CHAPTER SUMMARY

TAKING THE PULSE OF ENERGY ACCESS IN UGANDA

Table CS 1

Uganda: Key Figures[128]

Year end	2018	2030
Population (millions)	37.7	55.4
Households (millions)	8.9	13.8
Grid Access (%)	19	47
Mini-Grid Access (%)	.04	.5
Stand-Alone Solar Access (%)	19	52.8
Clean Fuels Use (%)	1.3	7.5
ICS Usage (%)	4.2	100

Uganda has made solid progress in expanding electricity access in recent years, aided by rapid growth in the market for stand-alone household solutions and steady expansion of the electricity grid. When combined, the existing electricity grid, mini-grids, and stand-alone solar currently provide electricity to almost 38 percent of households in Uganda, leaving an access deficit of 62 percent. In looking towards the Sustainable Development Goals (SDG7) target date of universal access[129] by 2030, grid expansion will play a significant role in closing the electrification access gap; this report forecasts 4.7 million new grid connections, representing a fourfold increase in annual connections compared to recent connection trends. Uganda currently only has 11 operational mini-grids, servicing approximately 4,000 households. Development of the mini-grid sector has been hampered by an unclear regulatory framework that has limited private sector participation, while public resources have focused on the expansion and densification of the main electricity grid. The report forecasts a thirtyfold increase in mini-grid deployment through to 2030 (with 320 new mini-grids to be built), though their impact on universal access will remain modest given that each is expected to serve an average of 200 customers. This will require a total of over USD 50 million in debt, equity and grant financing. By way of comparison, *Energizing Finance: Understanding the Landscape 2019* tracked USD 1.4 million in commitments for Ugandan mini-grids in 2017. Stand-alone solar has transformed the electricity market in Uganda over the past five years, and currently delivers access to 19 percent of Ugandan households. Meeting the contributions of stand-alone solar to the 2030 target will necessitate reaching 52 percent of Ugandan households, which translates into supplying 5.3 million new household connections during the period 2020-2030 at a total cost of approximately USD 1.4 billion. When looking at financing flows, the *Understanding the Landscape 2019* report tracked USD 33.7 million in commitments for stand-alone solar in Uganda in 2017. Furthermore, a solution will need to be found for the affordability challenge given that over half of households are unable to pay for access to Tier 1 electricity access. The affordability gap related to stand-alone solar is estimated to be a total of USD 330 million.

Ninety-five percent of all Ugandan households rely on charcoal, wood, or other forms of biomass for their household cooking needs.[130] Despite this, ICS use remains extremely low at around 1 percent. The use of clean fuels (such as liquefied petroleum gas (LPG), biogas, and ethanol) also remains under 1 percent. A competitive market of LPG suppliers is beginning to emerge (though only 0.7 percent of households use it for cooking), with over ten medium-to-large sized companies currently operating in the market. The report forecasts that the use of clean fuels will grow to ten times where it currently stands, contributing 7.5 percent of cooking access. The remaining 12.2 million households (88.7 percent of the total) are expected to continue to cook with wood and charcoal. The challenge will be to shift all these households away from traditional cooking technologies (namely three-stone fires and lower-quality semi-industrial stoves) and onto high-quality industrial improved wood and charcoal stoves. ICS have a cumulative financing need of USD 193 million for enterprises alone. Uganda will also re-

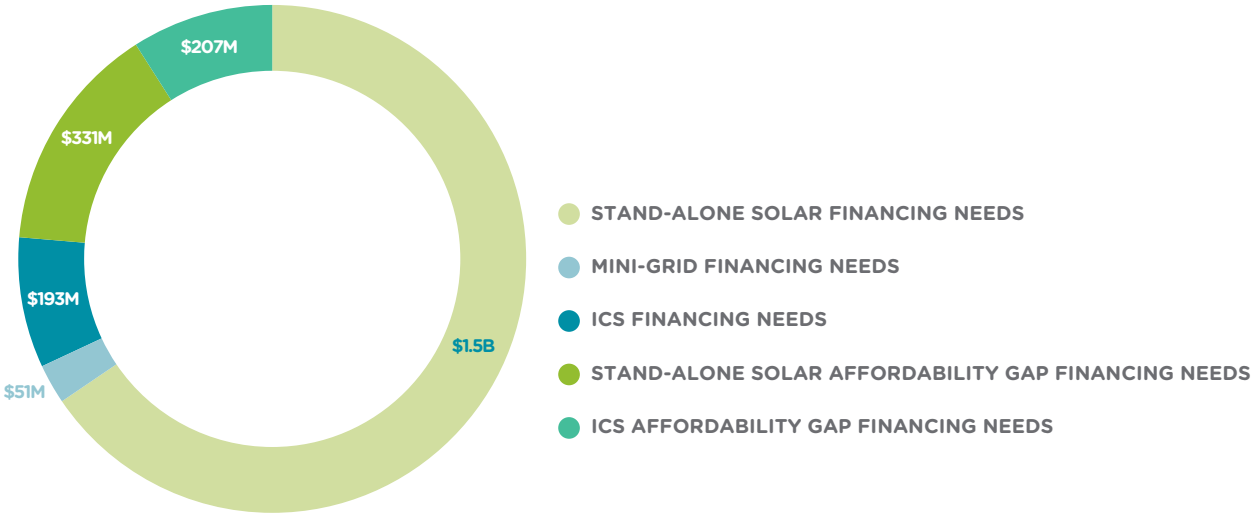
[128] Key figures in this table reflect, for end-2018, best estimates based on the most up-to-date figures available from various official and unofficial sources, extrapolated by leveraging recent trends. For end-2030, figures reflect model outputs for the forecast scenario, i.e., whereby SDG7 is met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

[129] SDG7 seeks to ensure access to affordable, reliable, and sustainable modern energy for all. For additional details, please see: https://sustainabledevelopment.un.org/sdg7

[130] UBOS. 2017. "The Uganda National Household Survey 2016/17".

Figure CS 1

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



quire a cumulative of USD 207 million in affordability gap financing to help the 81 percent of households that cook with wood but cannot afford ICS.

There are several supportive actions that will need to be taken to facilitate investment and achieve universal electrification. These are summarized as follows:

For mini-grids:

- Develop a comprehensive mini-grid regulatory framework that clearly stipulates the rules of the game around tariff setting, grid encroachment, licensing and permitting, technical quality standards, and end-user subsidies.
- Strengthen the capacity of government officials to effectively monitor and enforce the rollout of the regulatory framework.
- Provide financing that would help de-risk and incentivize the private sector to accelerate mini-grid deployments in Uganda.

For stand-alone solar:

- Improve market intelligence to help the private sector to effectively scale and encourage commercial investment.
- Implement initiatives to enhance household affordability, particularly in difficult to serve areas of the country.
- Foster adoption and enforcement of International Electrotechnical Commission (IEC) quality standards to protect consumers and decrease competition from poor quality products.

For improved cooking:

- Develop and deliver public awareness campaigns on the benefits of clean cookstoves adoption to encourage behavior change.
- Support initiatives to enhance household affordability, particularly for the uptake of industrial cookstoves and the use of clean fuels.
- Kickstart the scaled-up adoption of clean fuels.

PART 1

TAKING THE PULSE OF ELECTRIFICATION IN UGANDA

SECTOR CONTEXT

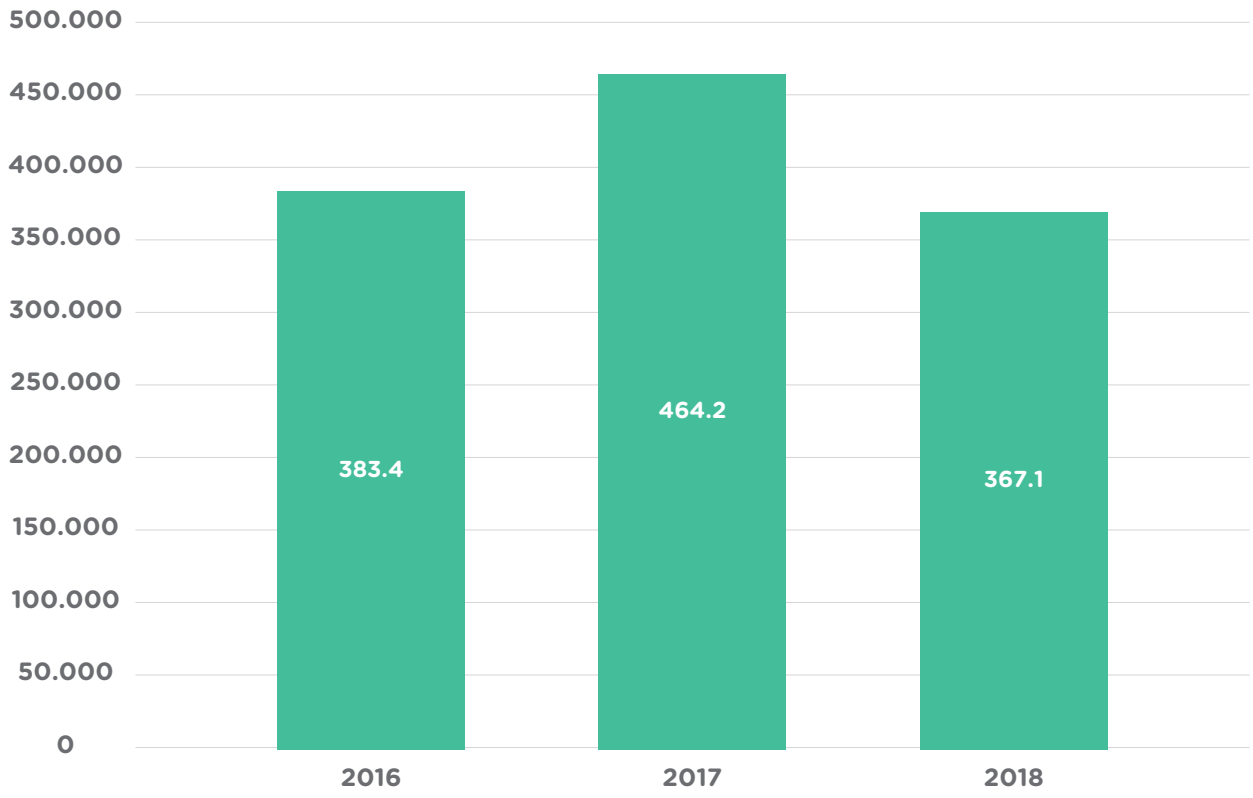
Government Electrification Strategy

The Rural Electrification Strategy and Plan (RESP) details a ten-year plan to expand access to electricity in 13 energy service territories outside the concession area controlled by Umeme Limited, Uganda's main electricity distribution company. Private service providers operate government-owned assets, via the Rural Electrification Agency (REA), in seven territories. The Uganda Electricity Distribution Company Ltd. operates assets in the remaining six service territories until REA grants concessions in a competitive bidding process.

REA has created a complementary plan, the Off-Grid Strategy, to address the policy needs of the

Figure 1.1

Annual Stand-Alone Solar Sales 2016-2018[131]



rapidly growing stand-alone solar sector. The Off-Grid Strategy is currently awaiting approval from the Ugandan Council of Ministers.

Stand-Alone Solar

Between 2016 and 2018, stand-alone solar emerged as a significant source of electricity in Uganda and grew to deliver energy access for 19 percent of households across the country.

