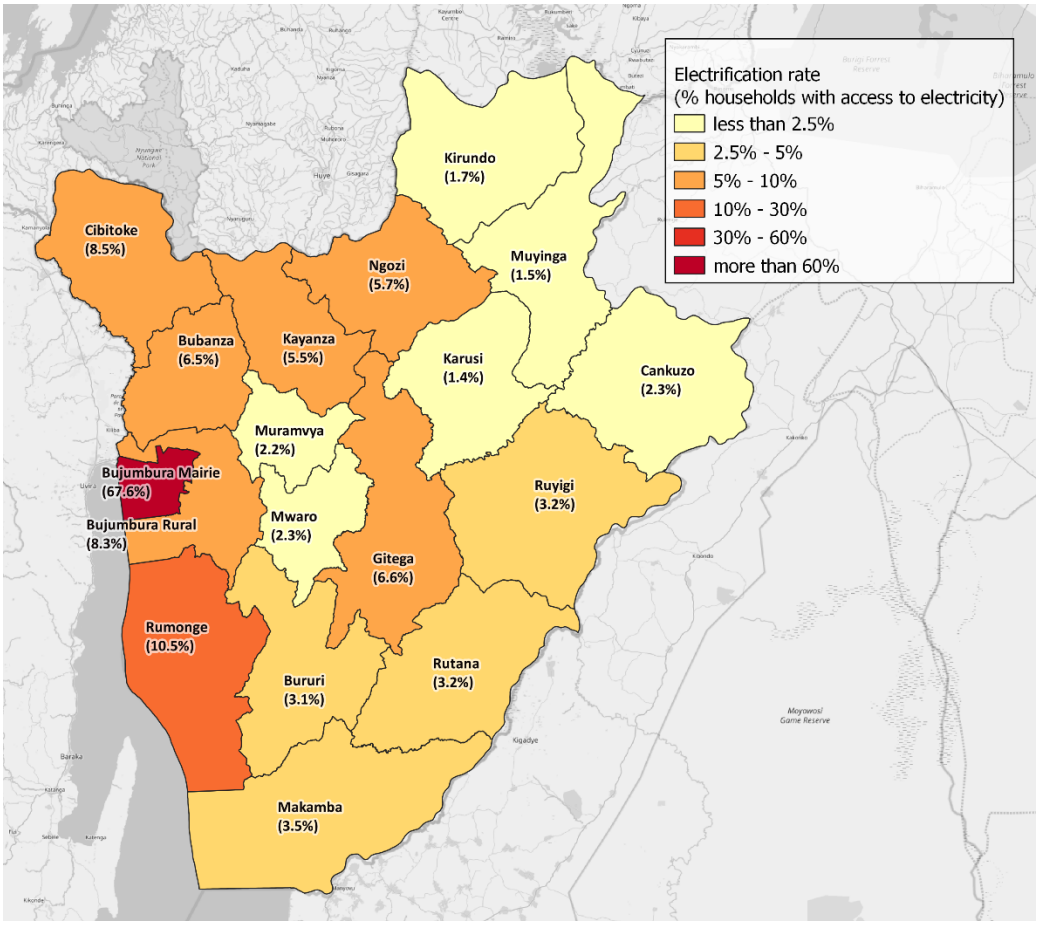
Source: Consortium based on SDG 7 tracking data

[17] IEA, IRENA, UNSD, WB, WHO. (2019*) Tracking SDG 7 results.* Available at: https://trackingsdg7.esmap.org/results

Even across regions that are predominantly rural, there is substantial variation in the rate of electricity access, with relatively higher access concentrated in the North-West (Figure 2). The highest electricity access rates by province are Bujumbura Mairie (68%), Rumonge (10.5%) and Cibitoke (8.5%). The North-Eastern provinces of Kirundo, Muyinga, Cankuzo, and Karuzi have the lowest rates of access, with all four provinces at under 2.5%. As described in Section 3, these provinces are also relatively poor, and with low levels of ownership of household assets such as mobile phones and radios.

Nationwide, 80% of the population use candles and kerosene lamps for lighting at home. The vast majority (68%) of households use candles, while 13% use kerosene-fueled hurricane lamps.[18] The remaining households burn solid fuels such as firewood or dry grass to light their dwelling or use torches with single-use batteries. More recent company research (with relatively small samples of households) confirms that between 80% to 90% of households rely on these traditional solutions for lighting, although the product mix may be evolving / vary by region, with candles being replaced by a growing share of kerosene lanterns and single use torches.[19]

Figure 2 Less than 10% of the population has access to electricity in all provinces except the urban capital, Bujumbura Mairie



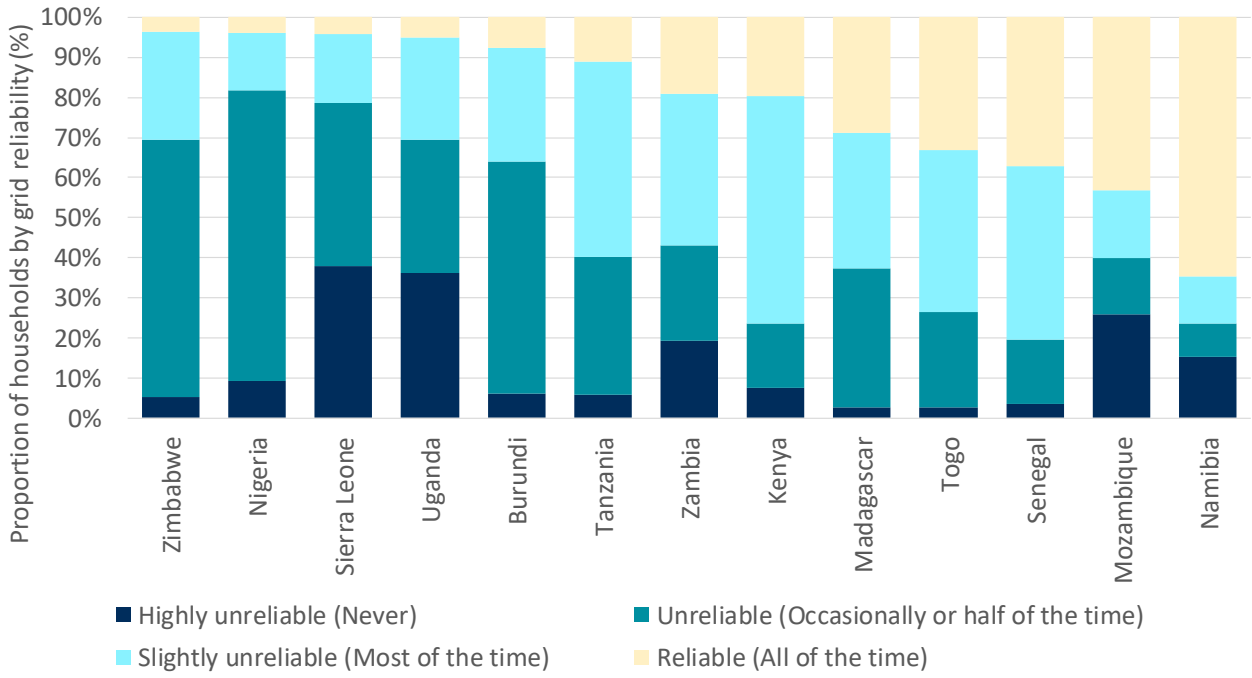
Source: Vivid Economics, Greencroft Economics and E Co Ltd ("Consortium") based on DHS 2016-2017

Even among those households who do have access to the main grid, the majority receive electricity only some of the time (Figure 3). In the Afrobarometer household surveys (latest available data for Burundi from Round 6, in 2015), just 8% of households with a grid connection responded that they had access to electricity

[18] Enquête sur les Conditions de Vie des Ménages du Burundi (2013-14), supported by confidential research shared by Burundian companies.
[19] Based on two confidential company studies collected in this study, with 1,105 and 80 households surveyed in 2019 and 2013, respectively.

"all of the time." A further 28% had electricity most of the time, while 64% had access no more than "occasionally or half of the time."[20]

Figure 3 The majority of grid-connected households in Burundi have access to electricity only some of the time, and only 8% have reliable electricity all of the time



Source: Consortium based on Afrobarometer 2016

There have been a few initiatives to roll out off-grid solar products, yet still only around 1% of the population use quality-verified off-grid solar solutions.

Penetration of quality-verified off-grid solar products is low in Burundi, with sales in the last 12 months reaching only around 1% of the potential market.[21] Over 22,000 quality-verified solar lanterns and solar home systems have been sold or distributed in the last year or so, the majority by international NGOs. Based on this annual sales volume, and an average asset life of two to three years for a solar lantern, there are expected to be between 50,000 to 100,000 quality-verified OGS products currently in use in Burundi. Even the upper end of this estimate (100,000 OGS products in use), would represent just 5% of a potential market of 2.1 million households nationwide.[22]

While there is no data recorded on the sale of non-quality-verified solar lanterns, penetration is likely to be relatively low as there are limited low-cost technologies available in the market. Even in Bujumbura, the sale of solar lanterns in retail outlets and markets is not common. In the two main retail outlets indicated during the course of this market assessment – *'Adams'* in the Quartier Asiatique, and *'HomeWorld'* in the center of town, a limited range of imported Chinese-made solar lanterns were available from around BIF 40,000 (US$ 20), with very small solar lanterns and rechargeable torches available from around BIF 10,000 (US$ 5). At markets in Bujumbura and up-country there may be some cheaper products, but these are likely to be low-

[20] Afrobarometer. (2019) *Burundi country profile.* Surveys and data available at: https://www.afrobarometer.org/countries/burundi-0

[21] "Quality-verified" in this report is taken to mean products meeting Lighting Global Quality Standards available at https://www.lightingglobal.org/quality-assurance-program/our-standards/

[22] The population is 11,175,378, with 4.78 people per household on average. The electricity rate is 8.7% on average, meaning 8.7% * 2,336,816 households are off-grid, i.e., 2,133,513 households. The population figures are taken from the UN population database.

quality based on visits to a couple of markets, and not much cheaper than those available at the retail outlets described above. While these products may provide some competition for quality-verified (QV) off-grid solar, they are not widespread nationwide.

Prior to 2016, OGS lanterns and solar home systems were sold to households without direct financial subsidies. The EnDev solar programs were discontinued in 2016, at which point they had reached an estimated 5,000 households in Gitega and Mwaro. A market approach was adopted to support distributors such as Groupe LADAK (which was selling d.light lanterns), and ITCO (which was selling Sun King and Barefoot hardware), through marketing and consumer awareness campaigns, also working with MFIs (e.g. FSTE). While there were no direct subsidies for these sales to households, EnDev also supported distribution of standalone solar electricity to 26 health centers and five schools, where the public institution paid 20% of the purchase price and EnDev provided a subsidy for the remainder. Similarly, EnDev sold over 100 solar kiosks for small enterprises, with the recipient paying 30% of the purchase price.

Almost all OGS products sold to date have been pico lanterns –single light systems sometimes with mobile phone charging – with a much smaller share of sales of small solar home systems.[23] Among the quality-verified stock reaching Burundi, d.light, Barefoot, and Sun King branded lanterns were imported prior to 2016. In the last few years, the most common products are Sun King single light or multi-light systems. A few companies are also offering multi-light and solar home systems, mostly sold to customers in Bujumbura and often as a secondary source of electricity alongside a weak grid connection. The reason for this concentration of (nonetheless very limited volumes) of larger systems in Bujumbura is that customers are easier to reach through over-the-counter sales at retail outlets and word of mouth, generally have higher ability to pay, and can also use the SHS to make direct financial savings by reducing consumption from the main grid.

Most sales have been made through existing networks with rural households by NGOs, or through consumer associations. A successful route to market for local OGS distributors has been to make business-to-business (B2B) sales to either NGOs who are working with households in rural areas, or through consumer associations such as Village Saving and Loan Associations (VSLAs). Larger international NGOs have also been successful in adding OGS products to the range of services they offer to smallholder household farmers in rural areas.[24]

UNICEF's ongoing *'Lumière'* program is supporting the distribution of solar lanterns, underpinned by high levels of subsidization. The ongoing *'Lumière'* program, supported by UNICEF and implemented by local NGO FVS-Amade, has evolved from selling rechargeable headlamps to offering solar lanterns. Through this program some 13,000 rechargeable headlamps were sold, and more recently over 150 solar lanterns. The subsidy on the purchase price for both the headlamps and the lanterns has been around 60% to 70% (business model and subsidies described further in Section 4.2).

No single business model has emerged as the "best" approach to serving households in the Burundian context, with neither over the counter cash sales nor PAYGo sales reaching significant scale. Direct business to customer (B2C) sales have not yet achieved significant scale, and over the counter sales through retail stores have generated only a handful of sales. While OGS products are not new to Burundi, with some successful commercial sales and partnerships emerging prior to 2015, the market remains nascent in the sense that product penetration remains low and there are very few operators. As a result, there is still relatively limited consumer awareness of off-grid solar products, and limited extent of retail networks reaching households in rural areas. While companies are piloting PAYGo enabled technologies, the PAYGo business model has also not yet reached many households. This is in part due to the same barriers that have restricted over-the-counter sales, and also due to limited access to and familiarity with consumer finance,

[23] Pico products are defined as solar lanterns less than 10 Wp, following the product categorization used on the Lighting Global website at https://www.lightingglobal.org/products/

[24] For example, One Acre Fund works with farmers in five central provinces of Muramvya, Gitega, Ngozi, Kayanza, and Mwaro including selling solar lanterns.

combined with very low ability to pay, which even spreading payments over time cannot fully mitigate. These challenges are described in far greater detail in Section 3 below.

2.2 Access to clean and efficient cooking solutions - baseline

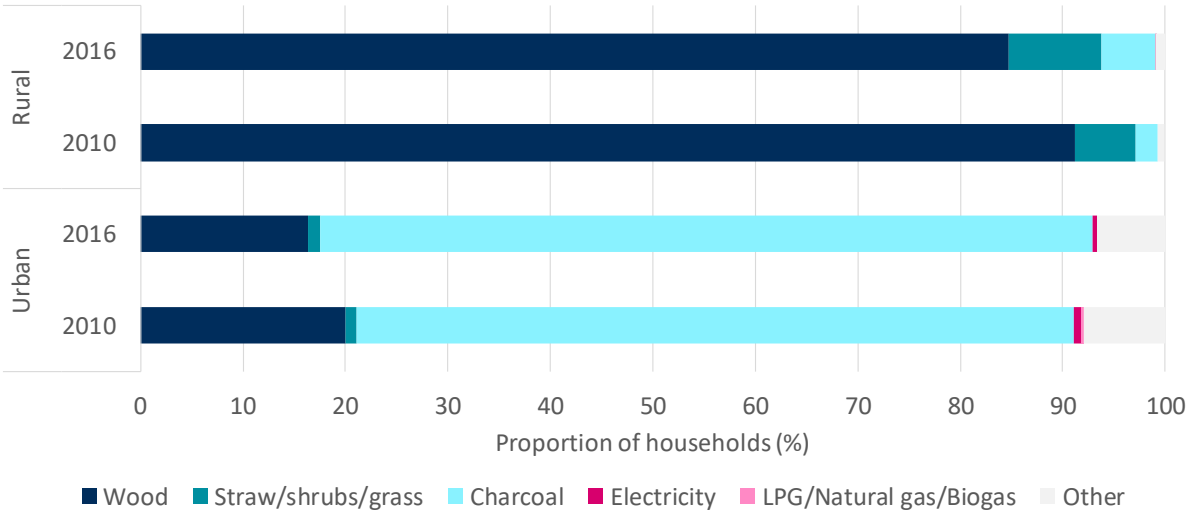
- Households in rural areas remain reliant on wood as their main cooking fuel, while in urban areas charcoal is more prevalent.
- Initiatives in recent years have disseminated improved cookstoves to households, but current total penetration remains low, at less than 2% of the population.

Households in rural areas remain reliant on wood as their main cooking fuel, while in urban areas charcoal is more prevalent.

Households – especially in rural areas – remain heavily reliant on wood fuels for cooking. Some 99% of households use solid fuels as the primary fuel for cooking, with 77% relying on wood, 13% on charcoal, and 8% on farm residues such as straw, shrub, or grass, with almost no change in the fuel mix since 2010.[25]

This reliance on wood fuels and traditional cooking methods is largely driven by low incomes and results in a considerable amount of time devoted to food preparation. For rural households, firewood represents an affordable option, especially because it can often be collected for free and only a small percentage is commercially traded.[26] While cooking is the main use of energy at home, firewood is also used for lighting and heating.

Figure 4 The fuel mix for cooking has not changed much since 2010, with wood predominant in rural areas, and charcoal accounting for around 70% in urban areas

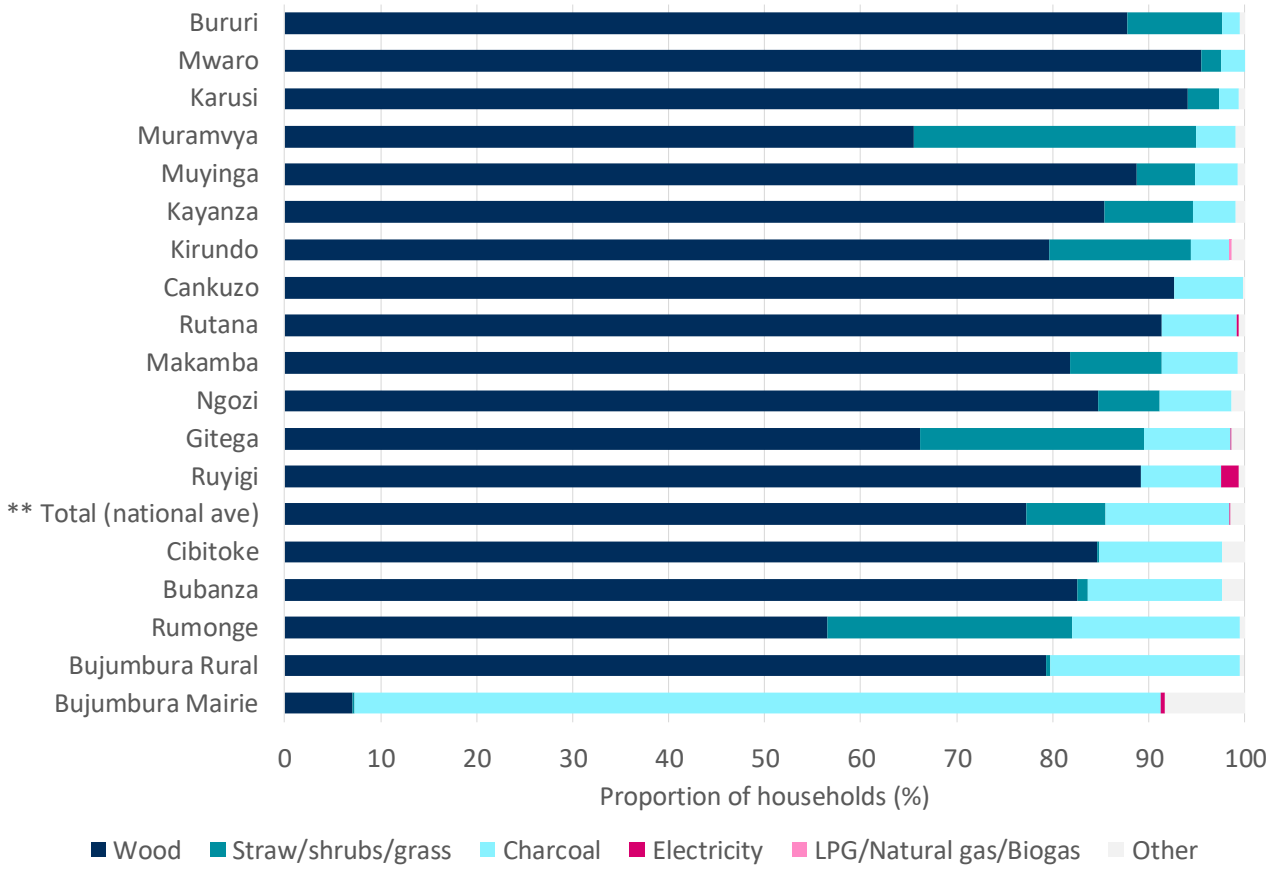


Notes: "Other" includes kerosene, coal, lignite, agricultural waste, and dung
Source: Consortium based on DHS, 2016-2017, MIS 2012, and DHS 2010

[25] ISTEEBU. (2016-2017) *Troisième Enquête Démographique et de Santé au Burundi (EDSB-III).* Available at: https://www.isteebu.bi/images/rapports/eds%20burundi%20%202016-2017%20-%20rapport%20des%20rsultats%20prliminaires.pdf
[26] UNIDO, Project Gaia. (20130) Baseline Report of Clean Cooking Fuels in the East African Community (EAC) region. Available at: https://cdn2.b2match.io/event/2901/assets/8478585412-9cc8c37a39.pdf

There is limited variation in fuel use across provinces, with wood accounting for the majority, except in the capital (Bujumbura Mairie) where charcoal is the main source of cooking fuel. In Bujumbura Mairie, 80% of the population uses charcoal as their primary source of fuel for cooking. This underlines a key cooking habit in Burundi, which is that even where households have access to an electricity grid – for instance Bujumbura Mairie where 68% of households have access to electricity – they nonetheless rely on charcoal as the main source of cooking fuel. In all other provinces, which are predominantly rural, wood accounts for most cooking fuel, although in some provinces such as Gitega, Muramvya, and Kirundo, over 10% of households use straw/shrubs/grass.

Figure 5 Wood fuels account for the vast majority of cooking fuels in all provinces except Bujumbura Mairie, where charcoal is the predominant cooking fuel



Notes: "Other" includes kerosene, coal, lignite, agricultural waste, and dung
Source: Consortium based on DHS 2016-2017

Burundi is losing on average 5,850 ha of forest per year, which makes reliance on fuelwood and charcoal increasingly time consuming and unsustainable in the long term. Burundi is located in a "hot spot" of unsustainable wood fuel use[27] which extends from Eritrea through Eastern Ethiopia, Kenya, Uganda, and Rwanda, where the rate of depletion of renewable biomass outstrips the rate of regrowth. . According to the FAO (WISDOM project[28]), Burundi faces high deficit conditions for the supply of woody biomass, with 77% of the rural population being in high deficit, and 19% being in medium-high deficit. Similar deficit situations are found in Rwanda, where 42% of rural population is in high deficit and 38% is in medium-high deficit, and in some areas of Eritrea, Tanzania, Uganda, and Kenya. Deforestation and forest degradation in Burundi have been mainly concentrated in the most densely populated areas, with the main deficit areas

[27] Bailis, R., Drigo, R., Ghilardi, A. and Masera, O., 2015. The carbon footprint of traditional wood fuels. Nature Climate Change, 5(3). 266–272. DOI:10.1038/nclimate2491

[28] FAO. (2005) *WISDOM - East Africa Woodfuel Integrated Supply/Demand Overview Mapping*. Available at: http://www.fao.org/sustainable-forest-management/toolbox/cases/case-detail/en/c/410783/5

identified in the central and northern provinces of Ngozi, Muramvya, Karuzi, Gitega, Kayanza, and Kirundo. The loss of forest cover not only increases fuelwood scarcity, it will also have long-term impacts on forest degradation, CO_2 emissions, soil degradation, biodiversity and ecosystem losses. In terms of cooking fuels, fuelwood scarcity will pose an additional burden to fuel-poor households who already spend up to 18 hours per week collecting wood (described in Section 3.3). This will lead to an increase of time spent searching for fuelwood and in a widespread shift to lower grade biomass fuels such as straw and residues.

Initiatives in recent years have disseminated improved cookstoves to households, but current total penetration remains low at less than 2% of the population.

The market for quality-verified improved cookstoves is very nascent, reaching less than 2% of the population with almost all rural households using traditional three-stone stoves. There is a strong tradition of using open three-stone fires due to their cultural importance within the household and to households' cooking preferences. These stoves serve multiple functions alongside cooking, including space heating, lighting, and repelling insects, and are easily constructed from local materials and scrap parts. In recent years, around 60,000 to 80,000 improved cookstoves have been distributed to households through major programs funded by EnDev, WFP, and the EU (summarized in Table 1). As a conservative assumption that around half of these stoves are still in use currently, around 2% of rural households are currently using an improved cook stove.[29] While access to clean cooking is very low in Burundi, other countries in the region also still have much progress to make, with for example Rwanda, Uganda, and Tanzania all at less than 5% access, and Kenya and Zambia at 16%. Across sub-Saharan Africa, the rate of access to clean cooking technologies is just 14%.[30]

Initiatives promoting improved stoves have focused on meeting households' affordability needs and on providing fuel savings. These initiatives have focused on stoves that generate fuel-savings and can meet households' low purchasing power. EnDev has been working with local manufacturers to sell "Matawi" clay stoves based on a design from Tanzania, which provides a much more efficient (Tier 3) stove in terms of fuel usage, although they do not achieve higher than Tier 0 status on other categories. Under the Safe Access to Fuel and Energy program (SAFE), the WFP has distributed three types of stoves based on customer segments: (i) mobile clay stoves for rural households, (ii) institutional stoves for schools, and (iii) solar cookstoves targeted at urban households. Clay stoves targeted at rural households aimed at reducing 40% of fuelwood usage and at reducing smoke, while ensuring affordability for lower income customers.

Most stoves are produced locally by artisans and distributed close to the point of manufacture through associations and cooperatives. All the major cookstove initiatives have either used local producers (for example, BQS and Alfaco) and/or have worked directly with local artisanal production of stoves. WFP's program has supported cookstoves production at six sites around Gitega province. Implementing partners AVEDEC, Action Batwa, and Croix Rouge have been responsible for production and distribution of improved stoves made of clay, with a cooperative model established for management of the sites. Under the Lumière project's cookstove component, UNICEF is distributing cookstoves through VSLAs, which are supported and trained in production by the implementing partner, local NGO FVS-Amade. Similarly, the EnDev program has established local manufacturing by using local clay artisans. Under the recently funded UMUCO program (EU), NGO "AVSI", UNDO and FAO and other partners plans to distribute clay stoves using local manufacturing.

[29] Considering a two-year average lifespan for distributed stoves, the estimate is that half of the total cumulative stoves sold in recent years are still in use.

[30] IEA, IRENA, UNSD, WB, WHO. (2019*) Tracking SDG 7 results.* Available at: https://trackingsdg7.esmap.org/results

Table 1 Programs and initiatives for cooking

Program	Funder	Status	Implementing entities	Provinces	Targeted energy services / technologies
Lumière	UNICEF	Since 2015	FVS-AMADE	Makamba and Rutana	Improved cookstoves (clay)
Improved cookstoves	EnDev (funded by Dutch Embassy)	Since 2016	IFDC, BQS	Gitega, Kayanza, Kirundo	Improved cookstoves (clay and clay+metal)
Rural energy services for the resilience of Burundian population	UNDP and FAO (funded by the EU)	Planned	Local production, cooperatives, agricultural institutions, private sector	Kirundo, Karuzi, Makamba, Rutana, Cankuzo	7,000 households provided with improved cookstoves; Installation of briquettes production
RENOUVE Burundi – Renewable energy for Burundi	LVIA, We World – GVC Onlus, ICU (funded by the EU)	Planned	FENACOBU, Reseau Burundi 2000 Plus, Great Lakes Initiatives for Communities Empowerment	Ruyigi, Rutana, Cankuzo, Kirundo	Improved cookstoves: clay, metal and clay/metal; awareness raising and capacity building
Contribution à la résilience intégrée de communautés rurales à travers l'accès à l'énergie durable	AVSI, Norwegian Church Aid (funded by the EU)	Planned	Local manufacturers	Kayanza, Ngozi, Kirundo	11,000 clay improved stoves
SAFE (Safe Access to Fuel and Energy)	WFP	Since 2015	Croix Rouge, AVEDEC, Action Batwa	Gitega (6 sites)	Clay improved stoves for rural households, solar cookstoves for urban households
Improved Cooking Stove Program in Burundi supported by Republic of Korea	ECOEYE Co.	Ongoing	OBEN (Observatoire de l'Environnement et de la Nature)	N/A	50,000 clay improved stoves

Source: Consortium

The nature of artisanal manufacturing and the limited experience of manufacturers in producing improved cook stoves has resulted in limitations in terms of production capacity, quality, and durability. While traditional three-stone fires have a long lifespan and can easily be fixed with local materials at low cost,

improved stoves have a shorter life (1-2 years) and this is often further shortened where production quality has been low, resulting in breakages. Traditional stoves used in urban areas include charcoal stoves, produced locally or imported from Tanzania. These stoves have a low efficiency and a limited lifespan (1-2 years).[31] Charcoal is inefficiently produced in an artisanal way and it is estimated that urban households relying on charcoal and using traditional stoves consume a higher equivalent of fuelwood than a rural household using firewood in combination with the three-stones fires.

2.3 National policy landscape

- Burundi has a commitment to off-grid energy in its long-term vision but is yet to translate this into specific targets with a clear and resourced implementation plan.
- The institutional framework overseeing the off-grid energy sector is young – with most institutions still getting to grips with their mandate and role in fostering growth of the off-grid energy technologies.

Burundi has a commitment to off-grid energy in its long-term vision but is yet to translate this into specific targets with a clear and resourced implementation plan

Burundi's Vision 2025, and the five-year National Development Plan underline energy access as a key national priority. The *'Vision 2025'* includes the goal to ensure that *"rural and urban populations have access to reliable, clean sources of energy at competitive prices."*[32] The '*National Development Plan 2018-2027*' (PND) places a priority on increasing access to energy, although it is focused on extending and improving the national grid for electricity access. For cooking, it prioritizes capacity building, production, and dissemination of improved cookstoves, and the promotion of peat and briquettes using agricultural waste. Similar priorities for the promotion of improved cookstoves are underlined in the 2011 *'Energy policy letter.'*[33]

These national policies and strategies are yet to be translated into specific targets with a clear and well-resourced implementation plan. Existing policies tend to focus on extension and improvements to the grid. The 2011 *Energy Policy Letter* is the most recent national policy document for the energy sector and needs to be updated. While the Electricity Sector re-organization law (2015) enables off-grid electricity production independently from the national utility, REGIDESO, there is no specific target or implementation plan for either off-grid solar or improved cookstoves. The lack of specific targets has been identified as a key weakness of government strategies.[34] Sector development plans are currently being developed to operationalize the PND and are expected to include a defined role for off-grid energy technologies.

