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Review Article

The Potential of Distributed Generation in Malawi

C. Tenthani[a*] C.C. Kaonga[b] & I.B.M. Kosamu[c]

[a,b,c]Physics and Biochemical Sciences Department, University of Malawi, The Polytechnic, P/Bag 303, Chichiri, Blantyre 3, Malawi

*Corresponding author; E-mail: ctenthani@poly.ac.mw; Cell: +265 5 684 682

Abstract

About 95% of Malawi's electricity needs are provided by hydropower using the Shire River cascaded hydro schemes and Wovwe mini hydro plant in the Northern Region. The total installed capacity of 302MW (20% of which is lost during transmission) does not meet the current demand. Only 7.6% of the Malawian population has access to electricity. This figure accounts for 20% of the urban population and only 1% of the rural population. Distributed generation is by definition the type of generation with capacities of about 10MW or less and interconnected at a substation, distribution feeder or customer load levels. Distributed generation technologies include internal combustion engine-generators, wind turbines, fuel cells, small and micro sized hydro schemes and photovoltaics. Since for distributed generation systems generation and consumption of the power is localized, resistive losses during transmission and distribution are minimized. The sizes of distributed generation systems is small as such they have lower capital costs than huge centralized installations. This paper discusses the potential of distributed generation and how it can help in meeting the electricity demand for Malawi.

Key terms: distributed generation, generation capacity, capital costs, electricity demand, Malawi

Introduction

Energy in general is important for development of a nation in all sectors. Actually energy is a crucial input into any industrial processing and serves as the life-blood for any economy. Though not mentioned exclusively in the Millennium Development Goals (MDGs), it is directly or indirectly linked to all the different MDGs because modern energy service provision is crucial for the overall social and economic development of any nation or region in the world. Energy is a major requirement without which MDGs cannot be attained, especially in sub-Saharan Africa where poverty level has been increasing over the years. [1].

MDG 7 which aims at achieving environmental sustainability calls for integration of principles of sustainable development into country policies and programmes and reverse the loss of environmental resources. It must be noted however, that, energy production, distribution and consumption has many adverse environmental effects at the local, regional and global levels including indoor air pollution in slum communities, land degradation and global warming. Cleaner energy systems are needed to address all of these for environmental sustainability. The essential beneficial role of energy as an input to achieving this MDG is not reflected in the MDG framework. Energy use and production, however, affect local, regional and global environments. Fuel wood and charcoal use in households and industries is unsustainable when it leads to land degradation from fuel wood gathering and to indoor air pollution from biomass combustion. Likewise, combustion of fossil fuels can lead to outdoor air pollution, acidification of land and water and emissions of greenhouse gases. In all these cases, the environmental damage and its harmful

effects can be reduced by increasing energy efficiency, introducing modern technologies for energy production and use, substituting cleaner fuels for polluting fuels, and introducing renewable energy.

At present, about one quarter of the world's population, have no access to electricity. Without such access to electricity, it is virtually impossible to carry out productive economic activity or to achieve environmental sustainability [5]. In Malawi, about 95% of Malawi's electricity needs are provided by hydropower using the centrally located Shire River cascaded hydro schemes and Wovwe mini hydro plant in the Northern Region. The Electricity Supply Corporation of Malawi (ESCOM) Limited is the sole provider of electricity and manages the generation, transmission and distribution of the power throughout the country. The total installed capacity of 302MW of which about 20% is lost during transmission due to resistive losses is not enough to meet the current demand. Even though only 7.6% of the Malawi population has access to the grid, load shedding is the older of the day. This figure accounts for 20% of the urban population and only 1% of the rural population.

Malawi is well endowed with a wide variety of energy resources [5]. The country receives about 20.81 x $10^6 Jm^{-2}$ of insolation which is good enough for solar energy applications that can be used as substitutes to conventional ways of energy provision like cooking using firewood. Apart from that it is known that Malawi has potential sites for small, mini and micro hydro schemes that would be able to supply to local communities at reasonable costs. However there are constraints that have inhibited the development of the energy sector and these include; structural, operational and institutional challenges. The Government aims to reduce the duration of black outs, increase access to reliable, affordable electricity in rural areas. One of the activities that the Malawi Government wants achieve this is by construction of multipurpose dams that will among other functions be used for electricity generation. However, with the financial constraints and high costs associated with such type of projects this has not been done.

Distributed Generation

Electricity providers have for many years depended on producing electricity at a centrally located position and distribute it through extensive transmission and distribution networks. However, as the demand increases the capacity to generate, transmit and distribute the energy is always constrained. The most obvious direction to take is to build new plants to meet the increasing demand [6]. Alternatively, this demand can be met by generating the power locally using small scale technologies in what is known as distributed generation (DG). Though with many differing definitions, DG can be defined as the production of electricity near or at the point of use with capacities of not more than 10MW interconnected at a sub-station, distribution feeder or at the customer load levels unlike central power stations that are usually located far from load centers [1]. Distributed generation technologies include but are not limited to internal combustion engine-generators, wind turbines, fuel cells, small and micro sized hydro schemes and photovoltaics. DG is not a new phenomenon because it spans as early as the 20^{th} century before alternating current was used as all power requirements including lighting, heating and cooling were supplied at the point that the power was required [11].