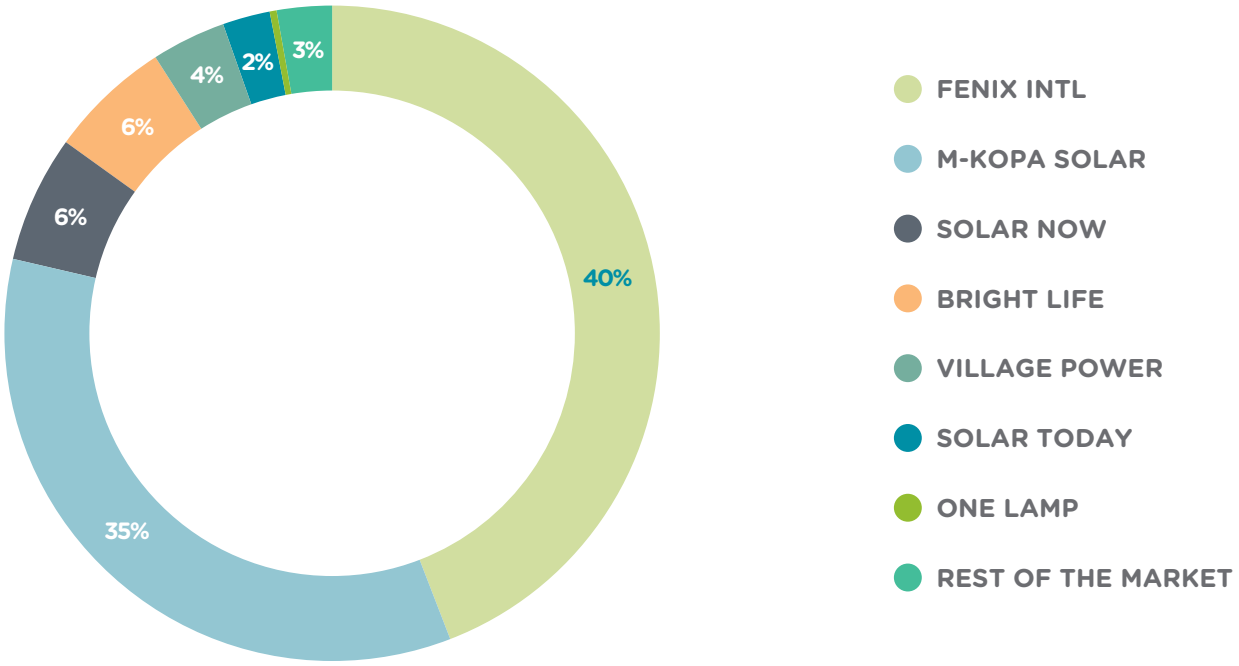
In 2018, about 370,000 high-quality stand-alone solar solutions were purchased by Ugandan households, 61 percent of them on a pay-as-you-go (PAYG) basis, according to the Global Off-Grid Lighting Association (GOGLA). This is a 20 percent decline from the total volume of stand-alone product sold in 2017. One cause of the decline was the 1 percent levy on sending, receiving, and depositing of funds through mobile money, which was introduced by the government in May 2018. Though the levy was reduced to 0.5 percent and restricted to withdrawals, the uncertainty caused by this policy change might have contributed to the decline of PAYG solar sales. Second, broader regional issues, like the widespread drought, affected solar sales across East Africa, as poor harvest impacted household cash flow. In addition, the decrease in the sales amount of GOGLA affiliated products is broadly attributed to the increase in competition from generic, copycat and counterfeit products in East Africa.[132]

[131] GOGLA. 2018. "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data, January-June 2018".

[132] GOGLA. 2017. "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data, July-December 2017".

Figure 1.2

Solar Products Sold by Major Companies in Uganda[133]



Given the overall growth of the sector, it is not surprising to observe that the number of private companies providing stand-alone solar services in Uganda has grown from a handful in the mid-2000s to many dozens of companies at present.[134] [135] A diverse supplier landscape provides a wide range of products that include both Lighting Global quality-verified[136] and non-quality verified lanterns, plug and play solar kits and larger component-based systems. Consumer credit from the private sector is driving distribution, with the highest volume of sales being driven by a mix of international PAYG companies. These businesses provide stand-alone solar systems ranging from individual lanterns and small multi-point lighting systems to larger systems capable of charging a television, a radio, a battery, and other household appliances, serving as an effective replacement for the grid.[137] Consumer financing via mobile money payments, including PAYG technology, has also accelerated market growth, minimizing the upfront cost for the consumer and dramatically increasing the addressable market for off-grid electricity as a service. The pie chart above summarizes sales of some of the key companies up to 2018.

Many international development partners are supporting a wide range of programs to advance energy access through stand-alone solar solutions, cultivating market growth and stimulating capital investment, as noted in the Uganda Off-Grid Energy Market Accelerator's 2018 market map.[138] Programs of key development partners that are actively supporting off-grid solar (OGS) are outlined in Table 1.1.

[133] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[134] Uganda Off-grid Energy Market Accelerator. 2018. "Annual Impact Report, 2018".
[135] Lighting Africa, 2014. "Market Assessment of Modern Off-Grid Lighting Systems in Uganda".
[136] Lighting Global conducts solar products quality testing. Products are tested for durability, system quality, lumen maintenance, availability of warranty and whether advertising materials reflect tested product performance.

[136] Based on market information gathering by UNCDF under its CleanStart program.
[137] Ibid.

Table 1.1

Major Development Partners and Their Main Programs[139]

Development Partners	Key Programs
European Union (EU)	Scaling-up Rural Electrification using Innovative Solar Photovoltaic distribution models Project
The World Bank	Lighting Africa Campaign
United Nations (UN)	UN Capital Development Fund CleanStart
United States Agency for International Development (USAID)	Power Africa Program
Shell Foundation	Market Development Program
Embassy of the Netherlands	Milking the Sun and Harvesting the Sun
The Federal Ministry for Economic Cooperation and Development (BMZ)	Promotion of Renewable Energy and Energy Efficiency Program
Agence Française de Développement (AFD)	Sustainable Use of Natural Resources and Energy Fi-nance in East Africa (SUNREF)
Department for International Development (DFID)	Energy Africa Campaign

While Uganda is one of the top five stand-alone solar markets globally, and the second biggest market for PAYG sales, trailing only Kenya, continued market growth will depend on increased consumer awareness, a rigorous quality assurance framework, financing to help companies access hard-to-reach rural areas and affordability gap financing. Households in the bottom third of the income pyramid will have particularly acute affordability issues without the introduction of affordability gap financing.[140] The affordability gap will be discussed in more detail later in this chapter.

Mini-Grids

Uganda's mini-grid sector is much less mature than the stand-alone solar sector. Uganda has 11 operational mini-grids that serve approximately 4,000 households and various commercial and small industrial customers. The bulk of these feature solar power generation and battery storage. Most have less than 50 kilowattpeak (kWp) of generating capacity and serve 100-200 customers each. The outlier, Kalangala Island's 1.6-megawatt peak (MWp) photovoltaic (PV)-diesel hybrid mini-grid that serves over 2,000 household consumers, could be deemed a 'small isolated grid' instead of a mini-grid. Only one of the eleven is private-sector owned and operated.[141]

[139] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[140] Ministry of Energy and Mineral Development. 2015. "Uganda's Sustainable Energy for All (SE4ALL) Initiative Action Agenda".
[141] Uganda Off-Grid Energy Market Accelerator. 2019. "Market Map of Off-Grid Solar in Uganda: 2019 Edition".

Mini-grid growth has been constrained by an undefined policy and regulatory framework, which greatly undermines developer and investor confidence, and a lack of incentives to sufficiently de-risk the business model and bring down the price of power for consumers.[142] Additional issues that limit mini-grid investment include fears over grid intrusion in mini-grid service areas, lack of transparency around licensing and permitting, issues with technical and quality standards, a uniform tariff policy that requires regulatory approval to enact cost-reflective tariffs, and a shortage of grants to buy down the cost of mini-grid electricity and make it more affordable for poorer households.[143] As one interviewee observed, mini-grid strategy documents need to be streamlined and tariff uses resolved to create a more effective mini-grid policy environment and in turn build a more attractive mini-grid sector.[144]

Despite these challenges, several mini-grid sites are being evaluated in the north and south of Uganda, including hydropower sites. The REA master planning process has identified 320 mini-grid sites serving approximately 32,000 customers (including some 26,000 households) for development.[145]

Many international development partners are supporting a wide range of programs to advance energy access through mini-grids, cultivating market growth and stimulating capital investment.[146] Partners include the EU, the World Bank, the UN, USAID, AfDB, the Shell Foundation, Foundation Rural Energy Services, World Wide Fund for Nature, and development agencies in Austria, Finland, Germany, and the United Kingdom. BMZ is leading the way in support for mini-grid development in Uganda. The Promotion of Mini-Grids project, funded by BMZ and implemented by GIZ and Ugandan government partners, includes targeted support to the Ugandan Ministry of Energy and Mineral Development (MEMD) to further develop and improve the regulatory framework for mini-grids.

[142] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[143] Based on in-country interviews; NARUC Practical Guide to the Regulatory Treatment of Mini-Grids, November 2017.
[144] Based on in-country interviews.
[145] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[146] Ibid.

Anecdotes from stakeholders in Uganda demonstrate that the financing available for mini-grids outside of development partner grants is negligible. Developers for two projects totaling USD 3.2 million, indicated that one project used 100 percent grant financing while another used 74 percent grants and 26 percent equity. One mini-grid company was refused a loan from a commercial lender because the business model could not meet the bank's required seven- to ten-year debt repayment period. Support between grid, stand-alone solar, and mini-grid has also been highly inequitable. As one interviewee noted, mini-grids are the least supported electrification segment but require the most reform and support going forward to succeed.[147]

CURRENT STATE OF ENERGY ACCESS

Defining Energy Access

Taking the Pulse uses the globally accepted Multi-Tier Framework (MTF) to define energy access.[148] The MTF establishes five "tiers" of household electrification that are based on capacity, duration, reliability, quality, affordability, legality and health and safety impacts. The MTF is often referred to as the "energy access ladder," whereby households may graduate from one level of service to another depending on what sources of electrification they have access to, what they need, and what they can afford. Tier 0 represents a household that uses stopgap measures to meet their basic electrification needs, often using fuel-based lighting (e.g. kerosene lanterns, candles) or battery-operated flashlights for lighting needs, and relying on third-parties to power their devices (most notably cell phones). Tier 1 and 2 services are most often delivered by "stand-alone solar solutions", frequently in the form of single or multi-light point systems that derive their power via solar PV panels. Tiers 3 through 5 are most typically met by connections to a centralized or localized grid (i.e. a "mini-grid"). However, it is important to note that having a grid connection can also qualify as Tier 1 (or as low as Tier 0 if power is available for less than four hours

[147] Based on in-country interviews.
[148] Bhatia, M. & Angelou, N., 2015. Beyond Connections – Energy Access Redefined, Washington: Energy Sector Management Assistance Program.

per day) if the MTF duration criteria are not met. More details on the MTF can be found in the *Taking the Pulse* methodology chapter.