The commitment to promoting clean electricity and cooking solutions is reflected in the reduced import duties imposed on off-grid solar components, clean cook stove components, and cooking fuels – although these are not always consistently enforced. There are no import duties on cooking fuels and stove

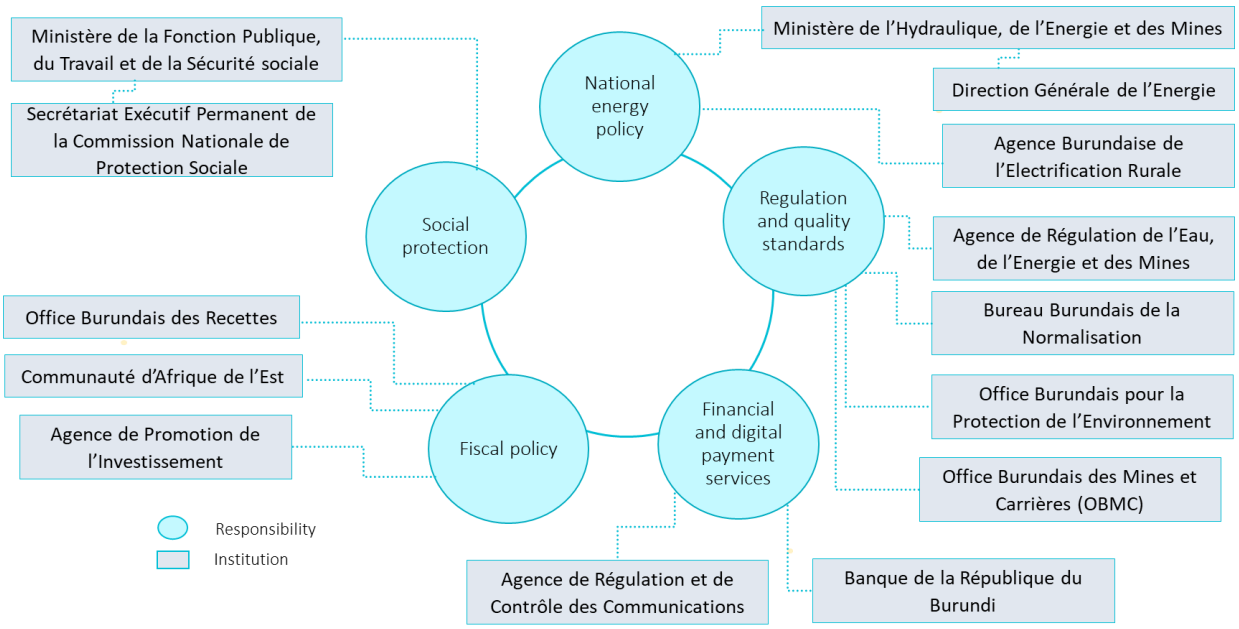
[31] Charcoal stoves' lifespan is around 3 years. For locally produced charcoal stoves a thermal efficiency of 20-25% is considered satisfactory, however the charcoal used in Burundi impacts the overall efficiency and limits fuel savings.
[32] Ministry of Planning and Communal Development/ Forecasting unit, UNDP. (2011) *Burundi Vision 2025*. Available at: https://www.undp.org/content/dam/burundi/docs/publications/UNDP-bi-vision-burundi-2025_complete_EN.pdf
[33] Ministère de l'Energie et des Mines. (2011) *Lettre de Politique Energetique*. Available at: http://www.euei-pdf.org/sites/default/files/field_publication_file/EUEI_PDF_Burundi__Strat%C3%A9gie_%C3%A9nerg%C3%A9tique_Lettre_de_Politique_Jan2011_FR.pdf
[34] Sustainable Energy for All, Ministère de l'Energie et des Mines. (2013) *Etude diagnostique du secteur de l'Energie au Burundi dans le cadre de l'Initiative du Secrétaire Général des Nations Unies sur l'Energie durable pour tous.* Available at: https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_RAGAs/Burundi_Rapid_Assessment_Gap_Analysis__FR_.pdf. This is corroborated by the government's 2011 Lettre de Politique Energetique, and 2018 Plan National de Développement du Burundi. La Republique du Burundi. (2018) *Plan National de Développement du Burundi 2018-2027*. Available at: http://www.presidence.gov.bi/wp-content/uploads/2018/08/PND-Burundi-2018-2027-Version-Finale.pdf

components, while there are duties on complete stoves, at a rate of 10% for solid and gas fuel stoves, and 25% for liquid fuel stoves. Similarly, the government, as part of the East African Community, has exemptions for solar components – such as individual lanterns. However, these import duty exemptions are not always clearly defined or enforced, with OGS companies sometimes benefitting from the exemption and sometimes facing the full 25% import duty (particularly for kits containing a solar lantern and other component parts as a bundle). There are no sales tax exemptions in place currently for either OGS or cooking technologies.

Regional policies, strategies, and plans on energy are also relevant since Burundi belongs to six regional communities, including the East African Community (EAC). The EAC Strategy on Scaling-up Access to Modern Energy Services promotes joint EAC countries energy investment, and national initiatives to improve energy security. The promotion of improved cooking fuels and stoves are identified under this strategy, with a target on achieving access to modern cooking energy for 50% of traditional biomass users. The Strategy does not mention off-grid solar as a solution to improve households' electricity access.

The institutional framework overseeing the off-grid energy sector is young – with most institutions only recently taking up their mandate and role

Figure 6 Policy and regulatory agencies involved in the Burundi energy sector



Source: Consortium

A number of key institutions are evolving to take ownership of the OGS and improved cooking mandates, but will need support to be able to take on this role effectively:

- **Ministère de l'Hydraulique, de l'Energie et des Mines (MinHEM).** The Energy Directorate of the Ministry of Water, Energy and Mines sets national energy policies and oversees activity in the sector. Regarding off-grid solar, the ministry's role has been limited to supporting existing NGO initiatives, while the Directorate of Renewable Energy and Energy Efficiency oversees clean cooking initiatives.
- **Agence Burundaise de l'Electrification Rurale (ABER).** The Rural Electrification Agency oversees rural electrification and owns and manages five mini-grids (solar, hydro, and wind), serving 600 households. It does not currently have programs to support household solar appliances and is only recently beginning to take on its role in fostering access to off-grid energy solutions in rural areas. It

will be an implementation partner in the forthcoming World Bank and Lighting Global SOLEIL project component related to energy services for rural communities through mini-grids.

- Agence de Régulation de l'Eau potable et de l'Energie (AREEN). The Drinking Water and Energy Regulation Agency was created in 2018 as a result of the 2015 Electricity Law and oversees implementing the energy sector norms and quality standards set by the BBN, as well as setting prices for larger installations (capacity over 500 kW). It also oversees competition among energy suppliers, including promoting private sector initiative in the energy space. AREEN is very young, with a small team and limited experience working on issues relating to off-grid energy provision.

- Bureau Burundais de la Normalisation (BBN). The Bureau of Standards' remit is to set national quality standards and norms, and this would include off-grid solar products and improved cookstoves. To date, there are no national standards for off-grid energy products and BBN has limited experience to develop and enforce such standards and supporting certification and test methods.

- Office Burundais pour la Protection de l'Environnement (OBPE). The Burundi Office for Environmental Protection is the key environmental agency established in 2014 and it is responsible for the protection of natural resources, including forests. Together with the OBM, the OBPE is responsible for safeguarding the extraction of natural resources (e.g. clay) and monitoring the environmental impact of projects and programs.

- Office Burundais des Mines et Carrières (OBMC). High quality clay is essential for the production of improved cookstoves and the extraction of resources used for cookstove production is subjected to the issue of permits. Clay is often found in government-managed mines and permission is required for the extraction of these resources. The Office for Mines and Quarries (OBMC) oversees extraction of primary resources, including licensing and regulation for extractive resources - including clay. It also oversees a recent law appointing specific cooperatives to be responsible for all such extraction.

- Banque de la République du Burundi (BRB). The Central Bank includes oversight of financial institutions in its mandate, which includes supervision and rule-setting for micro-finance institutions. It also sets foreign exchange rates and rules for accessing foreign exchange. The BRB takes a light touch to regulation of microfinance and emerging sectors such as digital payment mechanisms.

- Agence de Régulation et de Contrôle des Communications (ARCC). The telecommunications sector regulator oversees operations of telecom companies, and this may extend to where mobile services are offered, including the deployment of mobile money.

- Agence de Promotion de l'Investissement (API). The Investment Promotion Agency, in collaboration with the Commerce and Industry Ministry, would be well-placed to publicize any tax breaks for OGS or improved cooking products which could make Burundi an attractive new market for companies operating in other East African countries, particularly. Its creation in 2009 has led to an increase in Foreign Direct Investment in the country, although the 2015 political crisis has stalled this evolution.

- East African Community (EAC). As a member of the EAC customs union, Burundi implements the import duty rates set by the Community. Most energy-specific policies of the EAC relate to facilitating the interconnectivity of electricity grids, making customs rules the most important element for the development of a private market in off-grid solar products and improved cookstoves.

- Office Burundais des Recettes (OBR). The Tax and Revenue Office sets import tariffs and tax rates. Any changes in import duties would have to be developed and agreed upon in collaboration with the East African Community, given that Burundi is part of its customs union.

- Ministère de la Protection Sociale. The ministry for social protection oversees social security, social safety nets, and cash transfer programs, including working with the World Bank's Merankabandi

program. No specific social safety programs targeting energy access have been developed, although these could contribute as part of the wider objective of poverty reduction.

Finally, a key non-governmental organization is the Burundi Renewable Energy Association (BUREA). BUREA has over 100 members, and a network of technicians for installation and maintenance of renewable energy assets. BUREA-affiliated technicians are connected through a common WhatsApp group to share experiences and help find solutions to technical challenges. Nonetheless, its experience in standalone off-grid energy solutions remains relatively limited. Strengthening the capacity of BUREA as the industry association could be an effective way of supporting all providers looking to build up experience in these technologies.

3 Assessment of the potential demand for off-grid solar and improved cooking technologies

3.1 Market characteristics

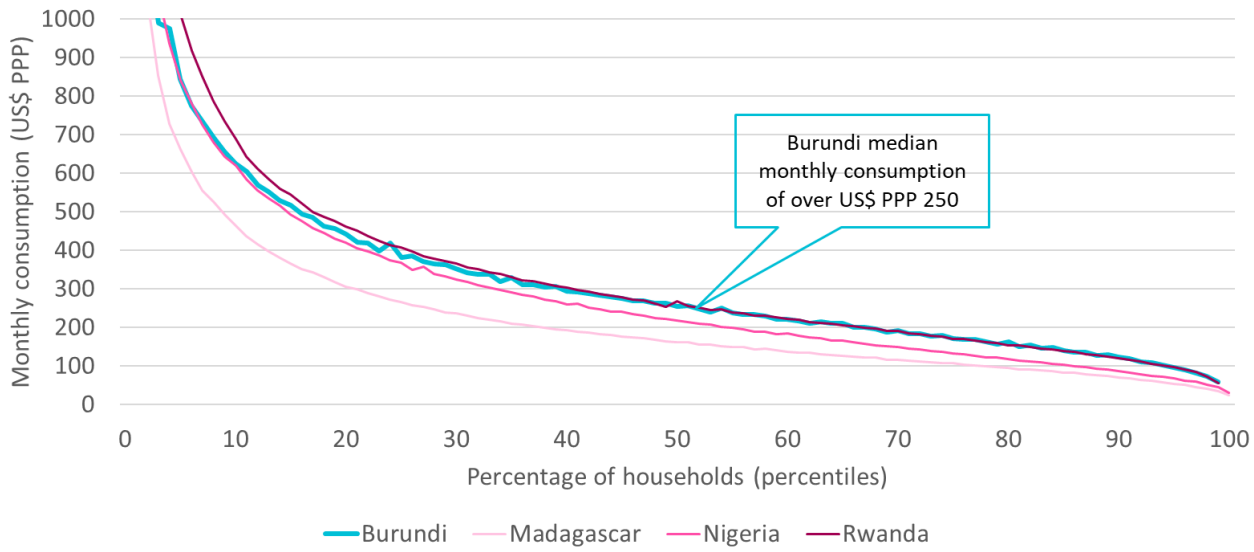
- Average household expenditure in rural areas is extremely low, which places a hard limit on the ability of households to pay for OGS and improved cooking products
- Rural livelihoods are largely agriculture based, and ownership of assets such as mobile phones and radios is low compared to other countries in the region
- Most of the population has limited awareness of the value of OGS products and improved cooking technologies, including their environmental and health benefits

Average household expenditure in rural areas is extremely low, which places a hard limit on the ability of households to pay for OGS and improved cooking products

The average (median) household *consumption* in Burundi is estimated at around US$ 250 per month.[35] This is based on curves constructed using the PovcalNet tool as shown in Figure 7, and adjusted to reflect aggregate household consumption, with an average household size of 4.8.[36] This captures the value of consumption – whether traded or from subsistence consumption. On a consumption per household basis expressed in Purchasing Power Parity, Burundi is broadly comparable to neighboring Rwanda, and has higher consumption per household than both Madagascar and Nigeria.[37]

[35] Conversion is adjusted for differences in Purchasing Power Parity (PPP)
[36] Household size information is from the UN population database.
[37] Average household size is comparable across these countries, with 4.8 people per household in Burundi, 4.3 in Rwanda, 4.6 in Madagascar, and 4.5 in Nigeria.

Figure 7 The distribution of household consumption recorded in PovcalNet is relatively high – and higher even than neighboring Rwanda and substantially higher than Nigeria and Madagascar



Source: Consortium analysis of PovcalNet data and UN population database data

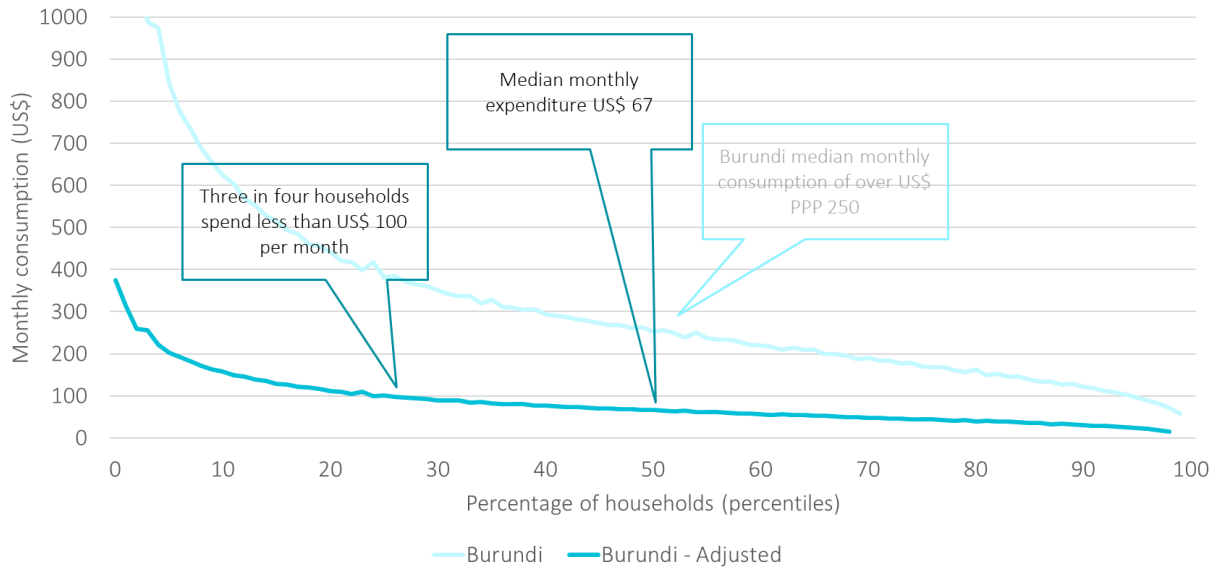
However, this is likely to overstate the value of *expenditure* that households could mobilize to spend on energy access. PovcalNet measures the value of *consumption* with the primary purpose of estimating poverty levels. This may not be a good proxy for *expenditure* which can be allocated to traded goods and services. In Burundi, where subsistence consumption is likely to account for a significant proportion of consumption, disposable income available for spending may be much lower than the value of consumption.

Indeed, Burundi's latest recorded gross national income (GNI) per capita was US$ 280 in 2018 – the lowest in sub-Saharan Africa.[38] This is about one third of the GNI per capita of neighboring Rwanda, about half of that in Madagascar, and only around 15% of the GNI per capita of Nigeria. This highlights the pitfalls of taking data such as PovcalNet out of its intended context, while GNI per capita itself is also not a good measure of disposable income of households.

To estimate the amount of money that a typical rural household could spend on energy access, we adjusted the curve shown in Figure 7 to provide an estimate of available *expenditure* rather than *consumption*, as shown in Figure 8. This adjustment is done by using ISTEEBU estimates of consumption per adult-equivalent (US$ 36 per month), and an estimated number of adult-equivalents per household of 2.5. This adjustment, shown on Figure 8 better reflects expenditure in Burundi in two ways. First, the GNI per capita relative to comparator countries suggests that Burundian households have less money available (expressed in US$) for energy access than, for example, counterparts in Nigeria, Rwanda, or Madagascar. Using the ISTEEBU estimate reflects the order of magnitude of the GNI per capita level, while still relying on household- rather than economy-wide estimates. Moreover, the resulting consumption level, when combined with the assumption that households spend about 5% of their expenditure on energy, corresponds to the expected available expenditure of households for energy access products cited consistently by respondents in-country, of US$ 3 to US$ 4. This approach gives an estimate of monthly consumption for the average (median) household of US$ 67 per month and shows that around three in four households spend less than US$ 100 each month.

[38] World Bank. (2019) *The World Development Indicators*. Available at: https://databank.worldbank.org/source/world-development-indicators

Figure 8. Monthly expenditure per household in Burundi is estimated to be around US$ 67 for the average (median) household, and three in four households spend less than US$ 100 per month



Note: The value of expenditure is expressed in 2014 US$, converted from Burundian Francs (BIF) using the average 2014 exchange rate.

Source: Consortium analysis of PovcalNet adjusted to account for differences in GNI per capita (World Development indicators) and in-country consultations

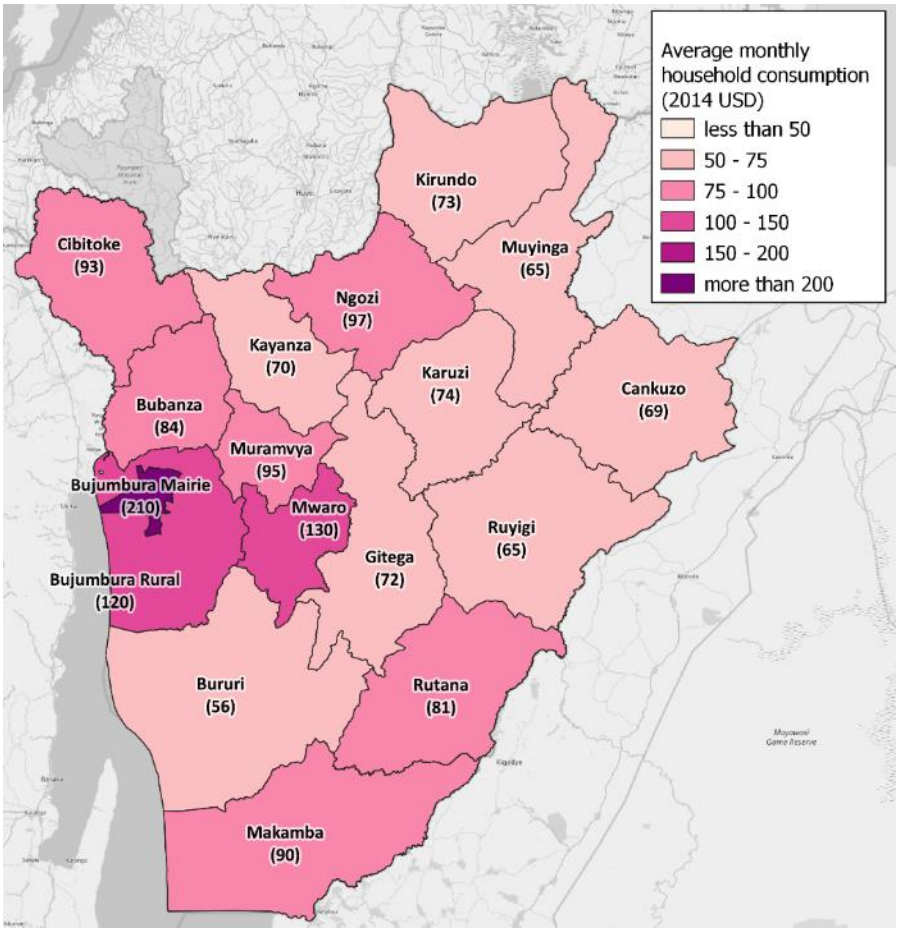
Average consumption levels are lowest in the North-Eastern and Central provinces, particularly Bururi, Kirundo, Muyinga and Cankuzo (Figure 9). These are also the provinces with the lowest electrification rates (Figure 2). In contrast, Bujumbura-Mairie has the highest average income - over three times that of Muyinga.

In terms of gender, over 80% of households are headed by men, although female-headed households present a lower incidence of poverty.[39] On one hand it is likely that married women or women in free unions may receive financial support from their male partners, while if women are single or widowed they are more likely to fall into poverty.[40]However, in some cases where men are formally the head of the households, women may represent the main source of income for the family, and they may be excluded from the household's financial decisions. This may explain why women-led households who have full control of their income and financial decisions present lower incidence of poverty.

[39] GNI per capita for the average female at US$807 is higher than that of the average male at US$594. GNI/capita of male and female members of the population based on the ratio of female to male wages, and female and male shares of economically active population. Source: Human Development Report – Burundi, available at - http://hdr.undp.org/en/countries/profiles/BDI

[40] World Bank. (2016) *Burundi Poverty Assessment*. Available at: https://consultations.worldbank.org/sites/default/files/consultation-template/public-consultations-inform-world-bank-systematic-country-diagnostic-economic-and-social-situation/related/burundi_poverty_assessment_2016-2017.pdf

Figure 9 Consumption levels are uneven across provinces, with Bujumbura-Mairie having the highest and Muyinga the lowest levels



Note: Consumption levels in 2014 BIF are converted to 2014 US$ using the average exchange rate in 2014.
Source: Consortium analysis of ECVMB data

Rural livelihoods are largely agriculture based, and ownership of assets such as mobile phones and radios is low compared to other countries in the region

The main source of income for 80% of rural households is agriculture and livestock.[41] Dependence on (often subsistence) agriculture is highly correlated with poverty – only 10% of households whose head works in agriculture are neither poor nor vulnerable.[42] Women constitute 55% of the agricultural labor force and carry out 70% of farm work. While the share of men and women working in the informal sector is similar (93% and 97% respectively), the main occupation for two-thirds of women is unpaid labor on small family plots of land, and women are also less likely to be independent farmers. Outside of the agriculture sector, opportunities in manufacturing and industry are limited, with non-agricultural employment concentrated in the service sector, particularly in sales jobs.[43]

Most agricultural production is of subsistence crops, with limited cultivation of traded cash crops like coffee and tea. Cassava, banana, beans, sweet potatoes, and maize are the dominant crop types in terms of area

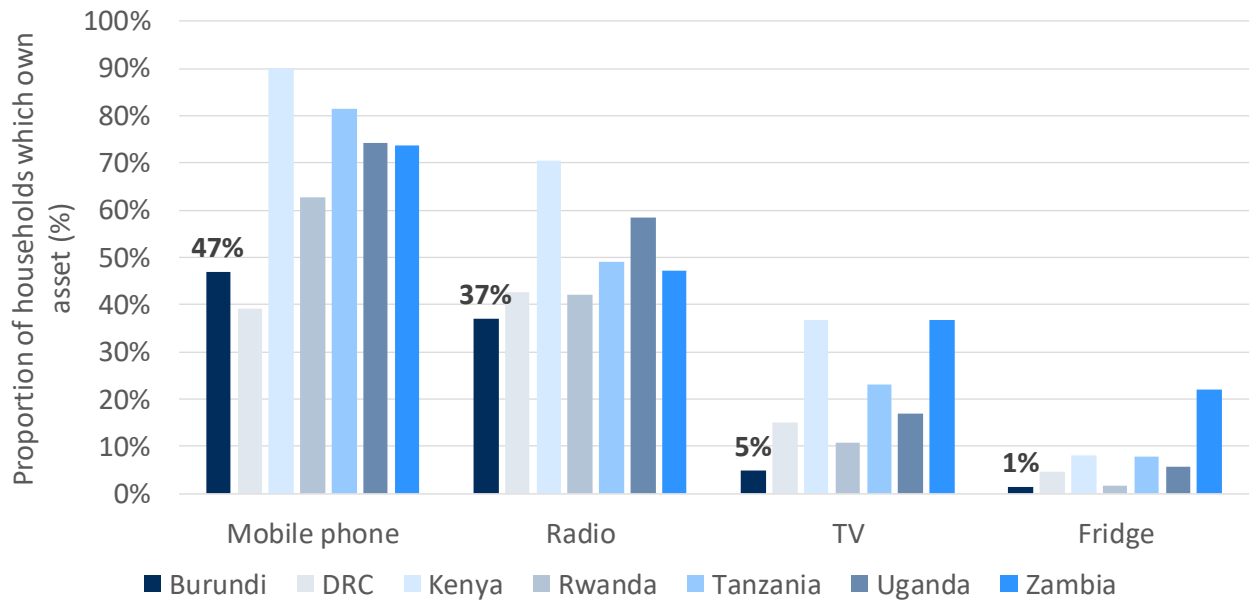
[41] DHS. (2016-17) *Demographic and health data.* Available at: https://www.statcompiler.com/en/
[42] ISTEEBU. (2014) *Rapport de l'enquête de conditions de vie des ménages 2013-2014*. Available at : Available at : https://isteebu.bi/images/isteebu/burundi%20-%20profil%20et%20dterminants%20de%20la%20pauvret%20-%20%20rapport%20final-%20isteebu%20df.pdf
[43] DHS. (2016-17) *Demographic and health data.* Available at: https://www.statcompiler.com/en/

harvested. While these crops have relatively stable yields,[44] meaning that incomes may at least be relatively stable, they are also often grown (at least in part) for subsistence consumption and generate limited income for households. Coffee and tea are the main export crops, but combined represent less than 3% of the area harvested and total production weight.[45] The value of coffee and tea exported has decreased in the last 10 years, which further limits the incomes generated by workers in the agriculture sector.[46]

Less than half of households (47%) own a mobile telephone (Figure 11), and this varies from 26% in Karuzi to 86% in Bujumbura. The spatial pattern of mobile phone ownership correlates with consumption and grid connectivity, with the lowest rates in the North-Eastern regions, dropping as low as 26% in the central province of Karuzi. Mobile ownership levels among women is even lower at 23% nationwide, and just 17% in rural areas. In contrast, in Tanzania, Uganda, and Zambia, over 70% of households own a phone, and this rises to over 90% in Kenya (Figure 10).[47] The lack of electricity access in Burundi means charging mobile phones is costly and can require long travel times.[48] As a result, the possibility to charge mobile phones on solar lamps could be highly attractive to households, and as described in Section 3.2, increased access to and use of mobile phones could also go hand in hand with deployment of the PAYGo business model.

Radios are a relatively widely dispersed household appliance, owned by 30% to 40% of households in all provinces (Figure 11) – and this could represent an attractive product package for solar kits. Nearly 40% households across Burundi own a radio, and this proportion is relatively constant across the country. Given the low rates of grid connectivity, it is likely that radios are using single use dry-cell batteries. The possibility to charge them through a solar system could be attractive to households.

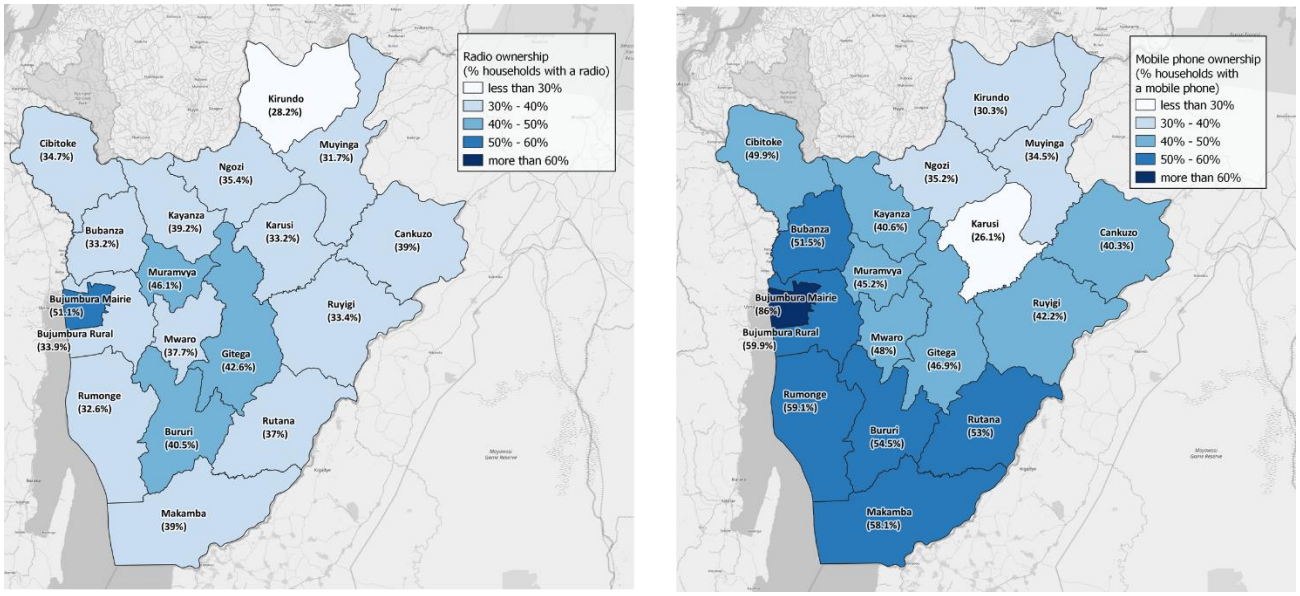
Figure 10 While Burundian households are less likely to own a radio than other countries in the region, the difference is less than, for example, TVs and Fridges



Notes: Latest available data was used for each country. Dates and sources are: Congo (2013-2014, DHS); Kenya (2015, MIS); Rwanda (2017, MIS); Tanzania (2017 MIS); Uganda (2016-17 DHS); Zambia (2018) DHS.
Source: Consortium based on DHS and MIS survey data compiled using the Statcompiler tool available at https://www.statcompiler.com/en/

[44] The coefficient of variation for the yields of major crop types grown in Burundi is 11%, which is in the middle range for sub-Saharan Africa
[45] Food and Agriculture Organisation of the United Nations (FAO), FAOstat database (2017), available at: http://www.fao.org/faostat/en/#data/QC
[46] AJG Simoes, CA Hidalgo. (2011) *The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development.* Available at: https://oec.world/en/visualize/tree_map/hs92/export/bdi/all/show/2010/
[47] DHS surveys run between 2016 and 2018 in each country
[48] Confidential company research

Figure 11 Radios are evenly owned by around 30% to 40% of households nationwide, while mobile phone ownership is more variable, with less than half of the population in the northern and eastern provinces owning a mobile phone



Source: Consortium analysis of DHS data

Most of the population has limited awareness of the value of OGS products and improved cooking technologies, including their environmental and health benefits

Lack of consumer awareness surrounding the benefits of off-grid solar products and improved cookstoves also inhibits the willingness of households to seek out these solutions. Over 50% of respondents in market surveys report they were partially or fully unaware of OGS products, and even those that are aware of their existence do not know where to purchase an OGS lamp.[49] Similarly, many rural households are not aware of the availability or the benefits of fuel-efficient stoves.[50] Subsidized distribution of cookstoves can lead to a perception among households that improved cookstoves are "donated" solutions, limiting their willingness to pay to purchase such products.

