

# Design and Calculation of Solar Power Plant in Myanmar

Dr. Zarchi San<sup>1</sup>, Dr. Than Zaw Htwe<sup>2</sup>, Daw Thidar Win Ngwe<sup>1</sup>

<sup>1</sup>Lecturer, <sup>2</sup>Professor

<sup>1,2</sup>Department of Electrical Power Engineering, Ministry of Education,  
Pyay Technological University, Pyay, Myanmar

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The following solar energy technologies can be successfully propagated: solar cookers; solar water heating systems for industrial application; solar distillation units for battery charging; solar photovoltaic systems for water pumping, battery charging, and power supply to children's hospitals for operating vital equipment. Solar air driers can be used for agricultural and industrial products.

Off-grid photovoltaic (PV) systems are used for supplying electricity to rural areas. Since Myanmar is a land of plentiful sunshine, especially in central and southern regions of the country, the first form of energy- solar energy could hopefully become the final solution to its energy supply problem. The direct conversion of solar energy into electricity using photovoltaic system has been receiving intensive installation not only in developed countries but also in developing countries.

It is mainly intended to present solar energy potential and application in Myanmar. It is also wanted to get the benefits of using solar energy for people in remote areas which are not yet connected to the national grids because of the high price of fossil fuel. MEPE (Myanma Electric Power Enterprise) experimental measurements indicate that irradiation intensity of more than 5kWh/m<sup>2</sup>/day was observed during the dry season.

In Myanmar, about 35 % of country areas is covered by national grid (MOEE). The Republic of the Union of Myanmar is a developing country with 53.37 million people of a total

## ABSTRACT

PV technology is the most famous among the several renewable energy technologies that was adopted globally. According to Myanmar weather condition, solar power plants are the best renewable energy source to provide electricity for both urban and rural areas. The case study is selected Tat Thit Kyun where is situated Latitude 18°44'N and Longitude 95°11'E 5.6 mile away from Padaung Township. 312 kWh demand is needed for 387 numbers of household. Data is obtained from Meteorological data of the village and NASA.

**KEYWORDS:** PV technology, renewable energy, urban and rural areas, Meteorological data, NASA

## I. INTRODUCTION

Solar energy is the energy that is available from the sun in abundance. Solar power plant is based on the conversion of sunlight into electricity by using photovoltaic (PV). Photovoltaic converts light into electric current using the photoelectric effect.

Solar power in Myanmar has the potential to generate 51,973.8 TWh/year, with an average of over 5 sun hours per day. The country aims to generate 8% of electricity through renewable energy sources—through wind and solar energy—by 2021 and 12% by 2025. The solar radiation of Tat Thit Kyun Village is 6.6 kWh/m<sup>2</sup>/day.

population (Population of Myanmar 2018 and historical); about 70 % of people live in rural areas (UNFPA Myanmar Country Profile). The national grid electricity of capacity in Myanmar is lower than demand because of the rapid increase of population. As a result, 50 % of population still lack of electricity. Therefore, there is a problem to solve the lack of electricity especially in rural areas.

## A. Case Study Area

Mega Global Green Automation Company Ltd is tendered to build solar power plant in Tat Thit Kyun Village. Tat Thit Kyun Village is locality in the middle of Ayarwaddy river, there is one of island, Tha Yey Lane village track, Pa Daung township Bago Division in Myanmar. Travel mode is just river cross by boat. Major business is agribusiness and fishery. One Primary School and three Buddhist Monastery. It was long village and five main road in Village.

The village is 4.89 miles away with National Grid but cannot to connect with it by river cross. Hydro power, wind power cannot use in this village because the source of this power aren't sufficient to use. The cost of diesel generator is more expensive than solar power. The propose project can be distributed the electrification to 387 household, 101 street lamp throughout 6 main road, multimedia classroom in one primary school, three Buddhist monastery and many of small scale industry business in village. If extension of national grid, the situation is ready to connect.







The altitude angle is the angle between the sun and the local horizon directly beneath the sun. From Figure 3, we can write down the following relationship by inspection:

$$\beta_N = 90^\circ - L + \delta \quad (5)$$

$\beta_N$  = altitude angle of the sun at solar noon  
 L = the latitude of the site

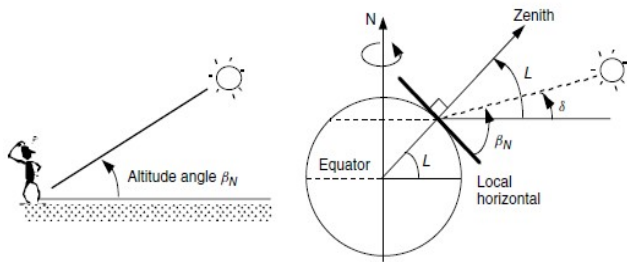


Figure3 the altitude angle of the sun at solar noon.

