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Net-Metering for Home to Conserve Electrical Energy

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Abstract:
This paper presents net-metering concept for the dc systems. Net-Metering is the concept, which records net energy between export of generated energy and import from utility. But in this paper, Utility grid is also considered as DC system. For exporting and importing of energy battery2 is connected. The main source of energy is solar energy. TShe solar energy is stored in battery1 and utilized sufficiently for the house and remaining unused energy is sent to the grid (battery2). Whenever there is no solar, energy for loads is importing from utility grid i.e, from battery2 as considered. In existing net-metering concepts there is no displaying of net energy. In proposed concept it is designed to measure the parameters such as current and voltage. Current and voltage measurement is carried out through current sensor ACS712 and voltage divider circuit respectively. Microcontroller is programmed to calculate the power, energy, and import-export energy tariffs. All parameters are continuously made to display on LCD. Automatic controlling is achieved by operation of relays. The proposed concept has been tested successfully.

Index Terms: Current Sensor, Load Switching, Net Meter, Relay, PIC microcontroller, Tariff

I. INTRODUCTION

In the present situation due to scarcity of non-renewable energy sources, renewable energy sources are having more importance. The demand for electricity is growing day by day. Power generation is not up to the mark, this encourages to use alternatives to reduce power deficit. In India the deficit is as best alternative. In view of this, in proposed concept solar panels are the source of energy. Net metering is a billing mechanism that credits solar energy system owners for the electricity they sold to grid. A net meter is a capable of measuring both the electricity supplied by the utility as well as any excess energy generated is supplied by customers system back to grid. Net metering is a utility metering practice that encourages direct consumer investment in renewable energy technologies.The net metering based solar roof top projects facilitates the self consumption of electricity generated by the rooftop and allows for feeding the surplus in to the network of the distribution liscensee. Here the type ofownership can be self owned. In self owned, the rooftop owner who is also the electricity consumer for the utility installs the rooftop solar system.The electricity generated is first used by owner and then excess solar power generated is fed in to the grid through net meter, which is bi-directional energy meter capable of registering both impot and exported energy.Thus there is combine of captive consumption and exchange of power with utility. This net generation is then credited to ownre's account and adjusted against imports from the grid.

The metering protocol for 'Grid connected rooftop solar PV system without storage' and location of solar meter and consumer meter shall be in accordance with the schematic diagram as shown in fig[1]. Basically the consumer now has two sources available to power there loads. Where the inverted SPV power line and a line from grid are connected at a junction in consumer load panel. SPV power is inverted and synchronized by using grid tie solar inverter which has the built in disconnect feature in order to prevent islanding in the distribution network when grid shuts off. The unidirectional AC solar meter is connected to the grid tie inverter output for measuring the amount of SPV generation and a Utility meter is connected at incoming point of the grid power line. Depending upon the power consumption of the consumer and the SPV generation, direction of power flow in between consumer load panel and distribution network is decided.

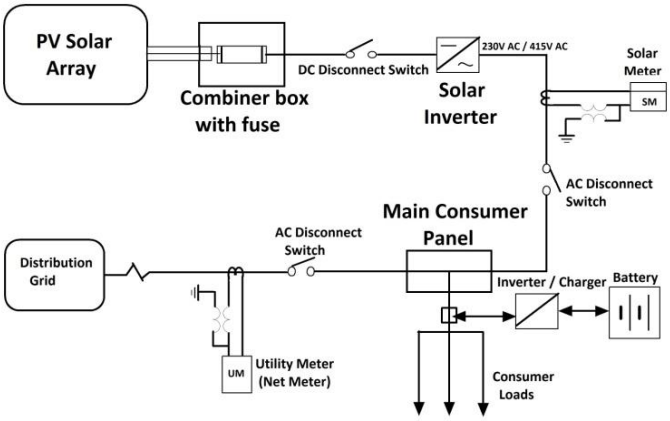


Fig-1: Excisting Net Metering arrangemetn.

II. METHODOLOGY

The functional block diagram of proposed met-metering concept is as shown in figure[2], and each blocks are described below.

