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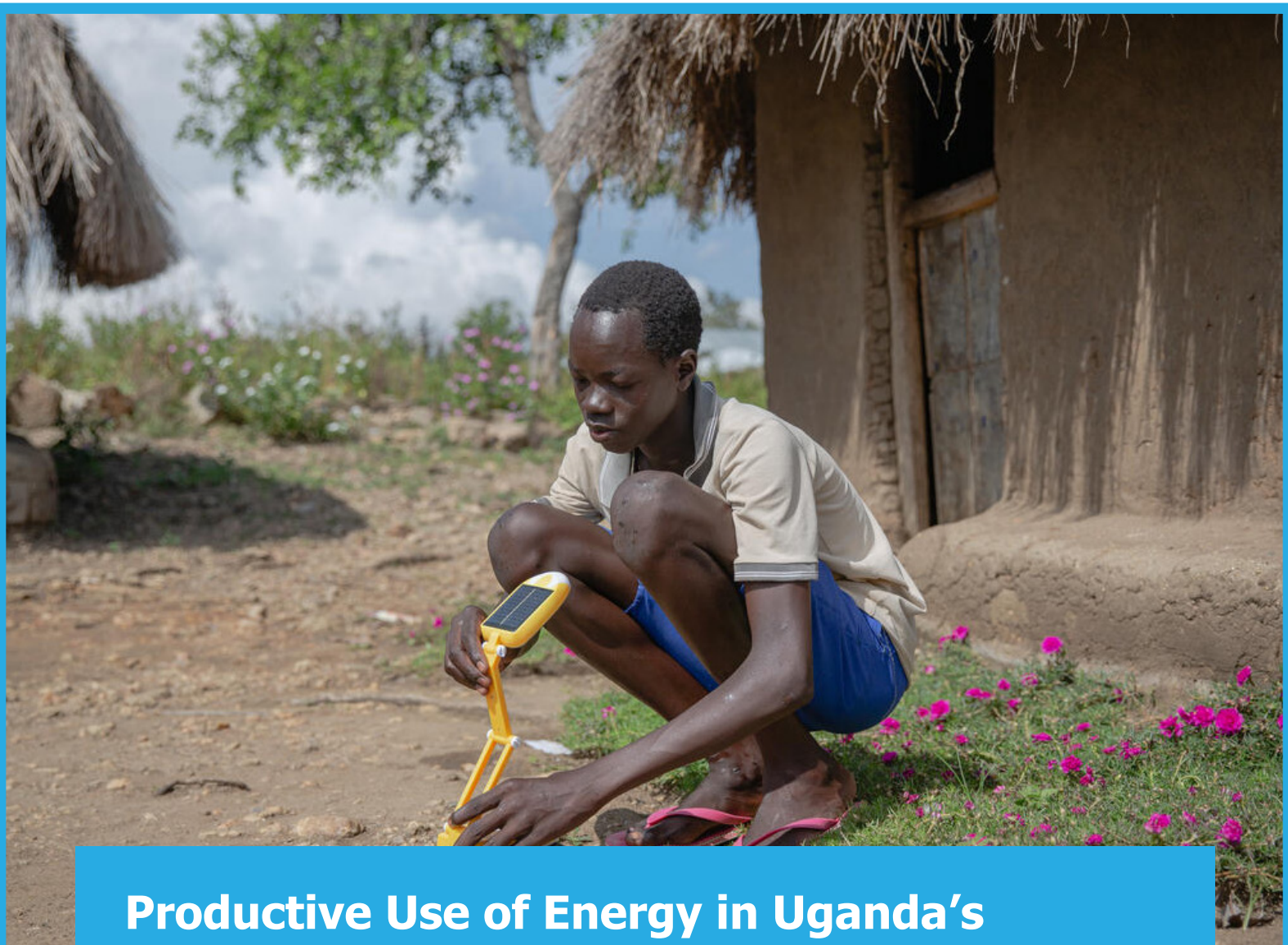


Productive Use of Energy in Uganda's Refugee Response - Annotated Bibliography

Save the Children

Uganda Learning, Evidence, Accountability, and Research Network

Annotated Bibliography

Abbott, R., **Scaling Off-grid Energy in Uganda: A Mid-Level Landscape Analysis of Issues and Stakeholders.** FHI360.
https://pdf.usaid.gov/pdf_docs/PA00W5JT.pdf

This analysis identifies key actors in the off-grid energy market in Uganda and considers their interest, relationships, and flow of resources through their networks. There are seven interconnected issues: solar operators lack access to capital; consumers lack access to finance; high-quality products compromised by imitations and limited service; solar home system products suffer from distribution and scaling challenges; new taxes and uncoordinated policies threaten a new industry; workforce training opportunities exist but have limited reach; greater need for advocacy and coordination. It concludes that the supply of solar home systems is the limiting factor, not demand. There are existing training programs, but it is a matter of getting more of the right people trained and implementing them in rural areas.

Africa Clean Energy (ACE). 2019. **Uganda Solar Water Pumping Report.** Kenya.
https://www.ace-taf.org/wp-content/uploads/2019/10/ACE-TAF-UGANDA-SOLAR-WATER-PUMPING-REPORT-SCREEN-1.pdf

Off-grid technologies, such as standalone systems and mini-grids, have struggled to reach consumers in Uganda. The Government of Uganda expressed interest in promoting productive use of energy as a strategy for energy access. However, it is yet to implement strategies to promote their uptake. The main benefits of solar water pumping are increasing productivity and incomes for farmers, and it is a cheaper alternative to diesel-run pumps. The main challenges are that the system configuration is not standard, there is limited consumer awareness of the products, there is limited technical expertise to support farmers in its use, there is low affordability and limited access to finance, inconsistent aftersales support, and unavailability of data on access to water. The recommendations are to increase coordination with government agencies and other stakeholders, develop a fiscal policy such as tax incentives and subsidies, and provide awareness and training.

