

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Design of Net Meter for Off Grid Microgrid

Vinayaka R Deskar¹, Prof. Pradeep Kumar²

PG Scholar, Department of Electrical and Electronics Engineering, NMAMIT, Nitte, Udipi, India¹.

Asst. Professor, Department of Electrical and Electronics Engineering, NMAMIT, Nitte, Udipi, India².

ABSTRACT: This paper will discuss about the design of one of the type of solar Metering called Net Energy Metering (NEM) which calculates Net usage and the Net amount of money to be paid. In this paper, not only the design, the application of this designed NEM in the field of Microgrid is discussed. Here, how the NEM works between two user groups connected to off grid Microgrid what are the inputs that NEM will take as and how it calculates the net electricity sent and received by two user groups through Microgrid and also the Net amount of money that is to be paid to each other is high lightened. This paper also includes the simulation of this NEM in MATLAB Simulink Function Editor where the function is written to perform the above mentioned calculations.

KEYWORDS: Net Energy Metering (NEM), Net Energy Meter, Microgrid, Off Grid Microgrid, Distributed Energy resources (DER).

I. INTRODUCTION

As of 2016 in India almost 50,000 villages are unpowered, which is a great challenge for the government to make India smart. Behind these unpowered villages there are two important reasons, one is that the power plants are not generating the enough power and second one is that, the grid doesn't reaches them. In India, the demand for the electricity is more than the generation which made us to switch towards the renewable energy sources such as solar, wind and etc. To overcome from this energy crisis many have already installed with rooftop solar systems with solar metering. But many villagers are unaware of these rooftop systems and solar metering and are unpowered due to the two reasons mentioned above. Providing these villages with the utility grid facility is of more investment, alternative system is required where these villages can be powered using the DES without utility grid.

This alternative system is a Microgrid system. Microgrid system is of off grid where it is independent of the utility grid. To this Microgrid the group of users are connected where their usage is monitored using the solar meter. Solar metering is of two types, one is Gross Metering where the complete generated solar energy is fed to the utility grid and is unidirectional meter. Another one is the Net Metering also called as Net Energy metering (NEM) where it is a bidirectional metering which calculates the net amount and usage by the user.

In this paper the design of this bidirectional Net Energy Meter which is used to control the Microgrid system is stated and the results of Net amount and Net usage of electricity shown. To show the application of this Net Meter in the field of Microgrid we consider that the two group of users GP1 and GP2 which are connected to this Microgrid where they are installed with solar panels. Output of these solar panels depends on the solar irradiation, this solar irradiation changes from region to region. All the solar panels will have the power output which is tested at the standard test conditions such as, at 25⁰ C of temperature and 1000Wh/m² irradiation. This solar panel is connected to inverter and then to the Microgrid.

If the GP1 generates more amount of electricity than the demand and the electricity generation is less in case of GP2 the GP1 has the provision to feed that the extra generated electricity to the Microgrid so that the users in the group GP2 can use it. The each user in the group is connected with the small meter that reads their individual usage and the cost but the Net Meter will calculate the wages for the group only.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

II. SYSTEM OVERVIEW AND WORKING PRINCIPLE

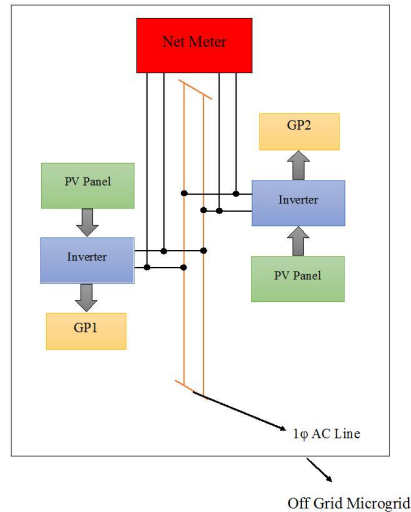


Figure 1: Block diagram of the system.

Figure 1 shows the block diagram system in which two group of users are connected to the off grid Microgrid with the NEM.

