International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 16 (2017) pp. 5995-6001

Solar Home System Application in Batik Industry

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Abstract

A Solar Home System (SHS) is a small-scale, autonomous electricity supply for households that are off-grid or have unreliable access to energy. It generates electricity from sunshine and stores the electricity in a battery for consumption during the night or cloudy days. SHSs generate direct current that can be used for a range of electrical appliances, from lighting and mobile phone charging to small televisions, air conditioner, computer or other appliances. By replacing fossil energy sources such as kerosene, candles and dry batteries, SHSs have the potential to reduce indoor air pollution and substitute energy expenditures. On the other side, one of the quite popular in Indonesia is Bantul batik, Yogyakarta Special Region. There are some Batik SMEs in Bantul. The issue of the SMEs is that the production process is still using kerosene stoves, while the price of kerosene is very expensive. Therefore, in this paper described the application of SHS for the batik production process. The SHS is used to distribute electrical power to the batik electric stove. The use of SHS and batik electric stoves is more practical and economical than kerosene stove. Another advantage is to reduce dependence on fossil fuels and help preserve the environment with the use of green technology.

Keywords: Solar home systems, SMEs batik, batik electric stove, Yogyakarta batik.

INTRODUCTION

Batik is one of the Indonesian nation's wealth. Batik is a piece of cloth applied by means of a dye-resist technique using "batik-wax" as the resisting medium [1]. Indonesian batik process has designated by UNESCO as a Masterpiece of Oral and Intangible Heritage of Humanity. As part of the acknowledgment, UNESCO insisted that Indonesia has been preserved their heritage. This fact should be grateful and responded with efforts to develop and preserve Indonesian batik. One effort to develop and preserve Indonesian batik is to adopt green energy technologies in the production process. As generally in Indonesia, batik industry is currently still a class of small and medium enterprises (SMEs). Batik is a fabric sheet made by drawing designs on fabric using dots and lines of hot wax. This wax is used to reject dye by soaking a cloth in one color. Once the color is applied, the wax is removed using boiling water and repeat if some of the desired color. Batik has been known to the world community that comes from Java [1]. Custom pattern often have a symbolic meaning that is used in certain ceremonies, while the coastal pattern draws inspiration from various cultures. Batik has been used as everyday clothing since ancient times, and is still used and very loved by many Indonesian people today in events ranging from formal to casual. In October 2009, UNESCO has set Indonesian batik as a Masterpiece of the Oral and Intangible Heritage of Man. As part of the recognition, UNESCO asserted that Indonesia preserve their cultural heritage [2].

The use of renewable energy and energy efficiency, which is a part of the green energy technologies, is very important to reduce global warming and protect the ecosystem. Green technology will be able to reduce carbon emissions [3]-[6]. Green energy technologies by utilizing alternative energy sources such as wind, solar, hydroelectric, and others reduce CO2 emissions by improving energy efficiency [7]-[10]. Climate change is now occurring due to uncontrolled carbon emissions that affect the world economy. Because of temperature increases, agricultural products will fall, damage from floods and storms will increase, tropical diseases will become more common and access to water will become more of a problem for more and more people. Costs incurred for our environment is greater and the loss could not be changed. Earth's flora and fauna will suffer both directly from the higher temperatures and indirectly through the destruction of their habitat. Even a small increase in temperature will lead to coral bleaching and threatening some amphibians. Temperature rises of 3°C or 4°C and more will lead to major extinctions around the globe [11]-[13].

A popular one in green energy technologies is solar energy. Solar energy has shifted impressive technology. Early solar technology consists of small-scale photovoltaic cells. The latest technology of large-scale PV systems has been fed into

the power grid. Technology costs have fallen substantially over the last 30 years [14]-[17]. The rapid expansion of the solar energy market is the result of government policies that support instruments, increased price volatility and environmental externalities of fossil fuels, especially greenhouse gas emissions.