Some households are aware of the impact of solid fuels to their health, nonetheless locally manufactured stoves and cheaper options are preferred to improved cookstoves. Rural populations, particularly women and children who are predominantly involved in cooking activities, are aware of some of the most immediate health issues related to smoke, in particular irritation to the eyes and lungs. [51] They are less aware of the most serious health impacts of household air pollution (HAP) such as long-term respiratory diseases. Cheaper options are still preferred, largely driven by low ability to pay, combined with low familiarity with alternative cooking technologies.

Decision-making over purchases of energy-related products and appliances is influenced by gender dynamics within the households. While 69% of women participate in decision-making over household purchases,[52] many of them do not have control over their earnings and do not decide which purchases are prioritized.

[49] Based on research carried out by companies in Burundi with relatively small sample sizes.
[50] WFP. (2016) *Safe Access to Fuel and Energy in Burundi. An Appraisal Report."* Available at: https://docs.wfp.org/api/documents/WFP-0000019952/download/
[51] Ibid
[52] DHS. (2016-17) *Demographic and health data.* Available at: https://www.statcompiler.com/en/

While women are often the primary users of energy appliances and their health may be directly impacted by use of fuels and technologies causing HAP, they may not be able to influence the decision to buy a cleaner and more efficient stove.

3.2 The potential market for off-grid solar products

- Around half of households in Burundi could bear the upfront cost of a small solar lantern, and with PAYGo could potentially afford a multi-light system
- In the short term, market growth for OGS products will rely on grants or subsidized finance to de-risk investments and bridge the affordability gap

Around half of households in Burundi could bear the upfront cost of a small solar lantern, and with PAYGo could potentially afford a multi-light system

Two thresholds are defined to benchmark affordability of off-grid solar products:

- Affordable. Energy access products are considered "affordable" if they amount to less than 5% of their monthly expenditure.[53]
- Affordable at a stretch. In some circumstances, households spend more than 5% on energy access – especially poorer households. To capture this, anything between the range of 5% to 10% of monthly expenditure is considered "affordable at a stretch". While there is evidence households may spend more (and substantially more) than 5% of expenditure on energy access products,[54] higher expenditure can also push households into "energy poverty" and may imply important trade-offs with expenditure on access to other important basic goods and services.

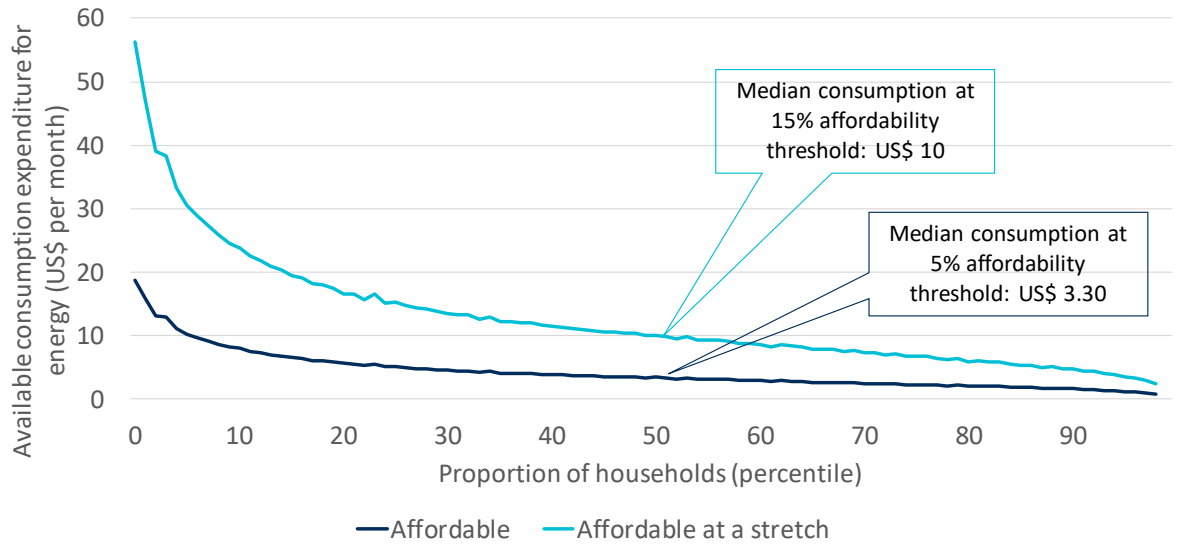
A further motivation for considering two thresholds for affordability is that off-grid solar products are often not directly comparable to traditional energy access products. At the lower tiers of off-grid solar products such as single lanterns, households may still partially rely on other sources of electricity. In this context, access to OGS does not fully displace expenditure on other sources of energy, so the 5% may be a somewhat aggressive threshold, as households will also still need to spend on traditional fuels. At the other end of the spectrum, solar home systems provide services far "beyond energy access", for example, including access to appliances such as lighting, radio, television, and access to digital finance. In this case, OGS not only displaces expenditure on other sources of energy, it also provides a higher quality of service including a broad package of consumer goods. In this context, the 5% threshold would be very conservative – and indeed access to OGS often increases expenditure on "energy" services.[55]

On this basis, the average (median) Burundian household can most likely spend around US$ 3.50 per month on access to energy, although this could possibly stretch to US$ 10 (Figure 12). These expenditure figures also correspond to both company research in Burundi and the views expressed during stakeholder consultations, indicating that rural households could spend up to US$ 3 to US$ 4 on candles, kerosene, or torches and batteries each month. For the purposes of subsequent analysis the lower bound estimate is

[53] This lower bound 5% estimate is commonly used in the literature, see for example Fankhauser and Tepic (2007), RISE (2018), ESMAP (2015), Banerjee et al (2015) etc.
[54] This upper bound is based on emerging evidence from the Multi-Tier Framework household surveys, and previous research (such as IRENA (2016), where household surveys record some households spending up to 10% (and in some instances as much as 25%) on energy services.
[55] See for example, GOGLA (2018) *Powering Opportunity The Economic Impact of Off-Grid Solar*, p. 46

used in this paper, which also reflects data from the ECVMB 2013-14, which shows that poor households devote over 70% of their consumption to food and only 2% to energy and water services combined.[56]

Figure 12 Affordable energy expenditure is US$ 3.50 per household per month



Source: Consortium based on PovcalNet and ECVMB, company research and stakeholder consultations

To estimate affordability, the expenditure thresholds described above are compared to prices for four OGS product types, shown in Table 2. These represent approximate prices for consumer facing products reaching rural households in Burundi – specifically, US$ 10 for a small single lantern, US$ 40 for a medium sized lantern, US$ 55 for a small lantern and radio, and an assumed (indicative) US$ 130 for a multi-light system.

Table 2 Indicative OGS products and prices for affordability comparison in Burundi

Product	MTF Tier of energy access	Price	Product life
Single Lantern (e.g. Sun King Pico Plus or d.light A2)	Partial Tier 1 – low end providing limited lighting to individual within household	US$ 10	2 – 3 years
Single light with phone charging (e.g. Sun King Pro 2)	Partial Tier 1 – low end providing limited lighting to individual within household	US$ 40	2 – 3 years
Single light with phone charging and radio (e.g. Sun King Boom)	Partial Tier 1 – low end providing limited lighting to individual within household	US$ 55	2 – 3 years
Multi-light system (e.g. Sun King Home 120)	Full Tier 1 – basic entry multi-light system providing household with full Tier 1 energy access	US$ 130	3 – 4 years

Source: Consortium based on consultations in Burundi

[56] ISTEEBU. (2014) *Rapport de l'enquête de conditions de vie des ménages 2013-2014*. Available at : https://isteebu.bi/images/isteebu/burundi%20-%20profil%20et%20dterminants%20de%20la%20pauvret%20-%20%20rapport%20final-%20isteebu%20df.pdf

In comparing the expenditure thresholds to product prices, two stylized business models are considered:

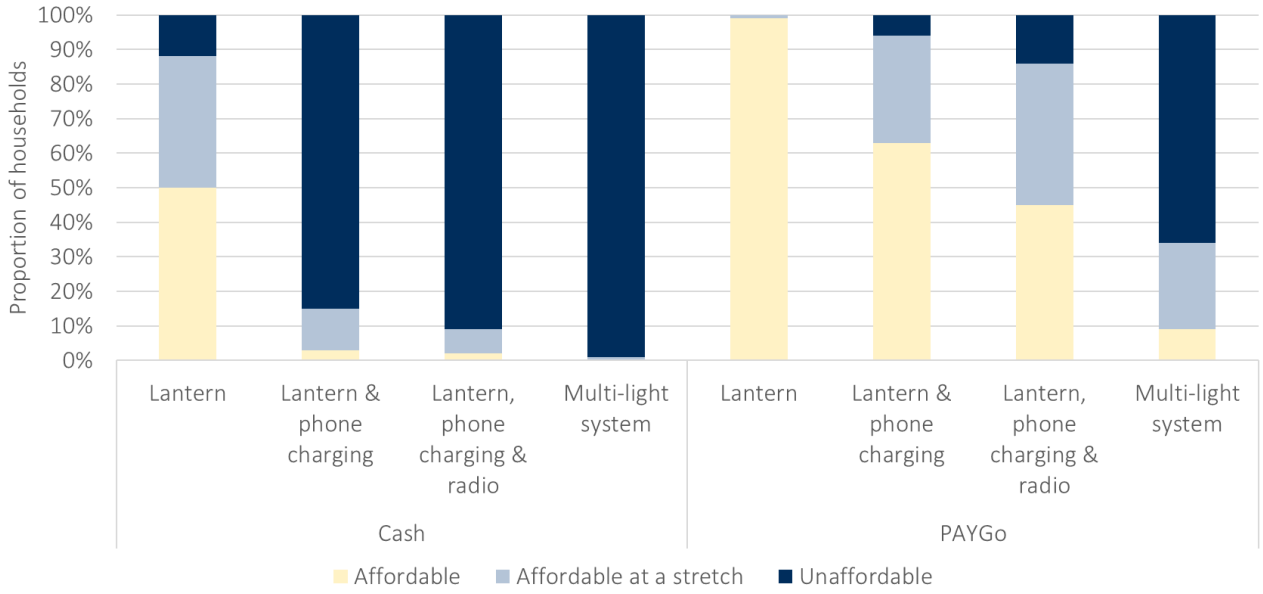
- **For over the counter or cash sales, households may be able to save, or pool, income in order to afford the purchase.** OGS products have a high up-front cost, but then no ongoing costs. To reflect this profile of high upfront costs, and benefits over the life of the asset (at least a year for a quality-verified product), it is assumed that households can save or pool three months' worth of expenditure.
- **For business models that allow customers to smooth the cost of purchasing an OGS product, a repayment profile with 12 to 18 monthly instalments is considered.** As a proxy for the PAYGo business model or households purchasing an OGS product on consumer finance provided by a microfinance institution, a payment profile with 20% up-front deposit and the remaining cost paid off over 12 or 18 monthly instalments is considered.

If bought over the counter or as a cash sale, only small single lamps are affordable to most households. The left-hand side of Figure 13 shows that if products are paid in cash, the small single light would be affordable to 50% of households. The proportion goes over 95% if households can save 10% of their monthly consumption for three months ("affordable at a stretch", see text above).

Spreading the cost of the OGS product over 12 to 18 months could considerably increase affordability – bringing larger lighting and possibly packages including radio within the reach of most households. Basic single solar lanterns would be affordable to all households under this approach, while 60% of households could afford a medium single light, and over 40% could afford a light-and-radio system. Both larger "pico" products, light-and-phone-charging or light-and-radio systems, would be affordable to more than 80% of households when devoting 10% of their monthly expenditure to make monthly repayments. Nonetheless, only 60% of households would be able to afford a multi-light system with an upfront cost of US$ 130, even under this higher monthly expenditure. It is worth noting that while spreading the cost helps make each monthly repayment more affordable, it does so at a cost. For example, including the cost of consumer finance would raise the cost of a system that costs US$ 130 to about US$ 160 if repaid over 18 months. This would need to be clearly explained to consumers and may influence uptake of business models using a form of consumer finance.[57]

[57] For example, in Nigeria when the full cost of the system was explained, some customers were more likely to prefer to pay the full price up-front rather than use the PAYGo model – see https://shellfoundation.org/app/uploads/2019/11/Greenlight-Planet-Nigeria-pilot-learnings.pdf

Figure 13 Ability to bear the cost of OGS products is very low – even if payments can be spread over the asset's life.



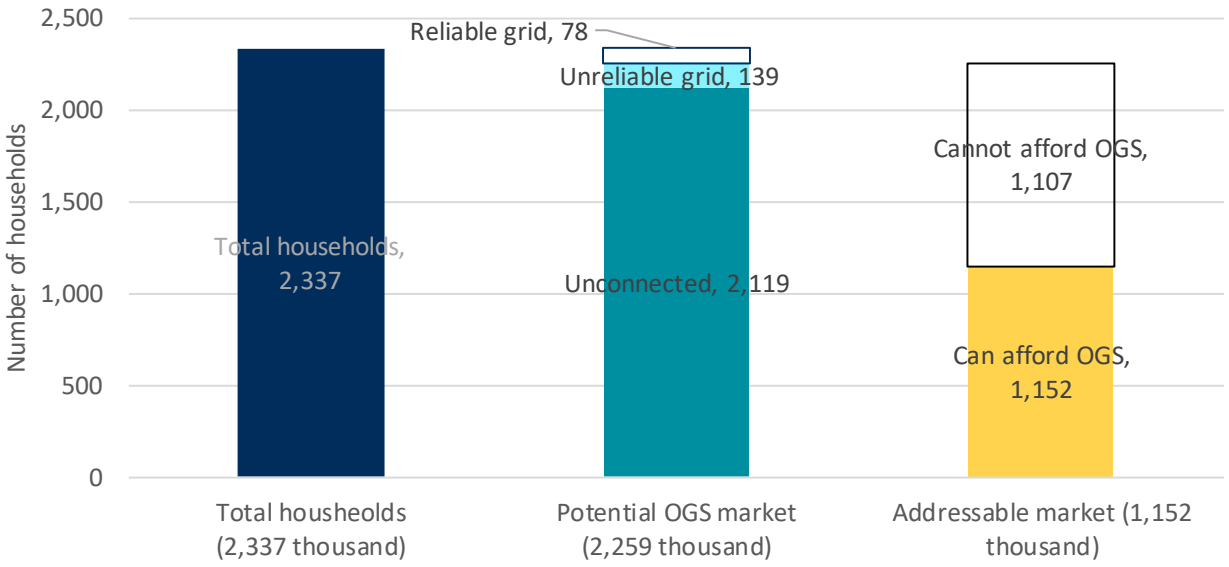
Note: Section 3.2 provides details on the methodology used to produce these graphs. These products roughly correspond to the prices of four typical (Sun King) products which are currently sold in Burundi.
Source: Consortium analysis of PovcalNet, ECVMB and confidential company and MFI data

In the short term, market growth for OGS products will rely on grants or subsidized finance to de-risk investments and bridge the affordability gap.

The vast majority of the population lacks reliable access to electricity – so the *potential* market for off-grid solar products is significant. Of 2.3 million households, just over 200,000 currently have access to electricity. Even among these households who are connected to the main grid, nearly two-thirds do not receive electricity most of the time.

However, the *addressable* market is much more limited, representing around half of the potential market. Based on the current business models for OGS products to reach customers, only half of the population – around 1 million households – could currently afford even a single lantern (Figure 14). Although if this is extended to include the "affordable at a stretch" category – with households allocating 10% of expenditure to this product, then almost all households could afford a single lantern although very few would be able to bear the cost of a multi-light system (Figure 13).

Figure 14 There is a substantial potential market for off-grid solar products in Burundi, but business models and financing options will need to overcome affordability issues.



Source: Consortium analysis

Given this low affordability, combined with very limited commercial scale of operations and potential climate and educational benefits, the market will require support from NGOs or international institutions if it is to scale up quickly. As shown above, affordability remains low even with PAYGo, and the combined assumption that households are able to allocate up to 10% of their monthly expenditure to energy and are able to save over 3 months to pull together a deposit is likely too demanding for many rural households. In this context even getting households partial access to Tier 1 electricity solutions such as solar lanterns, will require financial support both to catalyze the market and to bridge the affordability gap. It is also important to note that while this report has focused on the commercial market potential, and highlighted affordability as a major challenge, access to OGS products could also deliver substantial environmental and socioeconomic benefits, including reduced CO2-equivalent emissions where they replace fossil fuel based energy products, lighting for children's education, and improved health and safety.[58]

3.3 The potential market for improved cookstoves

- Cooking habits are influenced by a long time spent on fuel collection and food preparation, and the demand for clean stoves and fuels is affected by seasonality and cultural preferences
- Sales of improved cookstoves will depend on the financial savings provided – commercial models for basic stoves may reach a large share of the population, while higher-service stoves remain unaffordable to most
- Four key market barriers limit the development of commercial business models to sell ICS to rural households

[58] For a more complete description of the "co-benefits" and impact of the off-grid solar sector, see Chapter 5 of the Lighting Global (2020) *Off-Grid Solar Market Trends Report 2020* Lighting Global. Available at: https://www.lightingglobal.org/resource/2020markettrendsreport/

Cooking habits are influenced by a long time spent on fuel collection and food preparation, and the demand for cleaner stoves and fuels is affected by seasonality and cultural preferences

As described in Section 2.2, almost all households rely on biomass for cooking and heating water, with low-efficiency "three-stone" stoves used in most households. These stoves are notoriously wasteful, with an efficiency level of just 10%, and they have no improved combustion air supply or flue gas ventilation that is without a grate or a chimney, i.e. problems include the diffusion of heat during windy conditions, the difficulty of controlling the fire, users' exposure to heat and smoke as well as fire hazards.

Even those using improved cookstoves continue to use the three-stone stoves.[59] While cooking is the primary driver of energy use at home, firewood consumption is also used for lighting and heating, particularly in the hillier central and northern regions.

Diet and cooking habits are relatively stable across the country, with minor regional differences especially along the lakeshore. Staples such as rice, beans, sweet potatoes, corn and some meat (beef, goat and chicken) are eaten nationwide. In the regions surrounding Lake Tanganyika fish is a more common part of the diet, and in certain provinces (e.g. Rumonge) where there is higher population density, higher incomes and land fertility support a more diverse diet. Other areas, particularly the center-North of the country, are affected by land degradation and climate variability, which adversely impact food production and nutrition. Here the local diet is mostly made up of potatoes, wheat, and corn.

A long time is spent on food preparation and cooking, which is predominantly done indoors. Women and children are typically those responsible for firewood collection and preparing meals. Men also participate in food preparation and are involved in decision making for purchase of cookstoves. Families typically prepare two meals a day, however in some periods that can scale down to one depending on food availability. Households spend on average three hours per cooking session depending on the type of food prepared, and this time is reduced considerably if only vegetables are eaten. Most of the population cooks inside the home (41%) or in a separate building (51%), while 7% cook outdoors. Rural households mostly prepare meals in non-ventilated areas using ceramic pots with lids.

Rural households typically spend two-to-three hours collecting firewood, up to six times per week, spending between 12 to 18 hours collecting firewood each week.[60] The time spent to collect firewood has increased in recent years due to wood shortage, with population growth increasing pressure on natural resources – and this trend is only likely to worsen. Wood for cooking is collected by picking up small branches and twigs, and collection of wood in private afforested land or government-owned forests.

Fuel collection and cooking habits are affected by seasonality. Especially in the rainy seasons between October to November and from February until May, firewood collection can take longer as it is harder to find and collect dry wood. Damp leaves and grass are often used as alternatives, which generate more smoke while cooking. Some households have reported that the lack of available firewood during winter months can lead to skipping meals and in undercooking food, which affects food security and nutrition.

The vast majority – around 80% - of households collect firewood, with just 20% purchasing their fuel wood. The demand for fuel wood and charcoal has been growing steadily and it is estimated to be 1.2 cubic meters per year per person. In 2018 the demand was estimated to be 6.3 million tons for a population of 11 million people. Most of this wood is collected by members of the household itself without a financial cost; less than 20% of rural households purchase fuelwood.[61] For the remaining 80% of rural Burundians and particularly for women, there is a substantial time cost associated with collecting wood for cooking.

[59] Cookstove "stacking" is a common practice across countries. Households tend to use improved stoves alongside their traditional stoves rather than replacing them entirely.
[60] The sub-Sahara African average is 12-15 hours per week
[61] Based on stakeholder consultations

Sales of improved cookstoves will depend on the financial savings provided – commercial models for basic stoves may reach a large share of the population, while higher-service stoves remain unaffordable to most

In a market with very low ability to pay, adoption of improved cook stoves will likely only be successful if related to financial savings, for example, through reduced fuel usage. More efficient stoves have better heat retention, minimizing time heating up and allowing for reduced fuel consumption for the same cooking time and comparable quality of cooking. However, only a small proportion of households – the 20% who purchase firewood – will see immediate financial benefits from adoption of ICS technologies.

The annual average cost of fuel wood for households who purchase fuel is about US$ 63 (BIF 120,000) per year. Households using charcoal as their main source of cooking fuel (concentrated in urban areas) spend substantially more, at US$ 305 (BIF 580,000) per year (Table 3).

For these households that purchase firewood, adoption of ICS may therefore bring substantial direct financial savings – which would justify the purchase of ICS technologies. Taking the example of a simple "Matawi" clay stove, which would reduce fuel wood consumption by about 26%, this would result in savings of around US$ 16 per household per year (Table 3). For households purchasing charcoal, savings from the adoption of an efficient Tier 3 stove would translate in greater savings, up to US$ 113 per year. These potential savings dwarf the up-front purchase cost of only US$ 2.50 for the Matawi stove, and US$ 30 for an efficient charcoal stove.

Table 3 Summary of fuels costs for households

		Baseline (three stone fire for wood, baseline stove for charcoal)		ICS (Matawi for wood, or a Tier 3 stove for charcoal)	
Fuel	Cost per ton (US$)	Annual consumption (tons per household)	Annual expenditure (US$ per household)	Reduced annual consumption (tons per household)	Reduced annual fuel expenditure (US$ per household)
Wood	9	7.1	63	1.85	16
Charcoal	169	1.7	305	0.67	119

Source: Consortium analysis

For the 80% of households who do not pay for fuel wood, households cite reduction in time spent and improved security as major drivers of demand for ICS. The main concerns of households related to cooking technologies are the shortages of wood and the distance to collect wood (because of the risks of physical aggressions or sexual violence against women).[62] One analysis of ICS adoption among rural households in the province of Gitega showed overall satisfaction with improved stoves, with the main advantages reported being the savings on fuelwood and the savings of adults' and children's time spent collecting fuelwood:

- All households reported reduced time collecting fuelwood, with collection frequency falling from 4 to 6 hours per week to less than 3 hours per week.

[62] Analysis conducted by donor to assess ICS adoption on a sample of Burundian households

- On average, households saved 1h30 per day, freeing up time for agricultural labor and other income-generating activities.

Other drivers for ICS adoption reported in the survey include ease in starting the fire, ease of use, reduced cooking time, ease of use for cooking outside, lack of need for special fuel, and adaptability to different pots. The only disadvantage noted by households is that the ICS does not manage to warm the house because the fire is concentrated on the bottom of the pot only, unlike the traditional three-stone hearth where the fire is diffuse in all directions, thus heating the house. For this reason, households with ICS usually have two fires at the same time while cooking.

Access to improved cooking technologies could bring a wider set of co-benefits, but these may not (immediately) influence household decisions and behavior. For instance, for the 80% of households who collect (rather than purchase) firewood, time savings could be substantial and valuable, although they may not immediately carry a financial value to the recipient household. Similarly, a shift to more efficient stoves with lower fuel consumption, would also reduce greenhouse gas emissions (GHG) associated with burning conventional fuels, and reduce harmful household air pollution (HAP). These co-benefits are described in Table 4. As these benefits do not immediately deliver cash savings or generate revenue for households, they are unlikely to successfully drive commercial sales in what is a very low ability to pay customer base.

Table 4 Benefits from the adoption of improved cookstoves in Burundi

Description and relevance in Burundi	Potential value from access to ICS for rural households
Financial savings. Only 20% of households in Burundi purchase cooking fuel. Access to more efficient ICS reduces this expenditure, which can be used to repay the initial outlay on the ICS, and free up ongoing expenditures for other purposes such as nutrition, medicines, school materials, and business activities.	Financial value to beneficiary. **US$ 16 in cost reductions per household per year.[63]**
Time savings – earnings. Around 80% of households in Burundi collect firewood, making 4 – 6 collections per week, and a total of up to 18 hours spent per household each week. Using an efficient ICS reduces fuel consumption, and so reduces collection time, and can also reduce cooking time.[64] These savings may translate into higher earnings, as the time freed up can be spent on income generating activities, or can be put to other valuable uses. In Burundi, where there is high unemployment and underemployment, it is unlikely that time savings would immediately translate into (substantial) higher earnings.	Financial and non-financial value to beneficiary. **US$ 0 – US$ 20 increased earnings per household per year.[65]** **4h30 saved per household per week – typically by women or children.**
Time savings – education. Burundi is among the top 10 countries worldwide in terms of time spend collecting wood or water among boys and girls.[66] So it is likely that a substantial portion of time savings described above accrue to children, freeing up time for education and other activities.	
Gender and youth. Women typically spend around four hours per day cooking, and women and children bear most of the burden for collecting fuelwood. Time reductions on fuel collection can free up time for other activities – including work (described above), while reduction of household air pollution carries important health benefits (described below).	

[63] Based on an annual fuel saving of 1.5 and 3.5 tons, and a price per ton of firewood of US$ 28

[64] Practical Action (2014) *Gender and livelihoods impacts of clean cookstoves in South Asia*

[65] Based on up to 4h30 freed up per week, which sums to over 230 hours over the course of a year, equivalent to 30 working days. At an average national wage of US$ 700 this would be equivalent to US$ 56. However, only a portion of this will translate into increased earnings – we here present a range of between 0% and 30%.

[66] WHO (2016) *Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children*. Available at: https://www.afro.who.int/sites/default/files/2017-06/9789241565233_eng.pdf

Description and relevance in Burundi	Potential value from access to ICS for rural households
Health. The WHO estimates that indoor air pollution causes 10,200 premature deaths in Burundi each year.[67] Women and children are the most exposed to the impact of household air pollution (HAP) caused by traditional cookstoves.	Non-financial value to beneficiary. Nationwide around 100,000 Daily Adjusted Life Years (DALYs) averted per year.[68]
GHG emissions reductions. Between 2001 and 2017, Burundi lost 22,400 ha (4.2%) of its tree cover, equivalent to 1.83Mt of CO_2 emissions. ICS can reduce the use of biomass for cooking compared to traditional stoves, if people are cutting down trees (rather than collecting fallen wood).	Externality value – no direct benefit to beneficiary. 3.6 tons of CO2 emissions reduced per household per year. Using a (conservative) social cost of carbon of US$ 56 per ton, this would equate to US$ 200 in climate mitigation benefits per household per year from adopting a Matawi stove.

Source: Consortium analysis on various sources – further information provided in footnotes to the table

While this section has so far focused on basic higher-efficiency stoves, higher tier stoves could unlock the co-benefits described in Table 4. However, as these co-benefits do not release direct financial benefits to households, they would likely require subsidies (at least in the short term) to catalyze the market. Such subsidies may well be good value given the important benefits they could deliver. A range of potential stove options and their relative merits are set out in Table 5.

Table 5 Mapping of different stoves, key benefits and service provided

Stoves	Purchase Costs	Benefits and key features	Limitations
Wood stoves			
 Three-stones fire	Free or very low cost	• Made from locally available materials and scrap parts; • Used for various purposes: heating, repelling insects, lighting;	• Extremely low efficiency (8-10%) • Household air pollution
 Fixed stoves	N/A	Heavily insulated which can increase their efficiency and durability	Built ad-hoc, not commercially traded

[67] WHO. (2009) *Country profile of Environmental Burden of Disease – Burundi*. Available at: https://www.who.int/quantifying_ehimpacts/national/countryprofile/burundi.pdf

[68] Daily adjusted life years (DALYs) averted using the HAPIT tool available at https://householdenergy.shinyapps.io/hapit3/. The tool estimates the risk of disease from HAP exposure (PM 2.5 levels) using traditional stoves and compares this to exposure *"post intervention."* One DALY represents one lost year of "healthy" life. In this analysis we present a "maximum" upper bound, assuming 100% of households were to adopt ICS in the "post-intervention" scenario.

