POWERING PRODUCTIVITY

Lessons in Green Growth from the EEP Africa Portfolio

EEP Africa

NDF NORDIC DEVELOPMENT FUND

Acknowledgements

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Key Definitions:

Green Growth
Green growth is a term which describes a path of economic growth that uses natural resources in a sustainable way. It is used globally to provide an alternative concept to typical industrial economic growth. This path would lead to what is known as a green economy (see below).

Green economy
A green economy is defined as an economy that aims at reducing environmental risks and ecological scarcities, and which aims for sustainable development without degrading the environment. The green economy is characterised by being efficient, clean, circular, collaborative and low carbon. As such, it is central to achieving the key objective of the Paris Agreement on climate action

Mini-grid
A mini-grid, sometimes referred to as a micro-grid or isolated grid, is a system involving small-scale electricity generation (10 kW to 10MW) that serves a limited number of consumers via a distribution grid that can operate in isolation from national electricity transmission networks (EUEI mini-grid policy toolkit, 2014).

Productive Use of Clean Energy
The productive use of clean energy can be defined as agricultural, commercial and industrial activities that generate income and are powered by clean energy sources. These activities increase productivity, enhance diversity, and create economic value. (ARE, 2015; NREL, 2018).

Productive use activities in rural settings primarily include:
- local industries, such as agriculture, livestock and fishing;
- light manufacturing, such as welding and carpentry;
- commercial and retail activities, such as tailoring, printing, catering and entertainment; and
- medium-scale production, such as small factories or intensive agri-processing.

Stand-alone systems
Stand-alone systems are small electricity systems, which are not connected to a central electricity distribution system and provide electricity to individual appliances, homes or small business. They serve the needs of individual customers, while utilising locally available renewable resources (ARE, 2013).

Cover:
A plant nursery in South Africa powered by clean energy. Electricity and heat for the nursery come from a biogas plant installed by Renen Energy Solutions with financing from EEP AFrica.

EEP Africa is hosted and managed by the Nordic Development Fund (NDF).
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AUSTRIAN DEVELOPMENT AGENCY
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EXECUTIVE SUMMARY

EEP Africa financing has played a key role in early stage testing and refining of a growing number of innovative applications of clean energy and productive use in Southern and East Africa.

This study presents an analysis of selected project case studies from the EEP Africa, highlights an evolution in productive use business models, and identifies some of the key innovations taking place in the next generation of projects and companies combining clean energy and green growth.

One of the key lessons learned from EEP Africa project case studies is that growth in rural electricity demand is a gradual process and proactive measures to grow demand are often required to achieve commercial viability. Increasing demand by promoting the productive use of energy is an effective way to strengthen the financial sustainability of both mini-grids and stand-alone systems.

For mini-grids, the business models adopted by EEP Africa project developers have evolved to meet demand challenges and to compensate for weaknesses in the market. The level of engagement by the energy service provider depends on which model they adopt and where they position themselves in the local value chain.

The evolving business models for mini-grids can broadly be described as follows:

1. **Energy Supply Model**: The energy service provider produces and supplies reliable and affordable electricity to consumers via a small distribution grid. The mini-grids are designed to accommodate a primary offtaker or to convert existing users from diesel to electricity. Potential primary offtakers are largely linked to local agricultural production and operations are site specific.

2. **Business Acceleration Model**: The energy service provider combines energy supply with appliances and equipment, through direct sales and/or financing. In some cases, this is combined with targeted business development support. This has been shown to boost revenue generation for both the developer and the user.

3. **Supplier-Offtaker Model**: The energy service provider fills the demand gap by establishing and operating a commercial or industrial activity, serving as the primary offtaker. Initiating a productive activity based on a local commodity (such as producing ice for fisherman) that supports revenue generation can be more profitable for the energy supplier than providing energy to end consumers.

In comparison to mini-grids, stand-alone systems are designed for a particular activity, such as irrigation or refrigeration, and provide targeted, small-scale solutions for productive use. Decreasing technology costs mean that the payback period on a range of productive use appliances is now between three months and two years.

The innovation visible in the EEP Africa portfolio in the stand-alone category is in the expanding variety of applications, covering everything from motorbikes to mills to water pumps. These technologies are either turning existing productive activities green or bringing sustainable solutions to off-grid markets. The portability of stand-alone equipment makes deployment less complicated. Project developers are driving costs further down by adopting low-cost smart technology to reach markets at the bottom-of-the-pyramid that have not yet been unlocked.

As developers increasingly integrate innovative measures to stimulate the productive use of clean energy, the projects and companies in the EEP Africa portfolio are moving beyond merely addressing energy access to becoming drivers of sustainable productivity, jobs and growth in local economies. The case studies and pioneering project developers featured in this report are leveraging clean energy to shift economies onto green growth pathways, delivering sustainable, inclusive economic development while reducing and avoiding fossil fuel-based greenhouse gas emissions.

Scaling up clean energy driven growth and continuing to finance and support early stage innovations will be critical for achieving the objectives of the Paris Climate Agreement and the Sustainable Development Goals in the years ahead.

Recommendations

Driving green growth:
- Expand early-stage financing to test productive use applications and innovations
- Support the potential for productive use throughout the value chain

Facilitating green growth:
- Adapt project design to the local context
- Address the impact of tariffs and demand management on productivity
- Incorporate innovative financing mechanisms for appliances
- Commit to long-term business development support
- Develop partnerships to draw on institutional strengths

Promoting inclusive green growth:
- Strengthen the role of women and youth as agents of change in productive uses
- Expand financing mechanisms that facilitate productive use and clean energy affordability for the bottom-of-the-pyramid

Celfre Energy's robust solar-powered water pump enables farmers in Zimbabwe to grow cash crops throughout the year.

1. INTRODUCTION

The Energy and Environment Partnership Trust Fund (EEP Africa) is a clean energy finance facility manged and hosted by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF.

EEP Africa provides early stage financing for innovative clean energy projects, technologies and business models in Southern and East Africa. The objective is to enhance clean energy access, development and investment, with a particular focus on benefitting vulnerable and underserved groups.

EEP Africa financing has played a key role in early stage testing and refining of a growing number of innovative applications of clean energy and productive use in Southern and East Africa. By enabling companies to test and pilot new business models for mini-grids and stand-alone systems, EEP Africa is contributing to the financial sustainability of the clean energy sector and providing valuable lessons learned in delivering green growth in local economies.

This study, based on recent interviews with current and completed projects in the EEP Africa portfolio, presents an analysis of selected case studies, highlights an evolution in productive use business models, and identifies some of the key innovations taking place in the next generation of projects and companies combining clean energy and green growth.

Productive use of clean energy is critical to the commercial viability of energy access projects, particularly in rural areas where initial energy demand may be limited. Boosting energy demand reduces the levelised cost of energy and increases the affordability of energy services, thereby stimulating productivity and improving the viability of clean energy solutions.

The productive use of clean energy is also key to achieving the Paris Climate Agreement and the Sustainable Development Goals. Successful socio-economic transformation requires that users are able to take advantage of the opportunities available as a result of the improved energy access (Terrapon-Pfaff, et al., 2018), and that they are able to generate an income from the use of this energy. By stimulating local productivity and job creation, the productive use of clean energy opens up green growth pathways for the poorest households, promoting inclusive and efficient solutions that avert harmful carbon emissions.

The 2019 Sustainable Energy for All (SEforALL) *Energizing Finance* report confirms that global investment in clean energy is not sufficient and that funds are not generally directed to supporting the most energy impoverished. Investment flowing to Sub-Saharan Africa is "alarmingly low" and investment in off-grid solutions and mini-grids are a tiny proportion (less than 2%) of total finance (SEforALL, 2019). This underlines the value of financing mechanisms such as EEP Africa, which support developing countries in driving green growth.

This study presents an overview of the EEP Africa portfolio in relation to productive use, describes the evolution of mini-grid business models and the diversity of stand-alone systems that are stimulating productivity and job creation in rural areas. The study builds its analysis around direct case studies from the EEP Africa portfolio and features projects from Burundi, Kenya, Malawi, Rwanda, South Africa, Tanzania and Uganda.

The study concludes with a look at the way forward, including recommendations on how the clean energy sector can further boost green growth and propel economies in Southern and East Africa toward low carbon, sustainable and inclusive growth pathways.

2. PRODUCTIVE USE OF CLEAN ENERGY IN THE EEP AFRICA PORTFOLIO

Since 2010, EEP Africa has supported 250 projects in Southern and East Africa. Within this diverse portfolio, many projects have generated energy for productive activities and this trend is growing. In the most recent call-for-proposals in 2019, nearly half the applications (48%) incorporated a component promoting productive use in their core project design.

As the focus on clean energy solutions for productive use has increased, EEP Africa has supported early stage innovation with a view towards demonstrating both impact and viability for other investors.

The productive use solutions that have been financed are diverse, ranging from providing solar-powered illumination to community markets to developing biogas-powered mini-grids and refrigeration units. When they were initially financed by EEP Africa, most of the projects (almost 80%) were in a pilot or demonstration phase but many have now become market leaders in productive use.

This study analyses 22 project case studies from the EEP Africa portfolio. Four of these are in active development and 18 are completed. Total EEP Africa financing commitments to the 22 case studies represents EUR 7.2 million with a total project value (including co-finance commitments) of EUR 19.9 million.

The most common technology in EEP Africa portfolio projects which promote productive use has been solar PV mini-grids (Table 1).

Of the completed projects included in this study, a significant proportion (over 40%) were implemented in Tanzania. The legal and regulatory framework in Tanzania has generally been strong in promoting mini-grid development. Licensing and approval requirements are relatively streamlined for systems under 100 kW and it has been possible to apply cost-reflective tariffs but this may be impacted in the future by new regulations being introduced.

The widest range of technologies used has also been in Tanzania (see Figure 1).

Solar PV is frequently used for productive use applications because the cost of PV modules has decreased by over 80% since 2009 (IRENA, 2019). However, a variety of clean energy technologies are being used to meet productive needs. This is due to the minimum generation capacity required for some productive use activities, such as welding (3-7.5 kW). The most common productive activities supported by EEP Africa financing are light manufacturing, agri-processing, illumination and service provision (see Figure 2).

One of the key lessons learned from EEP Africa projects is that growth in rural electricity demand can be both a gradual and a long-term process. Stimulation measures are often required to achieve commercial viability within a feasible timeframe. Increasing demand through productive use of energy is of particular importance to the viability of mini-grids and stand-alone systems designed for productive purposes.

The business models adopted by the developers of EEP Africa projects have evolved to meet these challenges at various points along the value chain. For mini-grids, efforts often focus on identifying a primary offtaker and, especially for solar PV mini-grids, increasing productive use applications during the day to even out the demand curve. For stand-alone systems designed for a particular activity, such as solar irrigation or refrigeration, efforts focus more on addressing barriers to market penetration in the local value chain. This may include scalable modular units that offer flexibility to the end user, as well as innovative financing or payment options.

The next two sections examine successful business models for mini-grid solutions and stand-alone systems. Each business model is then described in case studies from the EEP Africa portfolio.

