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7-8 October 2013
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Yogyakarta, Indonesia

“Intelligent and Green Technologies for Sustainable Development”

Organized by
Department of Electrical Engineering and Information Technology
Universitas Gadjah Mada, Indonesia
Welcome Message from the General Chair

In Honor of the celebration of the 50th Anniversary of the Department of Electrical Engineering and Information Technology, Faculty of Engineering, Universitas Gadjah Mada (UGM), it is my great pleasure to welcome you to Yogyakarta City for the 5th International Conference on Information Technology and Electrical Engineering (ICITEE 2013) on 7-8 October 2013.

ICITEE 2013 is intended as an International Forum for those who wish to share their latest research results, innovative ideas, and experiences in the fields of Information and Communication Technology (ICT) as well as Electrical Engineering. Nowadays, modern technology makes our lives easier. Yet this progress is affecting our climate as a result of the increased carbon dioxide (CO$_2$) emissions. Under the theme of “Intelligent and Green Technologies for Sustainable Development,” the conference is expected to provide opportunities to explore emerging green and intelligent technologies that can contribute to environmental sustainability.

In addition, the conference committee has invited three renowned Keynote speakers, Professor Dr. Tadashi Matsumoto of JAIST, Japan, Emeritus Professor Dr. Susumu Yoshida of Kyoto University and Dr. Eng. Khoirul Anwar of JAIST, Japan. The conference committee also invited Professor Dr. Ramesh Kumar Pokharel of Kyushu University, Japan as Invited speaker to present his current research activities.

This conference is technically co-sponsored by IEEE Indonesia Section and supported by Department of Electrical Engineering and Information Technology UGM.

As a General Chair, I would like to take this opportunity to express my deep appreciation to the organizing committee members for their hard work and contribution throughout this conference. I would also like to thank authors, reviewers, all speakers, and session chairs for their support to ICITEE 2013.

I hope that participants will have a fruitful experience to enjoy the cultural heritage, natural beauty of Yogyakarta, and the taste of traditional Javanese cuisines, coupled with the friendliness of its people.

Finally, I would like to welcome you to ICITEE 2013 and wish you all an enjoyable stay in Yogyakarta.

Sincerely,

Dr. I Wayan Mustika, S.T., M.Eng.
General Chair of ICITEE 2013
IEEE UGM Student Brach Counselor
Welcome Message from the TPC Chair

On behalf of the technical program committee (TPC), it is my pleasure to welcome you to the 5th International Conference on Information Technology and Electrical Engineering (ICITEE 2013). As an annual International conference, ICITEE provides an excellent platform to share innovative ideas and experiences, exchange information, and explore collaboration among researchers, engineers, and scholars in the field of information technology, communications, and electrical engineering.

This year, the ICITEE 2013 Technical Program Committee received 190 paper submissions from about 14 countries throughout the world. All the submitted papers were thoroughly and independently reviewed by at least three reviewers in accordance with the standard blind review process. Based on the results of the rigorous review process, 92 papers have been selected. These papers have been grouped into 5 technical sessions, ranging from information technology, communications, power systems, electronics, and control systems. Besides the regular sessions, ICITEE 2013 also features world-class keynote/plenary speeches and distinguished invited speakers that reflect the current research and development trends in green and intelligent technology to achieve environmental sustainability.

We are deeply indebted to all of our TPC members, as well as our volunteer reviewers, who have greatly contributed to the success of the ICITEE 2013. Many thanks should be given to our keynote and invited speakers who will present their work in this conference. In addition, our sincere gratitude should be given to all authors who submitted their works to ICITEE 2013 and hope you will enjoy a wonderful experience in this small traditional city of Indonesia.

Welcome to Yogyakarta, explore a thousand years old temples, enjoy its traditional arts and cultures, taste the varieties of traditional Javanese cuisines, and bring them back with your memories of Yogyakarta and new collaboration opportunities.

