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Mulanje: pioneering a social enterprise approach in clean energy mini-grid schemes

Clean energy mini-grids (10 kW to 10 MW) are increasingly seen as a viable solution. Systems of 10 to a few hundred kW are also referred to as 'micro-grids'. These can be a viable and cost-effective route to electrification where communities are far from the national grid or where population is not dense enough to justify a grid connection, but demand of households and local businesses is at such a level that cannot be provided by off-grid solar home or pico-solar system. The challenge has been to provide adequate financing and management and operation models for mini-grid systems, that range from the pure utility or government agencies model, to private sector companies, community-driven ownership-operator models and hybrid combinations of these.

To address issues and options in clean energy mini-grid implementation and business models in Malawi, UNDP is supporting the project, *"Increasing Access to Clean and Affordable Decentralised Energy Services in Selected Vulnerable Areas of Malawi"* with co-financing support from the Global Environment Facility (GEF).

Site: Mulanje

Business and financing model: community-based social enterprise with partial subsidy

This case study in one of five that seeks to understand the possible role of energy mini-grid and off-grid systems in Malawi.

1. Mulanje area

The Mulanje Mountain massif is located in southern Malawi, measuring about 30 km from west to east and 25 km from north to south and its highest peak towers up to 3,000 metres over the surrounding plains. The area has a very rich forest reserve, which is a home to a rich and diverse endemic plant species (such as the Mulanje cedar) and plenty of wildlife. The Mulanje Mountain Conservation Trust (MMCT) aims at conservation of biological diversity and sustainable utilization of natural resources of the Mulanje Mountain Forest Reserve. The Trust works together with Malawi's Department of Forestry by bringing in community participation, maximising benefits among users of the forest reserve, and protect and reforest its watershed area.

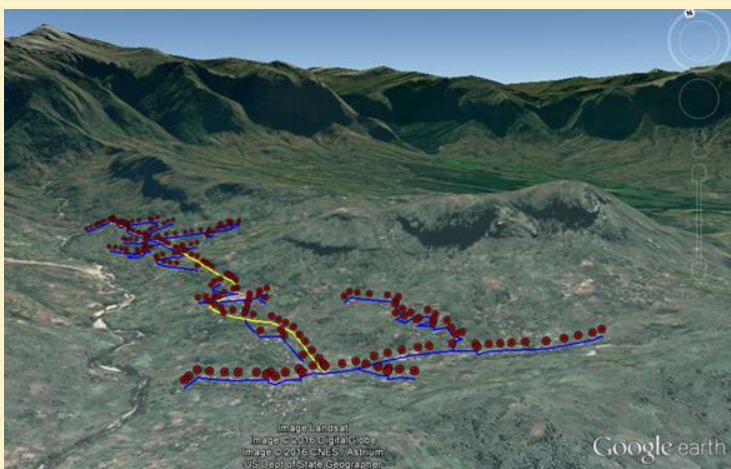
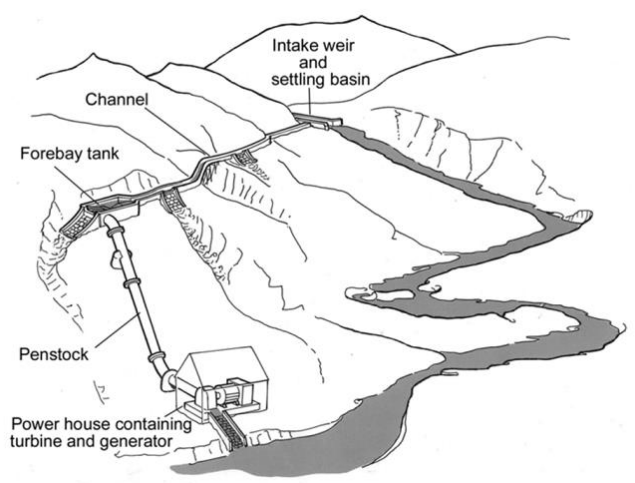
Mulanje has high levels of rainfall attracted by the mountain. It is, therefore, a very fertile area and home to many tea estates that employ large numbers of people and engage thousands of smallholder farmers that live on the peripheries of the estates. The lush climate also supports a rich fruit harvest of pineapples, mangoes, avocados, and bananas.