Africa Clean Energy. 2021. **Productive Use Potential and Sales of Of-Grid Solar to Women and Youth in Uganda.** Tetra Tech International Development.
https://www.ace-taf.org/kb/productive-use-potential-and-sales-of-off-grid-solar-to-women-and-youth-in-uganda/

The objective of the study was to establish the uptake and identify opportunities for the use of stand along solar (SAS) products for PUE by women, youth and Persons Living with a Disability (PLWD) in Uganda. The study reveals that the level of awareness of off-grid systems (OGS) is high. Awareness of SAS products is higher in urban areas than rural areas. At the micro-level, households are using solar home systems (SHS). PLWD are using solar for lighting but less for business. There is limited awareness of PUE among PLWD. Some agricultural processors have installed solar panels in their coffee production facilities, powering the hulling system. Coffee organizations use OGS solar water pumps for irrigation. OGS is increasingly used for water heating in urban areas in both homes and businesses. Women dominate the service sectors, such as food vending, which consume low energy. Men dominate agriculture, fisheries, and manufacturing which are heavy energy consumers. Electricity use was associated with better outcomes for mainly male business. Female enterprises had lower profits and lower electricity consumption. Low income levels of PLWD, women and youth affect their ability to pay for OGS. There is increased use of OGS in many refugee settlements, including the use of solar for home lighting and PUE like fridges for cold storage and phone charging. One local solar company designed business hubs powered by solar to enable the establishment of women-owned businesses like hair salons and kiosks. Youth-run business in OGS PUE include barber shops, phone charging, small printing and computing shops, discos and cinemas.

Booth, S., Li, X., Baring-Gould, I. 2018. **Productive Use of Energy in African Micro-grids: Technical and Business Considerations.** National Renewable Energy Laboratory and Energy for Impact. https://www.nrel.gov/docs/fy18osti/71663.pdf

The report is a resource to understand the technical and business model challenges related to PUE in smaller micro-grids, focussing on agricultural processing and small industrial and commercial loads. It examines best practice for promoting PUE and key considerations for productive use. In a value chain analysis case, it is important to look at existing products, services and activities and how value can be derived from the supply of electricity. It is important to analyze the value chain in the four areas of inputs, processing, outputs and end use. A second consideration is enterprise development and training. This includes training on the use of electrical appliances and training on how to run a business with the product. Equipment financing is the third consideration. In remote areas there may not be a financial institution close by. Some micro-grid developers set up their own financing schemes to bridge the gap (e.g., concessionary loans, lease-to own model of equipment). The business case for PUE must consider both the cost of electricity and the monthly repayments. The study provides businesses cases for five different types of PU: ice making, milling, carpentry, egg incubation and water treatment. When designing a micro-grid, the characteristics of loads such as timing, magnitude and seasonality can have a large impact on the financial viability of the overall system. For this reason, the power requirements of a PU business may positively or negatively impact the design, operation, and resulting costs of power.

Brüderle, A., Attigah, B., Bodenbender, M. 2012. **Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners.** GIZ and Energy for Development (EUEI PDF). http://www.produse.org/imglib/downloads/manual/euei_productive_use_manual_med.pdf

The manual provides a background on the productive uses of electricity. It provides a step-by-step guide to promoting productive use of electricity in four phases. The first is feasibility and planning to determine if there is a case for productive use promotion, defining the objectives, and mapping stakeholders. The second phase is the analysis and design of the intervention strategy, analysing the local economic structures in the target area, planning productive use by identify key bottlenecks, and assessing the scale on which opportunities are replicable. The third phase of implementation is to raise awareness of productive uses, encourage energy service providers to act as technology facilitators, provide technical assistance to MSMEs, and facilitating access to financing. The fourth phase is monitoring evaluation, assessment the impact and feeding lessons learned into future planning.

Brüderle, A., Diembeck, K., Hartmann, J., Rammelt, M., and Volkmer, H. 2014. **Productive Use of Thermal Energy: An Overview of Technology Options and Approaches for Promotion.** Energy for Development. GIZ
http://www.produse.org/index.php?lang=eng&page=14/

This booklet provides information on the technology options and approaches for productive purposes of efficient thermal energy appliances for micro, small and medium enterprises (MSME). It summarizes the ways that thermal energy can be used in agricultural, industrial and commercial value chains. It provides examples of the main applications of cooking, drying, baking, smoking, cooling, and heating water. It also provides practical guidance on how to promote the distribution of efficient biomass and solar thermal appliances for productive uses for energy and private sector. It summarizes the opportunities and challenges and the key criteria for the adoption of an appliance and energy supply: the key criteria that the reliability, quality, affordability, and adequacy.

Buyinza, J., Okia, C., Medum, R., Acanakwo, E., Kyomuhendo, P, Kabasindi, H., and Njenga, M. 2023. **Response to increased environmental degradation and promotion of alternative energy sources in refugee hosting districts in Uganda. Reducing Environmental Degradation (RED) in refugee context in Uganda.** Brief Series No. 1. CIFOR-ICRAF: Bogo, Indonesia; Nairobi, Kenya. https://reliefweb.int/report/uganda/response-increased-environmental-degradation-and-promotion-alternative-energy-sources-refugee-hosting-districts-uganda-brief-series-no-1-february-2023

The RED project aims to contribute to increasing environmental protection and forest restoration and to improve sustainable energy and alternative livelihoods for displaced populations and host communities. It is being implemented in refugee settlements in 5 districts (Yumbe, Leju, Madi Okollo, Kiryandongo, Adjumani). The expected outputs of the project are inclusive market systems assess for alternative energy sources, alternative green livelihood opportunities are created, energy-efficient stoves and heat retaining bags are constructed and/or distributed, and alternative sources of energy are accessed.

Centre for Research in Energy and Energy Conservation (CREEC). 2018. **The environmental impact of settling refugees in refugee hosting areas in Uganda.** Uganda. https://www.mwe.go.ug/sites/default/files/library/Presentation%20-%20OPM_WFP_CREEC_Sept%202018.pdf

The study aimed to assess the impact of settling refugees and their energy use on the environment, to assess the impact of environmental changes on their energy use and well-being and examine potential mitigation measures. It surveyed refugee and host communities (51% female) from 13 settlements. In the 13 settlements, the majority of fuel consumption was firewood, ranging from 57% in Oruchinga to 97% in Palorinya. The rest use charcoal. The majority (62%) reported that the distance walked to collect firewood had increased, with the highest percent reported in Adjumani and Lobule. Due to the scarcity of fuel, 51% report skipping meals. Proposed interventions are 'stove for work', tree growing, alternative fuels, market-led solutions (PAYGo), and promoting energy efficient cookstoves.

