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Case Study of the Malawi Renewable Energy Acceleration Programme

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Abstract— Advantages and challenges of an integrated approach to energy for development are presented through the Malawi Renewable Energy Acceleration Programme (MREAP) within context of the development of the Malawian energy sector. Initial indications suggest synergies exist between sub-programs of work that would otherwise be less likely to occur in non-integrated programs. Likewise, additional challenges such as coordination and management are required to realize the potential benefits. This paper presents a survey of the Malawian energy sector, an energy for development research framework and a programmatic outcome strategy designed for MREAP.

Keywords—Community Energy; Energy for Development; Off-grid; Renewable Energy Technologies; Capacity Building; Malawi; Institutional Development; Rural Electrification

I. INTRODUCTION

Although not mentioned explicitly by the Millennium Development Goals (MDGs) [1], it is widely recognized that the provision of safe, clean, reliable and affordable energy to the rural communities in developing countries is an essential underlying requirement of the stated development objectives [2]. The UN Sustainable Energy For All initiative has further bolstered the drive to provide universal energy access [3].

Approximately 1 billion of the world’s population of 6.7 billion people lives in Africa. Africa accounts for 2% of the global economic output and its population is projected to rise to 1.3 billion by 2020 [4]. Excluding South Africa, Africa has the lowest rural access to electricity of any continent; with many countries continuing to rely heavily on traditional fuels. For example, in Malawi 97% of energy comes from biomass in the form of fuel wood, charcoal, and agricultural and industrial wastes [5]. Approximately 7% of all Malawians have access to electricity. Of those living in urban areas, 30% have access, while only 1% of rural Malawians have access [6] [7].

While rural electrification may be a well-established need in developing countries, simply maintaining the existing grid infrastructure is often the first challenge for the national Government and private sector. National electricity grids are plagued with intermittent power black outs and heavy load shedding programs [8]. Incentives for utility companies and private sector investors to address the electricity needs of rural communities of developing countries are limited due to the significant levels of capital investment required and the risks and challenges associated with establishing sustainable market models to recover investment costs [9]. As an alternative or complement to grid expansion, off-grid renewable energy technologies (RETs) are expected to play a major role in achieving energy access in the future [10]. Potential reasons for including standalone renewable energy initiatives in rural electrification programs are that it can: (i) be a least cost economic solution; (ii) be environmentally sustainable; (iii) contribute to MDGs and renewable energy targets; and (iv) bring service faster than awaiting grid supply [11].

Several studies have investigated the sustainability of off-grid RETs in developing countries [12]-[17]. Despite the ambitious plans for adoption, results have been mixed and there are still many questions on the most effective and sustainable deployment models for such systems.

This paper discusses the advantages and challenges of an integrated approach to energy for development in the context of Malawi and the Malawi Renewable Energy Acceleration Programme (MREAP). Section II presents the status of the Malawian energy sector. Section III describes the MREAP’s integrated structure along with the challenges and synergies that are emergent. The paper concludes in Section IV.

II. REVIEW OF ENERGY FOR DEVELOPMENT INITIATIVES IN MALAWI

A. National Energy Strategy

1) Government Policy

Energy policy in Malawi is determined by a number of key policy documents representing wider areas of the ‘enabling environment’ that link energy policy clearly into the Malawi Growth and Development Strategy (MGDS). A non-exhaustive list of strategies and policies that affect the renewable energy sector in Malawi includes:

- Vision 2020,
- Energy Policy (2008),
- MGDS (2006) & MGDS II (2011) ,
- National Forestry Policy, 2006 and Forest Act 2007
- Local Government Act (2008)
- National Energy Policy 2003
The government’s National Energy Policy (NEP) aims to influence the energy sector’s contribution to realization of the country’s Vision 2020 and Poverty Reduction Strategy. It sets out short and long term policy priorities and strategies for energy sector reforms to improve technical and economic performance of energy supply industries, the enactment of legislation for improved energy sector governance and rural electrification initiatives, and to establish a more liberalized and private sector driven energy supply industry through the Malawi Energy Regulatory Authority (MERA) [18]. Challenges remain however. The International Monetary Fund, United Nations Development Fund and Government of Malawi argue that the participation of the private sector in energy production and supply has been almost non-existent although there has been an improved climate of doing business [19][20].