Table 1: EEP Africa financing for (completed) productive use projects, by energy source

TECHNOLOGY	TOTAL PROJECT COST	EEP AFRICA FINANCING
Biogas	963,652	57%
Biomass	779,598	62%
Hybrid	4,524,838	31%
Hydropower	5,196,160	27%
Solar PV	6,841,968	41%
Solar PV/ biomass	3,478,417	32%
Waste-to-Energy	343,814	62%
Total	**19,889,630**	**37%**

Figure 1: Total project cost, per technology and country, for completed productive use projects

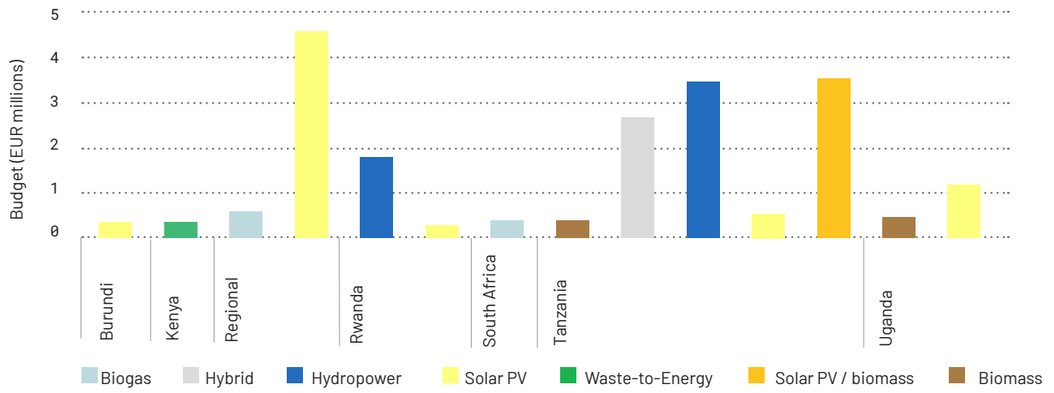
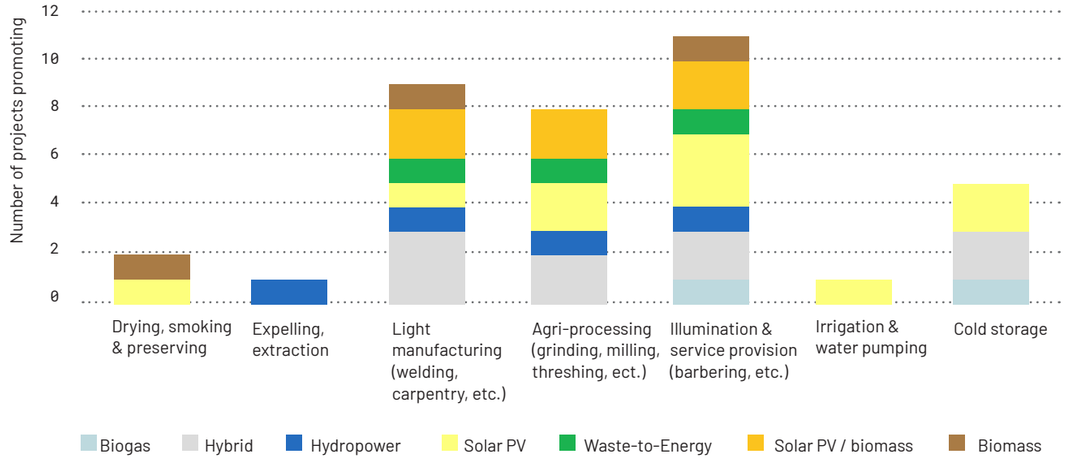


Figure 2: Productive activities supported by EEP Africa financed projects



Women Entrepreneurs Using Clean Energy

The role of women in productive use is evident across the value chain. Women have long been recognised as important end users of energy, but they are also influential in the uptake of energy and in the delivery of services that make use of energy.

Absolute Energy found that 40% of their women customers initiated the subscription for a connection to their household or business. Almost half (49%) of their customers are women who own a business that requires electricity. Women as productive users are particularly represented in the service sector and auxiliary functions, such as retail, hairdressing, food preparation, and tailoring.

Doreen is a customer of Absolute Energy. Thanks to AE's power supply, she opened a hair salon less than 12 months ago and is now an entrepreneur. The distinguishing feature of her business, compared to other hairdressers, is that she is the only one to own and operate a hairdryer, which she acquired from Absolute Energy. "I would like to buy a new hairdryer if possible, I will be the most famous hairdresser in Kitobo."

According to EEP Africa project developers, the engagement of women in productive use of energy is limited due to the following factors:

- Lack of access to finance for capital investment in their businesses
- Lack of management skills to develop and implement a business expansion strategy
- Limited ability to market the products and services they offer
- Cultural norms and personal safety
- Lack of role models

The challenge is that addressing these barriers falls outside the core competencies of most project developers in the energy sector. This increases the importance of partnerships and development financing in incorporating activities to address these barriers in core project designs. In 2019, EEP Africa held a call-for-proposals with the theme of "Promoting Gender Inclusion, Female Leadership and Opportunities for Women across the Clean Energy Sector in Southern and East Africa." The call attracted 285 applications and a combined financing request of EUR 97 million. The applications included a diverse set of innovative business models covering 12 clean energy technologies and 14 countries. Projects financed from this call will be launched in early 2020.

One of the successful applicants in the gender-themed call was Solar Sisters. In collaboration with CLASP, their project, "Unlocking Productive Power Through Women-Led Distribution Networks," will pilot the distribution of high-quality, energy efficient productive use appliances through female sales agents. The project will also provide business development support and upfront financing to local entrepreneurs using their equipment.

Page 13:
A client using the hairdryer outside of Doreen's Salon on Kitobo Island, Uganda.

3. EVOLVING BUSINESS MODELS FOR MINI-GRIDS

The increasing importance of stimulating end-user demand in rural off-grid areas is reflected in the evolution of the business models adopted by mini-grid developers since EEP Africa was launched in 2010.

During the past decade, incorporating provisions for productive use in mini-grid system specifications has become a core feature of project design. But the level of engagement by the energy service provider depends on which model they adopt and where they position themselves in the local value chain.

The evolving business models for mini-grids in terms of productive use can be broadly described as follows:

1. **Energy Supply Model:** The energy service provider produces and supplies reliable and affordable electricity to consumers via a small distribution grid. The mini-grids are designed to accommodate a primary offtaker or to convert existing users from diesel to electricity. Potential primary offtakers are largely linked to local agricultural production and operations are site specific.

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Page 14:
An entrepreneur in Ifumbo, Tanzania uses her new solar fridge system from Devergy to cool drinks, dairy products and food.

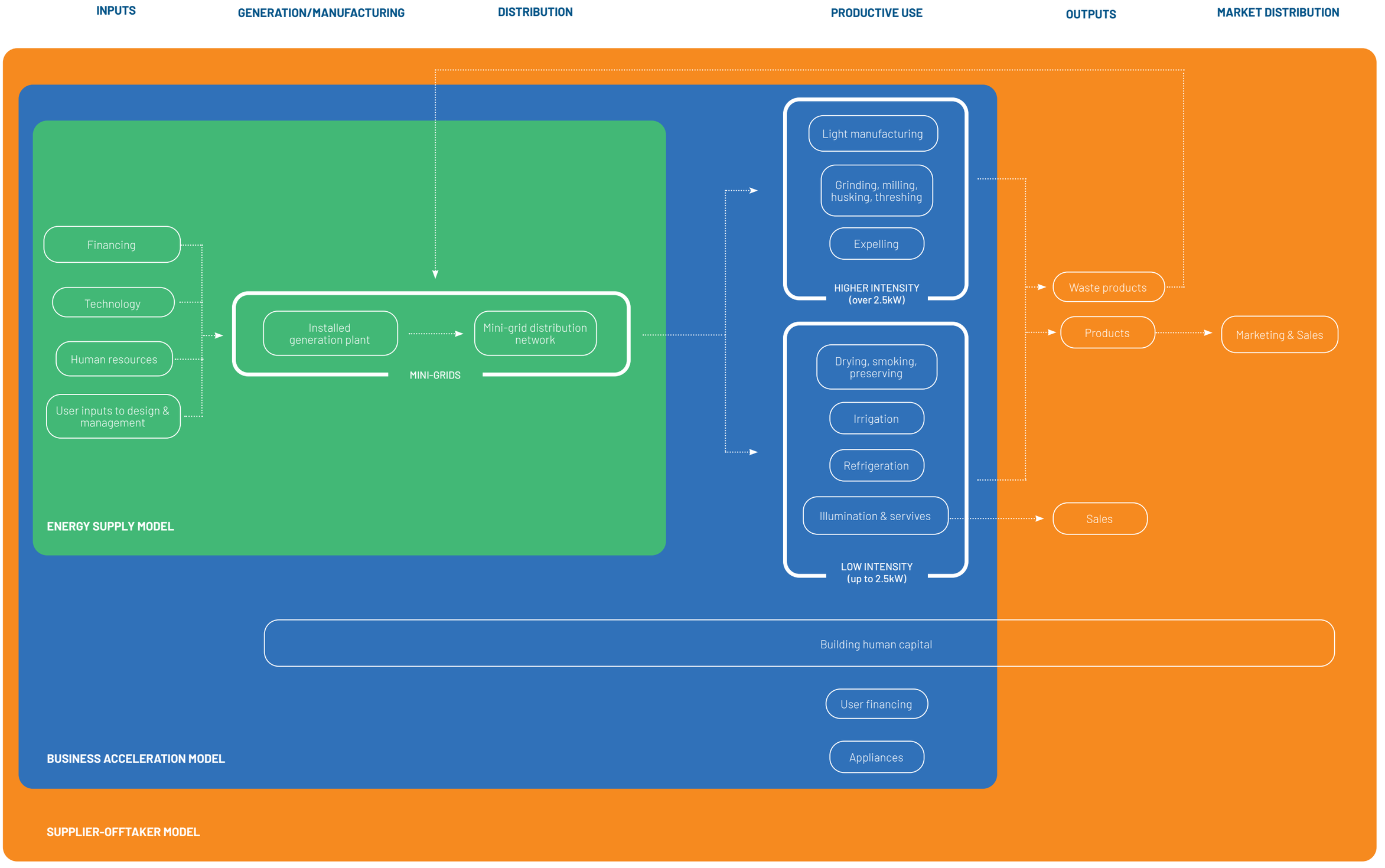


Figure 3: Business models adopted by mini-grid developers at different points in the value chain

3.1. ENERGY SUPPLY MODEL

Mini-grid solutions generally provide grid-quality electricity to off-grid communities in concentrated settlements. Mini-grid operators that adopt the energy supplier business model focus on the first three phases of the value chain (inputs, generation/production, and distribution).

The technology used to generate power and its generation capacity are key to the extent to which productive activities are facilitated. Project developers often report that new users overestimate their future consumption of energy. If systems are sized to meet that ambitious demand, they may not perform optimally. Therefore, it is important to obtain a realistic assessment of demand during the design phase.

The capacity of the system, the power rating of the productive load, and the time of day the equipment is operated often determine whether there is surplus capacity to allow for expansion. The typical demand curve for mini-grids in rural areas peaks after dark, and demand is limited during the day. Balancing the curve and boosting daytime consumption therefore increases revenue without requiring additional investment in generation assets. This is especially important for solar PV mini-grids, as it limits the need for storage capacity or generation back-up. Combining daytime productive use applications with a distribution network that supplies households with electricity after dark, evens out the demand curve across a 24-hour period and optimizes the system's capacity.

Time-of-use tariffs can facilitate the management of the demand profile, encouraging productive uses during the day with an attractive tariff relative to other energy sources, usually diesel. However, not all productive activities occur during the day, so time-of-use tariffs can also suppress demand in certain sectors. This requires the business model to have a degree of flexibility and adaptability to reflect the local context which makes it difficult to standardise one model across multiple project sites.

As defined in a recent EEP Africa study, *Opportunities and Challenges in the Mini-grid Sector in Africa*, the main priority for project developers implementing this model is to identify a primary offtaker. Therefore, developers often link their installation to an existing productive value chain, such as some form of agricultural processing.

For example, Renen Energy Solutions established a biogas plant in South Africa that supplies electricity and heat to a plant nursery, using feedstock from nearby farms and abattoirs. Renen also installed a mini-grid supplying power to a training college on the site. There is a synergy between the activities of the nursery and the biogas plant, as the effluent from the biogas, which is an effective fertiliser, is used in the nursery and can be sold more widely. This fertiliser is a critical revenue stream that contributes significantly to the viability of the biogas solution. As a result of this pilot initiative, Renen has been able to prove its business case and demonstrate the added value of the model to the community. Renen was awarded first prize for a Pilot Green Energy Project and the demonstration site convinced 10 local farmers to commission the design and installation of their own biogas systems.

An effective way to anchor a mini-grid in an existing value chain is through partnerships. Practical Action is currently developing a 300 kW hydropower mini-grid in Malawi in partnership with Mzuzu Coffee, a local association of coffee growers. Mzuzu Coffee will be the anchor client and will co-manage the mini-grid with a Community Trust that will promote productive use among local households and businesses. As a result of the hydropower mini-grid, Mzuzu Coffee will remove the parchment from coffee beans on site, cutting transport costs to the factory by 75% due to the reduced volume of beans. This partnership approach enables both the anchor client and the local community to benefit more widely from the clean energy supply.

