IoT Based Solar Power Monitoring System

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ABSTRACT

The electronic PV framework observing to quantify electrical creation and utilization to the heap or utility lattice is introduced in this paper. This observing framework comprises of an Arduino Mega 2560 with two PZEM 004T sensor modules. The observing framework has been intended to store estimation information of current, voltage, power and energy in the data set and show on the page continuously and info graphics history. The PZEM sensor estimation has been tried with a typical power contrast 0.29% not exactly IEC-62724 least precision. Real time information is gotten as one-line information for like clockwork, with an information size of 375-byte and 75ms conveyance delay. For one day time frame testing, the electrical energy that can be created by the PV framework is 5,885 kWh, while the power consumed by the heap is just 1,368 kWh so the gathered electrical energy that can be traded is 4.75 kWh. The experimental outcomes show that the framework has had the option to gauge net energy product or import by the PV framework to utility lattice.

Keyword : - *Web-based PV observing, Arduino PZEM sensors, and Grid associated PV framework.*

1. Introduction

Expanding power request influences in lessening energy saves. Indonesia, with the best potential for sun oriented energy through the public authority guideline No. 14, 2012 gives an open door to proprietors to associate their PV Systems into public utility organization.

Usage of PV framework in appropriation network requires bidirectional power meter to assess how much electrical energy delivered and the weight used to diminish power bill. Hence, the usage of correspondence innovation, sensors, and data to circulated age metering and control are the subjects of interest in the advancement of future brilliant network [1],[2].

A few past investigations have examined different strategies for electrical energy creation and utilization checking. The examination on incorporated information procurement framework for photovoltaic blocks mutualization observing utilizing LabView [3], remote checking framework in light of GSM information correspondence network for country regions [4], LoRa remote sensor networks [5],[6] and electronic through web networks [7],[8], have been done and detailed.

In a review directed in [9], a Web-Scada was carried out to screen and control sun powered breeze mixture generator frameworks somewhat through the web and in view of LabView programming by means of RS232 sequential correspondence [10]. The association with the web network is done through a server PC with correspondence between sensors, far off terminals, and the server PCs in the review utilize sequential correspondence wired organizations and Local Area Networks.

This paper presents the proposed electronic net energy meter framework utilizing two PZEM 004T modules in light of Arduino microcontroller. The checking framework is planned continuously estimation and record in verifiable web-based information. With the goal that the information got can be observed whenever anyplace and put something aside for additional examination. The electrical information from the power delivered by the PV framework and the power utilized in the heap interest with the utility matrix are gotten through PZEM 004T sensors estimations. The after effects of this study are supposed to assist with acquiring the utilization of electrical energy and energy produced by PV framework progressively and verifiable web-based information, showed on sites that can be gotten to whenever and anyplace, in order to upgrade the utilization of electrical energy to be more effective.

2. Hardware and Software of Web-Based PV Monitoring

The electronic net energy observing framework is utilized to gather the power and energy created by PV framework continuously and on the web. The gathered information is shown on a site that can be gotten to whenever and anyplace for additional assessment, streamlined and made more proficient. The checking framework comprises of two significant parts equipment and programming.

The web-based monitoring system consists of three main hardware components i.e: an Arduino Mega 2560, two PZEM 004T sensor modules and an Ethernet shield. PZEM 004T is a sensor used to measure single phase voltage, current, power and electrical energy. The PZEM-004T uses SD3004 energy measurement SoC chip from SDIC microelectronics, which has very good measurement accuracy. This PZEM 004T operates for the use of active energy with a frequency of 50 Hz and 60 Hz in one phase of the circuit. This tool is equipped with 4 PINs that function as voltage and current input, 2 serial communication PINs and 2 PINs as a voltage and current source to operate the sensor. In this sensor, in measuring the flow carried out by the installation of CT in one of the input circuits, the ratio of the number of turns on CT is 1000: 1.

Ethernet safeguard is one of the Arduino yield gadgets for interfacing Arduino microcontrollers with web organizations. Ethernet safeguard utilizes a Wiznet W5100 chip that can give network by means of an IP address so Arduino can speak with TCP or UDP. The Ethernet safeguard utilizes a RJ45 link as an information transmission way. It is additionally outfitted with a SD Card connector that effectively stores information through a SD Card. In working the Ethernet Shield, correspondence is brought out sequentially through the SPI (Serial Peripheral Interface) transport. The four SPI signals on the Arduino Mega 2560 are Master in Slave Out (MISO) on PIN 51, Master Out Serial In (MOSI) on PIN 50, Serial Clock (SCLK) on PIN 52 and Chip Select (CS) on PIN 10.

Writing computer programs is done to peruse information from the PZEM sensor utilizing the Arduino IDE in light of C ++ language structure, with the goal that it can associate among Arduino and PZEM 004T sensors and Ethernet Shield. Then, executing programming contentions, the advanced information got by Arduino is utilizing the PHP programming language, while for information capacity is finished with MySQL data set administration. Then it is shown as infographics on the site utilizing Javascript programming language and HTML checking language, with the goal that it turns out to be more intuitive and can be shown progressively.