Centre for Research in Energy and Energy Conservation (CREEC). 2020. **Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda.** GIZ. https://reliefweb.int/report/uganda/baseline-assessment-market-based-energy-access-scale-projects-refugee-settlements-uganda

CREEC conducted a baseline survey to assess the energy market supply and demand situation in four refugee settlements and host communities in Uganda. The study was designed to prioritize the settlements and host communities for their appropriateness to implement market-based energy access interventions. The energy market is underpinned by three factors: availability, accessibility and cost. The demand gaps in all four settlements present opportunities to increase coverage of one stop energy kiosks. The adoption of improved cookstoves (ICS) is low due to lack of awareness of benefits. Solar is the only available lighting option in the settlements, but in Palabek it is in limited supply. Nakivale and Kiryandongo are the most willing and appropriate settlements to adopt market-based approaches. In Maaji and Palabek, the incomes of the residents are lower as well as a slower uptake and appreciation of ICS was noted.

De Gouvello, C., and Durix, L. 2008. **Maximizing the Productive Uses of Electricity to Increase the Impact of Rural Electrification Programs.** Energy Sector Management Assistance Program (ESMAP).

Rural electrification programs may have some natural trickle-down effects, but spontaneous positive effects on social and economic development are generally limited. Two deterrents to the productive use of electricity are the lack of technical knowledge and skills of potential users, and the financial means to acquire the equipment. To be successful, a rural electrification program should target the direct impact on livelihoods and revenue generation beyond the provision of connections. A systematic approach to doing so analyzes the technologies used in the production process of goods and services and identifies bottlenecks. The five steps are: identifying the productive activities taking place in a project area; analyze the production processes involved and identifying possible improvements and limitations; review the contribution of electricity to these expected improvements and what equipment is required; analyze the technical and economic feasibility and the social viability of the electrically based solution proposed; targeted promotion campaign to potential users about the potential benefits.

Eder, J., Mutsaerts, C., Sriwannawit, P. 2015. **Mini-grids and renewable energy in rural Africa: How diffusion theory explains adoption of electricity in Uganda.** Energy Research and Social Science,

5:45-54.
http://dx.doi.org/10.1016/j.erss.2014.12.014

The study analyses the factors that influence the adoption of renewable electricity in the household. It is based on a case study of a Swedish energy service company, Pamoja Cleanteach AB, operating a small-scale biomass gasification power plant in rural Uganda. Three critical dimensions are identified as crucial to adoption: technology; economic requirements and the social dimension. The study found that higher income households adopted electricity. There were conflicts in the village as a result of the division between those who could and could not afford electricity. Income was cited as the main reason for not adopting. There was high awareness of the technology's relative advantages and had a positive view that it was sustainable energy. However, the company could not always provide electricity service every day from 5pm till midnight as promised, so it was viewed as unreliable. Other factors affecting adoption were affordability, payment system (how to pay), investment costs, and appropriate tariffs. When entering a new social system with a disruptive innovation, the firm should collaborate with local actors. A lack of understanding of local communities can lead foreign companies to fail.

Efficiency for Access Coalition. 2019. **Use and Benefits of Solar Water Pumps: Kenya, Tanzania and Uganda Consumer Research.**
https://www.clasp.ngo/wp-content/uploads/2021/01/Use-and-Benefits-of-Solar-Water-Pumps.pdf

The report outlines findings from the solar water pump sector in East Africa. Most solar water pump uses have higher incomes relative to the average off-grid consumer. Irrigation related expenses decreased by 91% on average with the use of solar water pumps. However, this excludes the repayment costs for pumps that were financed. Consumers reported increased agricultural productivity. Satisfied customers also reported time savings, decreased intensive physical labour, and cost efficiencies. The most common challenges they faced was equipment malfunction. This could be due to lack of training or misuse.

Efficiency for Access Coalition. 2021. **Off- and Weak-Grid Solar Appliance Market Uganda.**
https://efficiencyforaccess.org/publications/off-and-weak-grid-appliance-market-uganda

Uganda's electrification rate is growing rapidly, but the majority (59%) still do not have access to electricity. There is high potential for off-grid appliances in the country. Many development programmes have supported the deployment of off-grid solutions. Consumer financing is one of the main barriers to growth. Televisions have become the key driver of off-grid solar energy system uptakes and most in-demand appliance for off-grid households. The off-grid refrigerator market is new, with only 2% of the rural population owning a refrigerator. Solar water pumps are the most commercially viable productive use appliances, but the market is nascent.

Energising Development (EnDev) – Uganda. 2018. **Piloting Energy Access in Refugee Settlements and Host Communities to Create Evidence for Market-Based Approaches.** GIZ. Germany.
https://data.unhcr.org/en/documents/details/64605

The factsheet summarizes the pilot activity Energy Access in Refugee Settlements. EnDev Uganda carried out a baseline in Rhino and Imvepi camp, finding that the majority of households (85%) use firewood for cooking and heating, 76% use three-stone fire for cooking, and households use 10-12kg of firewood/day. Based on the findings, the project will carry out awareness raising activities, train local stove artisans, support local vendors of energy products, set up energy kiosks, which will be equipped with high quality cook stoves.

Energising Development (EnDev). 2019. **The State of Sustainable Household Energy Access in Refugee Settings in Uganda. Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region.** GIZ. Uganda.
https://data.unhcr.org/en/documents/details/69808

The aim of the pilot project "Sustainable Use of Natural Resources and Energy in the Refugee Context in Uganda" was to pilot an integrated approach to natural resource management by creating sustainable solutions to improve access to energy, water, and other ecosystem goods. The objective was to find evidence to which extent market-based approaches can provide access to sustainable energy in refugee settlements and host communities. The findings show that firewood and charcoal are the main sources of fuel in the settlements. On average, two meals a day are prepared by women from inside shelters, which has negative health impacts. Most residents are aware of the benefits of improved cooking technology and would be willing to pay for it. The provision of electricity and lighting devices has been both advantageous and retrogressive. Solar lamps received as handouts increase access to solar products but stifles the free market. There are hardly any businesses that provide improved cooking stoves or good-quality solar products nearby.

Energising Development (Endev). 2021. **Sustainable Energy for Smallholder Farmers (SEFFA) in Ethiopia, Kenya and Uganda Baseline Study and Market Assessment.** GIZ. Germany
https://endev.info/countries/sustainable-energy-for-smallholder-farmers-in-ethiopia-kenya-and-uganda/

This report presents the findings of the Baseline Study and Market Assessment commissioned by the Sustainable Energy for Smallholder Farmers in Ethiopia, Kenya and Uganda (SEFFA) project. The study aimed to inform the design of SEFFA by i) conducting a baseline survey of horticultural and dairy producers to provide a diagnostic of current production systems and energy needs, ii) conducting a market assessment of PUE technology demand and supply in the target countries, iii) developing business cases for each country, iv) establishing key indicators to measure project performance. In Uganda, the main opportunities for PUE technologies among horticulture and dairy farmers are: solar powered water pumps, solar powered cold storage for horticulture (especially for co-operatives), cold storage for dairy (with at least 20 cows), milk processing, solar powered horticulture processing to produce dried fruits, through there are no drying technology suppliers in Uganda. The main constraints of PUE are limited awareness, high capital costs, low access to consumer financing, and pay-as-you-go (PAYGO) companies have struggled with repayment rates.

