Malawi Renewable Energy
Acceleration Programme (MREAP)

MREAP is led by the University of Strathclyde and funded by the Scottish Government. It has operated over 2012 - 2015.

Programme Impact Overview

June 2015

The Malawi Renewable Energy Acceleration Programme (MREAP) was funded by the Scottish Government to explore multiple yet coordinated strands of work to improve prospects for renewable energy in Malawi. The programme ran from 2012 – 2015 and had two key outcomes: improving the enabling environment for renewable energy and improving access rates to affordable and appropriate energy for poor Malawians. Much of the emphasis of MREAP has been on demonstrating and improving the model for community energy in Malawi, especially in rural areas where electricity access rates are only 1%.

This overview presents a selection of the imagery, reports, and data generated from MREAP that highlights the impact that has been produced.

First use of electricity from Solar PV at the Gumbwa Health post
Chikhwawa, Malawi

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For more information visit: http://www.strath.ac.uk/eee/energymalawi/
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ENERGY IN MALAWI

Population Size: 16 million
Rural Population: 85%
Growth: 2.75%
Location: Southeast Africa
Language: Chichewa, English
GNP per capita: $752
Economy: Agriculture (35%)
Gini: 43.9

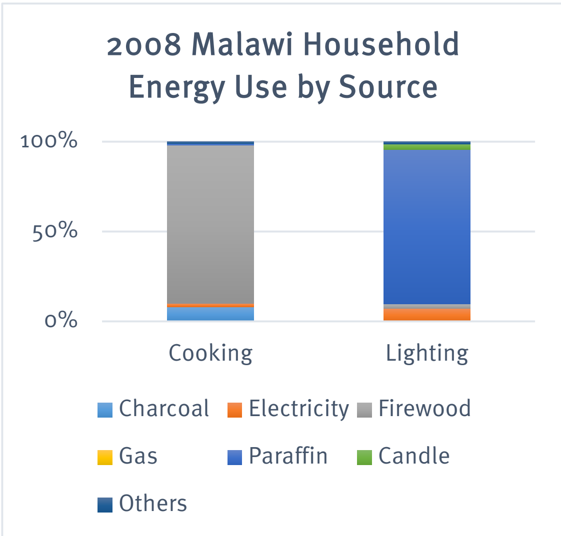
Malawi is a landlocked, Sub Saharan Africa country with a population of approximately 16 million. Only 9% of the population has access to the national grid electricity and access to the rural areas has remained stagnant to less than 1% for a long period of time. Comparatively, the sub-Saharan average is 16% for the rural and 32% overall thus making Malawi one of the least electrified countries in SSA.

Poverty is widespread in Malawi; it ranks 174th of 187 countries in the Human Development Index in 2013. Life expectancy is 55.3 years while the mean years of schooling is 4.2 and GNP per capita is $752.

While Malawi's economy has good growth prospects, it is severely hampered by shortages of energy supply both in liquid fuels which it must import as well as electricity supply where it experiences frequent outages. Even in places with electrical connection, use of diesel generators as a backup is common. Over the past few years, the Malawian economy has experienced a large currency devaluations as well as persistent high inflation which has affected the economy as a whole.

Meanwhile, Biomass use is comparatively important with 97% of Malawi's total energy supply. The population is heavily dependent on firewood and charcoal for cooking which puts noticable pressure on the forestry resources. Reduction of this dependence on firewood by using more modern cooking and fuel sources is a key long term goal of the 2003 National Energy Policy.

Paraffin is the primary energy source (86%) for household lighting requirements. However, paraffin is costly, relative dirty, and can have serious health effects.



References:
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MREAP STRUCTURE

MREAP joins multiple programmes of work within one coordinated entity. The overall objective is to **accelerate the growth of community and renewable energy development in Malawi through multiple, targeted and coordinated activities with good potential to provide a platform for that growth.** Each separate component has its own operational objectives and deliverables that stand alone as contributions to the energy sector in Malawi but also offer opportunities for synergies.

Objectives of Each Work-stream

Institutional Support	Malawian institutions have evidence and systems to support the effective development of the renewable energy sector to provide development benefits for Malawian communities.
Community Energy Development	Effective community renewable energy deployments are facilitated by capable stakeholders who support & empower communities to develop and own renewable energy projects and in so doing support the effective development of the renewable energy sector to provide development benefits for Malawian communities.
Renewable Energy Capacity Building	Higher Education Institutions, trainers and entrepreneurs have the knowledge of renewable energy to support the effective development of the renewable energy sector to provide development benefits for rural communities.
Wind Energy Preparation	Effective wind power resources are deployed by capable stakeholders within government, civil society, communities and private sector to support the effective development of the renewable energy sector to provide development benefits for rural communities.

