Automated Monitoring System for Small Scale Dual-Tariff Solar PV plant in UiTM Pulau Pinang

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***Abstract*—The virtual monitoring system has rapidly increased its popularity because of its graphical based programming especially for data acquisition and measurements. In order to monitor the performance of the system especially for renewable energy (REN) source application such as solar photovoltaic (PV), data-acquisition systems had been used to collect all the data regarding the installed system. In this paper, the development of automated monitoring system for dual-tariff small scale solar PV plant in UiTM Pulau Pinang, Malaysia is described. The measurements of data are made using sensors, National Instruments (NI) data acquisition modules, and LabVIEW software. Then, all the real-time data collection of the electrical output parameters of PV plant such as voltage and current are displayed and stored in the PC drive. With all the measurements, the calculation of I-V and P-V curve for a specific period of time can be made. The advantages of the system are the performance of the PV system can be monitored virtually and remotely where the data can also be retrieved on-line. Furthermore, this system allows the collection of data for long periods of time without being interrupted by human. Thus, with the collected data, more research on solar PV can be done in the future.**

***Index Terms*—Virtual monitoring system, data-acquisition system, PV, LabVIEW, dual tariff.**

I. Introduction

One of the most popular renewable energy that currently been studied in Malaysia is solar PV system. PV systems are not only friendly to environment but could also contribute to the improvement in power quality and increase the reliability of the electric power systems [1]. Every renewable energy plant or system plant needs monitoring and control systems [2]. Same goes to solar PV plant where the parameters must be closely monitored and controlled, thus requires adequate data acquisition system. The data acquisition system requires large number of measured data where very frequent recordings are necessary needs to be automated to eliminate the probability of human error as well as to save time. Several data acquisition systems have been developed for use in a wide variety of applications, which include measuring, acquisition and processing environmental variables [3–5], monitoring and evaluating the performance of PV systems [6–8], monitoring the status of batteries for water pumping PV systems [9,10], measuring operational parameters of hybrid photovoltaic-Diesel system [11], etc. It is also necessary that the data can be represented in graphical form for straight-forward monitoring and analysis compare from having the data in numerical format. Thus, the development of a virtual measurement system that can be used for monitoring the solar PV system performance is much desired.
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This paper describes the development of an automated monitoring system for a solar PV plant based on virtual instrumentation that used LabVIEW software that can be implemented at lower cost than the commercial one. This virtual monitoring system has the advantages of flexibility in the case of extending the plant with more PV modules and also allows the collection of data for long periods of time without being interrupt by human. With this virtual monitoring system of PV plant, the performance of the solar PV plant can be monitored remotely and data can be retrieved at any time anywhere.

II. Methodolgy

A. System Design

This dual-tariff solar PV system generating electricity is constructed on a guard-house in Universiti Teknologi MARA (UiTM) Pulau Pinang, Malaysia that operates for 24 hours using a load of 9kWh/day. During on-peak demand which is defined as 7.00 am until 6.59 pm, the solar PV provides electricity to the load in the guard house which consists of air-conditioning, CCTV and lightning system. Whereas, during the off-peak, the local energy supplies, Tenaga Nasional Berhad (TNB) supplies the energy for the night time which is defined as 7.00 pm until 6.59 am. The system will be provided with battery bank to regulate deficiencies in unreliable solar energy. Fig 1 below illustrates the dual-tariff solar PV system in UiTM Pulau Pinang. In order to change between the solar PV and TNB, the change over circuit [4] plays a role by connecting the load to the PV system during the on-peak demand (7.00am- 6.59pm) and change connection to the grid in the off-peak demand (7.00pm – 6.59am).