Stoves	Purchase Costs	Benefits and key features	Limitations
 Matawi clay stoves	US$ 2.50	• Tanzanian design, locally manufactured • 20% thermal efficiency • Multi-purpose stove capable of using both firewood and charcoal depending on the preference of the user at the time of cooking • Entry cost levels	• Comparable cooking times with three-stone fire • Heavy and fragile, require distributed manufacturing to limit transportation costs
 Matawi clay+metal stove	US$ 6.50	• Same as above with additional metal cladded and added insulation	Not affordable for most rural households
 ILF Rural Wood Stove	Up to US$ 3	• 29% thermal efficiency, 47% of fuel savings • Compatible with a variety of pot sizes • Reduces toxic smoke emissions • Lifespan of +2 years • Easy to repair with a thin layer of clay and cow dung • Documented willingness to pay for a second stove	• Without subsidies, it is not affordable for most rural households • Heavy and fragile, requires distributed manufacturing to limit transportation costs
Charcoal stoves			
Metal-clay charcoal stoves	US$ 5 – US$ 13	Efficiency of about 20-25% Lifespan of 1-2 years	Not affordable for most rural and lower income households
Metal charcoal stove	US$ 6 – US$ 10	Steel-made stove Produced by GIZ and found in urban markets	Not affordable for most rural and lower income households
Clay charcoal stoves	US$ 10 – US$ 13	Efficiency of about 20-25% Lifespan of 1-2 years	Not affordable for most rural and lower income households
Other improved stoves found in the region			
Zoom Dura by EcoZoom	US$ 30 – US$ 40	• Thermal efficiency of 27-38% • Very long life +5 years • Emission savings above 55%	• Not affordable for the majority of the population • It has to be imported • Requires established distribution channels, maintenance, and after sales services
Jikokoa by BURN Manufacturing	US$ 40 – US$ 50	• Uses 50% less charcoal compared to traditional stoves • ISO/IWA Tier 4 stove for PM2.5 emissions	• Not affordable for the majority of the population • It has to be imported

Stoves	Purchase Costs	Benefits and key features	Limitations
			• Requires established distribution channels, maintenance and after sales services

Source: Consortium analysis

Four key market barriers limit the development of commercial business models to sell ICS to rural households

Despite the range of potential benefits enumerated above, rural households are highly price-sensitive, and even at relatively low up-front costs, many households will not buy an ICS and may prefer to stick with familiar cooking technologies. Even though the benefits described above compare very favorably to the cost of a simple clay Matawi stove, which has a market price of around US$ 2.50, not all households can or are willing to pay the full up-front cost of the stove. This is due to a number of market frictions, including:

- **Poor reliability / quality of improved cookstoves**, such that either (1) there are additional costs to maintain, repair, or replace improved cookstoves after purchase, and/or (2) households continue to use their traditional three-stone fires, so only a proportion of the benefits enumerated above are achieved.
- **Low awareness of the potential benefits of improved cookstoves**, with social norms tending to result in households sticking to their traditional and trusted method of cooking.
- **Labor market frictions which mean time cannot be (literally) monetized.** Burundi has relatively high unemployment and underemployment, and much agricultural activity remains subsistence based. This may mean that while time savings free up time for other activities, these activities do not translate into the extent of income increases described above.
- **Fuel wood may often be collected for free.** Especially in a context where extra time cannot easily be translated into increased earnings, households may be prepared to spend more time collecting fuelwood, thus reducing the potential financial savings from more efficient stoves.

For these reasons, the market for improved cookstoves remains at a very early stage of development but has a high potential to be scaled up. Conditions for market scale-up are promising due to the increasing difficulty in sourcing firewood, the increasing time of collecting fuelwood due to fuelwood shortage, and the high (and potentially increasing) fuel costs (and to a certain extent the dissatisfaction with cooking on an open fire because of the indoor air pollution). In order to scale-up ICS, experimentation with effective business models along with product innovations and increased awareness on the benefits of ICS in terms of fuel and time savings will be critical. In addition, designing ICS marketing and sales strategies should be based on payback periods with respect to fuel cost savings/time saving.

4 The supply chain for off-grid solar and improved cooking solutions

4.1 Supply side conditions

- Burundi's relatively small size and high population density may help keep distribution costs low, although to date there are very limited established distribution networks for OGS and cookstove companies
- Peak sun hours are favorable for OGS companies, but daily variation implies solar products will need to be appropriately sized to capture enough sunlight on cloudy days
- OGS is well suited to bring Burundian households onto the energy ladder and least cost geospatial planning tools suggest a major role for OGS technologies to achieve universal access to electricity
- The supply of improved cookstoves can take advantage of locally available raw materials, but market expansion should consider the impact of resource extraction and fuel availability

Burundi's relatively small size and high population density may help keep distribution costs low, although to date there are very limited established distribution networks for OGS and cookstoves companies

Burundi is very small and densely populated, with over 90% of the population living in moderate to extremely high-density provinces. Around 11 million people live across the country's 27, 830 $km^2$and the vast majority of these people (92%) live in moderate to high density areas, with more than 250 people per km^2 (Figure 15). [69] Nonetheless, while there are very few people living in very remote, sparsely populated regions, the population in general is dispersed across a rugged and hilly terrain, with relatively poor road access beyond major towns.

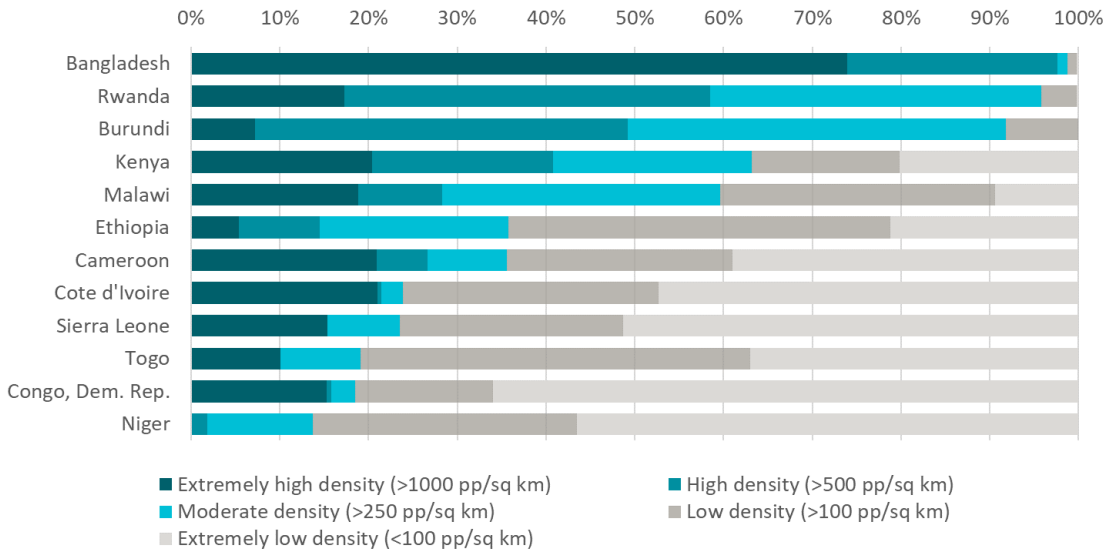
The quality of road access to rural communities is poor, which may increase the cost of last mile distribution. The Rural Access Index estimates that only 19% of the population live within 2 km of an all-season road - although the most recent data point for Burundi is very outdated, from 1998.[70] Nonetheless, it is likely that even now the extent of high-quality paved roads is very low, except a few major road arteries in and out of Bujumbura. This could raise transportation costs for businesses operating in rural areas; for example, transportation accounted for 35% of the import price for agricultural products in 2009. [71]

To date, production and distribution of improved cookstoves has used very localized manufacturing and distribution. Transportation costs have been negligible as in many cases each *colline* (just under 3,000 collines nationwide)[72] has an artisanal production site, and customers could purchase stoves directly at the point of manufacturing or benefit from local distribution absorbed by NGOs and community associations.

[69] World Bank. (2019) *The World Bank Databank.* Available at: https://databank.worldbank.org/home.aspx
[70]World Bank. (2019) *The World Bank Rural Access Index.* Available at: https://datacatalog.worldbank.org/dataset/rural-access-index-rai
[71] AFDB. (2009) *An Infrastructure Action Plan for Burundi – Accelerating Regional Integration*. Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/An%20Infrastructure%20Action%20Plan%20for%20Burundi%20-%20Main%20Report%20v1.2.pdf
[72] The DHS Program. (2017) *Troisième enquête démographique et de santé au Burundi*. Available at: https://dhsprogram.com/pubs/pdf/FR335/FR335.pdf

Clay stoves are fragile and very heavy (between 5kg and up to 20kg) and transport would be a considerable driver of costs if stoves were to be distributed at a larger scale.

Figure 15 Burundi is relatively densely populated – with few people living in "high density" areas, and very few people living in remote "low density" areas



Source: Consortium analysis of SEDAC population density data

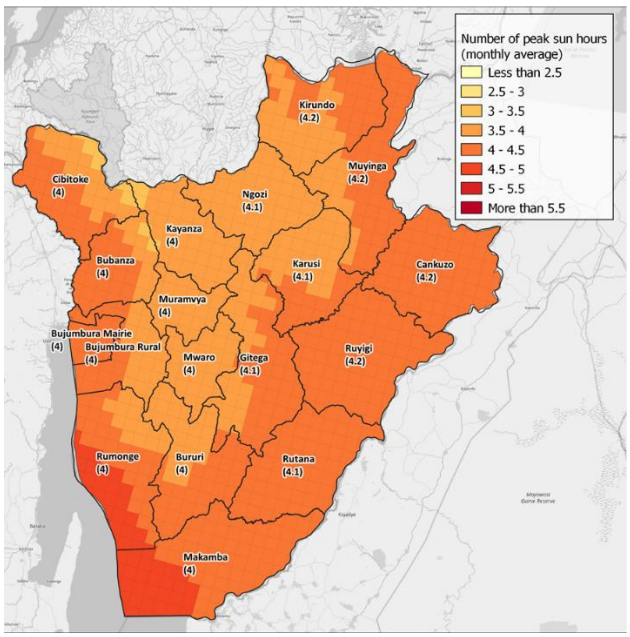
Peak sun hours are favorable for OGS companies, but daily variation implies solar products will need to be appropriately sized to capture enough sunlight on cloudy days

In general, Burundi receives consistent sunshine throughout the year, although in some regions cloud cover – particularly during the rainy season – may limit direct sunlight hours. Average hours of direct sunshine vary between around 4 to 5 hours throughout the year, although this varies quite substantially by region; solar yield is typically higher in the flatter regions along the lakeside and to the east of the country but can drop much lower in the hillier regions in the middle and north (Figure 16). Further, on cloudy days or weeks solar hours can be far lower than the average expected solar yield.

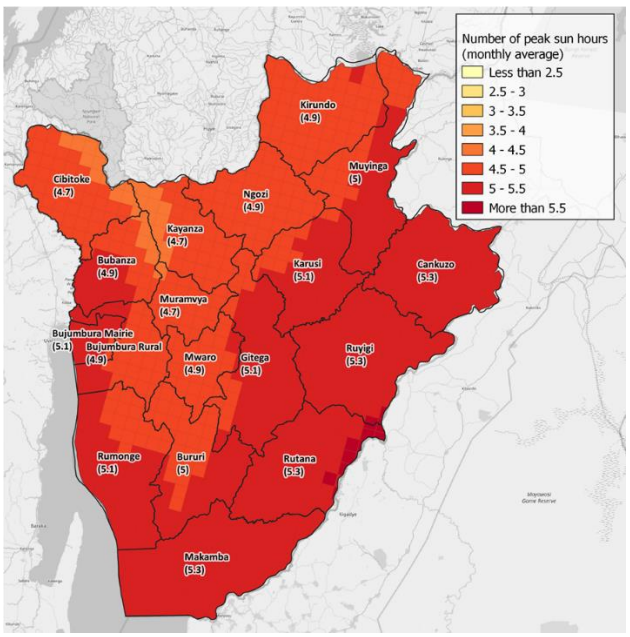
This may mean products need to be slightly oversized but does not pose a major constraint for OGS product performance. A few providers in-country raised concern that solar products were not providing reliable access to electricity during cloudy periods, when hours of sunlight may be insufficient to fully charge the batteries. However, this challenge should not represent a major barrier, and can be addressed by appropriate product sizing (including oversizing panels if needed, as e.g. Ignite does in neighboring Rwanda).

Figure 16 Regional variation in sunlight is highest in May and August, with lower solar yields in the hillier center and north of the country

May



August



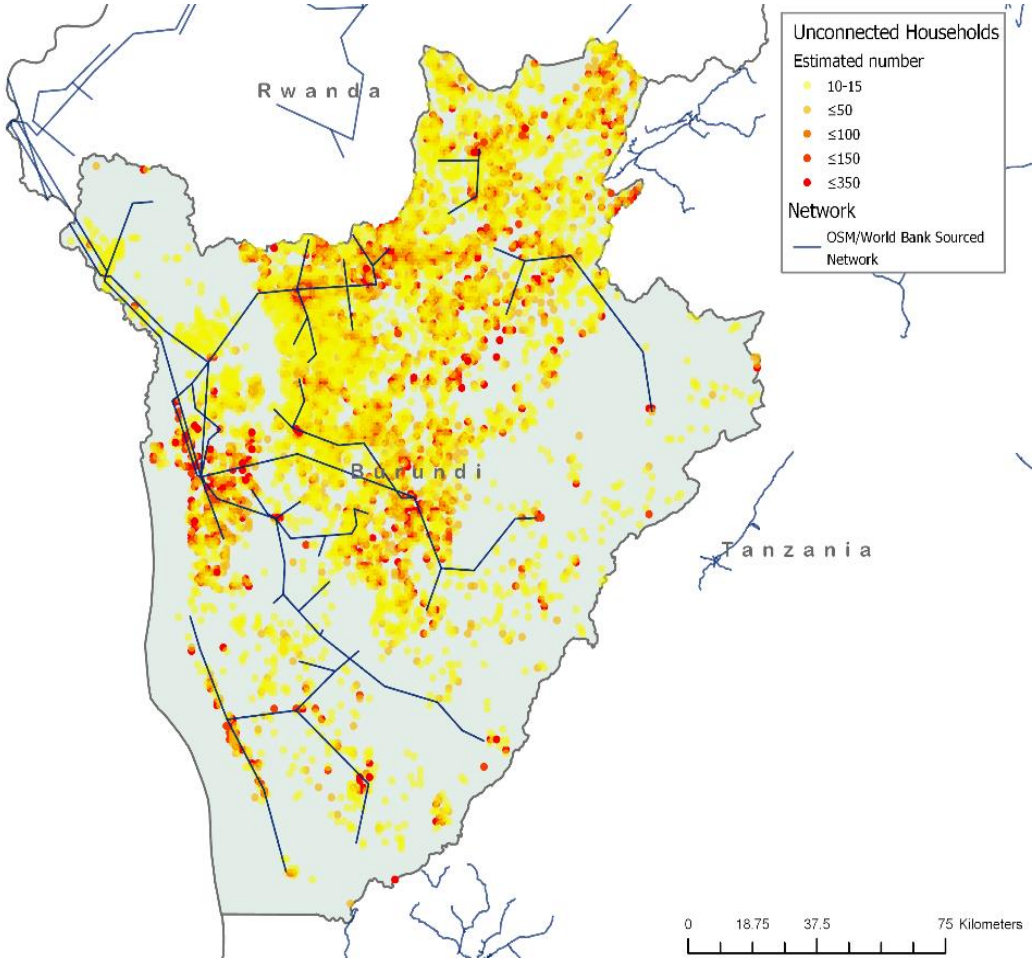
Note: Peak sun hours are calculated as an average for each month at the 10km^2 level
Source: Consortium; WorldClim Version2

OGS is well suited to bring Burundian households onto the energy ladder and least cost geospatial planning tools suggest a major role for OGS technologies to achieve universal access to electricity

Off-grid solar will play a key role as Burundi makes progress towards Sustainable Development Goal 7 (SDG7). The main REGIDESO operated grid does not reach much of the country (see Figure 17), and currently only 9% of the population has access to electricity (see Section 2.1). The current size of the grid, and the fact that most households live far away from it, mean that the capital costs of expanding grid-based generation are likely to be very high, and unlikely to represent a cost-effective way of connecting most households in the near term. In contrast, the supply conditions for standalone solar are relatively favorable, with relatively high rural population density, and stable solar yield year-round. Indeed, the recently launched Global Electrification Platform (GEP) shows that OGS could be the least-cost technology to provide electricity to 75% of the population, adding close to 40 MW of generating capacity under a low energy demand, medium population growth scenario.[73]

[73] GEP is developed based on the Open Source Spatial Electrification Tool (OnSSET) and uses a nationwide least cost approach to calculate the optimal pathway to 100% electrification in Burundi and nearly 60 other countries at the time of writing. Though off-grid solar market grows under all scenarios, the split between grid to off-grid energy access varies depending on assumptions of population electricity demand. While most of the population achieve energy access via a grid-connection under a high-demand scenario, standalone solar PV is most important to achieving energy access under a low demand scenario. In the latter, the urban demand target is defined as the nearest access tier for currently electrified areas in the country; the rural demand target is set to Tier 1 energy access.

Figure 17 Existing grid infrastructure and households without access to electricity



Source: World Bank analysis, 2019

The supply of improved cookstoves can take advantage of locally available raw materials, but market expansion should consider the impact of resource extraction and fuel availability

Clay is widely available around the country and enables local production with low transportation costs. Extraction of clay is carried out predominantly by artisanal producers involved in brick making, and the only commercial enterprise, Burundi Cement Co. (BUCECO), quarries clay domestically from state-owned mines for cement production. However, some manufactures cite sourcing good quality clay as a growing challenge. If local production of clay-based improved cookstoves were to be ramped up, it would benefit from an assessment and mapping of both the availability and the quality of clay nationwide, as well as considering the environmental impact of extracting these resources, particularly the impact on land degradation and increased emissions.

4.2 The supply chain for OGS technologies and routes to market

- The private sector market in Burundi is nascent, with OGS companies only beginning to penetrate the market
- To date, most OGS companies are making B2B sales, relying on partnerships with NGOs or community associations, such as VSLAs, for last-mile distribution
- PAYGo is an emerging opportunity in Burundi but faces barriers, including high working capital requirements and low mobile money penetration in rural areas
- Supplying OGS to households in Burundi would roughly double the Free on Board (FOB) price – although this could be substantially lower with well targeted support

The private sector market in Burundi is nascent, with OGS companies only beginning to penetrate the market

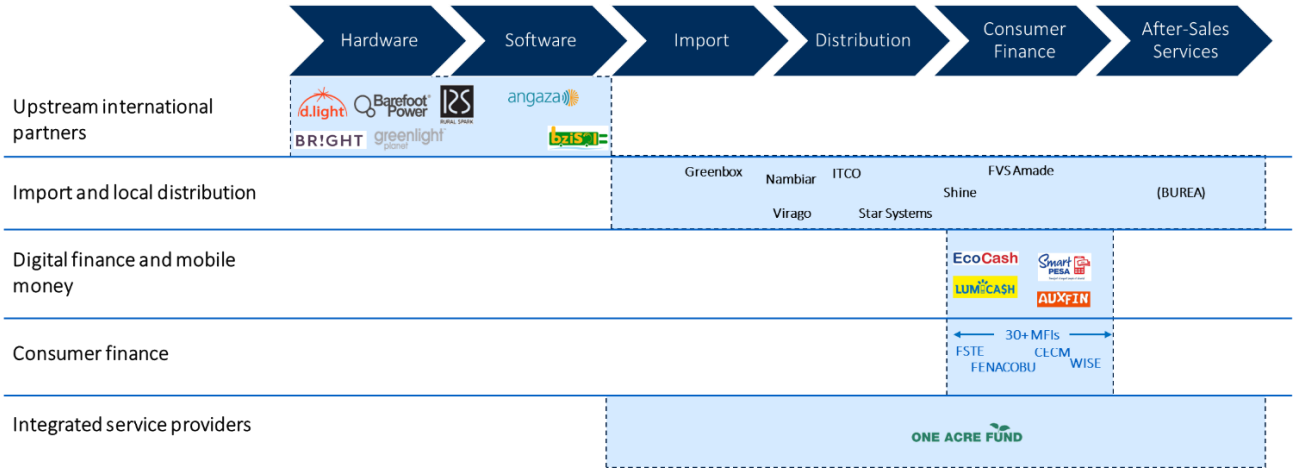
The number of units sold by these companies is limited – with all companies still getting to know their customer base and not yet achieving scale. The private sector market for OGS in Burundi is relatively nascent, with most companies currently active in the market having been established in the last five years. Sales by OGS companies are limited to between hundreds and a few thousand. A few companies have had more success in penetrating the market, but none have a long-standing sales track record.

OGS operations in Burundi are typically limited to importing, marketing, and distribution, as shown in Figure 18. Actors in the off-grid solar supply chain in Burundi are typically responsible for:

- **Importing products from international manufacturers**. Greenbox, One Acre Fund, and Shine PAYG are among the companies and NGOs importing OGS products. The most common OGS hardware products found in Burundi include Greenlight Planet,[74] Barefoot Power, d.light, and Bright.
- **Marketing and consumer awareness,** both through community training and after sales care. Shine PAYG is one organization that supports training sessions and awareness campaigns through local field supervisors, for example.
- **Distributing products to households and/or associations.** This last mile distribution has often been carried out by NGOs such as FVS-Amade, or international organizations such as One Acre Fund, while MFIs and VSLAs also have wide reaching household customer bases.

[74] Hardware sold as Sun King internationally

Figure 18 Mapping (local and international) OGS companies across the supply chain



Source: Consortium

To date, most OGS companies are making B2B sales, relying on partnerships with NGOs or community associations, such as VSLAs, for last-mile distribution

Very few companies operate nationwide distribution networks for fast-moving consumer goods in Burundi. The state-owned Post Office (Régie Nationale des Postes) has nationwide coverage through 156 service points, distributed relatively evenly across all provinces.[75] Beyond this, the local Heineken-owned brewery *'Brarudi'* operates a nationwide distribution network to sell beer and soft drinks through a network of hubs in each province. Savonor products (soaps, detergents, cooking oils, etc.) are also sold nationwide, through regional agents selling Savonor products on commission. Similarly the two major telecom companies, Econet and Lumitel, have retail outlets at the provincial level, and have a wide network of around 30,000 agents. There are no established nationwide retail networks for basic consumer goods, with instead small retailers and agents selling products through small shops and market stalls.

Similarly, no OGS companies have yet established national distribution networks, with most sales being business to business (B2B) to NGOs or MFIs. Most OGS companies either choose to not sell directly to households in Burundi or have only been able to sell a limited amount directly. The route to the end-consumer market instead typically relies on selling to other businesses, NGOs, or MFIs which then market and distribute products to customers. Where companies have not entered such partnerships, sales have been highly concentrated in Bujumbura.

VSLAs currently play an important role as last mile distributor, energy service provider, and potentially, credit provider. Originally set up in Burundi 2009, VSLAs were intended to bring together households to save together and provide credit to members. There are now approximately 4,500 VSLAs in operation throughout the country, although only those in Makamba and Rutana are involved in the OGS sector through FVS-Amade. Their impact on the Lumière program, described below, shows the vital role they can play in the OGS ecosystem, as a last-mile retailer for solar lamps and a local charging point for households requiring electricity, both for solar lamps and other devices such as mobile phones. In the future, they could also play a similar role in distributing affordable cookstoves to last-mile customers; also, educating potential

[75] BRB. (2019) *Rapport Annuel de de la Banque de la République du Burundi 2018.* Available at: https://www.brb.bi/sites/default/files/Rapport_annuel_2018_complet-min.pdf

consumers on the benefits of OGS and improved stoves and providing credit to members to purchase systems.

In view of limited existing retail networks, and low consumer affordability, a combination of business models could be utilized to reach households in the future, including:

- **Direct distribution to households, with OGS companies establishing their own last mile distribution (LMD) networks**, whereby the OGS importer is also responsible for distribution and retail of products to end-consumers. For example, Greenbox has reportedly partnered with Argos Energy (both OGS providers) to provide lanterns to a Batwa community in Muyinga. One Acre Fund also uses its own distribution network to sell directly to member farmers.

- **B2B sales to a retail dealer.** In this approach, the OGS provider sells products to a third party intermediary who then sells on through their own network of customers. This could include partnerships with existing retailers such as the Telcos. To date the most common model for this distribution model in Burundi is sales to community associations such as VSLAs, which then sell goods or services on to their members.

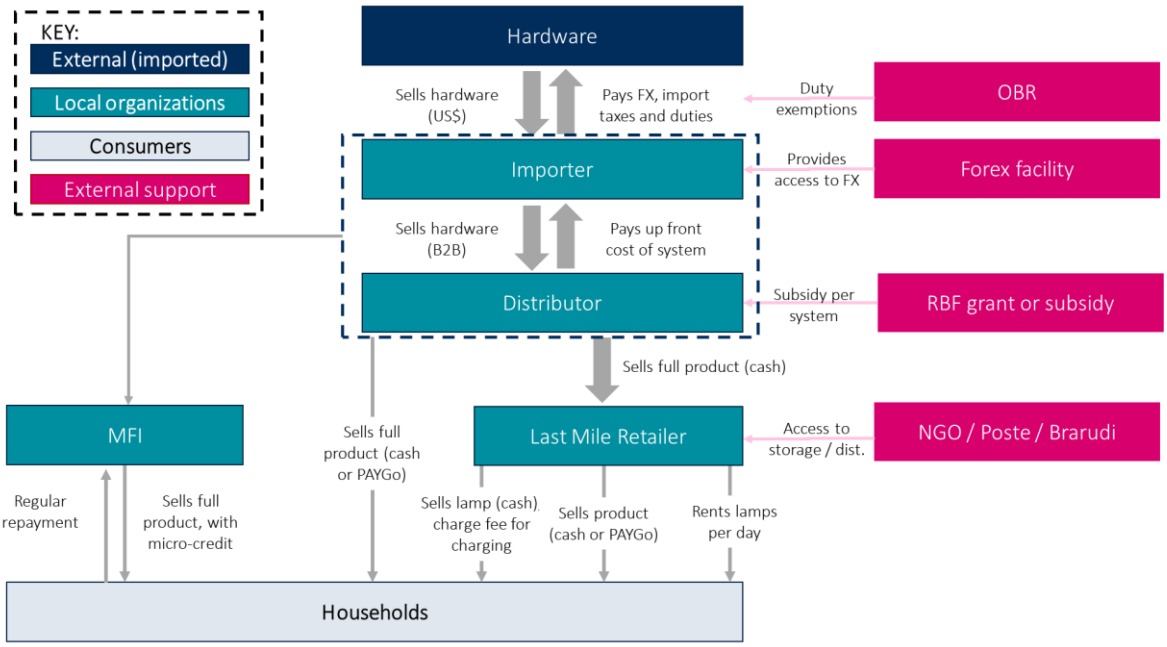
- **Leasing models – including through dealers.** For example, rather than selling a product at full cost to each household, rechargeable OGS appliances could instead be leased by households for a daily fee. This could be an attractive model in the early stages of market development, to raise awareness and address affordability constraints, as households may then gradually transition by leasing to an OGS product only some of the time, until they can afford to purchase and own a system outright. For example, leading international OGS provider Sunny Money has implemented its "Light Library" model in a number of countries, where lanterns are provided to schools and then borrowed by students for a nominal fee. Alternatives could include solar kiosks, which could serve as a central charging point for OGS appliances or batteries. A variant of this latter model has been adopted by VSLAs in Burundi (more information below).

- **Partnerships for distribution with local financial institutions.** In this model, OGS providers partner with either local banks or MFIs to sell products with consumer finance. A number of MFIs have been in discussion with OGS providers to explore this model, including WISE and FSTE.

The involvement of women in the solar supply chain has great potential to reach end customers even in remote and hard-to-reach areas. Companies such as Greenbox and ITCO have been working with women's savings groups and associations (e.g. WISE) to distribute solar lanterns on a renting basis. A recent program by UNDP is piloting a model where women's associations manage solar kiosks provided by ITCO and offer a lantern charging service.[76] As a leading international example of women-led off-grid energy supply chains, Solar Sister's female entrepreneurs and last mile distributors have sold over 300,000 off-grid solar or improved cooking products across sub-Saharan Africa.[77]

[76] Autonomisation des femmes à travers l'accès à l'énergie
[77] Solar Sister. (2019) *What we do – our impact.* Available at: https://solarsister.org/what-we-do/our-impact/

Figure 19 Potential supply routes to market include possible partnerships at a range of levels throughout the value chain



Source: Consortium

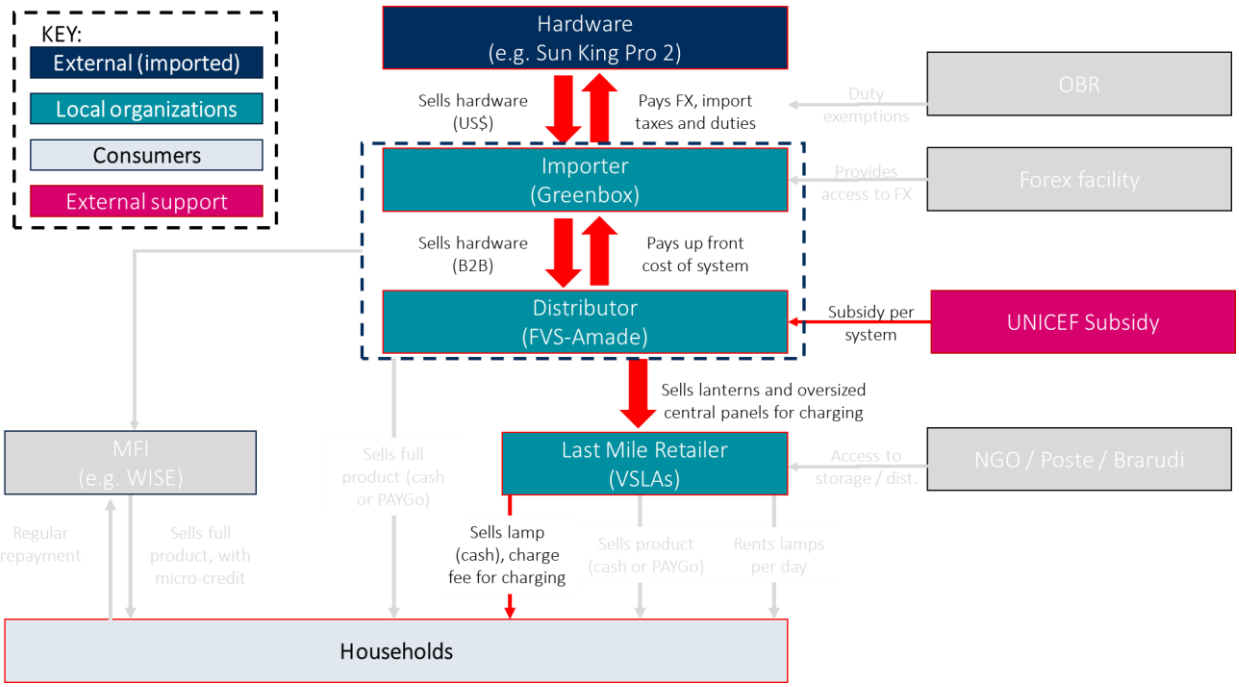
The Lumière program, implemented by local NGO FVS-Amade in partnership with UNICEF, works with VSLAs to serve the last mile. In this approach, UNICEF subsidizes the purchase of OGS products by the NGO FVS-Amade, which purchases imported hardware from Greenbox and on-sells (at a subsidized price) either directly to households or to VSLAs (Figure 20). The subsidy per unit sold under this program is around 60% to 70% of the purchase price, and distribution costs are also absorbed within the NGO's operations. To reach some of the more remote rural parts of Burundi, distribution could add around 30% to the upfront purchase price, thus raising the effective subsidy level of this approach to as high as 80%.