PV PANEL

In our system for simulation purpose we used Solarex MSX64 solar panel is used which output 64 watt. The output of the solar panel depends on the solar irradiation. To make the solar panel to give constant power output we need to make that solar panel to work at some constant voltage and to make this we need to use MPPT controller [1].

NET ENERGY METER

Net Energy Meter is a metering device that runs in both the directions depending on the electricity that is sent or received from the grid. In this Microgrid Net Energy Meter is connected between the groups of two users GP1 and GP2, if excess power is sent to the GP2 from GP1 through Macrogrid then this meter runs in one direction and if transmission is from GP2 to GP1 then the meter will run in opposite direction.

INVERTER

Inverter is a type of converter that converts DC input in to AC so that it can be transmitted through the AC transmission line. Inverter are of two types one is single phase and another is three phase. Here in this system single phase inverter is used with MPPT controller. Maximum Power Point Tracking is used to get the maximum power output from the PV Panel. In this system MPPT control using Perturb and Observe Method is used as it is efficient and easy one [3] [5].

MICROGRID

Microgrid is the combination of various distributed energy resources that forms a complete energy system used to balance the captive supply and demand resources to maintain stability of service within specified boundary. Microgrids are of many types such as Campus Microgrid, Community Microgrids, Off Grid Microgrid and etc. here the Microgrid is of Off Grid Microgrid that helps the villages those are not connected to the utility grid[2][4]. When the electricity is fed to the Microgrid the synchronization between the grid and the feeder is not required as it is a single phase and the grid has no electricity until GP1 or GP2 feeds to it.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

WORKING PRINCIPLE:

Working principle of the Net Energy Meter is shown in terms of the flow chart. When the system starts first it checks for any of the control signals C1 or C2 is ON or not. If C1 is on it means that there is a request from GP2 to GP1 for the supply of Electricity and if C2 is on then there is request from GP1 to GP2 for the electricity. Once the control signals are checked, if any of the control signal is on then it calculates the Voltage V1 or V2, Current I1 or I2, and Time T1 or T2. After this it calculates the Power P1 or P2 and the amount power consumed by the customer in terms of Units using the below shown formula.

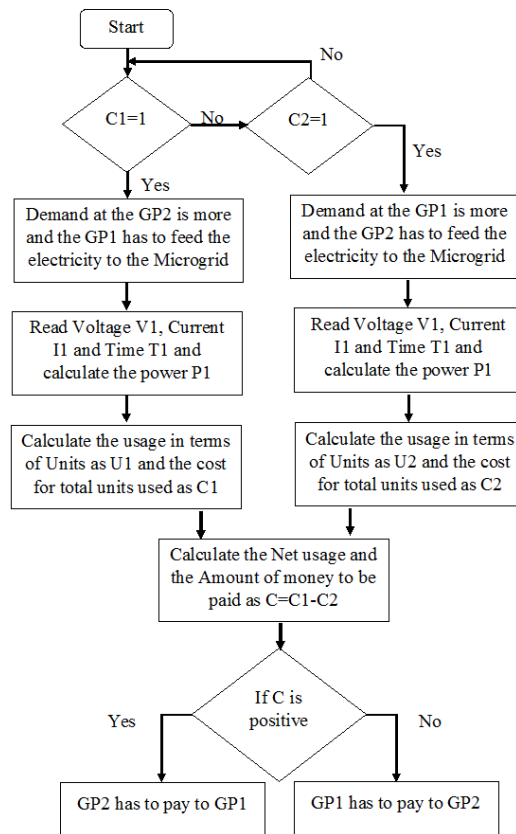


Figure 2: Flowchart for Principle of Working

Now consider that the control signal C1 is ON and there is request from GP2 to GP1, then power in terms of Units is given as,

$$U1 = \frac{P1 \cdot \left(\frac{1000}{Pp}\right) \cdot T1}{1000} \tag{1}$$

Where,

Pp is the Power output from PV panel at 1000 Wh/m² irradiation.

$P1$ is the power fed to the Microgrid from GP1.

