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Geothermal Development in Malawi – a Country Update 2015 - 2020

Kondwani Gondwe[1], Tufwane Mwagomba[2], Gift Tsokonombwe[3], Charleson Eliyasi[4], Khumbolawo Lungu[4]

[1]Faculty of Science, Technology and Innovation, Mzuzu University, Private Bag 201, Mzuzu, MALAWI,

[2]Malawi Energy Regulatory Authority (MERA), Private Bag B-496, Lilongwe 3, MALAWI,

[3]University of Malawi, The Polytechnic, Private Bag 303, Blantyre 3, MALAWI,

[4]Geological Survey Department (GSD), P.O. Box 27, Zomba, MALAWI,

[5]Department of Energy Affairs, Ministry of Energy and Mining, Private Bag 309, Lilongwe 3, MALAWI.

kondwanithapasila@yahoo.com, giftsokonombwe@gmail.com

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ABSTRACT

Development of geothermal energy in Malawi continues to register restricted growth due to among others, lack of financial and technical aptitude. On the other hand, the country continues to experience insufficient energy supply despite availability of alternative untapped clean renewable energy resources, including geothermal. The Country is situated within the western arm of the East African Rift System, and has low to medium temperature geothermal resources. Geothermal potential is manifested by the presence of hot springs across the country. Despite the potential, no exploitation has been registered apart from bathing and washing.

In an effort to cushion the financial deficit, the Government of Malawi applied and subsequently received a credit from the World Bank in 2014 through Energy Sector Support Project (ESSP). The funds were mainly aimed at initiating geothermal resources exploration in the country. The Ministry of Natural Resources, Energy and Mining through the Department of Energy Affairs and Geological Survey Department implemented the project with technical support from ELC-Eletroconsult. ESSP was implemented in three phases. Subsequent to the conclusions of first and second phases, six and then two geothermal potential sites were selected respectively based on technical criteria. In the third phase, detailed geological, geochemical and geophysical (MT, TEM, gravimetric) investigations were carried out at Chiweta and Kasitu prospects. Integrated conceptual models revealed subsurface geothermal reservoirs of temperature between 110° and 135° C at depths of 500-750m with electric potential of 7 and 15 MW for Kasitu and Chiweta geothermal prospects, respectively. If funds allow, the exploration drilling programme of slim and geothermal gradient wells will be probable for both sites based on pre-feasibility study approval.

The United Nations University Geothermal Training Programme (UNU-GTP), Geothermal Development Company (GDC) and Kenya Electricity Generating Company (KenGen) have trained more than 15 Malawians in Geothermal Surface Exploration since 2010, contributing to geothermal capacity building for Malawi. By 2018, four Malawians had undergone six months training fellowship under UNU-GTP in Iceland and two attained geothermal sciences master's degrees. ESSP trained three officers through on job training by ELC-Eletroconsult.

1. INTRODUCTION

Malawi has since 2015 embarked on an exercise to determine its geothermal resources. Under the Energy Sector Support Program (ESSP), an Italian company (ELC-Electroconsult) was assigned to carry out a general assessment of all geothermal resources in Malawi, do the Pre-Feasibility Study and make recommendations to the Government. Due to limitations in time and resources, only two sites were selected for detailed resource assessment.

This paper just outlines the activities done so far and the recommended way forward, where as detailed information on the actual works and data can be obtained from the reports and their associated appendices

2. STATUS OF ELECTRICITY GENERATION

Malawi's electricity supply remains very unreliable. It is greatly affected by flooding in the rainy season and low water levels in dry season. Hydro generation can go as low as 17% of its total installed capacity in the rainy season. Due to these challenges, Malawi has opted to use diesel powered generators to act as peaking plants. This is proving to be too costly leading to ever increasing tariff adjustment at the expense of the poor Malawians. Much as there has been a little improvement, the average number of days without power still remains very high. There is no reliable source to meet the base load.

2.1 Installed and Effective Generation Capacities

2.1.1 Installed Capacity

There has been a great variation in most documents as to what is the total installed capacity for electricity generation in Malawi.

According to the Department of Energy Affairs, before the commissioning of Kapichira Phase II and the grid connected Airport Solar PV system, there was a total installed generation capacity of 355.3 MWe. Electricity Supply Cooperation of Malawi (ESCOM) was responsible for 304 MWe while the remaining 51.3 MWe was being controlled by private investors, and used as

standby during the frequent blackouts of the ESCOM supply. Added is 47.3 MWe and 78 MWe of installed diesel generation from ESCOM and Agrenco respectively giving a total of 555.25 MWe.