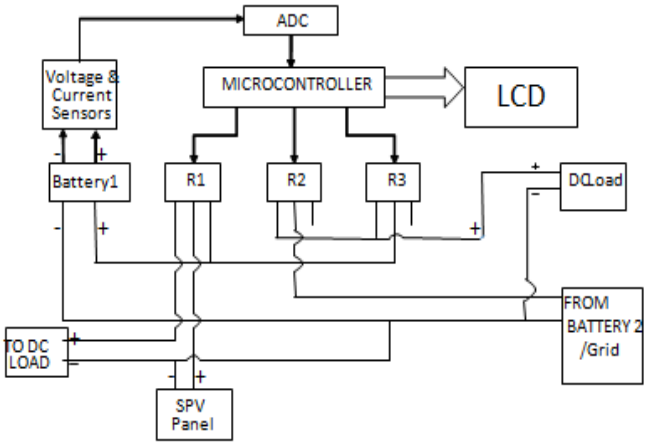


Fig-2:Block daigram of proposed net metering

a. Solar panel: It is a packaged assembly of solar cells, also known as photovoltaic panel. The solar panel can be used to generate and supply electrical energy whwn exposed to sun light. The generated energy is DC in nature.In the proposed project 21V, 0.3A solar panel is used.

b. AC power supply:AC to DC adopter has been used to get 12V DC input to PIC development board. The AC input i.e. 230V from the main supply is stepped down by transformer to 12V and then it is fed to rectifier.The output from rectifier is not pure DC, it is pulsating in nature and also consists of some ripples. In order to get pure DC voltage, the output of rectifier is fed to a filter to remove AC components even after rectification. Filter circuit employs electroytic capacitor in order to remove AC components. Now output voltage is 12V given to voltage regulator to obtain constnt DC voltage.

c. Lead acid battery: The battery is a device which converts chemical energy into electrical energy and vive versa. Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Lead acid with sealed maintenance free battery is used in this work. And it can be used when there is absence of sun in cloudy weather. It is of 12V chargeable battery with capacity of 7Ah.

d.Microcontroller PIC18F4520: It is low power high computational performance at an economic price.It has operating voltage range of 2.0 to 5.5. It is 16 bit microcontroller with 32K bytes of flash programmable and 256K bytes of EPROM. Writing or erasing program memory will cease instruction and fetches until the operation is complete.The program memory can not be accessed during the writing or erasing,therefore code can not be execute.The data EPROM is a non-volatile memory array,seperate from the data RAM. The program for calculation of power and energy has written and also relay operation is controlled by dumping the program into microcontroller.

e. Relays: Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. It consists of a primary coil and two contacts, normally open contact 'NO' and other is normally closed 'NC' and anothr one is common.When relay is in off condition the common is connected to normally closed (NC).Whenever sufficient fulx is produced common is connected to normally open (NO). In proposed work 12V, 10A single pole double trough (SPDT) relay is used.

III.OPERATION

The ACS712 current sensor is connected in series and voltage divider across solar panel measures the generated current and voltage respectively, and further these signals are given to PIC18F4520 microcontroller. Similarly voltage and current sensor is connected at line from which utility supply is taken, measures the amount of voltage and current drawn from utility.In proposed experimental set up battery2 indicates the utility as we considered for DC operation. Microcontroller is programmed in such a way to calculate power and energy and displayed in 20X4 LCD(Liquid Cristal Display). For the switching operation of relay referace battery voltage has to be taken.. The referance voltage is taken as 11V and the capacity of the battery taken is 12 V. Let consider the following conditions for operation of proposed circuit fig[2].

i. If solar is present and battery1 is fully charged: In this condition, since battery1 is fully charged the microcontoller will send three signals to operate relays in such a way that, relay1 (R1) is ON, extra energy generated is send to Utility(in proposed model it indicates battery2). Relay2 (R2) is in OFF state supply from utility is disconnected. And relay3 (R3) is ON indicates battery1 is input to for appliances usage.

ii. Solar is present and battry1 is not fully charged: In this condition, since battery1 is not fully charged its voltage is below reference voltage. At this condition microcontroller sends signals in such a way that, R1 is kept as OFF and battry1 is charged by solar. Now there is no sufficient energy to utilise hence need of energy from utility, and by keeping R2 ON supply from utility(battery2) is given to loads. At this moment R3 is OFF.

iii. Solar is absence and battery1 is fully charged: Since battry1 level is above referance voltage, microcontroller sends signal to R1 to operate hence Extra energy generated is transferred to utility(battery2). R2 is in OFF position as there is no requirement of energy from utility. R3 is in ON state for utilisation of generated energy.

iv. Solar is absent and battery1 is not fulle charged: If solar is absent obviously there is no generation of energy and R1 is in OFF mode. R2 operates, supply from utility(battery2) is taken. R3 does not operate (OFF) and it is open circuited.

