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UNIVERSITY OF LAMPUNG

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Bandar Lampung, October 27-28, 2021

Converging Technology for Sustainable Society

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Foreword from Rector of University of Lampung

Assalamu'alaikum warrahmatullahi wabarakatuh

All praise be to Allah SWT who has given us all salvation and blessing in Life. The Lord who created this word.

I'll never forget to sholawat and salam to our beloved Prophet Muhammad SAW who really loved by ALLAH SWT and saved the human life from destruction in the safety, that's the right path of ALLAH SWT.

I would like to say welcome to the First International Conference on Converging Technology in Electrical and Information Engineering (1st ICCTEIE 2021) with the theme: "Converging Technology for a Sustainable Society ".

The University of Lampung is very committed to advancing research and international collaboration as an effort to advance world civilization. ICCTEIE is an international conference co-sponsored by The IEEE Indonesian Section and organized by the Department of Electrical Engineering and Informatics – University of Lampung. The conference is held on October 27-28, 2021, in Bandar Lampung, Indonesia, on a virtual meeting base. This event provides a good platform for researchers, scientists, and the entire engineering community to meet virtually and exchange their ideas on electrical engineering, control engineering, electronics, telecommunications, computer science and engineering, cyber-physical system, informatics, sustainable energy and environment-related fields and their applications.

I do expect this conference will give imperative contributions to the development on the aspects of researches, academics, and industries nationally and globally. I hope that all participants have fruitful and technical discussions and please enjoy the meeting.

See you on next 2nd ICCTEIE 2023.

Thank you for your excellent attention.

Prof. Karomani – Rector of University of Lampung

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Welcome message from General Chair of 1st ICCTEIE 2021

Assalamu'alaikum Warrahmatullahi Wabarakatuh

Peace be upon you and God's mercy and blessings

On behalf of the committee, I am very pleased to welcome you to the 1st ICCTEIE 2021, The International Conference on Converging Technology in Electrical and Information Engineering, 2021.

We are very grateful for all the support from the Rector of the University of Lampung, all vice-rectors, director of the research institute and dean of faculty of engineering. I would also like to extend my sincere gratitude to IEEE Indonesia Section, Advisory Committee, Technical Program Committee, Steering Committee, and Organizing Committee for their support and efforts so that this event can be successfully conducted.

I welcome all the eminent speakers and guests from all over the countries from different walks of life you had come here virtually to share the knowledge and experience among the scientific community.

The conference will highlight recent and significant advances, the state-of-the-art, current status and future challenges on all aspects related to the research and development in the field of Electrical and Information Engineering including:

- Communication, Networking & Broadcasting,
- Components, Circuits, Devices & Systems,
- Computing & Processing (Hardware/Software),
- Engineered Materials, Dielectrics & Plasmas,
- Power, Energy, & Industry Applications,
- Robotics & Control Systems,
- Signal Processing & Analysis,
- Information Technology,
- Internet of Things, and
- Artificial Intelligence

The call for the paper was issued on the 25th of May, 2021 and closed on the 15th of October 2021. There are 46 submissions papers during that time. 31 papers are presented today. After this conference, the reviewing process will continue to ensure each article is ready for submission in the IEEXplore or otherwise it will be excluded.

As The University of Lampung is progressively expanding its research network and contributions to the world of science and technology, it is expected that the conference will significantly provide means to both UNILA's researchers and other researchers to engage in a fruitful discussion during and after the conference.

The 1st ICCTEIE is starting this year as the 1st year and it is projected to continue every 2 years. Hopefully, the Covid-19 pandemic soon subsides so the next conferences would be able to commence in the real meeting. This year our theme is Converging Technology for a Sustainable Society, and we are very happy the experts from the field of electrical and information as well as computer technology are with us today. We cordially welcome our keynote speakers:

1. Dr Laksana Tri Handoko, M.Sc., as the Head of National Research and Innovation Agency Republic of Indonesia,
2. Ir. Bob Saril, M.Eng.Sc., Director of Commerce and Consumer Management Indonesian National Grid Company,
3. Prof. Yasunori Mitani, The President of Kyushu Institute of Technology, Japan,
4. Prof. Prashant Pillai, University of Wolverhampton, England,
5. Prof. Jing-Ming Guo, National Taiwan University of Science and Technology, Taiwan, and
6. Dr Daniel Eghbal, Manager Future Network Strategy at Energy Queensland Australia and Australia Council Chair Institute of Electrical and Electronics Engineers (IEEE)

Also, let me inform you that all of our local committees are now registered as IEEE members as well as 15 of our electrical and informatics students are now also registered. Next month we plan to launch the IEEE Student Branch of Lampung, we hope through this endeavour will be able to broaden their horizons to the international society.

Before coming to a close with these remarks, I would also like to remind you and especially our moderators to strictly stick to our schedule and not to let any session overrun. I sincerely hope you will enjoy today of discussion, debate and networking.

I am sure you will have fruitful and rewarding exchanges on this conference day. I wish you all the best and success.

Thank you.

Dr. Khairudin – General Chair 1st ICCTEIE 2021

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***Abstract*—Internet of Things (IoT) provides opportunities for the internet to expand into the real domain of human life which includes industry and everyday equipment. With IoT, people are allowed to sense and to control objects remotely over existing network infrastructure. It creates many opportunities for pure integration of the physical world into computer-based systems. IoT results in increased efficiency, accuracy and economic benefits, while reducing human intervention. This paper presents the development of an IoT-based monitoring system for Solar Power Generation Applications. The Internet of Things Technology can greatly improve performance to monitor, and maintain photovoltaic solar power plants. The proposed system will display the use of current and voltage on the Solar Power Generation system online. This monitoring system is carried out using Arduino Uno and Raspberry Pi.**

***Keywords*—PV Power Plant, monitoring system, Internet of Things, raspberry pi**

I. INTRODUCTION

The internet of things (IoT) has become a revolution for all aspects of human life in the era of the industrial revolution 4.0. IoT comes with the idea to connect all sensors and devices through public networks such as the internet, either through cable or wireless. Therefore, users can access data and control devices from anywhere in the world through the internet [1-2]. With IoT technology, the process of automation using pre-defined logic is aimed to reduce human intervention as less as possible. In recent years, it has received a lot of attentions due to its very rapid and diverse use in the fields of consumer electronics, home automation, health care, smart cars, smart cities and security purposes [3].

One of clean energies is the energy resulted from solar that is rich in some parts of the globe and easy to harvest it. Solar energy is becoming increasingly popular with its technological advancements and decreasing costs. The electrical power harvested from a Solar PV system is vulnerable to variations of the weather, such as changes in solar radiation, temperature and many other factors. This causes monitoring of Solar PV power plant to be very important [4]. With modern monitoring and control systems, solar energy has become an increasingly reliable energy source and for near future, it is likely even substitute completely the traditional sources of energy.

An IoT-based monitoring system was chosen to avoid the dangers caused by cable systems. Meanwhile bearing in mind that the emerging requirements in the near future are that each device needs to be smart, automatic, and connected via internet [5].

The proposed system was tested through the experiment. The system is set up comprising of solar panels, voltage transducers, Hall Effect current sensors, temperature sensors, Arduino Uno microcontrollers and Raspberry Pi modules. The programming code was developed using the Arduino IDE and the Python programming language as well as data visualization carried out on the designed website.

This system is able to monitor PV voltage and current, Battery voltage and current, the voltage of the output, the current of the output, and the temperature of ambient. The system sends collected data to the server and displays graphical data on a designed website that can be retrieved from anywhere through the internet.

The rest of this paper is structured as the following. After this introduction section, state of the arts for solar photovoltaic in Indonesia is discussed in Section 2. Section 3 presents IoT based monitoring system and it is followed by discussing IoT based solar PV monitoring system in Section 4. Section 5 presents the monitoring results and its discussion. Section 6 concludes this paper.