Programme Steering Group meetings were held every 6 months for partners to discuss progress, raise common issues, and channel learning to key stakeholders.

Our Programme Steering Group was co-chaired by the University of Strathclyde and the Department of Energy Affairs for the Government of Malawi. Eight partners from both Scotland and Malawi were part of the delivery of MREAP:

- University of Strathclyde (Lead)
- Community Energy Scotland
- WASHTED
- IOD PARC
- Mzuzu University
- Concern Universal
- MuREA
- Renew'N'Able Malawi

COMMUNITIES

The energy projects within MREAP were strongly focused on meeting community needs. In rural villages, the investment in solar powered lighting at primary schools and health centres can improve the services provided and therefore provide a more effective public good.

The CEDP programme worked with communities and allowed them to identify the most important issues for their communities and assisted them in utiliising renewable energy as a solution. As a result, projects were inclusive and highly relevant to the communities that were impacted.

As a result of this process, we had many variations in technology choice and intervention level. One common feature was the empowerment of Community Based Organisations (CBOs) which represented the communities. CBOs received technical and financial management training, were linked to other community energy projects, and are now have a strong sense of ownership.

Three CBO offices gained access to solar PV lighting as a result of MREAP. Alongside the training provided, the CBOs are now better prepared to

manage energy projects and other community activities they take on.

In June 2014, MREAP initiated the first ever National Community Energy Conference. This brought communities together and gave them a common voice to discuss their experiences with Government, NGOs, Academia, and other key stakeholders.

- MREAP worked in 15 districts in Malawi
- Over 50 separate community energy projects
- Often the most remote, hard to reach locations
- Needs based approach
- Built the capacity of CBOs to develop and manage their projects

STUDENTS

The largest single grouping of beneficiaries were primary school pupils from the 30 primary schools that received solar PV systems. In total 21,160 primary school pupils were enrolled at schools that have sustainable lighting.

The national electrification rate of primary schools in Malawi is only 10% and 52% at lower secondary schools. With so few resources, rural schools often lack desks for students and many classroom materials. In addition to energy, school feeding programmes and access to adequate sanitation are also very important factors to academic success.

The main benefit is through the provision of lighting at night, especially during the period before the national secondary school entrance exams. An additional 2 hours of studying or the ability for the teacher to provided added lessons can be critical for learners. Achievement of high marks means

entrance into higher quality national secondary school and an improved education.

While top primary school pupils are selected to go to the District or National secondary schools many pupils need to rely on local (less well equipped) *Community Day* Secondary Schools to further their education. In four of these schools we have provided electricity for lighting and phone charging.

TEACHERS

The challenges facing Malawi's primary education system are considerable: while primary school enrollment rate is high (99%), less than half (46%) of pupils are still at school when they reach Standard 8 and then the total number of pupils drops to less than a third (32%) during the transition to secondary education. There is a cycle of dropout and repetition in Malawi which is expensive and exacerbated by poor learning.

Keeping good teachers in place at rural primary schools is critical. There is a lack of qualified teachers across the country – the teacher-to-pupil national average reached 1:74 in 2012. Many schools which typically require one teacher per grade level are understaffed.

In an MREAP study we interviewed 80 teachers who received solar home systems as part of the community projects. While they cited many challenges of rural life from lack of infrastructure to need for housing, the importance of modern energy services was made abundantly clear. The importance energy access has for teacher retention and attraction was strongly articulated by one headmaster we spoke to:

> "This technology develops the desire for going to those schools with electricity. Even for me, if I had to transfer somewhere with no electricity, I would cause a problem and demand to stay!"

Under MREAP, 74 homes of rural teachers now have solar home systems. This has improved job motivation and allowed for more working hours to prepare lesson plans.

TECHNOLOGY: BONDO MICRO-HYDRO

The Lower Bondo Micro-hydro project was funded by a consortium of which MREAP provided funds for extension of the power distribution network and metering equipment. The 88kW micro-hydro mini-grid utilises the Lichenya river to produce power and distribute it to the nearby community. During MREAP, the scheme became partly operational and it was recorded that nearly 140 homes were connected to the mini-grid as well as a variety of small businesses and shops.