Tier 1 stipulates either a certain level of installed capacity (in terms of power and capacity) or a level of service, which is expressed in lumen hours. Lumen hours is the unit of measure for the brightness of light. *Taking the Pulse* establishes the minimum level of electricity service based on the MTF service metric in lumens. It stipulates that fractional Tier 1 access counts toward the SDG7 goals. This means a single-light-point solar lantern that has the functionality to charge phones (one of the MTF service criteria) counts toward access goals. However, since the output of most solar lanterns is less than the MTF Tier 1 requirement of 1,000 lumen hours per day, this contribution is "fractional" given that the lantern does not deliver full service to all members of a typical household. *Taking the Pulse* assumes in its modeling that a lantern delivers sufficient lumen output to provide access to 60 percent of household members—in line with the capabilities of the typical modern lantern. As such, households would need to have two lanterns in order to achieve full Tier 1 access.

This is a critical methodological point, as lanterns are often more affordable than multi-light point systems. As such, this impacts the overall financing needs required to achieve universal access in a given market. The methodology chapter discusses how levels of service are derived in the model, and the assumptions that underpin them.

State of Electricity Access in Uganda

As of the end of 2018, 38 percent of households in Uganda had electricity access.[149] As seen in Figure 1.3 below, Uganda has expanded grid access to 19 percent, almost doubling grid coverage since 2010. Nevertheless, Uganda's electrification rate lags behind its African peers.[150] Stand-alone solar access, which was negligible at the start of the decade, now accounts for nearly 19 percent of Uganda household connectivity. Mini-grid access in Uganda is currently limited to about 4,000 households. Given that the number of households in the country now exceeds 8 million, the mini-grid access rate currently stands at 0.04 percent.

[149] Bhatia, M. and Angelou, N. (2015). Beyond Connections: Energy Access Redefined. ESMAP Technical Report Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/24368
[150] Energy Sector Management Assistance Program (ESMAP). 2018. Tracking SDG7: The Energy Progress Report. https://trackingsdg7.esmap.org/time?country=Uganda

Figure 1.3

Historical Electricity Access in Uganda

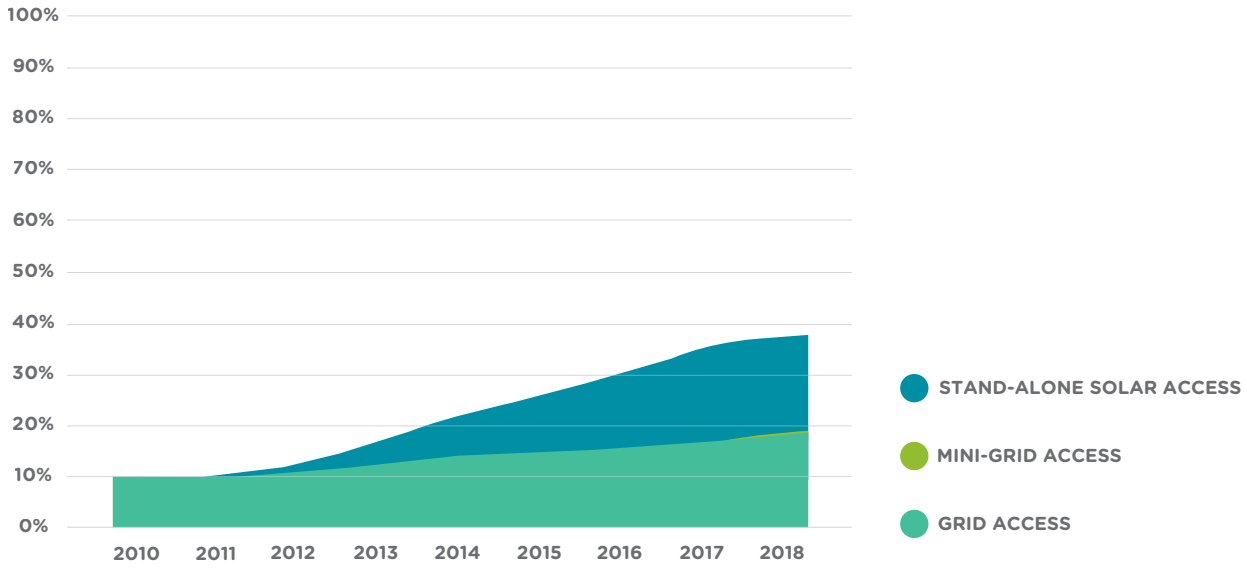
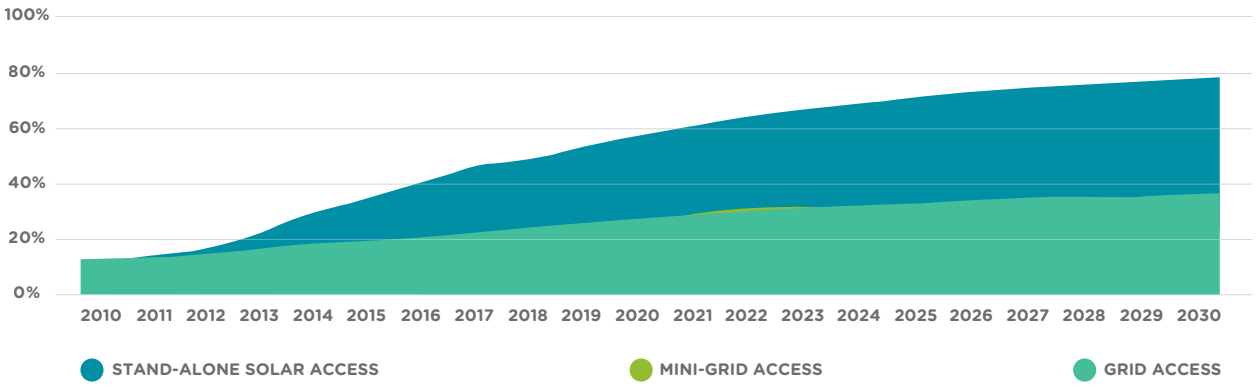


Figure 1.4

Uganda Business as Usual Electricity Access Scenario



As seen in Figure 1.4 above, the model outputs show that if Uganda continues to expand grid access at the pace seen in recent years, following a business as usual (BAU) scenario, grid coverage will reach just 28 percent in 2030. Stand-alone solar access, following its current trajectory, can be expected to reach 31 percent. This projection assumes an annual net increase of 200,000 to 250,000 households with 4.3 million households gaining access through 2030. This is slightly lower than the average net increase seen between 2014 and 2018 as it is projected that sales are likely to slow as stand-alone solar enterprises are forced to move into more rural, lower-density areas as the market becomes more saturated. They also need to move further afield to identify new customers. With the low number of current connections, extrapolating forward the BAU mini-grid scenario would be imperceptible (<0.1 percent, less than 10,000 households with access). In the aggregate, the BAU scenario shows that Uganda would provide energy access for 59 percent of households in 2030, leaving an access gap of 41 percent.

CLOSING UGANDA'S ELECTRIFICATION ACCESS GAP

Achieving universal energy access by 2030 in Uganda will require acceleration across both on-grid and off-grid technologies. The forecast projections modeled in Figure 1.5 below illustrate the targets for Uganda to achieve universal energy access by that time. The key assumptions driving this scenario are as follows:

- Grid connectivity would increase to 47 percent, yielding a total of 4.7 million new households connected to the grid between 2020 and 2030. The model outputs are based on a rather aggressive grid expansion scenario, whereby an average of 430,000 new household grid connections are added each year. This is in contrast to the past two years, wherein the number of new annual connections has averaged approximately 200,000. On balance then, the model foresees a 130 percent increase in grid connections under this scenario.[151]

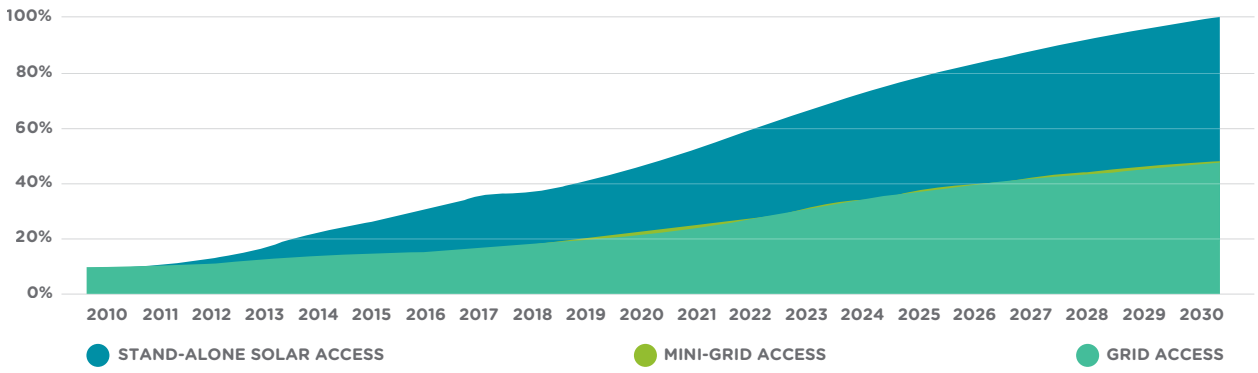
- The number of mini-grids will increase significantly under the forecast scenario (320 new mini-grids would be built, up from the current base of 11), though their contribution to the broader energy access deficit would remain modest. Mini-grids are expected to deliver access to approximately 70,000 additional households between 2020 and 2030.

- The electrification access deficit that remains from grid and mini-grid expansion will need to be filled by OGS. As a result, Uganda will be counting on stand-alone solar to deliver access to the remaining 52 percent of households—over 7 million—in order to achieve universal access by 2030.

[151] Despite the considerable increase in grid connections forecast in this scenario, it still falls short of the 600,000+ per year targeted in Uganda's 2015 Sustainable Energy for All Action Agenda. The authors chose a more conservative annual target that more closely reflects recent performance.

Figure 1.5

Uganda – Forecast Electricity Access (All Technologies)



Mini-Grid Contributions Toward Achieving SDG7

The forecast model projects that 320 new mini-grids will deliver approximately 70,000 new household connections over the period 2020-2030, through a concerted government mini-grid electrification program. This represents an approximate 1,600 percent increase in new connections via mini-grids, compared to the end of 2018. Though this is a substantial increase from the base case, it still means that mini-grid contributions to the SDG7 challenge will remain modest, at 0.5 percent of total connections.

Mini-Grid Financing Needs

Taking the Pulse establishes that mini-grids will deliver a minimum of Tier 3 electricity services.[152] The model therefore includes assumptions around the cost of delivering this level of service. This is a minimum and does not preclude the development of mini-grids that are capable of delivering Tier 4 or 5 access. However, if either of these levels of service were to be considered the minimum, the

[152] Based on the MTF; see the methodology chapter for additional detail on the MTF.