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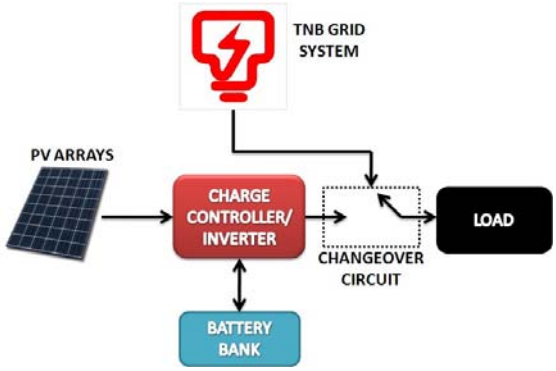

Fig 1: The design of dual-tariff PV system in UiTM Pulau Pinang

B. The data collection and processing interfaces

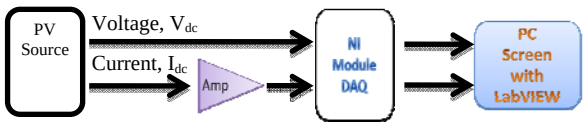

Fig 2: The block diagram of the DAQ process.

The automated monitoring system is developed by using GUI (Graphical User Interface) software which is LabVIEW and high precision NI DAQ cards. By implementing the automated monitoring system using LabVIEW and NI DAQ, all the parameters such as PV voltage and current can be collected and monitored at the same time. For this system, the NI compact DAQ can accept up to 8C series I/O modules, 256 analog input or 32 analog output, 64 digital I/O. To collect all the data, the NI 9219 24-Bit Universal Analog Input is used together with the NI compact DAQ. This module has 4 analog input channels that can measure voltage, current and temperature. It has ADC resolution 24 bit and a 100S/s maximum sampling rate.

Fig 3 and 4 illustrates the front panel and block diagram of the virtual instruments (VI) for the system. The front panel displayed the data of voltage and current in real time; whereas the block diagram illustrates the programming of the monitoring system.

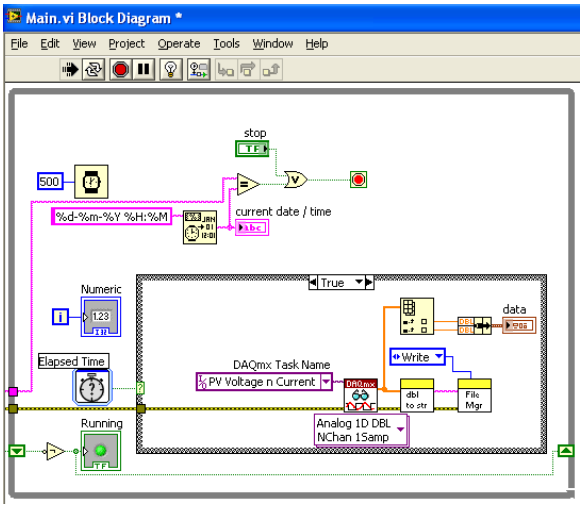

Fig 3: The main VI of the automated solar PV system.

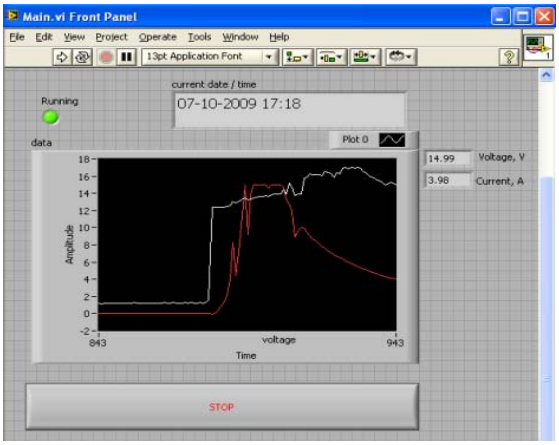

Fig 4: The front panel of the automated solar PV system.

C. Result

The system is installed in Permatang Pauh (latitude 5° 24' 46" North and longitude 100° 24' 27" East) which has higher solar radiation ranging from 13.0 MJm^{-2} to 20.0MJm^{-2} or 3.0 $kWhm^2$ to 5.5 $kWhm^2$ monthly as shown in Table 1.

