Journal of African Interdisciplinary Studies (JAIS): **ISSN 2523-6725** (online)
April 2020 Vol. 4, No. 4

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Assessment of the Feasibility of Deployment of Renewable Energy Mini-grids for Rural Electrification for Small and Medium Enterprises (SMEs) in Zimbabwe

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Abstract

Zimbabwe has an electrification rate of about 42% which means more than half of its population live without access to electricity. In 2012 more than 60% of Zimbabwe's population lived in rural areas where the electrification rate barely reaches 20%. The country has a goal to achieve universal access to clean, affordable and sustainable energy by 2030. The Zimbabwe Rural Electrification Fund has a Rural Energy Master Plan (REMP) which cites renewable energy mini-grids and micro-grids as a means to leapfrog the electrification rate of the country to 100% by 2030. Even though the REMP has convincing technical and financial feasibility of renewable energy mini-grids and stand-alone systems as a source of renewable energy for productive use by manufacturing Small and Medium Enterprises (SMEs) in Zimbabwe, there is dearth of information on the contribution by (SMEs) in the implementation of renewable energy mini-grids in terms of means of raising finances, ownership/management of renewable energy mini-grids and productive use of energy in this sector. This study was therefore triggered by the slow pace of adoption of the mini-grid by SMEs for productive use of energy in the sector as this has a negative contribution to the achievement of the country's goal to attain universal access to clean and sustainable energy by 2030. A literature review approach was used in this study. The researcher reviewed literature on how other countries have managed to boost the uptake of renewable energy mini-grids by SMEs for productive use of energy. The study found out that a number of approaches were used in different countries in different settings. Some approaches were successful while some were not. From the approaches used by other countries the study found out that to speed up the adoption of renewable energy mini-grids by SMEs in the manufacturing sector in Zimbabwe, policy has to provide for pooling of resources and risks from a number of SMEs in the sector to boost their capital base and increase their chances of accessing loans from local banks and climate funds. The study established that there is need for an ownership approach that involves the SMEs and their neighbouring communities for sustainability purposes. SMEs can also build their confidence in adopting renewable energy mini-grids by ensuring availability of human resources with technical knowledge and expertise in designing, installation and operation of renewable energy mini-grids thus the need to build capacity of SMEs' human resources in this area. The study thus recommends that Zimbabwe establish policies and regulations that encourage SMEs to adopt renewable energy mini-grids for electricity access at their workplaces.

Keywords: Zimbabwe, productive use of energy (PUE), mini-grids, Small and Medium Enterprises (SMEs)

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Introduction

Industry is responsible for about 50% of world energy consumption and therefore a big impact concerning greenhouse gas emissions and climate change (Alsharif, Nordin and Ismail, 2015). An important target of Achieving Sustainable Development Goal 7 (SDG 7) – ensuring access to affordable, reliable, sustainable and modern energy for all – with its targets on universal access, energy efficiency and renewable energy, will open a new world of opportunity for billions of people(Vinci *et al.*, 2017). It will lay the foundation for the eradication of poverty, for climate action and for a sustainable world. In simpler terms, with no progress on SDG 7, means it will be impossible to achieve the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change(Vinci *et al.*, 2017). When talking about industry, it must be remembered that small and medium-sized enterprises are a central part of economies worldwide, comprising 99% of enterprises and providing about 60% of employment (Henriques and Catarino, 2016). Increasing availability of reliable energy for their processes represents considerable value for economies, societies and the enterprises themselves (Nyanzu and Adarkwah, 2016). Together with cost savings, renewable energy can deliver other benefits that can help those companies grow and develop, for example by improving productivity, profitability and competitiveness and product quality (Scott *et al.*, 2014). By reducing reliance on energy imports, and lowering environmental impacts, it increases value, not only to business, but also to society. Despite the benefits resulting from renewable energy, their implementation in companies is not an easy task, due to existing barriers that must be identified in order to define motivation strategies that can fight those obstacles(Glemarec, 2012; Kappagantu and Daniel, 2018; V., Prasad and Samikannu, 2018). This paper aims at identifying the situation in medium-sized enterprises and to provide them the necessary conditions to adopt renewable energy for their operations.