For rural mini-grids in the EEP Africa region, productive activities are primarily agriculture and livestock-related and the equipment needed often has a power rating of under 10 kW. However, not all communities produce a commodity that is farmed on a large-scale, such as coffee. As the majority of production is subsistence agriculture, communities tend to process produce that will be consumed locally with the surplus being sold on.

In this context, the business case is easily demonstrated for small businesses converting from diesel to electric power due to lower costs and carbon emissions. The newer motors are more efficient, allowing for higher throughput, and cheaper to maintain. However, cost-reflective tariffs for solar PV mini-grids in particular may be higher than the cost of diesel. This highlights the importance of setting a tariff that is comparable to the cost of diesel, as this is an indication of the willingness-to-pay. Striking the balance between price

Renen Energy Solutions established a biogas plant in South Africa that uses feedstock from farms to power a plant nursery.

tolerance and financial viability can be challenging, particularly if the capital investment costs are high.

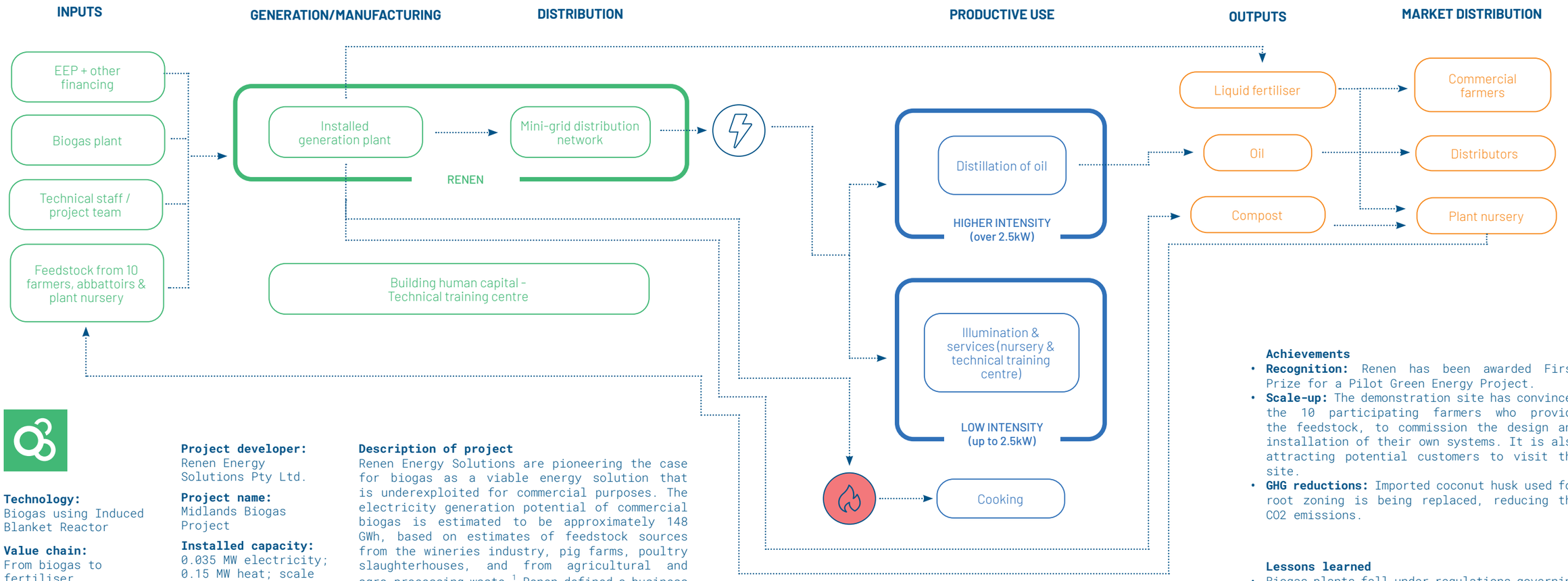
In Tanzania, Powergen has actively promoted the conversion from diesel to electricity for powering maize mills through the development of mini-grids. With EEP Africa financing, Powergen has implemented 18 mini-grids in Tanzania and is in the top three private sector developers of mini-grids, covering seven countries in Africa (ESMAP, 2019). This required a dedicated sales effort that included demonstrations of both the financial and technological benefits of the services. The change-over is made easier when clients have the capital to invest in replacement motors and possess an understanding of the business case. However, some millers are concerned about the investment they have already made in their diesel equipment.

For many companies in the clean energy sector, the quest to achieve commercial viability has required continuous adaptation. REDAVIA has evolved its approach along two lines: mini-grids and direct supply to commercial and industrial customers. REDAVIA began by providing off-grid solar solutions to individual SMEs in Tanzania. However, the limited number of off-grid SMEs with a large enough load, when combined with the need to achieve scale, prompted them to develop village mini-grids. These mini-grid installations have provided reliable energy to communities and achieved positive cash flows at village level. Several years of blended-finance support is required to scale-up to the level of financial performance needed to cover overheads and offer funders a minimal return on capital.

REDAVIA has thus directed its strategy towards the direct supply of electricity to both on and off-grid commercial and industrial customers. In countries where the energy tariff is relatively high and the quality of electricity is poor, it makes sense to augment the off-grid market with on-grid clients to provide a significant anchor load. REDAVIA tested this model in Ghana, supplying over 4 MW to over 15 local agri-processing and manufacturing companies with long-term debt financing that is released on the commissioning of solar farms. This model is now being replicated in Kenya and has secured follow-on financing from the EEP Catalyst window to scale-up this concept.

While its focus on commercial and industrial customers continues to grow, REDAVIA is also continuing to look at how it can further evolve the village mini-grid approach. As enterprise development plateaus, the barriers that prevent continued growth need to be addressed, e.g. access to finance, energy illiteracy and access to appliances. REDAVIA is now considering moving towards the business acceleration model and offering financing for popular appliances, such as maize shellers, maize cob threshers (for the poultry industry), and temperature regulated coffee storage.

RENEN'S MODEL



Technology:
Biogas using Induced Blanket Reactor

Value chain:
From biogas to fertiliser

Country:
South Africa

Project developer:
Renen Energy Solutions Pty Ltd.

Project name:
Midlands Biogas Project

Installed capacity:
0.035 MW electricity; 0.15 MW heat; scale of solutions 0.05 – 1 MW (60% capacity factor)

Description of project

Renen Energy Solutions are pioneering the case for biogas as a viable energy solution that is underexploited for commercial purposes. The electricity generation potential of commercial biogas is estimated to be approximately 148 GWh, based on estimates of feedstock sources from the wineries industry, pig farms, poultry slaughterhouses, and from agricultural and agro-processing waste.[1] Renen defined a business model that links the supply of feedstock for biogas electricity and heat production with the demand of commercial offtakers in the region. With EEP Africa's support, Renen established a project that demonstrates the benefits of biogas solutions in providing reliable electricity and heat for electricity, dairy processing and oil refining. The livestock farmers and abattoirs in the area supply the feedstock for the operations of the plant. The biogas is either consumed or sold. The seedling nursery is a direct customer for the electricity; the technical college students receive piped biogas to their accommodation facilities. The nursery is a direct customer for the compost and fertiliser derived from the effluent, and is considering distributing the compost to their customers after drying and packaging it.

[1] Kemausuor, F, Muyiwa, A & Morken, J. (2018) A Review of Commercial Biogas Systems and Lessons for Africa. Energies 2018, 11(11), 2984; https://doi.org/10.3390/en11112984

Drivers of success

- Identifying a single off-taker and defining system requirements to meet a known demand.
- Knowledge of farming and the resources offered by the farmers helps identify the optimal design. The supply chain for animal or plant waste must be consistent, linked to the operation of the individual farm or surrounding area.
- The quality of the feedstock is closely controlled and monitored.
- The solution requires a diverse set of skills from agricultural management to bio-mechanical engineering. By maintaining a proprietary stake in the facilities, installed in partnership with the farmer, Renen can guarantee the future sustainability of the technology.

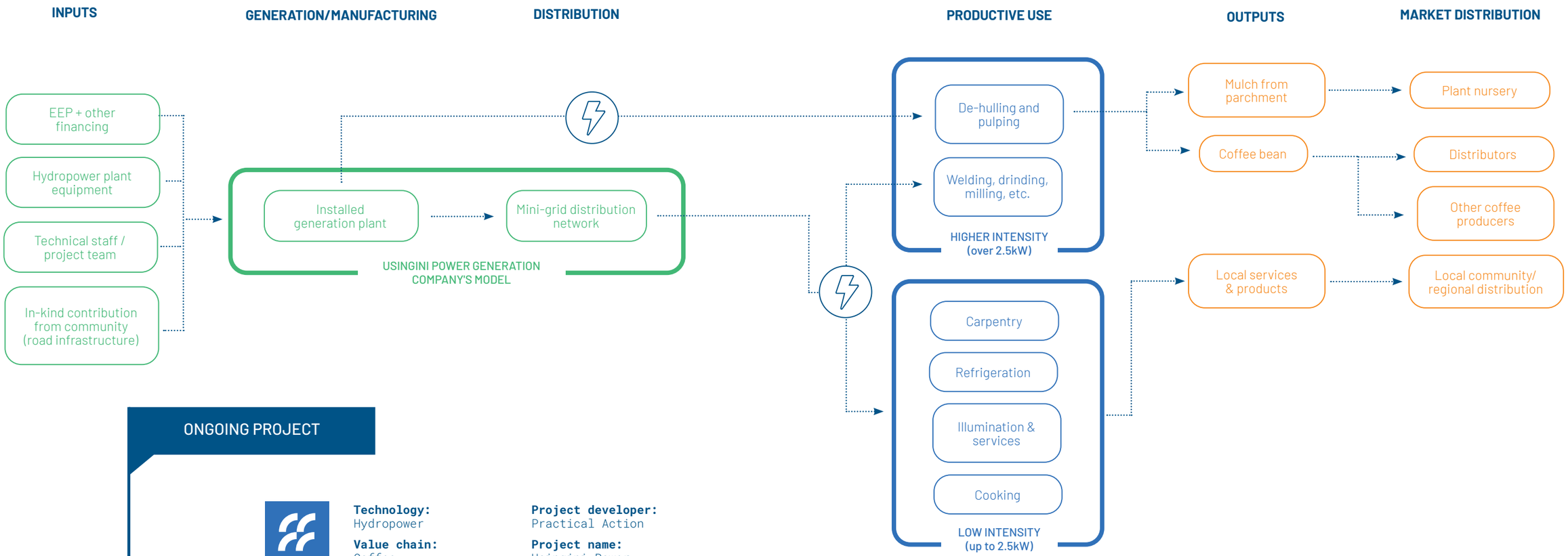
Achievements

- **Recognition:** Renen has been awarded First Prize for a Pilot Green Energy Project.
- **Scale-up:** The demonstration site has convinced the 10 participating farmers who provide the feedstock, to commission the design and installation of their own systems. It is also attracting potential customers to visit the site.
- **GHG reductions:** Imported coconut husk used for root zoning is being replaced, reducing the CO2 emissions.

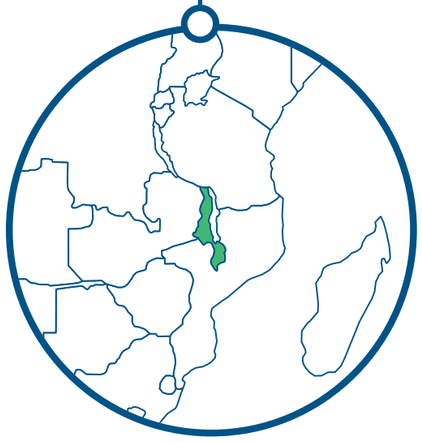
Lessons learned

- Biogas plants fall under regulations governing waste disposal in South Africa, even though these are not relevant to agri-waste. A recent dispensation has been introduced for agricultural waste, but this does not include animal mortality waste.
- The sale of by-products adds significantly to the business case for the biogas solution. The commercial marketing and sale of the fertilisers is critical to offset costs and ensure a financial return. Taking the product to market is challenging and resource intensive. The nursery or farmer associations are the ideal market for the compost.
- Ensuring that technical skills are available and that these skills are maintained is vital. The technical college training facility on site means that the engineers of tomorrow will have the skills to take the technology forward.
- Upscaling the solution is limited by the capacity of the pre-defined machinery which is included in the set configuration.
- The design of the installation is based on an individual farm's setup and needs, which makes investors nervous due to the risk associated with a single customer.

