Electrification of rural villages in Myanmar with photovoltaic solar energy on the basis of GIS data

Lin Htein1,*, Alexandr Bobyl2, Vladislav Malyskin2, Sergey Sanin3, Alexey Cheremisin3, and Angelika Gerner4

1Department of Photonics, St. Petersburg Electrotechnical University “LETI”, St. Petersburg, Russia
2Ioffe Institute, St. Petersburg, Russia
3All Russian Research Institute of Phytopathology, Moscow Region, 143050, Russia
4Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, 195251, Russia

Abstract. In order to be effective and optimal solar installation, especially for site selection, there are lots of things to be consider such as technical, economic, social situations, etc. For the purpose of electrification of rural villages in Myanmar with photovoltaic solar energy, using the geographic information system (GIS) is a lot helpful. According to transportation network, we can make a category, “Hard to reach villages” and again power line data can also decide which villages will be priority. Then according to population density, we can decide the size of the installation.

1 Introduction

Rural Electrification is a problem that many countries are still trying to solve nowadays. As Myanmar, currently only 48.3 % of total households have access to electricity. Since 70 % of total population live in villages and almost all urban area has already access to electricity, electrification of villages is the most important thing to do. Although national electrical grid system of Myanmar is being developed year by year, it is still fur away to reach the goal of 100 % electrified and also there are lots of rural villages which are not cost effective to extend the grid system. For that places, Photovoltaic (PV) solar energy can become alternative solution.

The potential solar energy of Myanmar indicated that “The highest GHI is identified in the central, lowland area of the country, where average daily totals reach yearly total of 1900 kWh/m2 (average daily total up to 5.2 kWh/m2) or higher. Further north, GHI values falls between 1400 and 1600 kWh/m2 (average daily total from 3.8 kWh/m2 up to 4.4 kWh/m2). Minimum GHI values in northernmost part of the country are lower than 1300 kWh/m2 (average daily total approx. 3.6 kWh/m2), yet the solar resource in these areas is still sufficiently high.” [1].

* Corresponding author hteinhteinlin@outlook.com
2 Using the geographic information system (GIS)

There are lots of GIS data that we can use for consideration but, here, we only used some simple data. They are village points (location), power line (the current grid connection), settlement (population density), transportation network and solar irradiation. The GIS data we used are provided by third party source [2, 3]. According to transportation network, we can make a category, “Hard to reach villages” and again power line data can also decide which villages will be priority. Then according to population density, we can decide the size of the installation.

In fig.1 the black dots are villages. Villages inside the red color, are “Hard to reach villages” that have no good road connection according to government data. Also, there are no power line (grid system) to these villages. Population of them are lower than ten thousand. Moreover, according to solar GIS data, these places have moderate or more solar irradiation. After considering above data, finally we got the villages as we see in Fig1, which should be priority for solar energy. After that we chose one specific village to create a model for solar energy by using Homer simulation software.

The black arrow indicated the village we chose, called “Tha Ngar” whose location is 23°58'25.0"N 94°36'24.5"E. It has 2959 population and 439 household. 10 km away from road and 68 km away from grid connection. For climate data for this village, we used NASA data. In simulation, we recommended three different types of load scenarios which were low, medium and high-power consumptions;1kWhr,6kWhr,16kWhr(daily) respectively for them in order to able to choose. But even the high consumption was still low comparing with urban usage but this is for minimum cost. Two systems, PV only and Hybrid (PV-Diesel) for each load scenario were compared.
Fig. 2 is only for “PV only” system of High consumption. As for PV-Diesel hybrid system, the production was lower and each share almost half of the production (PV 50%-Diesel 50%). Generally, PV system should have backup system because there are some conditions when PV system can’t be available (due to weather, maintenance etc.). But here it was simulated without backup generator in order to compare PV only cost and Hybrid systems.

3 Discussions

Simulation result recommended a little more diesel usage in hybrid system because of its cost (initial cost, fuel cost) seem cheaper than PV cost. But the fuel cost here we used, was 0.67$/L which was urban price. Generally, in rural area of Myanmar, the fuel cost always more than the urban price due transportation, usually can be double or even triple. Energy storage cost also highly effects on system cost. Current leading technology of solar energy storage in Myanmar is Lead Acid batteries which are expensive and have some failures such as voltage drops, very short life (sometimes less than 20 months) [4]. But now it is also started to recommend to use Lithium-ion battery in Myanmar because of its longer lifetime and falling price.

Due to analyzing only one place in this, it was difficult to cover details of all rural areas in Myanmar. But most fundamentals and backgrounds situations are similar so that we can adopt this while considering to other villages or rural area of Myanmar in future. At least, neighbor regions of this village which can be seen in Fig.1 can also be similar result because of similar climate data and situations.

Hybrid were cheaper than PV only due to the reasons we discussed above. Moreover, at initial cost PV only had to be calculated all cost while hybrid did not need to consider all fuel cost at initial stage. Overall, we can say that PV system is cost effective and good solution for electrification rural area of Myanmar.

For further alternative ways related with PV although it was not analyzed in this paper, there are also good potential for other solar hybrid systems (solar +diesel, solar +wind, solar +Biomass) [5]. Moreover, not only off-grid system but also mini-grid and on-grid system should be considered [6].
4 Conclusions

Levelized cost of energy (LCOE), shown in simulation ranges from 0.36 to 0.41 US $/kWh for Hybrid and from 0.47 to 0.485 for PV only. It will be more suitable in future because of price falling and technologies development. So, PV system can be recommended as one of the reliable alternative energy sources for rural villages of Myanmar. Moreover, in rural electrification, it is not only for household usage but also for others such as worship places (pagoda, monastery), Education (primary school), small business, Agriculture related usage (irrigation), etc. Almost all villages in Myanmar have above places at least one or more and they also need electricity.

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