Figure 1.6

Uganda – Mini-Grid Electricity Access Forecast

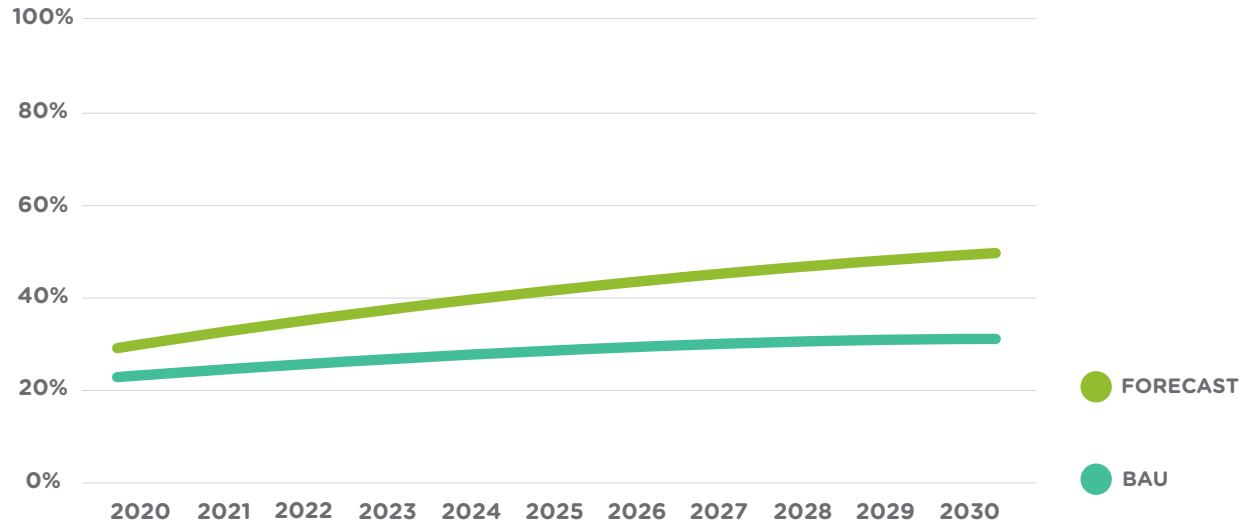
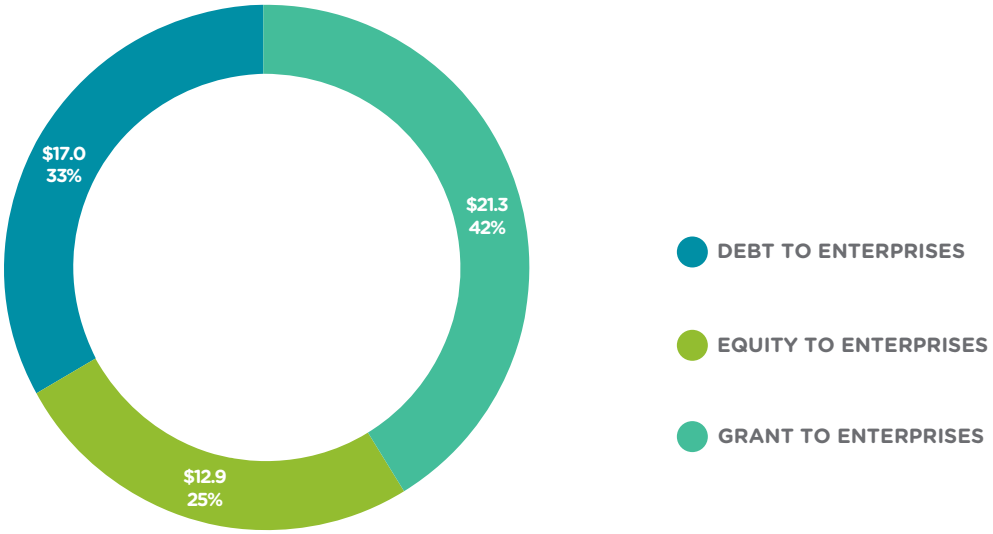


Figure 1.7

Cumulative Financing Needs for Ugandan Mini-Grid Enterprises (Million USD)



overall costs of delivering energy access via mini-grid solutions would increase considerably. To achieve the nearly 70,000 mini-grid connections envisaged in the forecast scenario outlined above, mini-grids will have a cumulative financing need of USD 51 million, averaging out to USD 4.6 million per year, as seen in Figure 1.7 above. The number of new mini-grids aligns with that of a government program designed in 2018 that specifically mapped villages where mini-grid deployment was appropriate. The *Taking the Pulse* model assumes that each mini-grid will support 200 households and two large anchor clients that consume at least one-third of the mini-grid's generated electricity, and that connections will cost between USD 650-1,050 per connection, depending on the maturity of the mini-grid developer. A mature developer, by virtue of experience deploying at least 25 mini-grids, is expected to be able to develop new mini-grids at lower upfront cost than its peers.[153] In reality, it is also more likely to ensure its mini-grids are efficiently exploited and thus more economically viable going forward. It is noteworthy that at this time, there are no mature developers operating in the Ugandan market.

[153] The methodology chapter provides details regarding the assumptions that underpin the mini-grid modeling outputs, including the enterprise level characteristics.

Table 1.2

Capital Blend by Mini-Grid Company Maturity

	Pilot	Validation	Scale-Up	Mature
Grant	75%	50%	40%	30%
Equity	25%	30%	30%	20%
Debt	0%	20%	30%	50%

Mini-grid projects rely on a blend of grants and equity to finance early-stage development and operational costs, and as leverage for the additional debt financing needed to build and maintain infrastructure, as illustrated in Figure 1.7. In the model, the blend of capital is directly tied to the companies' stage of growth, where pilot stage companies require closer to 75 percent grant funds and little to no debt, and mature companies require 30 percent grants and are much more reliant on debt.

Due to the early stage of mini-grid developers in Uganda and the early stage of the mini-grid market overall, the analysis of financing needs for mini-grid development in our forecast scenario assumes that international development agencies, local government agencies, trusts and foundations will provide grants to cover 42 percent of enterprise financing, while venture capital, private equity, and impact funders will contribute 25 percent in the form of equity. The remaining 33 percent of enterprise financing would come from debt provided by local and international investors. A main challenge will be to catalyze local sources of capital. To date, these actors have played a modest role in supporting energy access. As one interviewee remarked, "…most local investors don't understand the space and aren't very interested in learning."[154]

Affordability of Mini-Grids

Project developers have had difficulty setting cost-reflective tariffs in the current regulatory environment that recoup installation costs and operating expenses while staying within a rural household's willingness and ability to pay for electricity. Even with an anchor customer that has substantial energy needs, such as an agricultural facility, a cottage industry, or a mobile phone tower, mini-grid projects require subsidies to offset the tariff charged to energy users or buy down the connection cost. Therefore, the report model assumes a considerable contribution of grant financing (ranging from 30 to 75 percent) to make mini-grids economically viable. This financing would enable mini-grid operators to lower the cost of power to their customers to a level that would be affordable. This would also reflect the lowered risk profile of the business model as it matures, which would reduce the sector's dependency on concessional financing over time.

Key Challenges and Opportunities Relative to MGs Delivering on SDG7 Targets

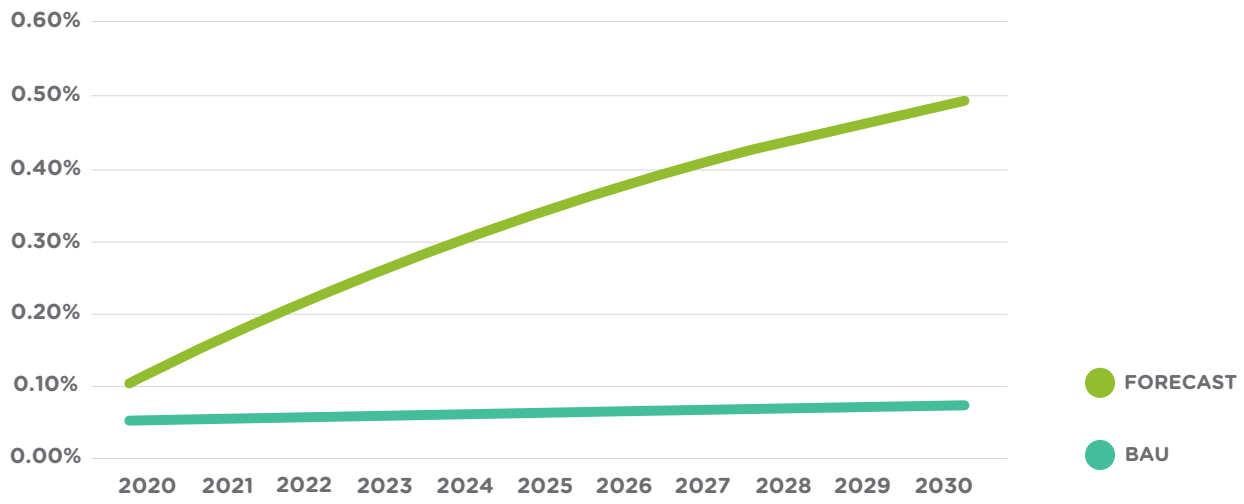
Fears over grid intrusion in mini-grid service areas, a lack of technical and quality standards, and uncertainty in the project review and approval process have been cited as key constraints for Ugandan mini-grids. Developers identifying project sites lack information on sites under consideration by competing developers, energy demand within a site, and whether the site is under consideration for grid extension. This can slow the site selection process significantly.[155] In addition, Uganda has not yet established mini-grid quality of service, interconnection policy, or equipment standards.[156] This can be difficult for developers whose mini-grids will eventually be reached by the grid and require transparency on integration standards and models for owning and operating the mini-grid, and the policy uncertainty can also deter medium- and long-term investors. Licensing for developers is time-consuming, sometimes exceeding a year. The government initially had little or no precedent for evaluating mini-grids separately from grid projects. As the project pipeline has grown, so has the need to build up human capacity. For example, a two- or three-person team at the Uganda Regulatory Authority performs technical evaluations for grid and off-grid projects. Grid projects generally take priority. Once evaluations are underway, they are characterized by a high degree of subjectivity. While reviewing a developer's business model and a project's balance sheet, evaluators use discretion to assess financial feasibility because there are no established criteria or clear guidelines for applicants to reference.[157]

[154] Based on in-country interviews.

[155] National Association of Regulatory Utility Commissioners (NARUC). 2017. "Practical guide to the treatment of Mini-grids".
[156] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[157] Based on in-country interviews.

Figure 1.8

Uganda – Stand-Alone Solar Electricity Access



STAND-ALONE SOLAR CONTRIBUTIONS TOWARD SDG7

In a BAU scenario, stand-alone solar for households is expected to reach 31 percent, whereby net new connections (gross additions minus retirements) range from 200,000 to 250,000 Tier 1 equivalents per year through 2030. This scenario reflects the general slowdown in stand-alone solar product sales witnessed across many solar markets in recent years, including the slowing pace of sales referenced in Figure 1.1.

The forecast model, however, projects that new stand-alone solar will account for 5.3 million new household connections over the period 2020-2030 (52 percent of electrified households). This also means that stand-alone solar will deliver electricity access to nearly 7.2 million total households by 2030. This is a 66 percent increase from the BAU scenario and will require significant capital and private-sector absorptive capacity – and execution capability – to achieve. The challenges around delivering on these ambitious targets are discussed in more detail later in the chapter. The significant increase in solar uptake has already been observed by some interviewees. One noted that increasingly its new customers are second-generation users who are buying either improved or larger systems.[158] Another pointed to the growth of the stand-alone solar sector being manifested in the increasing awareness for solar as an alternative to the grid and being able to differentiate product quality.[159]

Financing Needs

To achieve the additional 5.3 million connections envisaged in the forecast scenario outlined above, stand-alone solar enterprises will have a cumulative financing need of approximately USD 1.43 billion, averaging to USD 130 million per year, as seen in Figure 1.9 below. The outputs depicted in this figure are based on three key assumptions:

- PAYG companies require long-term, up-front financing to accommodate the payment schedule of their customers—which is often 12 to 18 months but can extend to three years or more. This means that the initial financing challenge resides with the solar enterprises themselves. Debt is the most appropriate form for this financing to take, as it will enable stand-alone solar companies to import inventory, and in some cases, ex-

[158] Based on in-country interviews.
[159] Ibid.

tend loans to their customers. As those systems are purchased, loans can be repaid.[160]

- Stand-alone solar systems are assumed in the model to have a lifetime of four years and, as such, households purchasing a system in a given year are projected to require a new system to maintain access fully four years later.

