



Uganda Productive Use of Renewable Energy Market Assessment



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Abbreviations

ASSP	Agriculture Sector Strategic Plan
BGFA	Beyond-the-Grid Foundation Africa
CSO	Civil Society Organization
DC	Direct Current
DDA	Dairy Development Authority
DP	Development Partner
EASP	Energy Access Scale up Project
ERA	Electricity Regulatory Authority
EU	European Union
FI	Financial Institution
GEAPP	Global Energy Alliance for People and Planet
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOU	Government of Uganda
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MDA	Ministries, Departments and Agencies
MEMD	Ministry of Energy and Minerals Development
MTIC	Ministry of Trade Industry and Cooperatives
MWE	Ministry of Water and Environment
MSME	Medium and Small and Micro Enterprises
NDCs	Nationally Determined Commitments
NDP	National Development Plan
NGO	Non-Government Organization
NREP	National Renewable Energy Platform
OGS	Off Grid Solar system
PAYGo	Pay as You Go
PUSE	Productive Use of Solar Energy
PV	Photo Voltaic
PVOC	Pre export verification of conformity (PVOC)
SDG	Sustainable Development Goals
SHS	Solar Home Systems
SWP	Solar Water Pumping
UECCC	Uganda Energy Credit Capitalisation Company
UN	United Nations
UNBS	Uganda National Bureau of Standards
UNREEEA	Uganda National Renewable Energy and Energy Efficiency Alliance
UOMA	Uganda Off Grid Market Accelerator
URA	Uganda Revenue Authority
USAID	United States Agency for International Development
USEA	Uganda Solar Energy Association
VAT	Value Added Tax
VSLA	Village Saving and Loan Association

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CREEC's core team consisted of James Baanabe, Dr. Mary Suzan Abbo, Paul Asiimwe and Moses Kakooza.

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About GOGLA

GOGLA is the global association for the off-grid solar energy industry. Our 200+ Members provide millions of low-income and climate-vulnerable people with affordable, high-quality products and services; rapidly increasing customers productivity, connectivity, and resilience.

To enable sustainable businesses and accelerate energy access, we provide market insights, standards and best practice, and advocate for catalytic policies, programmes and investment. With the right support, our pioneering industry can improve the lives of 1 billion people by 2030.

About WE4F

Water and Energy for Food (WE4F) a joint international initiative of the German Federal Ministry for Economic Cooperation and Development (BMZ), the European Union (EU), the Ministry of Foreign Affairs of the Government of the Netherlands, the Norwegian Agency for Development Cooperation (Norad), Sweden through the Swedish International Development Cooperation Agency (Sida), and the U.S. Agency for International Development (USAID). WE4F, through its Regional Innovation Hubs, provides financial support, technical assistance, and investment

facilitation to water-food, energy-food, and water-energy-food innovations,

The supported innovations impact smallholder farmers, helping them unlock missing inputs, finance, technology, and markets. By using these innovations, farmers and food companies can enhance their climate resilience and reduce CO2 emissions.

About CREEC

CREEC's story started in 2001 as a project part of the Makerere University Faculty of Engineering. 20 years later, the Centre for Research in Energy and Energy Conservation (CREEC) is still pioneering a greener future for renewable energies in Uganda. The centre is currently registered as a not-for-profit organization providing methodological, technical and well-researched approaches for renewable energy interventions. As an advisory body and agent for change, for the past twenty years CREEC has delivered, advocated, and lobbied for her vision to enhance access to modern energies across East Africa. CREEC has continued in their efforts to deliver this mission, by partnering with government organizations, donors, private sector players, individuals and academia representatives, to provide innovative programmes and develop technical expertise through capacity-building activities that foster knowledge sharing and business support for renewable energy businesses. The center is also recognized by the Uganda National Bureau of Standards (UNBS) in accordance with the ISO 17025 quality management system.

About USEA

Uganda Solar Energy Association (USEA) is an independent non-profit association dedicated to facilitating the growth and development of solar energy business in Uganda and the East Africa region.

USEA was formed in 2016 by private sector companies that deal in solar energy business with help from the Ministry of Energy and Rural Electrification Agency. It is registered under section 10 of the Ugandan Societies Act.



Executive Summary

Productive use of renewable energy (PURE) has a high potential in Uganda and can provide positive impacts across several key sectors within the country. These include:

Agriculture: The main application of PURE can be seen in the agricultural sector, including for irrigation, cooling, and agro-processing. Currently, solar water pumps (SWPs) are showing the biggest potential due to their demand in crop and livestock production, the advanced development of the technology and the financing models which are already being applied by SWP companies. Emerging PURE technologies include solar refrigeration units (SRU) and solar milk coolers.

MSMEs: The use of PURE by medium small and micro enterprises (MSMEs) is already proving transformative. Standalone solar systems and mini-grids are being used to provide light and power for MSMEs such as shops, stalls, salons and restaurants, and off-grid solar energy is often complemented through the sale of other assets that can be used productively, including TVs, phone chargers and hair clippers.

Transport: E-mobility shows exciting promise, particularly the deployment of e-motos to provide taxi services. Although still at an early stage and concentrated in urban areas, the sector is drawing significant levels of interest.

Health: PURE can provide a critical input to the health sector, for example through the cold storage of medicines and vaccines. However, the PURE-for-health market is mostly dependent on funds from government and donor agencies, challenging its

capacity to scale using market-based models.

Hospitality: Electric cooking is an emerging application and has been given a boost by the Government of Uganda's (GOU's) drive to increase electricity demand and energy efficiency through e-cooking, supported by development partners who wish to support the country in its efforts to conserve the environment and mitigate climate change.

However, while the potential of PURE in Uganda is strong. The sector also faces several challenges. These include:

- low affordability amongst consumers,
- limited knowledge and awareness of PURE technologies amongst end users and key stakeholders (e.g., financial institutions)
- limited access to finance and working capital for PURE companies,
- low technical capacity to install, operate and maintain PURE equipment, and
- limited coordination of GOU and development partner efforts to accelerate access to PURE, leading to the duplication of effort and reduced efficiency.

The key challenges for adoption and scaling of PURE in Uganda, by stakeholder type, are presented in Box 1.

Executive Summary

Box 1 - Key challenges for the adoption and scaling of PURE

Off-Grid Solar Companies:

- Limited access to finance for PURE technology dealers, which limits scaling of businesses and importation of off-grid PURE assets.
- Limited technical capacity to respond to client's needs such as repair, operation, and maintenance of PURE technologies.
- Limited access to asset financing partnerships to offer off-balance sheet financing options to clients.
- Limited existing last mile distribution networks for PURE distributors and ag-tech suppliers.
- Limited understanding of end-user needs which limits opportunities for accessing alternative financing options that can support customer acquisition of PURE.
- Highly specialized products are not viable for all value chains e.g., the solar cooling for dairy value chain might not be directly applicable to horticulture.

End-users:

- Inability to afford high-quality PURE technologies, which limits their ability to buy them or means that they resort to purchasing lower quality, locally fabricated solutions.
- Limited consumer awareness on various existing on- and off-grid PURE.
- Limited access to PURE solutions due to the limited offering of PURE technologies.
- Limited asset financing and digital infrastructure, which undermines uptake of innovative financing solutions.

Financial Institutions:

- PURE products are expensive for most Ugandans and need new innovative financing mechanisms. e.g., flexible payment schedules to match agricultural seasonality.
- Follow up on loan repayments can be challenging due to locations or limited financial records of agri-businesses.
- Some PURE assets are hard to recover/repurpose reducing their attractiveness as collateral, e.g., water pumps.
- Limited understanding of PURE sector by financing institutions undermines risk assessments and capacity to develop tailored products.
- Lack of standardized impact metrics for measuring investment success hinders access to blended capital.
- Funding is skewed towards international off-grid solar and cookstove players, with funds predominantly provided by development partners

Development Partners/NGOs

- Fragmented efforts in the sector and lack of a centralized monitoring and overview of PURE interventions and impact.

Government:

- There is a lack of policy coherence and inadequate coordination among relevant government ministries particularly the ministries of energy, agriculture, and environment, as well as their respective departments and agencies.
- Restrictive tax policies by government keep prices of PURE appliances high.

PURE industry actors consulted for this market assessment prioritized increasing access to finance for both companies and consumers as the most important action for scaling up adoption. In addition, there is a need to create awareness

amongst end users and decision-makers about the opportunities and benefits of PURE.

Key recommendations for each stakeholder group are presented in Box 2.

Executive Summary

Box 2 - Recommendations for scaling PURE

Off-Grid Solar Companies:

- Explore partnerships with financing schemes to access and extend flexible payment solutions that match expected cash flows of agro-processors and healthcare providers.
- Partner with last-mile distributors like Copia and Jumia and/or agri-input dealers like OMIA or Holland that have a large geographical footprint to increase access to PURE technologies.

Financing Institutions:

- Banks and microfinance institutions can partner with development organizations to access cheaper pools of capital that can be used for intermediated lending to the PURE sector. aBi Finance Limited provides lines of credit and loan guarantees to partner banks e.g., Equity, Post Bank, etc.
- Promote asset-based finance partnerships between tech suppliers and banks.