USINGINI POWER GENERATION COMPANY'S MODEL



ONGOING PROJECT



Technology:
Hydropower

Value chain:
Coffee

Country:
Malawi

Project developer:
Practical Action

Project name:
Usingini Power Generation Company

Installed capacity:
300KW

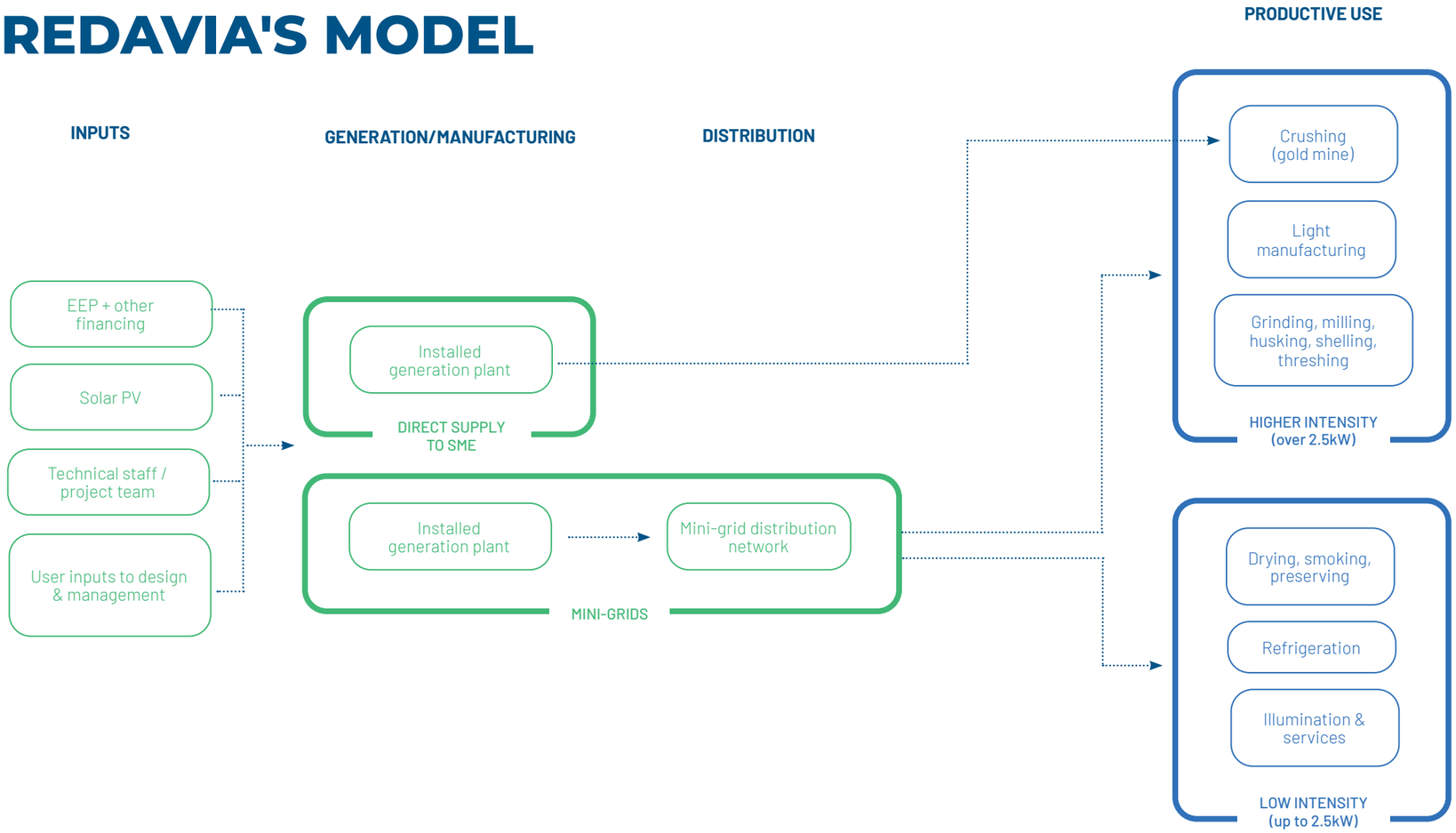
Description of project
The plan is to install a 300 kW hydro-powered mini-grid serving 100 households in Usingini, a remote farming community in Northern Malawi 15 km from the grid. It is projected that 26 business connections (from large commercial farmers to small local business) will be established; the main anchor client, a local coffee cooperative called Mzuzu Coffee, will utilise the electricity for their pulping and hulling machine. Five other large farmers have indicated interest in being connected to the grid to operate their pulping machines. Practical Action has also identified several other productive activities, including irrigation and maize milling, and will conduct a productive uses market assessment to further research the potential of these opportunities.

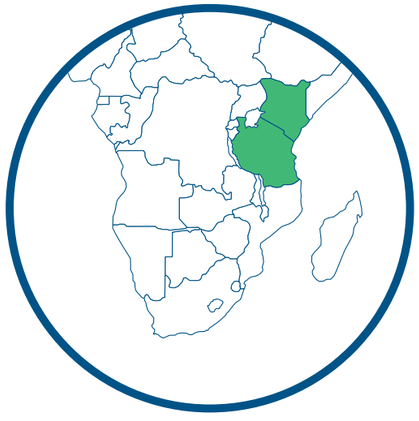
Additionality

- Financial viability: Provides access to energy and stimulates productive use activities in a remote area in a financially viable way through a community owned mini-grid.
- Local job creation: coffee processing on site by Mzuzu Coffee will enhance local employment by creating an additional 50 seasonal jobs to operate the hulling plant.

Expected Impact
The project will demonstrate the financial viability of a micro-hydro scheme with a reliable anchor customer and community ownership. The mini-grid will provide clean energy to local households and businesses. The 300 kW generated electricity will result in EUR 37,000 in household savings and support productive uses such as agro-processing, fish farming and tourism. This will have a wider impact on community livelihoods and improve quality of life in terms of household activities, security, education and health.

REDAVIA'S MODEL





Country:
Tanzania, Kenya

Project developer:
REDAVIA

Project name:
Rental Solar Power For Food Processing in Tanzania

Installed capacity:
3.8 MWp, of which 1.0 MWp in Tanzania

Technology:
Solar units with integrated monitoring

Value chain:
Multiple

Description of project
The concept promoted by REDAVIA is the versatility of a solar farm to provide medium-scale energy infrastructure to on- and off-grid SMEs and off-grid communities. Through EEP Africa, REDAVIA installed two community systems and a system supplying a poultry farm to demonstrate the concept and further refine its business model.

Drivers of success
Mini-grid segment:
- Robustness and reliability of the solar farm technology as well as 24/7 availability of service by the site technicians convinced initially doubtful village customers that solar can power processing machines.
- Including women who are engaged in the value chain through farming, selling or cooking food produce.
- Incentivising energy use in the community, e.g. evaluating a customer's energy and payment profile and making an offer that best suits the customer and REDAVIA.

Commercial and industrial segment:
- Focusing on customer value proposition, including significant cost-savings compared to grid and/or diesel generator power.
- Flexible contract terms and in-country B2B sales teams.

Achievements
Mini-grid segment:
- >500 households and businesses connected supplying power to ~2,600 people.
- Achieved break-even for local operational costs for the mini-grids.
- Received the East Africa Leadership Awards (Green Future Leadership Award) 2019

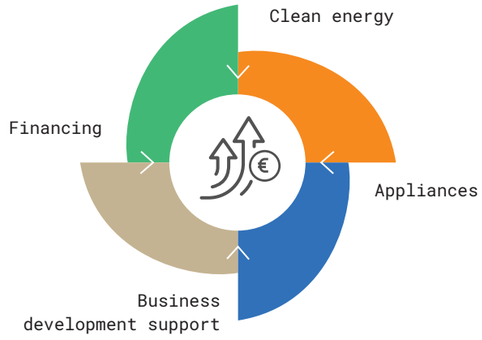
Commercial and industrial segment:
- Built largest SME-solar leasing business in Ghana with 2.8MWp in operation and >50MWp pipeline
- Successfully entered Kenya and built >25MWp pipeline, contracted a first solar lease
- Lowered cost and carbon emissions for local businesses employing tens of thousands of people
- Achieved excellent credit quality and lease payment track-record, raised >$10m debt funding
- Selected for Euronext TechShare pre-IPO programme, positioning REDAVIA to become first-ever "Impact IPO" in the medium term.

Lessons learned
- Because the grid tariff is heavily subsidised in Tanzania, dedicated installation for SMEs has not proven to be very effective. Therefore, the community mini-grids are considered to be more relevant in Tanzania and SMEs are the focus in Ghana and Kenya.
- Supporting farmers to store their produce levels out grinding activities across the year, instead of confining them to just the harvest period. It also means farmers can sell out of season, thereby getting a better price for their produce.
- As enterprise development plateaus, the barriers that prevent continued growth need to be addressed, e.g. limited access to finance, energy illiteracy and access to appliances. This triggered REDAVIA to consider appliance financing and provision of popular appliances, such as maize shellers and maize cob threshers (for poultry industry) and temperature regulated coffee storage.

3.2. BUSINESS ACCELERATION MODEL

Many energy service providers and project developers have realised that facilitating appliance uptake through financing and appliance distribution is instrumental in increasing end use energy demand in rural locations. In the business acceleration model, energy generation is combined with a facility to purchase the equipment and appliances required to utilise the energy. The appliances are sold either on a cash or credit basis, making the appliances more affordable for low-income and bottom-of-the-pyramid customers. In some cases, the sales and financing components are further enhanced by business development support activities.

Figure 4: Key components of the business acceleration model



Recent research performed by the Minigrid Innovation Lab (2019) found that the average revenue per customer increased steadily to 18% above baseline levels 11 months after the introduction of appliances.[2] This indicates that making appliances available addresses some of the challenges of increasing demand and productivity.

The most common appliances bought by small businesses and households in the regions where EEP Africa operates tend to be entertainment-related, mainly televisions and satellite decoders (Minigrid Innovation Lab, 2019; EU, 2019). These appliances do not increase energy consumption significantly, and are primarily used in the evening. It is vital to make available appliances and equipment that have a higher load for productive use. For solar and wind powered systems in particular this may need to be combined with demand management measures to balance the demand curve. Energy efficient appliances increase the range of services provided for the same electricity cost, thereby offering value-for-money, as well as reducing the demand surges that occur on start-up (ESMAP, 2019). Several EEP Africa project developers have implemented this model with varying degrees of success.

Fondazione ACRA, which installed hydropower plants in Lugarawa and Madope in Tanzania, implemented a revolving fund that required the user to contribute 15% of the cost of the appliance in order to release a loan for the remaining 85%. This did facilitate the uptake of appliances but the requirement for a deposit was a barrier to some businesses. The project required businesses to apply for financing through a competitive process, ensuring that they demonstrated business acumen before being provided with the appliance.

JUMEME installed mini-grids in 20 island villages on Lake Victoria, Tanzania. Their customers were required to provide a 15% deposit for appliances and a 15% annual interest rate was applied. The appliances were sourced by JUMEME on request based on local business needs. However, limited business management capacity, as well as poor access to markets for the outputs produced, has led to defaults. New businesses have suggested that a grace period would enable them to build their cash flow based on the new equipment. This highlights the importance of maintaining a balance between financing appliances and the tariffs applied. Rural start-ups lack resilience and are particularly price sensitive (EU, 2019).

The demand for appliances is likely to increase as the cost of productive equipment decreases. A growing number of appliances have a payback period of less than a year (see Table 2). Therefore, the business case for small businesses to invest in appliances, particularly through a financing scheme offered by an energy supplier, is likely to continually improve. This will result in increased daytime demand, allowing mini-grids to increase their load factor to more than 40% (ESMAP, 2019).

