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Solar Panel System with Internet of Thing Based Control on Dome Dryer for Coffee as A Support for Sustainable Agrotourism

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ABSTRACT: The need for electrical energy in people's lives is very important. The government is currently implementing policies, especially in the electricity sector, to develop potential alternative energy sources as an effort to diversify energy in the form of implementing regulations, namely by developing solar power plants (PLTS) as a type of renewable energy. Renewable energy from solar power plants (PLTS) will be used as energy that can replace electrical energy from PLN to power a control system that can be monitored via the internet of things (IOT) on dome dryers for drying coffee. Problem Formulation: The use of electricity from PLN is felt to be very expensive; Difficulty in controlling temperature and humidity in the Dome drying room and a lot of heat energy is wasted; The quality of traditional drying results is uneven and the production quality is not good. Research Objectives: Analyze the electric current of solar energy from renewable energy based on control system requirements; Analyzing environmental (external) factors in the Dome solar dryer; Designing an IoT-based control system; Knowing the temperature and humidity in the Dome solar dryer room; Determining the water content of coffee beans produced by the Dome dryer to support sustainable agrotourism. Uses or Benefits of Research: Application of Renewable Energy Technology, especially Solar Photo Voltaic (PV); Practical knowledge and technology for the community on the Solar Drayer Dome; Knowing the Solar Panel System from Renewable Energy with Remote Control (IoT) Control System to obtain the right temperature for drying coffee; Obtaining the correct water content value in coffee products from dome dryers to support sustainable agrotourism. Research Method: carried out in stages, namely observation and installation of supporting equipment for collecting data directly in the field (Experimental). Research results: Solar panels convert solar energy into electrical energy. Solar panels produce Direct Current (DC) electricity or direct current; Reducing carbon emissions: PLTS produces electricity without emitting greenhouse gases such as CO2, which contributes to global warming.

KEYWORDS: Agrotourism, Drayer Dome, Energy, IoT, Solar.

INTRODUCTION

The need for electrical energy in everyday life is very important, from cities to villages and is not only used for lighting or household needs, but can also be developed towards productive businesses, both large industries, medium industries, small industries and household industries so that they can improve the economy of the community [3]. The government is currently implementing policies, especially in the electricity sector, to develop the potential of alternative energy sources as an effort to diversify energy in the form of implementing its regulations, namely by developing solar power plants (PLTS) as one of the renewable energies [1]. Renewable energy from solar power plants (PLTS) will be used as energy that can replace electrical energy from PLN to power the control system that can be monitored via the internet of things (IOT) on the dome dryer for drying coffee. Coffee is one of the plantation commodities that has a fairly high economic value among other plantation crops, and also plays an important role as a source of foreign exchange for the country. In addition to playing a very important role as a source of foreign exchange, coffee is also a source of income for farmers whose number is no less than one and a half million people as coffee farmers in Indonesia [2]. Coffee is a necessity for humans that has health benefits that can: reduce the risk of diabetes, increase stamina, reduce headaches and relieve breath, and others. Indonesia is one of the coffee producing countries with the most species in the world so that the demand for Indonesian coffee continues to increase. Along with the increasing demand for coffee for domestic and foreign markets, the government will expand coffee plantations in hilly and mountainous areas. So far, coffee from Indonesia has been in great demand by the international market with high prices, and has even won a number of prestigious awards. These coffee producers should be able to make quality coffee products that are produced through a good drying process, so that they have a specialty that

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is felt by consumers [4]. Consumers will certainly choose high-quality coffee products that are processed in a good and hygienic manner according to the desired quality standards. A coffee product can be said to be of high quality if consumers feel that their needs or desires have been met. A cup of coffee that is enjoyed usually goes through a very long process, starting from cultivation, harvesting, post-harvest processing, to coffee lovers. Coffee that has a high taste is only obtained from quality coffee beans that are processed with good treatment. Good coffee production quality is one of the factors that affect the high selling price because the quality standards of coffee products are better. If a company can provide good quality coffee products, it will add new consumers to consume the product [4]. [Problem Formulation: The use of electricity from PLN is considered very expensive; The use of traditional drying takes a long time and the drying results are less than perfect and not hygienic; Difficulty in controlling temperature and humidity in the Dome drying room and a lot of heat energy is wasted; The quality of traditional drying results is uneven and the production quality is poor [5].