Government and Development Partners:

- Provide additional de-risking mechanisms, such as lines of credit, to increase the level of intermediated PURE lending through financial institutions. Borrow lessons from existing facilities, such as the Agricultural Credit Facility, and apply them to new initiatives such as the Parish Development Model.
- Increase PURE focus on ongoing financing programs by the Government of Uganda and development partners. The government could consider expanding the focus of programs such as the Matching Grant Facility Infrastructure to focus on PURE to boost productivity in agriculture.
- Develop sensitization materials around the importance of PURE applications for boosting agricultural productivity to increase awareness.
- Develop a dedicated PURE strategy, including a monitoring tool that measures cross-sector impacts.
- Explore access to alternative financing mechanisms, such as climate finance, carbon credits or innovative financing facilities.¹
- Boost inter-governmental coordination, with multiple Ministries, Departments and Agencies of government collaborating, such as MEMD, MAAIF, MWE, MoFPED.
- Co-host multi-stakeholder engagement, for government institutions to be aware of new PURE technologies and the private sector barriers and opportunities (in the shape of working groups like the ones initiated by USEA, Power for All and MEMD).

Energy and Agricultural Sector Associations (e.g., UNFFE, USEA, and UNREEEA):

- Aggregate members to support the joint purchase of machinery.
- Invest in sector coordination to leverage the strengths and networks of members.
- Host awareness sessions for members to better understand PURE equipment and its applicability to their business needs.
- Develop sensitization materials around the importance of PURE applications for boosting agricultural productivity.
- Collect and analyse industry data on PURE (sales, imports, customer preferences and feedback) to inform planning.
- Engage with government institutions and co-host, along with government agencies, spaces for the stakeholders from all areas (government, private sector, development partners, NGOs etc) to interact and share the knowledge needed to accelerate the adoption of PURE.



**About this
research**



About this research

The assessment report on the Productive Use of Renewable Energy (PURE) in Uganda provides an in-depth analysis of the potential, challenges, and opportunities of solar energy for productive use in Uganda.

For the purposes of this report, the term PURE is used to refer to any agricultural, commercial, or industrial activity involving solar energy services as a direct input to the production of goods, or provision of services.²

The report aims to inform policymakers, practitioners, and investors on the status and potential of solar energy for productive uses in Uganda. It does this by sharing:

- analysis of PURE products and companies in the market,
- an overview of PURE customer profiles,
- analysis of the demand, supply, and anticipated trends in productive use of solar energy,
- a review of current PURE business models,
- a review of the enabling environment, including policies, programmes, and plans.

To inform this report, valuable information regarding the productive use of solar energy was gathered through desk research, stakeholder

mapping and key informant interviews.

Consultations were held with relevant Ministries, Departments and Agencies (MDAs) of Government, Development Partners (DPs), Civil Society Organisations (CSOs), the Private Sector, and industrial associations such as UNREEEA and USEA.

Desk Review: Several key reports, strategic documents, policies, and legislative frameworks were analysed. A list of the documents reviewed is provided in Annex II.

Stakeholder Mapping: Through desk research and informant interviews, the research identified the key actors involved in the productive use of solar energy in Uganda. The list of the stakeholders consulted is provided in Annex I.

Data Collection Tools: To support this data collection, Informant Interview Guides were developed and implemented for the different stakeholder groups.



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² Shell Foundation 2017: Promoting Productive Uses of Energy in Uganda <https://shellfoundation.org/app/uploads/2018/10/SF-OCA-Uganda-Accelerator--Productive-Use-Technology.pdf>



Context



Electrification in Uganda

Uganda is richly endowed with renewable energy resources for energy production and for provision of energy services. Uganda's energy mix is largely dominated by hydroelectricity power (82%), followed by thermal power (8%), PV solar (5%) and Bagasse (biofuel) (5%). Most of the electricity generated is consumed by medium, large, and extra-large industries (64.6%) and for domestic consumption (24.24%). Commercial consumption uses 11.6%.³ The Government of Uganda has made remarkable progress in recent years, with power sector reforms and other incentives to speed the rate of connections. This has led to an increase in the total installed power capacity to 1,250MW, a total which is expected to increase further with the completion of the Karuma Dam. This means that Uganda's electricity sector has now shifted from having capacity shortages to having an excess of electricity supply, with this excess generation capacity envisaged to last until 2040. The focus of the GoU has therefore moved from on-grid generation towards enlarging the footprint of the grid, increasing demand, and creating pathways for the productive use of electricity and / or utilisation of this electricity.

From a user perspective, Uganda's electrification rate remains low. According to official sources in 2022, 28% of Ugandan's had access to the grid, 28% to off-grid solar photovoltaic (PV) power, and 1% to mini grid power: leading to a combined electricity access rate of 57%, predominantly in urban areas.⁴ Given the access gap, the GoU considers electrification a national priority and placed it at the core of the Third National Development Plan (NDP III). The plan has been complemented by other efforts, such as the Electricity Connections Policy and the Rural Electrification Programme which set an annual target of 300,000 new connections with about a third coming from the off-grid segment.⁵ Together, these programs

support the realization of Uganda's Vision 2040, which aims to increase national electrification access to 80% of the population. Given the cost-effectiveness and viability as a solution for last-mile electrification, off and weak grid solar technologies will be instrumental to the government's ambitions of providing clean energy.⁶

With only 28% of the population having access to the grid, Uganda presents a huge potential market for alternative technologies such as solar PV systems.⁷ The World Bank estimates that the market potential for off-grid solar is over five million households.⁸ These households are affected by both demand side (uptake and ability to pay) and supply side (absence of the grid) limitations as shown in Figure 1.

Off-grid solar technologies are therefore emerging as a key part of the solution to Uganda's energy access problems. Uganda is endowed with plenty of sunshine giving solar irradiation of about 5.1 kWh/m²/day.⁹ This level of insolation is favourable for all solar technology applications.

Status of PURE

Until recently, productive uses of renewable solar electricity have not been incorporated into Uganda's policy and strategy. Initial targets used by the Rural Electrification Agency (now the Rural Electrification Programme (REP) of the Ministry of Energy & Mineral Development (MEMD)) to evaluate success of programs were focused on electricity connection numbers, rather than the use of electricity. However, the potential of off-grid PURE is becoming increasingly recognised and the recent Electricity Connection Policy (ECP) saw the GOU incorporate productive uses of electricity into its electrification strategy for the first time, through the ECPs provision on the 'promotion of PUE through publicity and mobilisation'.

3 Energypedia https://energypedia.info/wiki/Uganda_Energy_Situation last accessed June 2023

4 Uganda Bureau of Statistics (UBOS), 2021. Uganda National Household Survey 2019/2020. Kampala, Uganda; UBOS https://www.ubos.org/wp-content/uploads/publications/06_2021UNHS2019-20_presentation.pdf

5 Government of Uganda (2018) National Electricity Connections Policy 2018/2027 <https://energyandminerals.go.ug/wp-content/uploads/2020/07/Electricity-Connections-Policy.pdf>

6 "Renewed Hope for Free Electricity Connections – Ministry of Energy and Mineral Development." <https://memd.go.ug/renewed-hope-for-free-electricity-connections/> (accessed Aug. 22, 2022).

7 UBOS 2018: National Electrification Survey

8 <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=UG>

9 GIZ (2022): Sector Brief Uganda: Renewable Energy - <https://www.giz.de/en/downloads/giz2022-en-sectorbrief-uganda-renewable-energy.pdf>

Context

In Uganda, dedicated PURE technologies are emerging as a promising segment in the off-grid solar sector. These solutions present a way for rural off-grid households to boost their income and support their farms or businesses. They are currently being used in agriculture, by MSMEs (including food processing, textile manufacturing and carpentry), in transport and in the health sector. PURE has the potential to contribute to poverty reduction, job creation, and economic development in rural areas of Uganda.¹⁰

Where PURE technologies are bought on an individual basis (e.g., as a standalone power, irrigation, or cooling system), additional income generated can be used to pay for the PURE asset (whether via savings for a loan or payments for consumer financing). Where PURE technologies are used with a mini-grid or the centralised grid, increased income can cover the cost of the increased energy supply which, in turn, improves the unit economics of the mini-grid (or grid) which require sufficient demand (and payments) to make them sustainable.

Figure 1 - Total market potential for solar PV systems in Uganda by region

Sub regions	Demand side gap	Supply side gap	Potential market
Kampala	13,800	0	13,800
South Buganda	320,700	81,700	402,400
North Buganda	252,700	209,500	462,200
Busoga	286,400	315,100	601,500
Bukedi	112,500	249,700	362,200
Bugisu	82,600	248,000	330,600
Teso	104,800	281,200	386,000
Karamoja	73,600	156,200	229,800
Lango	75,100	341,100	416,200
Acholi	207,800	109,500	317,300
West-Nile	101,100	435,200	536,300
Bunyoro	90,600	208,000	298,600
Tooro	87,900	250,600	338,500
Ankole	208,200	132,600	340,800
Kigezi	71,400	144,800	216,200
Residence			
Urban	585,000	885,700	1,470,700
Rural	1,504,300	2,277,600	3,781,900
Uganda	2,089,300	3,163,300	5,252,600

SOURCE: Frontiers in Energy Research - Estimating Market Potential for Solar Photovoltaic Systems in Uganda

10 USAID Power Africa (2022) – Power Africa Off-grid Project Factsheet <https://www.usaid.gov/sites/default/files/2022-05/Power-Africa-Productive-Use-of-Energy-Fact-Sheet.pdf>



Demand Analysis



Demand Analysis

The case for PURE in Uganda

Energy is a critical component of Uganda's Vision 2040. From powering industries, education centres, households, and health facilities to crop and livestock production and value addition processes, electricity is a lever for the country's development.