The product is utilized in the checking system to gather, save, cycle and show information in an intelligent and alluring way for the client. These strategies are known as web of things (IoT) engineering which comprises of: recovering information in the discernment layer, putting away and figuring information in the organization layer, and showing information in intuitive structure (illustrations or activity) to clients on the application layer [13],[12].

3. System Design

The framework will peruse the voltage, current, and RMS power at the inverter result and burden utilizing the PZEM 004T sensor. Then, at that point, the information is sent utilizing a TTL link to Arduino with TTL sequential correspondence. After the information is gotten on Arduino, it is handled in light of calculation computation and correlation then transferred to the site data set utilizing Ethernet Shield that has been associated with the web organization. After the information has been transferred to the data set, the estimation information can be shown continuously on the site.

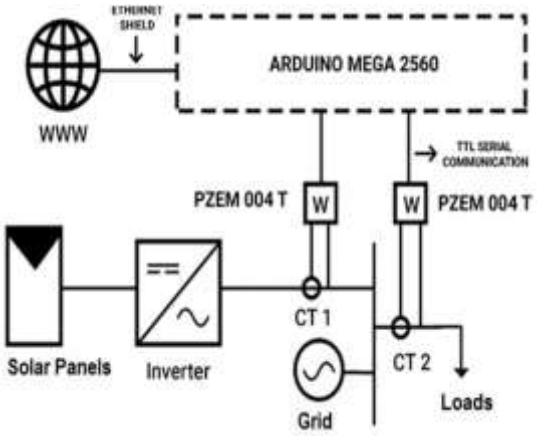

Figure 1. PZEM Based Net Energy Meter

Writing computer programs is finished utilizing the Arduino IDE which utilizes the C ++ language design to compose programs into Arduino, so it can associate among Arduino and PZEM 004T sensors and Ethernet Shield. The program for site creation is finished utilizing PHP language to associate among data sets and site sees. The information base programming language utilizes the MySQL language and constant readings from the site with the goal that it becomes intuitive utilizing HTML, CSS and the Javascript programming language. In this way, clients can admittance to get data of their energy utilization through web application locally or by means of Internet. The framework outline is displayed in Fig. 1.

This observing framework test is done in the electrical designing division which has a sun oriented power plant associated with the network utilizing a lattice tie inverter. The inverter will be observed alongside how much burden associated so the kind of force stream utilized by the heap is acquired.

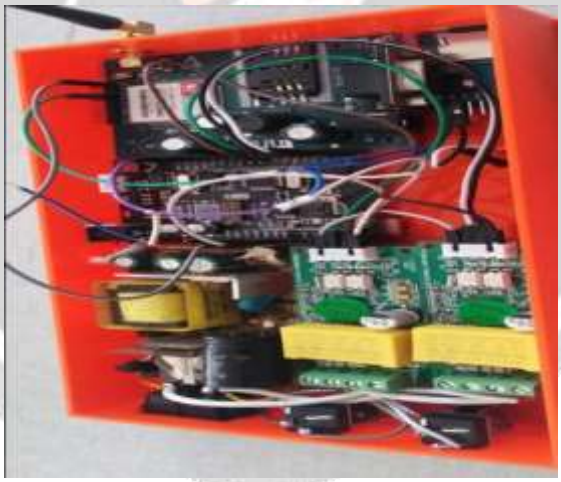

Figure 2. Web-based Net Energy Meter Real Circuit.

Testing system components consist of two parts, namely testing with hardware and testing with software. The system hardware is tested based on the installation of Arduino Mega 2560 and PZEM 004T pins or cables that are following the design. The system software tested using Arduino IDE and Google Chrome Developer Tools. The Arduino program tested using Arduino IDE using monitor serial output parameters, while on servers and clients it is tested using Google Chrome Developer Tools software with output parameters on the network.

The overall system is designed as shown in Fig. 2 below.

4. Result and Discussion

The PZEM 004T test used to decide the sensor arrangement framework with the Arduino Mega 2560 microcontroller. This point has been accomplished. The activity of the sensor required four TTL links comprising of one 5V voltage working link, one ground link, and a couple of links that capacity as shippers (TX) and information collectors (RX) with sequential correspondence lines as displayed in Fig. 3.

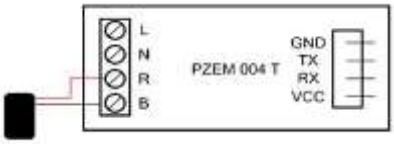

Figure 3. Schematic diagram of PZEM 004T

Equipment testing is brought out by introducing links straightforwardly through GND, TX, RX, and VCC pins on pins that are accessible on Arduino Mega 2560. Establishment of at least two PZEM 004T requires a task board to interface in lined up between VCC pins and GND. The PZEM Pin association is displayed in Table 1. PZEM 004T (1) is introduced in Arduino Mega 2560 Serial 2, and PZEM 004T (2) is introduced in Arduino Mega 2560 Serial 1 while VCC and GND on each sensor are associated in lined up through the venture board. At the point when the Grid tie inverter effectively synchronizes with low voltage circulation network, then PZEM 004T (1) and (2) will straightforwardly communicate voltage, current, power and energy information to Arduino Mega 2560 as genuine advanced values.