Coffee Theory Study

Definition of coffee Coffee is a drink made from coffee beans that are processed into powder and then brewed using a certain method; Types of coffee: 1. Arabica coffee is a type of coffee bean that is often used to make coffee drinks. This is because Arabica coffee beans have a more sour, fruity and less bitter taste when compared to other types of coffee; 2. Robusta coffee is the second type of coffee bean after Arabica which is in great demand by the public where only certain groups of people can enjoy robusta coffee.

Solar panels (Photovoltaic).

Definition of Solar Panels (Photovoltaic) is a tool that can convert sunlight energy into electrical energy. Photovoltaic technology (photovoltaic / PV) is a technology used to convert solar radiation into electrical energy. The electrical energy produced will be stored in batteries, which can be used for electronic devices and adjusted to their electricity needs (Anonymous, 2021); 1. Types of Solar Panels. Monocrystalline Silicon: Is one type of solar panel that is widely used. This type of solar panel has various advantages such as high efficiency and long service life. The solar cells that make up the panel are made of pure silicon crystals that are thinly sliced using a machine to form a circle. This solar cell is called "monocrystalline" because the silicon used is single crystal silicon (Anonymous, 2021); 2. Polycrystalline Silicon: This is a type of solar panel made of silicon crystal rods that are melted or melted and then poured into a square mold. The advantage is that the arrangement is neater and denser. The characteristics of this solar panel are quite unique because there are cracks or fragments in the solar cell. As the name suggests, this type of polycrystalline silicon solar panel consists of many silicon crystal fragments (Anonymous, 2021); 3. How solar panels work: The way solar panels work in simple terms or the working principle of solar panels is as follows: Solar panels convert energy from the sun into electricity. The inverter converts the electricity generated by the solar panel from direct current (DC) to alternating current (AC). The energy is used to power electrical equipment.

Control System.

1. Definition of a control system is an activity carried out to measure the value of a quantity and then carry out activities to limit deviations from a desired price (Anonymous, 2022); 2. Automatic Control is the control of a process quantity if there is a deviation or deviation, an automatic repair effort will occur so that it can limit the deviation or deviation from the desired value. In automatic control, the role of the operator in manual control is replaced by a tool called a controller (Anonymous, 2022); 3. A control system is a tool for controlling, commanding, and regulating the state of a system. The term control can be practiced manually to control the control system (FX Setiawan, 2016). A control system or control system is a system that produces a certain value as its output through controlling or changing the provisions of the system input. A control system can be interpreted as a system that controls or regulates a condition in order to produce the desired output (Anonymous, 2022).

Drying.

1. Drying is a way to remove or eliminate most of the water from a material using heat energy. The removal of water from the material is carried out until it reaches a water content in equilibrium with a certain environment where fungi, enzymes, microorganisms, and insects that can damage it become inactive (Anonymous, 2017); 2. The purpose of drying is to reduce the water content of the material to a certain limit so that it is safe to store until further use. With drying, the material becomes more durable to store, the volume of the material is smaller, it makes it easier and saves space for transportation, makes transportation

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easier, and production costs become cheaper. The principle of drying is the process of transferring heat and mass that occurs simultaneously. In drying, water is removed by the principle of the difference in humidity between the drying air and the material being dried (Anonymous, 2017).