For countries such as Uganda, transformation of the economy cannot occur without a scaled increase in productivity and income. This is particularly true when it comes to the agricultural sector, which makes up almost a quarter of GDP and 33% of export earnings.¹¹ According to the UN Food and Agriculture Organisation (FAO), extending electricity distribution networks into rural areas can bring social and economic benefits through the positive impact of mechanizing processes such as storage, drying and milling, among others.¹² The FAO estimates that each unit increase in agricultural activity could lead to 1.5 units of economic growth.¹³

Given that the agricultural sector employs approximately 65 per cent of the total population,¹⁴ GOU has identified solar irrigation as a particularly powerful avenue for social and economic impact in the promotion of energy access. Solar water pumps and sprinklers can open more land for agricultural production in the north of the country and other water stressed areas of Uganda; in the dairy producing regions of West and Central Uganda where the 'spoil rate' of milk at the farm level is almost 22.5 percent,¹⁵ a range of solar cooling solutions including direct current (DC) fridges, solar cold rooms can also benefit dairy communities. Other productive uses of solar energy lie in solar maize milling, coffee pulping and solar drying.

In the health sector, hospitals and health centres are already using solar for lighting but solar cooling is emerging as an application for

preserving vaccines, medicines, and samples. For MSMEs, solar energy kits (solar lanterns and home systems) are often used to provide light and power to enterprises e.g., to extend the operational hours of shops, stalls, or restaurants. While other applications of PURE in Uganda include the use of off-grid solar to power welding and metal fabrication, solar powered appliances used in salons and beauty centres (clippers and dryers) and solar powered TVs and music systems used in cinema halls and entertainment centres.

3.1 Potential market size/market opportunity

According to the Ministry of Energy and Mineral Development (2019), just 9% of the population in rural Uganda is electrified. Of the estimated 5.3 million households without electricity access, 3.2 million face supply side constraints i.e., due to unavailability, unreliability, or limited capacity of the grid, while 2.1 million households suffer demand side constraints i.e., they cannot afford grid electricity.¹⁶ The former constitutes an immediate market for solar PV systems due to assumed possession of willingness and ability to pay.

By boosting consumer productivity and revenue, productive use appliances have the potential to expand access to energy, eventually creating more disposable income that can be used to fund increased energy consumption. Although at a limited scale, solar powered PURE technologies are already being used by Ugandan farmers to increase farm yields and revenues, reduce post-harvest losses, and build resilience to shocks.¹⁷ Greater adoption of these technologies is expected to stimulate growth in electricity demand and enhance progress in the real economy. Table 1 shows the range of PURE technologies which could help improve productivity in Uganda, along with their applications and average energy consumption.

11 Uganda - Agricultural Sector <https://www.trade.gov/country-commercial-guides/uganda-agricultural-sector>

12 FAO: Environment and Natural Resources Working Paper, FAO Corporate Document Repository, Produced by Natural Resources Management and Environment Department, <https://www.fao.org/3/x8054e/x8054e00.htm>

13 FAO: Future Energy Requirements for Africa's Agriculture, FAO Corporate Document Repository, Produced by Agriculture and Consumer Protection, www.fao.org/docrep/V9766e/v9766e02.htm,

14 UBOS (2020) National Household survey https://www.ubos.org/wp-content/uploads/publications/06_2021UNHS2019-20_presentation.pdf

15 ILRI 2005: Types, levels and causes of post-harvest milk and dairy losses in sub-Saharan Africa and the Near East: <https://cgspace.cgiar.org/handle/10568/3741>

16 Aarakit SM, Ssenono VF and Adaramola MS (2021) Estimating Market Potential for Solar Photovoltaic Systems in Uganda <https://www.frontiersin.org/articles/10.3389/fenrg.2021.602468/full>

17 UOMA (2020): Productive Use of Energy in Uganda: Learnings from the Uganda Off-Grid Energy Market Accelerator (UOMA) <https://uoma.ug/1336-2/>

Demand Analysis

Table 1 - Productive Use of Solar Energy Applications

Category	Applications	Band by minimum daily consumption	Power range of equipment (Horsepower)
Large agro-processing	<ul style="list-style-type: none"> Coffee hulling, maize, rice, and millet processing. Tea processing, oil pressing, milk processing, tea, and beef processing. 	2 to 9 KWh	3 to 10 HP
Cold chains (refrigerators)	Storage for agricultural products or inputs and health products like medicines and vaccines.	0.1 to 1.5 KWh	0.134 to 2HP
Small agro-processing	Dryers, low-capacity milling, threshers, oil seed pressers.		
Irrigation	Sprinklers and water pumps.		
Retail appliances	Light and power systems, fridges, television for cinema halls, radios, hair clippers for salons, phone charging.	0.012 to 0.1 KWh	0.016 to 0.134 HP

Solar water pumping

The Government of Uganda has highlighted solar irrigation as a particularly potent pathway for social and economic impact given that the agriculture industry employs over 65% of the population. When compared to the country's irrigation potential, Uganda's ratio of irrigated land to total land area is significantly lower than the SSA average, at just 0.5%, while freshwater sources cover over 15% of the country's surface area.¹⁸

Solar water pumps (SWPs) are emerging as an affordable clean energy technology for expanding irrigation amongst rural off-grid farmers in Uganda. Rural farmers that use solar irrigation are not constrained by certain growing seasons and can concentrate on growing a variety of high-value crops. Despite their higher initial installation costs (ranging from USD 1,000 to 3,000 per acre depending on the kind of land, crop water requirements, and irrigation system employed) SWPs are more cost-effective than diesel pumps when looking across the whole product lifetime.¹⁹

The Uganda Bureau of Statistics (2019) places the number of small holder farming households in Uganda at three and half million, while a report by the International Solar Alliance (ISA) estimates that 58% hold land sizes of 1 hectare or less. To meet the needs of these farmers, the ISA recommends deployment of smaller size pumps in greater numbers.

In the short term, deployment of SWPs appears to present significant potential. SWPs can be purchased by individuals making them a relatively simple technology to market and sell. If the upfront costs of SWPs can be reduced by consumer financing or other alternatives, they can also become cost competitive with diesel pumps which have high maintenance costs and are subject to volatile fossil fuel prices.

Solar for cooling

In Uganda, agricultural losses and waste from inadequate post-harvest processing are frequent. This is particularly common during the wet seasons when there is an abundance of fresh product but inadequate storage facilities. Since there are no chilling facilities in the existing marketplaces and stores, a lot of the produce perishes. Modern cooling devices, like freezers and refrigerators, are used by food companies that deal with commercial goods. Such coolers are very expensive, and only commercial businesses with sizable revenue streams can afford them. Therefore, most small businesses and farmers are unable to purchase them due to their high initial cost.

However, if these high upfront costs can be addressed, there is a market opportunity for solar cooling systems (freezers, milk chillers, cold rooms etc). Solar freezers cost between USD 420 (for a 150-litre DC freezer) to up to USD 800 (for a 400-litre freezer).

¹⁸ Government of Uganda. National Irrigation Policy 2017 <https://www.mwe.go.ug/sites/default/files/library/Uganda%20National%20Irrigation%20Policy.pdf>

¹⁹ Africa Clean Energy (2019) Uganda Solar Water Pumping Report <https://www.ace-taf.org/wp-content/uploads/2019/10/ACE-TAF-UGANDA-SOLAR-WATER-PUMPING-REPORT-SCREEN-1.pdf>
<https://www.gogla.org/reports/powering-opportunity-in-east-africa-proving-off-grid-solar-is-a-power-tool-for-change/>

Demand Analysis

Cooling as a service is on the horizon too and could help to address both consumer cost and risk. In this business model, customers pay to use cold space to store their produce but do not have the burden or risk of paying for a full cooling system. However, this assessment did not find any company providing cooling as a service on a commercial scale yet in Uganda.

Solar powered milk chilling is currently being piloted by Heifer International with a few dairy farmer cooperatives under its Solar for Sustainable Income in Dairy (SSID) Project, as well as the Dairy Development Authority in conjunction with Panda Solar. The findings of the pilots are not available at the time of this assessment but could also prove inciteful in establishing future demand for cooling technologies.

Solar cooling could also prove impactful in the health industry for the storage of vaccines and other applications. However, solar for cooling within health infrastructure is likely to be driven by government and donor led, rather than commercial, models.

Solar for commercial agro-processing

Though Uganda does not have significant commercial scale application of solar for agro-processing a couple of pilots have been tested in parts of the country. These include Power for All's Utilities 2.0 Integrated Energy pilot, that deployed a containerized milling and drying solution powered by a solar minigrad. The milling solution processes maize, cassava, and other produce for the community in Kiwumu, Mukono district. Another use case is the rooftop industrial solar power plant at the National Union of Coffee Agribusinesses and Farm Enterprises (NUCAFE) whose capacity is estimated at 172Kwp. The plant supplies electricity for coffee processing.

Solar for MSMEs and retail outlets

Solar lighting and home systems are also commonly used to support small enterprises. For example, by extending working hours by providing light, or via powering efficient DC appliances that attract or serve customers. Common examples are phone charging for a fee, the use of solar powered TVs to create video halls, and the use of hair clippers in salons. Research undertaken in 2019 found that, in East Africa, approximately 20% of solar home systems sold were used in micro-enterprise.²⁰ Given the low electrification rates in rural Uganda, this suggests that there is a large potential market for the use of off-grid solar and DC appliances within MSMEs.