- Uganda will also require a total of USD 329 million, an average of USD 29.9 million per year, in affordability gap financing to achieve universal electricity access. A more detailed explanation of consumer affordability is provided in Part 3 of this chapter.

The model assumes that OGS businesses are at different stages of maturity during the forecast period (pilot, validation, scale-up, mature)[161]. The blend of capital associated with these stages varies, as summarized in Table 1.3 below. Early-stage enterprises will be more reliant on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure significant debt that will finance their consumer receivables and inventory finance needs.

Stand-alone solar enterprises benefit from increasing access to debt, limiting the need for grants in the financing mix. Through 2030, grants are expected to continue providing 15 percent of enterprise financing, largely due to the need to incentivize companies to establish sales channels in underserved rural areas. Equity finance covering 40 percent of enterprise needs will support ongoing operational activities and growth, while debt providers will contribute the remaining 45 percent of enterprise capital needs, accounting for low-cost funds to commercialize loans to solar service providers and first-loss guarantees against borrower defaults.

[160] Uganda Off-grid Energy Market Accelerator. 2018. "Mapping the Ugandan off-grid energy market".
[161] The report's methodology chapter provides more details regarding the assumptions underpinning these enterprise stages.

Figure 1.9

Cumulative Financing Needs to Achieve Stand-Alone Solar Targets in Uganda (Million USD)

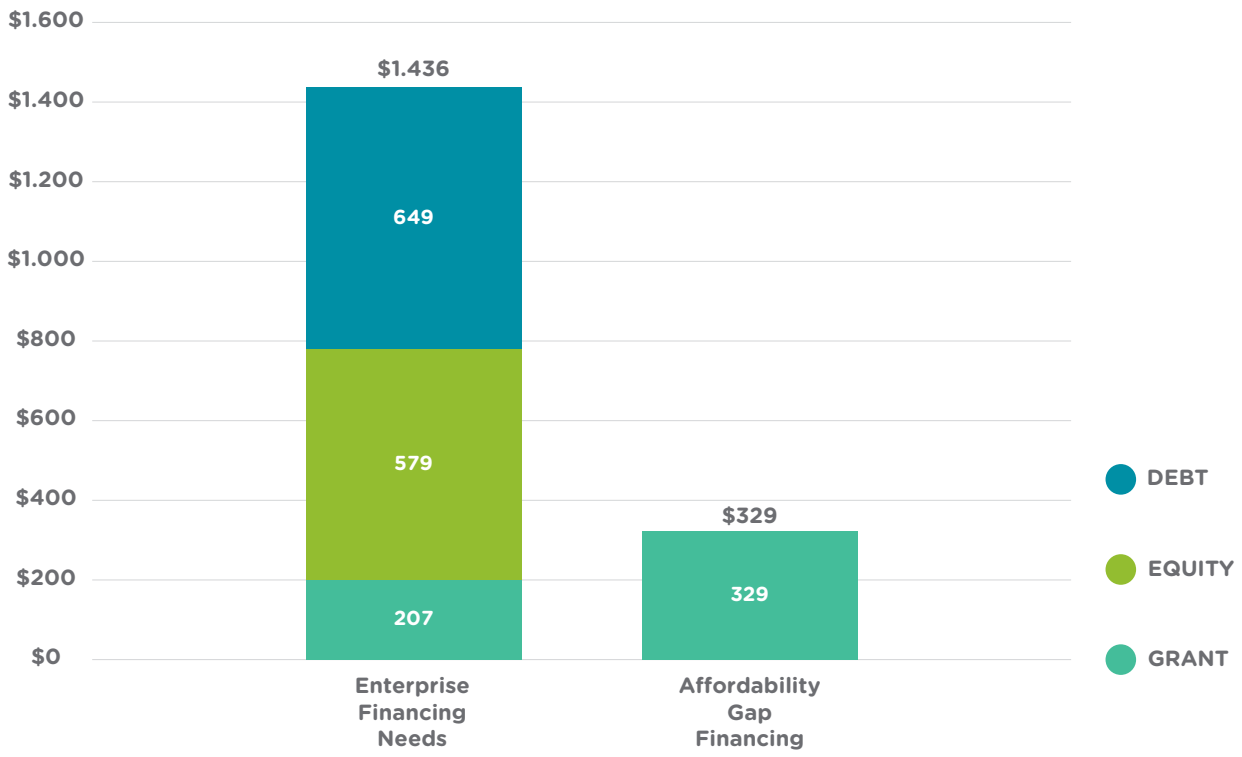


Table 1.3

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

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

To date, many companies have struggled with accessing non-grant capital. As one interviewee highlighted, grants can be limiting in terms of purpose or application of funds. They mostly cannot finance inventory and the reimbursement structure means they must have funding to do the work before being reimbursed.[162] Another noted that there is a lot of buzz regarding investments into the renewable energy sector but companies, especially the small ones that have no fundraising teams, don't really know where to start to access this money or will not qualify for the money.[163]

Affordability of Stand-Alone Solar

A large proportion of Ugandans live under or near the poverty line[164] and, as such, it is likely they will have difficulty affording even basic stand-alone solar products. An estimated 13 percent of households are unable to afford the USD 3.3 per month[165] to buy a solar lantern on a PAYG basis. A further 44.5 percent are expected to be unable to afford a full Tier 1 solar home system at a cost of USD 7.5 per month[166], as illustrated in Figure 1.10 below. Interviews with private sector actors validated the affordability challenge that they face, with one player going so far as to lower its initial deposit requirement in order to boost sales.[167]

The estimated affordability constraints outlined above were determined by leveraging the World Bank poverty calculator (PovCal) to create Ugandan household consumption curves, i.e., charting the percentage of households with consumption at or below specific dollar amounts.[168] Then, by assuming that households are willing to allocate no more than 5 percent of their monthly consumption on electricity access (a threshold often used by practitioners to define electricity affordability), the model is able to estimate the percentage of households that cannot afford either the USD 3.3 a month for a PAYG lantern (marker "1" in Figure 1.10) or, separately, the USD 7.5 for a Tier 1 solar home system (marker "2" in Figure 1.10).

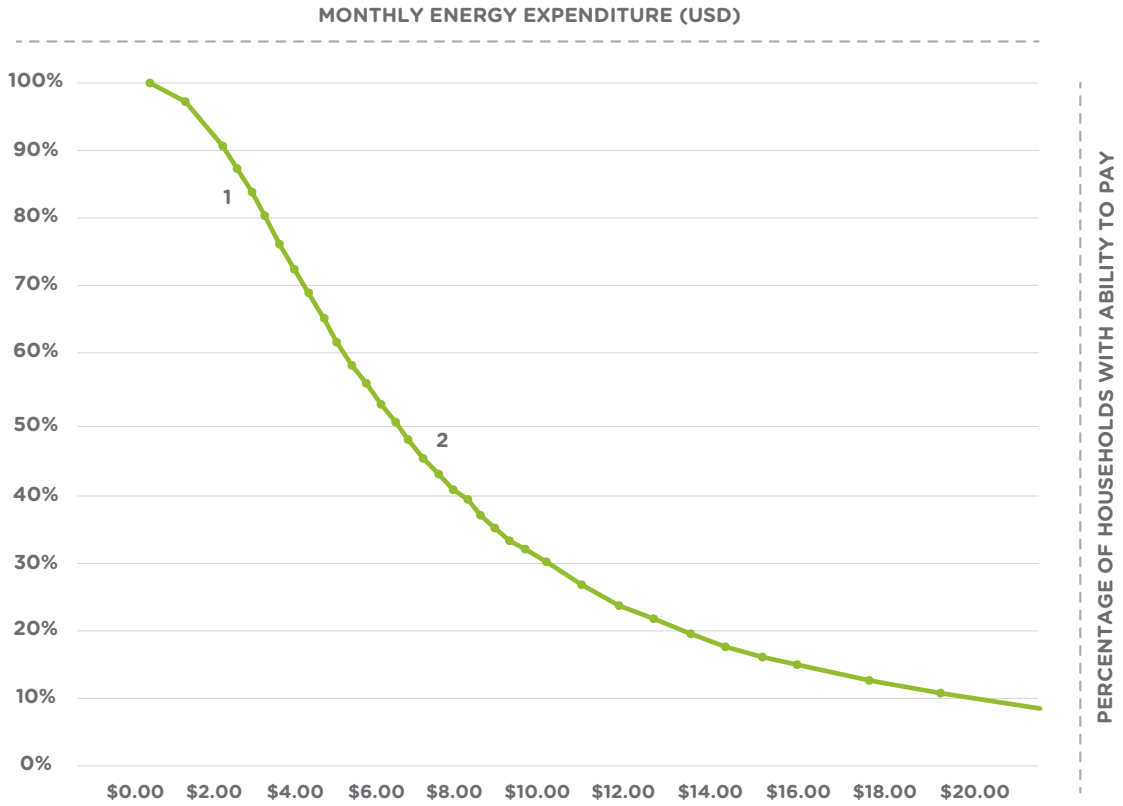
Key Challenges and Opportunities Relative to Stand-Alone Solar Delivering on SDG7 Targets

Although stand-alone solar has seen rapid expansion in Uganda and is expected to play a central role in electrification, there are still several major challenges to its advancement. First is a lack of access to resources to accelerate expansion, including capital, talent, and market knowledge. To overcome capital constraints, businesses will require technical assistance to improve investment readiness. To overcome gaps in market knowledge, companies will require higher-quality national data. This data could include in-depth, up-to-date market data on consumer af-

[162] Based on in-country interviews.
[163] Ibid.
[164] The international poverty line is set at USD 1.90 using 2011 prices by the World Bank. For additional information, see: https://www.worldbank.org/en/topic/poverty/brief/global-poverty-line-faq
[165] The model assumes this retail price point for a household to purchase a quality verified mid-range lantern, paid for in installments over 12 months.
[166] The model assumes this monthly cost for an entry-level multi-light point solar system, paid for in installments over 12 months.
[167] Based on in-country Interview.
[168] The methodology chapter discusses the approach to modeling affordability in detail.