Solar Drayer Dome and Components

1. Solar Drayer Dome is a dome-shaped drying device with a closed room incubator like a Greenhouse and at first glance it is similar to a solar tunnel, the only difference is in the cover material used so that green houses and solar tunnels usually still use polyethylene terephthalate (PET), while the Dome solar driers use polycarbonate (Wijanarko, et al., 1017); 2. The increase in temperature that occurs in the Dome drying room can shorten the drying process time on the product because it is also assisted by solar PhotoVoltaics and exhaust fans installed as supporting equipment on the Dome solar driers, which can help air circulation to remove water content in the product and can remove air humidity that can damage the tissue structure of the dried material (Report, 2023); 3. The advantage of this dome solar drier is as a drying device that can dry products quickly, with quality, hygienic, so that the drying process can work effectively. On the other hand, the use of polycarbonate covers on solar dryer domes can protect products from ultraviolet rays which can damage product components, such as color, chemical components, aroma, taste and product quality (Report, 2023).

Sustainable Agrotourism

1. Sustainable agrotourism is a form of tourism activity that utilizes the potential of agriculture as a tourist attraction, by applying the principles of sustainability. This involves managing natural and cultural resources responsibly, ensuring that tourism activities do not harm the environment, supporting the social and economic life of local communities, and providing meaningful and educational experiences for visitors; 2. The principles of sustainable agrotourism include: Reducing the Use of Chemicals: Replacing chemicals with compost from organic materials to maintain the authenticity of the soil and ensure that the products produced are safe for consumption; 3. Conservation of Nature and Culture: Protecting wild plants and animals, and adapting to the local natural and cultural environment; 4. Empowering Local Communities: Businesses are run responsibly with cooperation between government and community elements to meet the needs of local residents; 5. Education: Providing learning and reminding tourists about the importance of conservation; 6. Thus, sustainable agrotourism not only provides economic benefits through increasing farmer incomes and creating new jobs, but also helps in preserving the local environment and culture.

RESEARCH METHOD

The research material is wet coffee beans as the media to be dried. This research was carried out in several stages, namely observation and installation of supporting equipment in data collection carried out directly in the field (Experimental) and continued by analyzing the data.

Research Procedure

The research procedures used are as follows:

1. Background of the Research

1.1. Explain the importance of renewable energy and the application of Internet of Things (IoT) technology in agrotourism.

1.2. Identify problems in the existing coffee drying system, as well as opportunities for increasing efficiency through the use of solar panels and IoT.

2. Research Objectives

2.1. Design and implement a solar panel system with IoT-based control on a dome dryer for coffee.

2.2. Evaluate system performance in the context of sustainable agrotourism.

3. Research Methodology

3.1. Literature Study:

3.1.1. Conduct a literature review related to solar panel technology, IoT, and coffee drying systems.

3.1.2. Collecting data and information on IoT applications in drying systems and the benefits of solar panels in agrotourism.

3.2. System Design:

3.2.1. Designing a dome drying system for coffee using solar panels as the main energy source.

3.2.2. Developing an IoT-based control system to optimize the drying process.

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3.3. Implementation:
3.3.1. Installing solar panels and IoT devices on the dome dryer.
3.3.2. Testing system functionality under real operational conditions.
3.4. Data Collection:
3.4.1. Collecting system performance data, including energy efficiency, drying time, and drying result quality.
3.4.2. Using sensors and IoT devices to monitor environmental and operational parameters.
3.5. Data Analysis:
3.5.1. Analyzing collected data to evaluate system performance.
3.5.2. Comparing results with traditional drying systems to assess efficiency improvements.
3.6. Conclusion and Recommendation:
3.6.1. Summarize the research findings and evaluate the extent to which the research objectives have been achieved.
3.6.2. Provide recommendations for further development and practical application in sustainable agrotourism.
4. Research Schedule
4.1. Create a research schedule that includes the stages mentioned above, including an estimated time for each stage.