$T1$ is period in which the electricity is fed to the Microgrid. Now the amount that is to be paid is calculated using the formula,

$$C1 = U1 * (\text{standard rupee per unit}) \tag{2}$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Where, C_1 is the cost that GP2 has to pay to GP1 at that period. If the control signal C_2 is ON then same procedures are followed as stated above to calculate U_2 and C_2 finally the Net amount of Power consumed and the wages that is to be paid is calculated as,

$$U = U_1 - U_2 \tag{3}$$

And $C = C_1 - C_2 \tag{4}$

At the end of the month if C is positive then GP2 has to pay to GP1 if it is negative, then vice versa.

III. SIMULATION RESULTS

The input to the NEM is the Current, Voltage, Time (Period) and the control signal from the GP1 or GP2. The output from the solar panel is fed to the inverter where the DC is converted to AC and it is boosted to 230V so that it can be transmitted through Microgrid easily. When one of the control signal is ON then the Net Energy Meter will read the required values from GP1 or GP2 and calculated the net electricity usage and the net wages the is to be paid at the end of each month. To calculate the period a digital clock is added that takes the complete time taken for the simulation and makes the calculation.

The figure 3 shows the simulation of the NEM in the MATLAB Simulink function editor. The output will be the Net amount that is to be paid and whether GP1 has to pay or GP2 has to pay will depend on the sign of the output of Net Energy Meter.

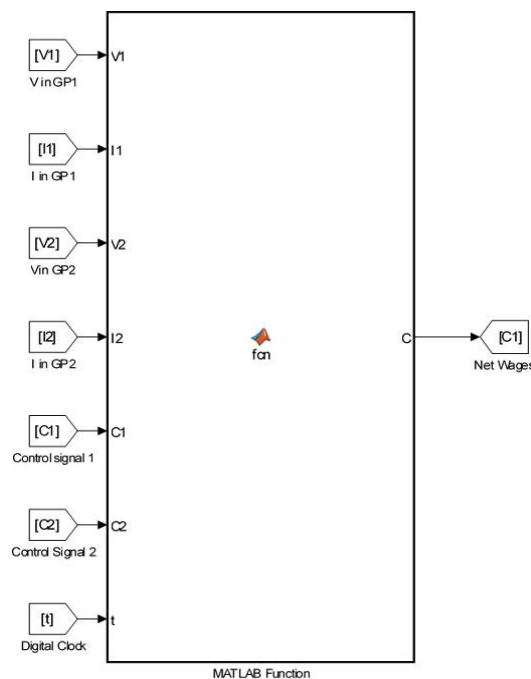


Figure 3: NEM Simulation Result

IV. CONCLUSION

As a developing country it is must for India to power those unpowered villages, for this it is best to go towards the Distributed Energy Resources like solar and implement these solar panels as the rooftop systems to avoid energy crisis. In this context this system will provide an easiest way for villagers to get powered by the natural resource which is

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

abundantly available and monitor their usage using Net Energy Meter where whole system is called as the Off Grid Microgrid system.

REFERENCES

- [1] Chandani Sharma, "Solar Panel Mathematical Modelling Using Simulink Int.Journal of Engineering Research and Applications" www.ijera.com ISSN: 2248-9622, Vol. 4, Issue 5 (Version 4), May 2014, pp.67-72.
- [2] Mohammed A. Elgendy, Bashar Zahawi, "Assessment of Perturb and Observe MPPT/Algorithm Implementation Techniques for PV Pumping Applications", Transactions on Sustainable Energy, Vol. 3, No. 1, January 2012.
- [3] Sajib Chakraborty, M. A. Razzak, Md. Sarwar Uddin Chowdhury, Sudipta Dey, "Design of a Transformer-less Grid Connected Hybrid Photovoltaic and Wind Energy System", The 9th International Forum on Strategic Technology (IFOST), October 21-23, 2014, Cocks Bazar, Bangladesh.
- [4] Microgrid Systems in India is available at <http://www.tatapowersolar.com/Solar-Microgrid>.
- [5] Bhim Singh, Ikhlq Hussain, Grid, "Integration of Single Stage Solar PV Power Generating System using 12-Pulse VSC" Department of Electrical Engineering Indian Institute of Technology, New Delhi.