

Pico Solar PV Systems Development in Kenya as Opposed to Rural Electrification

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Abstract-Pico Solar homes systems use have greatly grown in Africa with Kenya taking the lead. Most rural areas do not have to electricity. Due to poverty most households cannot afford electricity either way, hence settling for kerosene or candle as their source of lighting. This can lead to health problems and is expensive in the long run. This study discusses power situation in Kenya. It explains why we need to embrace solar in the rural areas as compared to national grid rural electrification. Majority of Kenyans still use kerosene for lighting even though the Pico PV is very affordable. The government, donors and solar companies have a big role to play in promoting the use of green energy in the rural areas. This can be done by creation of awareness of the product and ensuring that the standards on the solar systems are met.

Keywords- Solar Pico home systems, Renewable energy, sustainability, PV systems, rural electrification in Kenya, Challenges facing solar in homes.

I. INTRODUCTION

Access to electricity in rural area is one of the major challenges that Kenya is facing in terms of energy hence there is need to explore solar as a resource to provide power. Even in area with electricity, the power is not sufficient to meet the demands of people hence sometimes there is power rationing. Use of solar has grown in Kenya for example Garden City and Strathmore University are powered with solar installed in their roof tops. Another project is Changoi tea farm in Bomet County where British firm solar century installed 1MW PV solar system. And many more projects are coming up like the 3 mini grid solar project to be developed in Turkana. Talek together with the county government of Narok and German Agro Action has set up a power mini grid in Narok consist of 50 KW solar-hybrid generation power plants. All these projects show that Kenya is advancing in solar as renewable source of energy.

Insolation rate in Kenya is high at about 5-7 peak hours in a day receiving an average daily insolation of 46kWh/m². Approximately 200,000 Kenyan homes have solar home systems [14]. A PV solar systems annual sale in Kenya is between 25,000-30,000 PV modules. This is because many private companies have joined in the solar business by ensuring that the solar PV best fit the purchasing power of the rural homes and that they are easily accessible. The project on

Pico home solar system was funded by World Bank to promote off-grid lighting products in Sub-Sahara.

A Standalone institutional PV system is another project which many institutions are now interested in, but the system can only be installed under the government procurement. 700 institutions had embrace standalone institutional PV systems by 2014. Solar PV systems in public institutions result in a total power output of 2MW (Mbiti, 2014). The government is also planning to install solar systems in all the primary schools to provide power for the laptop project. 220 schools are already installed with solar system with a total capacity of 574.22 KW. Solar streets lighting is another project on solar which has been very rewarding millions of shillings has been spent in installation of solar streets lighting hence increase in Kenyan security.

Large scale grid connected PV systems is still on the low in Kenya but the government placed a Fit in Tariff policy for commercial projects that wants to contribute to the national grid [9]. This has encouraged many private sectors to invest in solar energy leading to about 25 Fit in Tariff already approved and being developed. Kenya power is currently operating 18 micro-grids with a total capacity of 19MW [14]. Of which two sites have the wind generation and 6 sites with solar generation installed with capacities of 10 (Merti), 30 (Habaswein), 50 (Elwak), 60 (Lodwar), 60 (Hola) and 300KW. Other 9 micro grids are under construction financed by REA.

A. Why go solar?

Hydro power and geothermal power in Kenya does not meet the demand of energy in Kenya leading to power rationing in many areas of the country. Kenya being at the equator and having sufficient solar can utilize the use of solar energy to provide electricity. Solar plants can easily be built and deployed.

What makes it more suitable is the fact that solar is carbon free. There is zero emission of CO₂ or any other gases which can enable Kenya to fulfil vision 2030 which is to embrace the use of renewable energy as a way of reducing global warming.

Poor and most marginalized community always have the greatest dependency on the environmental assets for their basic needs such as forest resources, land and water [17]. Since solar is a natural resource it has been used a lot in developing countries in preservation of food, heating water and sometimes cooking. Hence it is easier for the people to adapt to solar energy because they are familiar with it and it is a free resource too.

Solar has boosted many businesses especially in the rural areas where there is no electricity. There are many entrepreneurs using it to charge for people's phones, to operate a barber shop and many other businesses which require low power. Some institutions have even opened a solar operated cyber to make it easier for the local to access the internet and become computer literate. Hence solar has led to the growth of Kenyan economy by far.

Schools with solar has made it easier for the students to have night preps hence they can read at night in school instead of going home and reading with traditional lamps which are not good for the eyes. This has boosted education in Kenya.

0.27 Million euros have been used to install the solar street lights especially in the western region. This has increased the security in Kenya. In some towns the street lights has enabled them to operate their businesses until late hours smoothly.