It is also a catchment of headwaters and a source of nine perennial rivers and tens of streams. This offers scope for generating power derived from the energy of falling water, fast running water. The concept of a community-based mini-hydropower project was first discussed in 2008 and led to the establishment of the Mulanje Energy Generation Agency (MEGA) in 2011 by three founding partners. Two of these have a place on the Board of Directors; these are MMCT (majority owner) and the Mulanje Renewable Energy Agency (MuREA, itself an implementing arm of MMCT), while the third founding partner, the international NGO Practical Action, has been providing project management and technical assistance. MEGA also works with Fairtrade Foundation on community development and the Scottish SgurrEnergy in project engineering and management.



MEGA's mini-grid scheme, Lower Bondo, Mulanje

The hydropower generation is run-of-the-river, i.e. it requires no water storage but instead diverts some of the water from the river, which is channelled along the side of a valley before being 'dropped' into the turbine via a penstock pipe (see figure). The 60 kW Lower Bondo system operates with 200 litres per second of water with a head of 50 metres. The weir is a permanent concrete structure and the channel is some 600 metres long. The turbine is a three-jet Pelton wheel. The system is regulated by an electronic load controller that monitors demand and dumps excess power.



The powerhouse is 8 km from the national grid, though the mini-grid extends to within 3 km at the closest point. The mini-grid network consists of 7.1 km of medium voltage (11 kV) transmission and four substations distributing three-phase power at 400 V over 3.8 km. The substations are strategically placed at centres in the village.

The system runs 24 hours and caters currently for 403 households, 2 businesses, 3 public institutions and 4 churches. Peak demand is between 5-10 PM in the evening and 4-7 AM in the morning. The off-peak demand is 10 PM to 4 AM and 7 AM to 5 PM.

The water resource is readily available but the quantity reduces during the dry season and affects electricity production. Normally, the system can power 2 maize mills during off peak hours. However, in periods of low water levels the system cannot power maize mills.

Figure above: schematic of a micro hydropower system (Source; Practical Action)

Figure below: MEGA's mini-grid. (Yellow = MV line. Blue = LV line. Red = Distribution poles)

With financial support from the European Union and the OPEC Fund for International Development (OFID), a 56 kilowatt (kW) mini-hydropower scheme at the Lower Bondo on the Lichenya River (on the southern side of Mount Mulanje) started in July 2013 and became fully operational in 2016. Technical details on the plant and operations are given in the text box above.

The Bondo community was targeted for a reason of its relatively high population density and high incidence of (energy) poverty, as described in the text box on the next page. By providing improved access to health, education services and provision of electricity to 400 households in the first phase, the project developers hoped that the community would benefit and be incentivised to invest further in the energy model and ensure expansion to the neighbouring villages.

Additional financing for a second 80 kW hydropower facility is expected to come from MEGA's own internal accruals, UNDP/GEF and funding from the Scottish Government. This mini-grid will serve the Bondo, Nessa, and Namainja communities and provide electricity to about 3,500 households in the service area, 2 to 3 maize mills, around 5 shops, 2 primary schools and 1 clinic.

Socio-economic description of the Bondo area and community involvement

The tea industry employs between 10-18% of the adult Mulanje population. About 40% of the district population can be said to be directly benefiting from the tea industry. Some 8,280 smallholder farmers are engaged in tea growing. This makes tea the backbone of Mulanje's economy; providing cash income and creating demand for goods. Bondo is a community of seven villages on the lower slopes of Mount Mulanje with about 25,000 inhabitants. All the beneficiaries are of low but steady and reliable income that is generated by employment on nearby tea estates and the smallholder horticultural production of fruits, such as pineapples, mangoes, avocados, bananas and litchis. People in Bondo (predominantly women) also grow tea on a small scale, which they sell to the larger tea estates through the Sukambizi Association.