Basically the solar energy resource potential that far exceeds the entire global energy demand [18]-[19]. Although the technical potential is very large and the recent growth of the market, the contribution of solar energy for the global energy supply mix is still negligible. Numerous studies, have been discussing various issues related to solar energy [20]-[24]. This study provides an overview of the synthesis of existing literature and presents an economic analysis to look at the competitiveness of solar energy compared with fossil energy [25]-[26]. Although the presence of the clean development mechanism of the Kyoto Protocol has been contributed to assist the implementation of several projects of solar energy, its role in promoting solar energy is very small compared to that of other renewable energy technologies as cost competitiveness [27]-[28]. An existing study has shown that the share of solar energy in the world energy supply mix could exceed 10% in 2050 [29]-[34]. This share would still be a small part of the total world energy supply. This share is also a small fraction of renewable supply.

SOLAR HOME SYSTEM

The sun is a renewable source of clean energy and that's an increasingly valued benefit. Solar photovoltaic (PV) systems produce electricity without emissions of air polluting gases, greenhouse gases and particles that are byproducts of combustion or burning fuels. The supply of "fuel" for solar PV systems – sunlight and solar heat – is endless and free. That doesn't mean the electricity is free, but you may be able to save money. With the ongoing advancements in solar PV technology, the cost of solar power continues to drop and its use is on the rise. Since solar PV systems are long-lasting and require little maintenance, the cost of producing electricity remains relatively stable and predictable over a long time. Owning a home solar power system can be insurance against energy cost increases that affect other power sources.

Solar home systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. In rural areas, that are not connected to the grid, SHS can be used to meet a household's energy demand fulfilling basic electric needs. Globally SHS provide power to hundreds of thousands of households in remote locations where electrification by the grid is not feasible. SHS usually operate at a rated voltage of 12 V direct current (DC) and provide power for low power DC appliances such as lights, radios and small TVs for about three to five hours a day. Furthermore they use appliances such as cables, switches, mounts, and structural parts and power conditioners / inverters, which change 12/ 24 V power to 220VAC power for larger appliances. SHS are best used with efficient appliances so as to limit the size of the array.

A SHS typically includes one or more PV modules consisting of solar cells, a charge controller which distributes power and protects the batteries and appliances from damage and at least one battery to store energy for use when the sun is not shining.

They contribute to the improvement of the standard of living by:

- reducing indoor air pollution and therefore improving health as they replace kerosene lamps,
- providing lighting for home study,
- giving the possibility of working at night and
- facilitating the access to information and communication (radio, TV, mobile phone charging).

Furthermore, SHS avoid greenhouse gas emissions by reducing the use of conventional energy resources like kerosene, gas or dry cell batteries or replacing diesel generators for electricity generation. Further impacts of renewable energies, such as SHS, can be found in the Report on Impacts.

Stand-alone photovoltaic systems can also be used to provide electricity for health stations to operate lamps during night and a refrigerator for vaccines and medicines to better serve the community. To assure the quality of a photovoltaic power system and its correct functioning and guarantee costumers' satisfaction, it is important that the components of the system and the system as a whole meet certain requirements.

Before installing a photovoltaic (PV) SHS, its size has to be calculated according to different assumptions, such as measurement of solar radiation, solar insolation and power demand. Regarding the installation process, Solar Home Systems have to be installed by a trained technician who knows how to handle its different parts. Thus, aspects of maintenance and a solar technical training manual are presented: Planning, Installation and Maintenance of SHS.

RESEARCH METHODOLOGY

The problem-solving step in the batik industry in this research is shown in Fig. 1.