### F. Stand Alone System Design

For stand-alone sizing of PV systems, (1) Sizing of the PV Array and (2) Battery Sizing should be considered.

#### 1. Sizing of the PV Array

Designing stand-alone PV-battery systems is clearly much more demanding than sizing grid-connected systems. Month-by-month load estimates and solar resource evaluations, making trade-offs between ac and dc loads, choosing a system voltage, and determining battery storage with or without a back-up generator are things that simply don't apply to grid-connected systems. Having addressed those topics, the most important part of the system: the PV array.

Our simple sizing procedure will be based on the same "peak hours" approach used for grid-connected systems.

For the solar power plant, the step by step calculation is required by using the following equations.

$$\text{Required array output per day} = \frac{\text{Total energy demand per day}}{\text{Inverter efficiency}} \quad (6)$$

$$\text{Energy output per module per day} = \text{PV module power at STC} \times \text{peak sun hr} \quad (7)$$

$$\text{Module energy output at operating temperature} = \text{energy output per module} \times \text{derating factor} \quad (8)$$

$$\text{No. of module required} = \frac{\text{Required array output/day}}{\text{Module energy output at operating temperature}} \quad (9)$$

$$\text{No. of string in parallel} = \frac{\text{Inverter maximum current}}{\text{Module current}} \quad (10)$$

$$\text{No. of module required per string} = \frac{\text{no:of total module}}{\text{no:of string}} \quad (11)$$

#### 2. Battery Sizing

Stand-alone systems obviously need some method to store energy gathered during good times to be able to use it during the bad.

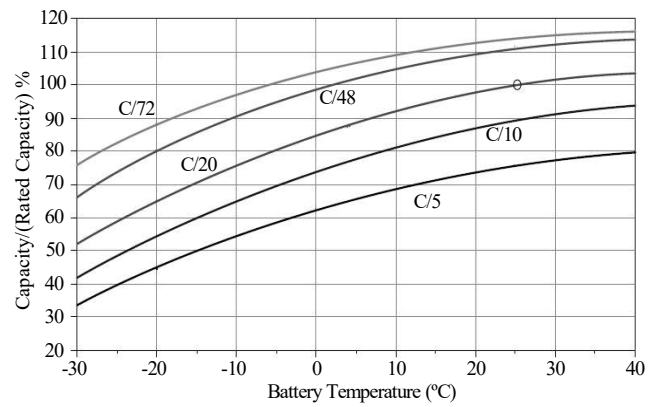


Figure4. Lead-acid Battery Capacity Depends on Discharge Rate and Temperature

Among the many possible battery technologies, it is the familiar lead-acid battery that continues to be the workhorse of PV systems.

Lead-acid batteries are by far the least expensive option, they have the highest efficiencies, and the more expensive ones, when used properly, can last nearly as long as their competitors.

The amp-hour capacity of a battery is not only rate-dependent, but also depends on temperature. Figure4 captures both of these phenomena by comparing capacity under varying temperature and discharge rates to a reference condition of C/20 and 25°C.

These curves are approximate for typical deep-cycle lead-acid batteries, so specific data available from the battery manufacturer should be used whenever possible.

Battery capacity C is given in amp-hours rather than watt-hours; charging and discharging are expressed in C/T rates, which are amps. For batteries wired in parallel, amp-hours add. For batteries in series, voltages add.

For battery sizing, the following equations are required.

$$\text{DC load} = \frac{\text{AC load}}{\text{Inverter efficiency}} \quad (12)$$

$$\text{Usable storage (Ah)} = \text{Total load ( Ah/day)} \times \text{Day of storage( days)} \quad (13)$$

$$\text{Total storage capacity} = \frac{\text{Usable storage capacity}}{\text{MDOD} \times (T,DR)} \quad (14)$$

$$\text{No. of battery in series} = \frac{\text{System voltage}}{\text{Nominal battery voltage}} \quad (15)$$

$$\text{No. of string of battery in parallel} = \frac{\text{Total storage capacity(Ah)}}{\text{Capacity of a single battery}} \quad (16)$$

$$\text{Storage days (99\%)} \approx 24.0 - 4.73 (\text{Peak sun hours}) + 0.3 (\text{Peak sun hours})^2 \quad (17)$$

To account for a range of load criticality, two curves are given: one for loads that must be satisfied during 99% of the 8760 h in a year and one for less critical loads, for which a 95% system availability is satisfactory.