An energy survey undertaken in 2014 showed a high level of poverty, perpetuated by the inability to access good health services, and lack of income-generating agro-processing and good educational services. The average household cash income was estimated at MWK 5,337 per month (about USD 14). Before electrification, households in Bondo relied on the commercial services (milling, battery charging) and other commodities that are found in the electrified towns on the main tarmac road, about 8 km away. Travelling to these areas costs money; the alternative of hiring the services of someone to take the battery to the charging station also costs money. Lighting needs were met by paraffin bought from local re-sellers who add their own margin on to this expensive commodity (MWK 220 to MWK 375 per litre).

Practical Action and MuREA also conducted a separate gender mainstreaming exercise which helped to direct the appropriate gender interventions for the project. The focus on including Bondo Health Clinic, for example, is a direct effort to influence a reduction in maternal and/or child mortality. Also, by providing lighting for the school, the benefits of education are for both boys and girls. With funds from the German GIZ, solar power had been installed at the clinic but the system was abandoned after malfunctioning, while the Ministry of Health had removed the clinic from a planned electrification scheme.

The involvement and dedication of the community has been evidenced by the manual excavation of a 238-m trench for the first-phase hydropower facility that passes through difficult rocky and undulating area. In addition, female community members donated productive land (on their small-holder plots) for the canal to pass through. Community in-kind support also had some negative effect at first; many local people were at first given the impression that electricity will be free due their community participation during the construction of the scheme. This thus brought challenges of revenue collection during the first year of operation.



* Of which an estimated MWK 3,465 spent on food, MWK 1,025 on energy and MWK 1,176 on health care. Source: *Energy Access in the Southern Region of Malawi, Results and Analysis of Total Energy Access*, by Practical Action and MuREA (2014). Other sources: www.iodparc.com; *Community Renewable Energy Toolkit for Malawi* (CES-MuREA, 2014)

This is part of MEGA's overall aim to provide the rural, off-grid villages of the Mount Mulanje area with access to affordable and available electricity and energy services, locally generated through a series of ten mini-hydropower schemes (of about 40 to 100 kW each) in which 9,600 households (42,420 men, women and children) are expected to be directly connected.

There were some technical hick-ups in the beginning. The Bondo hydro-electric power plant was not functional for four months in 2014 and was finally repaired and components replaced under the supervision of MuREA and Practical Action. Learning from this experience, MEGA will now procure a complete hydro-mechanical and electro-mechanical generation package from a single source only for its next mini-hydropower schemes.

Inspection of MEGA, by the Malawi Energy Regulatory Authority (MERA), revealed minor safety issues to be addressed. These issues were resolved and MEGA obtained its Power Generation license in 2014.

2. A new business model

MEGA is being set up as an independent social enterprise, in which MMCT owns a majority share. The model allows for community members and/or investors to have a share. Being a socially-oriented company MEGA will not seek to maximise profits but will balance the pricing of its electricity tariffs between its social objective of offering low-cost electricity and being financially viable.

The MEGA business model aims to achieve economies of scale for central operations by developing multiple sites. MEGA aims to establish a new micro-hydro turbine site (with an accompanying distribution system), every year for 10 years. Achieving this requires initial donor grant funding to cover the cost of all infrastructure investment of the micro-hydro turbine sites, and depreciation costs, plus a contribution to the operations in the years 1 to 5. After the fifth year, MEGA is projected to reach economies of scale and will start making operational profits and will progressively improve its asset base to be able to meet an increasingly larger part of the investment costs of new clean energy mini-grids.

Comparison between MEGA and ESCOM pre-paid tariffs

(tariff in MWK/kWh)	MEGA	ESCOM	
	Single phase	Single phase	Three phase
Community institutions	32	38.56	59.57
Households	64	38.46	59.57
Commercial	106	66.21	79.45

Source: MEGA, ESCOM (2016-17 tariffs).