Supply Analysis



Supply Analysis

4.1 Technology and product mapping

Currently, PURE technology suppliers in Uganda predominantly deal in energy technologies for agriculture, with the highest agricultural application being seen in irrigation. In particular, solar water pumps are sold by 45% of the interviewed companies. Figures 2 and 3 provide a snapshot of the sectors served by PURE companies and the technologies they sell.

Some technologies are still on the horizon (i.e., under development), others are emerging (piloted in a few geographical areas) but not yet

scaled, while the rest are at near to market and commercial stages. Table 2 gives an overview of the market maturity of different PURE technologies in Uganda.

4.2 Company and brand mapping

Table 3 presents some of the companies dealing in PURE technologies in Uganda. The companies predominantly deal in solar water pumping systems with a few selling solar refrigeration units, solar home systems, lighting, solar milk chilling and e-mobility solutions.

Figure 2 - sectors served by OGS companies

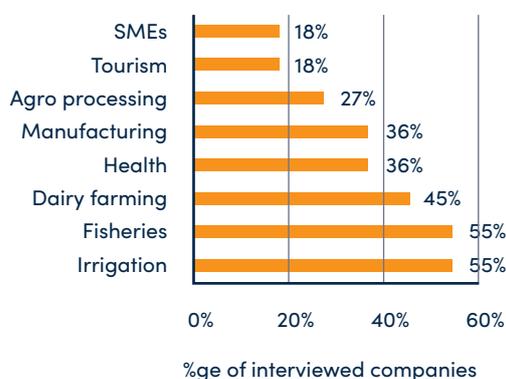


Figure 3 - Percentage of companies dealing in PURE technologies

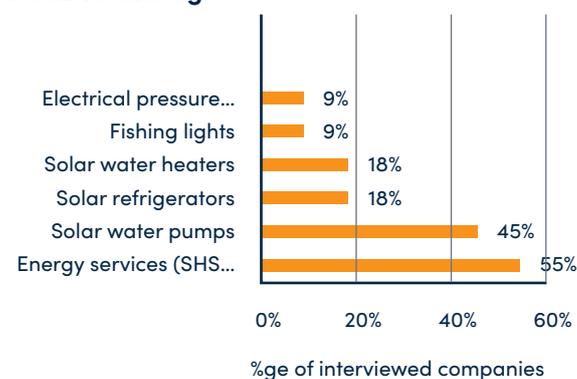


Table 2 - Maturity of PURE technologies and applications in Uganda

Sector	Application	Technology	Use DC/ Inverter	Maturity stage	
AGRICULTURE	Irrigation	Solar water pumps	DC and inverter	Commercial	
	Cooling	Walk-in cold rooms	Inverters		Emerging
		Refrigerators	DC and inverter		Near to market
		Freezers	DC and inverter		Near to market
		Milk chillers	Inverter		Emerging
		Ice makers	Inverter		Emerging
		Agro-processing	Mills	Inverter	
	Agro-processing	Threshers	Inverter		Emerging
		De-huskers	Inverter		Horizon
		Oil presses	Inverter		Emerging
		Dryers (Solar-powered)	DC and inverter		Emerging
	Poultry	Egg incubators	Inverter		Horizon
	Fishing	Fishing lamps	DC		Near to market

Supply Analysis

MSMEs	Hairdressing	Shavers	DC and inverter	Near to market
		Dryers	Inverter	Emerging
	Cooking	Electric cookers	DC and inverter	Emerging
	Cooling	Refrigerators	DC and inverter	Commercial
		Freezers	DC and inverter	Commercial
	Lighting	Solar home systems	DC and inverter	Commercial
	Entertainment	TVs and audio systems	DC and inverter	Commercial
	Clothing	Flat irons	DC and inverter	Near to market
TRANSPORT	Electric vehicles	Motor bikes (bodas)	DC and inverter	Near to market
		Tricycles	DC and inverter	Near to market
HEALTH	Cooling	Freezers	DC and inverter	Near to market
TOURISM	Heating	Electric cookers	DC and inverter	Near to market

Table 3 - Solar companies dealing in PURE systems and appliances

	Company	Product offerings
1.	Solar Now	Solar systems for commercial and social institutions
2.	Kambasco	Solar water pumps
3.	Davis and Shirliff	Solar water pumping solutions
4.	Adritex	Solar water pumps
5.	ADH	Solar Refrigerators
6.	Assen Ventures	Solar irrigation systems
7.	Battery Plus	Solar home systems
8.	Kirchiner Solar Group	Solar home systems
9.	Water and Pumps International	Solar water pumps, solar home systems
10.	Advanced Solar Power Ltd	Solar water pumps, solar home systems
11.	African Energy Depot Ltd	Solar water pumps
12.	All in Trade	solar home systems, solar water pumps
13.	All Africa Ultimate Solar Energy	Solar system installation for hotels, gas stations, cold warehouses, hospitals
14.	Bitcom Delta EA Ltd	Solar home systems
15.	Exide Chloride	Solar home systems
16.	Crown Energy Systems	Solar water pumping systems
17.	Access to Solar Technologies	Solar home systems, water pumps, solar refrigerators
18.	Azuri Technologies	Solar water pumps
19.	Barefoot Power	Solar phone charging systems
20.	Basal Solutions	Solar water pumps, solar home systems
21.	Aptech Africa	Solar water pumps, solar home systems
22.	ARED SMC	Solar kiosks for phone charging and internet services
23.	Ekorn Solar Ltd	Solar home systems, solar water pumps, solar refrigerators

Supply Analysis

24.	Energy systems Ltd	Solar refrigerators, solar water pumps
25.	Epicenter Africa	Solar water pumps
26.	E-power solutions	Solar water pumps
27.	Fresca Investments	Solar home systems
28.	Global Solar Systems Limited	Solar home systems, solar water pumps
29.	Great Seas (U) Ltd	Solar refrigerators, fans, and solar home systems
30.	Green Power International	Solar water pumps
31.	Hagotech Gen. Electricals & Technical Service (HTGETS)	Solar refrigerators, solar home systems
32.	Solar Pipo	Solar cooling systems, solar water pumps
33.	Innovation Africa Ltd	Solar motors, solar water pumps
34.	New Age Solar Technologies	Solar refrigerators
35.	New Sun Solar	Solar water pumps
36.	SUNami	Solar refrigerators, solar water pumps
37.	TASS	Solar water pumping solutions
38.	UltraTec	Solar water pumps, solar home systems
39.	W. Water Works	Solar water pumps
40.	Tulima Solar	Solar water pumps
41.	SunCulture	Solar water pumps
42.	One Lamp	Solar milk chillers
43.	Balton Uganda	solar home systems
44.	Bodawerk	E-mobility in public transport e.g., boda bodas
45.	Zembo	E-mobility in public transport e.g., boda bodas
46.	Asobo	e-mobility for electric outboard engines for fishing boats powered by solar energy
47.	EnerGrow	Solar refrigerators, sewing machines, electric pressure cookers
48.	East African Power	Solar milling solutions
49.	Power Trust	solar home systems
50.	Easy Power	solar home systems
51.	KuaSolar	Fishing lights
52.	Sure chill	Solar refrigerators

Supply Analysis

Solar Brands in the Ugandan market:

Most of the solar products used in Uganda are imported from Asia and the Middle East (China, India and UAE, Japan, Hong Kong), with a few products imported from Europe (Netherlands, Greece, UK). Table 4 presents popular brands for solar equipment.

Table 4 - Popular solar brands for selected productive use appliances

Appliance	Brand	Source country
Solar water pumps	Grundfos	Denmark
	Victron	Netherlands
	Fronius	Germany
	Shiyuan, SunStar, Difful, Kingmax, Vackson, Winsolar	China
	Lorentz	Germany
	Speroni	Italy
	DayLiff, Sunflo	Kenya
	Shakti	India
	Solarlite	United Kingdom, USA
	Marscorp	China
Solar refrigerators	Dulas	UK
	ADH	China
	Freecold	France
	Midea	China
	MediTech, Rockwell	India
Electric pressure cookers	ECOCA	Denmark
Solar energy kits and appliances	Sun King	USA, China
	MySol	France, China
	d.light	USA, China



PURE Firm Profiling



PURE Firm Profiling

5.1 Firm size

The majority (73%) of the off-grid solar companies dealing in PURE technologies that were interviewed identified as Small Enterprise (employing 5 – 50 people, with annual sales of up to UGX 360 million), while 27% were Medium Enterprise (employing > 50 people with annual sales of UGX 360 million – 30 billion). Further, 55% of the firms were categorized as being at the business survival stage (i.e., the company is focused on generating enough revenue to cover its expenses to survive), and 18% were at the start-up stage (i.e., the company is just starting more focused on acquiring customers and establishing its brand). An equal share, 9% of companies, viewed their businesses as being at a) take-off stage (the company is experiencing increased sales, significant growth, and expansion), b) successful stage (company has achieved breakeven point) and c) mature (i.e., the company is well-established in the industry, with a well-known product and loyal customer following).

Please note: While companies selling solar lighting and home system kits are also selling products used for PURE in Uganda, these companies were excluded from the analysis of firm size as it was not easily possible to make a distinction between the kits that are sold for productive use vs those sold for access.

5.2 Current sources of investment / financing

Lack of access to finance by PURE product providers, in terms of required ticket sizes and type of finance, hinders their capacity to grow their stock and offer credit to consumers. The majority (73%) of the firms interviewed stated that limited working capital was the leading challenge they faced. Most of the companies rely on owner's equity (73%) to finance their businesses.