RESULTS AND DISCUSSION

Analyzing Electric Current from solar energy based on the needs of the control system. Based on the provisions of the Minister of Energy and Mineral Resources Regulation No. 49 of 2018, in conjunction with Regulation No. 13 of 2019, in conjunction with Regulation No. 16 of 2019, rooftop PLTS is a process of generating electricity using photovoltaic modules, which are placed on the roof, walls, or other parts of buildings owned by customers/the community. In general, Solar Power Plants (PLTS) placed on roofs/walls have main mechanisms and components. The mechanism of the rooftop/wall Solar Power Plant (PLTS) system is as follows: 1. Solar panels convert solar energy into electrical energy. Solar panels produce Direct Current (DC) or direct current; 2. Direct Current (DC) is converted through an inverter into Alternative Current (AC) or alternating current; 3. Alternative Current (AC) is connected to the electricity network in the solar dryer dome through the Alternative Current (AC) breaker panel; 4. Use of electrical energy for lighting or electronic equipment in the control system in the solar driers dome; 5. Use of kWh import export (exim) meters using a net metering system; 6. The exim meter will read electricity exports from PLTS customers to the PLN network, and read electricity imports from the PLN network to PLTS customers (Connection with PLN). All of these components work together to convert solar energy into electrical energy that can be used in solar driers domes or distributed to the public electricity grid. In some cases, the Solar Power Plant (PLTS) system can also be integrated with other energy sources, such as electricity from the grid or generator, to ensure a stable and continuous energy supply. As with various fossil fuel-based projects, the construction of various renewable energy-based facilities also requires land. The need for land varies between one type of renewable energy and another. So that it can describe the land requirements for various types of energy systems, both for electricity generation and fuel production.

Analyze environmental factors in solar panel systems.

1. Environmental Aspects: Solar Power Plants (PLTS) have a number of impacts on the environment. As a renewable energy source, PLTS has many advantages compared to conventional energy sources such as fossil fuels, but still has several impacts that need to be considered. Some of the positive impacts of PLTS include; 2. Reduced carbon emissions: PLTS generates electricity without emitting greenhouse gases such as CO2, which contribute to global warming. By reducing the use of fossil fuels, PLTS helps reduce greenhouse gas emissions significantly. The reduction in carbon emissions with the entry of PLTS will clearly occur if the electricity supply in the area previously used oil-fueled electric generators (gensets). Does Not Produce Direct Emissions: One of the main advantages of PLTS is that they do not produce direct emissions during their operation. PLTS converts solar energy into electricity without requiring fuel combustion, so no greenhouse gas emissions such as CO2 are produced; 3. Fossil Fuel Substitute: Solar power plants (PLTS) can replace power plants that use fossil fuels, such as coal-fired or natural gas power plants. By reducing the use of fossil fuels, carbon emissions from the energy sector can be significantly reduced; 4. Support for Clean Energy: By adopting PV and other renewable energy sources, communities can move towards a cleaner and more sustainable energy portfolio, which ultimately reduces carbon emissions; 5. Support for Climate Policy: Governments and international institutions often encourage the use of renewable energy as part of global efforts to reduce carbon emissions. Developing Solar Power Plants (PLTS)

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can help countries achieve emission targets set in climate agreements; 6. Increased Energy Efficiency: The continued development of Solar Power Plant (PLTS) Technology will have a positive impact on increasing the efficiency of converting solar energy into electricity. This means that Solar Power Plants (PLTS) can produce more electricity with the same amount of sunlight to reduce the need for additional resources; 7.Combination with Energy Storage System: Solar Power Plants (PLTS) can be combined with energy storage systems, such as batteries, to store energy generated at sunrise and use it when the sun is not shining. This helps overcome the problem of fluctuations in energy production and maximizes the use of renewable energy.

Designing a control system based on the Internet of Thing (IoT)

Designing a remote control-based control system (Internet of Thing) to read, regulate the heat from the sun supplied with solar power for electrical power and read the temperature and humidity of the air in the dome dryer (Solar drayer Dome) using a data storage device, namely a data logger based on the Arduino Uno microcontroller in the solar dryer dome type drying room.