II. SOLAR PHOTOVOLTAIC IN INDONESIA

Indonesia has great solar energy potential due to its geographical location which consists of islands located in the tropics and crossed by the equator. Indonesia has high levels of sun radiation that can be utilized. Based on solar radiation data collected from 18 locations in Indonesia, solar radiation in Indonesia can be classified as follows: irradiation in the Western Region of Indonesia around 4.5 kWh / m2 / day with a monthly variation of around 10%, and in Eastern Indonesia around 5.1 kWh / m2 / day with a monthly variation of around 9%. Thus, Indonesia's average solar radiation potential is around 4.8 kWh / m2 / day with a monthly variation of around 9.5%. So that solar energy is one of the important renewable energy sources in Indonesia.

One method for utilizing solar energy that has been widely developed in Indonesia today is Photovoltaic Technology. Photovoltaics (PV) is a method of producing electric power by converting solar radiation into direct current electricity using semiconductors that demonstrate the photovoltaic effect.

The photovoltaic system is one of the important renewable energy sources that offers many advantages such as the energy produced is not polluting, requires little maintenance, most promising and inexhaustible. In the application of photovoltaic systems, solar panels equipped with supporting components to form a complete PV system.

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The supporting components used in a PV system consist of inverter, battery, charge controller, and other parts as shown in Fig. 1.

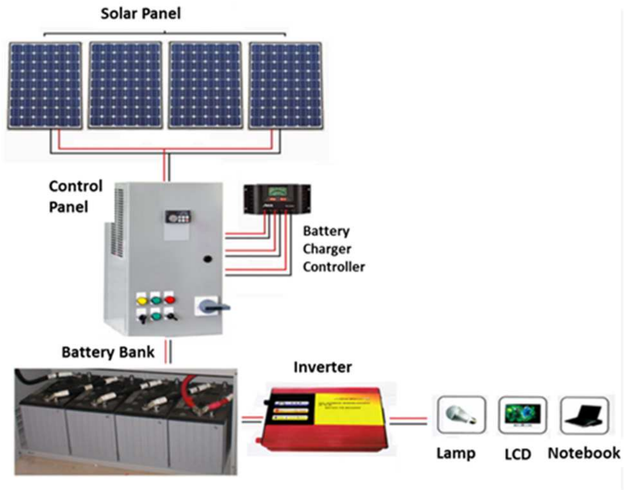

Fig. 1. Solar photovoltaic system.

The main device in solar PV system is Solar Cell that can capture sunlight and convert it into direct current electricity. In its use, several solar cells are connected in series and parallel to form a PV module, and some PV modules can be connected in series or in parallel to increase the output power of the PV system.

The energy produced by solar panels, will be regulated through a charge controller to be stored in batteries. The battery in the PV system serves to store electrical energy obtained from the conversion of solar energy and is ready to supply electrical energy to the load at any time.

The charge controller can prevent battery over-charge and over-discharge automatically. Due to the cycle times of charge, discharge and the depth of discharging is the main factor to determine the usage of battery life, therefore a charge controller is an essential equipment. The charge controller can be used to supply power for DC device which is with solar panels. The charge controller can supply a regulated DC output and store the excess energy in a battery, and it can also prevent over or under charging by monitoring the battery voltage.

Inverter is a device that can transform direct current into alternating current. Since solar cells and batteries are DC power sources so an inverter is needed when the load is an AC load. According to the operating mode, the inverter can be divided into stand-alone inverters and grid inverters. Stand-alone inverters are used in solar power generation systems operated independently to supply a separate load. Grid inverters are used in solar power generation systems that are connected to the electricity grid.

The PV monitoring system is aimed to provide information about some parameters of PV system. The parameter to be measured for PV system are output voltage, output power, output current, output energy [6]. It is also noticeable that the most eminent operational and metrological parameters are solar radiation, temperature, PV voltage and current, while other parameters are configuration dependent. The monitoring system consists of numerous sensors that provide information of different assets under various conditions. This information can be used by operators in making decisions related to utilization, replacement, and system reliability.