With best regards,

Eka Firmansyah, ST., M.Eng, Ph.D
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1 MWp Grid Connected PV Systems in the Village of Kayubihi Bali; Review on Location’s Characteristics and Its Technical Specifications

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Abstract—Bali is one of the small islands in Indonesia with total land area of 6,800 square kilometers and with population of around four million people. The island’s economy is mainly driven by its tourism industry that leads to annual growth of 6.8%. The life and economy is supported by electric power system with 696 MW generating capacity but at peak time already operating at 679 MW which forces industries to operate their own captive powers. This condition requires swift and effective response from the authority to improve the generating capacity of the local power system so it can continue to support the regional development. Bali has no fossil based resources hence fuel for the power plants need to be externally sourced but with the dwindling capacity of the nation’s conventional energy resources together with the prospect of global warming therefore solution has been directed on renewable generation. As tropical island which is in close vicinity of the equator line, Bali has abundant quantity of sun power. The sun insolation index is estimated between 5 to 6 kWh per square meter everyday. And also, photovoltaic system is suited for urgent power demand as it can be built in relatively short time and with advantage of being environmentally friendly. These general facts have led to to the installation of 1 MWp grid connected photovoltaic systems in the village of Kayubihi by the Ministry of Energy and Mineral Sources. The system is currently the largest PV system in Indonesia and connected to the 20 kV distribution network. The report presented on this paper is the review on natural and social characteristics of the location and technical specification of the hardware system. This information are useful in analyzing performance of the photovoltaic system particularly on energy production, reliability of system and components, tariff calculation and investment, as well as developing model for the running of remote PV system based on partnership between local government and university.

Keywords—Bali renewable electricity, PV location characteristics, photovoltaic system, grid connected PV system

I. INTRODUCTION

The utilization of photovoltaic system in Indonesia was started some time ago in the early 80-is. It was introduced to villagers in remote areas which could not be connected to PLN; a state owned utility company, grid due to geographical constraints. The photovoltaic system was built as a small PV system known as solar home system (SHS) to replace kerosene lamps for lightings. Until today, this system continue to be installed by the government as alternative for providing electricity access for people who live in remote islands of Indonesia. In fact, the SHS is also part of program to achieve the 2025 renewable target by distributing one million units of 50 Wp SHS to people living outside of PLN’s grid. In addition, the government has also set to build 346 MW hybrid PV systems as energy source for remote areas, [1]. However, there has been little information about the progression of the two programs as to whether it will be able to meet the national target.

The Indonesian National Energy Policy states that by 2025, the contribution of new and renewable resources should be around 5% of the national energy mix for electricity generation. The renewable resources include hydropower, sun power, wind power, bio fuels, and nuclear. Total electric power demand by 2020 is estimated at around 50 GW [2] and by 2025 the figure will rise to between 60 to 70 GW. Currently, the total national power capacity is 30 GW. If the contribution of photovoltaic system is assumed 1% then it requires the development of 600 MW PV systems by 2025 within 12 years from today, which means that every year for the next 12 years, a total of 50 MW PV systems should be built. This figure is relatively large if it is compared with the current progress, particularly as the government had set a much higher target of 870 MW PV system by 2025 [3].

On February 27th, 2013 in the Village of Kayubihi, District of Bangli, Province of Bali, Minister of Energy and Mineral Resources officially inaugurated the operation of 1 MW grid connected photovoltaic system injecting power into PLN’s 20 kV distribution networks. On his speech, the minister Mr. Jro Wacik clearly stated that the development of this photovoltaic system which currently is the largest grid connected PV system in the country should be disseminated to public, particularly the stakeholders of renewable energy in Indonesia. This pilot project should be considered as milestone on strengthening and increasing the national capacity of renewable electricity generation toward achieving 5% electricity from renewable resources by 2025 as stated on the National Energy Policy [4].