EEP Africa project developers have reported that seasonality has a significant effect on consumption and on users' ability-to-pay. As rural communities rely mainly on agricultural produce for their income, the cash flow is often limited outside the harvesting period. As a result, some mini-grid developers are changing their business model to reduce exposure to this risk. Devergy is introducing a "grid-in-a-box", which includes solar PV mini-grid and productive appliances. It targets local diesel generators in rural areas to convert them to solar PV-power. The costs of managing and maintaining the mini-grid will be borne by the local mini-grid operator. With their market insight, operators are likely to be able to incentivise small businesses to connect.

East African Power (EAP) has initiated an Empowering Villages initiative, which will introduce a "business-in-a-box" model. Effectively, fully equipped business units are rented out to provide the services and products needed by the local community. This is accompanied by mentoring and advisory services for business owners to ensure sustainability. EAP intends to begin by identifying existing successful entrepreneurs and providing them with an opportunity to mechanise their operations.

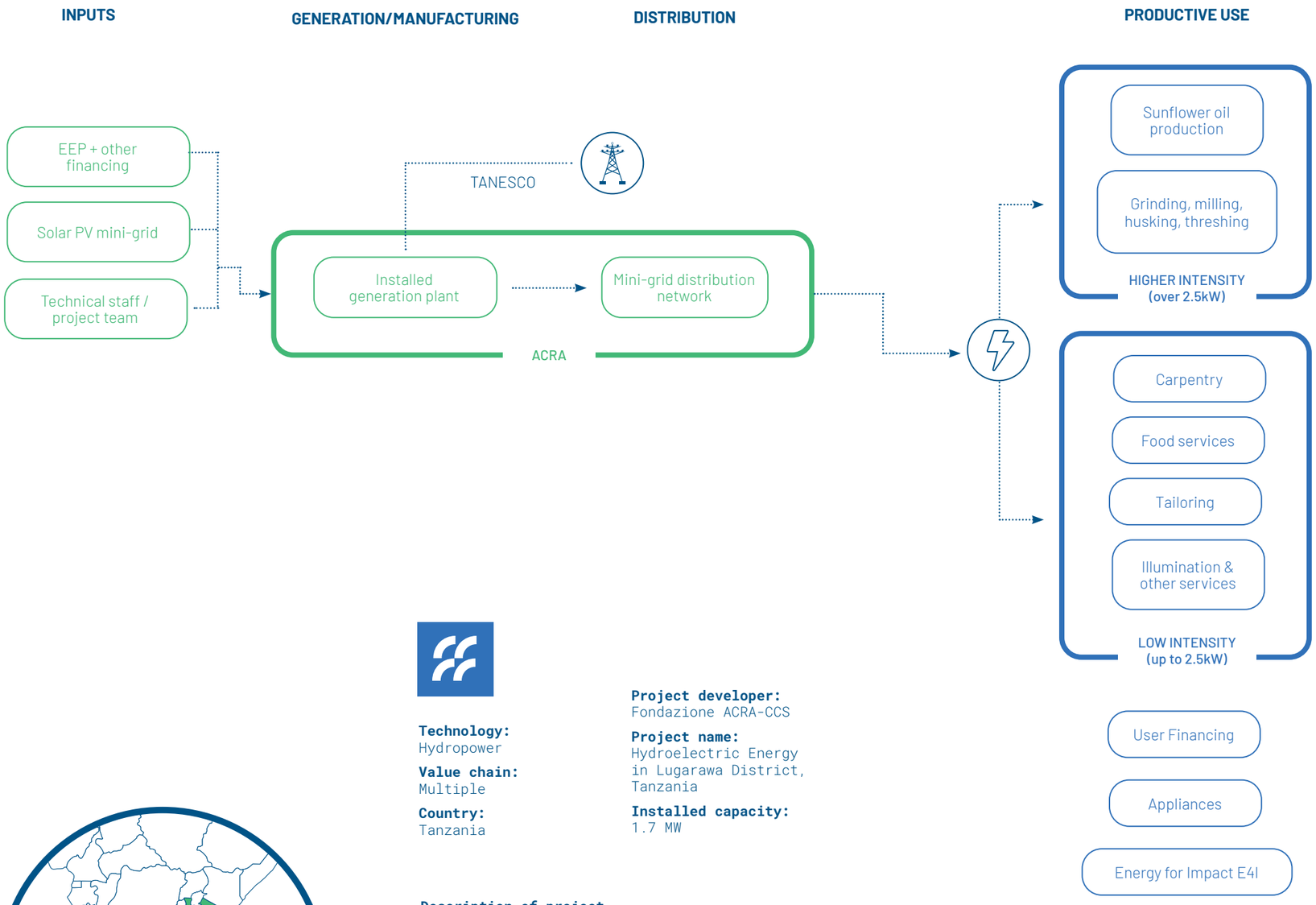
Supporting local business development can have a positive effect on stimulating productivity but it is resource-intensive for project developers. It involves not just facilitating appliance access, but supporting new value chains and market access while also compensating for external drivers, such as seasonality. The skills set needed to effectively implement these business concepts is outside the usual scope of most energy service providers. It requires knowledge of agricultural production, as well as of local community needs. Apart from the resources and skills required, the timelines to achieve scale are testing the boundaries of patience for both project developers and financiers. This has provided the impetus for further innovation and a growing trend toward the third business model: energy service providers are establishing local production or manufacturing to guarantee the anchor load.

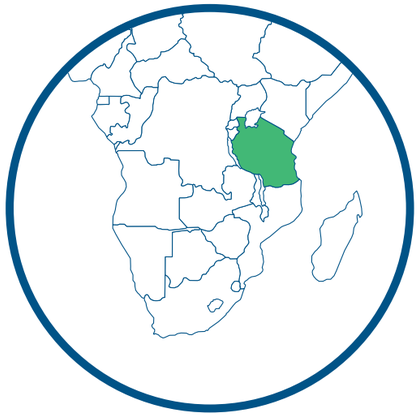
Table 2: Power requirements, costs and indicative payback periods of select productive use appliances. Source: ESMAP, 2019

Sector	Activities / Appliances	Power required (kW)	Cost from supplier ($)	Payback period (months)
Primary industries (agriculture, fishing)	Egg incubator	80 to 160W	$50 to $100	1 to 3
	Grinder for pulses and beans	5.2 kW	$1,500 to $4,000	6 to 12
	Water irrigation pump	3.7 to 22.4 kW	$200 to $1,000	3 to 6
	Sterilizer (for dairy processing)	3 to 6kW	$600 to $2,000	1 to 3
	Packager	250W to 3kW	$500 to $1,000	6 to 12
Light manufacturing	Electronic welding machine	3 to 7.5 kW	$200 to $300	6 to 12
	Jigsaw	400W	$100	3 to 6
	Electric drilling machine	400W	$20 to $50	3 to 6
	Popcorn maker	1.5 to 2.1 kW	$50	1 to 3
Commercial and retail activities	Computer	15 to 100W	$250 to $800	3 to 6
	Printer/scanner for stationery	0.5 to 2kW	$150 to $250	3 to 6
	Sewing machine	200W	$30 to $100	3 to 6
	Television for local cinemas and bars (including decoder)	50 to 200W	$100 to $200	1 to 3

[2] These results were gathered from 24 mini-grid sites in East Africa and did not include the businesses receiving business development support.

ACRA'S MODEL





Technology:
Hydropower

Value chain:
Multiple

Country:
Tanzania

Project developer:
Fondazione ACRA-CCS

Project name:
Hydroelectric Energy in Lugarawa District, Tanzania

Installed capacity:
1.7 MW

Description of project
In its second project with EEP Africa financing, ACRA is developing a 1.7 MW hydro plant in the Ludewa region of Tanzania to take advantage of the abundant water resources to bring clean energy access to rural communities. The plant is designed to electrify 20 villages, including 4,000 households and multiple SMEs. The access to appliances is being provided through a competitive application for grant financing. Local entrepreneurs must describe the business case behind their concept and contribute 15% of the cost of the appliance. Excess production will be exported to the grid.

Drivers of success
- The production of electricity from hydropower mitigates the challenge of limited capacity as there is significant potential.
- The project link to TANESCO provides an additional revenue stream by exporting electricity to the grid.
- The partnership with 'Energy 4 Impact' contributes resources and experience in working with business development in rural areas.
- Commodities produced in the area are in demand outside the region including sunflower oil and timber.

Achievements
- Over 40 productive users have been identified, performing services such as carpentry, welding, sunflower processing, fruit juice processing, nut processing, milling, tailoring, bakery, potato processing, egg incubation, and general retail activities.
- ACRA has entered into an agreement with the Small Industries Development Organisation (SIDO), responsible for industries, business and investment promotion in Tanzania. SIDO provides technical training and capacity-building to SMEs and will provide technical support to SMEs when their businesses are operational.

Lessons learned
- Access to appliances should be built into the project design from the start.
- The appliance financing scheme should incorporate a competitive process that encourages entrepreneurs with business acumen to manage a business but lack investment capital. Apart from the business model, users were asked to demonstrate the value they add to the community and how they have considered the gender and environmental implications of their businesses.
- The ownership model should include key stakeholders in the area to ensure that the project is sustainable. The local user association, the Catholic hospital and the local college all have a stake in the project.

3.3. SUPPLIER-OFFTAKER MODEL

Some mini-grid operators have recognised the potential of going beyond supply and business acceleration to establishing a productive activity in order to provide the anchor load their system needs. Developing a productive activity that supports revenue generation as a core feature of a clean energy project has proven to be effective in rural communities where local economic growth is gradual. This does mean that the project is more capital intensive and the project developers are required to have a diverse skillset across sectors. Pilot projects are being developed to test this model as a means to address weaknesses in the value chain.

Absolute Energy (AE) established a mini-grid on Kitobo Island, Uganda in 2016 and offered credit financing for appliances. Despite initial enthusiasm for a range of activities, the most popular appliances actually purchased were low intensity. Thus the system proved to be oversized (300 kW in total) for the demand. So in 2018, AE decided to boost demand for electricity to make the system more financially sustainable. AE established an ice-making unit on the island to produce ice to order, preserving the fish, and saving six hours of travel time for the local fishermen. Tests are also being carried out on a fish grinder, which produces an ingredient that is used in local recipes and in animal feed.

To reduce investment costs, smart technology is enabling project developers to refine their business concepts to be demand responsive. For example Equatorial Power is able to make hourly adjustments to the electricity they use for ice-making to actively manage demand. This allows for versatility because it is not critical to maintain a continuous cold chain in ice production.

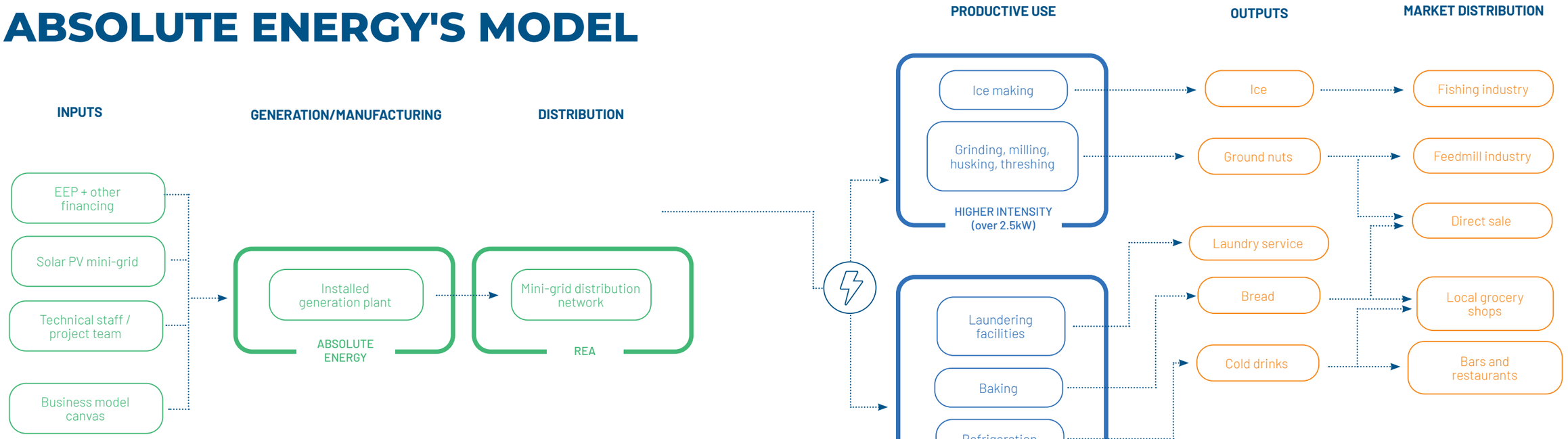
A significant constraint to this business model is that the potential for establishing a productive use is site dependent. However activities such as milling, grinding, and husking can be versatile enough to be adapted to different food crops. Social inclusion, identifying the ways for the community to participate in the value chain, is instrumental to this model.