Figure 1.10

Uganda's Ability to Pay at 5% of Monthly Consumption on Electricity Access

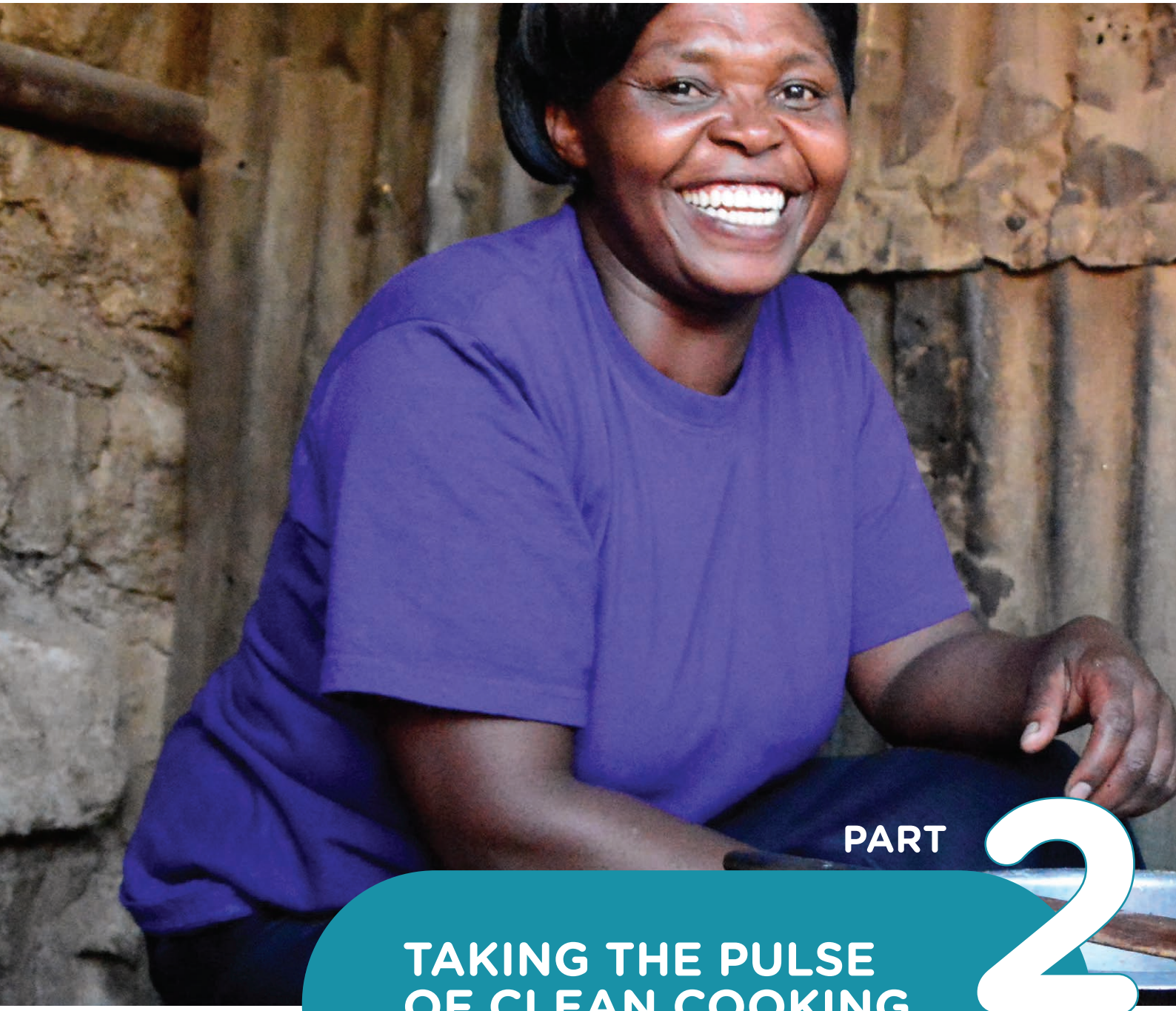


fordability, product availability, key policy initiatives impacting the off-grid sector, access to finance analysis for both companies and consumers, and a map of planned and existing electrification. Given the significance of this constraint, Uganda is already seeing increasing funding from development agencies to help businesses improve investment readiness and build up market data.

Second, the absence of quality standards is enabling low-quality products to flood the market and undermine consumer confidence in solar. Uganda has an opportunity to address quality assurance issues by adopting and enforcing the IEC/Lighting Global standards for Pico PV and stand-alone solar that set quality, durability, and truth-in-advertising requirements to protect consumers across different technologies. In addition to adopting national standards, the Government of Uganda can apply tariffs to non-quality verified products to improve affordability of quality products and lead consumer awareness campaigns to raise the visibility of quality brands with consumers. This would speed up sales and help reduce companies' customer acquisition costs.[169]

Finally, consumer affordability issues inhibit growth in connections. While PAYG solar companies have made great strides in improving affordability for many households, their price point is still not low enough to service the majority of rural Ugandans. For Uganda to reach 2030 access goals, affordability gap financing from government and development agencies will be an imperative. Agencies can direct funding to subsidize the cost of Tier 1 energy access for consumers with limited ability to pay, but this type of effort will take a great deal of planning and coordination among government, development partners, and the private sector to be effective.

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



PART 2

TAKING THE PULSE OF CLEAN COOKING IN UGANDA

INTRODUCTION

Government Initiatives

The Government of Uganda through its 2007 Renewable Energy Policy set out to "increase access to energy in Uganda", including initiatives to significantly increase ICS adoption and incentivize consumers to switch to modern fuels, by setting a target of reaching approximately 4.3 million households by 2017 with "clean and efficient" cookstoves. The Uganda National Alliance for Clean Cookstoves (UNACC), a nonprofit national coordinating partner and implementation agency, works to create an enabling environment for equitable universal access to clean cooking solutions in Uganda. Established in 2014, UNACC facilitates increased innovation in design, testing, production, marketing, and use of clean cookstoves and fuels; government policies and increasing public awareness; downstream and upstream access to

finance; and producer and distributor technical capacity.[170] Through the Uganda National Bureau of Standards and the Ministry of Energy and Minerals Development, the government has been working with the UN Foundation's Clean Cooking Alliance to improve consumer awareness and stove quality through a standards and labeling process.[171] As of 2017, Uganda scored a 63 (out of 100) on the robustness of its clean cooking policy framework, according to a 2018 Regulatory Indicators for Sustainable Energy (RISE) report.[172] While the existence of a national cooking plan and improved availability of data are highlighted as strengths of the clean cooking sector in the country, lack of incentives and standards were identified as weaknesses.

CURRENT SECTOR ECOSYSTEM

Defining Clean Cooking

Taking the Pulse uses the MTF[173] to establish the minimum definition of "improved cooking" that counts toward the SDG7 goal of universal access. The MTF measures household access to cooking based on indoor air quality, cookstove efficiency, convenience, and safety, affordability, quality and availability of the primary fuel.

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

Related to clean fuels, the report focuses on three primary fuels considered to have significant potential. These are a sub-set of cooking solutions that deliver high performance in terms of reducing household air pollution—often (although not always) regardless of the type of cookstove used: biogas, LPG, electricity, ethanol[174], natural gas, and solar cookers, collectively called "BLEENS".[175] Given that *Taking the Pulse* only focuses on biogas, LPG, and ethanol, it adopts the term "clean fuels" in discussing them. The report forecasts the expected uptake of clean fuels over time, but does not cost out the financing that would be required to achieve these forecasts. This is because it was not in the scope of this report given the complexity surrounding the costing of delivering clean fuels for cooking.[176]

Clean Cooking in Uganda

Ninety-five percent of all Ugandan households rely on charcoal, wood, or other forms of biomass for their household cooking needs.[177] Despite this, ICS penetration in the market is low. As of 2012, only 3.7 percent of households in Eastern Uganda owned an ICS, compared to 8.7 percent in central Uganda.[178] A study conducted to measure customer behavior towards clean cooking found that the practice of stove stack-

[170] GVEP International. 2012. "Global Alliance for Clean Cookstoves: Uganda Market Assessment – Intervention Options."
[171] Ibid.
[172] The RISE scores highlight a country's policies and regulations in the energy sector organized by four pillars: energy access, energy efficiency, renewable energy and clean cooking. The scores are out of 100 and a lower score indicates poor performance whereas a high score indicates good performance.
[173] Bhatia, M. & Angelou, N., 2015. Beyond Connections – Energy Access Redefined, Washington: Energy Sector Management Assistance Program.
[174] As there is no active ethanol market for cooking in Uganda, it is not discussed in this chapter.
[175] Bhatia, M. & Angelou, N., 2015. Beyond Connections – Energy Access Redefined, Washington: Energy Sector Management Assistance Program.
[176] In addition to the financing needs for distribution and/or installation of the cooking hardware, scaling LPG and ethanol uptake requires the build-out of large-scale distribution infrastructure, particularly related to shipping, storage, and processing of fuels.
[177] Uganda Bureau of Statistics. 2017. "The Uganda National Household Survey 2016/17".
[178] GVEP International. 2012. "Global Alliance for Clean Cookstoves: Uganda Market Assessment – Intervention Options.".

ing[179] was commonplace in Uganda,[180] as it is throughout the African continent. The primary types of stoves available in the market are fixed 'rocket' stoves, mainly promoted by NGOs and installed by local artisans, a 6-brick stove, and several portable versions such as the improved ceramic, metal-clad stove. Many producers are centralized in Kampala, where the demand is likely to be higher for their product, and over 90 percent of urban households still cook with wood or charcoal. Most produce under 100 stoves per month and make local, portable models with varying levels of quality.[181] Many are struggling to get the necessary finance and marketing expertise to scale up and enter new, more disparate markets.

Internationally, a number of companies—such as Eco-Zoom, Burn Manufacturing, and Envirofit—are producing high-quality industrial stoves through scalable and centralized industrial production. They achieve this by sourcing quality components, manufacturing with precision tools, and employing considerable levels of automation in their processes. Their focus is typically on rocket stoves, which have an insulated, L-shaped combustion chamber that improves combustion efficiency and reduces emissions. The resulting stoves are considerably higher quality than what can typically be produced in local markets, and generally, achieve Tier 2 or higher on efficiency and Tier 1 or higher on emissions.[182] While these companies continue to improve their product designs and manufacturing processes, they have avoided investing heavily in the in-country retail distribution networks that are critical to driving sales and achieving the volumes required to meet SDG7. One main reason for this is the high cost of distribution to rural centers for those companies which are mostly located in Kampala. As such, they have rather limited market share and have often relied on substantial concessional financing in order to reach consumers.[183]

[179] Stove stacking is the practice of using more than one stove or fire to carry out the cooking and other stove related tasks. It can be simultaneous use or at a separate time.
[180] The World Bank. 2015. "Willingness to Pay and Consumer Acceptance Assessment For Clean Cooking in Uganda".
[181] GVEP International. 2012. "Global Alliance for Clean Cookstoves: Uganda Market Assessment – Intervention Options".
[182] GVEP International. 2012. "Global Alliance for Clean Cookstoves: Uganda Market Assessment – Sector Mapping."
[183] Ibid.