III. IoT Based Monitoring System

As a result of the advancements of computers and telecommunications fields, all aspects of life need the internet in this modern era. Supported by the development of applications and usage of mobile communication devices, the smart livable environment which is called as the internet of things (IoT) can be built. In principle, the expression of IoT idea can significantly to promote the information exchanges via the context-aware applications among anything from any place in the world at any time [7].

In recent years, the IoT applications spread into many fields which can be categorized into four categories namely personal/home uses, enterprise, mobile, and utilities [8]. One of example for the applications of IoT in the personal/home uses is IoT in the healthcare. In this case, the monitoring of patient conditions in the real time manner can be provided by the IoT supports. Fig. 2 illustrates the IoT application in the personal/home uses in the monitoring system for healthcare application with the support of solar PV monitoring system using IoT.

The applications of IoT in the enterprise category include smart home, smart cities, and smart environments. In case of smart home, it means that all home appliances such as television, refrigerators, washing machines, lamp, etc. can be connected, controlled, and monitored by mobile phone from anywhere. For the purpose of home security, unoccupied home is likely be monitored from far distant using a mobile phone. When an unforeseen coming in to enter the house, the security system will send an alert to the house owner automatically.

The IoT is used to enhance the comfortableness of public transportation usages for the mobile category applications, such as building the smart traffic control and monitoring. Wireless sensor network can be used to provide the air quality conditions, gas emission monitoring, and the controlling of traffic light. In addition, the control and monitoring of vehicle speed on the road can be carried out.

Furthermore, the smart energy and smart grid are the examples of IoT applications for the utilities category. In this case, IotT is used to build those systems in managing the distribution and consumptions of energy. One of specific example for this category is IoT based solar PV monitoring that is described in this paper.

IV. Solar PV Monitoring System Based on IoT

In this paper, the considered system has the capabilities to measure the values of voltage, current, and temperature of Solar PV as well as sending them to the users through mobile networks with internet connection for the data logging and review. In addition, the system can warn the user by sending the alert signal to the user using the SMS message. Fig. 3 depicts the system schematic diagram.

The solar PV voltage and the current are sensed by the circuit of voltage divider and by using Hall Effect Current Sensor, respectively. In principle, Hall Effect means on the generation of voltage difference caused by the conductor that is carrying a current in a perpendicular mode of magnetic field [9]. The current sensors of Hall Effect work based on this principle. In order to feed the expected output to be measured,

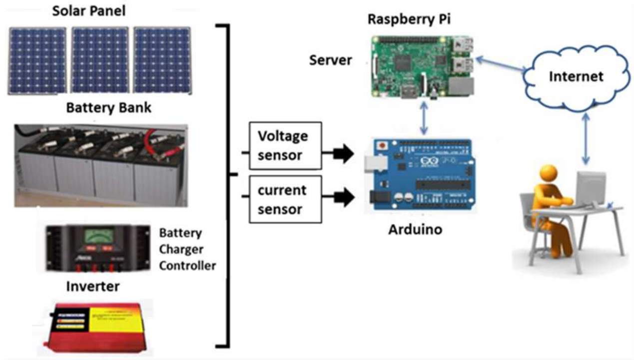

Fig. 3. IoT based solar PV monitoring system.

the system uses an installation of eight 125W Solar Panels from Emeral Energy Solutions Pvt. Ltd. Containing a total of 1 kW system.

The sensor temperature of LM35 is used to perceive the temperature. Very accurate readings in terms of degree Celsius over the range of 0-100^{o}C could be resulted in by this setting, meanwhile very low current about 60 micro-Amps can be drawn.

Arduino Uno microcontroller is employed to process the data that is obtained. And then, the resulted data is sent as serial input to the raspberry pi module. The Arduino board functions as a micro-processor in this conceptual system in which it processes the incoming information sensed from the numerous sensors. Since the Arduino board diminishes the requirement of various components such as the regulator for constant DC voltage, the hardware of the burner and it does not entail a software separately to convert the codes into hexadecimal file and it is burnt into the microprocessor, the Arduino board is chosen for the main board of the system. All tasks are carried out by Arduino IDE and they are burnt into Arduino board through an USB chord. The Arduino uno used is the microcontroller board that is based on a processor of ATmega328P. The coding can be done as needed by means of Arduino IDE using C/C++ language and we can upload the codes straightforward to the board. In the field of embedded electronics, the board has broad area of applications. The decision whether the values obtained by the various applied sensors are at the pre-determined limits is depending on the code of logics applied to the Arduino board. The data sensed by the sensors is processed by the board and they are sent to the raspberry pi module through serial communication protocol. And then, the data is sent by the raspberry pi to the internet through Local Area Network (LAN) cable; therefore, the data can be accessed and viewed then anywhere on the globe by using the internet connection.