Figure 4 - PURE company stage of growth

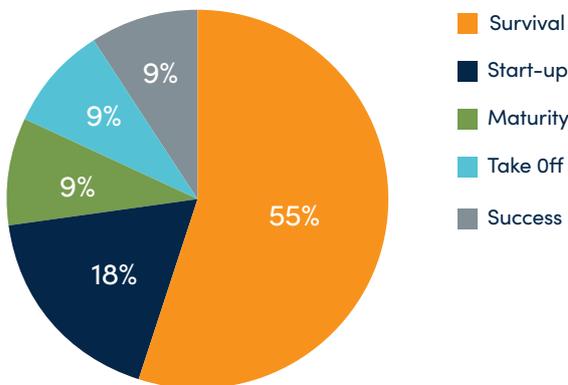


Figure 5 - PURE company size

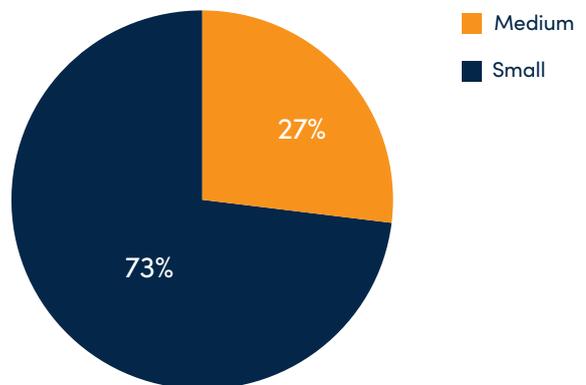


Figure 6 - Source of financing of PURE companies

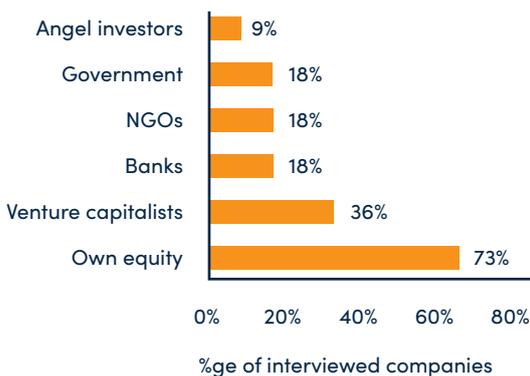
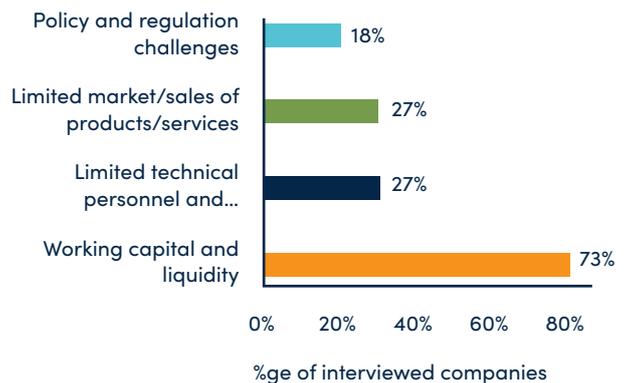


Figure 7 - Challenges to growth of PURE companies



PURE Firm Profiling

5.3 Distribution Models

All companies interviewed have built their own teams and capacities to undertake direct sales, however, many employ other mechanisms to reach customers. The most common, are sales via engineering, procurement, and construction (EPC) work e.g., through tenders, installations (55%), or via dealer or partner networks (45%) (see Figure 8).

5.4 Business models

As highlighted in Figure 8, PURE technology suppliers in Uganda predominantly require the outright purchase of their products on a cash basis (64%). Other payment models include pay-as-you-go (PAYGo), where a customer pays for their system in a series of instalments, usually after making a down payment (solar water pumps, refrigerators, salon equipment and e-cooking), fee for service (irrigation and milling services), and leasing models (e-cooking, milling, solar water pumps). Some companies offer a range of different business models.

5.5 Skills development

Despite growing demand for off-grid solar energy solutions in Uganda, there is a growing shortage of job-ready talent to finance, install, operate, and service PURE systems. Over 27% of the firms that participated in this survey identified limited technical capacity to respond to the client's needs as a key challenge (e.g., providing repairs and maintenance). To address this issue, some of the skills development interventions currently being undertaken include:

- Training of staff teams on installation, operations, and maintenance as well as customer care and retention strategies.
- Development of a standard curriculum, certification, and licensing for solar technicians.

Some companies are also benefitting from technical assistance which is helping them with their own operational management, including on proposal writing, reviewing financial models, and designing business strategies. However, these skills are also lacking in the broader ecosystem which is hampering the growth of local PURE companies.

Figure 8 - Distribution models by interviewed companies

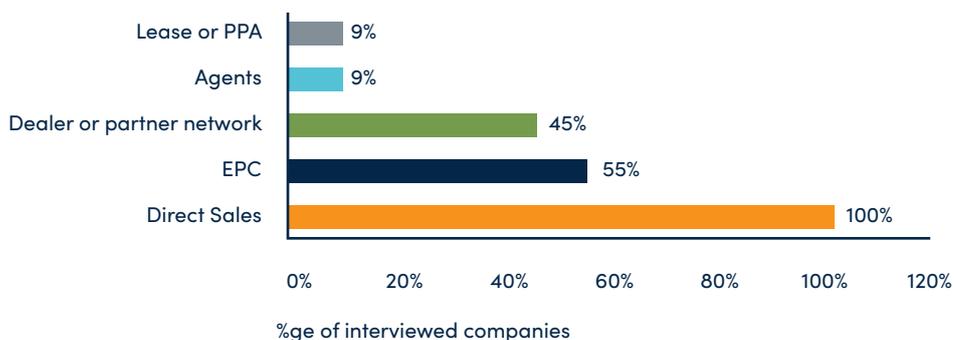
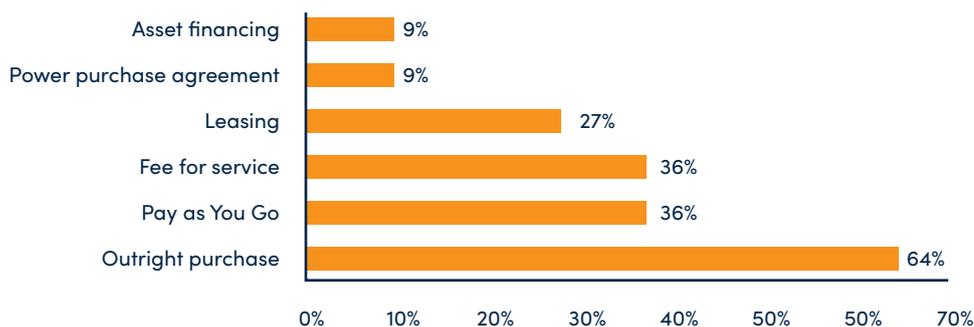


Figure 9: Business models for interviewed companies



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**Enabling
Environment**

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Enabling Environment

6.1 Regulation and policy

The Government of Uganda’s policy vision is to make modern renewable energy a substantial part of national energy consumption. There is political will at the Ministry of Energy and Mineral Development, led by the Department of Renewable Energy, to update the current energy policy to incorporate renewable energy comprehensively. The National Development Plan (NDP) III (2021–2025), for instance, highlights the challenge of biomass and has clear targets on increasing renewable energy to reduce its use (e.g., increasing the share of clean cooking to 50% by the year 2027). Further, the 2023 Nationally Determined Commitments (NDCs) include renewable energy targets for Uganda.

However, while policies such as the draft National Electrification Strategy and Plan, recognize the role of PURE in delivering economic benefits of using electricity to last-mile populations, and the Microfinance Act and Hire Purchase Act, 2009

allow companies to sell PURE on credit, there is no specific policy to support the adoption of PURE.

Further, while the NDP III and the Agriculture Sector Strategic Plan (ASSP) III that guides the country’s agriculture sector strategic direction, Green Manufacturing Strategy 2021–2025 of the Ministry of Trade Industry and Cooperatives (MTIC), and National Irrigation Policy 2018 all highlight the potential of renewable energy, it is unclear how PURE is embedded in these existing policies.

Building off the work initiated by Power for All, who developed an Action Plan for the Productive Use of Solar Energy for Agriculture, USEA and GOGLA are therefore working together to develop a national road map on scaling-up PURE for food security and economic empowerment in Uganda; to be published in 2023.

An overview of the current policy framework for PURE in Uganda is included in Table 5.

Table 5 – Policy framework for PURE in Uganda

Policies/strategy	Status	PURE component in policy/strategy
Energy Policy 2002	Under revision	PURE promotion both on and off-grid.
NDPIII	Enacted	E-mobility, e-cooking, irrigation, agricultural value addition.
National irrigation policy 2018	Enacted	Promotes irrigation that is environmentally friendly and economically viable.
ASSP III	Enacted	Agricultural value addition.
Green manufacturing strategy (2021–2025)	Enacted	Green manufacturing technologies including solar dryers for fruits, clean cooking, etc.
National Electrification Strategy	Enacted	The policy to ensure sustainable development and utilization of energy resources, services, and products is currently under review.
Rural Electrification Strategy and Plan (RESP II) 2013–2022	Enacted – however expired	Targets energy access and service penetration of 26% for rural customers
Updated NDCs 2022	Enacted	Off-grid access, irrigation, electric cooking, etc.
PUE Strategy	Draft – never finalised	Focused on PURE promotion (mostly on-grid) and financing under the former rural electrification agency which is non-existent.
Microfinance Act	Enacted	Companies selling PURE appliances on credit
Hire Purchase Act, 2009	Enacted	An Act to provide for the regulation and registration of hire purchase agreements and the licensing of persons carrying on hire purchase business and for related purposes. This includes companies selling PURE appliances on credit.
The Electricity Amendment Act 2022	Enacted	Removes the monopoly of the Uganda Electricity Transmission Company and Uganda Electricity Distribution Company as the single buyers and suppliers of generated electricity. The Bill further grants power to the Electricity Regulatory Authority (ERA) to classify licenses. Promotes mini-grid development
Climate Change Policy (2015)	Enacted	Supports energy policy implementation through the promotion and development of new clean energy technologies to reduce Greenhouse Gas (GHG) emissions.