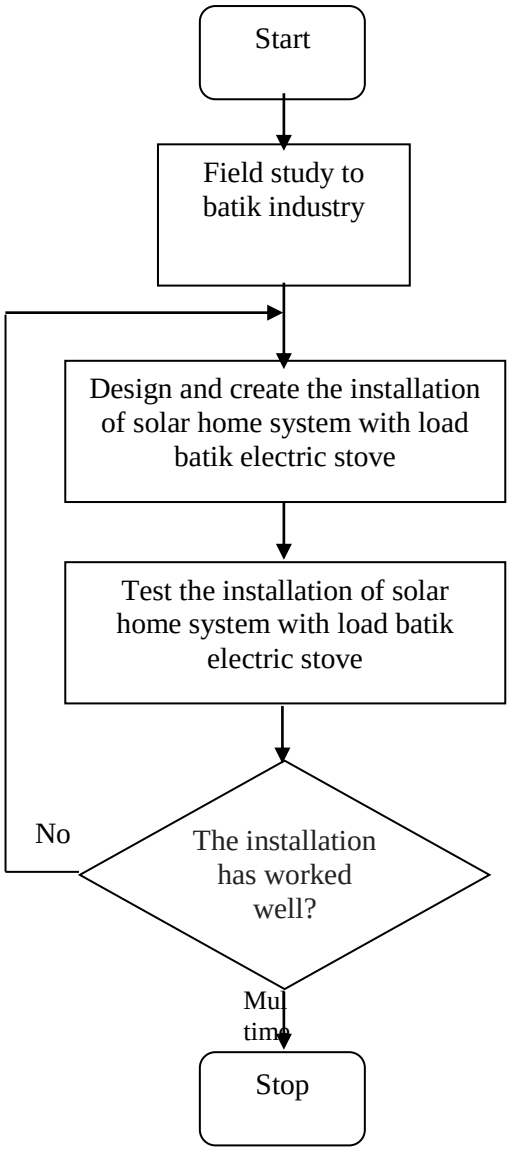


Figure 1: The problem-solving steps in the batik industry in this research

In order to increase production capacity, market expansion, and capacity building activities in The Bantul Batik SMEs, then in the programs carried out the following activities:

1) Batik production capacity of the SMEs can be improved:
   a. Provide an electric stove specifically for batik SMEs.
   b. Provide and install solar cell home systems to ensure continuity of the flow of electrical power to distribute electrical power to the stove and also home lighting batik production. Provision the solar cell home system is also useful to overcome the problems in both SMEs because it has a low power capacity installed and frequent power outages, while each SMEs will use electrical power continuously for 2 pieces of 125 watts electric stoves.
2) Improving human resource capacity in the respective SMEs.

RESULTS AND DISCUSSION

The geographical condition of Indonesia which is located in the tropical region is traversed equator particular gift for the people of Indonesia if it is associated with potential sources of electrical energy derived from sunlight [6]. On the bright midday sun radiation is able to reach 1000 Watt/m^2. If a semiconductor device with area of 1m^2 has an efficiency of 10 % then the solar cell module is capable of delivering 100 watts of power [7]. Currently commercial module efficiency solar cells ranged from 5 to 15% depending on the constituent materials [8]. On a national scale, the government of Indonesia has a serious program in renewable energy, one of which is the solar energy [8]-[9]. The government of Indonesia has targeted that power generator from renewable energy resources will be on-grid for up to 5% by the year 2025 [5].

In this work, the create-design of solar home system with loading of batik electric stove is done. The scheme of solar home system in this work is shown in Fig. 2. Solar cell home systems installation for each SME to ensure the availability of electric current for batik electric stove and lighting the batik production houses. The power capacity of solar cell in the installation is 100 Wp. The technical specifications of 100 Wp solar cell panel for batik industry has described in Table 1. The main burden of solar home systems is batik electric stove of 125 W, 220 volts, as shown in Fig. 3.

