CESET
Community Energy and the Sustainable Energy Transition in Ethiopia, Malawi and Mozambique

An Overview of Community Energy Systems in Malawi

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List of Abbreviations

MAREP	Malawi Rural Electrification Programme
MRA	Malawi Revenue Authority
EASE	Energy Access via Social Enterprise and Decentralisation
CES	Community Energy Systems
SE4RC	Sustainable Energy for Rural Communities
GoM	Government of Malawi
CARD	Churches Action in Relief and Development
CEM	Community Energy Malawi
CEOSC	Community energy service companies

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1.0 Introduction

Malawi has a low national electrification rate which is estimated at 12% the lowest rate captured in the SADC region. The current total installed electricity generation capacity in Malawi stands at about 520 MW comprising of about 390 MW of hydropower (EGENCO, n.d.), and a total of 129 MW of diesel generators for peaking. Malawi has also implemented solar projects, a total of 1.3 MW on Likoma and Chizumul island; and 60 MW in Salima under commissioning tests feeding into the national grid. According to (UNIMA, 2010) at least 98% of Malawians use biomass for cooking: charcoal accounting for 7%; and firewood at 91%.

The Malawi National Energy policy supports the implementation of various energy systems which involve communities in community energy planning and implementation with an aim of increasing access to clean and affordable energy for the low-income households. These energy systems include solar, wind, and small hydro power (GoM, National Energy Policy, 2018). By definition, a Community energy system can be defined as set-up of decentralised energy supply for utilisation by community groups; and wholly or partially owned/controlled by the community.

A number of energy system implemented across Malawi have helped and proved to reduce energy challenges faced by eradicating energy poverty in various rural communities. These energy systems have provided feasible energy options for low-income households through the energy kiosks and minigrids. These implementation experiences have fostered a view that community energy systems will foster an energy transition from the traditional biomass use to other clean and sustainable energy options.

This paper provides an overview of various energy systems implemented by different organisations across Malawi, which are locally managed by communities. The data used in this paper was collected through interviews, project presentations from project developers, and online literature. This report is a supporting document to the Malawi CES inventory database which has been developed capturing every single community energy project in Malawi. This is a live document and is subject to regular updates as new data relevant to the CESET project in Malawi becomes available.

2.0 Community Energy Projects in Malawi

Name	Energy Source	Region	Location/District	CES Status	Year of Commissioning	CES /Capacity	Number of direct beneficiaries (Households)	Activities	Project's Natural History	Maintenance provision?
Luafwa Minigrid	Hydro	Northern	Nkhatabay	Active/Running	2018	40kW	200 households	Agro processing such as maize milling, coffee processing and irrigation and also for domestic use	The luwafu micro grid is co-financed by YALI Grants of the American Embassy and Turbines Development Enterprise and it came into active in March 2018. The received funding has been used for the design, manufacturing and implementation of the project. However, there still a need to raise funds in order to build the transmission grid to bring electricity to the community.	Yes, by using the revenue generated
Kavuzi Enviro-Energy Minigrid-(Mchezi community hydroelectric power plant)	Hydro	Northern	Nkhatabay	Close to completion	Unspecified	60kW		Electricity that will be used for cooking, lighting, refrigeration and other income generation activities through the productive use of energy approach	The system was implemented by the community with the idea of reducing the cutting down of trees and transition to the use of clean energy to meet their energy needs. However, the project has been funded by the GEF, small grants program and UNDP. Developed by MTESO (Media and technology society of youth) and designed and manufactured by TURBINES ENERGY and MZITI (Mzuzu Institute of Technology and Innovation)	Yes, by using the revenue generated
Lujeri hydro	Hydro	Southern	Mulanje	Active/Running	1930	8.5MW	Unspecified	Used by the estate to run its machines and supply electricity to workers houses within the farm/industry	The system has been installed by the Lujeri Tea Estate to provide electricity for its domestic use and supply the excess to the grid	Maintenance is done by Lujeri Tea Estate
Elunyeni Minigrid	Hybrid (Solar & Wind)	Northern	Mzimba	Not Active/Failed	2012	20kW	150	Lighting, charging phones	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Mdyaka	Hybrid (Solar & Wind)	Northern	Nkhatabay	Not Active	2012	20kW	150	Lighting, charging phones, barbershops	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Mtengo Wamthenga Minigrid	Solar	Central	Lilongwe	Active/Running						