Currently the Department of Energy is implementing two major projects to increase electricity access rates through extension of grid and solar PV. The first project is the Malawi Rural Electrification Programme (MAREP) whose objective is to extend the grid to rural growth centers and is implemented by the national operator ESCOM. The second project is the National Renewable Energy Programme whose core objective is promotion of solar energy and is funded by the United Nations Development Fund. Despite ESCOM’s involvement in rural electrification since 1980 focusing on grid extension, studies show that the extension of the grid to rural areas has so far been minimal [21].

2) National Energy Initiatives

There are a number of national energy initiatives underway in Malawi focused primarily on two key national issues: existing electricity grid infrastructure and household biomass consumption. The World Bank Energy Sector Support Project (US$84 million) aims to “increase the reliability and quality of electricity supply in the major load centers in Malawi” [7]. This project will be implemented by Ministry of Natural Resources, Energy & Environment and ESCOM. The UNDP have initiated the Sustainable Energy Program in Malawi [22], due to be around US$2 million over 5 years with an expected focus on energy sector analysis and biomass. Recently, the Millennium Challenge Account Malawi has re-launched its US$350.7 million program focusing on reducing power outages and technical losses, enhance the sustainability and efficiency of hydropower generation, and improve service to consumers [21]. DfID have recently undertaken a £2.6m national low energy light bulb initiative to reduce overall load [23]. Outside of these multi and bi-lateral agencies supporting the Government of Malawi with large infrastructure projects, the main actors in the energy sector are Non-Governmental Organizations (NGOs) and Charities working with local communities.

B. The Contribution of Off-Grid Renewable Energy Solutions

The contribution of off-grid renewable energy to the Malawian energy sector is not formally tracked. There is no database of installations and where installations have been recorded in some format, they are not monitored and their ongoing status is unknown. The information presented here is the result of a recent evaluation of the sector by the Malawi Renewable Energy Acceleration Programme (MREAP)[24].

The main off-grid RET actors and contributions can be summarised in terms of their target groups and scale of installation.

1) Individuals

Individual scale solutions are primarily targeted at the supply of efficient cook-stoves and pico-scale solar systems that provide LED lighting and battery charging. As outlined above, efficient cooking is a national strategic priority and multiple large scale programs are supported by Government, NGOs and Charities [25][26]. There are numerous NGO and charity led pico-solar programs operating in Malawi, one of the largest being Solar Aid.

2) Households

Household systems are primarily solar PV or solar thermal and form a large portion of the private market in Malawi. Systems are supplied by the small network of commercial renewable energy system suppliers and costs dictate that these systems are beyond the reach of the majority of off-grid households.

3) Community Service Infrastructure

Systems are again primarily solar PV or solar thermal supplying health centres and schools with energy for lighting, refrigeration, ICT and water pumping. There are some examples of community irrigation projects. These projects are financed by government via rural electrification programs (often in collaboration with international donor agencies) and multiple NGOs and charities working to address a primary development need (e.g. health and education) in off-grid areas [27][28].

4) Mini Grid

A small number of mini-grid systems utilizing a central generation source and a distribution network have been deployed to serve off-grid communities. A 75KW micro-hydro system in Mulanje serving a school, health clinic, maize mill and up to 400 households is nearing completion. Six hybrid solar-wind villages have been deployed by the Government of Malawi through MAREP.

C. Sustainability of R.E. and off-grid solutions

Sustainability issues around off-grid RET installations in developing countries are well discussed in the literature [28], [29]. The lack of hard data on the installed RE base in Malawi does not allow an in-depth analysis, however an evaluation and pilot inventory undertaken via the MREAP program verify the anecdotal evidence in Malawi that the majority of installations lack a long term sustainability plan or post-installation support and are often non-operational after a few years [24].

This pilot inventory scoped out more than 270 installation sites which were undertaken by more than 30 development programs or projects. These installations are spread out across Malawi’s 28 Districts. The installations include Solar PV
(single and multiple installations), Biogas (community, household and institutional scale), Improved Biomass Stoves, and Micro-Hydro. Main findings from the inventory and case study analysis indicate that poor technical sustainability in the areas of design, agreed usage, maintenance process and monitoring are compounded by a lack of appropriate community engagement and long term economic planning in the majority of cases.