The nomination of Bali as location for this relatively large size PV system as national pilot project supports the regional government of Bali in the implementation of Bali Green and Clean Programs and also the fact that Bali is currently experiencing power deficits. Bali’s electrical power system is supported by three power plants with total capacity of 696
MW, transmission lines of 662 kilometers long, 14 units of substations to serve over 800,000 consumers. The three power plants are fueled by high speed diesel oil (HSD). Bali is also interconnected with Java’s grid using submarine cable and the power is supplied from Paiton coal power plants on East Java. It is clear that Bali is solely dependent on fossil based fuel for its power generation. On the other side, it is now better understood that the national reserved on oil, gas, and coal are estimated to only be available for the next 75 years. On the demand side, Bali’s peak load has reached 679 MW with growth is estimated at 6.8% which largely due to extensive development of tourism industry. While villages’ electrification has reached 100% which means all of the villages in Bali has had access to electricity but the more remote sub villages are still without it. Kumara [5] reported that there were more than 45 sub villages in Bali that had no access to electricity due geographical and topological characteristics of the areas which hinder expansion of PLN’s distribution networks. Further, it was identified that local resources such as hydropower or sun power are alternatives for electricity generation for these sub villages.

The report presented here is an initial part of an on going research on the monitoring and performance analysis of the 1 MW Kayubihi PV System that covers energy production analysis, system and components reliability, energy tariff and investments, as well as developing model for operating a remote or rural medium size PV system by incorporating local government agencies and university. This paper will review the area or regional characteristics where the system is installed and the technical specifications of the PV hardware and system.

II. PROFILE OF PV LOCATION

A. Village of Kayubihi in District of Bangli

In order for PV system development project to generate maximum benefits for people and the stakeholders of renewable energy sectors, then various factors are considered in nominating the location of the PV system. This part will discuss natural and social characteristics of the region where the 1 MW PV systems is installed. The factors include the existing power grid, topography and demographics of the region, weather and climate, as well as the potential of sun power itself.

Bangli is one of the district governments of Bali with total area of 52,000 hectares and divided into four sub districts consisting 72 villages [6]. The region is spanned from 115° 13’ 48” to 115° 27’ 24” longitude and from latitude of 8° 8’ 30” to 8° 31’ 87”. The location is at elevations from 100 to 2,152 meter above sea level. The population is around 216,000 with population density around 415 people per square kilometer [7].

Village of Kayubihi is within the administrative area of Sub district Bangli. It consists of four sub villages, namely Bangklet, Kayang, Kayubihi, and Undisan. The population of the village is around tens of thousands of people and the main livelihoods are dry crops farming, cattle breeding, bamboo and wood handicrafts production, as well as other general trades.

B. Electricity Grid in District of Bangli

From electrical power point of view, the regional area of Bangli is part of PLN’s Eastern Bali Area Networks. The area is served by 20 kilometer 150 kV transmission lines, 20 kV distribution networks, 220 V low voltage networks. The customers are mainly residential type. All of the 72 villages in the district have been connected to the grid except some sub villagers that are located beyond the reach of PLN’s distribution networks. Kumara [5] reported that in 2009 there were tens of sub villages that are not yet connected to the grid. Topographical characteristic of the areas such mountains and valleys are the constraints for PLN to reach for these people.

The 1 MWp Kayubihi PV system is a demonstration of grid connected distributed generation. The generated power is injected into the 20 kV distribution networks owned by PLN. The unit is located very close or it is inside the Kayubihi 20 kV feeder hence connection is straightforward. Observation on many existing renewable generation system in Bali shows that often the power plants are located far from the distribution lines hence extending the link is necessary and this will add into the initial investment and sometime could hinder the utilization of the natural resources.

C. Environmental Profile of Bangli

Output of PV system is affected by various natural factors such as the availability of sun, temperature, rainfall, shading, condition of atmosphere in the surrounding location, cleanliness of PV modules, site condition, wildlife and domestic animals, community villagers, etc. On this section, condition of those factors are presented and data are of secondary type are taken from local authorities.

Generally, the potential converting sun power into electricity in Bali is quite high, as it is shown by high sun’s insolation index which are between four to six kilowatt hours per square meter every day. However, there has been little information on the actual energy production per square area of previously installed PV systems and perhaps comparing it to these figures to get more realistic data with respect to performance or energy production. It is clear that PV’s output will be greatly affected by the actual availability of sun throughout the year. One factor that affects the availability of the sun is the number of rainfall and rain days. Based on Kopen weather classification, the area of Bangli belongs to wet weather condition [8]. At one time, the rainfall was recorded at 797 mm per year. Table I shows monthly rainfall and rain days on Bangli in 2010 [9]. The table shows that the number of rain days in the region is quite large where more than half of the month had rains which would directly affect the PV system performance with respect to energy production.