The mini-grid is first of its kind in Malawi and continues to develop under the scope of national (and international) attention. The model involves the creation of a privately owned enterprise, MEGA, to operate and maintain the power network. Many stakeholders are now hoping that it can be replicated elsewhere in Malawi where renewable resources are available.

Stimulation of Small Business

Shortly after the Bondo scheme came on-line, entrepreneurial activity began. New business such as barber, video shows and lighting for small shops have sprung to life. As MREAP ended, the new electric powered maize mill was not yet operational, but in time it will be a clear time saver for locals.

A Transitioning lifestyle

As one of the households to connect to the mini-grid early on, Florence (pictured above) and her family were able to power electric lighting and a television. She recounted the first moments:

"The very first day we were connected, we were so excited. There was a lot of jubilation, a lot of dancing. We kept on watching video the whole night - we didn't sleep at all. It was amazing to see that we had light throughout the night. All the boys and girls are coming from far away -- we are really popular in this area!"

In the home, she said she used lighting when she cooks and that her children used it for studying.

TECHNOLOGY:

SOLAR PV SYSTEM MONITORING

The Remote Monitoring (RM) strand of MREAP was incorporated within a Strategic Energy Project in Chikhwawa. RM was deployed as a measure to bolster technical sustainability of the project and to consider its readiness for scale-up. Distributed energy systems in Malawi, particularly solar PV systems, have historically had poor sustainability performance.

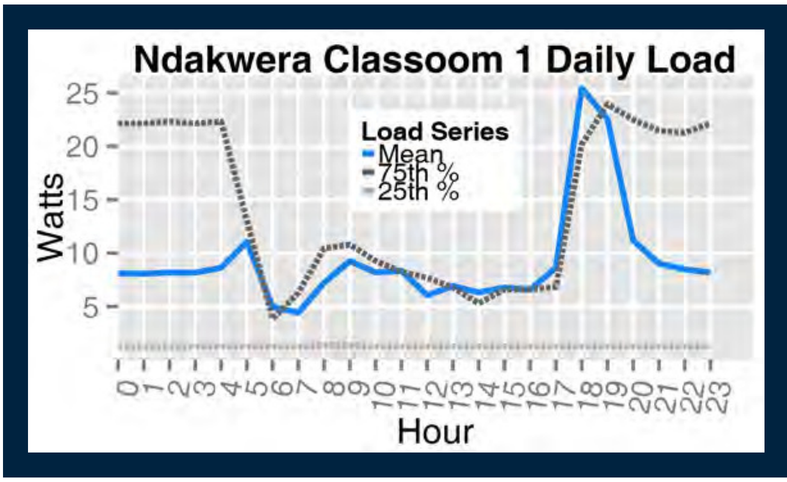
During MREAP it was included at 4 separate locations comprised of 21 separate electrical systems to capture key technical performance data. These systems were each standalone Solar PV installations on health facilities and primary schools in Chikhwawa district. The technology utilized Wireless Sensor Networks (WSN) and open-source models to communicate via mobile phone networks remotely to WASHTED's office in Blantyre.

Data could then be viewed at near real-time, analyzed, and corrective actions could be enacted. The purpose of the RM strand was to demonstrate the technology's effectiveness towards improving sustainability of off-grid community energy projects, particularly the technical performance.

Energy use over this time period was around 830 kilo-watt hours (kWh). While this level of energy use is low compared to energy use in industrialised countries, it provided critical functionality for the systems involved. This included lighting at the health centres' maternity wards, out-patient departments and recovery wards. At primary schools, use consisted of staff room lighting, classroom block lighting, mobile phone charging, and television. RM was demonstrated to assist in identification of situations that could have presented major sustainability challenge over time had there been no RM present. The 'faults' that were identified included misuse of the system (connecting consumer devices that were too power hungry for the system) and malfunctioning of key system components.

The data captured can inform system design process of future Solar PV projects, ensuring they are scaled properly and consistent with actual use patterns.

- Remote Monitoring improves technical sustainability of systems
- Allows for near real-time oversight of 4 Solar PV projects 46km away
- Equipment designed and implemented by the Polytechnic
- Data is used for research purposes and to improve future system design



CAPACITY FOR RENEWABLE ENERGY

New MPhil Degree in Renewable Energy

Under MREAP, WASHTED, one of the centres at University of Malawi – The Polytechnic in conjunction with the University of Strathclyde (Scotland) launched the renewable energy research collaboration programme with the aim of

- Building renewable energy research and academic knowledge base in Malawi
- Setting up enduring mechanisms for the research programme to last beyond MREAP
- Addressing research priorities for renewable energy in Malawi.