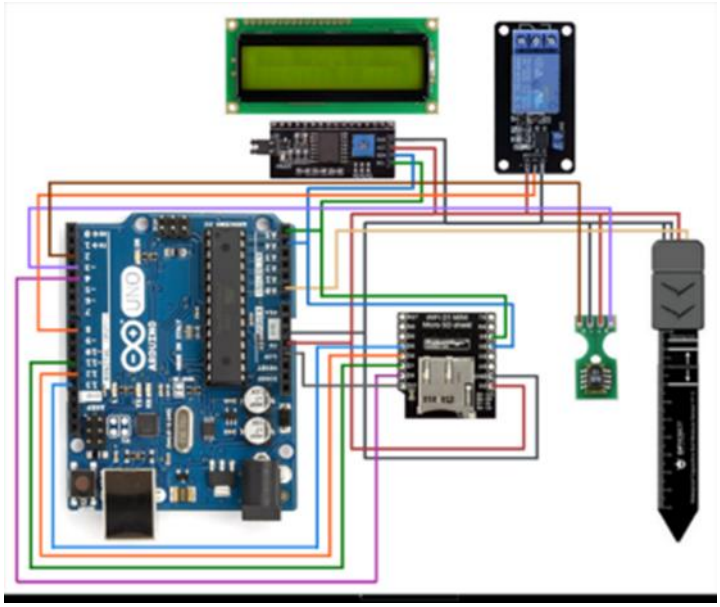
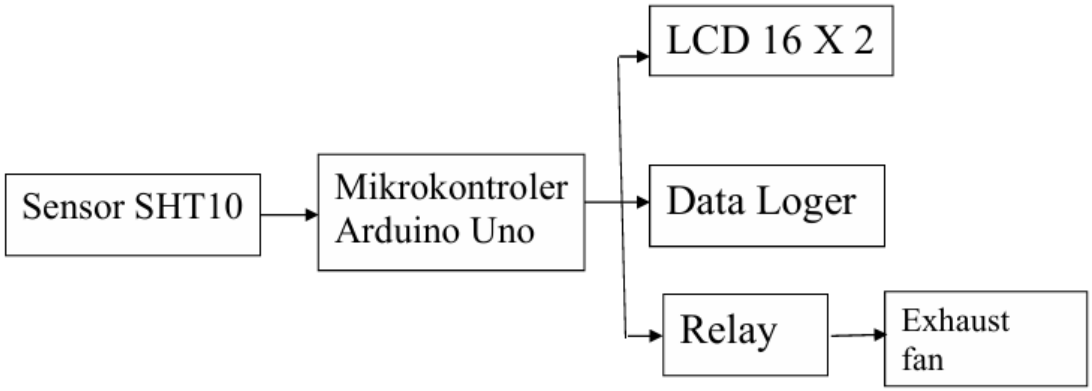


Image: Temperature and Humidity Control Circuit.

Flow of Temperature and Humidity Control System in Solar drayer dome



Based on the flow of the remote control system (Internet of Thing) in reading temperature and humidity with a data logger using the SHT10 sensor as input data for taking temperature and humidity data in the dome drying room. The data is then processed by the Arduino Uno microcontroller which functions as a control center, involving the wemos D1 mini component which has been equipped with an RTC module and micro SD. The SD module functions as a timer for the data storage process into the micro SD

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module, while the results are also displayed on the LCD. In addition, the Arduino Uno microcontroller is also responsible for controlling the relay to regulate the ON / OFF exhaust fan according to the humidity conditions read by the SHT10 sensor.

Knowing the temperature and humidity of the Dome solar dryer room.