Statement of the Problem

SMEs sector has grown to become a veritable engine of economic growth globally resulting in employment creation, expansion of domestic and international market as well as widening of tax base among others (UNDP, 2015). SMEs provide more than 50% of productive employment in developed countries whereas in developing nations over 95% people are dependent on SMEs for employment (UNDP, 2015). In Zimbabwe SMEs contribute more than 50% of the country's Gross Domestic Product (GDP) (Odero, 2016). Despite the contribution by SMEs to developing countries' economies, little is being done to prioritise this sector on reliable electricity supply. In that regard, SMEs are required to invest in alternative forms of electricity energy if they are to remain competitive and productive without shifting their operation times. Mostly, SMEs have deployed fossil fuel powered generators to supply energy for productive use as alternative to the unreliable and inaccessible grid. However, with the verge of climate change and the move towards energy transition, renewable energy mini-grids have been proved to be the most cost effective given their low cost of operation and maintenance as well as low levels of pollution. SMEs in Zimbabwe have not embraced the concept of renewable energy mini-grids for their energy for productive use,

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which is the reason why this paper was done to analyse the challenges and possible solutions for the improved adoption mini-grids by SMEs in Zimbabwe.

Challenges faced by SMEs in deploying renewable energy mini-grid

Some of the challenges faced by the SMEs in developing countries including Zimbabwe as they wish to venture into deployment of mini-grids for energy for productive use, include unavailability or inadequate laws and policies, innovative financing models and applicable business models, among others. These were raised by a number of scholars, (ZELA, 2015; IRENA, 2019; Meier, 2014). According to the Zimbabwe Environmental Laws Association (2015), laws and policies are critical in the deployment and uptake of renewable energy by SMEs in any country, Zimbabwe included. Though the Renewable Energy Policy has been approved by Cabinet in 2019, there is still a gap on the implementation of the policy in terms of regulations and procurement of mini-grid projects in Zimbabwe. The International Renewable Energy Agency (IRENA) noted in its 2019 innovation outlook that innovative financing models are key to boost the adoption of renewable energy mini-grid systems to provide electricity to Small and Medium Enterprises in developing countries such as Zimbabwe. In that regard, the deployment of mini-grids and stand-alone renewable energy systems due to their unique nature in terms of size and communities they serve, calls for highly innovative financing models that attract participation of the private sector like SMEs or small scale entrepreneurs (IRENA, 2019).

Financiers and the private players have limited knowledge and experience with the renewable energy distributed generation systems thus they are not very keen to sponsor the projects of their nature**.** Meier, (2014) supported this and asserted that applicable business models these are usually linked to the financing mechanisms and are usually a challenge to deployment of renewable energy distribution systems especially in low income countries and low demand communities Therefore countries should work on creating conducive business environment that provide incentives to attract private partners to make business sense in deployment of mini-grids for clean energy access for productive use. With the availability of clear supporting laws/policies, innovative financing and business models, the deployment of renewable energy mini-grids by SMEs can be a reality as this will help in access to suitable funding and return on investment assured (Environment, Management and Studies, no date; Anisuzzaman and Urmee, 2006; Glemarec, 2012; Meier, 2014; Baurzhan and Jenkins, 2016; Raisch, 2016; IRENA, 2019).

Opportunities for mini-grid deployment

The EEP portfolio demonstrates that renewable energy mini- grids perform well in terms of electricity generation. They offer stable connections that are cleaner and more affordable than diesel generation and provide a significantly higher capacity than SHS (Raman *et al.*, 2012; E E P Africa, 2018). For the success of mini-grid deployment in Sub-Saharan Africa the following success factors are key. These include financial, technical and socio-economic issues.

Technical Considerations

Before designing a renewable energy mini-grid system, it is always prudent to consider the available energy resource in a given area. Solar PV mini-grids producing AC power are the most popular type of mini-grid in the in Sub-Saharan Africa given the abundance of the solar resource. They are also the easiest to install and operate. Additionally, the maturity of the solar photovoltaic (PV) technology including improvements in development of storage systems have led to falling costs of the solar – battery mini-grids. The next crucial stage is an in-depth assessment of local energy needs and usage before determining which type and size of mini-grid to construct. Systems

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that can start small and then be easily expanded as demand rises are recommended. This brings in the advantage if modularity of solar PV systems equipment.

The renewable energy mini-grid systems have to make business sense in order to attract investment from the private sector. For almost all private sector developers, the systems have to be commercially viable for sustainability. As such private players are moving away from grids that only provide basic electricity for households, and increasing their focus on grids that can support productive use of energy for small and medium-sized enterprises (SMEs). Thus SMEs are a favoured customer for renewable energy mini-grid. Nigeria has devised procurement methods that support these.