Most sales under the Lumière program have been through VSLAs, which sell lamps and provide a charging service separately. There are two prevalent models through which FVS-Amade sells OGS products:

- Model 1: The direct sale of lamp, solar panel, and battery to households. There have been relatively few sales under this model, due to the limited number of households who can afford to purchase both lamp and panel together.
- Model 2: The sale of lamps and a communal solar panel and battery, to VSLAs in Makamba and Rutana. Most sales of OGS lamps occur through this model, where VSLAs sell lamps to villagers (for approximately US$ 10) and sell access to a communal charging unit for OGS products. This charging unit can typically charge about 20 solar lamps each day, for which villagers pay a small charging fee (around BIF 300, or US$ 0.15). This model has also been favored as a way of promoting a community-building approach, as it both provides an ongoing revenue stream for the VSLAs and strengthens the links between VSLAs and community members.

A third option within this existing framework could be for VSLAs to provide a lamp rental service. To date, sales have mostly been by cash under every model. An alternative being considered by providers is to sell to an "aggregator" of customers such as a VSLA, which then loans out products to customers on for example a daily basis, for a daily fee.

Figure 20 UNICEF's Lumière program uses VSLAs as last-mile retailers, helping to reach households in rural areas

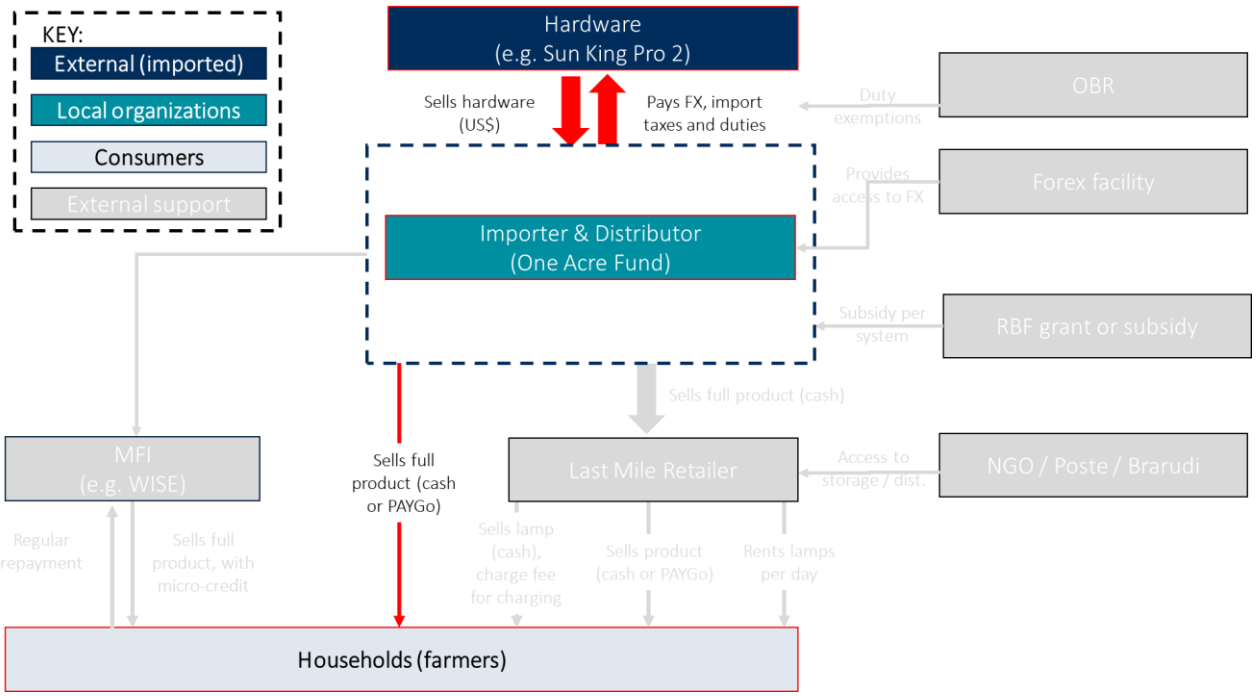


Source: Consortium

Like other community MFIs in Burundi, VSLAs benefit from their ability to pool customers, and thus supply energy services and credit at the community level. Given the low affordability of OGS products, a key benefit of a VSLA is the ability to supply electricity to a pool of households, for cheaper than if the same service was sold as a product to individual households. They benefit from their existing relationships with consumers, many of whom are members of the association. Although this communal consumption is heavily subsidized, the VSLAs' role as savings associations suggests that they could also help households collectively purchase OGS lamps. The characteristics of VSLAs are shared with other community MFIs in Burundi, which could play a similar role in educating potential OGS customers and helping companies reach last-mile customers.

One of the most successful routes to market has been through international NGO One Acre Fund (OAF), which has sold thousands of lanterns to the farmers it works with. The OAF business model is as a vertically integrated provider, from import through to last mile distribution, as well as provision of consumer finance to farmers throughout five central provinces (Muramvya, Gitega, Ngozi, Kayanza, and Mwaro). Farmers have expressed high regard and further demand for the OGS products sold, with high repayment rates – loans are typically paid back within two harvest seasons. Part of the success of the OAF approach hinges on the scale of its international operations, which enables access to forex (see detailed description in Section 5.2 below), and an ability to access large volumes of hardware at competitive prices from warehouses in neighboring countries.

Figure 21 One Acre Fund has reached thousands of end users through direct sales to farmers



Source: Consortium

A range of other promising business models are being explored with alternative partnerships to provide last mile distribution and access to consumer finance. For OGS companies interested in entering the market, partnerships with alternative distribution networks could be crucial to reach higher market penetration. For instance, Brarudi's distribution networks, or Econet and Lumitel's mobile money agent network, offer opportunities for transporting and selling OGS products.

The relative scarcity of these networks and the low appetite among companies to bear OGS market risks poses practical challenges for suppliers, however. Though in-country engagement shows the willingness of OGS companies to develop partnerships with existing distribution and retail networks, there are relatively few nationwide networks to utilize. Given the immaturity of the OGS market, retail agents also face higher risks if they are bulk purchasing OGS products. Partnerships will therefore only be successful to the extent that risks for retail agents are sufficiently low so as to be attractive to their business model. This could be the result of subsidies that reduce product costs, agreements by the OGS supplier to take a share of the upfront cost until a sale is made, or a business case to sell OGS where it can help increase revenue. For example, selling OGS products alongside mobile money helps to increase mobile phone charging, and increases the revenue generated per customer.

PAYGo is an emerging opportunity in Burundi but faces barriers, including high working capital requirements and low mobile money penetration in rural areas

PAYGo is an emerging opportunity but faces challenges to scaling up. Most off-grid solar companies operating in Burundi offer products through upfront cash sales. The PAYGo business model could be

attractive in reaching a wider customer base in that it can decrease upfront costs to an affordable level (see Section 3.2). However, the PAYGo business model will need to overcome a few additional challenges, including:

- **High working capital requirements** for PAYGo companies, which requires companies to take on high upfront costs and delay returns over a medium-term horizon. High capital requirements combined with high costs of accessing commercial finance (see Section 5.1) is likely to restrict the number of PAYGo sales a small OGS company in Burundi can support.
- **High credit risks**, as OGS companies are typically not best placed to assess the risks of potential PAYGo customers, who are likely to lack financial access and a reliable credit history.
- **Forex risks,** as the initial up-front costs are incurred in US$ (to import hardware), but revenue streams are collected in BIF over, for example, 12-18 months. Companies both need to be able to finance inventory – and need access to US$ to do so – and face a risk of volatility in the exchange rate which could result in BIF revenue streams that don't track the original US$ costs. More discussion provided in Section 5.
- **Low mobile money penetration in rural areas,** although this is changing quickly, as discussed in Section 5.3.

Most importantly, the immaturity of the market means that OGS companies and other financial intermediaries, such as MFIs, have a low appetite to take on the financial risk from PAYGo business models. MFIs could help to ease the challenges that OGS companies face under a PAYGo business model, due to their improved access to finance and understanding of the credit rating of potential customers. However, like OGS companies, the greatest barrier to MFIs selling PAYGo solar products is the high credit risks that this business model implies.

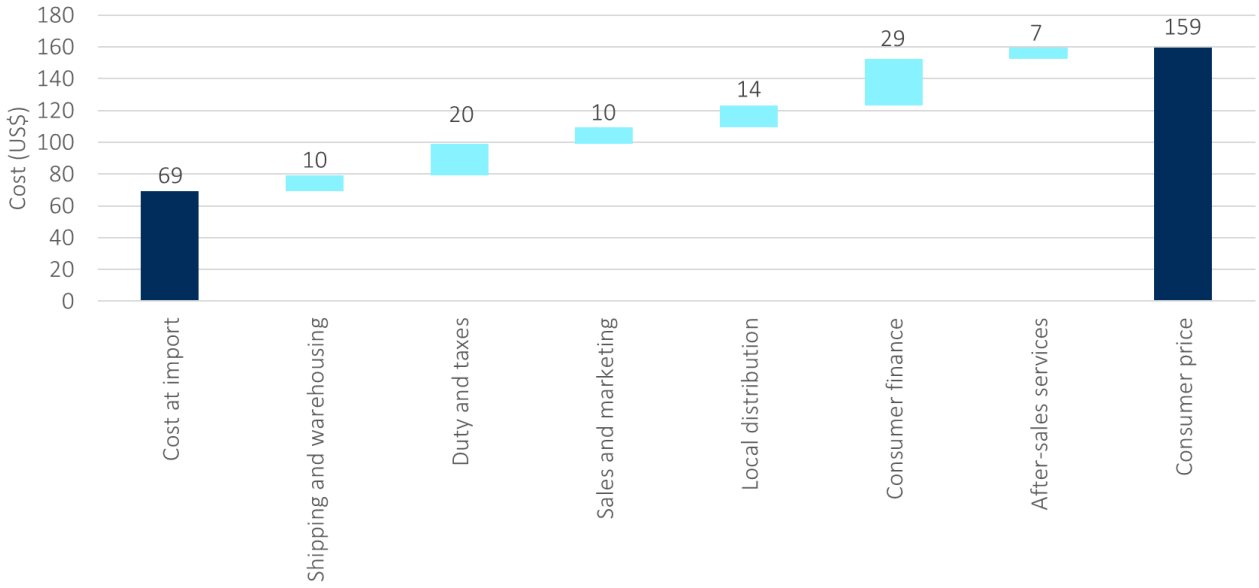
Supplying OGS to households in Burundi would roughly double the FOB price – although this could be substantially lower with well targeted support

As the market is still in very early stages, the cost at each point of the value chain has varied substantially depending on the approach adopted. For example, some companies have imported solar lanterns and benefited from application of the EAC duty exemptions on these products, while others have had to pay the full (25%) import duties on solar kits, and 18% VAT. Similarly, some companies have incurred no distribution costs, as they have distributed through NGOs who have not passed on the cost of distribution in the end user price.

As a conservative estimate, the final consumer price accounting for the costs along the value chain may be roughly double the cost of importing hardware. As shown in Figure 22, collection and warehousing of OGS products in Bujumbura adds around 15% to the FOB (import) price. Import taxes and duties could add another 30%, although these should be brought down to (or at least close to) 0%, through application of EAC policies. The remaining value-added tax (VAT) adds a further 18%. Sales and marketing costs have been quite limited to date but may rise if companies increase efforts to reach scale. There is very little experience of distribution costs within Burundi, as most companies have focused on distribution in a relatively limited area, at low sales volumes, and/or leveraged existing distribution networks. However, consultations would suggest nationwide distribution would likely raise end costs by a further 20%, although this may be lower for households near major urban centers (and therefore close to a high quality road). Consumer finance through MFIs or PAYGo technology could add up to a further 40% on the FOB price. After sales services (and associated costs) are minimal at present.

The costs at several points in the value chain could be reduced through financial and non-financial support. For example, where import duties and VAT are applied in full they contribute around 20% to the final end user price. This could be removed through implementation of EAC policy on customs duties, if applied to all OGS products and kits, and removing local VAT charges. Similarly, the cost of consumer finance could be brought down if companies looking to roll out PAYGo technologies have access to affordable working capital facilities, or if MFIs can bring down the cost of lending for OGS products. The cost of local distribution could be minimized by leveraging the facilities of companies who are already operating distribution networks, such as NGOs, or the "Regie des Postes", or the national Brewery "Brarudi."

Figure 22 Cost components for a mid-sized pico system providing lighting and charging for a mobile phone or radio, under a consumer finance model (e.g. PAYGo or through partnership with MFIs)



Note: Based on industry consultations on the relative cost of delivering each point of the value chain. This shows the breakdown if Import duty exemptions are fully applied (i.e. 0%), but includes VAT rate of 18%.
Source: Consortium analysis of confidential company and MFI data

4.3 The supply chain for improved cookstoves

- The supply of improved stoves is dominated by local artisanal production and not subjected to standardization
- Driven primarily by donor initiatives, last-mile distribution has been effectively implemented by community-based organizations and NGOs
- Despite great potential for reducing firewood consumption, briquettes have yet to translate into a viable option for meeting the demand for fuel

The supply of improved stoves is dominated by local artisanal production and not subjected to standardization

As of the end of 2019, there were two ICS companies retailing in Burundi and a number of artisanal production sites scattered across the country. Based principally in Bujumbura, companies operating at a commercial scale have been diversifying their offer by producing both briquettes and improved stoves. However, the vast majority of improved cookstoves targeted at households have been disseminated under various donor programs (as described in Section 2.2) by leveraging locally-based artisanal production sites distributed across the country.

Table 6 Improved cookstoves providers in Burundi

Manufacturers	Location	Description	Products
Companies			
Burundi Quality Stoves (BQS) and OBEN (Observatoire pour l'Environnement et la Nature)	Bujumbura HQ, with other smaller production sites	BQS produces improved stoves and briquettes. The company produced institutional stoves in collaboration with WFP and other donors OBEN is producing improved cookstoves under the carbon finance project[78], targeted at 50,000 rural households Production capacity: 10,000 stoves per month	Clay stoves produced in a semi-mechanized way
KTF	Bujumbura	Manufacturer of metal stoves targeted at urban households	Metal stoves produced with metal imported from Uganda
Locally established manufacturing sites			
5 local production sites	Mubunga, Rushanga, Itaba, Narushunga, Mongua	Developed under WFP program Supported by IFL, managed by Action Batwa, Croix Rouge and cooperatives Daily production capacity: 80-200 stoves (depending on the site)	IFL Rural Wood Stove
10-15 local production sites	Gitega, Kayanza, Kirundo	Supported by EnDev Monthly production of 2,500 stoves, set to be increased to 5,000/month by end 2020 and 10,000/month end 2021	Matawi Stove
3 planned local production sites	Kayanza, Ngozi, Kirundo	Supported by AVSI (EU project)	Matawi Stove

[78] UNFCCC. (2019) *Improved Cooking Stove Programme in Burundi supported by Republic of Korea*. Available at: https://cdm.unfccc.int/ProgrammeOfActivities/poa_db/U2ZYTF1EWXPBHKO069GCLNSDRIQ78A/view

Manufacturers	Location	Description	Products
15 planned local production sites	Provinces of Ruyigi, Rutana, Cankuzo et Kirundo	Supported by LVIA (EU project)	N/A
3 planned local production sites	Provinces of Kirundo, Karuzi, Makamba, Rutana, Cankuzo	Supported by PNUD – FAO (EU project)	N/A

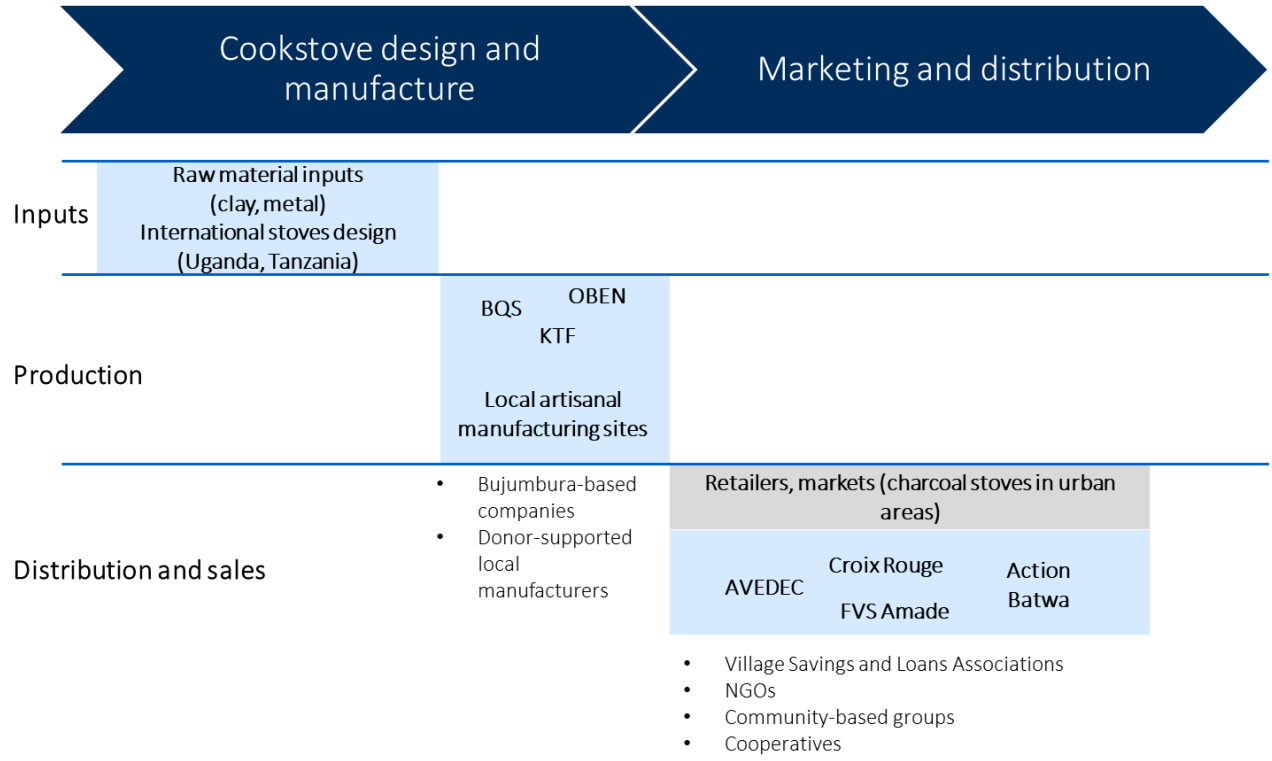
Source: Consortium

Driven primarily by donor initiatives, last-mile distribution has been effectively implemented by community-based organizations and NGOs

Artisanal stove producers dominate Burundi's ICS market. The production of ICS is distributed across the country, with availability of raw material playing a key role in the location of manufacturing sites.

Local availability of materials has enabled a vertically integrated supply chain, with a distributed production close to consumers. Clay used in the production of improved stoves is widely available, while metal used in some of the production is either imported from Uganda or purchased in Bujumbura. Local manufacturing has been enabled by improving the capacity of clay artisans and brick producers to produce stoves, as well as on the establishment of dedicated production sites and training of local communities. Sourcing for raw materials is often conducted with the collaboration of community-based organizations and other associations. Programs such as SAFE have leveraged voluntary community members for sourcing clay, fine sand and wood ash, while rice husk (used to mix with the clay) is purchased from the local market.

Figure 23 Supply chain for improved cookstoves



Source: Consortium analysis

Stoves are designed based on verified models used in other countries (such as Uganda and Tanzania), but the limited technical knowledge of manufacturers and the lack of standardization limit artisanal production. By introducing stove models tested and used in other contexts, cook stove programs have focused on providing capacity building to local artisans to manufacture efficient stoves. Local production has, however, encountered issues with quality assurance and quality control and an expansion of the production will require continuous capacity building and quality control, as well as the adoption of standards.

To date, donor-led initiatives have distributed ICS to households through up-front cash sales at a range of (sometimes subsidized) prices. Cookstoves are sold to customers, who pay the full price of the stove upfront. In some cases (e.g. EU program), households make "in-kind" contributions such as contributing raw materials for production, to benefit from lower-priced products. Other programs (e.g. SAFE) have provided subsidized stoves, with the level of subsidy tailored to meet households' ability to pay. Clay cookstoves produced in Bujumbura by OBEN / BQS have been sold to customers at US$ 1 – US$ 2 as compared to a production cost of US$ 4 (subsidized by the carbon credit program described in Box 3.

Local production and distribution using village-based associations and cooperatives has been proven to be a successful model to reach rural customers. Across donor led initiatives, implementing entities such as AVEDEC, FVS Amade, Croix Rouge, and Action Batwa have played a key role in mobilizing communities and in ensuring penetration of improved cookstoves in remote and hard-to-reach areas. The availability of partners has been identified as a key factor to ensure the successful production and dissemination of stoves, as these organizations have experience with Village Savings and Loans Associations (VSLAs) and other community-based structures that can support marketing and promotional activities. Charcoal stoves sold in urban areas present a slightly different value chain. These stoves are distributed through retail at local markets and shops.

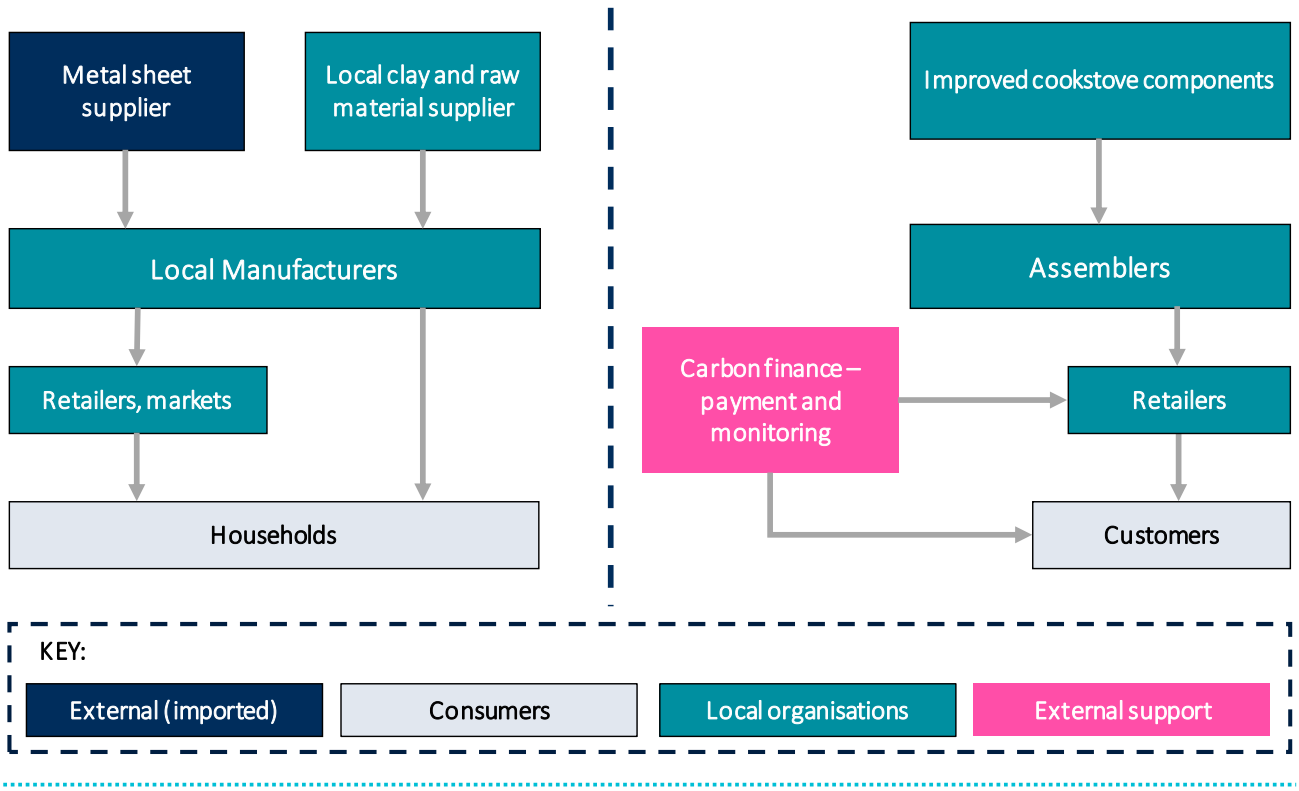
Maintenance and after-sale services are not included in the cash-based business models provided by the different programs. Due to their artisanal nature, stoves made of clay can be repaired by using a mixture of

animal dung and clay. In some cases, users have been trained on the correct use and proper handling of stoves, including cleaning ash from the combustion chamber. Other stoves that retail in urban areas have a limited lifespan and once they start degrading customers can simply replace them.

More sophisticated and more efficient stoves imported by neighboring countries (e.g. ILF Okello Stove or Ugastove from Uganda) would require a very different supply chain and cost structure. Manufacturing and assembly costs could be kept low by enforcement of import duty exemptions (described in Section 2.3) and by working with established artisanal manufacturers for assembly.[79] However, distribution costs could increase substantially, especially if establishing a network of retailers or sales agents to reach a wide geographic set of customers. With poor roads, and fragile stove designs, transportation costs would likely be significant. Combined with low awareness of ICS, and the need to include repair services, higher tier stoves would require greater investments and appropriate subsidy mechanisms to meet the affordability constraints of rural households.

The introduction of imported efficient stoves could benefit from subsidies obtained by a carbon finance entity (described in Section 5.2). However, higher costs would be driven by data collection requirements to comply with carbon finance rules, encouraging participants to keep tight control over distribution and work directly with retailers. This creates a barrier to the introduction of a more efficient supply chain with streamlined transport and distribution.

Figure 24 Value chain for locally manufactured stoves (e.g. Matawi) vs value chain for imported stoves (e.g. ILF Okello Stove = from Uganda)



Source: Consortium

[79] if fully assembled stoves were imported by neighboring countries, a 10% import duty would be applied

Despite great potential for reducing firewood consumption, briquettes have yet to translate into a viable option for meeting the demand for fuel

There is a small but growing market for briquettes made from agricultural waste, but the production is mostly targeted at institutional clients. There is a potential to increase the production of briquettes to target households and reduce pressure on wood resources, however a market expansion will require detailed analyses of available biomass and raw inputs, and cost/benefit analysis of logistics and associated cost.

5 Financing the market for off-grid solar and improved cooking

5.1 Overview of the financial market

- Access to commercial and consumer finance is provided by 12 banks and 37 MFIs
- While bank branches are heavily concentrated in Bujumbura Mairie, microfinance institutions have better reach throughout the country

Access to commercial and consumer finance is provided by 12 banks and 37 MFIs

There are 12 banks in Burundi, with over BIF 900 billion (around US$ 470 million) of credit loans provided in 2018, up from BIF 800 billion in 2017 (around US$ 420 million). The trade and retail sector received 25% of loans, followed by the housing construction sector with 15%, and industry with 8%. Half of the credits supplied by banks are short term, 30% are medium-term (2 to 5 years), and 20% are long-term (over 5 years).

There are 37 microfinance institutions (MFIs), among which cooperatives account for 85% of assets. There are 20 private companies providing microfinance, and 17 cooperatives which offer deposit and credit to members only. Burundian MFIs exhibit a very low rate of unhealthy credits, estimated at just 6% in 2019. Around BIF 220 billion (around US$ 120 million) in credits were provided in 2018, a 20% increase from 2017. Most loans (40%) are for housing, while agriculture only accounts for 8% of MFI loans.