USD = MWK 720 (Apr-Oct 2017, www.oanda.com)

MEGA has now introduced a connection fee for their consumers. Each new household applicant is required to pay MWK 5,000 whereas each business applicant is required to pay MWK 6,500.

The business plan forecasts that revenue from sales will cover all running costs, including staffing, operations, maintenance, VAT, site insurance and a 1% annual contribution to a community fund. For sustainability, it may be a challenge for MEGA to achieve both its social and financial objectives. MEGA sells electricity at approximately twice the current rate that the national utility ESCOM (Electricity Supply Corporation of Malawi) uses in other parts of the country. This price point is needed to generate enough revenue to create a financially viable operation. This pricing policy seems high but is justified when compared to the current average household expenditure on meeting the same energy needs through substitute products: kerosene, charcoal, and wood. It has been estimated that each connected household is likely to save 16% of its current expenditure by switching to MEGA energy.

Revenue will be generated from households, businesses and productive uses through electricity consumption charges and connection fees. The revenues collected per month ranges from MWK 300,000 to MWK 400,000. The consumers pay for their electricity through prepaid meters. There is an agent in the community who receives payments for electricity units from the consumers. After receiving the payment, the agent communicates to the system's electrical engineer who is in-charge of the billing system. The electrical engineer then sends a code (through the Airtel network) to the agent for entering the energy units of each consumer who has purchased the electricity. So far, the prepayment model has proven effective at recovering revenue from customers.



3. MEGA working on sustainable development

MEGA's focus on sustainable development means that MEGA's business model and value chain remain closely intertwined with MMCT and its social objectives.

Livelihoods and community use

MEGA supports local businesses to establish and grow with the aim of raising entrepreneurs' incomes and availing new products and services in the community. It already powers two maize mills; small businesses in the area, which are welding and machine shops, a carpentry and bakeries. Entrepreneurs will be given business and skills training and linked with finance providers for investment. These efforts are mutually beneficial for the commercial users and MEGA itself, i.e. MEGA's commercial viability hinges on revenue from high-power productive users.

In the near future, business centres will act as energy 'hubs/kiosks' and offer a range of services to their customers (including off-grid households and businesses). These services encompass indirect energy services (such as charging batteries and charging mobile devices, as well as offering, ICT (computer & internet use) and basic business services.

Watershed management

Watershed management activities target protection and improvement of the hydro system's catchment area and the generation infrastructure. The trees of Mount Mulanje are under threat from timber cutters, charcoal-makers, and upland agriculture. Deforestation increases the risk of flash floods that can damage the intake and generation infrastructure. It also reduces the water-holding capacity of the watershed area which leads to low river levels and reduced power generation in the dry season. For this reason, it is planned that some 200,000 trees will be planted in the hydro system's catchment area and place bamboo and grass around the power canal. Farmers will be trained in conservation agriculture and the community sensitised on the harm of deforestation.

4. Lessons learned, challenges

Impacts

Electricity has brought a drastic change in people's lives. Before the mini-grid scheme, after a day's farming or working at a nearby maize mill, the people of the village had to light their homes with candles, log fires, kerosene lanterns or battery-powered lamps, that provide families with only one or two hours of light in which to read and cook. In Mulanje, as in many African rural areas, it was rare, for example, to find teachers willing to live in an area without electricity. In Bondo village, schools had to turn down computers from the Ministry of Education because there was no electricity to run them. In the local health centre pregnant women were asked to bring their own candles to light the delivery room. The lack of electricity constrained opportunities to grow small businesses that could not use power tools.

Power is now being distributed to households, shops, and social services, such as the health clinic. Small shops are achieving greater turnover due to extended trading hours enabled by lighting. New enterprises are being set up. Bondo's school has nearly doubled the number of teachers on its books. Households now actually spend a lower percentage of household income on energy, in comparison with the expenditure on fuels such as kerosene, wood, and charcoal.