Energy4Impact. 2017. **Grid Powered Refrigeration for Productive Use.**
https://energy4impact.org/file/1946/download?token=2Li0aJN0

A survey about on-grid refrigeration was carried out to understand the context of how Ugandan micro-enterprise owners use refrigeration as part of their operations to inform the potential use of off-grid refrigeration. There is a clear business case for micro-enterprises to acquire fridges for selling drink, to diversify products sold, and provide additional revenue streams. The main challenges are the high energy cost related to high energy consumption of the fridges, power supply interruptions, and appropriateness of the products to their business needs. Solar refrigerators at their current cost do not make sufficient economic argument for a microbusiness. However, there could be a 3-year payback period for the power supply of a $546 170L fridge. There is a business case for energy efficient refrigerators (AC powered for on-grid enterprises, and off-grid users.

Etcheverry, J. 2003. **Renewable Energy for Productive Uses: Strategies to Enhance Environmental Protection and the Quality of Rural Life.** University of Toronto.
http://www.martinot.info/Etcheverry_UT.pdf

Most renewable energy projects in rural areas of less industrialized nations have concentrated on residential applications. A growing number of projects are being implemented to use renewable energy for productive uses. The study analyses the linkages between energy and productive uses and the potential benefits of sustainable energy options. It illustrates how new initiatives evolving from a traditional focus on satisfying residential needs towards a community development approach. Emerging evidence suggest that carefully designed productive-use projects can contribute to the enhancement of rural sustainability and improvements in rural quality of life.

Geofrey, K. and Tumwine, F.R. 2023. T**he impact of Refugee Settlement on Landscape and Green Environment in Yumbe District West Nile Sub Region, Uganda.** Advances in Social Sciences Research Journal – Vol. 10, No. 4. 139-152.
https://journals.scholarpublishing.org/index.php/ASSRJ/article/view/13682

Little information is available on impacts of refugees and host communities on land use changes. The study used GIS software to determine the current and past spatial areal extent of changes from 2010-2020. Findings showed a rarefied increase in areas under subsistence farming, with losses in grasslands and woodlands. These were primarily attributed to unending activities of deforestation, bush-burning, high refugee population, and land conflicts with host communities. There is a need to promote a shift from the use of non-renewable energy sources like charcoal to renewable sources like biogas and briquettes.

GIZ. 2013. **Bakeries with Efficient Ovens Uganda.**
http://www.produse.org/imglib/downloads/energy_sources/PRODUSE-Factsheet-Uganda.pdf

This fact sheet highlights good practice from the EnDev Uganda project Promotion of Renewable Energy and Energy Efficiency Programme (PREEP). It promotes the productive use of thermal energy for baking. PREEP promoted the use of efficient biomass baking ovens. It has also provided technical training for oven builders to construct and market efficient rocket baking ovens themselves. The firewood rocket baking oven comes in three sizes with a capacity of between 32 and 256 kg of bread in one cycle (between 12-760 loaves of bread), saving a baker time and money. Entrepreneurs need to invest between UGX 4 and 18 million to purchase the improved baking ovens. It considerably reduces firewood consumption and fuel wood costs.

GIZ. 2016. **Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances.**
https://www.preo.org/photovoltaics-for-productive-use-applications-a-catalogue-of-dc-appliances/

The catalogue provides an overview of various productive use applications and associated aspects. It describes technical issues of the development of DC mini grids. It provides the factsheets for 10 categories of appliances: Livestock breeding; Food Production – Water pumping; Food processing- Milling; Food storage- Cooling; Food for Sale; Tailoring; Workshop Tools; Media and Entertainment; Energy Services; Haircutting and Other Services.

GIZ. 2021. **Electrification of Six Health Centres in Rhino Camp and Imvepi Refugee Settlements. Baseline Assessment Report.** Uganda.
https://energypedia.info/images/6/65/Baseline_Assessment_Report_on_the_Electrification_of_Six_Health_Centres_in_Rhino_Camp_and_Imvepi_Refugee_Settlements_.pdf

The aim of the baseline assessment is to describe the status of health centres, service provision, and electrification prior to the intervention of the ESDS and ENDev projects. It took place in the Rhino Camp and Imvepi Refugee Settlements. All the six facilities studied have a maternity ward and in-patient ward. They have a limited capacity for blood transfusion as a result of unreliable electricity. All health facilities have emergency services, and basic diagnostic testing. None offered liver function tests. Two had imaging equipment. One has an ultrasound machine. Only one facility had a solar fridge for vaccines. All facilities send samples to a regional laboratory with more advanced diagnostic capacity. The facilities do not have electricity to store blood and so do not offer blood transfusion. Recommendations are to ensure adequate sizing of solar systems to fully function for health service delivery and develop a sustainability plan for each facility.

GIZ 2022. **An intermediate Outcome Study After the Electrification of Six Health Centers.** Uganda.
https://energypedia.info/wiki/File:An_Intermediate_Outcome_Study_After_the_Electrification_of_Six_Health_Centers.pdf

The intermediate outcome report is based on a field study of six electrified health centres in Imvepi and Rhino Camp Refugee Settlements. Its purpose was to provide information on the status of the health centres ten months after the solarisation of the centres. Findings show that the catchment population increased for 4/6 health centres. The number of patient visits reduced progressively. The number of services provided increased in all centres. Additional services include, for example, a pediatric ward, CD4 cell count lab services, urine microscopy, onsite ambulance, and serology testing. Operation and maintenance of the solar PV systems were low, and only one centre had a professional technician who could operate fault in the system.