While bank branches are heavily concentrated in Bujumbura Mairie, microfinance institutions have better reach throughout the country

Over 50% of bank branches are in Bujumbura Mairie, with much lower penetration in rural provinces – as low as just one branch each in Cankuzo, Mwaro, and Ruyigi (Figure 25). While there are nearly 10 bank branches per 100,000 citizens in Bujumbura Mairie, there is less than 1 branch per 100,000 citizens across the rest of the country. At the national level, Burundi has 3.2 commercial bank branches per 100,000 adults, compared to a sub-Saharan African average (excluding high income countries) of 5.0, and compared regionally to Rwanda (5.8), Kenya (5.0), Zambia (3.9), and Uganda (2.6).[80]

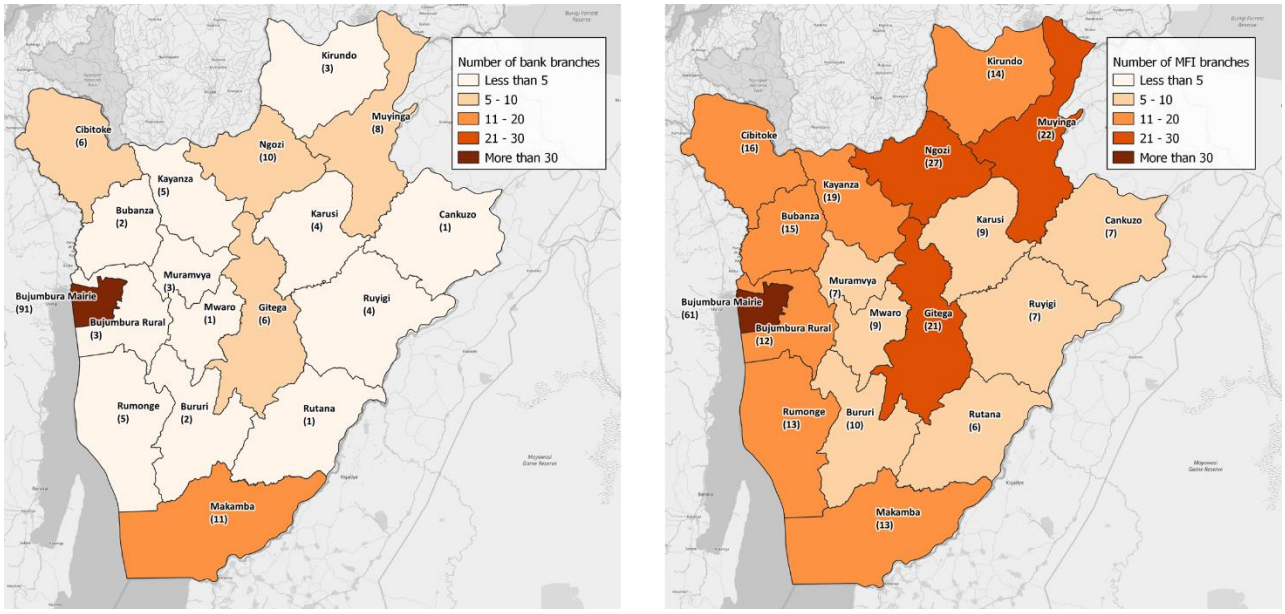
Micro-finance institutions have a deeper reach in rural areas, with nearly 80% of MFI branches outside of Bujumbura Mairie. Among MFIs, only the National Federation of Cooperatives of Burundi (FENACOBU) has a nationwide presence among its members (more than 100 individual savings and credit cooperatives). Other MFIs typically have a thematic and/or regional focus, such as:[81]

- The Union for Cooperation and Development (UCODE) which serves the northern part of the country.
- WISE, which is a women's cooperative whose members are also part of the Association Des Femmes Entrepreneurs Du Burundi (AFAB), mostly in Bujumbura.

[80] World Bank. (2019) *The World Bank Global Financial Inclusion Database.* Indicator is the number of Commercial bank branches (per 100,000 adults). Available at: https://databank.worldbank.org/home.aspx.
[81] BRB. (2020) *MFIs in activity.* Available at: https://www.brb.bi/fr/content/emf-en-activit%C3%A9

- Occupational cooperatives, such as the Solidarity Fund for Health Workers (FSTS) or the Solidarity Fund for Education Workers (FSTE).
- The Cooperative for Savings and Mutual Credit (CECM), which works with associations across the country and through 11 retail offices.

Figure 25 Distribution of bank branches (166 nationwide) and MFI branches (288 nationwide) by province



Source: Consortium analysis of BRB (2019) « Rapport de Supervision du secteur bancaire 2019 »

5.2 Commercial finance for OGS and cookstove companies

- Access to forex is a major challenge for OGS companies
- Commercial lending to OGS companies is limited in general, with relatively high interest rates and collateral requirements
- External finance options may be available if the market can demonstrate sufficient scale and financial viability
- Two major grant programs financed by development partners are planned to catalyze the off-grid solar and improved cookstoves markets in the coming years

Access to forex is a major challenge for OGS companies

Access to hard currency is limited and restricted to priority companies. Foreign exchange is accessed through the Banque de la République du Burundi (BRB). Decreasing foreign currency reserves have put pressure on the Bank to limit issuance of US$, resulting in hard currency only being made available to priority companies and, even then, only with limitations on the amount that can be converted.

There has also been a divergence – of around 50% - between the official exchange rate and the shadow exchange rate available on the black market. Such a gap between the official exchange rate and the shadow (market based) exchange rate and its variation means that companies faced a high degree of risk on

exchange rate fluctuations. In general, the official rate of conversion from BIF to US$ is lower than the black-market rate, which would be advantageous for companies acquiring US$ (but far less advantageous when converting US$ to BIF).

This limited access to official market forex represents a major constraint to local OGS companies which need to be able to access US$ to import hardware. There is no local manufacturing or assembly of OGS products and this is unlikely to develop in the near term. As such, the import of any quality verified lanterns or plug-n-play solar home systems will be paid for in US$. If importers turn to the shadow (i.e. "black") market, they are unlikely to be able to access US$ at sufficient scale, and it will be very expensive due to the much higher shadow exchange rate. This can also pose a pricing challenge for companies, as if the BIF depreciates relative to the US$, they may not easily be able to pass this increase in costs on to consumers, especially when establishing a new product where consumers may expect price stability.

In its current state, the cookstoves market is much less dependent on access to hard currency, but this would change if components for higher performance stoves were imported. The raw materials (i.e. clay) for production of, for example, the "Matawi" stove can be sourced locally, at least at current production levels. However, as production scales up, high quality clay may need to be sourced from abroad. More importantly, US$ would be needed to import metal sheets, which are a key component to cleaner and sturdier stoves which could be produced locally. Finally, higher performance stoves could be imported but would then face the same challenge of access to forex as local OGS providers described above.

International companies looking to establish operations in Burundi also need to be able to convert BIF revenue streams into US$. International companies establishing operations need to be able to convert revenue streams collected in BIF into US$ to repatriate profits. This is a hard constraint that will need to be addressed in the long term, while Section 6 describes measures that may mitigate this barrier in the short term.

There are international solutions to provide lending in local currency which removes the exchange rate risk – however such options remain expensive in Burundi and do not address the central issue of US$ liquidity. For example, TCX offers a fixed rate swap at around 23%, which would help international funders to provide local companies access to lending in BIF. This would at least match the borrowing currency to the revenues collected from customers. However, the rate (23%) is higher than the cost of borrowing from local banks, so is unlikely to be a major source of finance for OGS and cookstove distributors in Burundi. In other markets, TCX is able to offer local currency lending to companies at lower rates than local commercial banks, by offering a mechanism for international lenders to lend to local companies in local currency (this is the case in e.g. Kenya and Rwanda).[82]

Commercial lending to companies is limited in general, with relatively high interest rates and collateral requirements

In general, access to commercial credit is a major barrier to private sector development and competitiveness for businesses in Burundi.[83] The World Economic Forum ranks Burundi's financial institution as 135th out of 140, based on the low levels of financing to the private sector and high occurrence of non-performing loans.[84] High costs of accessing finance affect all companies in Burundi.

There are four main barriers to accessing commercial loans for companies:

[82] For more information, see the TCX webinar on Burundi, accessed on the 20 March 2020, at https://www.gotostage.com/channel/tcx
[83] WEF. (2016-2017) *Global Competitiveness Index: Burundi country profile*. Available at: http://reports.weforum.org/pdf/gci-2016-2017/WEF_GCI_2016_2017_Profile_BDI.pdf
[84] World Bank. (2019) *Doing Business 2019.* Available at: https://www.doingbusiness.org/content/dam/doingBusiness/media/Annual-Reports/English/DB2019-report_web-version.pdf; WEF. (2019) *The Global Competitiveness Report.* Available at: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

- **The loan tenors are typically short** – between six months and two years, which may not be long enough for companies to have rolled out sales networks and recovered revenue from customers.
- **High collateral requirements** – OGS companies report needing to provide 100% collateral to access commercial loans, in part reflecting their small current size, relative lack of exposure to lending so far, and representing a new sector which may be perceived as risky by banks.
- **The cost of debt is relatively high at around 16%.** Commercial lending rates for all SMEs is around 16%, which is relatively expensive for companies looking to establish operations, although not far out of line with the cost of debt from commercial banks in other countries in East Africa.
- **While liquidity in local currency is not a major issue, lack of familiarity with the OGS sector among financiers is a barrier.** There is no shortage of Burundian francs (BIF) for lending. However, access to commercial finance often requires an established track record for companies to be granted a loan, which go to preferred clients first. As the OGS sector seeks to establish itself in Burundi, the financial sector will also have to gain experience in assessing the viability of different technologies, business models, and providers.

As a result, most OGS companies rely on their own resources to meet their financial needs. Given the high cost of debt and collateral requirements to access commercial lending from local banks, and the relatively small scale of OGS companies operating in Burundi, companies tend to finance from their own resources. For example, companies use profits generated in other parts of a larger group of businesses.

This limited access to external finance would represent a challenge to achieving scale. All OGS and cookstoves companies interviewed would need to be able to access finance – either equity investment, debt, or working capital (discussed below) – with a blend of concessional and grant finance needed initially if they are to achieve scale.

External finance options may be available if the market can demonstrate sufficient scale and financial viability

Globally, investment into the off-grid solar sector is on the rise with increasing volumes, and types, of both private and public finance available. As set out in the recently published Off-Grid Solar Market Trends Report 2020, international sources of (concessional) public and private finance are increasingly available to support OGS companies and help them on the path to profitability.[85] However, the vast majority of external finance has gone to a small subset of First-Generation companies, with over 80% of investment since 2010 going to the top 10 OGS providers.[86] Nonetheless, as the larger established First-Generation OGS companies are maturing, they are also better able to build out their offerings into new markets, with many companies now operating across multiple country markets.

Local Burundian OGS importers and distributors will first need to attract seed funding and patient "angel" investors. To date, local OGS companies are self-financed from family resources or from other businesses owned by the founders. No local companies have undertaken Series A (or beyond) fundraising, and to our knowledge none have received external investment in the form of either debt or equity. This is not surprising, given the early stage of development of the market – and other markets have gone through similar stages of finance in the very early steps of market development. At this point, companies will need to attract grants or concessional loans (potentially convertible) to trial products and establish the robustness of business models.

[85] Lighting Global. (2020) *Off-Grid Solar Market Trends Report 2020.* Available at: https://www.lightingglobal.org/resource/2020markettrendsreport/
[86] Wood Mackenzie and Energy 4 Impact. (2019) *Strategic investments in off grid energy access – Scaling the utility of the future for the last mile.* Available at: https://www.energy4impact.org/file/2086/download?token=9-hw5RF1

Once companies have demonstrated initial sales, and customer satisfaction with these sales, access to more mature forms of commercial finance will be needed to drive growth. Once companies have established operations, a transition to external finance will be critical to achieving scale. While grants could continue to play a role, companies will also need to attract Series A and Series B finance to ensure sustainability – for example from other forms of patient capital (e.g. the Acumen Pioneers Fund), or access debt from specialist providers such as SunFunder.

As companies pilot the PAYGo business model and/or other forms of consumer finance, they will need to build experience in managing working capital requirements. While sales through PAYGo or on consumer credit can help address the affordability barrier, it imposes another layer of costs on companies that must provide the capital to deploy technologies up-front, which is then only later recovered through subsequent monthly repayments.[87] Being able to access affordable working capital facilities will be essential to deploying the PAYGo model in a sustainable manner – and international facilities such as the recently launched Solar Frontier Capital now offer working capital to companies who demonstrate a viable business model.

In the short term, financial support will be needed to catalyze the market, and there is an increasingly rich body of international experience to draw on for both supply side and demand side interventions to catalyze off-grid solar markets. For example, Rwanda is in the process of implementing a results based financing (RBF) program to incentivize companies to reach poor and underserved households (Box 1), while a mix of supply side finance and RBF is being implemented to reach underserved districts in Kenya (Box 2).

Box 1 **The 'Pro-Poor' RBF in Rwanda builds on experience from earlier RBF Programs to provide targeted supply and demand side subsidies to reach the rural poor that are not being served by current business models**

Rwanda's 'Pro-Poor' RBF program aims to improve energy access amongst low-income households in underserved parts of the country. An amount of more than EUR 2 million is available, from 2019 to 2021, for RBF incentives to address these barriers.

While OGS penetration has increased rapidly in Rwanda, companies have tended to serve relatively higher income rural customers. Rwandan households are categorized into four 'Ubudehe' categories based on their poverty levels, with Category 1 representing the highest poverty category, and Category 4 relatively more affluent households. Category 1 and Category 2 households are far less well served by OGS technologies, as they face a dual challenge of both having the lowest affordability, and often being the hardest to reach, as they tend to live in more remote rural areas.

To address this challenge, the 'Pro-Poor' RBF offers grants to companies, conditional on serving the poorest households in the poorest regions. The RBF scheme provides a grant to companies based on each unit they sell to a household in Ubudehe Categories 1, 2, or 3 that are living in target off-grid areas identified in the National Electrification Plan – currently operational in five districts in the southern provinces of Ruhango, Gisagara, Nyanza, Nyamagabe, and Huye.

The RBF grant provided to companies must be fully passed on to customers through a reduction in the retail price, with the grant size varying by Ubudehe Category of the recipient. The largest absolute incentive per system is EUR 90 for Ubudehe Category 1 customers, which represents about 87% of the

[87] The additional cost of consumer finance will differ depending on the cost of access to working capital, and the default risk. But a "typical" consumer finance cost would be around 40% annual interest rate, adding around 20% to the total cost of the system (but allowing these payments to be spread over time).

total cost of an entry level OGS system (Table 7). Of the total grant budget 60% is designated to go to Ubudehe 1 households, 25% to Ubudehe 2, and only 15% to Ubudehe 3.[88]

Table 7 Rwanda Pro-Poor RBF -- grant size per system

Ubudehe Category	Absolute Incentive Level	Relative Incentive Level
1	EUR 90	87%
2	EUR 70	68%
3	EUR 50	49%

Source: Consortium; Urwego bank

Box 2 **Kenya's Off-grid Solar Access Project (KOSAP) provides OGS and cookstoves companies RBF subsidies and access to finance to reach underserved districts**

KOSAP seeks to expand access to OGS and clean cooking technologies in underserved regions of Kenya. Despite the expansion of OGS in Kenya, there remain parts of the country which continue to face an energy access gap. These areas typically have a high share of Kenya's low-income households and are often remote and costlier for companies to access. Kenya's Commission on Revenue Allocation identifies 14 counties as 'underserved' based on their high poverty levels, minimal access to modern energy services and high dependency on solid fuels and traditional cooking methods.

For OGS, a debt facility aims to reduce working capital constraints (US$ 30 million). The debt facility for Solar Service Providers (SSP) provides loans for inventory purchasing (with a tenor of 6 to 12 months) and to meet PAYGo working capital needs (with terms of typically 1 to 3 years),[89] based on the company's track record.

A smaller RBF facility is contingent on verified sales in the target regions (US$ 12 million). Companies that are eligible to receive RBF grants are selected based on their business model, supply chains, and suggested methods for using the RBF grant, among other criteria. Companies receive a 'market-entry' grant to help establish operations, and then a subsequent RBF payment upon achievement of pre-agreed sales targets, and a final 'sustainability' grant upon demonstration of after sales care and honoring warranties.

For clean cooking, KOSAP provides a Solutions Challenge Facility which provides result-based financing for actors in the cookstoves supply chain. The objective of the CCS Facility is to address market failures and to establish sustainable supply chains of higher-tier cookstoves or/and cooking fuels through three streams:

i. Ex-ante RBF for Supply Chain Development: provides financial support for demand creation - including market awareness, distribution networks, training of female sales agents, and operating expenses that are directly attributable to customer acquisition.

ii. Ex-ante RBF for inventory: provides financing for product inventory from eligible cookstove manufacturers.

[88] Urwego Bank, Energising Development, EDCL. (2019) *Pro Poor Results-Based Financing Programme Call for Applications*. Available at: https://www.urwegobank.com/wp-content/uploads/2019/11/191107_EnDev-Pro-Poor-RBF_Call-for-applications.pdf

[89] Loan interest rates are typically 16%. For more information on loan products, see https://kosap-fm.org/assets/cfp-documents/solar-debt.pdf

iii. **Ex-post (results-based) incentives**: based on the sales of improved cookstoves, to be paid once sales are verified by an Independent Verification Agent (IVA).

Cookstove companies and artisanal producers have primarily relied on donor funding to finance their operations, while carbon finance and the companies' own funds have played a minor role

The current Burundian cookstove market is heavily reliant on donor funding to drive growth, with limited sources of commercial funding available to expand the market. The absence of external commercial investment is a result of the nascent state of cookstove production, and the high cost of / requirements to access local finance (described above).These challenges are not unique to Burundi. The cookstove market in sub-Saharan Africa has struggled to access commercial investments due to various market barriers. The lack of available market data hinders commercial investments, with a mismatch between investors' expectations and companies' financial and operating performances. Another challenge is related to unpredictable customer demand and variability of products sales, which result in complicated demand forecasting, discouraging commercial investments.

Some initiatives have provided supply side subsidies to scale up production and distribution of cookstoves. Programs such as SAFE and the EU-funded program have focused on the establishment of artisanal production, providing grants for capital investment, while leveraging community-based associations and NGO networks to cover working capital costs and distribution. Stoves have been sold to households both at full and subsidized prices (in some instances with demand side subsidies in the form of vouchers).[90]

On the other hand, EnDev's approach has focused on the development of local manufacturers through capacity building without financial subsidies. Rural artisanal manufacturers have been trained to manufacture the Matawi clay stoves, improving quality control measures and performing stove testing, as well as supporting producers on the development of a distribution network.

Cookstove programs have also accessed international climate finance through the Clean Development Mechanism (CDM). BQS/OBEN is implementing a "Renewable biomass fired improved cookstoves program for households in Burundi by BQS," described further in Box 3.[91] Carbon finance dependent on verified emissions reductions offer a way of monetizing the environmental co-benefits described in Section 3.3. In countries such as Uganda and Rwanda, access to carbon finance has helped achieve sustainable market development without direct dependence on donor or government support.[92] Nonetheless, access to this type of finance is not without cost. Carbon finance adds layers of complexity for project implementers, who must market themselves to prospective credit buyers and navigate a complicated accreditation process. In Burundi, the traceability of verifications and the durability and quality of stoves have emerged as the main challenges for the verification of carbon credits.

Box 3 **Burundi has received international climate finance through the UNFCCC Clean Development Mechanism for the dissemination of improved cookstoves to reduce emissions**

The goal of the program is to provide rural households in Burundi with affordable improved cooking stoves. BQS, through its NGO "Observatoire de l'Environnement et de la Nature" (OBEN), is currently

[90] SAFE programme by WFP
[91] Approved in 2013, renewed in 2019
[92] Climate and Clean Air Coalition. (2016) *Workshop on Existing Finance Models for Improved & Clean Cookstoves & Potential for Innovative Auction Instruments.* Available at: http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/2016_events/AG4_Workshop_9-11_May_2016_-_Benin/Existing_Finance_Models_for_Improved___Clean_Cookstoves.pdf

implementing the project registered under the Clean Development Mechanism (CDM) and supported by the Republic of Korea.[93]

BQS manufactures and distributes 50,000 Matawi stoves as an efficient and emissions-reducing alternative to traditional stoves. Improved cookstoves are manufactured both in Bujumbura and at other BQS sites nationwide, and they are expected to exceed 20% thermal efficiency targets. The stoves are produced at a cost of US$ 4 and sold to customers at the subsidized price of US$ 1 or US$ 2.

In this model, the manufacturer derives much of its profit from the carbon finance payments – which are expected to run well above the cost of stoves themselves. This provides a significant opportunity for local manufacturers to attract financing to increase their production and distribution capacity to serve previously unreachable market segments. It also represents a substantial opportunity to monetize the substantial environmental benefits of ICS (described in Section 3.3), which would otherwise not be captured by the free market resulting in under-investment in emissions-reducing technologies.

To meet the terms of funding from the CDM, targets must be met in terms of thermal efficiency of the stoves, and the number of products adopted. As a condition for payment, sales records and usage by target customers are verified by an independent third party (AERA Group).

To scale up activities, cookstove suppliers will need a combination of affordable capital financing to expand manufacturing, as well as indirect subsidies to develop the value chain

Cookstove companies have relied on their own funds to scale up operations, while artisanal manufacturers have been supported by donor-led activities, which limits their ability to scale up distribution. The two companies producing improved cookstoves, BQS and KTF, have relied both on their own funds and on donor programs to finance the production of ICS. BQS, for instance, has benefitted from grant financing from various programs (e.g. WFP, UNICEF) to sell stoves at a subsidized price for customers and the company is currently implementing a carbon finance initiative that has yet to demonstrate financial sustainability through carbon credits (described in Box 3).

To scale up activities, companies' financing needs include initial capital to cover manufacturing expansion and the establishment of the distribution network, while working capital will be required for expanding customer-service points, sales and distribution channels, as well as marketing and awareness activities. Costs for increased production will be driven by initial capital to purchase equipment and expand capacity of personnel. So far, meeting the costs of personnel has been the largest financial cost, while costs for marketing and promotion have not yet been fully factored into production prices.[94]

In the near term, result based finance (RBF) will likely be needed to accelerate uptake of ICS – and there is a rich international experience that could inform RBF subsidies in Burundi. For example, even in Kenya where many households use OGS and ICS products, the Kenya Off-Grid Solar Access Project (KOSAP) aims to accelerate access to off-grid technologies in underserved parts of the country (Box 2). In a nascent market like Burundi, RBF schemes would need to be embedded into a broader market development program and combine adequate resources for accompanying technical assistance.

[93] (2019) PoA 10474: Improved Cooking Stove Program in Burundi supported by Republic of Korea https://cdm.unfccc.int/ProgrammeOfActivities/poa_db/U2ZYTF1EWXPBHKO069GCLNSDRIQ78A/view
(2013) PoA 9634: Renewable biomass fired improved cookstoves program for households in Burundi by BQS https://cdm.unfccc.int/ProgrammeOfActivities/poa_db/1L6JS9B25W078EXKGFCTQHP3AZN4VM/view
[94] Based on financing needs for BQS

Two major new grant programs financed by development partners are planned to catalyze the off-grid solar and improved cookstoves markets in the coming years

The World Bank and Lighting Global recently announced a US$ 100 million grant program called *'Soleil – Nyikiriza'* to support development of the off-grid energy market. It aims to reach 91,000 households, 4,000 small businesses, 500 schools, and 400 health centers with standalone solar electricity, as well as reaching 300,000 households and 400 schools with clean and efficient cookstoves.[95]

The EU's 'Promoting Resilience in the Burundian Population' program, includes a US$ 7 million off-grid energy component. The program is a partnership with UNDP and the FAO and aims to reach at least 7,000 households with improved cooking and 4,500 with standalone solar technologies. It also includes a separate component to pilot solar water pumps. An overarching component to support financial inclusion will also be implemented, with subsidies for the production of energy products and services, the development of a PAYGo model in partnership with Ecobank and Lumitel, and a fund to support the installation of mini-grids and solar kit sales. Overall, the project aims to reach around 30,000 households across the components of the project, with a budget of almost US$ 7 million. The provinces targeted are Kirundo, Karuzi, Makamba, Rutana, and Cankuzo, located in the North, East, and South of the country.

5.3 Access to consumer finance and digital payment mechanisms

- Access to banking services remains very low, reflecting limited reach of bank branches and costs of setting up an account
- Access to telecommunications and mobile money is increasing, although in rural areas most households do not own, or regularly use, a mobile phone
- There has been no use of consumer financing for ICS so far, but there are opportunities to use VSLAs and other village-based organizations

Access to banking services remains very low, reflecting limited reach of bank branches and costs of setting up an account

Only around 10 – 20% of households have access to a bank account, with women far less likely to have access to financial services. Nationwide 11% of men have a bank account compared to just 5% of women. As would be expected given the concentration of bank branches in Bujumbura Marie, access to banking is heavily concentrated in urban areas, where 20% of women have a bank account compared to just 3% in rural areas.[96] Furthermore, due to the absence of an inheritance law, 91% of women do not own land or property to meet collateral requirements, further reducing their ability to access credit. While the majority of women (69%) participate in households decision making over important purchases, men have decisive control on how women's income should be spent, and only 21% of women decide how to use the money they earn.[97]

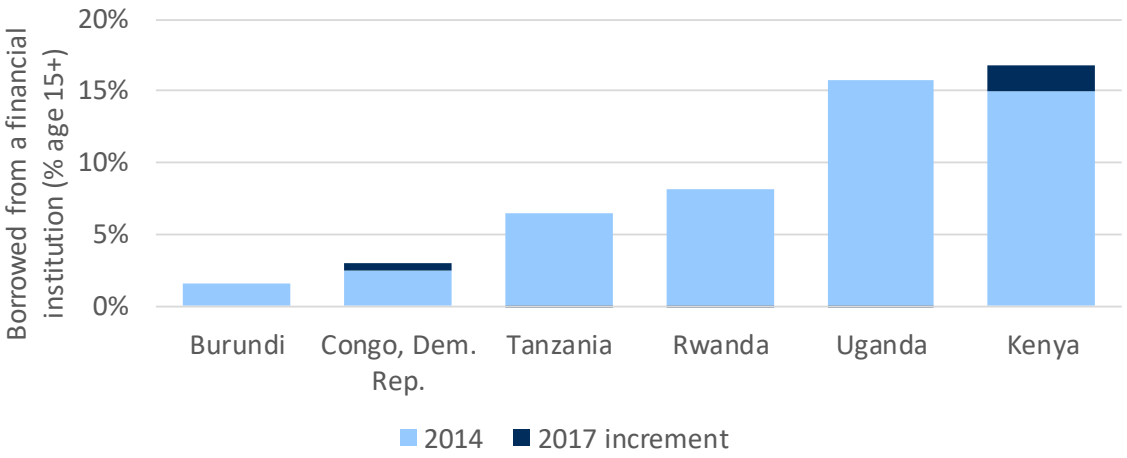
[95] The World Bank. (2020). Press release, *Burundi to Improve Access to Services and Opportunities for the Poor in Rural Areas.* Available at: https://www.worldbank.org/en/news/press-release/2020/02/28/burundi-to-improve-access-to-services-and-opportunities-for-the-poor-in-rural-areas

[96] ISTEEBU. (2016-2017) *Troisième Enquête Démographique et de Santé au Burundi (EDSB-III).* Available at: https://www.isteebu.bi/images/rapports/eds%20burundi%20%202016-2017%20-%20rapport%20des%20rsultats%20prliminaires.pdf

[97] Ibid

Access to credit is also amongst the lowest in the world, with Burundians far less likely to have borrowed from a financial institution than people in neighboring countries (Figure 26).[98]

Figure 26 Less than 5% of the population have borrowed from a financial institution in Burundi, compared to 15% in Uganda and Kenya



Note: There is no available data for Burundi post-2014
Source: Consortium analysis of Global Financial Inclusion data

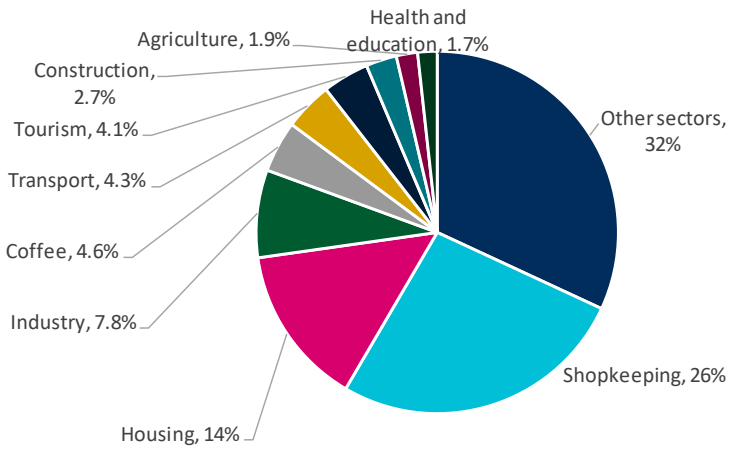
Access to microfinance is expanding and has greater geographical reach than banks. The value of MFI lending increased by 58% between 2016 and 2018, and although the cumulative value of MFI loans is far lower than those provided by local banks, they are far more equally distributed across the population. For example, MFI cooperatives provide 7 loans per 1,000 adults nationwide compared to just 1 loan per 1,000 adults from banks.[99]

Some microfinance institutions such as WISE specifically target women members and offer basic training on financial inclusion alongside lending products. Often loans are targeted to income generating activities, mostly agricultural loans based on seasonality needs. Gender-specific barriers in accessing microfinance include women's lower education levels and lack of collateral to get access to capital. In addition, socio-cultural norms hinder women's participation in entrepreneurial activities, resulting in them being risk averse towards starting a business and accessing microfinance.

MFI loans typically have an effective annual interest rate of around 40%, with regular monthly repayments. Interest rates offered by MFIs can range from, for example, 2% per month for short term (6 month) loans with limited or no collateral required, to sometimes lower rates for longer tenor loans, which have stronger collateral requirements.

[98] CGAP. (2009) *Financial Access 2009: Measuring Access to Financial Services Around the World.* Available at: https://www.cgap.org/sites/default/files/CGAP-Financial-Access-2009.pdf
[99] Ibid

Figure 27 Distribution of loans from banks and MFIs by sector



Source: Vivid Economics

Village savings and loan associations (VSLAs) also play an important role in improving access to finance for rural Burundians, with over 4,500 VSLAs in total. VSLAs emerged in 2009 to bring together household savings and to provide credit to members, through the pooling of resources.

The VSLA model can also help increase access to financial services among women. Women often rely on savings associations and women's groups when they face economic problems, for example, to cover health expenses or receive support when agricultural production falls short.[100] Women often seek credit from women's groups as a dignified choice compared to requesting credit from formal institutions. Those who do participate in VSLAs tend to see an increase in income and financial contributions to the household, together with greater influence in the economic decision-making and improved self-esteem.[101]

Group loans have been used by Burundian MFIs to encourage uptake and repayment of financial products. A group repayment model allows households to afford credit by pooling resources for repayment and sharing risks between themselves. Risk-sharing within a small community can improve repayment rates on any credit taken, as any individual's default will have both social and financial repercussions. These benefits are similar to those provided by VSLAs.