Enabling Environment

Current challenges in the policy framework:

- Absence of a PURE policy and implementation strategy/plan. This should clearly stipulate the interventions needed to accelerate the adoption of PURE, create a policy mandate and detail different stakeholders' roles.
- Inconsistent application of existing tax exemptions. PURE companies struggle with delays in clearing consignments of off-grid solar products and sometimes incur fees on solar components that are otherwise exempt (see Case Study 1).
- The need for standardized pay-as-you-go ("PAYGo") portfolio performance metrics for PURE distributors.

- Unclear government strategy regarding mini-grids, and gaps in mini-grid regulations limit robust development of mini-grids, which are a necessary component of PURE.

The Ministry of Energy and Minerals Development is the line ministry charged with the task of developing an enabling environment for scaling up PURE by developing and implementing the right policies and regulations. The ministry acts as an anchor for all other stakeholders within the country. Table 6 shows the policy framework for PURE to date.

Case study 1: Addressing inconsistencies in taxation guidelines for solar system components

Importers of deep cycle batteries (DCB) to be used in off-grid solar technologies have been subjected to import duty under Heading 85.07 ("Electric accumulators, including separators therefore, whether or not rectangular (including square) Lead-acid, of a kind used for starting piston engines"). This classification attracts import duty of 25%. However, DCBs for use with solar applications should benefit from duty exemption (under paragraph 26 of the fifth schedule of the EAC CMA).

The URA has argued that DCBs can be used for other purposes other than solar development and therefore not every importer should benefit from duty exemption. The URA and USEA have reached an agreement that once an importer provides proof (clearance letter from Ministry of Energy and USEA) that they members of USEA, they should benefit from the exemption.

Table 6 - Institutional framework for PURE

Institution	Key role
Ministry of Energy and Mineral Development (MEMD)	Creates an enabling for scaling up productive use of energy in Uganda through policies, regulations, tax exemptions, and extending subsidies to the end-user.
Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	Develops policies to scale up or support the growth of or mechanization of agriculture through use of solar powered water pumps, tax exemption on agricultural inputs including solar powered pumps. National irrigation policy developed by Ministry of Water and Environment, which guides the agricultural transformation through irrigation development. The policy focuses on to ensuring there is reliable water for irrigation to optimize, intensify and diversify crop production and productivity.
Ministry of Water and Environment (MWE)	Developed policies to promote water for production including established of irrigation using solar powered water pumps. National irrigation policy developed by MWE, which guides the agricultural transformation through irrigation development. The policy also calls for the prioritization of investments in irrigation development by public, private and other players.



Research and Data



Research and Data

PURE remains a nascent market and current research efforts to understand how PURE can be optimised within Uganda are limited. Different public and private sector institutions are conducting research on various PURE technologies and applications. MEMD has implemented some research on solar dryers in agricultural research centres, however these remain at pilot stage. Various funding partners have also conducted market and baseline studies for their projects, but

these are intervention specific and not applied to the whole PURE sector. These include:

- USAID Feed the Future: PUE Landscape Assessment,
- Power Africa Off Grid Project: Health Facility Electrification and PURE Catalogue,
- GIZ/Endev: Baseline Survey and Market Assessment Sustainable Energy for Smallholder Farmers project.



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**Capacity
building**

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Capacity building

7.1 Convening & standards

7.1.1 Convening

Uganda has seen emerging efforts towards coordinated implementation of electricity access and PURE. A National Renewable Energy Platform (NREP) has been established under MEMD for harmonisation of Uganda’s renewable energy utilisation. With support from GOGLA, the Uganda Solar Energy Association (USEA) has also established a PURE technical workgroup involving donors, government, private sector, and other key stakeholders. This is leveraging the working groups established under Power for All’s ‘Powering Agriculture’ initiative. There is still a need for collaboration across Government Ministries Departments and Agencies, donors, research institutions and academia.

7.1.2 Standards

The Uganda National Bureau of Standards (UNBS) is mandated to undertake quality and standards enforcement. The standards for solar energy systems recently developed by the Uganda National Bureau of Standards (UNBS) cover systems of up to 350 Wp capacity. Importers are also required to have their appliances and system components tested for pre-export verification

of conformity (PVOC) and present these PVOC certificates as a condition for customs clearance. In addition, Verasol provide quality guidelines for items like TVs, fridges, and solar water pumps at the international level. However, specific standards for most PURE appliances in Uganda are not yet existent.

The Electricity Regulatory Authority (ERA) regulates the development and operation of mini-grids including power quality and tariff setting. ERA also licenses electrical technicians for various applications including solar installations.

7.2 Tax Regime

Interaction with solar companies indicates that, while solar panels are tax exempt, most PURE components are fully taxed. For example, solar pumps and solar fridges attract taxes (import duty, VAT, and withholding tax) and some components like batteries and solar lights are subjected to tax. Case study 1 highlights such inconsistencies. There is need to review the Tax Handbook guidelines for solar equipment and components to clear these inconsistencies and provide a supportive tax environment across PURE technologies.



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**Access to Finance
for Companies**

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Access to Finance for Companies

PURE financing in Uganda is an amalgamation of debt, retained earnings, equity, grants, venture, and impact investments from both local and international investors.

Key financing projects or actors are summarised in the Table 7 and explained further below.

Table 7 – Key solar financing projects and respective actors

Government	<ul style="list-style-type: none"> The Government has launched the Energy Access Scale-up Project (EASP) with the World Bank Is implemented by MEMD and UECCC with PURE as one of the key areas of focus. The Micro-irrigation scheme under the Uganda Intergovernmental Fiscal Transfers Program Project for Uganda (UGIFT) has supported several Solar Powered Irrigation companies to reach farmers.
Donors (Grants and RBFs)	<ul style="list-style-type: none"> GIZ EnDev has developed results-based financing (RBF) schemes supporting the market-based expansion of PURE, with a focus on solar water pumping for agriculture. CLASP has recently launched a PURE RBF (with support from GEAPP in several countries including Uganda). The Beyond the Grid Fund for Africa (BGFA) has launched its second financing window in Uganda, with PURE as one of the target areas. The Universal Energy Facility has launched, targeting PURE and mini-grids.
Debt	<ul style="list-style-type: none"> SIMA's Energy Access Relief fund continues to provide debt to companies including PURE companies.
Investors	<ul style="list-style-type: none"> Angel investors, impact investors and venture capitalists and impact investors are increasingly taking an interest in PURE in Uganda. These include Frontier Energy Fund, Renewable Energy Challenge Fund, Climate Investor One, Solar Energy Foundation, Solar Aid, etc.

Government: The government is partnering with development agencies and other bilateral partners to finance PURE. The World Bank Energy Access Project (EASP), under its financial intermediation component through the Uganda Energy Credit Capitalisation Company (UECCC), will offer access to finance for entrepreneurs' PURE applications such as solar milling, solar irrigation and refrigeration. The government of Uganda is also employing instruments such as export loans to scale the adoption of PURE. For instance, Nexus Green was contracted by the government of Uganda to supply and install 687 micro-irrigation sites supported by a \$104.1 million loan from UK Export Finance.

Grants and RBFs: RBFs are increasingly utilised to support private sector companies expand the adoption of PURE technologies. In an RBF scheme, companies receive an incentive for achieving pre-agreed milestones and targets. Beyond-the-Grid Africa (BGFA) has recently launched the BGFA 6.3 million EUR fund targeting, among other applications, productive use. GIZ EnDev had two RBFs targeting PURE with one specifically focusing on solar irrigation for horticulture. SEforAll has Uganda as one of its target countries for the Universal Energy Facility targeting productive use and mini grids. It should be noted that while

RBFs offer a good opportunity for financing to companies, they often have stringent eligibility and verification requirements that may be prohibitive for smaller companies.

Debt: Local debt financing is still low. Local financial institutions still regard most PURE business models as risky and thus are reluctant to provide debt to PURE companies. Financial institutions also have high interest rates. Impact debt financiers like SIMA fund, however, can play a valuable role supporting PURE companies. For example, the Energy Access Relief Fund is designed to offer low-cost unsecured loans of \$50,000 to \$2.5 million to energy companies in several countries including Uganda and covers PURE technologies. Some companies also seek supplier credit to help finance their operations, but this is not easy to attain, especially for longer periods of time.

Investors: Foreign investment is not uncommon in the Ugandan context, but generally targets larger PURE companies or foreign owned entities. Impact investors such as the Acumen Fund that have previously provided impact investment for organisations such as Solar Now are still actively seeking investment opportunities to the tune of millions of Euros in PURE in Uganda.

Access to Finance for Companies

Financing from own earnings: Financing from profits/earnings is being employed in the PURE sector but is challenging. Asset financing models, such as PAYGo, require substantial amounts of finance, result in unpredictable cash flows, generate working capital constraints and have

longer break-even periods. Financing from profits/earnings is more straight forward with cash sales but only for the most commercial products. Most PURE technologies are at an early or emerging stage and have yet to create the client base needed to be able to finance scale from profits.