This paper discusses the potential of distributed generation and how it can help in meeting the electricity demand for Malawi. This will be done by looking at the environmental aspects of DG technologies against centralized plants and also on the cost implications of the two.

Potential Benefits of Distributed Generation to Malawi

Advantages of distributed generation over centralized generation would be categorized into two broad areas of costs and environment [3]. Transmission and distribution of electricity, apart from contributing to environmental degradation through the laying of long distance transmission lines, comprise the biggest challenge that utility companies have to supply electricity to users as their costs are usually high. This means that for those areas that do not have access to the grid DG technologies can play an integral role in reducing these environmental concerns and costs. DG technologies can be installed for various reasons some of which include; selling of power to the grid, which would be a possible source of income, providing backup power for critical loads like in hospitals, prisons and schools and supplying to sensitive loads [7].

Some distributed generation technologies including those that are powered by renewable resources that use modern emission control systems such that the power produces has less impacts on the environmental as compared to the conventional counterparts. Distributed generation in form of biogas digesters that produce methane gas from waste products for cooking can provide an economic incentive. This can be achieved by using the gas as a substitute to firewood or charcoal thereby reducing deforestation.

If generators are located where there is no access to the grid costs for extension of the grid could be delayed, reduced or even be eliminated. This saved resource could be used for other purposes or indeed building new small plants to increase access to energy to those that do not have. The actual benefit of distributed resources in deferring grid investments is site-specific and depends on their ability to reliably serve peak loads on congested transformers, feeders and lines [9].

Smaller, more modular units require less project capital and cause less damage to the environment through site clearing which is the case with large scale projects. To the extent that distributed generation operates reliably during standard peak periods, severe weather events and high market prices, it reduces demand on the utility system when power costs are highest and the grid is most congested. Customers can use their generators to participate in demand response programs. And utilities can make use of distributed generation to keep their costs down during the highest load hours of the year.

Black outs or load shedding coupled with power quality problems can cause severe financial losses for businesses through process disruptions, losses in finished products, equipment damage, lost productivity and failure to meet customer needs [10]. Distributed generation can provide the very high reliability and power quality that some businesses need, particularly when combined with energy storage and power quality technologies [11].

Distributed generation provides reliability benefits for the utility system by adding generating capacity; freeing up the utility's own generating resources or contracted supplies; freeing up distribution system capacity; reducing congestion on the transmission system, improving the reliability of supply into the service area; and providing backup power to support utility maintenance and restoration operations.

In terms of security it is seen that a large number of small units are more reliable than a small number of large units. This is the case because in case of an attack of failure of one of the units, power can still be generated from the remaining systems and be fed into the other smaller grids. Small units do not require a large block of potentially costly replacement power, and they tend to be faster to fix. Distributed resources further increase reliability by reducing the distance the power must travel and the number of grid components that could fail along the way thereby reducing the cost of distribution and losses due to resistive heating. Apart from that small generating equipment can more readily be resold or moved to a better location.

Distributed generation is available in Malawi through individual companies like the diesel powered units at Kayerekela in Karonga, the Kavuzi micro hydro plant in Nkhata-Bay with installed capacity of about 10kW, the Lujeri mini hydro scheme with a generating capacity of just under 1MW [7]. Further to that ESCOM had a gas power plant in Blantyre, a thermal one in Mzuzu rated at 1.1MW and at Likoma Island with rated capacity of about 1.050MW [4].

Challenges Associated with Distributed Generating Systems

Central rather than distributed generation is still the preferred electricity generation in many countries including Malawi because of economies of scale. It is a known fact that when large systems are developed the cost per megawatt decreases compared to smaller units [2]. However, for countries like Malawi, who do not have enough capital and have other priorities apart from energy generation and supply, smaller units look like a better option because of their lower initial costs. Further to that it is seen that the advantage of economies of scale is decreasing over the years because of advances in technology that has resulted in building small generators that can provide energy as cheap as that from large generators [12]. The other challenge would be conditioning of power so that it is of the same frequency in the case where it is connected to a common grid. This however, can be abated by having a regulating body that will ensure that before the power is fed into grid it is of good quality.

Concluding Remarks

It has been see that DG technologies do not only offer alternative low cost power to consumers because of some of the costs that can be averted if such a system is preferred to the local large scale generation but also conserve the environment by making use of renewable sources of energy. The Malawi Government should therefore explore issues related to distributed generation and see whether it can engage ESCOM or individual investors to venture into constructing such small plants. There is need to investigate how to include distributed generation in utility planning and acquisition processes to meet energy, capacity, distribution and transmission system needs at the lowest cost. Policies to advance distributed generation should take into account how to achieve desired benefits.

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