Lessons learned

MEGA is first licensed (social) independent power producer (IPP) in Malawi; it has been a steep learning curve for all involved and there are many experiences to share. If MEGA is able to achieve and maintain momentum, there is potential to influence the wider energy landscape in Malawi, paving the way for further investment in private energy provision.

The centralisation of core business functions in a cross-community 'hub' makes MEGA's model different from other community-based models used in distributed energy schemes in neighbouring countries. In other schemes, mini-grid energy infrastructure has typically been initiated by a third party and then handed over to a community group after construction. There is an opportunity for MEGA to establish itself as a model of commercially viable distributed rural energy solutions – if the social enterprise model succeeds.

MEGA's own financial analysis shows significant donor funding is needed to enable MEGA's business model to succeed in providing sustainable affordable available energy to consumers. The reason is that tariffs are higher than ESCOM's (subsidised) tariff, but still do not reach what would be needed to function as a fully commercial enterprise, not dependent on grants. However, by wanting to expand to up to 10 mini-hydropower plants, the company wants to achieve certain economies of scale, in which increased revenues accrued by the realised hydropower facility are able to cover larger parts of the initial investment needs of the future facilities. In case of MEGA, a break-even point is expected to be achieved halfway the construction of the chain of the mini-hydropower facilities.

It also opens the option that the various mini-hydropower facilities are interconnected. On one hand, the interconnection transmission line would mean additional cost; on the other hand, this allows a hydropower facility (not yet producing power at maximum power demand) to already deliver power to the next village to be electrified (and thus accruing revenues, while benefitting the next village already with a first power supply).

Regarding supporting social services in the area, MEGA will connect and wire schools and can support the purchase of medical equipment for the health clinic. Electrification of schools (wiring and consumption costs) will need to be covered by donor grants and/or parental contributions as neither MEGA nor the Department of Education is able to (fully) cover these costs. Also, power for hospitals and health centres should be paid for by local government on a cost-recovery basis.

Successes

Successfully establishing the first site at Lower Bondo has been critical to the realisation of the business plan: communities needed to be convinced that electricity access is possible and MEGA has demonstrated that tariffs can be collected and are sufficient to cover operational costs. The success of MEGA hinges on a combination of success factors:

- *Affordability* of energy to the target market (of households, social services, and small local businesses). This means having a tariff minimisation policy in place to keep tariffs as low as possible but within the limits of pursuing a commercially viable business;
- *Accessibility* of electricity and of payment credits to the target markets. MEGA has community-based energy credit vendors in the communities, so that connected households can purchase electricity as need, while working on the retail model for businesses and energy kiosks/hubs;
- *Availability and reliability* of energy in the distribution system by means of well-maintained operations with the local community. Further local training and engagement will help in ensuring a consistent and reliable energy supply.
- The latter factor is linked to *customer awareness and engagement* of product/service offering and understanding of the economic and social benefits, for which MEGA has set up a community engagement plan.
- The *safety of generation, distribution, and use* is addressed through the training of operators on proper use and maintenance.

Challenges

Despite achieving key milestones, there remain some question marks around the capacity of community-based organisations to run mini-grid energy projects. MEGA faces particular challenges as the upfront infrastructure investment is high and largely charged in US dollars while the potential tariffs are limited by consumers' ability to pay and are largely in Malawi Kwacha (MWK). The economies of scale needed to realise commercial sustainability can be difficult to achieve with community-by-community ownership. MEGA hopes that a central over-arching management function will assist its commercial viability.

The scheme has long off-peak periods which could have been utilized for productive uses. The current level of productive use of electricity is at lower than expected levels needed to ensure operational profits. MEGA is seeking larger commercial users for the electricity such as mobile telephony service providers. Also, hampering the feasibility of mini-grid hydropower plants is the fact that, initially, these do not function at the maximum power demand that are designed for. The reason is that in practice not all households are willing to be connected (and all productive uses are not in place). In the first year, maybe only 20% of the households are connected, while in the subsequent years, more households are connected, thus densifying the coverage of the mini-grid facility and raising revenues in the process. Despite the (partly) subsidised social tariff, prospective clients may be reluctant initially to be electrified due to cost reasons. Households do not face the connection fee only, a household needs to invest in up-to-standard internal wiring, sockets, switches that may cost about MWK 100,000.