Consumer Financing



Consumer Financing

Consumer financing, like supply side financing, is multi-faceted. Table 8 provides a high-level summary:

PAYGo Financing: PAYGo financing is becoming increasingly common among PURE companies especially for near-to market and mature technologies, such as solar water pumps and solar fridges.

Financial institutions: The business case for PURE is generally still not understood by FIs and some end-users lack collateral for the loans being sought, especially women since property and land ownership is still mostly by men. Regardless, Uganda’s PURE market has seen initial steps towards third-party financing. The third-party financiers include financial institutions (FIs) like commercial banks, micro-finance institutions (MFIs), Savings and Credit Cooperative Organisations (SACCOs) and Village Savings and Loan Associations (VSLAs). However, the SACCOs and VSLAs that offer these loans sometimes lack adequate capitalisation to offer larger loans. Financial products are also emerging in commercial banks for example EquiGreen loans in Equity Bank. PURE tech providers are also seeking and establishing MOUs with FIs and SACCOs. In Western Uganda for example, Solar Today and Rwanyamehembe SACCO have established an MOU. The SACCO provides loans to the consumers to obtain solar cooling systems. The SACCO pays

directly to Solar Today and Solar Today installs the systems for the end users. The end users make loan repayments to the SACCO. This is a mechanism where PURE tech providers are de-risking themselves by leaving the financing aspect to FIs/ SACCOs, etc.

End user subsidies: Given the nascent nature of the market, subsidies still play a role in the promotion of and uptake of PURE. Subsidies are applied to either the energy system or the appliance or a combination of both and are applied both in stand-alone and mini-grid interventions. For example, an appliance finance scheme was run alongside the mini grids developed in Northern Uganda by Winch Energy with support from Government of Uganda and GIZ. In the scheme, PURE appliances were subsidised to help stimulate electricity demand for the mini-grid and create positive economic impacts for their purchasers. Under the Government of Uganda’s Micro-Irrigation Scheme, farmers also receive up to 75% subsidy if they purchase a solar water pump.

Financing from own earnings: End-users can also use their own earnings either from current activity for which solar energy is being sought or other income sources to buy a PURE asset. Taking irrigation as an example, farmers can use savings from switching from diesel powered to solar powered irrigation to finance the solar water pump.

Table 8 - PURE technology financing available to consumers

PAYGo Finance	<ul style="list-style-type: none"> Pay-as-you-go (PAYGo) consumer financing allows customers to pay for a PURE product in instalments over time, until they own it outright. Usually, PAYGo asset providers also require an initial downpayment for the product at the time of sale.
Loans	<ul style="list-style-type: none"> Equi-Green loans launched by Equity Bank can be used to buy PURE assets. MoUs between PURE technology companies and FIs to provide consumer financing e.g., Solar Today and Rwanyamehembe SACCO.
End-user subsidies	<ul style="list-style-type: none"> Government initiatives have been launched such as the Micro-irrigation scheme which provides up to 75% of the cost price of a Solar Powered Irrigation System (SPIS), with the purchaser paying the remaining 25%. Appliance financing schemes including in mini-grid schemes e.g., the scheme run in the mini-grid villages operated by Winch in Lamwo with support from GIZ where part of the appliance cost is subsidised, and the rest is paid by the customer.
Own financing	<ul style="list-style-type: none"> Investing business earnings to attain PURE e.g., farmers using earnings or savings to purchase solar water pumps.

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Key Challenges and Barriers to Scale

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Key Challenges and Barriers to Scale

Affordability is still a challenge for most end users. The Ugandan economy is still recovering from the effects of the COVID-19 pandemic. For most end users, PURE technologies remain largely unaffordable, which limits adoption and uptake. The business cases for most PURE technologies are still not clear to most FIs. There have been some steps towards developing financial products for PURE e.g., by Equity Bank and Opportunity Bank Uganda, but PURE is still considered a risky venture. Where consumer financing is available, the interest rates are prohibitive. This exacerbates the affordability challenge.

Awareness is relatively low among end users. While awareness of off-grid solar lanterns and home systems is growing, awareness on PURE capabilities remains limited. Even where awareness exists, end-users still don't know critical information, including how to access the products, available consumer financing options (if any) and how to optimise use of the technologies.

Working capital and liquidity challenges are still prevalent among PURE companies. This holds true across the board, from nascent to mature technologies, and is more pronounced for companies offering consumer financing options like PAYGo. Local debt financing is also not easily accessible and, where available, has high interest rates as the PURE business models and in some cases technologies (e.g., solar dryers) are considered too risky by FIs. In addition, importers of PURE appliances and systems also face challenges arising from the volatility of foreign exchange rates, as imported stock often loses value between time of importation and sale. There is also a lack of research and development grant facilities for companies to prototype, test and implement business models. Finally, smaller companies struggle to access grant financing, as most funding tickets are designed to target larger companies.

Taxation policy remains mostly unfavourable for PURE appliances. While there have been efforts to waive taxes like import taxes on items such as the solar panels, solar controllers and DC powered mills, items such as solar water pumps and solar fridges still attract import tax. This raises the cost of operations of the importers and distributors, which is ultimately transferred to end-users and exacerbates the affordability challenge.

Insufficient coordination of PURE interventions: Thematic working groups in PURE are growing in Uganda, however, these are still more at a knowledge exchange level. The various ongoing PURE efforts are still not sufficiently coordinated across MDAs, and across donors which often leads to division of resources and duplication of efforts. This is exacerbated by insufficient data and an absence of centralised tracking for PURE interventions. Some of the private companies interviewed had received support from three different donors in the last year. Looking at a critical aspect like awareness, there are fragmented efforts ongoing for PURE such as irrigation.

There is a capacity and skills gaps for most of PURE technologies: There have been several skilling efforts in the field of solar systems and appliances, however capacity gaps persist. Solar irrigation for example requires electrical, mechanical, and plumbing skills for a fully functional system installation. For the more nascent technologies like agro-processing mills, solar cold rooms and solar dryers, the capacity gaps for installation, operations and maintenance are more pronounced, hindering PURE uptake, especially in the last-mile areas.

Key Challenges and Barriers to Scale

Mini-grid tariffs are still prohibitive for PURE applications. The number of mini-grids in Uganda continues to grow, with over 30 in operation. The relationship between mini-grids and PURE is symbiotic: energy is a critical element of production and PURE is essential for driving up demand for energy and supporting the commercial viability of mini-grids. However, for most mini-grids, the tariffs remain prohibitively high for end-users, often higher than national grid tariffs.

Business models of PURE companies are not fully resilient: PURE tech providers continue to explore various business models including PAYGo and rental and service models. These are being continually refined, however are still not yet impervious to shocks. The COVID-19 pandemic greatly impacted several companies leading to lay-offs and closure of branches. Some companies migrated from asset-financing to cash operations, while others have become more specialised. Despite the continuous business innovations, the energy-as-a-service models are not yet fully

de-risked. For example, during the rainy season, irrigation companies operating this model struggle to collect payments from farmers as the farmers don't fully irrigate during this season.

There is little business development support and other auxiliary support/services that are often critical aspects for PURE. PURE technologies are only one input into an intended outcome and can be significantly optimised if access to them is augmented by other catalytic inputs. For example, in agriculture, good agronomical practices are also a critical element of increasing yield size and durability. While donor programmes like EnDev Uganda's Sustainable Energy for Smallholder Farmers (SEFFA) project implemented by GIZ and SNV have aspects of business development and agronomic services training embedded in the implementation, most PURE beneficiaries still lack sufficient capacity in business management, financial literacy, marketing and other essential business skills to ensure that they can maximise the benefit of their PURE product.





Emerging Opportunities and Trends



Emerging Opportunities and Trends

Innovative consumer financing mechanisms, including service and rental models for PURE are growing. The SWP market has seen an introduction of models such as PAY-N-PUMP and irrigation-as-a-service. The service models offer PUSE users such as farmers an opportunity to pay for the service being utilised rather than the product. End-users are also assured of after-sales services and operations and maintenance (O&M) support since payment is premised on system functionality.

PURE companies are increasingly seeking partnerships with financial institutions. To de-risk their business operations, PURE companies are seeking MoUs with financial institutions to provide the technology/appliances and consumer financing respectively. In addition to addressing the consumer financing barrier, this has potential to address the working capital challenges prevalent with asset financing business models.

Several mini-grids have been built and more are in the pipeline, unlocking the potential to power larger PURE equipment. Uganda's electricity access is currently 57% with 38% as off-grid access. Along with solar home systems, mini-grids have been critical in providing off-grid electricity access and unlocking PURE opportunities. In both the current mini-grids and those under development, there is potential to use PURE equipment that requires a larger power input, such as grain milling and welding machinery. For example, the mini-grids developed by Winch Energy in Lamwo also offer three-phase connections which support a wider range of electrical appliances.

E-mobility is gaining traction and has significant potential. For both donors and the government of Uganda, e-mobility is of increasing interest. Currently, Uganda currently has over 300 e-bikes and the number is increasing rapidly. In collaboration with GIZ, Uganda's GBE project developed three e-boda charging stations along the Masaka-Kampala Corridor. E-mobility projects are also looking at key aspects like circular economy (e-waste handling) where e-boda batteries transition to stationary applications in the next phase e.g., for solar home systems, etc.