GIZ. 2021. **The Uganda Energy Kiosk Model in Refugee Settings.**
https://energypedia.info/images/6/69/Factsheet_Energy_Kiosk_Model_in_Uganda_ESDS.pdf

This is a case study of the construction of two energy kiosks with solar-powered electricity in the Rhino Camp Refugee Settlement from the project Energy Solutions for Displacement Settings (ESDS). Before the kiosks, it was hard to find a place to buy energy products or buy a phone. Members of the refugee and host community are now making use of the services offered, such as phone charging, secretarial services, sale of cold drinks, purchase of energy efficient cookstoves and solar lights. The kiosks were achieved with support from private sector financing through results-based financing. There is a need to carry out awareness raising campaigns in local languages to promote the use of energy products.

GIZ. 2022. **Creating Energy Solutions in Rhino Camp.**
https://energypedia.info/images/9/9f/Creating_Energy_Solutions_RhinoCamp.pdf

The case study summarizes good practices from the project Design Lab financed by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented in the Rhino Camp Refugee Settlement. In partnership with MIT D-Lab, Kulika Uganda and the Youth Social Advocacy Team, and GIZ's Energy Solutions for Displacement Settings (ESDS), an innovation center was established in the camp. The participants of the Creative Capacity Building (CCB) trainings learn about design process and building prototypes of technologies to address a specific problem. They learned specifically about clean energy technologies. Through the process, the participants built machines to help solve a problem, such as a laundry machine with a hand-crank mechanism, a portable light with a rechargeable cell phone battery, and a table-top juice blender with a string-drive technology to spin the blender.

Habersbrunner, K., Mirembe, A., Ruhlemann, A. 2018. **Affordable, Empowering and Sustainable Decentralised Renewable Energy Solutions: Potential of energy communities in Uganda.** New Energy for Uganda. Kampala.
https://www.wecf.org/de/wp-content/uploads/2018/10/Report_Ecommunities_Uganda_2018.pdf

Small scale renewable energy community projects will boost rural development and provide multiple benefits. If local people are close to the energy grid, the financial conditions may not enable them to access the energy. Thus, energy projects also need to follow bottom-up approaches. Cross-sectional samples in terms of renewable energy sources (solar, wind, biomass, hydro), user needs (electricity, food preparation, lighting, PUE) can be organized in community management models considering local context. The main challenges are the high initial investment, lacking quality assurance, and lacking awareness of potential business models and technologies. A roundtable discussion in Uganda concluded that 'energy' should be part of the solution, rather than the solution itself. There are several projects in Uganda for community energy fun by GIZ, KfW, SNV, ARUWE, FINCA, Solar Sisters, Climate Justice for Women and Children, and the Ugandan Solar Energy Associations. They range from mini-grids, household biogas, selling clean energy technologies, and solar home systems.

Havinga, M., and Tuele, R. 2021. **Productive Use of Energy: Moving to scalable business cases.** Energising Development (EnDev). Germany
https://endev.info/wp-content/uploads/2021/03/EnDev_Learning_Innovation_PUE.pdf

The report provides background on productive use of energy (PUE), technologies and initiatives. Multiple factors support the use of energy for productive uses, such as increased energy access, payment models like Pay-As-You-Go (PAYGO), technological innovation, and lower costs for solar technologies. The report maps PUE initiatives by categories (Target group, Value Chain Approach, PUE approach, Focus on supply side and technology). Key challenges identified in the analysis of initiatives are the lack of availability of appropriate products and business cases, and lack of an enabling market environment to facilitate the scaling of PUE. Key success factors are a detailed analysis of demand, an integrated market development approach, continued support to businesses adopting PUE and detailed monitoring using tailored PUE indicators. The analysis shows that PUE promotion requires a more holistic or 'ecosystem' approach to PUE promotion, addressing the key barriers and integrating the key success factors.

International Bank for Reconstruction and Development. 2019. **Rapid Assessment of Natural Resource Degradation in Refugee Impacted Areas in Northern Uganda.**

The report summarizes the findings and recommendations of the assessment of natural resource degradation around refugee settlements in northern Uganda. The main findings are: the refugee influx led to an increase in the rate of degradation and tree loss; land cover change analysis shows an increase in tree cover loss in and around refugee settlements; refugee and host households are highly dependent on forest and other woodlands; total cooking fuel demand in the 14 settlements is about 345,000 metric tons of wood per year; refugee woodfuel consumption at Bidibidi settlements has significantly reduced; refugees and host communities have a tradition of building improved mud-stoves from locally available materials; households need additional wood to build and maintain living structures; there are few organizations working on environment and energy-related activities in refugee-affected areas. It is recommended to develop agroforestry systems on household plots and farmland, establish woodlots for energy and other purposes, rehabilitate degraded forests, enhance energy efficiency of cooking practices.

International Finance Corporation. 2019. **The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa.**

Productive use leveraging solar energy (PULSE) represents the next frontier of off-grid solar (OGS). The use cases are diverse and encompass activities that can be mechanized across agriculture, industry, and commerce. PULSE appliances are increasingly available in African markets. The products are generally small-scale applications of 1 kW of below. The most common appliances are solar-powered water pumps and refrigerators. The PULSE sector faces traditional constraints, that individual farmers do not have the resources to expand their operations or reach a scale to benefit from mechanization. Affordability constrains uptake of all appliances. Growing the sector requires policy action, market development and coordination between energy and agriculture sectors.

International Finance Corporation (IFC). 2022. **Energy Access Baseline Study in Uganda's Refugee-Hosting Areas.** Washington, DC. November 2022.

Energy access is a challenge for refugee and host communities. The main source of lighting in households is solar energy and torches. The solar products used are pico-PV products and solar home systems (SHS). Both refugee and host communities rely on firewood (85%) and charcoal (14%) for cooking. Many of the refugee households using charcoal do so because the host communities restrict access to the forest. Most host community and half of refugee households use a three-stone fire, followed by mud stoves. More than half of businesses do not use any energy. Those that did use high capacity SHS. To increase private sector engagement, promote the use of energy-efficient stoves and alternative fuels, help local enterprises in trading solar products, incentivize suppliers of solar products to offer credit, and strengthen the supply chain.

Kapadia, Kamal. 2004. **Productive uses of renewable energy: A Review of Four Bank-GEF Projects.**
http://www.martinot.info/Kapadia_WB.pdf

The paper analyses the World Bank's approaches to promoting productive uses of renewables, with a view to providing recommendations. It provides a background on what is the productive use of energy (PUE) and the rational to promote it – to maximize the economic and social benefits that access to energy can catalyze, and to improve the economic sustainability of rural electrification projects and renewable energy markets. It analyzed the approaches of four projects, including the Uganda Energy for Rural Transformation (UERT) project. The project focusses on productive uses and aims to address issues of scale-up of rural energy services by focussing on developing appropriate policy, institutional, and regulatory capacity. All projects demonstrate that multi-sectoral projects are essential for promoting productive uses of renewables. There can be problems with the selection of technology, such as path-dependency which may lead to sub-optimal technology choices and lead to negative impacts on productivity and welfare.