The PZEM 004T advanced perusing is finished by the sequential correspondence with Arduino Mega 2560 to get how much voltage, current, power and energy as show in Fig. 4. By the correlation of PZEM 004T estimation and Hioki 3286-20 Clamp Meter, can be presumed that the PZEM 004T sensor (1) and (2) have functioned admirably in light of the fact that the deliberate worth is near the deliberate worth of Hioki 3286-20 Clamp Meter with a typical power distinction of 0, 29%. In view of IEC-61724 standard [11] this worth is OK on the grounds that the exactness is under 1 %. Hence, information got from current, voltage, power and energy of PZEM sensor can be utilized for PV framework observing.

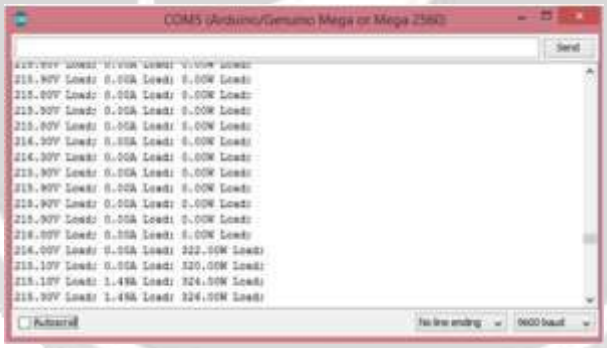

Figure 4. Data read by PZEM 004T

Information acquired from every sensor will be put away in the Arduino Mega 2560 program variable.

Table 1. PZEM Connection

Component	Init Pin	Final Pin	Note
PZEM 004T (1)	Vcc	VCC on project board	5V
	Gnd	GND on project board	negative polarity of circuit
	Tx	Pin 17 Arduino (RX Serial 2)	PZEM 004T (1) Transceiver data to Arduino
	RX	Pin 16 (TX Serial 2)	Receiver data of PZEM 004T (1) from arduino
PZEM 004T (2)	Vcc	VCC on project board	5V
	Gnd	GND on project board	negative polarity of circuit
	Tx	Pin 17 Arduino (RX Serial 1)	PZEM 004T (2) Transceiver data to Arduino
	RX	Pin 16 (TX Serial 1)	Receiver data of PZEM 004T (1) from arduino

The contrast perusing information of two PZEM will be assessed for deciding the power state at the heap, whether in the import or commodity status. The commodity or import status will be shown in the checking framework through web network access.

Fig.5 shows the three days estimation information that the securing of information from the framework functions admirably by sending information however much information with time delay for putting away information on normal is 4 minutes 40 seconds. Testing on the server is finished by sending information to the client, while testing on the client is to show the information into constant and infographics Fig 5. During testing, the information server is sent by changing the variable qualities that have been put away in the data set into the JSON information trade design. Testing servers is finished with clients utilizing Google Chrome Developer Tools programming. The information acquired is then shown on the site with the AJAX highlight so JSON information can be refreshed routinely without invigorating the site page consistently.

Figure 5. Display of real-time and historical data monitoring

Site show shows information continuously conditions at 10:37 WIB, PLTS will create force of 443 Watts, with the state of the heap utilization around then 101 watts, the overabundance force of 342-watts will then, at that point, be shipped off the utility organization as commodity power.

Figure 6. Overview Page of Energy production, consumption and status import/export display

Verifiable information testing for three days shows that the current produced by PV framework will be Export status at 6.00 am until arriving at the top at 12 am, then it will diminish and transform into Import status at 6.00 pm. Be that as it may, weather patterns and burden request are significant variables in deciding the product/import status of electrical energy of the utility lattice.

Figure 7. Bar Graph of Energy production, consumption and status import/export display

The gathering of force gathered for a specific time frame will be determined as energy. The estimation results have been shown as infographics to show the arrangement of energy use and energy creation as well as net energy in one day time frame from 05/21/2019 to 05/22/2019 as displayed in Fig. 6. For one day estimation the energy that can be produced by the PV framework is 5,925 kWh, while the power consumed by the heap is just 1,272 kWh, so the gathered electrical energy that can be traded is 4.65 kWh.

5. CONCLUSION

The net energy meter framework has understood voltage, current, power and energy created at the inverter yield terminal and burden terminal utilizing the PZEM 004T sensors. In view of these information the net energy product to utility or import from utility not set in stone. This framework is furnished with an information lumberjack include, so the estimation information can be straightforwardly recorded on the client PC. The PZEM 004T got information have a decent degree of exactness with a typical power contrast of 0.29% contrasted and Hioki 3286-20 brace meter. For one day estimation the energy that can be produced by the PV framework is 5,925 kWh, while the power consumed by the heap is just 1,272 kWh so the aggregated electrical energy that can be traded is 4.65 kWh. In view of these information, further examination to work out the energy costs per kWh delivered by a sunlight based power plant, saving the electrical energy got and the length of speculation costs return time accomplished can be performed.

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