Chigunda	Hybrid (Solar & Wind)	Central	Lilongwe	Not Active	2012	20kW	150	Lighting, charging phones, barbershops	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Kadambwe	Hybrid (Solar & Wind)	Central	Ntcheu	Not Active	2012	20kW	150	Lighting, charging phones, barbershops	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Kadzuwa	Hybrid (Solar & Wind)	Southern	Thyolo	Not Active		N/A		Lighting, charging phones, barbershops	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Chitawo	Hybrid (Solar & Wind)	Southern	Chiradzulo	Not Active				Lighting, charging phones, barbershops	This was one of the six solar village projects implemented by the government however with time the energy systems failed to sustain themselves due to poor technical and maintenance in additional, the community participation during implementation was limited, an inadequate tariff system was implemented which was one of the contributing factors.	
Matandani Adventist Mission Minigrid	Hydro	Southern	Neno	Not Active	1950	28kW		Lighting, charging phones, barbershops	The plant was built by missionaries, apparently in the 1950s and operated for more than 30 years. It has a head of about 40 metres driving a turbine connected to a 28 kW alternator by a belt drive. During its working life, it provided electricity for a primary and secondary school, with a total of about 700 pupils and staff, and a maize mill and carpentry workshops at the school. It also served the Neno Trading Centre which now has a rural hospital, police station, post office, and government offices for agriculture, forestry, health, education and social welfare. The project failed due to lack of maintenance	No
Likoma Mingrid	Solar diesel hybrid	Northern	Likoma	Active/Running		1MW		Shop Lighting, Charging phones, barbershops Maize Milling, Refrigeration,	The system was installed by EGENCO as a project to a solution to solve power challenges faced by the district.	Operations and Maintenance management is done by the Electricity Generation Company of Malawi

Sokola school Micro Grid	Solar	Northern	Chtitpa	N/A	2019	6.6kW	250 students	Lights and providing energy to run computers, printers and TV screens.	The system installed was as the result of donations/funded by African Mini Grids	Data lacking
Makanjira Solar project	Solar	Northern	Mangochi	Active/Running				Data lacking	Data lacking	
Usingini Minihydro	Hydro	Northern	Nkhatabay	Under Construction		300kW				
St Gabriel	Solar-diesel Mini-grid	Central	Lilongwe	Active/Running	2017	3kW			The system was installed in 2013 and was later upgraded in 2017 by including diesel generators	Yes
Illovo Cogeneration	Baggase	Central	Nkhotakota	Active/Running		18MW		The electricity generated by the system is mostly used for powering the sugar machineries and part of it is also used to power homes and facilities for workers, but some power is also sold to surrounding industries such as ethanol plants and haulage companies.	The plant was installed some decades ago with an aim of reducing energy cost and to supply uninterrupted power the industry and to the workers houses.	Yes
Chipopoma Hydropower Project	Hydro	Northern	Rumphi	Active/Running		50kW		Powering maize mills	The project was started by a local engineer from within the area with some financial help from the local social enterprise business owners that is the Mushroom Farm, Naomi Oppriecht and community contributions. With the funding, a 50Kw generator was procured together with PV pipes and in 2018 the system was commissioned	Yes
Ruo-Ndiza	Hydro	Southern	Mulanje	Active/Running		8.2MW			The plant is owned by Mulanje Renewable Energy and is located within the vicinity of Lujeri Tea Estate	Yes
Chipula Energy Kiosks	Solar	Southern	Chikwawa	Active/Running	2019	Not Specified		Phone charging, radios, TV, solar lamp rentals	The project was implemented by Practical Action in partnership with CARD Malawi	Yes

Table 1: Community Energy Projects in Malawi

With reference to the database, Malawi has 30 community energy systems implemented in various community areas. According to Figure 1 below, Malawi has a total of 22 active community energy systems operating as of June 2021. Solar PV systems appear to be the most common technology implemented CES in Malawi. And the reasons are: Solar PV uses solar radiation which is available in every part of Malawi as such harnessing energy using solar PV technology becomes easy. Solar PV has some economic benefits and one of them is that it has a lowest maintenance cost annually which is about 2%[1] of the initial system for smaller systems and 1% for the larger systems, this is because solar PV systems have no moving parts. Lastly solar PV generates clean energy which does not cause any healthy issues on the end users or pollute the environment.

Small hydro emerged to be the second most energy system implemented in Malawi. These small hydro systems are implemented by local communities and Non-governmental organisation in rural areas. Some of the notable small hydro systems are; Bondo mini hydro, Kavuzi Pico hydro systems, Usingini mini hydro and Lujeri small hydro systems.