D. Evidence base and knowledge sharing

Although some evidence has been generated on the level of (poor) sustainability for RE systems deployed in Malawi and the types of issues that appear to be behind this, there is no strong evidence base of why systems have failed. Post failure survey points towards various aspects of sustainability that appear to have been weak; however information on why certain technical issues occurred or why an approach to community engagement failed is not available. Hence, significant questions currently exist in the off-grid power sector. These are mainly in the areas of: maintenance and operations, financial management and the piloting of new technologies. Furthermore, information on success or failure of projects has not been captured and disseminated across the sector hence best practice is not established and mistakes are repeated. There is a clear need to expand the evidence base to support stakeholders. Finally, it is noted that parallels exist between off-grid RET and the development path of the water sector in Malawi, which offers some potentials for cross-sector learning [24].

III. MREAP

The Malawi Renewable Energy Acceleration program arose from a scoping study and series of recommendations made to the Scottish Government in 2011.

The recommendations comprised of a range of activities addressing issues raised by stakeholders during the scoping study and covered community projects, research, institutional support and large scale wind energy. Instead of commissioning individual organizations to undertake project work in each of these areas, a consortium approach was adopted and MREAP was initiated. MREAP is organized into 4 streams overseen by a program steering group (Fig. 1.)

Stakeholders from the Malawian energy sector identified significant gaps in knowledge around off-grid energy management in the country. In particular, it was noted that there were a reasonable amount and variety of small-scale interventions being undertaken – for example solar photovoltaic (PV), hydropower, energy efficient cookers – but that there was no clear or shared understanding around the relative merits of each approach. Moreover, there was no overall national inventory of off-grid energy installations in existence – it was felt that the absence of such an inventory could be weakening regulatory oversight, and increasing the risk of a fragmented, inefficient off-grid sector [24].

A. MREAP structure

1) Program Steering Group

The PSG is co-chaired by the University of Strathclyde and the Govt. of Malawi Department of Energy Affairs. Each stream has its own project management, M&E processes and budget responsibilities, reporting back to and co-ordinated by the PSG. The PSG provides input to the direction of each stream, reviews and approves progress reporting, promotes linkages across the streams, synthesizes learning and contributes to wider stakeholder engagement.

2) ISP

This stream is led by the development consultancy IOD PARC and includes initial evaluation, case-studies, pilot inventory and support for M&E of community energy projects. It will also provide policy and strategy support at the institutional level in Malawi to support the formation of policies for renewable and community energy.

3) CEDP

This stream is led by the organisation Community Energy Scotland and includes establishing a Malawian organisation that will provide support mechanisms for community led renewable energy projects in Malawi. Four Strategic Energy Projects undertaken by Malawian organisations are implementing community energy projects and provide support and learning to the CEDP program. The Mulanje Renewable Energy Agency (MuREA) is deploying a micro-hydro mini-grid with capacity 75 kilowatts serving 400 households. The University of Malawi Polytechnic (WASHTED) is deploying solar PV systems for community service infrastructure (schools and health centres) in Chikwawa district. Mzuzu University (TCRET) are targeting reductions in wood fuel consumption and deploying bio gas digesters for 10 farming households and one orphan care centre in Mzimba district. Concern Universal are deploying an efficient cook-stove distribution network in the Balaka district, linking a new cohort of stove promoters to existing production centres and targeting wood fuel reduction in 100 villages. Existing sustainable forestry management programs are being expanded to 8 new areas. Solar PV systems are being scaled up at 5 primary schools.

4) RECBP

This stream is led by the University of Malawi Polytechnic (WASHTED) and will support the development of the

Fig. 1 – MREAP workstreams
knowledge base and relevant research, education and training capacity. A cohort of local MPhil researchers are being recruited along with additional curriculum development and support for proof of concept and commercialisation projects.

5) WEPP

This stream is led by the renewable energy consultancy Sgurr Energy and will provide the basis for development of the wind power resource in Malawi. A national wind and constraints mapping exercise along with initial feasibility assessment of large-scale wind deployments is being followed by detailed wind resource assessment at specific locations.