V. Monitoring Results and Discussion

The designed system has the main aim in sending the data through the internet. The Arduino board senses the various values of data from the sensors and processes it and then send it to the raspberry pi module through the serial communication protocol. From this point, the data is sent to the internet through LAN. The website user interface is built and can be accessed through a PC and mobile phone at http://iot.mte.eng.unila.ac.id. Therefore, it is expected that

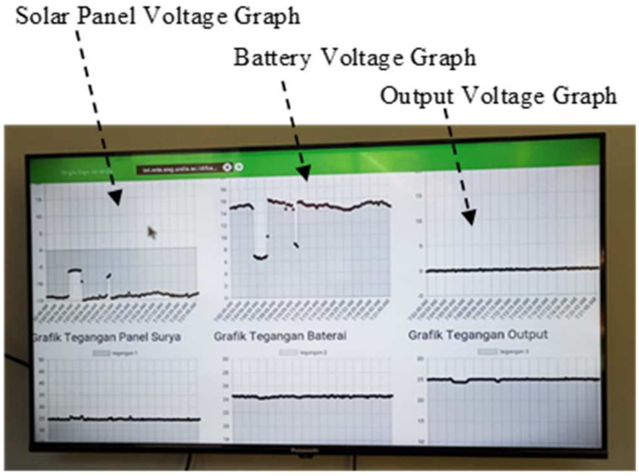

Fig. 4. Display of the system.

the user can access the collected data and monitor the installation of the solar PV from anywhere suing the internet connection. The data is displayed as a graph as shown in Fig. 4. In Fig. 4, Grafik Tegangan Panel Surya, Grafik Tegangan Baterai, and Grafik Tegangan Output mean Solar Panel Voltage Graph, Battery Voltage Graph, and Output Voltage Graph, respectively, captured from the display of the monitoring system. The on/off buttons to turn the solar PV system on or off are also provided at the website to control the system and other devices attached to the system.

Kind of data on the website are PV voltage and current, Battery voltage and current, Output voltage and current, also ambient temperature. The data are collected from the sensors and the data has been captured every 5 seconds along the day. Fig. 5 shows the example of the data for 24 hours. It is depicted that the PV voltage starts to reach high voltage at about 6.00 am and move to low voltage at 6.00 pm. It is reasonable results because PV voltage depends on availability of sunlight.

VI. Conclusion

IOT based solar PV monitoring system has been built successfully. Solar panel has generated electrical energy which measured by sensor and the data sent on internet. The data can be real-time monitored by user from mobile telecommunication devices. Also, user is able to turn on/off

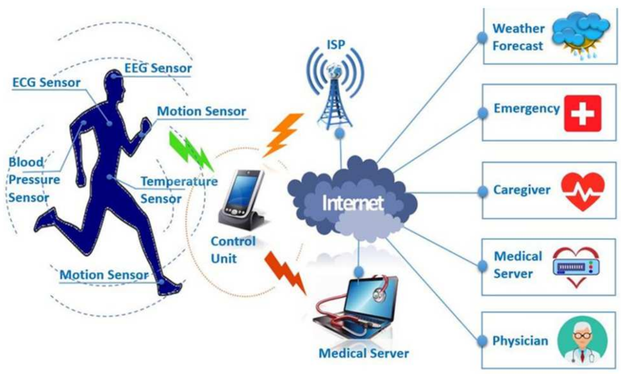

Fig. 2. IoT based healthcare monitoring system.