Pamoja Cleantech designed a closed loop, biomass gasification project. It provides energy services and also processes maize. As a significant offtaker, the maize milling enables Pamoja to be flexible and adjust to demand. Using agricultural waste to generate power, Pamoja processes locally bought maize for immediate sale or to sell out of season when prices are higher. The biochar from this process is blended with manure to provide fertiliser to farmers, which creates an additional revenue stream. The consumption of electricity from the mini-grid has been lower than projected, partly due to local fishing restrictions put in place after the project was designed. Pamoja is therefore also incorporating an appliance financing component that will be accompanied by business development support in partnership with organisations that have experience in supporting rural SME development.

Having experienced similar challenges, JUMEME, which has installed a 60kW solar PV mini-grid on Bwisya Island, intends to develop the tilapia fish value chain. Their "Key Maker Model" effectively creates demand that allows the operator to steadily unlock local potential. At present, JUMEME purchases and transports fish bought from local fishermen to Dar es Salaam but they are in the process of establishing a fish farm. The fish food may be partly produced on the island, with the fish being processed before transport, thereby creating employment and increasing electricity demand. This approach is considered to be more profitable than the direct supply of energy. JUMEME aims to expand the Key Maker Model to other island mini-grids.

Page 31:
Ensol's 48kW solar hybrid mini-grid in the remote village of Mpale (Tanzania) enables local entrepreneurs to keep operating after dark.

ABSOLUTE ENERGY'S MODEL



Technology:
Solar PV

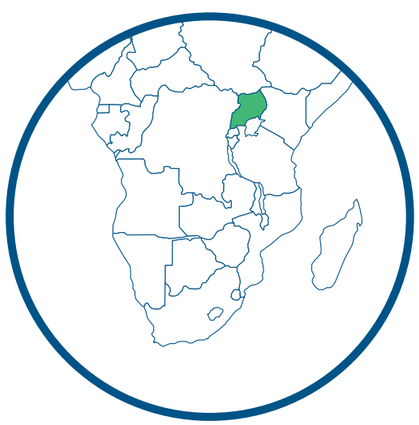
Value chain:
Fisheries

Country:
Uganda

Project developer:
Absolute Energy

Project name:
Sustainable Energy Services for Kitobo Island

Installed capacity:
0.229 MWp with 0.520 MWh storage



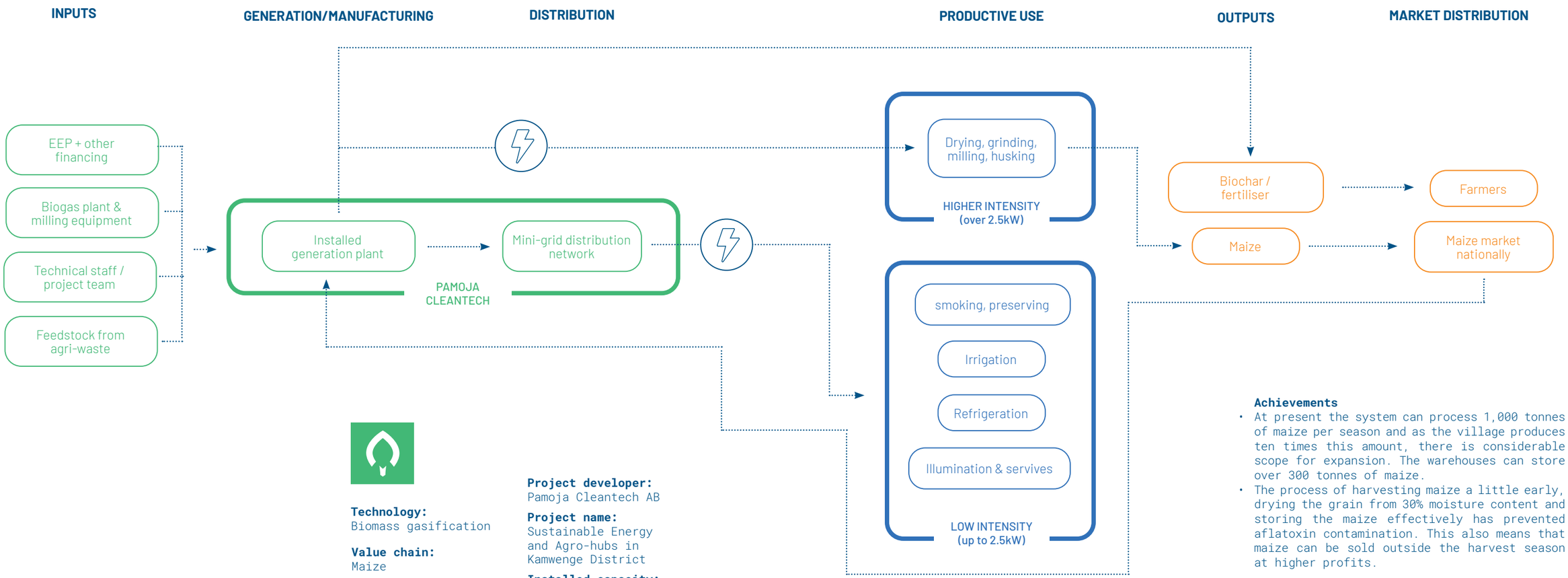
Description of project
Absolute Energy (AE) was drawn to Kitobo Island due to its dynamic economy based on fishing. The mini-grid installed on Kitobo Island in 2016 was designed to specifically cater for the cold chain. The value-chain analysis of the island identified ice-making, groundnut processing, bread making, poultry farming, entertainment, and laundry services as the main productive uses. Business development support was incorporated into the design in partnership with the AVSI Foundation. The appliances available from AE included irons, televisions, fridges, kettles, and washing machines and were provided on credit. Alongside this, capacity development was provided to village savings and leasing schemes. Given the low energy demand, AE established an ice production plant in partnership with a local company in 2018. Ice is produced to order, ensuring that demand can be predicted and at the same time providing an anchor load.

Drivers of success
- By incorporating smart technology and developing technical expertise on-site, the mini-grid can be managed remotely, thus reducing staff costs.
- Providing wiring and meters with the connection has increased uptake and ensured the quality of installations.
- The flexibility of producing ice to order allows the operator to adjust to variable demand.
- The mini-grid business case is dependent on a value chain that is at risk. The Government of Uganda has introduced restrictions on fishing that have affected productivity in the area.

Achievements
- The Kitobo Island installation supplies clean electricity to 543 customers (90% of the potential customers), generating approximately 400 MWh of energy per year.
- New jobs have been created directly and indirectly through the launch of new, diversified businesses.

Lessons learned
- The ice production plant could have been established from the start to de-risk slower than anticipated development.
- Access to markets is a critical factor. Geographic and logistical boundaries have affected the success of the MSME businesses, such as bread making.
- Working with village savings and loans schemes involves local politics; therefore, establishing E-clubs that operate on a similar basis for providing loan schemes has proved to be more effective.
- The local economy is non-diversified, limiting the scope of activities that can be electrified. The appliances that consumers were interested in are context specific.

PAMOJA CLEANTECH'S MODEL



Technology:
Biomass gasification

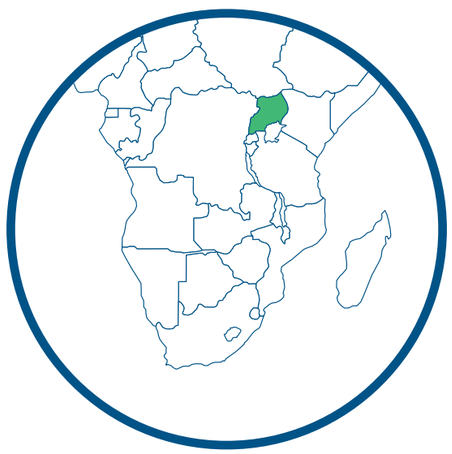
Value chain:
Maize

Country:
Uganda

Project developer:
Pamoja Cleantech AB

Project name:
Sustainable Energy and Agro-hubs in Kamwenge District

Installed capacity:
0.060 MW



Description of project
Pamoja has established one Agro-hub to integrate the mini-grid system into the agricultural value chain. The Agro-hub aggregates, threshes, dries, stores and grinds locally grown maize under a fair price policy. It uses the agricultural waste to power the mini-grid using biomass gasification. The mini-grid supplies electricity to the local village of 562 households, is along the shores of Uganda's Lake George. With follow-on financing from Innovations Against Poverty (IAP), Pamoja plans to establish a business incubation programme, providing training for local entrepreneurs and combining this with a revolving fund for electric appliances. The training will include energy literacy and ways to apply energy to new productive uses.

Drivers of success
- Strong partnerships are required. Pamoja lacked market knowledge on agro-processing and so partnered with an organisation engaged in the maize value chain as a seed provider.
- The tariff model is simple and easy for users to understand, based on either 3-phase or single-phase connections. No connection fee is charged and the installation of basic internal wiring is included in the tariff. There are no fixed charges.

Achievements
- At present the system can process 1,000 tonnes of maize per season and as the village produces ten times this amount, there is considerable scope for expansion. The warehouses can store over 300 tonnes of maize.
- The process of harvesting maize a little early, drying the grain from 30% moisture content and storing the maize effectively has prevented aflatoxin contamination. This also means that maize can be sold outside the harvest season at higher profits.

Challenges and lessons learned
- The concept is site dependent and thus location is important. However, it could be adapted to process other agricultural products, apart from maize.
- Facilitating energy access needs to be accompanied by appliance financing, energy literacy training, and business development support to allow communities to engage and benefit economically from access to electricity.
- Establishing joint venture partnerships and identifying several offtakers reduces implementation risks.

Absolute Energy electrified a remote fishing village on Kitoba Island, Uganda with a solar PV mini-grid. The company also sold appliances and eventually established an ice production plant to generate demand and support the local value chain.

4. OPTIMISING STAND-ALONE SYSTEMS FOR PRODUCTIVE USE

The range of stand-alone systems that use clean energy to power productivity is expanding. The business model for these technologies is also more straightforward because project developers manufacture or source equipment for a specific use. In some cases, the project developer provides financing to end consumers (PAYG) or to a distribution company to encourage equipment uptake.