As a result, a new Masters of Philosophy degree in Renewable Energy under the University of Malawi was established in 2013. The Mphil programme was designed in such a way that it is cross-disciplinary addressing engineering/technology, environmental, socio-economic and financial issues that directly affect design, implementation, management and sustainability of renewable energies.

The first cohort of students began their studies in 2013 and are on track to finish their research projects in 2015. The study programme in the first year included courses such as: Financial Environment, Research Methodology, Environmental Impact Assessment, Project Management, Clean Technology, Environmental Policy Implementation and Sustainable Energy Management.

The MPhil degree course will expand the University of Malawi's links with industrial partners in the field of renewable energy. It has enabled MPhil students to conduct relevant research as well as find employment as leaders in the renewable energy sector. For those students who are already employed or on part time jobs, the MPhil research study has assisted them to build knowledge and skills for innovation in their organizations.

MPhil Research Areas

1. Financing Model for Micro-Hydro
2. Market for Off-grid Community Based Solar PV Systems in Malawi
3. Functionalities and Market for Solar PV in Malawi
4. Biogas and Organic Fertilizer Production
5. Scaling Up Energy Efficient Cook stoves
6. Biogas Technical Performance in Malawi
7. Impact of Rural Stand Alone PV Systems
8. Community Solar PV Component Cost, Availability and Alternatives
9. Low Cost Design Methods for Micro Hydro Generation
10. Impact of Climate Change on the Generation Profile of Micro Hydro Micro Grid
11. Opportunities for Small and Micro Hydro Power in Malawi Rural Areas: Promoting Public Private Partnership Approach
12. Alcohol/Fusel Oil Blend for Efficient Cook stoves
13. Micro Grids

Renewable Energy Training

Renewable Energy Short Courses

With a general low levels of knowledge and skills around renewable energy technology and applications, WASHTED led the development of renewable energy handbooks targeted at communities, technicians, and industry.

Nine developed short courses include:

- Micro Hydro Power
- Monitoring and Evaluation
- PV Power Systems Installation and Maintenance
- Renewable Energy Appreciation
- Renewable Energy Entrepreneurship
- Renewable Energy for End-Users
- Solar PV Design for Rural Communities
- Solar PV for Water Pumping
- Wind Power

Training for Communities

During the development of 46 projects in 12 districts throughout Malawi, the Community Energy Development Programme (CEDP) conducted extensive renewable energy training to prepare the communities for management of projects. This included leadership, financial management, awareness raising and technical training.

Targeted learners:

- Community Based Organisations
- Project Managers
- School and Energy Committees

Community Renewable Energy Toolkit for Malawi

The Community Energy Toolkit was developed under the CEDP Programme as a guide for development officers in establishing new projects. An open source document, the 170-page toolkit is a key resource offering critical information and suggestions from the development process itself to using specific technologies.

Training of Biogas Constructors

The Biogas Strategic Energy Project led by Mzuzu University installed 12 biogas digesters in the Mchinji district. Biogas uses dung from cattle to produce a burnable gas used for cooking and replaces wood-fuel.

Realising that promotion of the technology requires more widespread availability of trained labourers, Mzuzu University also trained 9 local bricklayers (8 men, 1 woman) in the process of construction. The training process was hands-on and collaborative.

Once they learned part of the process, they would apply it to other sites and this process would repeat until construction was completed. Many of the builders had some experience in constructing houses and shops, but this was the first opportunity they had to learn how to build a biogas digester.

Mzuzu University envisages their skills coming to use in future projects and potentially stimulating the local market once people know more about biogas and can see it working.

TRAINING

LEARNING

Solar PV Sustainability Study

Under MREAP, several studies were undertaken to learn more about sustainability challenges for off-grid solar PV project at schools and health centres. In 2012, an MREAP evaluation identified many weaknesses of the existing stock of projects leading to poor sustainability outcomes: many projects were failing. Lessons were taken forward into new MREAP projects including adopting more robust technical systems and ensuring community buy-in for projects.

In 2014-2015, a dedicated study with MREAP partners sought to establish stronger evidence around sustainability factors of PV projects in Malawi. A survey covering the pillars of sustainability (technical, economic, social, organisational, and environmental) was developed and delivered to 43 institutions dispersed throughout the country.