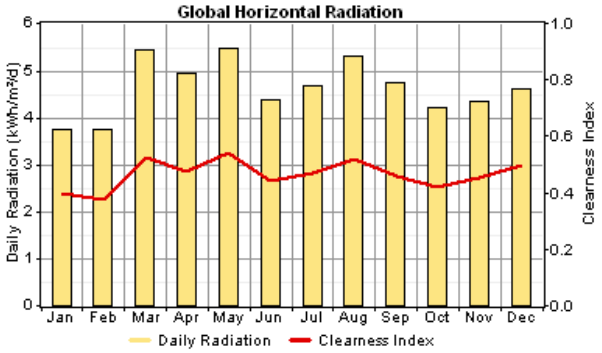

Fig 5: Annual solar radiation tabulation for Permatang Pauh

Table 1: Solar PV voltage reading for a specific date

Date / Time	Voltage
10/4/2009 0:22	0.75
10/4/2009 1:22	0.78
10/4/2009 2:22	0.77
10/4/2009 3:22	0.8
10/4/2009 4:22	0.81
10/4/2009 5:22	0.83
10/4/2009 6:22	0.84
10/4/2009 7:23	12.88
10/4/2009 8:23	17
10/4/2009 9:23	18.65
10/4/2009 10:23	18.34
10/4/2009 11:23	18.64
10/4/2009 12:23	19.13
10/4/2009 13:23	18.73
10/4/2009 14:23	18.58
10/4/2009 15:23	18.73
10/4/2009 16:23	18.28
10/4/2009 17:23	17.7
10/4/2009 18:23	15.9
10/4/2009 19:13	13.01

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The tabulated data of solar PV voltage in Table 1 shows that the PV voltage is higher from 9 am until 4 pm. Fig 5.0 and 6.0 show the collected solar PV voltage data for a specific time.

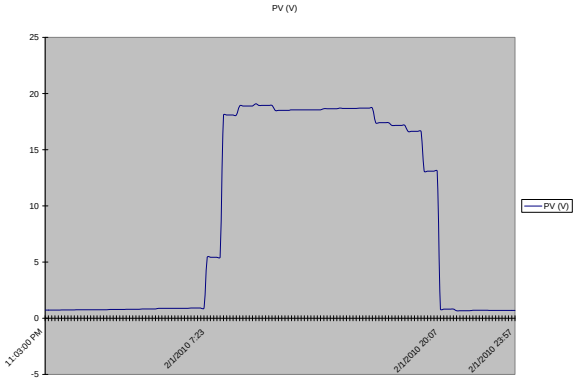

Fig 6: PV Voltage from 11pm till 11 am

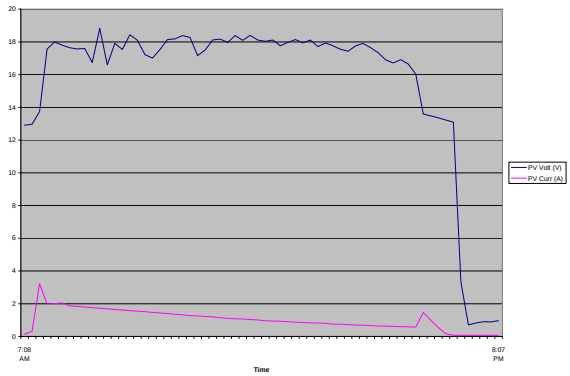

Fig 7: PV Voltage from 7 am till 8 pm

III. Conclusion

The automated monitoring system has the advantages of flexibility in the case of extending the plant with more PV modules and also allows the collection of data for long periods of time without being interrupt by human. It also can be monitored remotely and via-internet. With the collected data, more research on solar PV can be done in the future. This system can be commercialized to low cost automated monitoring system for dual-tariff solar PV plant and applicable for Green Technology with the minimum energy usage from TNB.

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