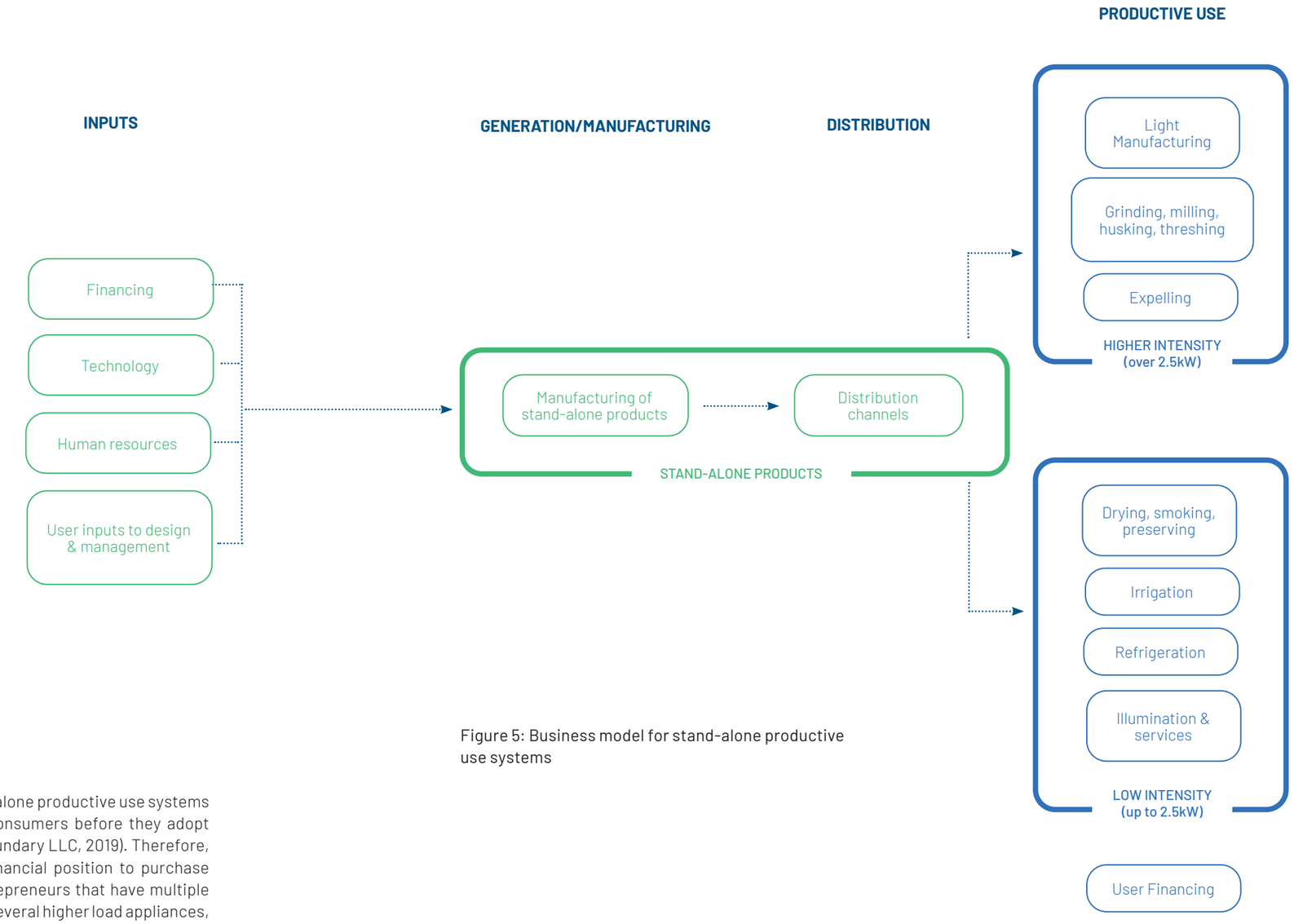


Figure 5: Business model for stand-alone productive use systems

The investment cost for the user may present a barrier, but the technology is targeted to revenue generating activities so the return on investment is often short-term.

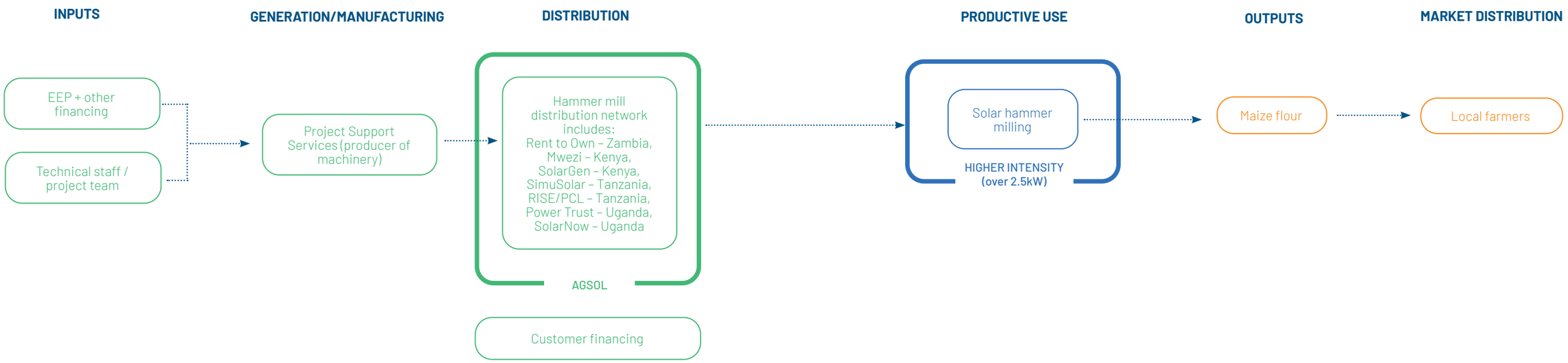
Unlike mini-grids, these systems provide solutions for productive use and are significantly more versatile. The portability of stand-alone equipment makes deployment much less complicated. Within the EEP Africa portfolio, projects have distributed solar water pumps for irrigation and agricultural processing equipment for activities such as milling and refrigeration. The increase in productivity for end users is usually significant. IRENA (2016) estimates that introducing solar water pumping improves revenue generation by a minimum of 47%.

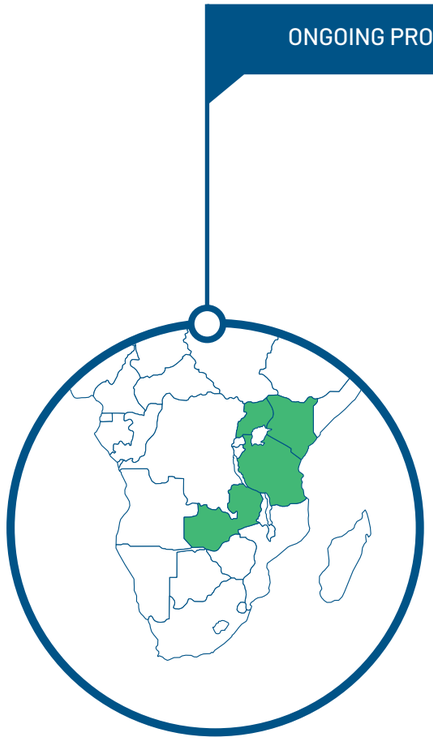
Users that take up stand-alone productive use systems tend to be higher-load consumers before they adopt new appliances (CrossBoundary LLC, 2019). Therefore, they are in a stronger financial position to purchase equipment. Existing entrepreneurs that have multiple businesses tend to have several higher load appliances, and are able to see the value in investing in more energy efficient equipment (EU, 2019).

SunCulture has become a market leader in solar irrigation since it first received EEP Africa financing (see Box 1). One of the newest projects in the portfolio, by Celfre Energy, plans to bring solar-powered water pumps to farmers in Zimbabwe's challenging market. The Celfre portable unit can pump one litre per second and has a USB port for phone charging.

A PAYG model is being introduced to enhance accessibility, particularly for women and youth. Another project developer, Agsol, aims to improve the efficiency of milling in four countries with its solar-powered, high-speed hammer mills. Agsol accesses new markets through local partners and provides financial, technical, sales and marketing support to them. Customer financing is also incorporated, thereby addressing a gap in the value chain for equipment financing.

AGSOL'S MODEL





Technology:
Solar milling

Value chain:
Maize

Country:
Kenya, Tanzania, Uganda, Zambia

Project developer:
Agsol

Project name:
Solar Mills: Powering Rural Productivity

Installed capacity:
0.43 MW

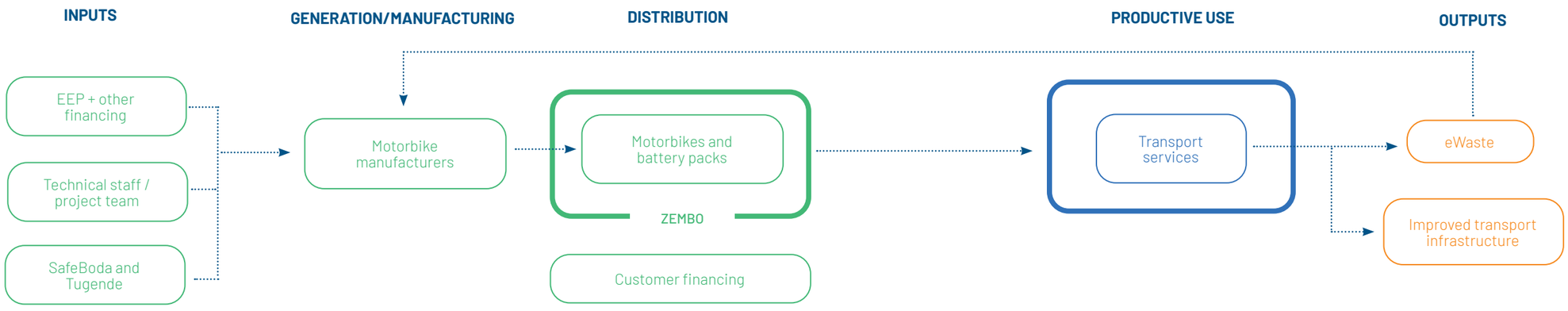
Description of project
Agsol is a manufacturer and distributor of solar-powered, high-speed, brushless DC motor-powered hammer mills for processing maize or other cereals for flour or animal feed in off-grid farming communities. Its latest model (GEN2) has been specifically adapted for local maize milling in East Africa and the company is distributing 570 GEN2 mills. With a minimum power capacity of 800W, each machine provides grid quality energy access to end consumers. Agsol is planning to distribute the machines through local distribution partners (starting in Kenya, Tanzania and Uganda), and will provide financial, technical and sales & marketing support to these partners.

Additionality

- **Providing value for money:** Agsol's mills are designed to serve small farming communities of 50-300 households and return payback within 2 years. This is compared to >4 years for a diesel mill. Mill owners benefit from a profitable milling business, other business opportunities (e.g. trade store, barber shop), and access to power. Furthermore, money stays within the community.
- **Time savings for users:** Customers benefit from having convenient access to milling and energy services close to their homes.
- **Better efficiency:** Agsol's DC machines have efficiency gains well over 50% compared to an equivalent sized AC machine.

Expected Impact
The project aims to sell 570 solar mills in four countries, providing 45,000 rural households with access to renewable energy and a tool for economic growth. The machines improve agricultural processing and enable other commercial activities. This generates income savings and boosts labour efficiency, which has broad socio-economic benefits for rural communities, especially for women and girls.

ZEMBO'S MODEL



ONGOING PROJECT

Technology:
Solar PV electric mobility

Value chain:
Transport

Country:
Uganda

Description of project
This project aims to replace polluting motorcycle taxis (boda boda) in Kampala with solar-powered electric models selling them by PayGo. Zembo has designed electric motorcycles that can be recharged at solar PV stations through a battery swap model (a discharged lithium-ion battery against a charged one). The motorcycles are low cost to operate and are sold as lease-to-own, thus increasing the drivers' revenue. With EEP Africa financing, Zembo will launch 200 electric motorbike prototypes and construct 10 solar charging/battery swap stations in Kampala to pilot and validate the technology and payment solutions.

Project developer:
Zembo

Project name:
Sustainable and productive solar motorcycle for Africa

Number of motorbikes:
200

Additionality
- **PayGo principles:** Boda boda riders will be able to acquire electric bikes through a lease-to-own model over 1.5 to 2 years. This enables the boda boda drivers to become the owner of their asset and improve their revenue.
- **Battery swap:** The investment cost of the battery is higher than the bike, which the drivers cannot afford. The battery swap scheme includes the electricity required for charging and the battery's amortization.
- **Increased income:** The cost of services will be equivalent or less than petrol. The service allows drivers to offer competitive charges and reduces overheads once the vehicle is paid off.

Expected Impact
The project provides an alternative to the large fossil fuel-based "boda-boda" market, which is a major contributor to pollution in African cities. During the pilot phase, the switch from fuel to battery power will reduce 350 tonnes of CO_2e emissions and decrease fine particle emissions and noise pollution. The battery swap model will maximise the use of each battery and ensure they are properly recycled at the end of their life. The project will bring significant cost savings and revenue creation to taxi drivers. It will also create new jobs, especially for youth, as the motorcycles are assembled in Uganda.

The Impact of SunCulture

SunCulture's solar-powered water pumps can pump up to 2,500 litres per hour from wells, rivers, or dams. This enables farmers, who traditionally rely on rain-fed agriculture, to take control of their environment. Irrigation increases agricultural productivity by increasing crop yields by 2-5 times and dairy outputs by 1.5–2 times. It also enables farmers to cultivate more land, grow higher-value crops, and grow during the dry season. As a result, SunCulture's customers can see their incomes increase 5-10 times.