The OPzV series adopts an immobilized Gel and Tubular Positive Plate technology. It offers high reliability and stable performance. By using die-casted positive grid and patented active material formula, it exceeds the DIN standard values and offer 20+ years design life in float service. It is very suitable for cyclic use under extreme operating conditions. This series is recommended for telecom outdoor applications, renewable energy systems and other harsh environment applications.

**Table9. characteristics of battery**

Name	Rating
Model	OPzV tubular gel battery
Nominal capacity	1500Ah
Nominal voltage	2V
Designed Floating Life	20 years

**Result**

The national grid electricity of capacity in Myanmar is lower than demand because of the rapid increase of population. As a result, 50 % of population still lack of electricity. Therefore, the lack of electricity especially rural areas in Myanmar becomes one of recent main issues to be solved. Electricity is an essential role to be comfortable for people in rural area.

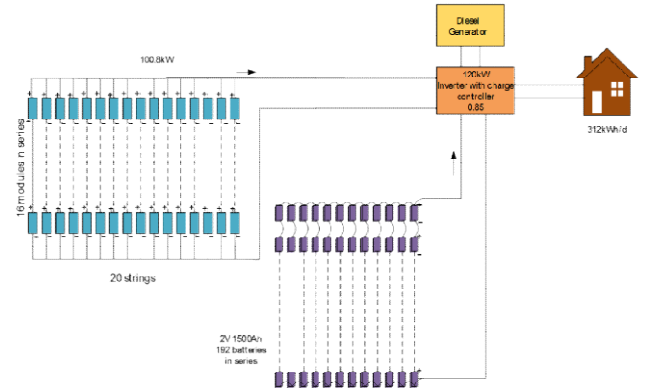
**Table10. sizing result of the tat thit kyun**

Description	Values
Total Estimate load	312 kWh/day
PV module	315 W
Total number of modules	320 nos
Total number of PV module string	20 strings
Number of modules per string	16 nos
Total number of battery	192 nos
Ah per battery module	1500 Ah
Inverter capacity	120 kW
Diesel generator	80 kW

To solve these problems, solar power plant can be built in Tat Thit Kyun according to the design as Table 10.

There are many difficulties without electricity, it can effect on modernize environment for rural area. A large increase in energy consumption was noted especially after the living standards were improved. Many energy sources usually classified into two groups; non-renewable energy and renewable energy, are used to meet the needs. Coals, petroleum, natural gas, propane and uranium are non-renewable energy as their supplies are limited. Renewable energy includes biomass, geothermal energy, hydropower, solar energy and wind energy as they are replenished in a short time.

Among them, Tat Thit Kyun village is lighted with solar and this village will consume 312 kWh per day. 16 numbers of 315 W solar panel are connected in series in a string and 20 strings are needed for this plant. By connecting 192 numbers of batteries in series and 3 numbers of 40kW that is total 120 kW diesel generator, back up supply when night or rainy days is ready. Figure 5 is Solar Power Plant Design which can get by surveying, estimating and calculation of above equations.



**Figure5. Solar Power Plant Design for Tat Thit Kyun**

This design will be grantee within 20 years. Although the initial cost can cost, solar power plant is the best choice for long term situation. As supply is 100kW and demand is nearly 50kW, this design is ready for connecting National Grid or extra loads are waiting during 25 years.

**Recommendations**

For future work, other renewable energy sources should be added such as wind. The control system should be added to get more stable power. Optimization methods should be analyzed in this system. Moreover, generator detail design and wire sizing should be considered. Next, extra load and extra line length can be guessed for other years because the population of village can be increased. Or people can be extended many industrial due to good Government and Economic. Maintenance and operation should be thought as other factors. In Myanmar, it is required to think weather though peak sun hour is nearly 6 hour.

**Conclusion**

In Myanmar, renewable energy especially solar power is applied in many villages without connecting National Grid. This research work has been carried out in two parts. The first part is oriented in the collecting of the energy consumption and meteorological data of selected area. The second part is oriented in the consideration of the design procedure, and then the system is designed based on the data collected. In this design, all energy which is needed from village is sufficient by supplying solar power 100kW. But, battery and diesel generator are applied for back-up power during the night and no shining days. At present, demand is very less than supply about 50 percent.

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