Mayer-Tasch, L., Mukherjee, M., and Reiche, K. 2013. **Productive Use of Energy – PRODUSE: Measuring Impacts of Electrification on Small and Micro-Enterprises in Sub-Saharan Africa.** GIZ. Germany.
https://www.esmap.org/sites/default/files/resources-document/esmap_giz_bmz_aei_produse_study_fulltext_optimized_0-1_0.pdf

The study aims to gain insight on the interaction between electrification and productive use of energy by examining the impact on micro-enterprises, based on field surveys in Benin, Ghana, and Uganda. Stark differences between industries show up. While service firms tend to get connected to the grid, uptake in the manufacturing sector was low in rural areas. Connected firms in both sectors used electricity mostly for lighting and phone charging. Some rural manufacturing firms used electric appliances. In the three studies, electricity usage hardly translated into higher firm profits in a measurable way. The financial burden from the investment in the connection and subsequent electricity bills can even reduce profitability. There was, however, evidence that electrification can lead to the creation of new business and in a few cases can attract larger firms to the area, contributing to economic development. One conclusion is that project managers should be realistic in their expectations with regard to the measurable economic impact of electrification projects.

Ministry of Energy and Mineral Development (MEMD). 2015. **Biomass Energy Strategy (BEST) Uganda. Uganda.**
https://www.undp.org/uganda/publications/biomass-energy-strategy-best-uganda-0#:~:text=Biomass%20is%20used%20in%20all,Strategy%20for%20Uganda%20(BEST).

The biomass energy sector is flawed, having and inadequate scanty data. There is a dependency on the use of tree biomass, estimated at 44 million tonnes per annum, which could rise if no interventions are put in place. There are options to increase efficiency through improved charcoal and improved stoves, using other type of biomass, or using modern forms of clean energy. The strategic objectives of the BEST are to create a Biomass Information System, enhance institutional capacity to regulate the use of biomass resources, increase fuel efficiency and clean cooking environments, promote efficient technologies, increase the biomass supply, and improve financing mechanisms for efficient technologies and renewable energy.

Ministry of Energy and Mineral Development (MEMD). 2020. **Sustainable Energy Response Plan for Refugees and Host Communities (SERP) Inception Report**

The inception report outlines the process to develop the SERP. It summarizes the main energy sector context in refugee hosting districts. There are insufficient levels of access to energy for the needs of households, PUE, and social institutions; primary reliance on biomass for cooking on inefficient stoves and low access to alternatives; protection risks for women and children while collecting firewood, and limited access to on- and off-grid solutions. To develop the SERP, a participatory, inclusive and evidence-based approach will be taken. Promoting the use of innovative financing will be an important component, as well as institutional strengthening.

Ministry of Energy and Mineral Development (MEMD). 2022. **Sustainable Energy Response Plan for**

Refugees and Host Communities (SERP) 2022-2025. Uganda.
https://energypedia.info/wiki/File:The_Sustainable_Energy_Response_Plan_for_Refugess_and_Host_Communities_2022-2025.pdf

Uganda hosts over 1,582,892 refugees. The SERP aims to support the implementation of emergency response and longer-term interventions for effective transition and integration of humanitarian-based services into Uganda's national service delivery system. The SERP vision is for refugee and host communities to attain universal access to affordable, reliable and clean energy for socio-economic transformation in an environmentally sustainable manner. The SERP is a three-year plan and the main results to achieve are: increased access to energy for household and productive uses; decreased reliance on biomass for cooking; enhanced awareness and increased adoption of clean energy solutions; and reduced impact on the environment.

Ministry of Energy and Mineral Development (MEMD). 2023. **National Road Map on Scaling up Productive Use of Solar Energy.** Uganda.
https://www.gogla.org/wp-content/uploads/2023/07/Gogla_PURE-Roadmap-Report-Uganda.pdf
The National Road Map on Scaling Up Productive use of Solar Energy (NR-PUSE) provides an analysis and strategic direction to leverage solar energy for productive uses. The NR-PUSE's vision is "to have a vibrant and competitive productive use of the renewable energy ecosystem for food security and economic empowerment." Barriers to promoting PUSE are limited access to financing, lack of affordability, limited technical and human capacity, presence of low-quality products on the market. The strategy proposes actions to improve the enabling environment, increase awareness about PUSE, enhance financing opportunities, and support research and development.

Ministry of Water and Environment. 2019. **Water and Environment Sector Response Plan for Refugees and Host Communities in Uganda (WESRP).** The Republic of Uganda.
https://www.mwe.go.ug/sites/default/files/library/Final%20Water%20and%20Environment%20Sector%20%20Refugee%20Response%20Plan.pdf

The WESRP provides a comprehensive planning for both refugees and host communities within the context of the Water and Environment Sector Development Plan. Uganda's population is heavily reliant on natural resources to meet basic needs and is seeing forest cover quickly diminish. Some of the expected outputs of the plan are to raise 18 million seedlings, and to provide alternative and renewable energy for cooking and/or fuel wood from licensed providers. It aims to shift Water Resource Management to a deconcentrated system where planning and management is done at the lowest level. Refugee settlements have low sanitation coverage. Hard ground conditions, and limitations on construction materials mean latrines are poor and serve for a shorter duration. Challenges in implementation are inadequate coordination between refugee hosting district and sub counties, low community involvement and little behaviour change, and inadequate planning for emergency, humanitarian, integration and repatriation phases.

Moncada, A., Ruiz, L., Meyer, M., Surya, R., Wanyahoro, W. 2022. **Assessment of Market-Driven Solutions: Energy Access in Refugee Settlements in Sub-Saharan Africa.** Smart Communities Coalition. Smart Communities Coalition.
https://www.mastercard.us/content/dam/public/mastercardcom/na/global-site/public-sector/other/scc-whitepaper.pdf

The report summarizes findings from 13 projects that target increasing energy access in refugee camps and settlements in sub-Saharan Africa. In Uganda, the project De-Risking PAYGO Solar Home Systems in Refugee Settlements encouraged private PAGO SHS companies to consider refugee communities as a viable market. Three companies were granted awards to stimulate market activities in refugee settlements. This included subsidizing sales office. The three grantees are continuing sales and are seeing acceptable repayment rates. The lack of mobile money penetration impedes repayment. The AMPERE project used market-based interventions to enhance long-term investments in BidiBidi. Funding was used to provide a 60% subsidy for clients buying power from two partner solar energy provides. It showed how more

flexible financing options to accommodate inconsistent income streams can strengthen market systems. It concludes that Direct Supplier Financing to set up operations can stimulate market development and works well for productive uses as the revenue streams can support ongoing operations after. Projects should start with comprehensive market surveys. Demand-side interventions generally carry more long-term risk as they do not fundamentally alter the economic landscape or income of refugees.