The results provide important learning but point to a grim situation on the ground. It confirms anecdotal evidence and suggests that the majority of installed projects can be considered ‘unsustainable’ and at risk of failure in the near future. The study demonstrates the complicated interactions between sustainability pillars and highlights the need for a holistic approach to project design and implementation.

Key components of a strong design

1. Robust technical design scaled to meet likely system demands and installed by a MERA accredited contractor
2. Follows a needs-based community engagement process with a management structure in place
3. Utilises local revenue generation or has an established and credible funding source that covers long-term (5yrs+) equipment replacement
4. Supported technically over the long-term and has periodic training for community

Results by Sustainability Pillar

- **Technical**: There are significant indications of poor design and installation practice that indicate poor technical sustainability. 38% of the systems have completely lost all service. 58% of room lighting is not fully meeting expectations. 43% of batteries are showing ‘bad’ battery health indicator. 31% of the mainly compact fluorescent installed bulbs are not working
- **Economic**: Poor financial performance or support in most projects. Only 15% of projects had a bank account and a positive net income.
- **Social**: Community presence often limited to a single committee that meets irregularly, if ever. Few projects had district involvement. Theft occurred in 28% of projects.
- **Organisational**: Presence of key roles to manage the project (financial, managerial, and technical) is uncommon. Training is not routinely provided and almost non-existent once the project is commissioned.

Learn more about MREAP: http://www.strath.ac.uk/eee/energymalawi/

Process of Community Energy Development

In January - March 2015 a Process Evaluation was conducted of the Community Energy Development Programme (CEDP) projects in order to assess what has been delivered, how this has been achieved and to compile learning from the process for policy and future projects. While strong conclusions are limited by only 6 months of data available, the results show a considerable impact for rural Malawians. The evaluation has shown that longer term support will still be required despite the existence of a local support organisation Community Energy Malawi (CEM), a local NGO established as part of MREAP.

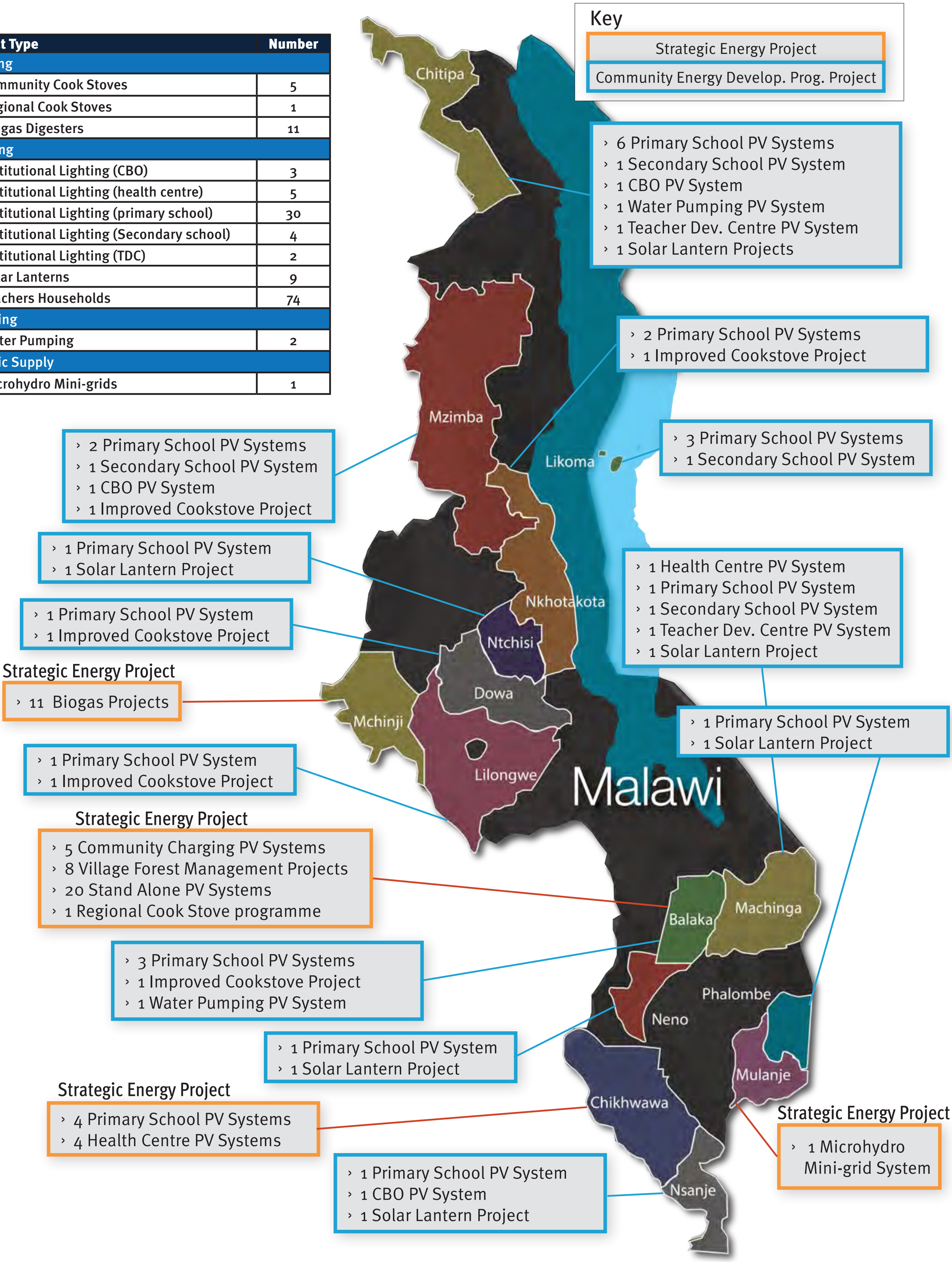
The CEDP portfolio is made up of 46 projects across 12 Community Based Organisations (CBOs) located in 12 districts across all regions of Malawi. The total number of beneficiaries of CEDP projects is 20,439. A total of 378 healthy babies were born at the single health clinic monitored by CEDP. CEDP has modestly supported the country's push for improved cookstoves nationwide by setting up producer groups and selling 325 cookstoves. A total of 9 solar lantern social enterprises were set up by CBOs and sold 465 solar lanterns. All CBOs had generated an income in the first 6 months and users have generating savings from solar lantern adoption. For educational attainment, the overall trend is that exam performance is very gradually improving in CEDP-targeted schools and that lighting does make a difference to a teacher's job satisfaction.