LPG Market

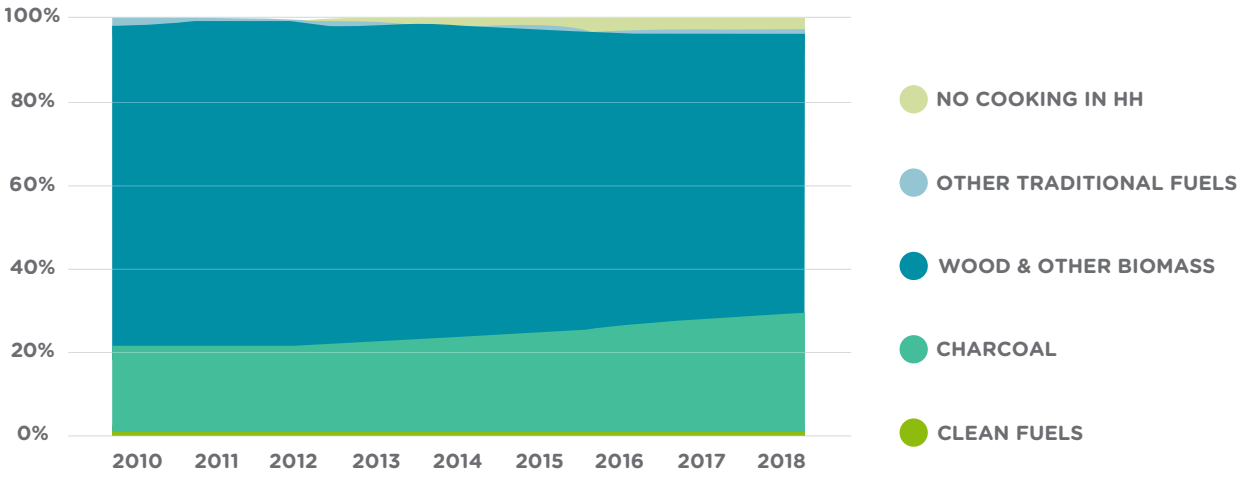
Despite the fact that less than 1 percent of households utilize LPG for cooking, there is a competitive market among LPG suppliers in Uganda, with over 10 medium-to-large sized companies operating. Shell Gas or Total are available in almost every region, mainly at petrol stations, along with a number of other local and regional players.[184] From a supply standpoint, Uganda has recently taken steps to begin exploiting its domestic oil resources.[185] Although much of this oil is expected to be refined into transportation fuels, it is anticipated that as much as 60,000 tons of LPG per year could be produced by 2023,[186] enough to meet the cooking needs of between 2.2 million and 2.6 million households (or 21-25 percent of all households in 2023).[187] [188] However, the country's planned oil refinery has been pushed off by two years until 2022, according to recent reports.[189]

Currently, the larger LPG players are focusing mainly on the urban market and their existing distribution infrastructure (e.g., petrol stations), and not moving into rural and last-mile markets. The lack of economies of scale and comparatively lower income levels, in addition to the distribution costs and challenges, mean that the rural and remote market is broadly associated with higher risks and lower returns. To develop the market, efforts are being made to make the upfront costs of LPG more affordable and accessible in Uganda, notably on two fronts: i) by making smaller canisters available (e.g. 3-kilogram (kg) versus the standard 6kg or 12kg canisters); and ii) by piloting new pay-as-you-cook service delivery models. Anecdotal evidence from Uganda suggests that despite somewhat

[184] Other local and regional players include OilLybia, Lake Gas, Kobil, Wana Energy Solutions Gas (WesGas), Oryx Energies, Mpishi, Hashi, Mogas, Hass Gas, PET Gas, and RAMCO Gas.
[185] Export.gov. 2019. Uganda – Oil and Gas. 03 30. https://www.export.gov/article?id=Uganda-Oil-and-Gas
[186] Ssekika, Edward. 2016. Uganda targets 60,000 tonnes of LPG annually. 02 24. https://observer.ug/business/38-business/42758-uganda-targets-60-000-tonnes-of-lpg-annually.
[187] This is based on field research in Sub-Saharan Africa indicating annual household LPG consumption of between 22.6 and 27.3 kg.
[188] Economic Consulting Associates, The Global LPG Partnership. 2017. "Econometric analysis of potential LPG Household cooking market in Ghana".
[189] Mangula, George. 2018. Eagle . 09 20. https://eagle.co.ug/2018/09/20/plans-to-build-ugandas-oil-refinery-pushed-to-2022.html

Figure 2.1

Uganda's Historical Cooking Fuel Breakdown



higher per-unit (or per kg) costs, the 3kg cannisters are the highest in demand due to their lower initial cost.[190] However, reducing upfront costs is just one part of the problem. The bigger long-term barrier to higher LPG penetration remains its cost relative to alternatives. Even as households begin using LPG for small meals or elements of their meals, they are likely to continue using charcoal to limit their cooking fuel expenditure. Countries that have successfully boosted LPG uptake have done so by: i) subsidizing the cost of the fuel; and/or ii) successfully promoting economic growth and thus household purchasing power.

Biogas Market

SNV Netherlands Development Organisation (SNV) has been a major supporter of the biogas sector's growth in Uganda since 2009. At that time, a pre-feasibility analysis was conducted and found a market potential of 250,000 to 300,000 household biogas installations countrywide (equivalent to some 2 percent of the 2030 total). As of 2019, SNV estimates that there are approximately 10,000 biodigesters operating in Uganda. Several companies have been supported via Biogas Solutions Uganda (BSU), a company launched with the aim of providing training, management support, awareness raising activities, and other forms of technical assistance. The construction of the biodigesters is done by local companies, many of which are trained by BSU. It is estimated that there are approximately 20 biodigester construction companies in Uganda, over half of which work with the BSU.[191]

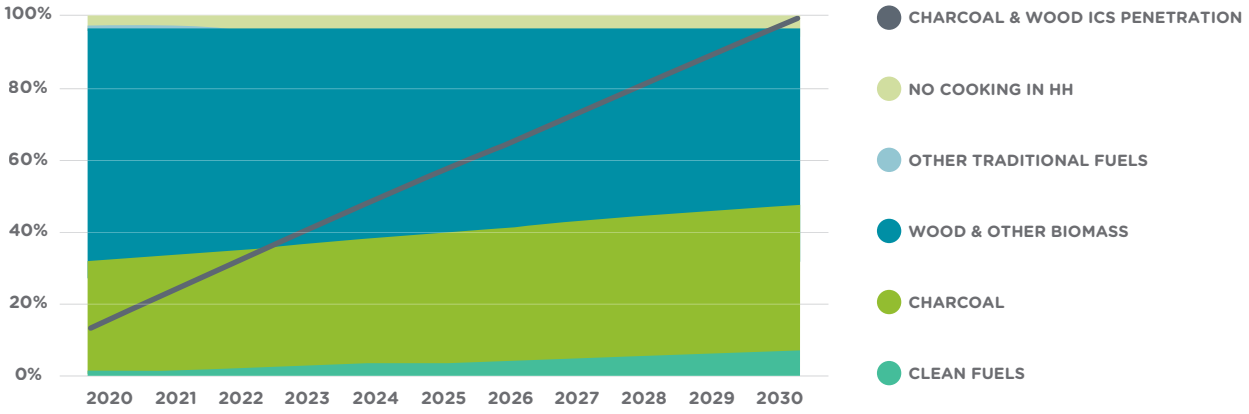
The biogas market is currently focused primarily on providing biodigesters to households with livestock, typically either cows or pigs. As a result, the customer base is predominantly rural. There are however some peri-urban biogas customers, typically households with two to three cows kept in a shed on small- to medium-sized plots. Given the high cost of borrowing from financial institutions in Uganda, much of the biogas market is based on cash sales. In an effort to bring down upfront costs, a form of results-based financing was available during an earlier phase of the SNV and Hivos' biogas initiative that provided up to 45 percent of the construction cost, a share that was reduced gradually down to 25 percent. There is also growing interest in Uganda from the institutional sector, particularly from institutions such as schools. For such larger installations with higher cooking demand, the economics of using food

[190] Based on in-country interviews.

[191] Based on in-country interviews.

Figure 2.2

Forecast Cooking Fuel Breakdown



waste rather than that from livestock can be quite attractive, particularly when compared to charcoal.

Another company trying to build a more commercially viable biogas business in Uganda is Green Heat International. The company has been successful in building larger projects, specifically for the institutional market segment. Awareness of the potential role of biogas is growing as familiarity with the technology grows, and as concerns around the depletion of forest resources and rising charcoal prices persist.

CURRENT STATE OF CLEAN COOKING ACCESS

By the end of 2018, just over 1 percent of Ugandan households were using clean fuel as their primary cooking energy source, typically LPG (0.7 percent) or electricity (0.5 percent). Approximately 95 percent of households still cook with wood or charcoal, as shown in Figure 2.1.

Based on outputs from the model developed as part of this report (see methodology chapter for details), at the end of 2018, only about 1 percent of households in Uganda were estimated to be cooking with charcoal or wood using a high-quality industrial ICS that meets international minimum standards on fuel efficiency and emissions. Fewer than 1 percent of households now cook with kerosene (the only other traditional fuel commonly used), though this share has dropped considerably over the years and is likely to continue to do so as better alternatives become available. The remaining households use a three-stone fire or an artisanal or semi-industrial cookstove that does not improve cooking efficiency and/or emissions enough to be deemed an ICS, with the exception of the 3.2 percent of households that do not cook at home, according to survey data.[192]

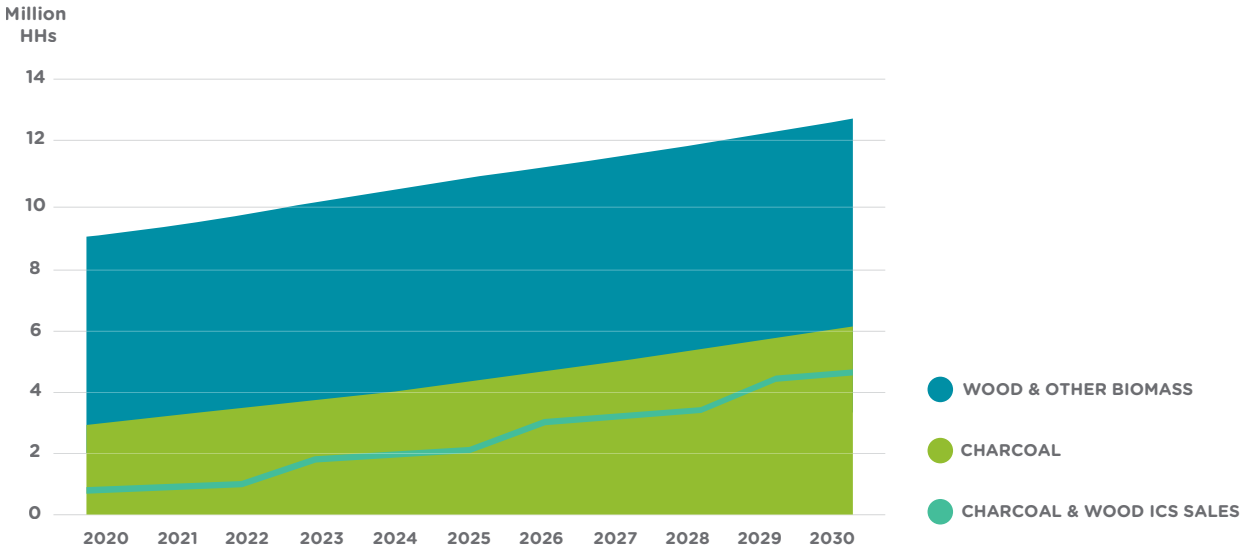
Closing the Clean Cooking Access Gaps in Uganda

Figure 2.2 illustrates the scope of the clean cooking challenge in Uganda. The model assumes that 3.2 percent of households will continue not to cook in the household. It also projects that households using clean fuels will increase to a total of 7.5 percent (just over 1 million households). This represents a seven-fold increase over the current situation. The remaining 12.2 million households (88.7 percent of the total) are expected to continue to cook with wood and charcoal. The challenge will be to shift all of these households away from traditional cooking technologies (namely three-stone fires and lower-quality semi-industrial stoves) and onto high-quality industrial improved wood and charcoal stoves, as illustrated by the blue line representing required penetration of ICS over the period 2020-2030.