NEFCO. 2023. **Scaling Productive Use of Energy Solutions in Sub-Saharan Africa: Market Scoping and Design of a Results-Based Financing Window for the PUE Sector.** Tetra Tech. https://beyondthegrid.africa/wp-content/uploads/Nefco-PUE-Market-Assessment-March-2023.pdf

Beyond the Grid Fund for Africa (BGFA) provides results-based financing (RBF) for companies selling solar home systems and developing mini0grids, including those that incorporate PUE appliances and applications. The report summarizes applications that generate income and create employment for socioeconomic developing. Numerous PUE initiatives have had successes, but they are relatively small and not at scale. Challenges to deploying PUE are significant, including th high cost of equipment, affordability, risks in providing financing to entrepreneurs, fewer potential sales in rural areas, complications in the supply chain and after-sale servicing, the need for customization, competition with incumbent technologies, and consumer awareness. The PUE that are starting to scale are solar water pumping; refrigeration and cold storage, agricultural processing and e-mobility are starting to show promise. Initiatives should be co-designed with government, donors, and private sector and maximize flexibility.

Open Capital Advisors. 2017. **Promoting Productive Uses of Energy in Uganda.** https://shellfoundation.org/app/uploads/2018/10/SF-OCA-Uganda-Accelerator-_-Productive-Use-Technology.pdf

There is opportunity to accelerate energy access by reducing market barriers. One of the core accelerator initiatives is enhancing business case for productive use technologies. The agricultural sector in Uganda provides the highest potential for impact. DC appliances are more energy efficient and are compatible with many solar home systems, mini-grids and other off-grid technologies. Technologies should be adapted to power generation, production quantities and local technical capacity to install, maintain, and repair. Solar irrigation has high potential in the North with appliances locally available. Ice production has potential in fishing communities near Lakes Kyoga, Victoria and Albert but requires high capital investment. Cold chain for dairy would reduce milk losses. Grain milling is an opportunity to benefit farmers throughout Uganda, which can triple the crops value by weight, but there is limited option to purchase energy efficient mills in the country. Oil seed processing presents an opportunity to meet growing demand but is not widely available locally. PUE projects are difficult to implement due to lack of funding, reliable machinery, awareness, and good data.

Power For All. 2020. **Power For All Fact Sheet: Leveraging decentralized renewables for Uganda's agricultural sectors.** https://www.powerforall.org/application/files/5016/0275/8163/FS_DRE_and_Ag_in_Uganda-1-1.pdf

The fact sheet highlights how decentralized renewable energy (DRE) has the potential to bridge the energy access gap in the agricultural sector. DRE technologies have had successful use cases in various agricultural value chains in Uganda, such as solar irrigation and milk chilling. Solar irrigation has a large potential, as it has low operating costs and can achieve payback in 2 years when replacing diesel. Milk coolers and refrigerators have a 2-year payback period from the reduced spoilage, and a positive 5-year return on investment.

Rural Electrification Agency (REA). 2013. **The Government of the Republic of Uganda Rural Electrification Strategy and Plan (2013-2022).** Ministry of Energy and Mineral Development. https://s3-eu-west-1.amazonaws.com/s3.sourceafrica.net/documents/119217/Strategy-and-Plan-2013-2022.pdf

This document presents the Government's Rural Electrification Strategy and Plan (RESP) for the ten-year period 2013-2022. This RESP is aligned to the Government vision of universal electricity access by 2040. the primary objective of the RESP 2013-2022 is: "To achieve an accelerated pace of electricity access and service penetration to meet national development goals during the planning period and beyond". A secondary objective is to ensure that, progressively, the program facilitates access to all forms of modern energy services to replace kerosene lighting and other forms of traditional cooking and heating by 2030. During this 10-year period, the Government aims to achieve a rural electrification access of 26%. It will be implemented on a model of scaled, multi-technology electricity service territories. Off-grid electrification services shall be offered in tandem with on-grid electrification services.

Shirley, R., Liu, Y., Kakande, J., Kagarura, M. 2021. **Identifying high-priority areas for electricity services in Uganda through geospatial mapping.** Journal of Agriculture and Food Researh 5: 100172 https://www.sciencedirect.com/science/article/pii/S2666154321000740

The study explores the opportunities to improve electricity mapping with electricity access. Using maize and coffee farming as a case study, the study compares data on electrification infrastructure and crop statistics. The study finds significant areas of underserved staple and cash crop farmland that can be served through grid and mini-grid electricity to improve productivity. Some key maize growing areas in the Northern region are unlikely to be reached by extended grid infrastructure. There are many coffee producing areas without grid access, limiting local processing activities like pulping or grinding.

Solar Sack. 2021. **Impact Evaluation Report for the Project: "Emergency Response to Deforestation Crisis of the Kyangwali Refugee Settlement."** CIDI, Caritas Denmark and SolarSack. https://reliefweb.int/report/uganda/impact-evaluation-report-project-emergency-response-deforestation-crisis-kyangwali-refugee-settlement

The report presents findings from the impact evaluation of the project which aimed to distribute 25,000 SolarSacks to reduce the prevalence of waterborne diseases and reduce deforestation. Household surveys found a 98% adoption rate. The percent of respondents reporting diarrheal diseases reduced from 32% to 9%. Beneficiaries are practicing good hygiene reducing the risk or recontamination. Charcoal consumption has gone down, whereas firewood consumption has gone up. However, most say they use less wood fuel to boil water.