With the additional 8 MWe under the MCC Nkula A upgrade and a peaking capacity of 125.3 MWe of diesel sets has brought the total installed capacity to 555.25 MWe with ESCOM managing 422.35 MWe.

2.1.2 Effective Generation Capacity

The generation capacity was 286 MWe and about 20% of it is lost as transmission and distribution losses. The new generation capacity is now at 404.35 MWe. Considering a 21% loss as estimated by ESCOM, the generation loss is 84.9 MWe giving the effective generation at 319.44 MWe. This is still less than the current peak demand estimated at 330 MWe.

However, the Malawi Foreign Policy and Government Guide records effective generation capacity for ESCOM as 224 MWe as the figure for 2019. It continues to state that out of the 224 MWe, 214 MWe is from hydro and 10 MWe from diesel power plant.

At the time of the writing this paper, information of the current status on the ground revealed that the total installed capacity for ESCOM is 367.35 MWe while the effective generation capacity is 350 MWe (348.4 MWe for grid and 0.75 MWe for Likoma Island). With a spinning reserve of 10 MWe the available generation capacity that is fed into the national grid is 338.4 MWe.

The privately owned generators have the total installed capacity of 62.9 MWe. Only the co-generation plants (18.5 MWe), the Kayerekera power plant (10 MWe), the Lujeri Estate's microhydro (0.84 MWe), Bondo microhydro (0.75 MWe) and the Airport Solar PV (0.85 MWe) plants operate on a regular basis and the rest of the 31.96 MWe is for standby supply.

2.2 Modes of Generation and their Contribution

Malawi's grid electricity generation is dominantly hydro with 95% of the total installed capacity and 99% of the effective generation capacity based on ESCOM's power plants. This represents an 81% of the total installed capacity and 87% of the total effective capacity.

Fossil powered generation accounts for most of the privately owned off grid generation. Fossil fuels contribute 8% of the total effective capacity while renewables contribute only 5% of the total effective capacity. It was that by the year 2020, the pattern will change with fossils to contribute about 81%, hydro 17% and other renewables being at 2% of the effective generation capacity, however, the coal powered power plant at Kamwamba has not been constructed and ESCOM is planning phasing out the peaking generation using diesel due to unnecessarily high operation costs.

2.3 Medium and Long Term Power Development Plan

According to the Malawi Growth Development Strategy 2, Malawi Energy Policy and the Vision 2020, Malawi is to become a technology driven middle – income country by the year 2020.

To achieve this, the government aims at removing the difficulties in security and reliability of power supply due to the over dependence on the River Shire for all the electricity that is fed into the grid.

Table 1: Present and Planned Production of Electricity

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Renewables (specify)		Total	
	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr
In operation in December 2019	0	0	158	1386	366	3208	0	0	19	170	544	4764
Under construction in December 2019	0	0	73	639	0	0	0	0	98	854	171	1494
Funds committed, but not yet under construction in December 2019	0	0	1300	113888	258	2260	0	0	121	1060	1679	14708
Estimated total projected use by 2020	0	0	1531	13414	624	5468	0	0	238	2084	2393	20966

The Malawi Energy Regulatory Authority in its strategic plan (2009 – 2012) has highlighted the promotion of renewable energy sources. In general, it intends to increase the electricity generation in the overall energy mix from the projected 10% in 2010 to 40% in 2050 for hydro and for the other Renewable Energy Technologies (RETs), from the projected 5.5% in 2010 to 10% in 2050.

The main desire for geothermal electrical development, is to have sustainable and reliable power source to cater for the ever increasing base load.

2.4 Potential Direct Use

Direct use of geothermal energy in Malawi has not been fully developed. Notable uses are the use for bathing in Nkhotakota, where bathrooms have been constructed. The rest are more of informal use for bathing and cassava curing. Only Air source heat pumps have been record for space heating and cooling at Protea Ryalls Hotel.

It is claimed that geothermal is being used for fish farming by Richard Bates (in his blog 2017) with support from Global Impact and EPSRC, however, the Department of Energy Affairs and the Department of Geological Surveys expressed ignorance on the same. Contacts to the implementers proved futile at the time of submission of this manuscript. It may be necessary to check with Departments of Water Resources and Department of Fisheries to verify this before the conference.

3. STATUS OF GEOTHERMAL DEVELOPMENT IN MALAWI

3.1 Geological Setting

Malawi's geological setting including that of the two study areas of Chiweta and Kasitu can be obtained from the 2015 country update and the resource assessment reports by ELC Consulting.