There is a drift from diesel pumps to solar pumps which are used for irrigation and to supply water in the buildings. This is better because after installation there is no additional cost of buying the fuel.

70% of Kenyans are not connected to the national grid hence they are forced to use expensive sources of energy like paraffin lamps and firewood which leads to a lot of pollution and damage to their health (Martin Kaggwa, Shingirirai Mutanga and Thokozani Simelane, 2011). This is the reason why home Pico solar system is of a great benefit to many people. The price of these solar systems keep reducing every year and hence becoming affordable. The fact that many rural homes use very minimal power makes it a suitable source of energy [19]. Many homes are connected to 3-6 lamps and a radio or TV which comes to 30-60 kWh per month.

B. Power Situation in Kenya

About 1700MW is the generation capacity of Kenya which is far below the recommended reserve margin [3]. By 2030 the capacity is expected to grow to 15,026MW after employing other forms of renewable energy which solar is one of them.

The number of customers connected to electricity by 2014 was about 2,286,065 and the number is expected to rise every year which means the demand of power in Kenya will keep rising yet even currently there is no sufficient power to accommodate Kenyans. Kenya still imports electricity from Uganda and there is power rationing sometimes.

The government has set projects which will raise the power capacity of Kenya to about 6700MW by the end of 2016.

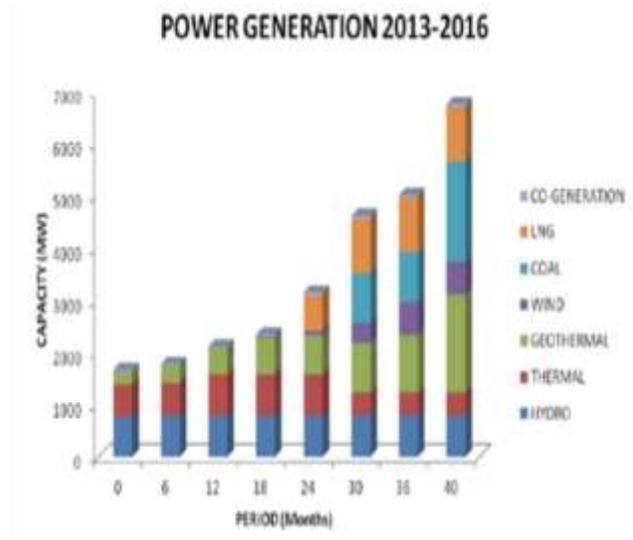


Fig 1: Power generation graph in Kenya

C. Pico solar home systems in Kenya

Pico solar home systems are very common in Kenya. The number of households keeps increasing especially in regions which are not connected to the grid with over 100,000 homes using these home systems. In Kibera slums in Nairobi, the youths are producing small solar panels which can operate the radio and charge phones. Pico homes systems consist of 12-14 watt photovoltaic panel, LED lights and lead-acid batteries [12].

The market for Pico solar systems have grown with many companies producing and selling the systems. The light African programme and World Bank test the lighting products to ensure that they meet the standard and give free training to technicians [8]. This program has enabled more than 35 million Africans to have access to clean and affordable lighting, and is targeting to reach 250 million Africans by 2030 [21]. According to a recent market research many people would like affordable lighting systems which are bright enough, portable, easy to operate, secure and have durable batteries [2].

Technology of the Pico home systems have improved with time. The focus now is to make more efficient electronics by use of LED lights to reduce the power requirement in homes. This will enable these solar systems to meet the demand in homes [11]. Apart from lighting there is a demand of mobile charging using solar in the rural areas. This takes about 2W in about 2 hours to charge a phone. The users are advised to charge their phones during the day directly from the sun without the need of a battery to avoid power loss due to storage [20]. This also offers a good business of creating

charging points in the village where people can charge their phones at a price.

Many rural homes use solar for lighting less than three rooms and for watching TV. This makes it easy to meet their energy demand with solar power rating of less than 10W. There are a number of homes which desire to use refrigerator, iron box and fan. Solar home system cannot meet this demand since a fridge consumes about 0.6 KWh/day and a fan can consume about 0.3 KWh/day [8].

1) What is dragging the growth of solar use and deployment in Kenyan Homes?

Solar is still very expensive in Kenya and its suitable for only scale off grid application. Solar produces low energy output compared to geothermal and hydropower plants. Solar power is unpredictable since the weather can sometimes change hence the energy output can go lower especially during cloudy and rainy seasons [18]. Consumers with low energy demand are willing to take up the solar system. This is not the same for consumers with higher energy demand such as households with refrigerators, iron box and microwave. This is because they will still need to use electricity from the grid or acquire a high powered solar PV which is expensive.