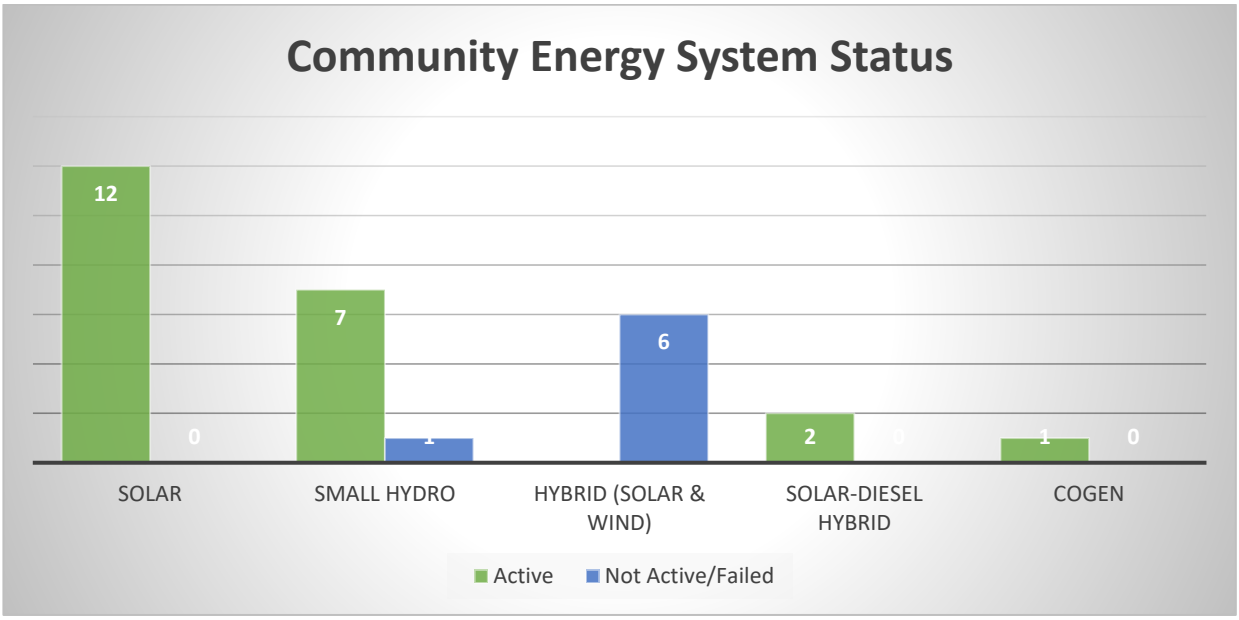


Figure 1 Status of CES in Malawi

For communities away from the national grid, small hydro system has proven to be one of reliable source of energy or electricity in particular. Some notable individuals in rural areas have also come up with different scale of hydro systems supplying electricity to their households and other nearby houses (10 houses on average) i.e. the case of Kavuzi Pico hydro etc.

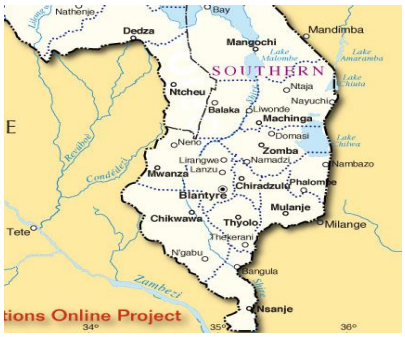
Six of the solar-wind hybrid minigrids implemented by the government are not operative. These systems were implemented with an aim of solving electricity problems in the target rural areas. However, the systems did not sustain themselves upon commissioning. Factors which contributed to the failure were lack of proper maintenance plan, lack of community ownership and lack of financial management skills.

[1] https://www.itsmysun.com/faqs/what-would-be-the-annual-maintenance-cost-for-a-solar-pv-system/

3.0 Community Energy Systems profiles

3.1 CARD Minigrids and Kiosks

The Nyamvuwu, Chimombo, Oleole and Mwalija are part of the minigrids which have been implemented by Churches Action in Relief and Development (CARD) as a way of promoting the use of solar energy in the area. The minigrids were also designed to reduce the power challenges faced in the targeted areas and provide energy for various uses which may help to foster the economic growth of the people. The mentioned minigrids are installed in Chikwawa and Nsanje districts. Historically these two districts are disaster prone areas which are strongly hit by drought and floods almost every year.