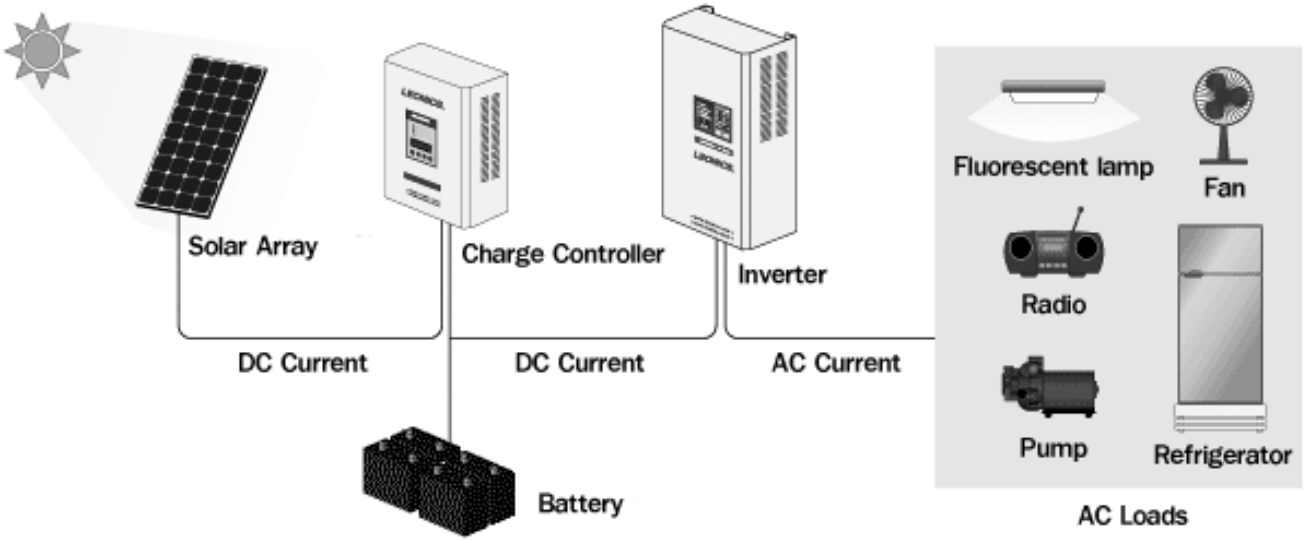


Figure 2: The scheme of solar home system

The main function of solar home system is the electrical power supply to the load on the batik electric stove with a power capacity of 125 watts each burner. Production of electric energy solar home systems is highly dependent on sunlight. In one day, the most effective sunlight to generate electrical energy in just over 5 hours, as shown in Fig. 4.

Solar insulation (Fig. 4) can be determined as follows:

1) Insulation sunlight can be estimated from that of predicted weather conditions.
2) Weather forecast data in the form of long sun emits rays can be obtained from meteorological and geophysics agency.
3) The length of time the sun radiates its light is converted into the peak sun hours

Table 1: Technical specifications of 100 Wp solar cell panel for batik industry

Parameters	**Values**	**Units**
Maximum power	100	watts
Open circuit voltage	21.6	volts
Short circuit current	5.70	amperes
Maximum system voltage	1000	volts
Dimension	835 x 540 x 28	mm
Test conditions	AM1.5 1000W/m225 ° C	-

Figure 3: Batik electric stove of 125 W, 220 volts

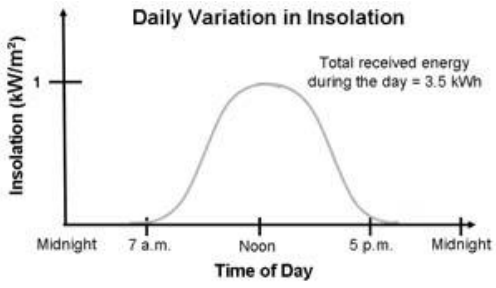


Figure 4: Daily solar insulation characteristics

Testing of solar home systems with a single load electric stove for batik described as shown in Table 2 and Table 3.