Energy management tools and technologies such as Smart meters, remote monitoring and demand-side management technologies are improving the efficiency and profitability of mini-grids in rural areas. Mini-grids continue to offer technical value when connected to the main grid, as they can store energy and ensure a more stable supply for the local community. Systems that are compatible with the national grid have less risks in terms of long-term sustainability. Funding programs such as EEP have an important role to play in supporting the transition of proof-of-concept to scale mini-grid models and technology.

Business Model

For sustainability of systems, mini-grids have to be economically viable, meaning they should make business sense to the developers especially if they are funded by private sector.

The most successful business model in use by mini-grid project developers is the ABC strategy: first Anchor client, then Business clients, and then domestic Consumers. The anchor client is often an agro-processing facility and should be active enough to ensure economic viability. The anchor should have a predictable electricity load profile and, ideally, be willing to adjust its demand profile to match supply. Such a client significantly reduces distribution grid costs. The secondary business clients should also have revenue sources that provide sustainable demand and encourage local economic growth. The energy developer may choose to foster business opportunities by also selling energy efficient appliances and machines to local entrepreneurs. Project viability should not be dependent on domestic customers except in densely populated locations.

Financial Issues

For the success of mini-grid deployment, the following financial considerations have to be taken aboard. Most mini-grid projects receive support from international donors or government authorities to pay for or reduce initial capital costs (Wagemann and Manetsgruber, 2016). This includes a wide range of grants, subsidies, loans, public-private partnerships, and other types of financing. Referring to Africa Mini-grid Development Association (AMDA)'s set of core financial issues, an analysis of the EEP portfolio in indicates that priority should be given to infrastructure financing and subsidy parity(Frisk *et al.*, 2016; Sawin, Seyboth and Sverrisson, 2016). In terms of scaling up projects, the priority issue is off-taker bankability. Public and donor resources for clean energy access must be leveraged to attract private sector capital. This is especially true for wind and hydro mini-grids (Glemarec, 2012). Such projects often require significant upfront investment, even as they benefit from low operating costs.

There are different tiers of financing needed to establish a profitable mini-grid: project finance for capital investments; business finance for small enterprises involved in construction and operations; and end-user finance to enable consumers to connect to the mini-grid and purchase electric appliances (Deshmukh, Carvalho and Gambhir, 2013). Private sector companies need to develop and implement a business model that allows tariff rates to remain low in order to remain

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competitive. The only proven way to do this without relying on grants/subsidies is by stimulating productive use of energy among consumers (Collaborating and Finance, 2015; Vinci, 2017). This will ensure sustainable demand and boost energy sales.

Developers need to invest in smart technology and demand-side management to reduce costs, while also investing in local business development to secure predictable and sufficient revenue. Pay-As-You-Go (PAYG) with mobile money is the best payment model for the region (SSA). According to Rolffs, Ockwell and Byrne, (2015); Blechinger *et al.*, (2016), the most sustainable business model for mini-grids is the ABC strategy of anchor, business, and consumer clients.

Socio-economic Considerations

Deployment of mini-grids come with a number of socio-economic implications to the clients in question, which include but not limited to; the spread of reliable access to energy improves the lives of rural people. Mini-grids offer communities that are not connected to the national grid a cheaper and cleaner source of electricity than current alternatives (such as diesel and kerosene) (Simms *et al.*, 2004).This is assumed to have a positive bearing on the SMEs' cost of production, thus competitive products.

It is important to reserve sufficient time at the start of a project to engage substantively with the local community and build strong relationships with potential customers. A key success factor is to recruit and train a dedicated local team for mini-grid operations and maintenance, including sales and marketing. Investments in training are needed to fill knowledge gaps in technical issues, cost and payment structures, and ethical behaviour. (Simms *et al.*, 2004) Job opportunities have more development impact when they are targeted at women and youth. Mini-grids for SMEs can thus boost the capacity for SMEs to employ and attract more employees in a given community.

The development impact of a small and medium-sized AC grid is substantial to the village it targets. Not only does it provide clean and consistent electricity to households, it also stimulates economic development by providing sufficient power for productive use (Terrapon-Pfaff *et al.*, 2014; Contejean and Verin, 2017). An improved electricity supply for agro-processing facilities brings increased revenues that are fed back into the community. Local business hubs develop around mini-grids, bringing new business development opportunities.

Secure connections for lighting and electricity improves local social services, including education and health care, and increases access to information. The linkages between mini-grids and sustainable socio-economic development need to be made clear (Riva *et al.*, no date; Mohammed, Mustafa and Bashir, 2014; Hatlelid and Aass, 2016). Both qualitative and quantitative facts are needed to raise awareness and stimulate public and private investment in the sector.