Highlights from the Process Evaluation

- **Relevance:** At 6 months, an analysis of evidence suggests the CEDP projects have contributed to an improvement in quality and relevance of education and that over time this could lead to improvement in zonal level results. An analysis of District Education Plans (DEPs) provided evidence that CEDP projects are targeting the most vulnerable and under-performing schools.
- **Efficiency**: Although all projects had a positive income and bank account balance, lifecycle cost modeling suggested that only 1 in 3 projects were on track to meet 9 monthly targets for income generation. This implies revisiting business plans and applying further emphasis on increasing revenue generating activities.
- **Sustainability**: Key factors demonstrating programme sustainability across the CEDP portfolio and approach are: strong quality control through MERA accredited contractors and inspectors; clear roles and responsibilities between Communities and Energy Management Committee; strong emphasis from the start on building and sustaining community ownership; conducting business planning and starting small social enterprises to generate income; and crucially that all social enterprises are generating income at 6 months.
- **Effectiveness**: Evidence points to positive changes in human and social capital. CEDP projects have contributed to building human capital improvements in terms of health, education, knowledge and skills. Solar PV installations in educational institutions and solar water pumps have produced the greatest increase in social capital through improvements in trust, decision making and leadership.

MREAP Community Energy Project Portfolio

Project Type	Number
Cooking	
Community Cook Stoves	5
Regional Cook Stoves	1
Biogas Digesters	11
Lighting	
Institutional Lighting (CBO)	3
Institutional Lighting (health centre)	5
Institutional Lighting (primary school)	30
Institutional Lighting (Secondary school)	4
Institutional Lighting (TDC)	2
Solar Lanterns	9
Teachers Households	74
Pumping	
Water Pumping	2
Electric Supply	
Microhydro Mini-grids	1



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Community Energy Project Impact Levels