Stewart, J, and Trace S. 2021. **Market Scoping for a Job Creation Agenda for the Beyond the Grid Fund for Africa (BGFA) Window in Uganda: Final Report.** Oxford Policy Management. United Kingdom.
https://beyondthegrid.africa/wp-content/uploads/Market-scoping-for-a-job-creation-agenda-for-the-Beyond-the-Grid-Fund-for-Africa_Oxford-Policy-Management_Final-report_2021.pdf

The report assesses the potential for off-grid jobs in Uganda to 2030 ad assesses the off-grid skills development sector. It projects that the direct jobs needed in the off-grid sector are 5,500-9,200 in Stand-alone/SHS; 3,000-5,400 in mini-grid operation and maintenance; and 600-2,000 in mini-grid construction. There is opportunity for growth of off-grid with a huge unserved market, particularly in electric-cooking and productive use. There are challenges in the low standard of SHS is damaging public perception, limited access to capital holds back off-grid companies, low willingness to pay, and companies struggle to achieve scale and profitability.

Sustainable Energy Fund for Africa (SEFA). 2016. **Project Summary Note SEFA Project Preparation. Uganda Earth Energy Syngas Biomass.**
https://www.afdb.org/en/documents/uganda-uganda-earth-energy-syngas-biomass-sefa-project-summary-note

This summary note provides a description of the development and operation of a 20 MW baseload Biomass Gasification plant at the outskirts of Gulu Town. The technology will generate electricity via gas engine and

added production of biochar to be sold as cooking and boiler fuel.

Tegendhat, E. 2017. **Transforming the Uganda Maize System. Positive Impact Case Study.** Palladium
https://thepalladiumgroup.com/news/Transforming-the-Uganda-maize-system

This case study looks at a proof of concept for modernising the traditional small farmer system and bringing it into the supply chain of a sophisticated company, Nile Breweries Ltd (NBL). There was a large gap between the requirements of NBL and the traditional maize system. Improvements were made in the supply chain infrastructure, technology and financing to improve productivity and efficiency. Village Aggregation Centres were constructed, operated by farmer associations. The VACs have the equipment and facilities for proper shelling, temporary storage and protection from pests. Mechanized maize shellers were provided to young operators. The equipment reduces the amount of broken maize and can shell 30 bags an hour compared to two bags an hour using traditional methods. The project improved productivity, increased household incomes, and women and youth.

Tumwesigye, A., 2021. **A report on end-user finance and payment systems to improve access to reliable, sustainable, and modern energy products in displacement settings (Uganda).** GIZ. Uganda.
https://energypedia.info/images/e/e0/ESDS_End_User_Finance_Report_Uganda.pdf

The lack of sufficient quality energy products and services for cooking and lighting, communication and productive use grossly limits opportunities to meet basic needs and strive for self-reliance. The report examines how End-User Finance (EUF), and Payment Systems improve access to energy solutions. The predominant EUF options are PAYGo, Village Savings and Lending Associations (VSLA) and Financial Service Providers (FSP). There are many factors that enable and hinder their usage. PAYG via mobile money is an ideal option but is limited by unreliable connectivity and low literacy. FSPs can provide subsidized loans, but limited reach, unclear policy, and lack of physical collateral are barriers. VSLAs are locally owned and managed and are the most ideal savings and borrowing mechanisms, but they have short repayment periods and disbursement amounts that are too low to acquire PUE. Options are to link VSLAs to FSPs to acquire more costly PUE or borrow from VSLA to cover an initial deposit and pay the rest through PAYGo.

Uganda Off-Grid Energy Markey Accelerator (UOMA). 2018. **Mapping the Ugandan off-grid energy market.** UKAID, Power Africa, USAID, Shell Foundation, Open Capital Advisors.
https://shellfoundation.org/app/uploads/2018/10/2018-UOMA-Market-Map.pdf

The market map seeks to provide a holistic and objective description of the off-grid industry in Uganda. It provides an industry overview, industry insights, and barriers to scale. Off-grid ecosystem is divided by Pico lamps, solar home systems, & mini-grids. Distribution of solar home systems is driven by the private sector offering credit, with the majority from PAYG operators. Mini-grids in Uganda are mainly driven by public sector but managed by private sector or communities. Government-led projects enable clearer planning to ensure economies of scale, de-risks projects, and makes utility cheaper for end-users through subsidies. There is a strong market potential for productive use solar products like water heaters, refrigerators, hair clippers, sewing machines, water pumps, and oil seed press. In order to reach unserved populations, it is critical to address the themes of affordability, distribution and awareness.

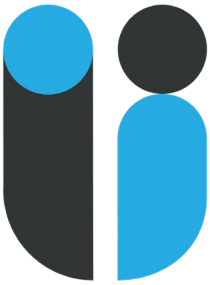
Uganda Off-Grid Energy Markey Accelerator (UOMA). 2020. **Productive Use of Energy in Uganda. Learnings from the Uganda Off-grid Energy Market Accelerator.** UOMA, USAID, PowerAfrica.
https://uoma.ug/wp-content/uploads/2020/10/UOMA-PUE-white-paper.pdf

Off-grid solar energy has become a major success story, accelerating energy for millions of Ugandans. Over the last decade, off-grid solar products have become commonplace in Uganda, with over 4 million products currently in the market. Productive use of energy (PUE) technology, powered by standalone solar systems, is emerging as a new market in the off-grid solar sector and a major opportunity to drive

energy demand and increase income levels. The study found that there are several key challenges that cut across all technologies. End users, particularly smallholder farmers of staple crops, have low affordability and willingness to pay; companies are still tailoring products for consumer demand, and other products require heavy customization that prevents scalability, there is limited access to finance for PUE companies, limited consumer awareness means that consumers don't yet fully appreciate the potential benefits of PUE technology, and market spoilage due to low quality products has discouraged consumers from purchasing quality systems. Recommendations to accelerate PUE in Uganda are: private companies can accelerate PUE by continuing to develop scalable business models and relevant technologies, donors and investors can promote PUE by providing the right forms of finance to scale early-stage business models, development parts can develop the right enabling environment so that PUE companies can flourish.

Utz, V. 2011. **Modern Energy Services for Modern Agriculture: A review of smallholder farming in developing countries.** GIZ
https://energypedia.info/images/f/fd/Energy_Services_for_Modern_Agriculture.pdf

Modernising agricultural production systems can increase productivity and energy plays a key role in this. Energy for transport (fossil fuels of biofuels) is needed for many services in the supply chain. Energy for production, processing and commercialisation can be provided in different forms – from the grid, renewable decentralized power, and hybrid systems. It can be used to provide irrigation (pumps), post-harvest treatment (cooling), or processing (drying, milling, pressing). The requirements of mechanical energy are also of critical importance, and this can include human and animal labour as well as fuels for mechanisation, pumping, and the production of fertilisers and agrochemicals.



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