B. Knowledge and Learning

1) Establishing knowledge gaps

As MREAP commenced, an evaluation of the sector was undertaken through the ISP stream. This evaluation developed a set of 12 case studies covering the 3 regions of Malawi and included a range of renewable energy technologies (RETs) that are being used at the community and household level. These case studies were complemented by key informant interviews and a “round table” with members of the Government of Malawi in March 2012. The final resultant 12 case studies were peer reviewed internally and fact checked by the organizations involved.

During the evaluation a pilot inventory of RETs was undertaken that included information from more than 270 installation sites which were undertaken by more than 30 development programs or projects spread out across Malawi’s 28 Districts. Main findings from the inventory and case study analysis indicate that poor technical sustainability in the areas of design, agreed usage, maintenance process, and monitoring are compounded by a lack of appropriate community engagement and long term economic planning in the majority of cases. In addition, there is a distinct lack of an evidence base from which learning can be drawn to inform stakeholders deploying RET in Malawi and wider policy making.

2) MREAP strategy

Although designed as a package of measures to address specific areas of need identified within the sector, MREAP established the following strategy (Fig. 2.) to direct the work of all streams within the context of two program level goals:

- Improved enabling environment and evidence based policy for RET in Malawi
- Increased poor Malawian communities accessing modern energy services

The CEDP stream contributes directly to the second MREAP objective via implementation and funding of community energy projects and the establishment of support organizations, networks, toolkits and process. All streams contribute to the first MREAP objective by a process either directly through their main objective (i.e. WEPP feasibility studies and wind mapping) or via an overlay of monitoring and knowledge capture. Critical tools to capture learning from MREAP are a Research Framework for RECBP and an M&E framework for CEDP.

### Fig. 2 – MREAP programmatic structure with outcomes

3) MREAP Research Framework

The MREAP research framework was designed to establish: A set of feasible general learning questions and method that can be addressed via basic project data gathered from CEDP, research topics and method requiring more extensive research approaches and data gathering, a prioritization process for research activity, and finally, a synthesis process to enable regular (annual) and end of research ‘learning’ material to be drawn out.

Starting from the high level question, “What works where and for whom?”, the following matrix was identified and populated with multiple questions (Fig. 3.), e.g. under economic sustainability - “how financially viable are revenue generating schemes for various off grid RETs in Malawi?” More detailed questions were specified for specific technologies, e.g. Solar PV – “what are the costs involved with owning and operating a PV system, how are PV systems financed, what are the ownership, operating models, etc.”

### Fig. 3 – Research Framework

Recognizing the huge range of potential questions (and required data) that could populate this matrix, a layering approach was taken to articulate the fact that questions could be answered with varying accuracy and robustness depending on the data available. With this in mind, data was categorized into three layers: 1) from the program reporting process, 2) through implementation of the M&E strategy across the CEDP projects, and 3) through a more extensive data capture
approach and research available through academic involvement associated with the MPhils in RECBP.

4) MREAP M&E framework

The community energy projects being deployed and developed by CEDP are varied in many aspects, including the range of technologies, applications, end-users, community ownership models and beneficiaries. In order to gather data that can be evaluated across the whole program, an M&E framework was developed to guide the objectives and indicators that would be monitored in any given project.

The CEDP objective statement was defined as: “Improve the livelihoods of communities through needs-based applications of RETs”. This statement draws together aspects from: human development, sustainable development and technology introduction under one objective. The following Outcome ‘areas’ were agreed to provide an initial focus for CEDP project monitoring and learning (data layer 2). They will be rationalized for the final monitoring framework:

- Improved staff retention in local service providers
- Improved use and access to energy efficient technologies
- Increased community empowerment
- Increased capacity to facilitate and manage RET applications
- Increased access and educational attainment at primary level
- Increased understanding of technical performance and standards of RET systems
- Increased understanding of economic impacts of RET applications
- Increased access and performance at health centers

C. Lessons Learnt

1) Benefits

MREAP is based on multiple programs of work joined within one coordinated entity. Each separate component has its own operational objectives and deliverables that stand alone as contributions to the energy sector in Malawi. Each program component within MREAP represents a theme of activity in the Malawian energy sector, within which many autonomous initiatives are operated. These themes are: community development, capacity building, policy engagement and national infrastructure enhancement. Opportunistic collaboration across these themes is of course possible without creating an integrated program; however it is the experience of MREAP that by proactively adopting an integrated approach, additional value are possible. It summarizes some of these initial synergies which are still being fully realized.