SunCulture's systems can also power household energy needs, such as phone charging and lighting, and use localised weather data to generate recommendations for farmers. SunCulture's flagship system costs EUR 1,100 and can be paid over 30 months using "Pay-As-You-Grow" financing. SunCulture is working to make their products more affordable. They recently launched a version of the system which excludes energy storage and provides daytime water pumping for a reduced price of EUR 550 over 18 months. Support from the government and development financiers is vitally important to de-risk the pump financing and potentially provide subsidies, as many governments do for on-grid electricity in the region. In Kenya alone, scaling solar irrigation to the total addressable market would feed 2.7 million food-insecure people and add EUR 1.5 billion to GDP (CrossBoundary market survey, 2019). Helping more smallholder farmers access this technology would significantly contribute to efforts to leave no one behind.

2x-5x

Increase in yields

1.5x-2x

Increase in milk production

5x-10x

Increase in income

17 hours

Saved from fetching water weekly

5. POWERING GREEN GROWTH: WAY FORWARD

EEP Africa financing has been the catalyst for innovative business models that address energy needs and drive productivity across Southern and East Africa. Project developers are increasingly integrating innovative measures to stimulate the productive use of energy to achieve financial sustainability. In combination with the right resources, financing and access to markets, this approach to clean energy generation can significantly boost green growth and position local economies to grow at pace and scale while avoiding fossil fuel-based greenhouse gas emissions.

Declining technology costs and expansion of distributed energy solutions and business models further support this trend and are rapidly opening up viable green growth pathways to households across the region, in particular poor, rural and off-grid households.

In the case of mini-grids, appliance financing appears to boost electricity demand and productive activity. Smart technologies then enable project developers to respond flexibly to real-time demand as it develops, reducing capital investment costs. Establishing production facilities has proven to boost revenue generation for EEP Africa developers, increasing the flow of produce and creating jobs in local communities. Despite these successes, the model is site specific and requires significant resources and skills. To further develop the pathways for green growth in local communities, financing mechanisms to support affordable energy access need to be combined with small business loans and skills development. Partnerships are effective in mobilising targeted assistance to ensure that start-up businesses don't just survive but thrive.

Companies are developing exciting innovations in stand-alone solutions that address specific productive activities. By designing lower cost solutions and removing expensive components, such as battery storage, the market for productive equipment is reaching lower-income users. The focus on agricultural production reflects the predominant economic activity of rural areas in the EEP Africa region. There is also growing market potential to consider clean energy for productive uses in areas such as transport, both urban and rural, thereby overcoming a significant barrier to green growth and unlocking a wide range of sectors.

Increasing access to the tools that boost productivity is key to unlocking the productive use of clean energy. From the point of view of project developers, there is a significant and still untapped market at the bottom of the pyramid. Companies are working to develop and refine clean energy and productive use products and solutions to align with the purchasing power and specific needs of poor and underserved households.

Financing mechanisms are required to reduce the cost for low-income end users until the cost of technology reaches the levels of affordability that solar home systems have attained. In the meantime, they may require innovative financing mechanisms, such as blended finance, or versatile models of ownership, such as shared schemes.

Innovative business models and financing mechanisms that promote the productive use of clean energy are driving green growth across Southern and East Africa. By supporting projects that are developing methods to reach the poorest households while still working towards financial viability, EEP Africa is helping to ensure that new green growth paradigms are inclusive and sustainable.

By supporting project developers as they increasingly integrate innovative measures to stimulate the productive use of clean energy, EEP Africa is also supporting the shift beyond merely addressing energy access toward driving sustainable productivity, jobs and growth in local economies. The case studies and pioneering project developers featured in this report demonstrate how it is feasible and commercially viable to leverage clean energy and shift economies onto green growth pathways delivering sustainable, inclusive economic growth while reducing and avoiding fossil fuel-based greenhouse gas emissions.

Scaling up clean energy driven green growth and continuing to finance and support early stage innovations will be critical for sustaining this progress and achieving the objectives of the Paris Climate Agreement and the Sustainable Development Goals in the years ahead.

Recommendations

Driving green growth:

- **Expand early-stage financing to test productive use applications and innovations:** To boost the transition to clean energy that will drive green growth for poor and vulnerable communities, significantly more financing and investment is needed for projects that target the productive use of energy to test and innovate approaches and technologies.

- **Support the potential for productive use throughout the value chain:** Identify potential offtakers and productive use activities in all sectors of local development. Incorporating some element of value added processing provides the opportunity for users to increase revenue generation, as well as increasing their electricity demand.

Facilitating green growth:

- **Adapt project design to the local context:** Develop the baseline and conduct an assessment of the financial and human capital of local MSMEs and potential productive use value chains before electricity arrives. Reflect the gradual growth of productive activities in demand projections, scaling the system up as peak demand approaches installed capacity. Observe how user-demand evolves before introducing a range of appliances to ensure that the appliances are relevant and add value.

- **Address the impact of tariffs and demand management on productivity:** Based on the price sensitivity of rural customers, consider a strategy for achieving scale without surpassing the limit of affordability. Evaluate whether the demand-side management, such as variable tariffs, is likely to facilitate or hinder energy intensive activities.

- **Incorporate innovative financing mechanisms for appliances:** For productive use appliances, financing options can extend beyond the standard pay-as-you-go model. Incorporating a grace period for the repayment of loans would allow start-up businesses the opportunity to develop their cashflow.

- **Commit to long-term business development support:** Business development support for local entrepreneurs is essential and should be provided for extended periods. Flexible business models should be encouraged to allow companies to expand or contract their services based on actual demand, particularly in off-grid areas. Support should also include help in accessing markets.

- **Develop partnerships to draw on institutional strengths:** Tap into the knowledge base to develop solutions that move the sector forward. Collaboration with technology suppliers, other developers, knowledge brokers, and renewable energy associations, can offer vital support. Select partners that have experience in running businesses in rural areas, potentially through local business networks.

Promoting inclusive green growth:

- **Strengthen the role of women and youth as agents of change in productive uses:** Consider a gender nuanced approach to promoting productive uses. Identifying women and youth who are driving agricultural production and empowering them with knowledge and financing them to grow their business will demonstrate to other women that boundaries can be broken.

- **Expand financing mechanisms that facilitate productive use and clean energy affordability for the bottom-of-the-pyramid:** Donors and governments should increase support to innovative, blended, results based financing mechanisms to enhance access to and affordability of clean energy technology and productive use appliances for the poorest households.

ABOUT EEP AFRICA

The Energy and Environment Partnership Trust Fund (EEP Africa) is a clean energy finance facility managed and hosted by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF. It is guided by a vision for a climate resilient, zero-carbon future with the aim of contributing to achievement of the Paris Climate Agreement and Sustainable Development Goals (SDGs). The immediate objective is to enhance clean energy access, development and investment, with a particular focus on benefitting vulnerable and underserved groups.

EEP Africa provides early stage grant and catalytic debt financing for innovative clean energy projects, technologies and business models in Southern and East Africa. Since 2010, EEP Africa has committed more than EUR 70 million to 250 pioneering projects, creating over 8,200 jobs, improving energy access for more than 5 million people, and avoiding 1.4 million tonnes of CO2e. EEP Africa focuses on three core activities:

Clean Energy Financing: EEP Africa channels funding through two windows. EEP Innovation provides early stage grant financing to projects in active development through competitive, open calls-for-proposals. There have been 15 calls since 2010. EEP Catalyst is the Fund's impact investing window providing flexible, follow-on debt financing to successful EEP Africa grantees.

Investment Facilitation and Business Development Support: EEP Africa improves the investment readiness of projects through targeted business support services and by facilitating linkages with the investor community. EEP Africa regularly organizes Investor Forums, an invitation-only matchmaking event offering investors access to a pipeline of investable clean energy projects.

Knowledge, Policy and Partnerships: EEP Africa leverages the large amount of applied learning that occurs inside its diverse project portfolio to develop a wide range of knowledge products that advance clean energy understanding and awareness. EEP Africa regularly organises Knowledge Exchange Forums (KEFs) - open events that bring together clean energy stakeholders for discussions on trends, experiences and lessons learned.

ABOUT THE PARTNERSHIP

HOST INSTITUTION

The Nordic Development Fund (NDF) is both Fund Manager and funding partner for EEP Africa and led the relaunch of the initiative as a multi-donor trust fund in 2018.

NDF is a multilateral development finance institution established by the governments of Denmark, Finland, Iceland, Norway and Sweden and focusing exclusively on climate change and development, primarily in low-income countries. Headquartered in Helsinki, NDF deploys flexible, catalytic financing for climate change mitigation and climate adaptation in Africa, Asia and Latin America.

FUNDING PARTNERS

The Austrian Development Agency (ADA) is the operational unit of Austrian Development Cooperation and has supported EEP Africa since 2010. ADA's goals prioritise reducing poverty, ensuring peace and contributing towards conservation of the environment with particular emphasis on gender equality and climate protection. ADA's focus themes, such as the water-energy-food security nexus and private sector development, are strongly supported by EEP Africa.

The Ministry for Foreign Affairs of Finland administers the ODA budget of Finland and led EEP Africa from 2010-2017. Finland's development policy supports eradication of poverty and inequality and the promotion of sustainable development with particular focus on strengthening the rights of the most vulnerable, promoting gender equality and improving climate change preparedness and mitigation. Enhancing energy access is a key component in reaching these goals.

LIST OF FEATURED PROJECTS

Many projects in the diverse EEP Africa portfolio have conducted activities to support the productive use of clean energy. This study examined 22 projects, 18 completed and 4 on-going, which had a primary focus on promote productive use of energy.

Country	Lead developer	Project description	Technology
Burundi	Gigawatt Global	Off-grid mini-grid in rural Burundi	Solar PV
Kenya	Sanergy Limited	Waste-to-energy mini-grid providing electricity to SMEs in slums	Waste-to-Energy
Malawi	Practical Action	300kW hydro mini-grid supporting coffee production and distributing electricity to households and SMEs	Hydropower
Regional	PowerGen Renewable Energy East Africa Limited	Scale-up project installing 110 AC micro-grids between 3 and 6 kW.	Solar PV
Regional	SNV Netherlands Development Organization	Pilot project launching a biogas-powered milk chilling (BMC) systems, providing smallholder dairy farmers an affordable and reliable off-grip cold storage.	Biogas
Regional	SunCulture Kenya Limited	Scale-up project providing solar PV irrigation systems to 450 farmers.	Solar PV
Rwanda	East African Power Ltd / Practical Action	300kW run-of-river power mini-hydropower	Hydropower
Rwanda	Neseltec LTD	35kWp solar micro grid providing access to clean energy to 40 small local businesses and 140 households	Solar PV
South Africa	Renen Energy Solutions	Biogas combine heat and power plant producing effluent used as an input into the local agricultural value chain	Biogas
Tanzania	Energy 4 Impact	Solar hybrid mini-grid operated by JUMEME, providing appliance financing and business development support	Hybrid
Tanzania	Fondazione ACRA-CCS	1.7 MW hydropower mini-grid supplying 20 villages in Ludewa, including appliance financing	Hydropower
Tanzania	Ensol Ltd	Solar-hybrid micro-grid supplying more than 250 households, community and productive services	Hybrid
Tanzania	Husk Power Systems	Ten 32kW biomass micro-grids distributing electricity to 80 trading centres	Solar PV/ biomass
Tanzania	Continental Energy Corporation	Solar biomass mini-grid promoting productive use of energy	Solar PV/ biomass
Tanzania	ONGAWA	Demonstration project based on rice husk gasification (32 kW) to 15 SMEs	Biomass
Tanzania	Redavia	Solar farms and village mini-grids aimed at supplying on and off-grid commercial and industrial activities	Hybrid
Tanzania	Devergy East Africa Ltd.	Solar mini-grids for the promotion of productive uses	Solar PV
Tanzania	Agsol	Solar agro-processing equipment specifically targeting off-grid farmers	Solar PV
Uganda	Absolute Energy Servizi S.r.l.	Solar smart mini-grid supplying SMEs; includes production of ice	Solar PV
Uganda	Pamoja Cleantech AB	Biomass agro-hub for sorting, drying and processing maize for on-sell; bio-char by-product feeds back into the hub	Biomass
Uganda	Zembo	Solar powered electric motorbike taxis and 10 solar charging/ battery swap stations	Solar PV
Zimbabwe	Celfre Energy	Solar water pumps to support climate adaptation and boost agricultural productivity	Solar PV

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