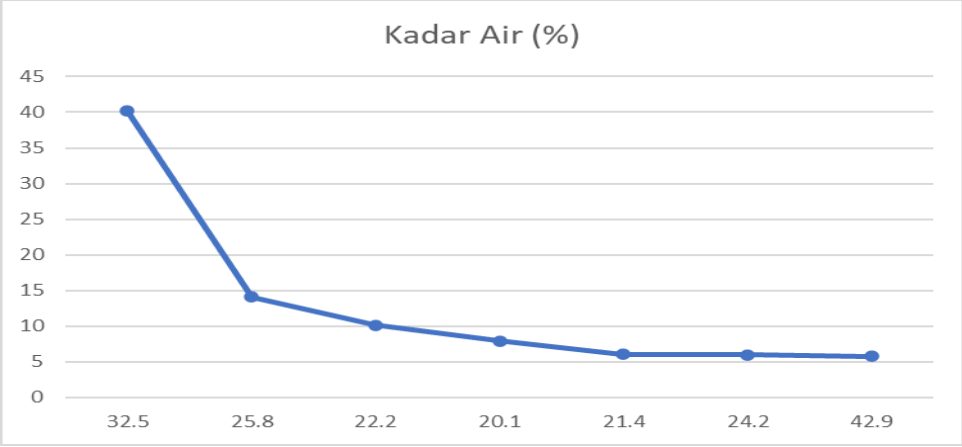
1. Temperature in a qualitative sense refers to cold, hot, and warm in everyday conversation. Heat can be interpreted as energy transferred from one object to another through radiation, conduction, or convection. It is important to note that heat and temperature are two different things. Temperature is a measure of heat intensity and not heat quality. Air humidity is the content of water vapor in the air, which is only a small part of the entire atmosphere, usually ranging from 0% to 5% of the total air mass. This water vapor content plays an important role in weather and climate. Air humidity comes from the process of evaporation of water from the earth's surface, groundwater, or water vapor released by plants. The tool for measuring air humidity is a hygrometer (Roby & Junadhi, 2019); Temperature is a measure that shows how cold or hot an object is, represented in degrees or levels. To ensure the level of warmth or coolness of an object, measurements are needed using the right measuring instrument. Relative humidity RH (Relative Humidity), is the ratio between the actual water vapor pressure at a certain temperature with the saturated water vapor pressure at that temperature. Another definition of humidity is the ratio between the amount of water vapor in the air at a certain time with the maximum amount that the air can hold at the same pressure and temperature (Fathulrohman & Saepulloh, 2019).

Temperature and Humidity Monitoring

Suhu (OC)	Kelembaban (%)
32.5	56.8
25.8	80.9
22.2	87.6
20.1	89.9
21.4	88.2
24.2	83.8
42.9	31.5

Monitoring of air temperature and humidity plays an important role in understanding the ecosystem and its dynamics. The use of DHT11-Arduino micro sensor technology enables precise and real-time measurements, providing valuable information for environmental monitoring and appropriate decision-making in controlling temperature in the dryer dome room, as well as early detection of overall environmental temperature problems and monitoring temperature and humidity. Thus, this technology can contribute to maintaining environmental balance and being responsive to climate change (Nudian et al., 2020). Monitoring is a meaningful supervision of the process of observation, inspection, control and correction of all activities that want to be known to obtain data. Meanwhile, monitoring of temperature and humidity is the process of continuous monitoring and measurement of temperature levels and water vapor content in the air. This is important in various fields, such as industry, agriculture, health, and weather, to ensure proper and optimal conditions. With proper monitoring, we can take appropriate action if the temperature or humidity is outside what is desired or needed (Wijanarko & Hasanah, 2017).

Determining the water content of coffee beans produced by the Dome dryer in supporting sustainable agrotourism.



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In supporting sustainable agrotourism, determining the water content of coffee beans produced by the Dome dryer is an important step. Here are some relevant Drying methods: The method of drying coffee beans affects the water content and quality of the final result. Drying using the natural method (direct sunlight) and the combination method (drying house with ultraviolet plastic cover) have differences in effectiveness and cleanliness of the results. Then the combination method tends to be more effective because the drying rate is faster and the results are cleaner from dirt (hygiene). In sustainable agrotourism, it is very important to choose an environmentally friendly and efficient drying method, so as to provide education to farmers and agrotourism managers about good drying techniques and the use of renewable energy that can increase awareness of sustainability. Integration of drying technology with sustainable agricultural systems can support the production of quality and environmentally friendly coffee. From a philosophy of science perspective, the use of drying technology in agriculture teaches about science and practices that can contribute to the sustainability and well-being of humans and the environment.