The district of Bangli has relatively cool daily temperature that varies from 15°C to 30°C with daily average of around 24.5°C. Generally, the low temperature occurs from late afternoon to evening and night time until morning, while temperature is generally toward the high end during day time when the sun in shining. The average humidity is around 68% and wind speed at around 7 knot [7].
TABLE I. MONTHLY RAINFALL AND RAIN DAYS IN BANGLI IN 2010

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (mm)</th>
<th>Rain days (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>456.0</td>
<td>16.0</td>
</tr>
<tr>
<td>February</td>
<td>198.5</td>
<td>13.0</td>
</tr>
<tr>
<td>March</td>
<td>252.0</td>
<td>15.0</td>
</tr>
<tr>
<td>April</td>
<td>267.0</td>
<td>18.0</td>
</tr>
<tr>
<td>May</td>
<td>334.0</td>
<td>15.0</td>
</tr>
<tr>
<td>June</td>
<td>219.0</td>
<td>16.0</td>
</tr>
<tr>
<td>July</td>
<td>300.0</td>
<td>18.0</td>
</tr>
<tr>
<td>August</td>
<td>255.0</td>
<td>18.0</td>
</tr>
<tr>
<td>September</td>
<td>595.0</td>
<td>18.0</td>
</tr>
<tr>
<td>October</td>
<td>475.0</td>
<td>21.0</td>
</tr>
<tr>
<td>November</td>
<td>200.0</td>
<td>17.0</td>
</tr>
<tr>
<td>December</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

III. TECHNICAL SPECIFICATIONS OF 1 MW PV SYSTEM

PV system converts sunlight into electricity and its output is affected both by the sun power and other environmental factors and the PV hardware. The current commercially available panel has efficiency in the range of 14 to 16 percent. The PV panel used on this application is of monocrystalline type which manufactured by PT LEN Industry which capable of producing maximum power of 200 watt at standard condition test.

A. Photovoltaic array

Photovoltaic panel is component that converts the energy of sunlight into electrical currents. The advance of PV system is greatly affected by the development of PV panel technology. Battery is used to store the energy during daytime and consume at night time, therefore for system that directly consume its output during daytime will not require energy storage. The Kayubihi system does not use battery as its output is directly connected to the medium voltage utility’s grid. The schematic of the 1 MW Kayubihi PV system is shown in Fig. 1. [11]. The environmental monitoring systems monitor various variables such as temperature, both ambient and module, wind speed, and solar irradiation level. This measurement will be useful in analyzing the performance of the PV systems in term of energy production and factors that affecting it.

The complete technical specification of the LEN 200W-24V panel is shown on Table II [12]. To meet the requirement of the input voltage range of the inverter, 18 units of PV modules are connected in series to form an array with total nominal voltage of 18 x 24 volts or approximately 432 V dc voltage but maximum voltage could go up to 670 volts depending on the level of solar irradiation. Between five and six PV arrays is then paralleled to form a group and this group is served by one unit inverter of 20 kW. To meet the power output, 50 groups are built to make up the one megawatt output. The configuration of panels used on the 1 MW Kayubihi PV system is shown in Fig. 1.

Fig. 1. Configuration of 1 MW Kayubihi PV system
**TABLE II. TECHNICAL SPECIFICATION OF LEN 200W–24V**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel efficiency</td>
<td>$\eta$</td>
<td>%</td>
<td>15</td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>V</td>
<td>V</td>
<td>24</td>
</tr>
<tr>
<td>Maximum power (STC)</td>
<td>$W_p$</td>
<td>W</td>
<td>200</td>
</tr>
<tr>
<td>Voltage at maximum power</td>
<td>$V_{\text{max}}$</td>
<td>V</td>
<td>37.4</td>
</tr>
<tr>
<td>Current at maximum power</td>
<td>$I_{\text{max}}$</td>
<td>A</td>
<td>5.3</td>
</tr>
<tr>
<td>Short circuit currents</td>
<td>$I_{\text{SC}}$</td>
<td>A</td>
<td>5.5</td>
</tr>
<tr>
<td>Open circuit voltage</td>
<td>$V_{\text{OC}}$</td>
<td>V</td>
<td>44.2</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>$t$</td>
<td>°C</td>
<td>-40–+85</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>%/°C</td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Power tolerance</td>
<td>%</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td></td>
<td>16.5</td>
</tr>
<tr>
<td>Dimension</td>
<td>L x W x H</td>
<td>mm</td>
<td>806x1576x50</td>
</tr>
</tbody>
</table>