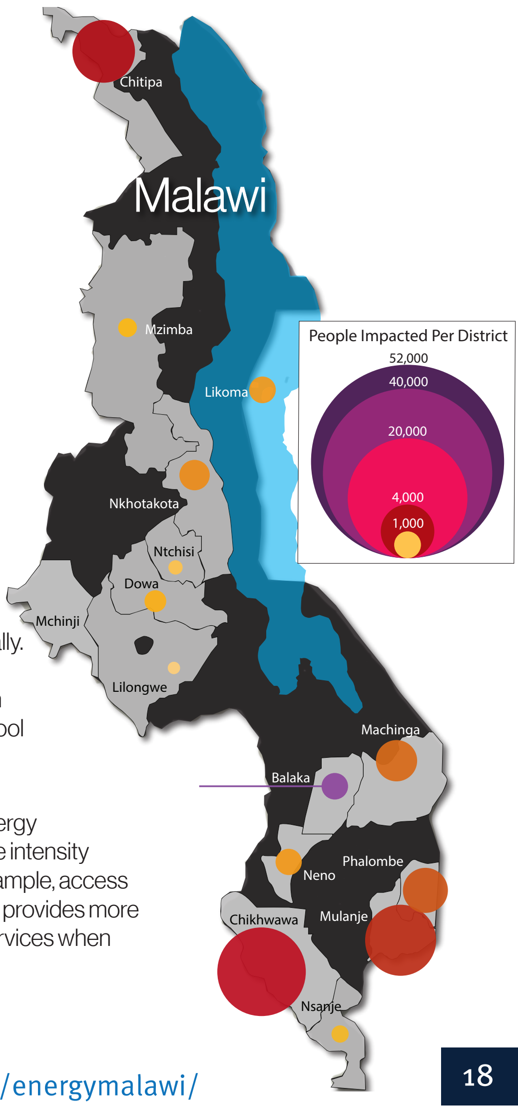
People Impacted

Beneficiary Type	Type of Benefit	Partner	Estimated People Impacted		
			Gender		
			Unspecified	Male	Female
Households	Improved cooking services (biogas digesters)	Mzuni	70		
Orphans	Improved cooking services (biogas digesters)	Mzuni	360		
Households	Electricity (Tier 3)	MuREA	3409		
Households	Improved cooking services (stoves)	CU	43836		
Teaching Staff	Lighting in classrooms (Tier 2)	CU	24		
Households	Lighting system at home (Tier 2)	CU	24		
Students	Lighting in classrooms (Tier 2)	CU	5142		
Teaching Staff	Lighting in classrooms (Tier 2)	Washted		38	5
Students	Lighting in classrooms (Tier 2)	Washted		2329	2187
Mothers	Giving birth at health centres with Power (Tier 2)	Washted			930
Health Centre Staff	Lighting in Health Centre (Tier 2)	Washted		59	23
Students	Lighting in classrooms (Tier 2)	CEDP*		7242	7260
Teaching Staff	Lighting in classrooms (Tier 2)	CEDP		180	42
Teaching Staff	Lighting systems at home (Tier 2)	CEDP	266		
Employees	Employed in Revenue Generating Activities	CEDP		11	1
Customers	Receiving Energy Services	CEDP		487	448
Households	Improved cooking services	CEDP	1650		
Households	Lighting system at home (Tier 1)	CEDP	2474		
Mothers	Giving birth at health centres with Power (Tier 2)	CEDP			378
		Total by Gender	**57,255**	**10,346**	**11,274**

*CEDP was lead by Community Energy Scotland who supervised Community Energy Malawi

By District

North					
Chitipa	Likoma	Mzimba	Nkhotakota		
3343	1419	991	1616		
Central					
Balaka	Mchinji	Dowa	Lilongwe	Ntchisi	
52411	430	1159	668	763	
South					
Mulanje	Chikhwawa	Machinga	Neno	Nsanje	Phalombe
3409	5571	2210	1395	929	2394



How is Impact Measured?

MREAP was unique in the diversity of types of renewable energy projects, the number of field implementors, and the geographical spread of the projects. Different technology and applications correspond to different types of impact.

The impact levels accounted for here include all types of direct impacts to community members from as little as a recharging a mobile phone at a charging station, to having solar powered lighting for a year or more at one's home. Nevertheless, all of the people here have benefited through the use of renewable energy technologies at some level through the combined efforts of the MREAP team. Different types of impact, potentially to the same person were counted individually. For example, a teacher gaining access to a solar home system **and** lighting at the primary school would be counted twice.

In some cases MREAP has adopted Practical Action's "Energy Access Tiers" to help define the intensity of the service provided. For example, access to a solar home system usually provides more lighting and other electricity services when compared to a solar lantern.

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