The impetus for this integrated approach was found when approaching MREAP as an evaluator might. What is the evaluative element of MREAP, where has the program changed or desired to affect a change in people’s lives? Arguably, the CEDP is at the center of this. Starting from existing Strategic Energy Projects and through to the design of the grant and loan projects, the MREAP team built a grounded, bottom up understanding and common vision of MREAP. This vision drove the requirement to address a wider range of issues beyond simply the implementation of projects in order to achieve the program goals, which are national and broadly applicable including: capacity building, knowledge exchange, and stakeholder engagement.

TABLE I

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<tr>
<td>WEPP</td>
<td>-Close links to dept. of energy</td>
<td>-Community based wind energy expertise available</td>
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<tr>
<td></td>
<td>-Dept. of Energy participation in wind feasibility studies</td>
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<td></td>
<td>-Better understanding of sector needs and available assets</td>
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<tr>
<td>CEDP</td>
<td>-Engagement with government stakeholders on learning from/for community energy projects</td>
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<td></td>
<td>- Research work more closely aligned with govt’ and sector stakeholders</td>
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<td></td>
<td>- Academic participation in wind national feasibility studies, measurement campaigns, detailed site feasibility visits</td>
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<tr>
<td>RECBP</td>
<td>-Highly relevant field data for advanced studies</td>
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<tr>
<td></td>
<td>-Link between academic research and rural communities</td>
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<td></td>
<td>-Additional training available for community members</td>
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A matrix of synergies is shown in Table I. By including all of the themes within a single program it has been possible to overlay a learning and knowledge capture strategy. Common learning topics with program wide objectives and indicators could be defined and adopted by CEDP. This will allow comparable data to be gathered from a variety of projects implementing different technologies to address a range of needs. A research framework that is aligned with the program wide objectives and indicators directs the work of RECBP, shaping research topics and questions and influencing the focus of capacity building activity. The technical consultancy of the WEPP program provides data for research and works alongside RECBP to support technical capacity building. This learning feeds into and is, in turn, influenced and shaped by the requirements and recommendations of the ISP policy engagement.

2) Challenges

Taking an integrated approach requires an additional overhead of management and administration. Resource is required to bring all the organizations together, agree a strategic approach, identify and facilitate collaborations and synthesize and disseminate learning and outputs. Each organization working within their respective theme has different priorities and perspectives on development approaches. This is compounded by growing international discourse on how to ‘treat’ energy needs in a development and
environmentally compatible way. For example, ensuring that energy needs are considered from a sustainable development perspective means integrating community development outcomes that reflect: environmental (energy efficiency, reduction of deforestation), development (health, social, energy, food, economic) and climate change (carbon reduction) needs. Each are experts in their field and use tools, process and language that are unfamiliar to others. Significant effort and resource needs to be expended in breaking down these barriers and working towards a common understanding of program wide objectives that have been jointly defined and have the buy in of all parties. Without this added effort, the planned for synergies and collaborations may fail to materialize.

IV. CONCLUSIONS

An integrated energy for development program in Malawi has been presented. The structure, strategy and learning framework of the program have been described and the benefits and challenges of an integrated approach have been discussed. An argument has been made for energy for development projects to consider the whole energy sector of the country they are working in. When embarking on the design of an energy project, consideration of not only the specific objectives of an energy project, but how this project fits within the various themes of activity present in the sector and how the project should interact and contribute best with the sector. This paper sets out the intended benefits through synergy and collaboration that an integrated approach can provide. Future work will present learning outcomes gathered as MREAP progresses and discuss the realization of the proposed benefits.

V. ACKNOWLEDGMENT

The authors would like to acknowledge the dedication of the MREAP partners for effort and contributions. In addition, the participation of the Government of Malawi Department of Energy, MET office, the Scottish Government who have funded MREAP, as well as supporters of renewable energy in Malawi is recognized for the vital role they have in converting knowledge and learning into action and policy.

REFERENCES