**TABLE III. TECHNICAL SPECIFICATION OF SUNGROW INVERTER**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power</td>
<td>$P_{\text{OUT}}$</td>
<td>kW</td>
<td>20</td>
</tr>
<tr>
<td>Input voltage</td>
<td>$V_{\text{DC}}$</td>
<td>V</td>
<td>250</td>
</tr>
<tr>
<td>Input currents</td>
<td>$I_{\text{DC}}$</td>
<td>A</td>
<td>40</td>
</tr>
<tr>
<td>Output voltage</td>
<td>$V_{\text{OUT}}$</td>
<td>V</td>
<td>400</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{\text{OUT}}$</td>
<td>A</td>
<td>31</td>
</tr>
<tr>
<td>Output frequency</td>
<td>$f$</td>
<td>Hz</td>
<td>50</td>
</tr>
<tr>
<td>Waveform</td>
<td></td>
<td></td>
<td>Pure sinusoidal</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>THD</td>
<td>%</td>
<td>3</td>
</tr>
<tr>
<td>Number of phase</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>$T$</td>
<td>°C</td>
<td>25–60</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Dimension</td>
<td>L x W x H</td>
<td>mm</td>
<td>648x695x237</td>
</tr>
</tbody>
</table>

**B. Inverter**

An inverter converts the DC voltage generated by PV arrays into AC voltage. The inverter used for this application is built using IGBT three levels inverter made by SUN GROW China of the SG 20 KTI product series. The inverter has maximum DC power input of 21 kW and maximum AC output of 20 kW. The number of inverter units installed of this system is 50 units giving maximum AC power of 1 MW. The major subsystems of the inverter circuitry are shown in Fig. 2 and its technical specification is shown on Table III [13].

**C. Connection to Grid**

The 1 MW Kayubihi PV systems is connected to utility grid on the 20 kV networks. The schematic configuration of the connection is shown in Fig. 3. [11]. Output of SG 20 KTI inverter is connected to five units three phase 400/20KV, 50 Hz, 250 KVA step up transformers. The transformers installed are of oil immersed outdoor type transformer manufactured by Schneider. The connection or removal of the system to and from the grid is established via motorized load break switch (LBS).

Fig. 2. Electronics systems of 1 MW Kayubihi PV system
D. Grid and PV Synchronization

The 1 MW Kayubihi PV systems is connected to utility grid on the 20 kV networks. Successful injection of power by the PV system depends on the synchronization of its output and grid’s parameters such voltage, frequency, and phase sequence. The PV system or indeed any generating plant can only be connected to the grid if its output voltage, frequency and phase sequence of the plant match those of the grid. The synchronization is implemented using phase lock loop (PLL) in which grid parameters are used as reference to generate output of the inverters [11]. This also implies that the PV systems will only inject power when the grid is in operation, hence the reference is available. If the grid is off for any reasons then the inverter does not have any input references and consequently will not producing output. At this condition the control system will deactivate the power plant. This will ensure that during maintenance of the distribution networks, the PV system will not injecting power to the grid which may endanger the maintenance team.

IV. DISCUSSION

The location of the PV system is within a waste disposal site own by District Government of Bangli. The total land area required for the power plant is around 1.2 hectare. The area is used for PV arrays installation, grid connection through five units of step up transformers, control panel and buildings for housing control panels and computer based monitoring systems. Fig. 4. Shows photos of the PV power plant.