Challenges facing SMEs in Deployment of Renewable Energy Mini-grids

Improving access to modern energy services in rural areas, urban and peri-urban areas in developing countries remains a major development priority. Even though many countries continue to pursue ambitious and often challenging grid connection programmes, there is increasing interest in decentralized generation and distribution through mini-grids (GEVP International, 2008). Like any other developments, mini-grid development has its own challenges. Some were cited by (Liang and Zhuang, 2014; Sawin, Seyboth and Sverrisson, 2016; Vinci *et al.*, 2016; Bhattacharyya, 2018).

Many governments in Sub-Saharan Africa including Zimbabwe are yet to provide enabling policies and regulatory frameworks specifically related to tariffs, licensing and permits, and grid connectivity and implement such policies in a predictable and transparent way (Kempener *et al.*, 2015; Bhattacharyya and Palit, 2016; International Renewable Energy Agency (IRENA), 2018;

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ESMAP, 2019). Moner-Girona, Bódis, *et al.*, (2016), cited lack of proper coordination among government institutions, power sector utilities, donors, private sector developers and local communities; including better linkages between mini-grid development and national (rural) electrification plans as one challenge that face SMEs as they wish to venture into renewable energy mini-grid business.

Developers lack access to market data and conduct analyses of consumer demand to help determine load profiles as well as willingness/ability to pay (Pueyo and DeMartino, 2018). (MacGill and Watt, 2015) asserted that SMEs face limited capacity and resources to disseminate information about successful business models and strategies for each tier of mini-grids. Additionally, according to Glemarec, (2012) SMEs suffer limited access to affordable finance such as tailored loans through risk finance companies with lower interest rates and longer payback periods which may stimulate public and private investment in the renewable energy mini-grid sector. Riva *et al.*, (2012); Hirmer and Cruickshank, (2014) indicated that there is also limited local capacity and community engagement to strengthen positive socio-economic impact and increase awareness of the benefits of mini-grids among end users.

Experience from other Countries

There are a number of countries with applicable experiences in renewable energy minigirds, for example Tanzania, Kenya, South Africa, Mauritius and others (Moner-Girona, Ghanadan, *et al.*, 2016). These countries have employed renewable energy feed-in-tariffs (REFiT) to promote deployment of renewable energy as a means to speed up access to electricity. However, Tanzania with an access of 3% in rural areas, Moner-Girona *et al.*, (2016), recommended an off-grid renewable energy feed-in-tariff (off_FiT) as a tool to promote deployment of mini-grids for rural electrification rather than the generic REFiT applied elsewhere. (Moner-Girona, Ghanadan, *et al.*, 2016) suggested that in the case of Tanzania, the off-grid Feed-in Tariff under the Standardised Power Purchase (SPP) program can offer a new alternative to expand energy access through the spread of renewable energy technologies in rural areas by covering the incentives for mini-grids.

Mini-grids can be designed using a range of technical and institutional/financial approaches. Hybrid mini-grids using multiple generation technologies can improve reliability of supply, although there may be trade-offs with management complexity. Further, a study by (GVEP International, 2008), suggested the following key points for consideration when deploying mini-grid. These were lessons learnt from deployment done in other developing countries from Asia and Africa; Successful mini-grid development requires a number of factors to be considered; design based on detailed analysis of local context including natural resources, supply chains, energy demand and current or future energy policies, a favourable policy environment which may involve changes to national laws which favour grid electrification. Moreover, in community schemes sufficient time is required during project design to establish clear governance structures and to build community trust. Mini-grid schemes need to be linked into wider rural development strategies in order to match demand. These will match very well with development plans which are done in line with devolution strategies (GVEP International, 2008). Above all securing sustainable finance to cover upfront costs is as important. Ideally, at least the operation and maintenance costs must pay for themselves (through tariffs) in the long run for schemes to be feasible. There is need therefore for policy makers to consider providing environments that favour financing of such projects by private-public partnerships (PPPs).

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Zimbabwe Experience

Zimbabwe currently has a national electrification rate of 41.5%. While electricity has reached 79% of the urban households, rural electrification is still below 19% (Zimbabwe Practical Action Consulting Southern Africa African, 2012). Practical Action Zimbabwe has developed a number of hydro and solar mini-grids in Zimbabwe from donor funds. These include the popular 99kW Mashaba solar mini-grid in Gwanda, southern part of Zimbabwe and Chipendeke mini-hydropower system in Manicaland (Practical Action Consulting Zimbabwe, 2012; Magrath, 2015). A market analysis by Practical Action, Zimbabwe 2012, concluded that for many of the people and communities living in isolated areas of the country, mini-grids represent the most cost-effective way to provide clean reliable energy for basic household, institutional and productive uses.