Table 2: Technical specifications of solar home system load

Parameters	Values	Units
Maximum power	125	watts
Nominal voltage	220	volts
Nominal current	0.60	amperes
Frequency	50	Hz

Load type : Electric stove for batik
Place of Testing : Bantul batik SMEs

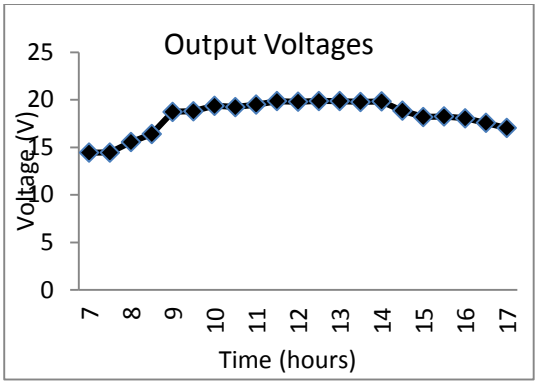
After the sunlit solar cells for 5 hours, then the solar cells can be used with a load power of 125 watts for 2 hours, which is described in Table 3.

Table 3: Test results of solar home system installation.

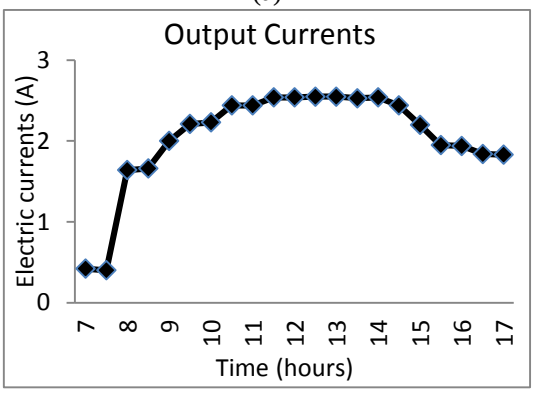
Parameters	Values	Units
Maximum power	100	watts
Nominal voltage	220	volts
Maximum drying time	5	hours
Frequency	50	Hz
Energy produced	100 x 5 = 500	watt-hours
Long duration usage load	500/125 = 4	hours

Fig. 5(a) and Fig. 5(b) show the output voltages and the output currents of solar cell under study, respectively. Testing of the solar cell with loading of 125 W batik electric stove is start from 7.00 AM to 17.00 PM. As shown in Fig. 5(a) that output voltage of solar cell has varied from 14.45 volts to 19.88 volts. Magnitude of the voltage dependent on sunlight, where the maximum voltage occurs at 12.00 AM and the minimum voltage occurs at 7.00 PM.

Thus, applications of solar home systems in Bantul Batik SMEs help continuity of batik production. This is in accordance with the needs of both SMEs who have often experienced a power outage that disrupts batik production process, especially if using an electric stove for batik.



(a)



(b)

Figure 5: (a) Solar cell output voltage, (b) Solar cell output currents.

The impact and benefits have been felt through service activities are:

1) Batik production capacity of Bantul Batik SMEs has increased with the following details: The Yogyakarta Batik SMEs, if prior to the work only capable of producing combination stamp and write batik and pure batik with a total capacity of approximately 250 pieces of cloth batik per month, then after our activity is able to increase its production up to 350 pieces of cloth batik per month. The increase in productivity has been accompanied by an increase in gross profit of an average SME Rp 7 million per month to an average of Rp 10 million per month.
2) Expansion of each SME market has increased. Both SME market has dared not only to supply the batik cloth batik shops around Malioboro street and Beringharjo mart, Yogyakarta, but also through exhibitions in several cities such as Jakarta and Bandung are often sponsored by the Department of Industry and Local Government of Yogakarta.
3) Human resources capacity in each SME has increased in quality, mastery of which operating and maintenance of solar home systems installation and electric stoves for batik.

CONCLUSION

This work has proved to be very beneficial for Yogyakarta Batik SMEs. Solar home systems installation and procurement of electric stoves for batik has managed to increase both production capacity and gross profit of the SMEs. In a period of one year the Bantul Batik SMEs productivity increased from an average of 250 pieces of batik cloth to an average of 350 pieces per month. The increase in productivity has been accompanied by an increase in gross profit of the SMEs.

ACKNOWLEDGEMENTS

The author is gratefully acknowledges the contributions of the Ministry of Research, Technology, and Higher Education, Republic of Indonesia, for funding in this research.

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