The power plant was developed by the Ministry of Energy and Mineral Resource and will be handed over to the local government after passing the commissioning period by the contractor. After the hand over, the operation of this PV system including the necessary maintenance will be carried out by the local government or agency set up for that purpose. Historically, many of the renewable power plants developed by the central government which then handed to the local government had experienced various problems due to lack of capacity of the operator’s side and other factors. To avoid or minimize similar problems, the Ministry has initiated collaboration with local university to assist the local government in the operation and maintenance of the power plants.

Theoretically, the 1 MW Kayubihi PV system could generate maximum power of one million watt during day time. However, environmental factors such as temperature, rainfalls, rain days, wind condition, etc, will affect output of any PV systems. In addition, site condition such as shading, modules cleanliness, wildlife, and non technical aspects such as site security or access will affect the operation of the plant hence energy production of the Kayubihi PV plant.

Generally, the climate on the location of PV is a transition between wet climate of Kintamani and mild wet climate of Bangli which means relatively large rainfalls and many rain days. The relatively long duration of rains will directly affect the energy production of PV system. The design has adopted a daily effective sun hour (ESH) of 6.17 to estimate the system’s energy production [11]. This number was obtained from NASA’s publication and applies for Bali in general so it is not specifically for the location of the Kayubihi PV system. The value is relatively large considering the history of rain days and the amount of rainfall which is largely different from one area to the other in Bali. However, it remains to be confirmed by the actual energy production.

With respect to temperature, although at first it seems that data of local temperature is very close to STC value, with daily average of 24.5°C, however, since there is little information on the actual daily temperature variation therefore this would need to be confirmed by actual measurement. Temperature needs to be monitored in order to better relate the effect of surrounding temperature on the energy production.

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Based on initial site observation, other factors that potentially affect the performance of the PV system is shading of the arrays as well as debris deposit on the modules’ surface. Surrounding the PV installation, small vegetation such as weeds and tall grasses already growing which can affect the reception of sunlight. Big trees in the vicinity of the PV panels may also block sunlight. The positioning of the modules among themselves will likely to cause shading to other parts of the arrays and this need to be observed.

Wildlife in this area is mainly birds and also loose domestic dogs. Initial observation on site also found that many of the PV panels are already covered by the birds’ manure and dry leaves or twigs. While this is minor but over time the accumulation of this debris could cause blockage of sunlight to the photovoltaic cells. Loose domestic dogs have been seen roaming the site and also tempering the installation and even climbing on the arrays.

The location of the PV power plant is part of an area designated for regional waste disposal site. Domestic wastes are collected by the local government unit and then dumped on the other part of the site. The surrounding atmosphere is likely to contain higher degree of debris or dusts which could drop and deposit on the surface of the PV module which occupies relatively large area of more than one hectare.

The site are visited by many people including those who work on the disposal site and people who scavenging used and scrap materials, therefore the power plant need to be secured from any tempering both for safe operation of the systems and equipments as well as safety for people.

V. CONCLUSION

This paper has presented information on the grid-connected 1 MW Kayubihi PV system with respect to environmental profile of the location and technical specifications of the installed PV system.

The environmental factors such as temperature, solar irradiation, weather conditions and their effects on the energy production will be analyzed using information recorded by the environmental monitoring systems.

To ensure maximum sunlight conversion, the cleanliness of the PV arrays should be given focus of attention as there are many factors on the surrounding site that could cause blockage of sunlight to the PV cells. Therefore, careful cleaning procedure and technique should be set up taking into account the potential amount of debris deposits, the delicate nature of the module surface and the way the modules are configured or positioned.

Disturbance on the site that potentially affect PV performance also come from animals that can get into the plant area relatively easy. Loose dogs have been seen tempering the wiring of the system and even climbing on the PV arrays. Measures should be taken to minimize unauthorized access and tempering the installation of the PV system.

Monitoring the operation of the PV systems and its performance are currently underway. The measurements will be used to discuss the energy production, reliability of PV hardware and systems, energy tariff and investments analysis, and development of model to operate this PV power plant, based on partnership between District Government of Bangli and Udayana University. The plan is aimed to enable sustainable operation of the Kayubihi PV systems and to provide better understanding on the actual electrical performance of large size grid connected PV system and other technical or operational aspects of the systems, and to provide benefits to wider community.

ACKNOWLEDGMENT

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