No	Name	Location	Size (kW)	No of Customers
1	Chimombo	Nsanje	15	13
2	Nyamvuwu	Nsanje	30	16
3	Mwalija	Chikwawa	15	8
4	Oleole	Chikwawa	25	17

Table 2: CARD Minigrids

The four mini-grids implemented by CARD were funded by the European Union under the Sustainable Energy for Rural Communities project. The project investment cost was about £840,000. The SE4RC project is implemented in partnership with Practical Action, HIVOS and Environment Africa. Furthermore, the SE4RC also implemented 7 Energy Kiosks to promote and increase access to clean and affordable energy to low-income households.

No	System Components	Quantity	Specifications
1	Solar Panels	14	195W
2	Batteries	4	183 Ah
3	Inverter	1	1000W
4	Charge controller	1	30A
5	Charge controller	2	45A
6	solar lantern charging stations	20	
7	Solar lanterns	500	

Table 3: Energy Kiosks specifications

The community energy systems (minigrids) were commissioned in the year 2019 and have been operating up to date.

Community energy service companies (CESCO)

The SE4RC project trained the community energy service companies (CESCO) to become legal entities and be able to access funds and deliver sustainable services to the local communities. These CEOSC own, operate and maintain the mini-grids in the four mentioned districts.

The CEOSC operate in the following detailed outline:

- Minor maintenance of the mini-grid system under supervision of the certified technocrat by Malawi Energy Regulatory Authority (MERA)
- Extension of grid distribution lines
- Revenue collection which is generated through tariffs. The community energy systems adopted the use of 'pay as you go' business model as a way of collecting revenue from the energy end users
- Paying of general labourers and other bills incurred during the mini-grid operation.

In addition, the revenue collected by the CEOSC is used to procure some of the maintenance equipment required by the system, such as cables etc. The remaining funds are used to contribute to any community development happening in their areas. One of the notable developments is fixing boreholes, which is the main source of drinking water in most of the rural areas in Malawi.

However, it has been noted that energy kiosks generate more revenue as compared to the mini-grids in their area. The reason is that energy kiosks offer most of the profitable productive uses of energy services which are accessed by the whole community regardless of whether they are connected to the grid or not. Most of the common activities include: charging of solar lantern, charging of phones, TV shows, etc.

The connection fee demands the user to pay an amount of circa USD$25.00, which excludes wiring, procurement of electrical cables and labour charges that are incurred by the customer/user. The project targeted 20,000 beneficiaries which includes women and children.

3.1.1 Tariffs structure

Below is the tariff structure for the mini-grids

No	Category	Tariff (kwacha)(kWh)	Tariff ($)(kWh)
1	Business	96.6	0.13
2	Households	86.2	0.12
3	Social facilities	67	0.09

The coming of the four CES in the two districts has spiked a lot of productive use of energy activities as follows.

No	Minigrids	Energy Kiosks
1	Agro processing activities (Milling of maize and peanut butter making)	Selling and lending of solar lantern
2	Small business enterprises which include barbershops, hair dressing saloons, phone charging, selling cold items, video shows	Small business enterprises; video shows, refrigeration services, barbershops, phone charging services photocopy and printing services.
3	Irrigation schemes (commercial farming, growing of vegetables, maize etc. during dry season)	

3.2 Kavuzi Pico-hydropower schemes

The Kavuzi Pico-hydropower schemes are implemented in the Nkhatabay district as an initiative by the households from the KAVUZI village. The genesis of these hydropower schemes originates from industrial Research and Technology development centre project used by the youth organisation to provide electricity to power a youth centre building. The knowledge attained was used to replicate the same idea across the community. These Pico systems are designed and constructed locally by their local artisans at a reasonable amount of fee. The systems consist of local materials from car scraps (starter motors, bearings) and PVC Pipes as their penstocks and a simple wiring. According to (UNDP, 2021) there are close to 6 artisans in the village/community trained to construct and design Pico hydropower systems. Furthermore, it is reported that it takes at least a month to set up and install a Pico hydro system for a household. As of now over 25 Pico hydro systems have been installed. These systems are owned and operated by the household/user once installed. Which means once installed, the maintenance and security of the system is provided by the household/user. One system is able to meet at 90% of the household energy basic needs and these are lighting and powering TVs and radios, phone charging etc. The bigger the systems in terms of the number of houses to service the more it cost the owner. According to (UNDP, 2021) they found out that the cost of maintaining the system depended on the worn-out parts and it could range from circa USD$1.23 to USD$7.23. Kavuzi area being one of the active communities, the coming of these Pico hydro household owned systems have spiked a lot of small business

Number of 100W bulbs	Pen stock size (diameter in mm)	Cost in WMK
4	50	60,000
7	70	80,000
8	70	90,000
10-15	90	110,000
20	110	150,000

Figure : Pico system specifications and associated costs

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activities within the area and these includes, phone charging, TV shows, and lighting shops.