3.2 Geothermal Resource Investigation

This involved three phases. The main focus of the first phase was primarily on the reconnaissance study of all the geothermal manifestations. It involved visiting all geothermal sites to get a general overview of their geological setting, collecting water as well as rock samples to get information regarding the origin of the fluids and the underground temperatures. The Geological and Geochemical surveys.(Eliyasi, 2018)

Secondly the sites were ranked and six were selected based on factors considered in the earlier phase. The factors were either technical or non-technical. Technical parameters included temperature, flow rate, geology and chemistry while the non-technical parameters were distance from grid, morphology, accessibility and environment. The Technical and non-technical parameters were given a score basing on their assumed relative importance. Those geothermal prospects with higher scores qualified into this phase. Six site of Chiweta, Kanunkha, Kasanama, Mawira, Chupudzi and Kasitu scored highly. These prospects were subjected to detailed work which involved remote sensing study, geological mapping and geochemical survey.

From the second phase Chiweta and Kasitu prospects were subjected to further geoscientific investigations. This included detailed geological, geochemical and ground geophysical surveys. The geophysical work mainly focused on magnetotelluric/transient electromagnetic (MT/TEM) and gravimetric surveys. Finally, the integrated based conceptual models revealed subsurface geothermal reservoirs of temperature between 110° and 135° C at maximum depth of 500-750 m with electric potential of 7 and 15 MW for Chiweta and Kasitu geothermal prospects respectively,(ELC-Electroconsult, 2017a),(ELC-Electroconsult, 2016)

3.2.1 Further Investigations

There is need to carry out exploration drilling in the two selected sites, and do the modeling and inventions to locate the heat sources and ascertain the available energy and its potential life of extraction. There is also need to carry out other studies in the other potential sites for which the ESSP project financing and time constraints could not allow(ELC-Electroconsult, 2017b). This would help to come up with a full, detailed geothermal resource data base and produce a readily available resource map for Malawi. Other sites for potential geothermal development are outlined in figure 1 below.

Figure 1: Location of hot springs of Malawi. Symbols: red >60°C; brown 50-60°C; orange 40-50°C; yellow 30-40°C.

3.2.4 UNU-GTP Geothermal Training for Malawi

On capacity building, the United Nation University Geothermal Training Programme (UNU- GTP), Geothermal Development Company and Kenya Electricity Generating Company have trained about 20 Malawians in Geothermal Surface Exploration since 2010. At the time of writing this paper, four Malawians have benefitted from the six months training fellowship under UNU-GTP in Iceland with two having successfully completed Geothermal Sciences Master's Degree at Reykjavik University and University of Iceland.

As part of the ESSP, ELC-Electroconsult offered basic training in Geothermal exploration to officers from stakeholder institutions and also organized a study tour to Italy for five government officials to appreciate the successfully implemented geothermal power project and geothermal direct use applications with respect to high, medium and low enthalpy geothermal resources. Three officers received on job training by ELC- Eletroconsult through the Energy Sector Support Programme funded by the World Bank. One officer from Geological Survey Department underwent a two – week International Summer School in Geothermics at Pisa University in Italy.

4. INVESTMENT OPPORTUNITIES

Malawi has unbundled its electricity generation company into separate entities, one dealing with generation and the other dealing with transmission and distribution. This has been done to allow other independent power producers (IPP) to come in. At the time of drafting this paper, several IPPs with different power purchase agreements have been signed. These include, 78Mw of diesel power generation,50 MW of wind power generation, 168.5 MW of solar PV generation, 73 MW of gas power generation, 300MW of coal powered generation and 296 MW of hydro.

Despite its increased total installed capacity, Malawi's effective generation capacity is very low due to effects of flooding during rainy season and extremely low water levels during the dry season. The excessive use of the diesel peaking plants has proven to be very costly. It is with this background that an appeal is made to all interested developers in the geothermal electricity production to be part of the IPPs to enhance the generation capacity to cater for the base load and sustain industrial productivity.

All those intending to participate are kindly advised to contact the Department of Energy Affairs in the Ministry of Energy and Natural Resources.

5. OUTLOOK AND CONCLUSIONS

Based on the preliminary investigations by ELC Consulting, there is need to advance into slim well drilling and full geothermal development. This therefore is an appeal to the international geothermal energy development partners to support Malawi as we plan to take it further into exploration drilling.

As previously argued, a geothermal working group consisting of all stakeholders should be established to direct the investigation and development of the geothermal resources of the country. The group should come up with a well-defined business model separating steam development and power plant investment. It should be able to advise the government on the best way of investing in geothermal development. Sustained funding by government, development aid agencies and lending institutions should be made available to finance the development work. According to Chakhala, *"Government should make it a priority co-financing and partnership for geothermal development and develop a well-defined regulatory framework."*

Technical capacity of the local Malawians needs to be developed through specialized on job training in both exploration and utilization of geothermal energy resources.

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