The dual focus on socio-economic benefit and commercial viability presents challenges in making MEGA commercially viable. MEGA has learnt that a clear understanding of the sales volumes is needed and will develop a sales incentives plan (for households and productive uses) in line with this. For example, one way to overcome the internal house wiring and connection cost barrier, is to include some cost internal wiring in the electrification scheme and let the household pay over time through the power tariff. The more early adopters, the easier the



demonstration of the financial and other benefits of using MEGA energy.

Other challenges relate to external risk factors. For example, MEGA needs to work with and employ skilled business people, engineers, trainers, and operators. This is largely lacking in the Mulanje area. Secondly, critical for MEGA's success as the target market is the engagement of the households and businesses. In principle, the residents of Mount Mulanje can participate in the ownership and governance structures of the organisation, and they have supported in-site construction, operation, and retail. Nonetheless, community members have commented that 'waiting' for 5-10 years to be electrified is too much time to wait for, and there are complaints that the village community is not really involved in day-to-day management decisions. The MEGA Board plans to invest in greater community awareness and collaboration with village leaders.

As the first IPP in Malawi, MEGA has faced challenges in going through the licensing procedure with MERA. The procedure has been designed with large grid-connected IPPs in mind, but for small village-level producers this means in practice time-consuming efforts at relatively high cost. MEGA's legal problems have challenged the

Malawian administration to review their current licensing framework for privately owned energy companies. The new energy bill is likely to make it easier for other (small) privately owned transmission and distribution entities to operate.

Opportunities

In low-density scattered communities, where mini-grids are less viable as the cost of distribution becomes prohibitive, electricity kiosks and stand-alone technologies such as solar lanterns or solar/wind home systems become more attractive. Mini-grids are most appropriate in areas such as the Bondo area that has relatively high population density above 250 inhabitants per km²

ESCOM, which supplies the national grid, does not reach remote areas of Mount Mulanje. The nearest point in the Mulanje grid is about 5 km from the medium-voltage grid line. The area may be connected to the national grid in the near future. This may pose a challenge as well as an opportunity. The MEGA mini-grid should not face competition from direct power supply. Instead, MEGA should be allowed to connect to the grid and sign a favourable power purchase agreement with ESCOM as the off-taker of its energy. Energy sales to ESCOM would bring MEGA an additional and stable flow of income and make the power facility sustainable by enabling to generate and sell power at full capacity. However, such energy sales should take place under the condition that the electricity to the Mulanje clients at the current tariff arrangements remains guaranteed.

5. Concluding remarks

A financially viable microgrid balances grant money for investment, revenue streams from tariffs with debt, equity, and operational expenses obligations both in the short and long run. The MEGA ‘social enterprise’ provides a successful example of a “partially subsidised business model” that simultaneously espouses private sector values for financial and operational sustainability and social values for inclusion. In other words, it tries to pass on the lowest possible energy services costs to its customers and considers local ability to pay while also ensuring that the microgrid is reliable and financially viable.

The social enterprise management may, therefore, prove to be an alternative to the community-based model and the private business model). Community-based systems are often hampered by local management issues and poor revenue collection, while private-owned systems aim at profit maximization (and prefer investments in larger systems to sell power to the grid at commercial feed-in tariffs over investments in small village systems at social tariffs).

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The UNDP/GEF project is currently supporting an expansion of the Lower Bondo mini-hydropower scheme with another 80 kW at Namainja village (referred to as the Lujeri mini-hydropower). At an estimated investment of USD 780,000, GEF provides investment co-financing and UNDP technical support. In addition, the UNDP/GEF project could provide assistance regarding the options regarding the possible connection to the main grid in the future and its technical and economic implications.