Building on the existing knowledge and experience on hydropower systems in the area there are calls by the community which have formed a committee to develop a system to provide electricity to the whole community. The hydropower plant will be owned and maintained by the community.

Kavuzi Pico hydropower plant Photo credit: UNDP

Despite that these systems are owned by end users it was still fundamental to be regulated as such government conducted a training with an aim of tackling safety issues on how to handle the systems. So far this initiative has proven that every community has the capacity to solve electricity/energy challenges and increase access to clean energy without depending on the government on donor aid.

3.3 Sitolo Solar Mini grid

According to (MERA, 2004) a minigrid is defined as a system which generates and supply electricity to a local community with a maximum capacity of 5MW. Mini-grids are either connected to the main grid or off the grid and provide power to a certain area. Sitolo solar Mini-grid is one of its kind installed solar mini-grids in Malawi which is located in Sitolo village, Mchinji district. The mini-grid is 14km away from the national grid and uses solar power to generate electricity by harnessing sunlight through its panels. The system has been implemented by Community Energy Malawi (CEM) with funding from UNDP of about USD$435,000 to increase access to affordable clean energy and foster economic growth in the area. The system was commissioned in 2019 and has a capacity to generate 80kW.

Sitolo Solar Minigrid, Photo Credit: CEM

Sitolo solar PV mini-grid generates electricity using solar radiation 24 hours a day without any backup.

The minigrid has connected close to 150 plus households and benefiting 300 indirect beneficiaries. The coming in of this minigrid has triggered a lot of small business activities in the area. Some of the noted businesses include: agro processing activities (maize milling), barbershops, phone charging, irrigation schemes, welding refrigeration services, lighting of shops, etc. The system is owned, maintained and operated by Community Energy Malawi. Every household is required to pay a connection fee to access electricity from the minigrid. The project adopted and replicated the Mulanje Electricity Generation Agency, MEGA business model which operates as a social enterprise. MEGA business model focuses on making electricity available and affordable to the community/target market by minimising pricing. To ensure that the minigrid is

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sustainable, CEM employed a skilled technician to monitor the maintenance of the system, fault troubleshooting and oversee the local technicians.

3.3 Bondo Minigrid

Bondo minigrid is a small hydropower plant which has been operational for a couple of years since the year of 2013. The community energy system is located in the Bondo village, Mulanje district, which is in the southern part of Malawi. The project is implemented by Mulanje Electricity Generational Agency (MEGA) which is a social enterprise based on a model of operational sustainability. The operational sustainability business model involves assessing whether the business has the ability to maintain the existing operations/practices without posing a threat on future resources whether social or economic. The infrastructure of the project is funded by an international donor agency (the Scottish Government, European Union and Global Environment Facility).

Bondo Power House

The project aimed at improving energy access in the area which is proven to be a driving factor of every social economic development. MEGA is also the first independent power producer in Malawi to be awarded with a valid licence for generating and distribution of electricity. The coming of the project in the area has provoked a lot of development activities and has proven to be a successful energy project in Malawi with unspeakable positive results.

3.3.1 The tariffs

No	category	Tariffs (MWK per kWh)	Tariffs (US$ per kWh)
1	Business Customers-	105.84	0.132
2	Domestic Customers	64.68	0.08
3	Social Customers	32.34	0.04

Table 4: Bondo Minigrids Tariffs structure

There are a lot of business activities which have been spiked by the coming of Bondo hydropower minigrid and these include:

- Refrigeration services, which involve the selling of cold drinks, freezes and fresh fish
- Lighting of shops, which have helped to extend hours of operation hence making a lot of sales
- Hair dressing business, which include running barbershops and hair saloons

- Charging services, which include phone charging, car battery charging, etc.
- Welding services, which include making/manufacturing of constructions materials like window and door frames and other fabrication activities.