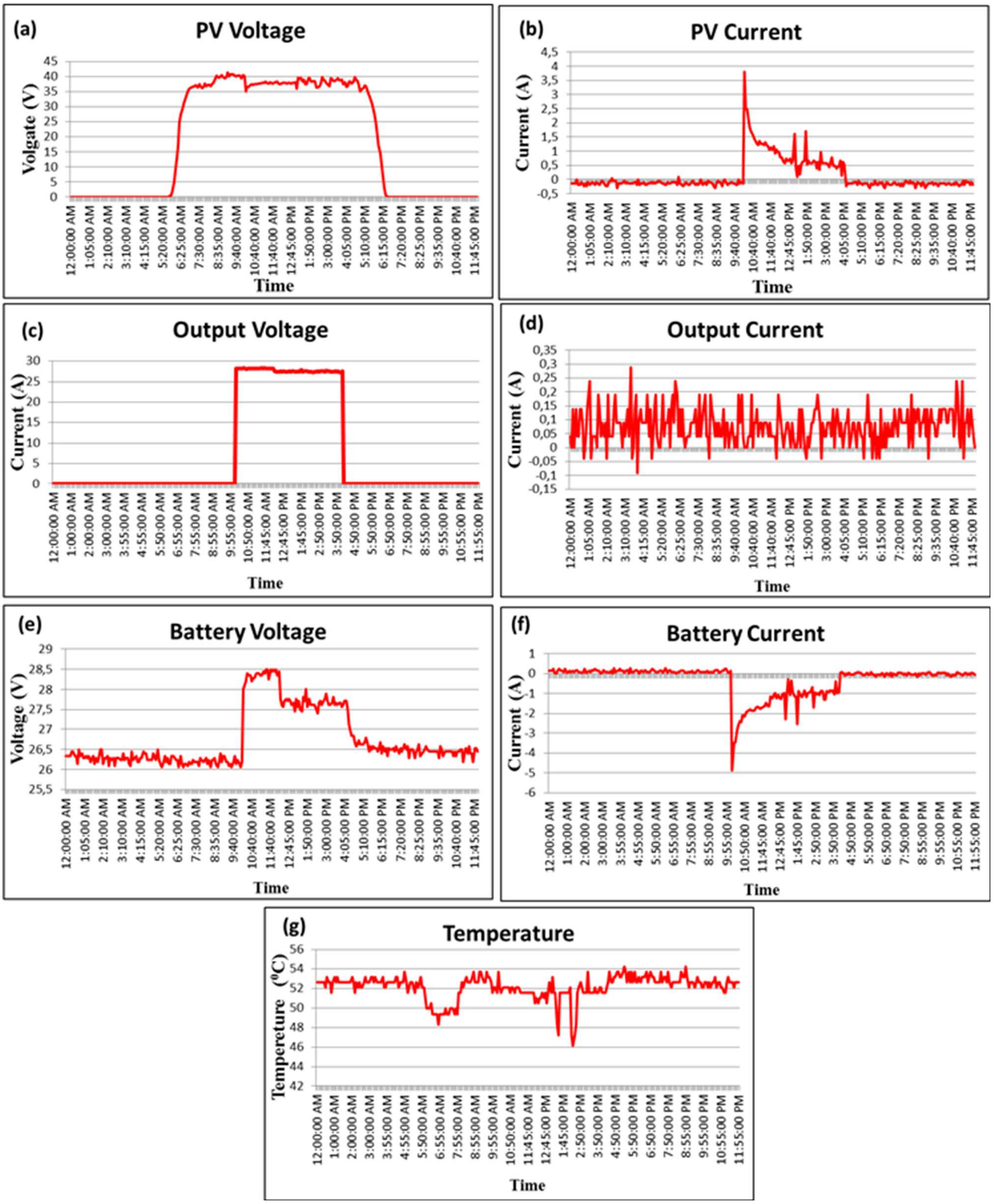

Fig. 5. Example of data measured along 24 hours.

the system and other devices connected to the system through the website. All of data also save in data logger for documentation and analysis purpose. This research may contribute to realize smart livable environment in the future.

ACKNOWLEDGMENT

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