Social safety nets and cash transfers can also provide a means of targeting consumer finance to vulnerable households. Box 4 describes the Merankabandi project, which reaches 50,000 of the most needy households in the north and east of the country – and a similar approach could be used to target demand side subsidies to improve access to OGS products.

Box 4 **The Merankabandi program provides a targeted cash transfer and strengthens social safety nets for the poorest households in the northern and eastern provinces.**

The Ministry of Human Rights, Social Affairs and Gender, with support from the World Bank, began implementation of the Merankabandi program in 2017, and it will run until 2022.[102]

[100] CARE. (2019) *Gender Equality and Women's Empowerment Programme, GEWEP II 2016 – 2018 Burundi, Rapport de l'évaluation finale*. Available at: https://www.careevaluations.org/evaluation/gender-equality-and-womens-empowerment-programme-gewep-ii-2016-2018-burundi-rapport-de-levaluation-finale-mars-2019/

[101] Ibid

[102] World Bank. (2019). *BI Social Safety Nets (Merankabandi).* Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P151835

The program has already exceeded its target reach in providing cash transfers to over 50,000 beneficiaries in Gitega, Karuzi, Kirundo, and Ruyigi, through an IDA grant of US$ 40 million. It is the precursor to a national program which would aim to reach the poorest (1st quintile) food insecure households.

A beneficiary database and targeting process identifies the most vulnerable households, and households with women and young children. Over 130,000 potentially eligible households were identified, of which 50,000 of the most vulnerable were selected to participate. Households were selected based on (i) having at least one child aged 0 – 12, (ii) a "proxy-means" test, which included estimated poverty levels and other indicators including access to social services, health, disability etc.

The regular monthly transfer is BIF 20,000 (around US$ 10), which corresponds to 40% of the national food poverty line. Households receive the cash transfer for 2.5 years and also receive training and support to develop economic activities for this period as well as an additional six months. This latter "foundational human capital" component includes facilitating access to information, communication and education designed to encourage the adoption of positive behaviors towards strengthened nutrition, early childhood development, school attendance, and income generating activities.

The experience gained from the Merankabandi project could be leveraged to understand how best to improve access to basic energy services among the rural population. In particular, the project has already identified over 130,000 vulnerable households in four provinces in the north and north east, which could form the basis for targeted subsidies to help vulnerable off-grid households gain access to energy technologies. The experience of working with households to provide training and help develop economic activities could also be used, in conjunction with access to OGS or clean cooking technologies.

Merankabandi has also used mobile money to make the cash transfer instalment payments through Ecocash. In some cases, this did require distribution of mobile phones to beneficiaries to enable use of mobile payment platforms. In some areas, where there is no mobile network, "cash out" agents are used instead.

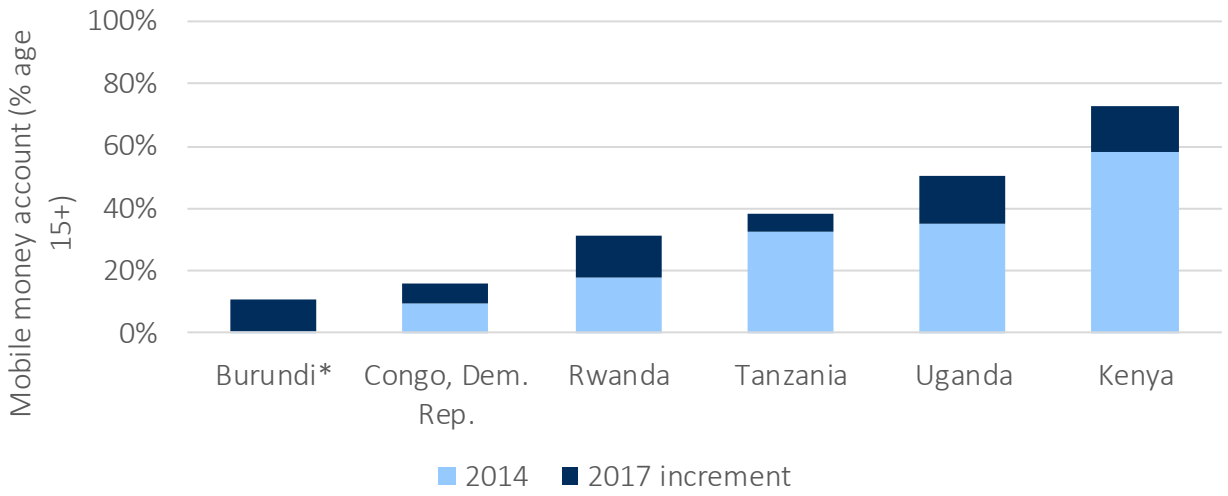
Access to telecommunications and mobile money is increasing, although in rural areas most households do not own, or regularly use, a mobile phone

Mobile money is bringing digital payment services to rural customers – and now reaches approximately 10% of the population. The two main national telco companies – Econet and Lumitel – have rolled out mobile money which now reaches between 500,000 and 1 million subscribers. Smart Burundi has also developed a mobile money offering (Smart PESA), although this remains largely concentrated in urban areas. In 2018, there were BIF 700,000 million (c. US$ 370,000) worth of mobile money transactions and between 30,000 and 40,000 retail agents across the country.[103]

Mobile network coverage could enable mobile money across around 95% the country – the larger constraint is lack of ownership and use of mobile phones. Together, Econet and Lumitel's 2G networks cover 95% of the population, meaning most of the country has sufficient network coverage to enable simple SMS based mobile money payments. However, as described in Section 3, less than half of the rural population owns a mobile phone. And even those who do, often do not regularly use these phones, in part as they cannot easily (and affordably) access electricity to charge their phones.

[103] BRB. (2019) *Rapport Annuel de de la Banque de la République du Burundi 2018.* Available at: https://www.brb.bi/sites/default/files/Rapport_annuel_2018_complet-min.pdf

Figure 28 Penetration of mobile money accounts in Burundi falls behind neighboring countries



Note: * Data for Burundi in 2014 is from the World Bank Finclusion data set, which has been updated to present day for the "2017 increment" based on in-country consultations

Source: Consortium analysis of World Bank Finclusion data, and for Burundi data reported by telco companies during consultations

Emerging partnerships between mobile money providers, OGS companies, and finance institutions can help support deployment of PAYGo business models. Digital payments decrease the operational costs PAYGo businesses and MFIs face when distributing or receiving payments from rural customers. These benefits are driving new partnerships between mobile money providers and other actors in the OGS supply chain. Econet reports partnerships with Greenbox, ITCO, and One Acre Fund, for example. At the same time, Lumitel and Econet both report working with commercial banks and MFIs, such as FinBank and WISE, to provide deposit and withdrawal services. Similarly, the forthcoming EU-funded *"Energy services for the resilience of the rural population"* program will also work in partnership with Lumitel and EcoBank to deliver OGS products to cooperatives.

Digital information platforms reach around 60% of households through associations, providing increasingly granular information about household ability and willingness to pay, and offering potential digital payment services. The most widespread digital platform in Burundi is provided by Auxfin, which provides a tablet to associations of households, through which users can then access a range of information services (such as localized weather forecasts and crop information), and potentially access e-banking services and manage (group) accounts with MFIs. Most recently, Auxfin has launched a program with Brarudi for sorghum farmers, where farmers are paid BIF directly to their e-account using the Auxfin platform. The platform could offer an effective way to provide e-payment services, as transactions could be provided for free (compared to mobile money platforms which charge a fee per transaction).

There has been no use of consumer financing for ICS so far, but there are opportunities to use VSLAs and other village-based organizations

Asset financing has not been used in Burundi so far, mostly due to the low awareness of improved cookstoves among finance institutions and households. Financing entities such as microfinance organizations are not active in lending specifically to enable the purchase of cookstoves and they may be unwilling to provide credit for such products due to the high perceived risks of a relatively new sector, and for a product

which neither directly generates income, nor provides a physical asset which can provide collateral on the loan.

VSLAs play an important role as last mile distribution for solar products and in some cases for cookstoves, and could be a provider of consumer lending. These organizations could play an increasingly important role in providing credit to members to purchase improved cookstoves – for example following a similar model to that developed working with financial services associations and village banks in Kenya (Box 5).

Box 5 **Lessons learned from tailoring consumer financing for improved cookstoves: a case study from a Microfinance Institution in Kenya**

K-Rep Development Agency (KDA) has developed and implemented financial products for access to energy solutions, working with Financial Services Associations (FSAs) or Village Banks in Kenya.[104] KDA offers financing mechanisms to enable target customers to acquire clean and improved cookstoves (BURN Jiko Koa, Ecozoom Jet and Dura, Wisdom Innovations, and Jiko Smart), as well as solar products. Loans are implemented through the FSAs, which are community owned and managed financial institutions through which members can access a range of financial services.

To leverage the FSAs' network of household customers, KDA works with youth groups and "green" entrepreneurs to approach local savings groups to create awareness of the fuel savings and health benefits of improved cookstoves. These entrepreneurs sell cookstoves to the savings groups and earn a commission for each product sold. This approach helped overcome awareness barriers and low ability to pay for the upfront cost of improved stoves.

Prices are tailored to customers' ability to pay based on energy costs savings. The customer pays an upfront deposit for the stove of around 10% of the product cost, with the remainder of the loan typically paid off over 3 months. KDA encourages customers to start weekly loan instalments derived from energy fuel savings. This approach has proven to be attractive for women who are able to meet the capital cost of acquiring energy-saving cookstoves through the small savings gained from the reduced cost of cooking of an average of KSH50 per household per day. Repayments are collected via mobile payments directly to KDA and via the young entrepreneurs' network who collect the group repayments at group meetings.

The appropriate mode of consumer finance for cookstoves differs by customer group – in particular depending on whether a household collects or purchases firewood or charcoal.

For fuelwood/charcoal purchasing households, the economic benefits of purchasing less fuel creates a straightforward and potentially compelling argument for the adoption of improved cookstoves. For this customer segment, if the savings from reduced fuel cost expenditures represent a convincing argument for cookstove adoption, the estimated payback period can be calculated based on the different improved cookstoves proposed. An entry point to market cookstoves to this customer segment would be to design marketing and sales strategies based on payback periods with respect to demonstrated fuel cost savings. For this approach to be effective, stoves need to meet quality standards and have a guaranteed lifetime, and maintenance and after sales services need to be ensured (further discussed in Section 6 below).

For households that collect firewood at no (or nominal) cost, the main challenge lies in the incentive structure for this market segment, since collection rather than purchasing does not have a clear financing incentive for households. In addition to targeted messaging about the co-benefits emerging from the adoption of improved cookstoves, subsidies may be needed to reach this customer segment.

[104] Global Alliance for Clean Cookstoves (2015) Consumer finance models for clean cookstoves. Global Mapping

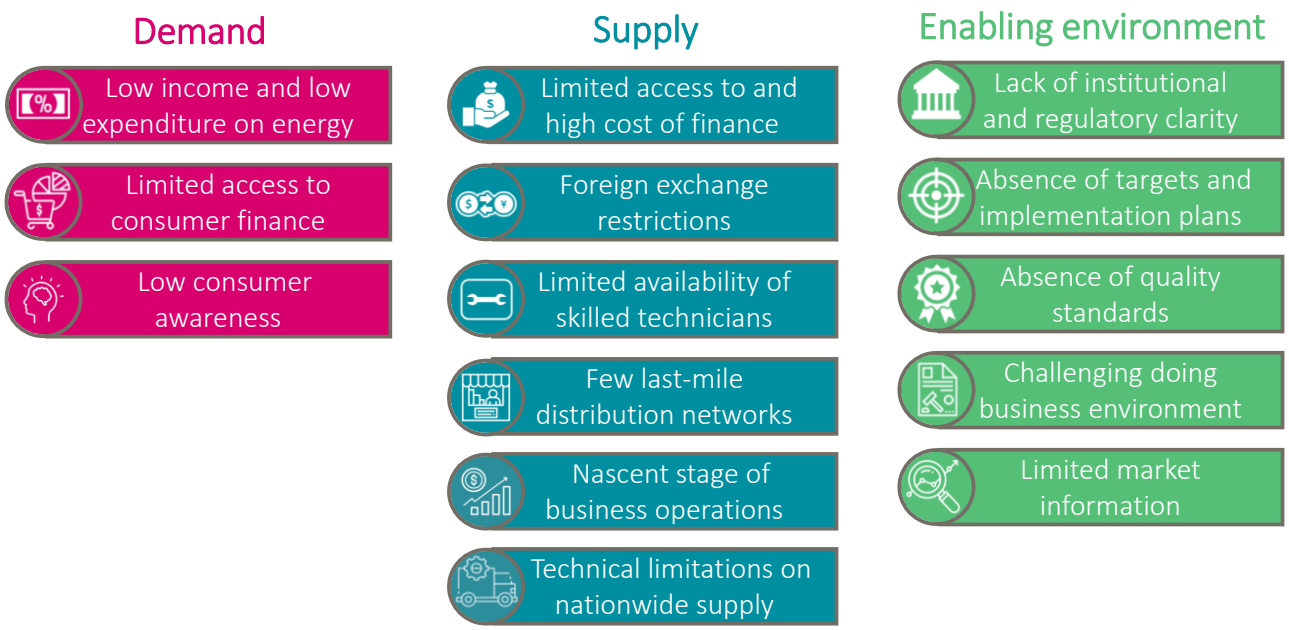
6 Barriers to market growth

6.1 Overview of market barriers

Burundi's off-grid solar and clean cookstove markets face a range of barriers to scaling up, organized as those relating to (i) catalyzing demand, (ii) supply side constraints to reaching customers, and (iii) the broader enabling environment (Figure 29). Each of these barriers are then mapped to potential solutions in the corresponding sub-sections below.

- **Demand,** which includes factors that affect the size of the addressable market, such as the ability of consumers to pay for, or access consumer finance for, OGS and ICS products.
- **Supply,** which includes factors that directly affect the cost of supplying OGS products and improved cookstove solutions and the quality of provision, such as the high cost of accessing finance and the limited availability of skilled technicians.
- **The enabling environment,** which includes factors that indirectly affect consumer demand and levels of market entry, such as the absence of clear targets for off-grid energy, and the lack of a policy framework or quality standards.

Figure 29 Barriers to market growth



Source: Consortium

The most critical barriers that will need to be addressed to catalyze private sector investment and provision of standalone solar and clean cookstoves for households are:

1. **Low consumer affordability in rural areas nationwide, and relatively low familiarity with OGS and clean cooking technologies.** As described in Section 3, only 50% of households can afford even a basic solar lantern. For cookstoves, while access to improved cooking technologies would reduce time and money spent on fuelwood, in the context of a relatively low wage economy where many households collect fuel (for free), access to more efficient technologies may not immediately translate into financial savings for recipient households. For both technologies, low affordability is

exacerbated by relatively low consumer awareness, and some mixed experiences with the quality of new technologies (particularly for cookstoves).

In the short term, results based finance should be used to catalyze the market for off-grid energy technologies, based on verified sales in target regions reaching the rural poor (described in Section 6.2).

2. **Limited access to hard currency, and volatility in the exchange rate.** As described in Section 5.1, access to foreign currency is restricted. Local businesses require US$ to purchase and import hardware, while international companies need to be able to convert revenue streams collected in BIF to US$ if they wish to repatriate profits.

   There are short-term solutions to this challenge. For example, provision of foreign exchange facilities, as implemented by the Development Bank of Ethiopia to address the same issue (see Section 6.3 for more information). These interventions will be a necessity until there is a more liquid market for foreign exchange in Burundi.

3. **Small scale and limited track-record of OGS and cookstoves providers, which is insufficient to attract international finance.** The private sector remains small and reliant on its own financial resources, with very limited access to local or international sources of external finance.

   In the short term, companies will need to continue to pilot technologies and business models to achieve scale. Once a path to scale and financial viability can be demonstrated, several international companies and investors have expressed strong interest in the market (but all would require a strong and trusted local partner).

4. **Limited experience and capacity among policy and regulatory agencies.** The policy and regulatory framework is nascent, and while there is a clear drive among government agencies to facilitate development of off-grid energy technologies, this will need to be translated into clearly defined targets, with a clear (and resourced) implementation plan.

   In the short term, government agencies should be supported in developing a favorable policy and regulatory environment, along the lines established in GOGLA's Guidance for Governments.[105] In particular, short term priorities include developing an integrated national electrification plan with a clear and well-resourced action plan for off-grid energy technologies, recognizing and implementing internationally-accepted quality standards (such as Lighting Global Quality Standards), robust implementation of import duty exemptions for all off-grid solar kits and components (described in Section 6.4), and raising public awareness to build consumer confidence.

[105] GOGLA. (2019) *Providing Energy Access through Off-Grid Solar: Guidance for Governments.* Available at: https://www.gogla.org/sites/default/files/resource_docs/energy_access_through_off-grid_solar_-_guidance_for_govts.pdf

6.2 Demand

Barrier	Relevance to Burundi	Potential solutions	Implementation
Low affordability	Average incomes, and consumption expenditure are low, with only around US$ 4 per month spent on energy services. Very limited purchases of OGS products to date, mostly solar lanterns. For cookstoves traditional three stone stoves are very low cost (or free), and most fuel is collected for free.	Focus OGS and cookstoves sales on relatively cheaper, lower tier systems, such as solar lamps and basic clay Matawi stoves	• Provides products at appropriate price point – likely to be more commercially viable. • May increase total HH expenditure on electricity if need to supplement lamp with other energy sources. • Only incremental improvement in quality of electricity access
		Support different models of stoves based on target segments (urban vs rural, charcoal vs fuelwood consumers) and on their fuel purchasing patterns	• Differentiating target segments will drive adoption, with a part of the population being able to purchase higher tier stoves with additional co-benefits (health, emission reductions). • Urban and higher income households can act as early adopters of more efficient and cleaner cookstoves, increasing trust and confidence in the product and acting as a catalyst for driving larger customer demand.
		Provide targeted subsidies to companies to reach poorer segments of the population	• RBF grant or subsidy awards should be at least partly conditional on verified sales of OGS or cookstoves products, to ensure target populations are reached. • For example, the Pro Poor RBF implemented by EnDev in Rwanda will offer up to 90% capital subsidies for companies selling to underserved, poor households, while KOSAP in Kenya provides subsidies to companies selling in 14 underserved counties, to support expansion into remote areas (Box 2).
		Provide direct demand side subsidies (i.e. conditional cash transfers) to households	• Could build on experience of existing cash transfer programs, such as Merankabandi (described in Box 4). • Cash transfers need to be designed carefully so as not to distort the market and create an expectation of subsidized products in the long run, which could jeopardize commercial market development.
		Promote consumer financing	• Described below
Limited access to consumer finance	Limited access to formal banking services and to MFIs. Women's ability to access financial services is extremely low, with only 5% of women having a bank account.	Partnerships with MFIs to offer loans to purchase OGS products (or cookstoves)	• MFIs, including VSLAs and cooperatives, are well placed to lend to the OGS consumer market, due to their access to rural households and understanding of HH credit ratings. • Success of MFI partnerships will depend on attractive terms on OGS credit, which is not guaranteed if MFIs see OGS as a risky sector.
		Train loan officers in Financial Institutions (FIs) on the range of OGS products and current business landscape	• Improved understanding of OGS products can increase the familiarity of FIs with the OGS sector. This can reduce the interest rate requirements on financial products.
		Concessional finance lines to FIs to reduce interest rates on loans	• Concessional financing can help to lower risk of non-repayment for lenders, resulting in lower interest rates for HHs.
		Leverage VSLAs, focusing on women's groups to increase access to finance for cookstoves	• Women's networks and savings groups are well positioned to increase credit access and to lower risks for microfinance institutions

Barrier	Relevance to Burundi	Potential solutions	Implementation
		A loan guarantee fund to participating FIs for loans to HHs to purchase OGS or improved cookstoves	• By decreasing risks faced by FIs, the fund can help to lower loan interest rates and increase affordability. • Should ensure adequate due diligence is done by FIs, to prevent an increase in poorly performing loans.
Low consumer awareness and consumer confidence	Customers are not widely familiar with OGS or improved cookstoves, in part due to very low product penetration to date. Lack of awareness of the full range of benefits from OGS and ICS adoption (including health, environment, etc.). Quality matters in building consumer confidence.	Sector-wide market awareness and education campaigns amongst rural households, to increase their understanding of products and how to purchase them, including environmental and health awareness	• Marketing can help to stimulate demand by communicating a product's benefits to individual households. • Messaging should communicate about the clear advantages for users, including fuel economy, durability, ease of use, low price, and cleanliness. These co-benefits often outweigh the perceived benefits of traditional stoves in the longer term, but it will take time to change often "sticky" cooking habits. • Targeted promotion strategies should consider different customers' needs, existing product penetration, price sensitivity, and influence of opinions leaders (e.g. church) at the local level.
		Establish customer feedback systems to improve operations and customer satisfaction	• Digital platforms like Auxfin, and PAYGo platforms like Angaza, can collect very valuable information on repayment rates, and customer preferences.
		Inclusive development of quality standards and after sales services to build consumer confidence	• Development of quality standards discussed in section 6.4 below.

6.3 Supply barriers

Barrier	Relevance to Burundi	Potential solutions	Implementation
Limited access to and high costs of finance	The cost of commercial debt is high (c. 16%), with stringent collateral requirements. Most businesses finance projects using their own resources, with limited access to external finance. Limited experienced selling to consumers on credit and of working capital needs for e.g. PAYGo.	Concessional finance for the purchase of inventory, and provision of working capital	• Could support PAYGo business models that help to increase affordability of OGS products. PAYGo businesses have particularly high working capital requirements. • In Kenya, KOSAP provides RBF working capital and inventory subsidies (Box 2). • Increasing availability of financing vehicles that provide more affordable working capital, including e.g. Solar Frontier Capital, although these would need to see a (even if short) track record of sales and financial viability.
		Guarantee (full or partial) for FIs lending to OGS and cookstoves companies	• Decreases risks for FIs, leading to lower loan interest rates and reducing collateral requirements for companies. • Could reduce level of due diligence by FIs, leading to an increase in poorly performing loans in the OGS sector. To limit this risk, the guarantor could pre-verify eligible companies.
		Flexible, risk-tolerant financing for cookstove providers to foster promising and viable business models and technologies	• The early stage cookstove market would benefit from concessional finance that supports producers to test and validate their business models and technologies.
		Technical assistance to standardize and simplify loan appraisal processes	• Faster and more efficient processes could help to lower administrative costs for FIs, leading to lower interest rates on loans. • Centralized funding windows for renewable energy projects, such as that implemented through the Renewable Energy Fund (REF) in Rwanda or through banks such as IDCOL in Bangladesh, can build core skills in a strong institution to foster investment into off-grid energy companies.
Foreign exchange restrictions	Access to hard currency is limited and there is a wide divergence – up to 50% - between the official exchange rate and the shadow (i.e. unofficial "black market") rate.	Foreign exchange facility capitalized by partners to provide priority access to forex for quality OGS products	• As an example, to address a similar challenge in Ethiopia, a Development Bank of Ethiopia credit facility included a financing facility worth US$ 40 million, capitalized through World Bank funding, so local companies could access US$ to purchase quality-verified OGS devices. Loans could then be repaid in local currency (matching revenue streams), and a grant fund was established to help companies meet collateral requirements. • International financiers could pay US$ denominated purchase orders directly on behalf of local companies. For example, SIMA Funds offers a range of senior debt instruments including working capital, inventory finance, receivables finance, and distributor finance.

Barrier	Relevance to Burundi	Potential solutions	Implementation
		Foreign currency hedging provided by third party intermediaries (such as TCX, or MFX)	• International currency hedging services are increasingly available and affordable – including specifically for OGS companies through providers such as TCX and MFX. • For example, FMO's US$ 32.5 million loan facility (US$ 17.5 million provided by FMO, and US$ 15 million from Symbiotics) to Zola Electric Tanzania was made available in local currency, with the hedge provided by TCX. • However, given uncertainty on macroeconomic fundamentals in Burundi (e.g. GDP growth, and the divergence between the official US$ exchange rate and the well-publicized shadow US$ exchange rate), hedging is relatively expensive, and unlikely to represent affordable finance for OGS companies in the near term.
Limited availability of skilled technicians	Limited trained professionals / experience in installation and maintenance of OGS products. Artisanal cookstove manufacturers need training to produce quality stoves, with limited experience to date.	Capacity building for training local technicians for installation and maintenance, including development of curricula, vocational training, and technical certification.	• Ongoing capacity building could be provided through a (relatively light touch) TA facility working to capacitate local engineers on installation and after sales service. This could include working with industry associations such as BUREA, or a market accelerator / dedicated TA facility. • Alternatively, partnerships with international OGS companies would also bring access to technical expertise and advisory services, in which case these skills will develop organically.
		Increase the technical capacity of cookstove producers, supporting stove testing and quality control	• Producers that meet standardization requirements are more likely to drive customer demand and trust in the technology • Producers will be able to attract financing such as carbon finance if they demonstrate technical production standards
		Facilitate knowledge transfer from neighboring countries	• Knowledge transfer activities from neighboring countries increase regional cooperation and integration
Lack of last-mile distribution networks	Very few companies operate nationwide distribution networks (e.g. Brarudi, Telcos, Savonor). Distributing ICS in rural areas is costly and transport is a considerable driver of costs if stoves are to be distributed at a larger scale.	OGS partnerships with existing distribution networks of companies, to distribute and sell OGS goods to rural customers	• Companies could form partnerships with existing networks of retail agents. For example, telco or mobile money agents could also offer OGS products, as improved access to electricity increases mobile phone charging and has positive returns on mobile money use. • Examples include e.g. CIZO in Togo, where government provides preferential tariffs to OGS providers for use of state-owned distribution channels, such as the postal network for transport and warehousing. • Partnerships with, e.g., Telcos have been instrumental to market development in other countries – with Lumos leveraging MTN's customer network and branding in Nigeria, and d.light recently launching a partnership with 9Mobile (also in Nigeria) to sell d.light products through the mobile network operators' retail network.
		Community-based organizations, VLSAs and other local groups could be leveraged to penetrate hard-to-reach rural areas	• The use of village-level organizations has demonstrated to be effective for product dissemination and as a marketing strategy. • Sales to consumer associations rather than individual households could serve as a good approach to both establishing last mile distribution (LMD) networks and to boosting affordability.

Barrier	Relevance to Burundi	Potential solutions	Implementation
		Customers that promote stoves to other customers could be offered rewards or cash incentives from producers or retailers	• Finding champions in communities and providing incentives for the sale of cookstoves is a successful dissemination strategy adopted in other similar contexts.
Nascent stage of business operations	Private sector operators are small and inexperienced, and not yet able to attract commercial finance. The majority of cookstove producers are working on a small scale and are not yet able to scale up production while maintaining quality.	Government / donor financial support to early stage market development	• International investors will only invest in Burundian companies once there is a sufficient track record and demonstration of sales, and path to financial sustainability.
		Provide technical assistance for business development, marketing and sales support for artisanal production	• With clear management and ownership structures, artisanal producers have the potential to become sustainable after donor interventions, if their business and sales capacity is increased.
		Support financial capacity of companies through demonstration of improved performance against reportable indicators	• Building financial capacity of companies to demonstrate improved performance can enable them to comply in the future with Result Based Financing models.
Technical limitations on nationwide supply	Sustainability of input materials for cookstove production (i.e. clay) and fuels (wood, briquettes) is not well understood and may be an important constraint to scaling up.	Assess national / regional availability of raw materials, including the environmental impact of extracting these resources	• Local production can ensure lower costs and distributed manufacturing, increasing opportunities for skilled labor and faster rates of repair and maintenance services.
		Promote hybrid approaches that make use of central manufacturing for some components (e.g. metal sheet) and local production for other stove parts	• Successful local assembly techniques combined with mass production of critical stove components off-site and local distribution can be efficient in maintaining low production costs for more efficient stoves.

6.4 Enabling environment

Barrier	Relevance to Burundi	Potential solutions	Implementation
Lack of institutional and regulatory clarity	Limited experience of off-grid energy among institutions in Burundi, limited "ownership" of policy and strategy development and implementation, and limited cross-sector coordination.	Build capacity among government entities that have responsibility for the OGS sector	• As policy and regulatory departments take on responsibility for driving development of the sector, they will need support – in particular technical assistance – to learn from a rich body of international experience.
		Establish cross-agency steering committee to spearhead off-grid market development	• The Focal Group working on design of the World Bank and Lighting Global "Soleil" program could form the basis for this function.
		Set up sector-wide task force to bring together public agencies and the private sector	• For example, in Sierra Leone, the *'Energy Revolution Taskforce'* brings together the energy ministry, international donors, and the private sector. It has helped develop capacity of the renewable energy association, and the implementation of quality-linked VAT and import tariff exemptions for OGS products.
Absence of targets and implement ation plans	No clear targets for OGS and cookstoves, and no clearly defined/resourced implementation plan.	Develop clear and realistic OGS and cookstove targets for next 5 to 10 years	• Target setting will not by itself result in improved outcomes unless supported by a supportive policy environment and a well-resourced implementation plan. • Targets could initially be set in national policies and strategies, and/or be enshrined in legal codes through, e.g., a Renewable Energy Bill.
Absence of quality standards	Currently no national standards framework in place for either OGS or cookstoves.	**OGS:** Develop quality standards and testing (both lab and in the field) for OGS products	• Ensures products can reliably meet the energy needs of Burundian households, helping to improve long-term customer satisfaction. • There is a risk of over-regulation if new standards are restrictive – standards must be suited to products that consumers in Burundi can afford. • Recommend standards adopted in line with Lighting Global Quality Standards and IEC/TS 62257-9-5 test procedures, with pre-verification of conformity (PVOC) prior to importation, to accelerate the process. Meeting these standards should be a condition for receipt of supply side subsidies.
		Cookstoves: Develop quality assurance standards and adapted testing capacity and norms (both lab and in the field) for cookstove products and tend towards international ISO norms for harmonized lab protocols	• Adapt the standards on cookstove harmonized lab protocols and the technical report on vocabulary (ISO TC 285) within national regulations. By emulating ISO standards, national policies will build on international best practices and be harmonized with each other, which can facilitate trade. • Local manufacturers that comply with ISO laboratory testing and standardized reporting can benefit from other measures, such as marketing approval requirements and appliance labels. • The determination of locally adapted standards and protocol criterion for product selection in donor programs ensures the dissemination of high-quality products. • Regional Testing and Knowledge Centers (e.g. Uganda, Kenya) could be used to confirm test samples of stoves made in Burundi.