CONCLUSION AND SUGGESTIONS

Based on the results of the study and discussion, the following conclusions can be drawn: 1. Solar panel system from renewable energy, Remote control system (Internet of Thing) in regulating temperature and humidity in solar dryer dome type dryers using Arduino Uno as the control center, SHT10 sensor to measure temperature and humidity, relay to control exhaust fan, LCD to display data and data logger (wemos D1 mini data logger and RTC shield) to record data directly to a MicroSD card; 2. Drying process for testing with solar dryer dome type coffee dryer obtained results by showing different levels of temperature and humidity variations in the drying room. At certain positions the highest temperature reached 63.5 with the lowest humidity of 12.6%, while the lowest temperature was 20.6 with the highest humidity of 85.4%. This condition affects the efficiency of coffee drying with a faster process at high temperatures and low humidity; 3. The use of an exhaust fan controlled by an air humidity regulator is very helpful in maintaining ideal conditions in the drying room so that it can prevent the growth of fungal pests and microorganisms that damage coffee. Thus, the solar dryer dome type dryer is very effective in increasing the drying temperature and reducing humidity in the drying room for optimal coffee drying. Suggestion: After conducting the research, the author's suggestion that can be conveyed for further research is the need to add batteries to the solar panel to ensure that the exhaust fan on the solar dryer dome can operate optimally and continuously until night. This is to ensure sufficient air circulation during the drying process which can affect the efficiency and quality of the drying results.

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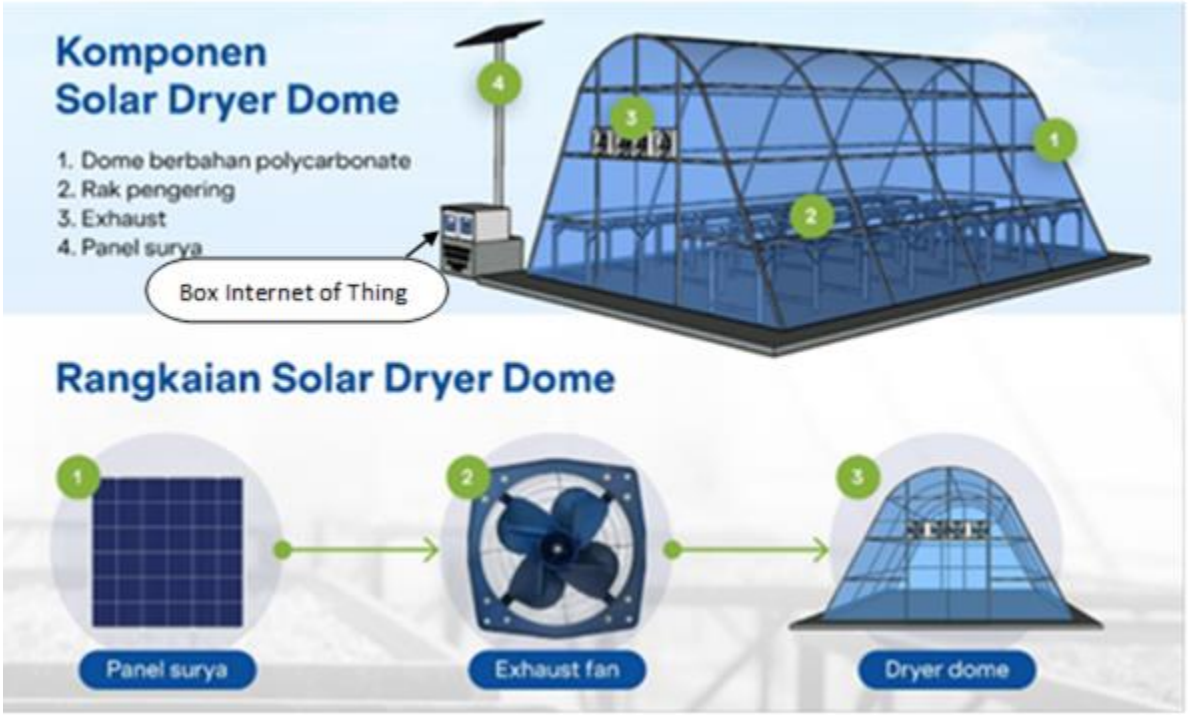

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