Energy and development mainstreaming in local government planning. Energy, and production planning are increasingly becoming mainstreamed in district local government planning. Currently, over 20 districts have energy focal points and many more have district production offices. This offers an opportunity to promote PURE interventions at the district level. This is the approach that has been taken for example with the Micro Scale Irrigation programme under the UGIFT programme where implementation is done through district production offices. Uganda also launched the Parish Development Model (2021 to 2026), with production, storage processing and marketing of agricultural products as one of its seven pillars. This offers an opportunity for bottom-up scale up of PURE.

Technology and Internet-of-Things (IOT) can help to improve efficiencies in PURE technologies and business models. For example, remote monitoring offers the potential to minimise to simplify the O&M of PURE appliances such as water pumps, as companies can use the monitoring systems to better understand how the pumps are used by customers and automatically detect when issues arise. Several companies interviewed, were already utilising remote monitoring technologies for their appliances/systems, and IoT applications support options e.g., building automatic system shutdowns in PAYGo technologies. Companies can use IoT to refine/adapt their business models and reduce the costs involved in system monitoring and provision of after-sales services.

Media coverage about PURE is growing. The last decade has seen a proliferation of local radio and television stations with over 150 local TV and radio stations. A critical aspect to note is that Uganda is multi-lingual, and these stations are mostly regional and customised to the languages of the target listeners, thereby offering great potential to reach all corners of Uganda with targeted awareness campaigns and vital PURE information. A number of donors interviewed, including GIZ and SNV Uganda, have recently run targeted regional media campaigns promoting the use of PURE technologies such as SWPs and cooling for dairy.

Emerging Opportunities and Trends

Government and donor focus on PURE is also expanding. PURE is increasingly becoming a focus of the government of Uganda and the donor community, due to its impacts on energy efficiency, demand stimulation and as a climate mitigation measure. Several donors interviewed, such as GIZ, SNV, USAID, WWF, etc all have PURE interventions ongoing including those which support agriculture such as solar irrigation, agro-processing and solar cold chain to reduce post-harvest losses. On the government side, both MAAIF and MWE have ongoing irrigation projects. In addition, the WB EASP efforts through UECCC will offer access to finance for both entrepreneurs and end-users. UECCC will also provide support for technology demonstrations, designed to boost confidence of commercial financial institutions. The growing focus on PURE offers opportunities for programmes to be designed that address the major challenges in scaling PURE technologies, such as affordability, awareness, and access to finance.

E-cooking is increasingly becoming a focus area both for the government of Uganda and development partners. Development partners focussed on e-cooking in Uganda include Energising Development (EnDev) Uganda and Modern Energy Clean Cooking Services (MECS).

While initial e-cooking efforts and studies have been focused on households, e-cooking can be used by canteens and restaurants to decrease overreliance on biomass fuels such as charcoal and firewood, cut energy costs and reduce cooking time. Electric cookers like ECOCA also offer opportunities for off-grid e-cooking without the need for an entire solar system or a mini-grid, as the ECOCA stove has an in-built battery and is supplied with a solar panel to charge it. Though still too expensive for the average household, UECCC and MEMD have partnered with microfinance institutions to extend loan facilities for e-cooking. Alternative sources of funding like the Green Climate Finance are worth exploring.

More climate financing may help to drive the uptake of PURE. There are increasing opportunities for PURE technology companies to harness climate financing to offset the cost of operations and increase the affordability of systems. Solar powered irrigation technology companies such as SunCulture that have used this approach in Kenya are now also in the Ugandan market as distributors. The Uganda Solar Energy Association (USEA) is also exploring potential collaborations with associations such as Carbon Clear to unlock climate/carbon financing for solar companies, including PURE companies.



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**Creating a
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Creating a More Enabling Environment

Better convening via a PURE Taskforce: Given the cross-cutting nature of PURE, the sector needs more coordination through a national PURE taskforce led by the Ministry of Energy and Minerals Development to implement a PURE roadmap. Such a task force could consolidate and build on the work of existing working groups and coordination platforms and include MDAs, donor groups, appliance companies, energy service companies, financial institutions, research institutions and academia, as well as end-user representatives. Critical to this taskforce would be robust monitoring and evaluation supported by a PURE database.

Access to end-user financing and affordability interventions: For both energy and PURE technologies, there is still need for interventions addressing end-user financing and affordability. These can be in the form of tailor-made financial products for different PURE applications or mechanisms that improve the affordability of PURE overall. In agriculture, for example, loan repayment schedules can be designed to follow harvest periods. The SACCOs and VSLAs can also be adequately supported with affordable cost of capital so that they can offer lower interest rates to end-users. While on the energy access front, mini-grid tariffs could be reconsidered by the regulator to make electricity more affordable for businesses, which could help to unlock demand for a range of PURE applications.

Create a more favourable taxation policy for PURE: Key informant interviews and a review of the taxation handbook revealed that the taxation landscape is still unfavourable, particularly for PURE appliances, where companies incur import taxes and end-users incur VAT. In line with its

electrification and PURE targets, the government should consider more tax exemptions and waivers on PURE items such as fridges and water pumps. The GOU should compare what they lose in terms of taxes (by exempting PURE products) with what they gain in terms of taxes imposed on exports for agricultural products and internal consumption of transformed products. Lower taxation will help to reduce costs to consumers and drive economies of scale that can address the issues affordability and availability.

Support R&D for PURE: The PURE market ranges from nascent to mature technologies. For more nascent technologies like solar milling and solar drying, there is still a need for more research and development to bring these technologies to economic and technological feasibility, while more insights are needed around effective business models to help later stage technologies reach maturity.

Enhance capacity building around PURE technologies: Technical and business skilling are crucial for the uptake of PURE. The government can partner with institutions like universities and TVETs for increased skilling in operation, installation, and maintenance of the various PURE technologies. An important aspect here is also matching the skills training to the need in the market. Additionally, business skills such as financial planning and marketing for the end users of PURE are also key to ensuring that the users of PURE can repay their cost and get the optimal return on their investment in PURE. In addition, development partners and the GoU should build the knowledge of MFIs on PURE to support the flow of local finance to end consumers for the purchase of PURE.



Annexes



Annexes

Annex I - Interviewed stakeholders

Name of respondent	Name of Organization	Designation
MDAs, FDI, CSOs		
Dominic Banaga Mucunguzi	MAAIF	Principal Engineer Irrigation and Drainage
Dr. Brian Isabirye	MEMD	Commissioner, Renewable Energy
Joshua Mutambi	MTIC	Commissioner Trade
Samson Akankiza	DDA	Executive Director
Joyce Nkuyahaga	PowerAfrica - OP	Country Advisor
Ivan Taremwa	GIZ/EnDEV	Energy Advisor: Solar Component
Yonah Turinayo	WWF	Coordinator - Energy Climate and Extractives, Ag. Head of Conservations
Ibrahim Mutebi	SNV	Project Manager - SEFFA /Uganda
Edna Nyamwaka	Heifer International	Project manager - Solar for sustainable income for dairy
Richard Kimbowa	Richard Kimbowa	Program Manager - UCSD / Chairperson Uganda Renewable Energy CSo Network
Virginia Semakula	Equity Bank	Manager for Energy Environment and Climate Change
Robert Baingana	EBO SACCO	Head of Business
Ismail Muyinda	USEA	General Secretary
Benard Mbaine	UNREEEA	President
Perez Magoola	Open Capital	Senior Analyst
Off-grid energy and PURE companies		
Arinda Franklin Okeyamba	FRES Solar	Compliance & External Relations Manager
Kyokushabe Shine	Sprinktech Uganda Limited	Projects Engineer
Vincent Sseremba	Tulima Solar	Country Director
Alex Wanume	Winch Energy	Country Director
Paul Kamoga	Aptech Africa	Project Manager
Edwin Kwesiga	EnerGrow	Managing Director
Shaban Kitimbo	KuaSolar	Country Manager
Dennis Mudde	Power Trust Uganda Limited	Sales & Marketing Manager
Ceri Jones	The SureChill Company	Corporate Marketing & Commercial Director
Amos Odhiambo	SolarNow Services Uganda Limited	Head of Projects
Ronald Bukulu	Equatorial Power LTD	Operations Analyst

Annexes

Annex II - Reference documents reviewed

- EnDev Uganda's Sustainable Energy for Smallholder Farmers (SEFFA): <https://endev.info/countries/sustainable-energy-for-smallholder-farmers-in-ethiopia-kenya-and-uganda/>
- GIZ 2022: Sector Brief Uganda: Renewable Energy - <https://www.giz.de/en/downloads/giz2022-en-sectorbrief-uganda-renewable-energy.pdf>
- Shell Foundation 2017: Promoting Productive Uses of Energy in Uganda
- UBOS 2020: Statistical Abstract 2020
- Uganda National Development Plan III
- Uganda Parish Development Model (2021 to 2026)
- Uganda updated Nationally Determined Contribution 2022
- UOMA 2020: Productive Use of Energy in Uganda: Learnings from the Uganda Off-Grid Energy Market Accelerator (UOMA)
- USAID Power Africa (2022) – Power Africa Off-grid Project Factsheet
- World Bank 2021: Energy Access Project (EASP) – Project information document (PID): <https://documents1.worldbank.org/curated/en/722961612536168002/pdf/Project-Information-Document-Uganda-Electricity-Access-Scale-up-Project-EASP-P166685.pdf>
- World Bank Global Electrification Database from the 'Tracking SDG 7: The Energy Progress Report; led jointly by the custodian agencies: the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank and the World Health Organization (WHO). <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=UG>