3.4 Rural Off-Grid Energy Kiosks project

Energy kiosk is an approach which is used to provide electricity to the low-income households especially in the rural areas. Most of the kiosks are solar powered with different capacities targeting areas which are away from national power grid. In Malawi there are now over 10 solar kiosks stationed in the rural areas. A number of projects have implemented these off-grid energy kiosks; SE4ALL project funded by EU and the Rural Off-Grid Energy Kiosks project by RENAMA funded by Scottish Government Malawi Development Fund just to mention a few.

The Rural Off-Grid Energy Kiosks project by RENAMA was implemented in two districts in the southern region of Malawi, namely Phalombe and Thyolo. This was just a pilot activity to test the viability of the energy kiosk in Malawi. The energy kiosks were then commissioned in 2013 upon completion. An energy kiosk committee was later elected to oversee the maintenance and management of the kiosk and to reduce the need for donor interventions and enhancing self-help capacity.

However, there is limited data on the energy kiosk technical specifications such us the total energy capacity generated.

The energy kiosks offer the following services/activities:

- Phone charging
- Solar home system rentals – big enough to power small homes with basic lighting, phone charging, radios, TV, etc.
- Solar powered TV rentals
- Solar lamp rentals
- Solar powered barbershop
- Popcorn making machine
- Cold drinks
- Peanut grinding mill

3.5 Mthembanji Micro-grid

The Mthembanji micro grid has been implemented under the Rural Energy Access via Social Enterprise and Decentralisation (EASE) project in Dedza district which is in the central region of Malawi. EASE[2] is a £1.3 Million funded project by the Scottish government to promote decentralised energy access in Malawi. The project is in partnership between the University of Strathclyde, Community Energy Malawi, United purpose[3] and WASHTED[4].

United Purpose is a non-governmental organisation working in Malawi to improve the livelihoods of the rural communities through various projects implemented ranging from food security, micro financing and sustainable energy. Centre for Water Sanitation, Health and Appropriate Technology Development WASHTED is an organisation which has also implemented various projects on energy in Malawi i.e.; a £2,300,000 funded project by The Scottish Government called Malawi Renewable Energy Acceleration Programme implemented between the years of 2012-15.

The project adopts the social enterprise approach in scaling up the off-grid electrification. The system demands an equivalent of circa USD$25.00 as a connection fee besides the house wiring costs. So far at least 53 households, 5 businesses and 2 institutions were registered during the customer sign up. The micro-grid was commissioned in the year of 2020 connecting 60 customers.

Technical Specification of a Micro grid

Battery Specifications	48V, Lithium batteries
Battery Capacity kWh	19.2 kWh
PV Specifications	Mono crystalline 320W
PV Arrays Size	11.52kW
Battery Inverter	8 kW
PV Inverter	10 kW

Figure 8: Photo Credit: United Purpose

[2] https://ease.eee.strath.ac.uk/
[3] https://united-purpose.org/malawi
[4] http://www.washted.mw/

The system capacity is 11.5kW

3.5.1 Tariffs Structure

There are several tariff categories which suits each level and nature of the energy demand in the area. The first category is Banja Bundle which demands a customer to pay at least a maximum of circa USD$4.30 a month. And Ufulu Bundle PAYG Tariff which depends on the time and type of usage and level of usage. And Mudzi Bundle which targets the institutions and is paid on a monthly basis. The project has employed two local agents which have been trained on basic system maintenance, sales and customer relations.

However, some of the operation maintenance costs are being covered by the EASE project funds. There are several activities which have come into action due to the access to electricity and these includes phone charging, running TV video shows, barbershops, etc. So far 11 businesses have been set up due to the implementation of the micro grid in the area.

4.0 Common Lessons

No	Challenges faced	Solution
1	Higher tariffs as compared to that of the National grid	Obtaining Waivers from Malawi Revenue Authority, MRA to reduce the investment cost which also affects the Tariff calculations
2	Energy is most consumed during the night hence losses are made during the day	Developing a business model which helps to add productive use of energy activities during the day and this may also help increase income revenue for the local households
3	Low participation of the community	The community should be involved in the whole project cycle to build the ownership spirit and train the local artisans
4	Lack of productive use of electricity/energy ideas by the community	Training the local community on possible productive uses of energy activities that would help to boost their household income
5	Encroachment of Malawi Rural Electrification Programme (MAREP)	Proper consultation should be done during the planning stage of the project with the department of Energy Affairs who are the core implementers of Malawi rural electrification programme.
6	High connection fee	The connection fee should be cushioned to attract a number of end users targeted by the system which may help to increase the revenue returns

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