IV. Flow chart

The flowchart of the proposed concept is shown in fig(3). Here whwnever their is solar enegy, then battery1 is get charged and if there is n solar energy loads are connected to battery2 (grid). During charging of battery1 it will check whether battery is full or not, if not then it will send signal to check availability of solar. If battery is full then excess amount of energy is sold to grid.

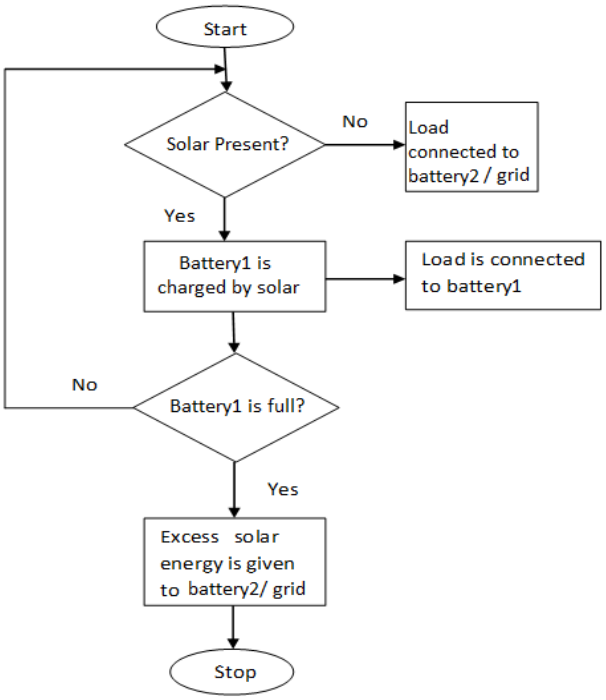
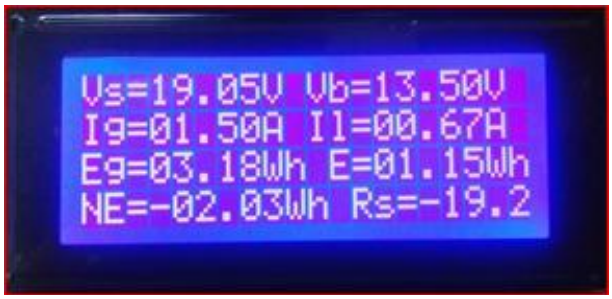


Fig-3: Flowchart of proposed net-metering concept

V. Results

The proposed model is designed to operare in two modes. In the following LCD displays, Vs is source energy i.e, solar energy generated. Vb is battery voltage, Ig is generated current and Il is load current. Eg indicates total generated energy in terms of Wh and E is consumed enegy. NE indicates net energy of difference between generated consumed and energy. If NE is negative then it indicates that enegy is buying from utility grid and if it is positive then selling energy to grid(battery2).



V. CONCLUSION:

Net metering is designed and implimented and tested successfully in DC mode of operation. Net metering arrangement for a consumer primarily offsets power consumption from the grid and therefore it compensates the owner of the rooftop system for solar energy consumption at the applicable rules and regulations and for retail tariffs for thecategory of consumers. As the power produced by solar energy using PV systems is difficult and costly to store, ths net metering provides opportunity to supply the excess power produced to grid and when solar power is not sufficient or unavailable, power can be drawn from grid, thus creating an opportunity of two way supply and making sola energy more reliable.It provides the simple, and and easy-administered method for encouraging direct customer investment in small-scale renewable. This paper of net metering allows customer-generators to offset a higher proportion of their retail electricity consumption with their own electricity generation.

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VI.BIOGRAPHS

Savita C. Kundargi, was born in Arakeri, Bagalkot district on june 20,1993.She has completeed her B.E in Basaveshwar Engineering College, Bagalkot in the year 2015 and completed her M.Tech in Power and Energy Systems,department of electrical and electronics engineering at Basaveshwar Engineering College(A), Bagalkot, She is currently working as Assistant Professor in department of EEE, SECAB Institute of Engineering and Technology , Vijayapura Karnataka. Her areas of interest are power systems and Renewable Energy systems.

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