Though Zimbabwe has a lot of potential for mini-grids especially the off-grid systems powered from different natural resources like, hydro, wind, solar and biomass, there seem to be low appetite for the area by developers. More than 60% of Zimbabwe's population live in rural areas where the electrification rate is only around 19% (Zimstat, 2012). However, most power project developers tend to favour the big grid connected systems as depicted by the number of licensees by the Zimbabwe Energy Regulatory Authority (ZERA) as compared to non-for mini-grid systems (ZERA, 2018).

However, in its Rural Energy Master Plan, the Rural Electrification Fund which is the Government arm responsible for modernising energy supply in Zimbabwe rural, has mini-grids as viable means for achieving universal clean energy access in the country Rural Energy Fund, 2016). This plan lacks the implementation framework and procurement framework that provide for private players to play their role. From a studies on success of mini-grids in South Asia, by Connolly *et al.*, 2015a, 2015b; Safdar, (2017), it was found out that sustainability of mini-grids and off-grid systems is anchored on availability of demand for energy for productive uses rather than household and social uses. Therefore, SMEs are key stakeholders in scaling up deployment of renewable energy mini-grids in Zimbabwe. The Rural Electrification Fund can work in partnership with SMEs to speed up uptake of mini-grid systems for energy access in the country and rural and remote areas in particular.

The policy Framework in Zimbabwe

The policy framework if Zimbabwe consist of the National Energy Policy of 2012 which has expanded the mandate of the Rural Electrification Fund to go beyond just grid extension but to look into all solutions that bring clean and sustainable energy to unconnected areas (Republic of Zimbabwe, 2012). This led to the development of an all-encompassing Rural Energy Master Plan of 2016. The plan has in it economically and technically viable solutions for grid extension, grid connected mini-grids, off-grid mini-grids and stand-alone systems like Solar Home Systems and isolated solar water pumping systems as means to stimulate electrification for universal access to clean and sustainable energy in Zimbabwe. Guided by the National Vision 2030, the Government of Zimbabwe also approved the National Renewable Energy and Biofuels policies in 2019. In addition, net metering regulations were also approved for implementation to promote distributed electricity generation, connected to the grid. However, the country has no regulations for off-grid systems and subsequent procurement and funding mechanisms.

Zimbabwe is a net importer of most of the equipment for solar and other renewable energy installations including the batteries for storage. This led to a higher cost of setting up a renewable energy mini-grid and thus higher energy tariffs. The current conventional electricity tariff is still being worked on towards cost reflectivity, which means the tariff is lower as compared to mini-grid one. However, the Government has made efforts to incentivise importation of solar and other

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renewable energy and energy efficient equipment by removing import duty through a Statutory Instrument in 2010.

Conclusion and Recommendations

The Zimbabwe is not spared from challenges that are being faced by other developing countries and Sub-Saharan African countries in the deployment of renewable energy mini-grids. In that regard most of the solutions that apply to these countries also apply to Zimbabwe. However, Zimbabwe has a unique situation in that the Government lacks resources to subsidise the renewable energy mini-grid developers, thus cost reflectivity of tariffs becomes key in development of mini-grids for energy access. This therefore brings in the greater role to be played by Small and Medium Enterprises to be anchor customers for renewable energy mini-grids if they are to be commercially sustainable. Given the situation that the Government has limited funding for subsidy, it is recommended that more incentives on top of the duty-free exemption in place. This will capacitate SMEs and other private players to invest in deployment of renewable energy mini-grid to augment the national grid which is intermittently supplied.

Funding and procurement mechanisms for mini-grid developers are very critical for the success of mini-grid deployment. On the same note, community engagement and ownership schemes have a strong bearing on sustainability and continuity of systems. It is thus recommended that the Government together with the Regulator hasten the development and implementation of the funding and competitive procurement mechanisms that encourage the productive use of energy by developers and SMEs. Also, the Government should work with stakeholders to establish ownership mechanisms that ensure involvement of communities and private players for sustainability and speed deployment of renewable energy mini-grids as most of them lack access to clean and reliable electricity supply for their operations, especially the manufacturing sector.

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Citation: Kavu, S; Chigerwe, J; Kajongwe, C & Magombo, G.S. (2020). Assessment of the Feasibility of Deployment of Renewable Energy Mini-grids for Rural Electrification for Small and Medium Enterprises (SMEs) in Zimbabwe. *Journal of African Interdisciplinary Studies,* 4(4), 78 – 88.

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