Barrier	Relevance to Burundi	Potential solutions	Implementation
Challenging doing business environment	Lack of clarity in the policies and inconsistent application of these policies on customs duties and import taxes.	Fully adopt and implement EAC import and customs duties	• Clarity over business costs can reduce the likelihood that the law will be inaccurately applied, decreasing risks for businesses.
		Capacity building for regulatory agencies, OBR, and customs officers to make sure policy consistently applied	• Effective enforcement is essential alongside development of quality standards. • Border officials will need to be trained on how to interpret import codes and policies to ensure consistent treatment across different of- grid energy product categories and kits.
Limited market information	Limited information sharing / awareness among stakeholders, and limited monitoring and evaluation.	Market awareness campaigns and information sharing activities	• See Section 6.2. • Publication of this market assessment. • Attendance of key stakeholders at regional workshops, such as the recently held Off-Grid Solar Forum and Exposition in Nairobi (February 2020).
		Support companies to prioritize data collection to increase market information and learning	• Gender-disaggregated data on demand preferences, affordability, and fuel patterns. • Support companies in collecting user data and customer feedback to monitor adoption. • A central “accelerator” program could provide a forum for shared experience and best practice among OGS companies and financiers, for example drawing on the experience of the Uganda Off-Grid Market Accelerator.

7 Recommendations to catalyse the markets for off-grid solar and improved cooking

Both the off-grid solar and the improved cookstove markets are at an early stage of development comprised of relatively young companies. As described in this report, there has been very limited sale of either OGS or ICS to date, with estimated product penetration below 5% of the potential market in both cases. In the case of cookstoves, providers are small – often at artisanal scale. Only international NGOs have so far achieved over 10,000 unit sales of either OGS or ICS to date.

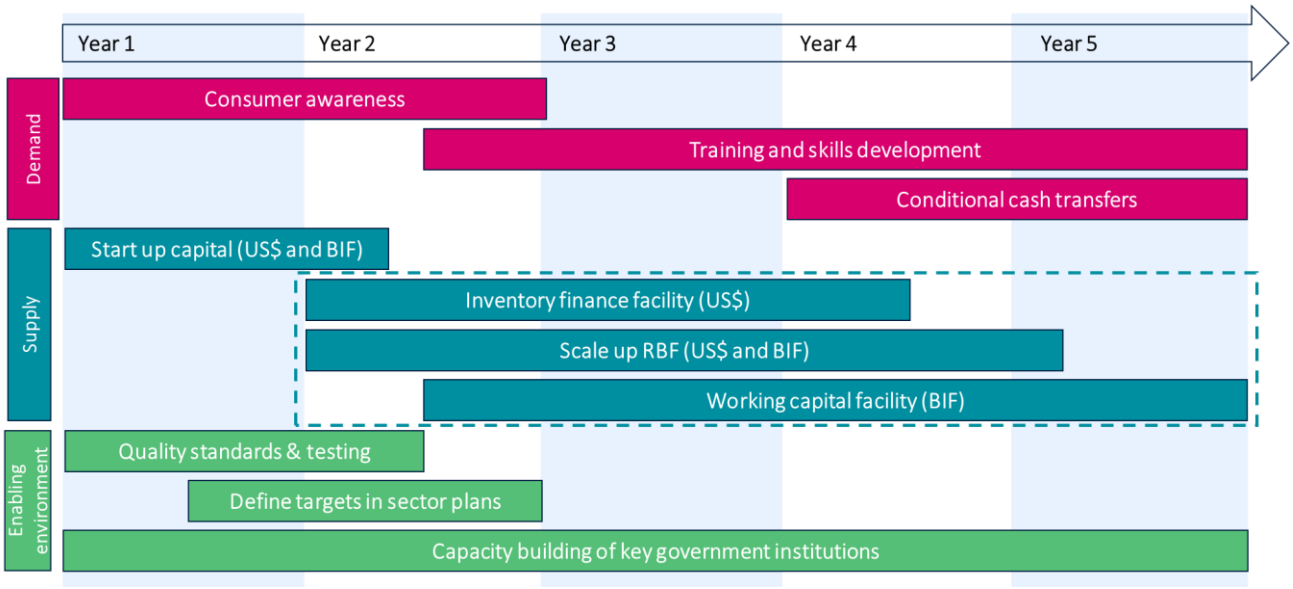
While access to OGS and ICS would deliver important socioeconomic benefits to households, a number of barriers mean it is unlikely that OGS and ICS markets will reach their potential quickly. In particular, very low affordability coupled with a lack of familiarity with the technologies and their potential benefits means consumer demand will not mobilize rapidly in the immediate term. Furthermore, companies lack access to both the finance and the technical expertise to achieve scale, while policy makers and regulators are still establishing their role in fostering the growth of what is a new market in Burundi.

In this context, financial and technical assistance will be needed to catalyze the market and crowd in external finance in the medium term. Grants and concessional finance can play a key role in fostering the development of sustainable commercial business models. Some macroeconomic barriers cannot be addressed through interventions alone, but these interventions can contribute to stimulating demand and helping suppliers establish themselves so that markets are ready to develop as the macroeconomic conditions improve. Interventions should have a clear exit strategy, with decreasing reliance on concessional funding in the medium term and a long-term strategy to crowd in other sources of external finance.

This section provides recommendations for how to target support to the OGS and ICS markets, taking into account key design features. In particular, the recommendations provided below aim to address the barriers identified in Section 6, providing target financial and non-financial support to catalyze activities that would not happen – or would not happen as quickly – in the absence of intervention.

7.1 Recommendations to catalyze the OGS market

Figure 30 Recommendations to catalyze the off-grid solar market



Source: Consortium

Phase 1 – consumer awareness, seed funding, standards and targets

During the early stages of market development, consumer awareness campaigns will be key to make sure consumers are fully informed on the benefits, costs, and financing options for products. The range of benefits of OGS products include cost savings and increased earning potential, as well as health, education, and environmental benefits.[106] This process should be two-way, with providers continuing to refine and improve their offering to match consumer needs. For example, off-grid providers and partners (such as MFIs) will need to offer and clearly communicate a range of business models that reduce the upfront cost of accessing OGS technologies, including allowing consumers to rent a system for a fee or by repaying the cost of their system through instalments. Similarly, companies will need to engage closely with their target customer to test technologies and business model and learn what matches best to consumer ability and willingness to pay.

Initially, providers will need patient seed funding (including concessional finance and grants) to continue to test and refine business models and demonstrate viability to achieve scale. As described in Section 5, there is very little seed funding available, with no "angel" investors currently present in Burundi. Early stage financing – either in the form of grants or concessional loans (potentially convertible) for companies to trial products in new areas will be needed to allow time for learning, product development, and establishing relationships with customers. This seed funding should be used to demonstrate a sound business model, including sales targets and a robust strategy for raising finance in the future. It could be contingent on, for example, piloting partnerships for last mile distribution, and could include participation in a technical assistance (TA) facility such as a market accelerator.

Given the very early stage of market development, grants should initially be of limited size and linked to critical inputs to the business, such as the upfront purchase of stock. For example, companies could receive an upfront grant of up to US$ 50,000 to US$ 100,000 in total value, with the aim to cover initial business plan development, and enough inventory to establish a sales volume of at least 1,000 units. At least 50% of the grant will need to be in US$ to enable companies to bring in hardware, as these costs likely represent about 50% of the final cost of distribution.

In this first phase, standards and testing methods will need to be put in place and adopted as quickly as possible. These should be based on international standards, such as the Lighting Global Quality Standards and IEC/TS 62257-9-5 test methods, to be carried out at existing test facilities in the region, prior to importation. These standards should define qualifying products for all the financial support described in this section.

Sector targets should be adopted to provide a clear policy commitment to the sector. Incorporating off-grid energy targets into sector strategies, with a clear plan as to how to resource (financial and human capacity) implementation of these plans will provide a clear framework for companies looking to enter and/or scale up their activities.

Phase 2 – training and skills development, RBF to scale up, capacity building

To mobilize demand, consumer awareness should be supported by working with households, farmers and communities to unlock financial savings and generate income. OGS products now have well-established potential to raise productivity and generate income for users.[107] Off-grid energy providers should also provide training to recipients on how to leverage these technologies to generate income. Organizations such

[106] For a comprehensive mapping of benefits see GOGLA (2018) *Powering Opportunity The Economic Impact of Off-Grid Solar*

[107] See for example: GOGLA (2018) *Powering Opportunity The Economic Impact of Off-Grid Solar ;* Lighting Global (2020) *Off-Grid Solar Market Trends Report 2020* ; Lighting Global (2019) *The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa* ;

as SHINE PAYG Burundi already routinely work with the communities to which they distribute off-grid solar products.

In this second phase, finance should be concentrated on companies beginning to show a sustainable growth trajectory and on the path to profitability. In this phase companies should be moving away from grant and seed finance, to Series A and Series B fund-raising rounds. While grants may continue to play a (reduced) role here, they should be contingent on crowding in other sources of finance to ensure sustainability – for example underpinning investment from other forms of commercial capital from international investors, local banks, or partnerships with international companies. A portfolio of companies should be supported that foster development of both (1) last mile distribution partnerships among local actors such as MFIs, VSLAs etc. and (2) partnerships that bring established international operators to the market, and leverage their experience and training programs to establish LMD operations.

Results based finance should incentivize distribution of quality verified pico products, providing partial or full Tier 1 access. Given the low affordability of Burundian households, sustainable commercial markets will initially focus on quality-verified pico products such as single lanterns and single lanterns with limited appliance charging (e.g. for a mobile phone and radio). A tiered approach should be adopted with most of the incentives provided for lower tier products. The recommended subsidy level by product type is summarized in Table 8. Subsidies should be targeted to rural areas, with stronger incentives to reach regions with low historic product penetration and low affordability. No subsidies should be provided for sales to households in urban centers such as Bujumbura, Gitega, and Ngozi, which could be reached through establishment of limited retail outlets in urban hubs. All such supply-side subsidies should be defined as a proportion of the upfront cost of the product at the border (FOB price), to make sure that there are strong incentives to minimize all costs over which operators in Burundi have (at least some degree of) control, to allow the private sector to find the best business models to reach customers.

Throughout this growth phase, the RBF will need to be linked to access to an inventory financing facility (for access to US$), and increasingly working capital (in BIF). As described in Section 5.2, access to forex is a major constraint, as hardware comprises around 50% of the cost to serve rural households. The RBF should initially mostly provide access to the inventory finance facility (in US$) to relieve this constraint, but if markets are to be developed sustainably this should be dialed down over time and eventually phased out (although this is contingent on successful macroeconomic reforms). As this barrier is relieved, the RBF could instead be provided through BIF grants to support local supply chain development and to scale up sale of products using consumer finance (such as PAYGo, or MFI partnerships). As companies achieve scale, grants should be replaced with access to a (concessional) working capital facility, which will become increasingly important to bridge the gap between costs incurred upfront by companies, and only recovered through repayments by customers over 12 to 18 months.

This phase should also see an increase in capacity building to support development of key agencies and the private sector. Government institutions such as the Ministry of Energy, the Rural Electrification Agency (ABER) and the Energy Sector Regulator (AREEN), as well as key cross-sector agencies such as BRB and OBR, will be critical in developing a policy and regulatory framework that supports the growth of the sector, and does not “over” regulate. An industry-wide taskforce, bringing together these government agencies with industry representatives and trade associations (such as BUREA) could be an effective body to facilitate exchange between government, private sector, investors, and civil society.

Table 8 Recommended level of RBF subsidy by product type

Product type	Recommended subsidy	Price without subsidy
Single Lantern (< 1.5 Wp)	No subsidy in regions with established sales history, nor in urban areas. Limited subsidy of up to 25% of total cost, or US$ 2.50, whichever is smallest to establish sales in regions with low current product penetration and low affordability e.g. Bururi, Cankuzo, Cibitoke, Karuzi, Kirundo, Makamba, Muyinga, Rutana and Ruyigi Preferential access to US$ through inventory finance facility	US$ 10
Single light with phone charging / radio* (1.5 – 10 Wp)	No subsidy in urban areas. Coordination with existing programs to further refine targeting – for example subsidy should not be offered in provinces where NGOs have already achieved substantial penetration (Gitega, Kayanza, Muramvya, Mwaro, Ngozi) Subsidy in rural areas of around US$ 25 per system, or 30% of the upfront cost, whichever is smallest.	US$ 30 – US$ 100
Multi-light systems and above (> 10 Wp)	No subsidy in urban areas. Subsidy in rural areas of around US$ 60 per system, or 60% of the upfront cost, whichever is smallest.	US$ 100 and above

Note: * Depending on the specific product, this could be an external charging unit or a built-in radio.
Source: Consortium based on consultations in Burundi

Phase 3 – commercial operations established, subsidies for the poorest and hardest to reach

As companies begin to achieve scale (i.e. over 10,000 sales), the supply-side RBF should be revisited and eventually phased out. The objective of Phase 1 and Phase 2 should be to support the growth of companies which can then raise finance externally and are commercially sustainable. In this phase, grants should be scaled back. To the extent that some market barriers may still prevail, such as limited finance available from local banks, concessional finance for e.g. working capital, and patient equity investors / debt providers may continue to play a role.

Demand side subsidies may be needed to target poor and/or hard to reach households, leveraging the databases collected for existing social safety net programs, but would be less likely to foster commercial market development. For example, as described in Section 5.3, the Merankabandi program identified over 130,000 potential beneficiaries, and is already providing cash transfers and social support to over 50,000 households. The Multi-Tier Framework surveys, expected to be undertaken late in 2020, will also provide much more granular data on household use of energy access products as well as both ability and willingness to pay – information which could provide the building blocks to develop demand side subsidies.

However, these demand-side subsidies should only be introduced once the supply of OGS products is sufficiently developed. Given the low current levels of access to OGS products in Burundi, and low ability to pay of rural households, sustainable business models will only develop if companies can identify a customer

base that has the potential to pay full commercial prices. Only companies who have demonstrated sufficient scale of commercial sales should be able to access these demand side subsidies if they are introduced.

7.2 Specific recommendations to catalyze the ICS market

At the early stage of market development, expanding local production and understanding user needs are critical to catalyze the market.[108] Investments should be targeted to promote the creation of a viable local stove industry, to awareness raising and marketing, to distributing basic technologies, and to the creation of a favorable enabling environment at the policy level.[109] First investments should be along the entire value chain, starting at the production level, where quality and standardization need to be ensured. On the demand side, interventions should focus on awareness raising to inform households about the benefits of improved cooking practices in terms of energy/ cost savings and health benefits, marketing campaigns to promote efficient stoves, and customer research to understand households needs and behaviours in regards to stove and fuel uses. Understanding end-user needs and incorporating their feedback into the design of stove programs is crucial to ensure long-term adoption of improved stoves.

Cooking intervention should address gender barriers by involving women in stove selection and in the design of financial mechanisms, as well as by improving the ability of women to participate in the sector. As the primary users of cookstoves, women should be an integral stakeholder group to any consumer awareness and education campaign. Cookstove programs can take advantage of women's existing skills and networking capabilities. The distribution of improved stoves can use women's groups especially where they are already organized to access finance and influence others in the community. Women entrepreneurs should benefit from vocational training as well as capacity building for business and sales.

Any effort to increase access to modern cooking technologies should be coupled with support for sustainable production of clean biomass and renewable-fuel alternatives. Given the rising demand for wood and Burundi's projected population growth, the sustainability of fuelwood value chains must be tackled with reforestation efforts. Fuelwood is mostly collected for free by rural households, but, when purchased represents a significantly larger portion of household income than traditional stoves which have minimal to no financial cost. For these reasons, fuel-side interventions, when properly executed, have high potential for sustainable market-based approaches and for driving the adoption of clean cookstoves.

Interventions will need to coordinate and be harmonized with other ongoing programs, notably those implemented by EnDev and through EU-funded projects. Key organisations include AVSI, which oversees the EU-funded program and is responsible for avoiding overlapping of activities with other donors and initiatives active in the country. Coordination efforts will be necessary to identify reputable local artisanal manufacturers who can be targeted to scale up production, to identify the provinces and communes with low penetration,[110] and to align technical assistance and advocacy efforts for quality standards with ongoing activities implemented by AVSI and EndDev.

Phase 1 – consumer awareness, stove testing and selection, standards and technical assistance

Initially, basic improved cooking technologies such as the Matawi stove will be the most feasible product given low consumer affordability. The promotion of high-quality artisanal improved stoves will generate both

[108] Gold Standard. (2016) Gold Standards Improved Cookstove Activities Guidebook. Available at: https://www.goldstandard.org/sites/default/files/documents/gs_ics_report.pdf

[109] The World Bank. (2014) *Clean and Improved Cooking in Sub-Saharan Africa: a landscape report.* . Available at: https://openknowledge.worldbank.org/handle/10986/22521

[110] EU programme locations: Kirundo, Karuzi, Makamba, Rutana, Cankuzo, Ruyigi, Kayanza, Ngozi. EnDev locations: Gitega, Kayanza, Kirundo

fuel savings and associated environmental and economic benefits. Previous programs have demonstrated that awarness raising campaigns and support to local manufacturers can help develop a viable commercial market. However, for the poorest and most vulnerable households, market-creation efforts may take several years, which may justify the application of more direct subsidies to increase uptake of ICS.

In the short-term, interventions on the supply side should focus on creating mechanisms that increase the growth of existing producers, improving their ability to expand production and access financing. Lessons learned from successful cooking programs indicate that bottom-up approaches involving local users and artisans are key to establishing a self-sustaining industry.[111] The distribution of basic improved stoves will involve investments in last-mile distribution infrastructures (e.g. sales agents channels, retail points), access to credit, and logistics—all measures that will facilitate the promotion of more advanced and cleaner cookstoves at a later stage.

During this initial phase of market development, standards and testing methods will need to be established to determine the eligibility criteria for qualifying products. Based on international standards and guidelines, the conditions for stove eligibility should be based on having completed necessary tests and having received certification to achieve minimum technical specifications.[112] Lab tests include the Water Boiling Test which in a first phase can be conducted in a certified laboratory (such as regional centers in Tanzania or Kenya) to verify the effective thermal efficiency and compare it to the minimum criteria required to be eligible for the RBF scheme. Technical specifications include a track record of quality and composition of raw materials used in the production (for clay stoves), and standardizations of molds and stove components among others. Additionally, stove eligibility should consider the manufacturer's production capacity and track record and ability to expand the production. Stove selection according to eligibility criteria can distinguish between a number of categories, each eligible to a different level of financing, based on quality and services performed. The examples below are provided purely as indications:

- Charcoal stoves
  - ◊ Basic improved clay and metal stoves that meet efficiency lab and field tests and that are manufactured according to technical standardized production—such as the Matawi stove.
  - ◊ Low cost and high-quality basic charcoal stove, such as the EcoSmart by International Lifeline Fund.
  - ◊ High-end charcoal stove, such as the Jikokoa by BURN Manufacturing.
- Wood stoves
  - ◊ Basic improved clay stoves that meet efficiency lab and field tests and that are manufactured according to technical standardized production—such as the Matawi stove.
  - ◊ Highly efficient wood stoves--such as the Zoom Dura by EcoZoom.

The evaluation of stoves should also include field tests with end-users to determine consumer preferences and efficiency under actual use and to inform the selection of appropriate technologies to be disseminated. We recommend using approaches such as stove bazaars,[113] where households can choose stoves from a menu of options and where prices and willingness to pay can be tested. This will allow for a better understanding of households needs and preferences which will help to define prices. Any technology should be tested at the household level and refined to meet cooking requirements and women's preferences.

[111] Urme and Gyamfi. (2014) *A review of improved Cookstove technologies and programs*. Renewable Energy Reviews vol. 33 pp. 625-635
[112] Global Alliance for Clean Cookstoves provides a clean cooking catalogue of verified stoves and manufacturers http://catalog.cleancookstoves.org/
[113] Mengwani et al. (2019) *Determinants of cookstoves and fuel choice among rural households in India.* Available at: https://depts.washington.edu/airqual/Marshall_101.pdf

Non-financial support through technical assistance will need to be provided at various levels to increase quality in production and support business development, sales and marketing. Local artisanal production should be supported with technical assistance to increase quality of production in addition to business development support, with training on sales strategies and marketing. The involvement of women in sales and distribution efforts will be beneficial to reach wider customer segments and ensure product uptake. Awareness and gender-responsive capacity building will be required for companies and local producers to ensure that gender considerations are included in their hiring practices, human resources, and business development processes. Other types of TA should include conducting technical assessments for determining clay quality and sustainability and environmental assessment of increased production of clay stoves. Technical assistance should be also targeted to regulators to develop quality standards.

Phase 2 – customer segmentation, subsidies for the poorest and hardest to reach, RBF to scale up

The selection of target areas for the dissemination of improved cookstoves should consider various factors that influence local production and dissemination, as well as the identification of potential customers. The presence of existing local production, the availability of raw materials, and the environmental impacts of increasing such production should be considered in choosing the locations of the target areas, and for planning scaling-up activities. Rural and suburban populations depending on fuelwood living in densely populated areas are likely to suffer severe shortages of wood, particularly in the North and Centre-East parts of the country. These areas are likely to be potential targets for the uptake of efficient stoves, particularly targeting households who are already spending a considerable amount of their time in fuel collection and whose situation is expected to worsen due to wood scarcity.

Two consumer segments have potential for the adoption of different models of improved cookstoves, but market-based approaches may not be suitable for all households. The criteria used for segmenting potential customers are: household fuel choice and acquisition (wood or charcoal, purchased or collected), geographic location (rural, urban, or peri-urban), income levels and cookstove acquisition behaviour (purchase or non-purchase of stoves). These criteria can be used to define the following segmentation.[114]

- *Segment 1:* Lower-income households living in rural areas, collecting or purchasing wood and currently not purchasing stoves (self-production of the three-stone fire at zero cost).
- *Segment 2:* Lower- and middle-income households living in peri-urban and urban areas purchasing charcoal and stoves.

While in the short term basic improved clay and metal stoves will be able to reach most of the addressable market, in the medium-term the introduction of higher-efficiency and cleaner stoves can target "early-adopter" groups, such as middle-income urban households. Marketing could target urban and peri-urban households who typically have higher ability to pay and high expenditure on charcoal, to stimulate an early market for higher tier stoves that provide financial savings as well as health and emission-reduction benefits. This will also require development of distribution and retail systems and the provision of after-sale services.

Multi-tier subsidy schemes offer an effective way of targeting different customer segments and to scale prices for stove models.[115] Interventions should address supply side barriers through an RBF mechanism which targets subsidies to reduce the cost of stoves for specific customer segments. Subsidy levels can be based on the type of stove and on the location of households (urban or rural). Subsidy schemes should be

[114] The forthcoming Multi-Tier Framework survey will provide detailed information on energy consumption and will inform the design of the Soleil program

[115] Rehfuess EA et al.(2014) Enablers and barriers to large-scale uptake of improved solid fuel stoves: a systematic review. EnvironHealth Perspect 122:120–130

aligned with past and ongoing activities supported by other programs (EnDev, EU) to identify provinces with low product penetration and those with established supply chains and higher product awareness.

In addition to the RBF mechanism, grants should support early stage growth of local artisanal companies to scale up operations. Reputable local artisans with a robust business plan should receive some seed funding to scale up production. The conditions to access these grants could be the establishment of partnerships with MFIs and distributors (e.g. VSLAs or local NGOs), as well as the participation in a TA facility or accelerator, as described for OGS companies. With the lack of proven business models, financial assistance in the form of grants is recommended for local companies or NGOs to pilot new business models that address affordability barriers for lower income customers. These can include partnerships with MFIs to provide flexible financing schemes that reflect current fuel expenditures and income fluctuations of rural households, or partnerships with VSLAs and saving groups used to leverage microfinance and to reduce upfront costs for customers.

7.3 Closing remarks and implications of COVID-19

The recent emergence and spread of COVID-19 could have important implications on the analysis and recommendations of this study. This report, developed between December 2019 and April 2020, describes the (substantial) potential of off-grid energy technologies to improve livelihoods, and recommends routes to commercial market development. These benefits are accentuated by the risks posed by COVID-19, which may also further accentuate some of the barriers to market development.

First, some of the benefits of access to off-grid energy technologies, which make rural communities more resilient will become even more critical:

- By supporting consumer services such as access to information and communication technologies, OGS technologies enhance the ability to coordinate nationwide responses and share information.
- By improving productivity and providing a source of light in the evenings, rural households will be better able to earn an income while spending less time in proximity to others and can spend more time at home.
- By providing lighting, children may be able to continue some studies remotely, if they can also access educational materials to read and work on from home.
- By reducing the amount of time spent outside collecting firewood, communities and households will be less likely to pass on the disease.
- Supply chains established to reach rural households with OGS products could also be used to distribute health equipment and products.

On the other hand, the development of off-grid energy markets is likely to face firmer – and some new – challenges:

- **International companies may focus on existing customers to ensure repayments are maintained and may be less willing to take on new customers** (for business models using any form of consumer finance). This may mean international companies are less willing to enter new markets, so local distributors and international NGOs may remain the main (or only) source of off-grid energy products.

- Access to hard currency (US$) is likely to worsen, as import of critical medical supplies are prioritized. Currency reserves are already down to below one month of imports, so there is very limited forex available to import off-grid energy hardware.
- Ability to pay of rural households may fall as incomes reduce and/or households spend more on healthcare. For many rural Burundians who depend primarily on agriculture, earnings may not be affected too much by "social distancing" measures, but household incomes will be affected if ability to work is reduced by health. In terms of the affordability analysis presented above, it may also imply that the "affordable at a stretch" category is less realistic, as the priority for households will be expenditure on healthcare, not on energy access products.

A few early recommendations to adapt to COVID-19:

- Establish a grant-based US$ inventory finance facility as quickly as possible, to make sure companies can continue to access – and indeed scale up access to – off-grid hardware
- Take care of employees and customers. While off-grid energy technologies can deliver important benefits to households and communities, it is critical that distribution is established in a safe way and keeps employees along the value chain safe and does not act as a transmission vector for the virus. Apart from the immediate health benefits, this is also critical to build consumer confidence and ensure a positive experience with what may be their first OGS or ICS product.
- Prioritize up-front cash sales. These should make use of available grant and concessional finance to reduce the price paid by customers. As households face significant uncertainty – with a risk of income reductions and an increase on health-related expenditure, relatively new and unfamiliar consumer finance methods should not be deployed.
- Harness existing distribution networks and prioritize public institutions. Health care facilities and schools should be prioritized as the most effective way to reach communities. These facilities could then serve as hubs to distribute products to communities – for example building on the experience of "Light Libraries".[116] This may be both a more impactful and safer way of developing supply chains to reach rural households than establishing "new" last mile distribution networks at this time.
- Scaling up will need to be managed at a cautious pace. Training and development of new personnel may need to be carried out while maintaining social distancing, and stocking and distribution will need to be managed to minimize social contact. This should not necessarily mean stopping activities but may mean companies do not scale up significantly.
- Mobile money and digital finance platforms should continue to be developed and piloted, as they are well suited to providing remote payment mechanisms that minimize social contact and exchange of paper notes.

Despite these notes of caution, the off-grid energy market can bring substantial benefit to households across Burundi in the coming years and there is a growing entrepreneurial community of providers across the value chain who, with the right support, could drive the sector forward.

[116] See for example Solar Aid's description of Light Libraries https://solar-aid.org/light-libraries/

Appendix 1 – Stakeholder Consultations

Our thanks goes to all those who gave their time generously through in-person discussions in Burundi, or over the telephone, including:

Jacques Dusabumwami, Jean-Bosco Ndikumana (ABER), Alexandre Dunod (Aera Group), Immaculée NSENGIYUMVA (AFAB), Eric de Moudt (African Frontier Capital), Khalid Jiwani (ALSAFA), Jeremie Sinzinkayo (AREEN), Karl Mfura (Argos Energy), Yannick Chokola (Auxfin), Laurent Nkunzimana, Leopold Simbarakiye, Nestor Mburente (AVEDEC), Alessandro Galimberti (AVSI), Cedric Rufyikiri (Bizisol), Pascal Rwemera, Claver Ndizeye (BQS), Julien Ndikuriyo, Dancille Nkengurutse (BRB), Donatien Nzokira, Theodore Kwigeze (BUREA), Madone KANYAMUNEZA, Cyprien Syomvo (CAFOB), Louise Nsabiyumva, (CECM), Audace Ndayizeye (CFCIB), Peter George (Clean Cooking Alliance), Martin Ndayi, Willy Ciza (DGE, MinHEM), Charlotte Heffer (d.light), Innocent Hakizimana, Wood Gitobu (EcoNet / Casava Smart), Esther Loeffen, Gerard Muringa (Embassy of the Netherlands Burundi), Michelle Heah (Energise Africa), Caritas Habonimana, Gordien Irankunda, Prosper Ndayishimiye, (FVS-Amade), Andrea Reikat, Stanislas Niyonzima (GIZ), Didier Niyokindi, Njeri Mwangi, Regis Mazamizero (Greenbox Solar Environment), Arthur Houston (Ignite), Josh Rosenthal (Implementation Science Network), Eric Reynolds (Inyenyeri), Barry Mazambo (ITCO), Leila Kateferi (KTF Concept), Vahid Jahangiri (Lifeline Fund), Murali Krishna N (Nambiar Associates), Leon Bankimbaga, Fiacre Nkengurutse (Nile Energy Company), Yael Hartmann (One Acre Fund), Leonard Akwany, Harry Stokes (Project Gaia), Matthias Kuntze (Savonor), Jean-Marie Nibizi (SHINE PAYG), John Keane (Sunny Money), Aliya Jiwani (SMART Pesa), Per van Swaay (TCX), Dan Rono (UNICEF), Marie Ange Kigeme (UNDP), Dieudonné Nikwibimpaye (Virago) Nadine Mutabaruka (WISE), Emile Uwezowamungu, Raffaella Bellanca (World Food Program).

To connect with the Lighting Africa team, please email: info@lightingafrica.org

https://www.lightingafrica.org