Poverty rate in Africa is very high hence many people cannot afford the solar home system as much as they are very affordable. There is limitation of access to finance where loans are not easily provided for people. There are programs which have come up like MKopa where Pico solar home systems are given on hire purchase basis. This has enabled many Kenyans in the rural areas to own such systems.

Consumers are unaware of the products. Many people still don't know the existence of the solar home systems and the few that do, do not know their benefits and affordability. Many Kenyan homes still use kerosene and candle for lighting which is very expensive in long run compared to solar home systems. If they are to be enlightened on how much money they spend on kerosene in a year compared to buying a solar which can serve you for 20 year, and the health hazards that kerosene has on the body; then most of them will shift to the use of green energy.

Existence of poor quality and cheap products has made many consumers to lose trust in the solar home systems. There is market spoilage due to availability of substandard products in the market. This makes it hard to penetrate the market and to tell the difference between the genuine and counterfeit products [10]. According to a study done by light Africa in 2009, 13 out of 14 Pico PV are substandard in the rural areas. It is therefore very important to educate the consumers and the entrepreneurs about counterfeits products so as to enhance the market for Pico PV.

Unavailability of enough technicians who are experts in troubleshooting, repairing and maintenance of solar systems

has contributed to the slow growth in the usage of the systems. When a system breaks down then the consumer might be forced to travel to the nearest city for repairs due to lack of technicians in the rural areas. There should training for technicians in the rural areas who can assist in installation and repair at a fee. This will provide jobs for the youth as well. However if the market is low, the trained technicians might move to the city to make more use of their skills.

The market for solar in Africa is growing yet there is still no solid solution to handle the electrical waste of the solar. Recycling of the product is very hard hence leading to compilation of the waste. This is a broad area that is still being studied to find solutions to this problem. Does this make solar green technology after all?

D. Limitations of rural electrification in Kenya

The energy demand in the country is higher than the generated power and keeps growing faster than the capability of investing on additional generation plants. This has led to frequent blackouts especially in the rural area. There is overdependence on hydropower which is controlled by the weather conditions. During the dry season with no rains, the dams dry up leading to low power output. This leads to importation of power from Uganda and Ethiopia.

The distribution network in the country is poor. The national grid has not reached other regions especially those with poor terrains. In addition, there is shortage of transformers leading to overstressed distribution network. Building of power generation, transmission and distribution requires a lot of capital. This can lead to delay due to overdependence on donors funding or the government. The process may take a long time from proposal to commissioning [4]. The rural areas with no national grid are forced to use other sources of power with majority using kerosene and candles. This is the reason why the market for Pico PV is high in the rural areas. Even if the grid was accessible, the cost of power is high for the poor who are surviving on \$1 per day. The government launched a rural electrification where there is free installation of power to rural homes[1]. But many families cannot afford the cost of power. Solar Pico is a better option because once bought, can serve a consumer for 20 years without monthly charges.

E. How to increase usage of Pico solar home systems

The Kenyan government has a big role to play in promoting the use of solar. This can be done by ensuring a rational tax regime and import duty is practised. The energy market should be open to competition. The power generation, transmission and distribution should be open to anyone who wants to invest. This will encourage more companies to invest on green technology and ensure that they provide quality service [7]. The country will be able to meet their energy demand.

Accessibility of solar equipment can be made possible by offering outreach and awareness of the products in Kenya through advertisements, workshops, seminars and exhibitions. The government need to allocate funds for such events. This will encourage use of solar in towns as well as the rural areas.

Technical standards for the solar systems should be set and applied. Many companies are producing substandard goods which end up breaking after short period of time [6]. This has led to lack of trust from consumers hence reduced usage of the solar home systems. The market for solar systems can be affected for a long time due to lack of quality assurance scheme by the government on the products

The donors and others companies investing in solar can also help by starting programmes to educate people on the importance of solar energy and its affordability [5]. There should be supporting micro- credits that can enable people in the rural areas to acquire the Pico solar systems and pay slowly with the money they would have used on kerosene.

II. CONCLUSIONS

Use of Pico solar home systems has greatly grown in Kenya with over 100, 000 homes using these systems by 2013. However 60% of the households still use kerosene and candle for lighting. This is due to the fact that majority of the people are still unaware of the existence, the benefits and affordability of the systems. This is also brought about by the existence of substandard products in the market leading to loss of trust on the products. Pico homes systems still stands a higher chance of being embraced in the rural areas than the national grid rural electrification. This is because majority of the rural population cannot afford monthly power charges. But can afford Pico PV with the support of micro-finance companies

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