[192] Uganda Bureau of Statistics. 2017. "Uganda National Household Survey 2016/17".

Figure 2.3

Forecast Traditional Cooking Fuel Use and ICS Sales



Wood and Charcoal ICS Contributions Toward Achieving SDG7

The analysis now focuses on the forward-looking projections through 2030 and, in particular, modeling what it would take for Uganda to achieve universal clean cooking access by that time. The figure above illustrates the model outputs through to 2030. The key assumptions that underpin the model are as follows:

- The minimum definition of access is high-quality industrial ICS that meets international minimum standards on fuel efficiency and emissions (namely Level 1 or higher in the MTF's multi-level matrix for access to cooking solutions).
- The assumed retail price is USD 25 for an industrial wood stove and USD 36 for an industrial charcoal stove.
- Population growth is factored in at 2.9 percent per annum, per Uganda Bureau of Statistics estimate.
- Stoves are assumed to be replaced at three-year intervals.

Based on these assumptions, the forecast model projects that 15 million industrial wood stoves and 11.9 million industrial charcoal stoves will be sold during the period 2020-2030.

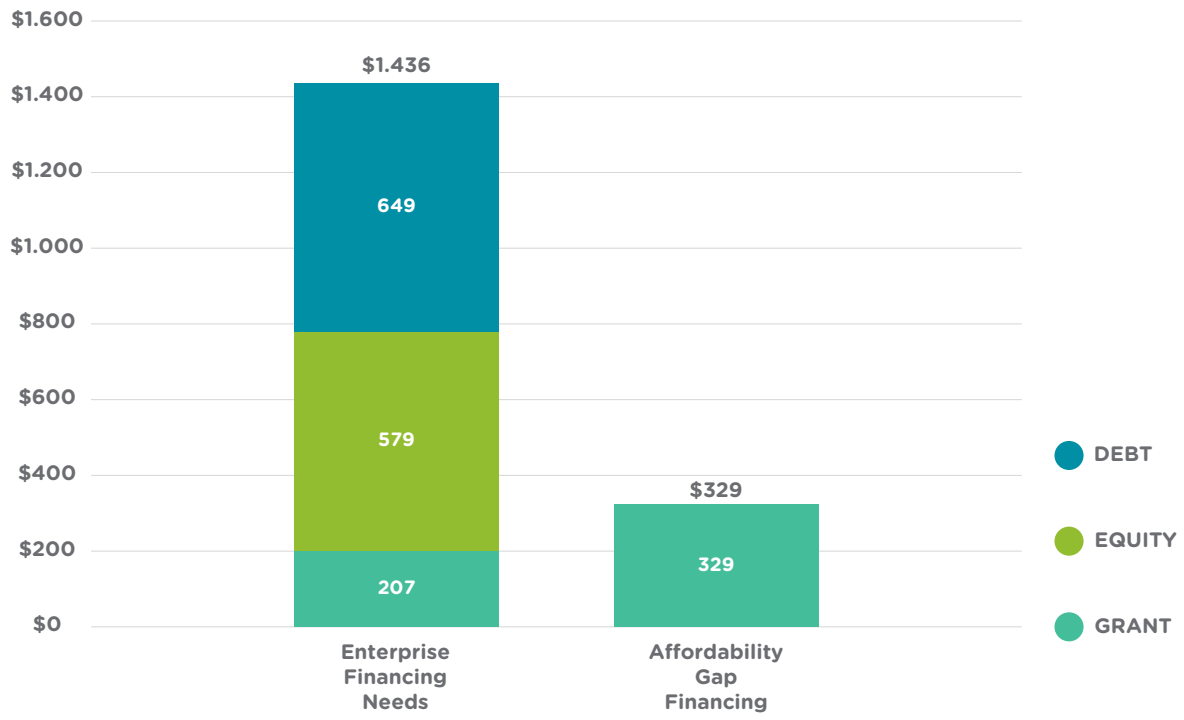
Financing Needs of ICS (Charcoal and Wood)

To achieve the aforementioned targets in Figure 2.4 above, ICS have a cumulative financing need of USD 193 million, averaging USD 17.5 million per year, for enterprises alone, as seen in Figure 2.5.

Grants to enterprises represent 17 percent of the capital mix (USD 32.6 million) used to lower costs associated with proving out the business model and displacing additional equity financing needs. Another 32 percent of financing needs will be in the form of equity investments (USD 61.7 million) in businesses that turn profitable at the scale-up phase. Debt financing accounts for 44 percent of the capital mix (USD 98.4 million). This is inventory finance to enable retailers to purchase stock of stoves and then repay those loans once sales are completed. The model assumes that all stoves are sold on a cash-sale basis.

Figure 2.4

Total ICS Finance Needs (Million USD)



Consumer Affordability

According to the forecast scenario, Uganda will require a cumulative USD 344 million, an average of USD 31.3 million per year, in affordability gap financing to help the 81 percent of households that cook with wood but cannot afford ICS. The model[193] assumes that households save an amount equivalent to two percent of total monthly household consumption for a period of three months in order to buy an ICS. The model also assumes that if a household can afford to buy charcoal, then there is no affordability gap in buying a stove. Since charcoal is expensive (nearing USD 0.50 per kilogram) relative to firewood and the charcoal stove enhances efficiency, reducing charcoal expenditures by purchasing the improved stove should be a selling proposition and compelling to consumers so long as they understand this benefit. Interviewees noted that consumers struggled to differentiate between high- and low-quality stoves and therefore would not justify paying a higher market price.[194] Therefore, priority must be given to efforts to understand what the customer wants in a cooking solution and in public awareness campaigns that provide information on the long-term benefits of adapting to cleaner cooking options.

With respect to clean fuels, the relatively high upfront cost of an initial LPG kit (including the cost of the cylinder, burner, hose, and regulator) remains one of the main barriers to scale-up in Uganda. However, the rising cost of charcoal has helped drive demand for LPG: a 50kg sack of charcoal currently sells for UGX 80,000 (USD 21.28), up from UGX 45,000 (USD 12.19) or UGX 50,000 (USD 13.55) two to three years ago. As a result, the economics of LPG are becoming increasingly attractive. That said, the refill cost of LPG would still need to drop by more than half before it becomes more affordable per useful unit of energy than charcoal. Table 2.1 below provides an overview of the current price range for LPG kit, broken down by component.

[193] The methodology chapter provides more details on how affordability was modeled.

[194] Based on in-country interviews.

Table 2.1[195]

LPG Price Range by Component (USD)

Cannister Size	Deposit Fee USD	Refill Cost USD	Grill in USD	Burner in USD	Hose in USD	Regulator in USD	Total LPG Start-up Cost
6kg	18.60 – 33.22	15.65	6.90	7.44	N/A	N/A	**48.59 – 63.21**
13kg	21.25 – 36.94	31.30	6.90	7.44	3.99	7.18 – 10.64	**78.06 – 97.21**
15kg	33.40 – 39.85	37.66	6.90	7.44	3.99	11.97 – 14.63	**101.36 – 101.47**

In a sign of the competitive nature of the country's current LPG market, one company has recently cut its upfront deposit *in half* to boost uptake.[196] Despite the high upfront costs, there are other peripheral factors contributing to fuel switching in Uganda. For instance, some landlords in Kampala are beginning to prohibit the usage of charcoal in their buildings. This leaves households with the option of either LPG, electricity or other non-charcoal alternatives. Much as with the LPG market, affordability remains the single biggest challenge to scaling up the biogas market. Current construction costs range between UGX 2.0-2.6 million (USD 530-700) per digester for a standard household, meaning that even with financing, such systems are out of reach to all but the wealthiest of households.[197]

An Energizing Development[198] program is currently providing results-based financing (RBF) to address the affordability challenge. The RBF is structured in two forms: The Credit Sanctioning Incentive, which is provided to financial institutions in the country to boost credit availability to the sector, and a Quality Plant Incentive, which is provided to so-called "Biogas Construction Enterprises" to encourage better after-sales services.[199]

KEY CHALLENGES AND OPPORTUNITIES: UGANDA'S SDG7 COOKING TARGETS

As outlined above, Uganda's clean cooking sector shows promise, but also requires a significant boost in order to achieve the SDG7 target. On the demand side, ICS operators struggle to sell to rural customers, where traditional cooking methods are preferred, and incomes are lower. Solutions include increased understanding of what drives household – and primarily women's – adoption of new cooking solutions and public awareness campaigns emphasizing savings in both time and money to influence household decision making around purchase and usage. On the supply side, operators must deliver cookstoves where the need is, in both urban and hard-to-reach rural areas. They will need to create supply chain and distribution channels along with the retail customer acquisition side of the business.

Regarding LPG, the Government of Uganda has recently committed to improving awareness of LPG fuels, as well as developing regulations to harmonize distribution, transportation, storage, and marketing.[200] The Uganda National Bureau of Standards has also been actively involved in developing safety standards for cylinders, and other key LPG system components. As a result, safety is becoming less of a concern among customers. De-

[195] Ibid.
[196] Ibid.
[197] The World Bank. 2018. The World Bank Data https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=UG
[198] Energizing Development. "Biogas Business Boost Benefitting Farmers (4B-F)" https://endev.info/content/Biogas_Business_Boost_Benefitting_Farmers_(4B-F)
[199] Ibid.
[200] Ssekika, Edward. 2016. Uganda targets 60,000 tonnes of LPG annually. 02 24. https://observer.ug/business/38-business/42758-uganda-targets-60-000-tonnes-of-lpg-annually

spite persistent concerns over affordability, the issue of introducing subsidies for LPG remains controversial, as many LPG players that would ultimately benefit are large, established companies. As a sign of the government's reluctance to give the LPG sector a free pass, it re-introduced a value-added tax on LPG in 2015, and LPG prices continue to remain unusually high at ~USD 2.50 per kg compared to neighboring countries such as Kenya where prices are closer to USD 1.50 per kg.[201]

With regard to biogas, the government has provided some credit to the SACCOs (local cooperative funds). It has also provided tax rebates for the importation of bio-digester components. There are also examples of RBF being made available by EnDev to support the construction and maintenance of biogas systems in the country. The national government is even currently in the process of re-drafting its renewable energy policy. This presents an opportunity to provide more strategic clarity on the future evolution of the clean cooking sector, particularly with regard to biogas and LPG, both of which benefit from relatively strong fundamentals.

[201] Based on in-country interviews.

The affordability challenge looms large for the improved cooking sector in Uganda. For ICS, fuel is less of a concern since most households collect wood themselves, though the cost of purchasing the stove remains a major obstacle. For clean fuel-based technologies, the affordability barriers to uptake are twofold. In addition to the upfront cost of the products themselves, the recurrent costs associated with fuel purchase constitute major hurdles for consumers. One solution is to further experiment with the PAYG model and mainstream its use in the clean cooking sector. Another way forward would be to eliminate the tax on cookstoves and their components. Stakeholders could also capitalize on the rapidly rising prices of charcoal which has already prompted some households to start using alternative fuels.[202] Helping consumers understand the economic benefits of adopting improved cooking solutions, in addition to their health, safety, and environmental benefits, could help accelerate adoption.

[202] The East African. 2018. The East African. 04 06. https://www.theeastafrican.co.ke/business/Uganda-bans-charcoal-exports-to-Kenya/2560-4375368-y8j06sz/index.html