

Development of Eco-Charger with Solar Power in Airport

Asep Muhamad Soleh ^{a,1,*}, Ni Putu Heni Handayani ^{b,2}

^{a,b} Politeknik Penerbangan Palembang, Sukarami, Palembang 30154, Indonesia

¹ asep@poltekbangplg.ac.id, ² heni@poltekbangplg.ac.id,

* corresponding author

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ABSTRACT

Renewable Alternative Energy is a very important issue due to global climate issues. In the 2021 United Nations General Assembly, the President of the Republic of Indonesia, in his speech, supported the development of renewable energy and stopped the development that uses coal as an energy source. Airports, as one of the infrastructures that use very large amounts of electrical energy, currently rely heavily on electrical energy, which still uses coal as fuel. The research method used is research and development (R&D), which has been carried out at the Politeknik Penerbangan Palembang since August 2021. The research we conducted produced an eco-charger with solar power as a power source and a battery as a medium for storing electrical energy controlled by a solar charge controller module. This research involved cadets in the development process so it also supports project-based learning. This eco charger's power source can be used for twenty-four hours non-stop because the source of electrical energy is stored in the battery. During the day, the battery will be charged with electrical energy from the solar panel and automatically stop charging if the battery is full. This eco charger is used to charge mobile phones at airports and can also be used in other places such as bus stops, bus terminals, and train stations.

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1. Introduction

Energy and renewable energy sources are currently a very important global issue and a concern among countries worldwide. This is also related to the issue of global warming that is currently happening throughout the world (Estevão et al., 2024). Global warming causes the ice in some poles to melt, causing sea levels to rise. With the increase in sea levels, low land surfaces will sink. The large amount of carbon causes global warming in the atmosphere that comes from the combustion of fuel used for energy purposes (Scafetta, 2024).

During this contraction in the growth rate of flights, there is no significant reduction in energy used at airports. Because it continues to use energy, even when not in use or due to reduced passengers. Therefore, ideas are needed to reduce dependence on energy produced from renewable energy sources (Melgar et al., 2024).

Airports in Indonesia generally still use electricity derived from coal and petroleum as fuel. This is not in line with the government's program to develop green energy as an energy source. Therefore, efforts are needed to encourage the use of green energy starting from the younger generation on campus.(Muhseen et al., 2020).

The use of solar panel energy is now widely used for equipment both in households and in industry. Three types of systems are used for this equipment, namely off-grid systems, on-grid systems, and hybrid systems. The off-grid system uses batteries as a backup storage of electrical energy in the battery (Soleh et al., 2024). This system is suitable for use in areas not covered by

electricity providers, such as the state electricity company. The initial investment costs are very expensive for the off-grid system because it must provide batteries, which are quite expensive. But this system provides electricity for twenty-four hours, depending on the battery capacity (Soleh et al., 2022).

The on-grid system is widely used by industry; this system does not use batteries, so the initial investment costs are not as expensive as the off-grid system (Mokhtar et al., 2024). But the weakness of this system is that if the main source of electricity goes out, the system will also go out. Likewise, if there is no sunlight, the system will also go out (Yıldız et al., 2019).

The Hybrid system is a combination of on-grid and off-grid systems. This system is very reliable for the electricity supply. But the equipment used will be more, and of course, the costs required are also very large (Henny et al., 2020).

Therefore, Politeknik Penerbangan Palembang needs to develop devices that can create innovative transportation for humans. One of the innovative developments at Politeknik Penerbangan Palembang is the availability of learning media for practical activities that also support equipment at the airport (Soleh et al., 2023). Therefore, to implement an innovative learning system, it is necessary to develop it by providing innovative and environmentally friendly learning media equipment using renewable energy, following current and future technological developments. So the author made an innovation entitled 'Development of Eco-Charger with Solar Power in Airport' (Juang & Radharamanan, 2019).

2. Method

Researchers use research and development methods to develop this eco-charger. Researchers widely use this method to develop the manufacture of tools (Soleh et al., 2023). Apart from that, the Analyze, Design, Develop, Implement, and Evaluate method is used because this tool is also used as a learning medium for students (Soleh et al., 2024). The research was carried out at the Politeknik Penerbangan Palembang. The research subjects were students in the 5th semester of the Politeknik Penerbangan Palembang taking the visual landing aids course at airports.

3. Results and Discussion

3.1. Eco charger unit design development stage

The stages of developing the electrical circuit for the eco charger that have been implemented are as follows:

3.1.1. Electrical Circuit Design

At this stage, we create a design form according to applicable regulations that will be developed according to needs and functions (Shufian et al., 2019). Likewise, this tool uses an electrical circuit as an energy source. The eco-charger electrical circuit image can be seen in the following image:

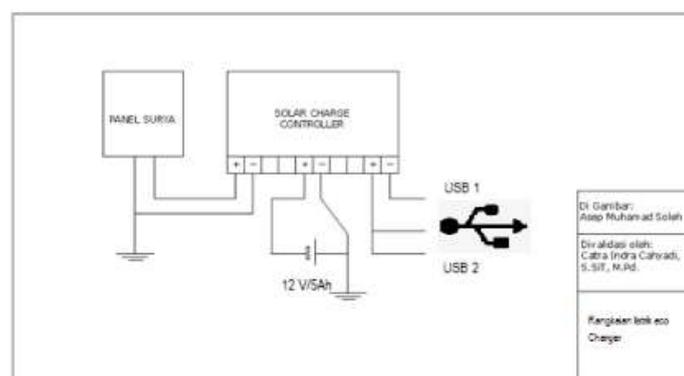


Fig. 1. Eco-charger electrical circuit

The solar panels used have a power of 10 Wp, which means that they can produce a maximum of 10 watts, producing an electric current of 0.5 Ampere. The solar charge controller is a Pulse-width modulation (PWM) type that can be loaded with a maximum electric current of 10 amperes. The battery used is a lead-acid type Valve Regulated Lead Acid battery with a maximum power of 5 Ah. Meanwhile, at a load of two USB ports, it will produce a voltage of 5 volts and a current of 1.5 amperes. The first USB port we use is a three-cable output that can be used to charge three types of mobile phones, namely micro USB, Type C, and iPhone. One more port is USB Type A for users who bring their charger cable (Gladwin Antony et al., 2021).

3.1.2. Electrical Circuit Validation

Once the electrical circuit design is made, the next step is to validate the design. Validators are experts in their respective fields. An airport electrician, Catra Indra Cahyadi, S.SiT, M.Pd., a graduate of airport electrical engineering and a lecturer at the Medan Aviation Polytechnic, validated the design of this electrical circuit. The validator gave a good score and was declared to meet scientific and safety standards so that the electrical circuit could be continued into the trial stage (Suhanto et al., 2024).

3.1.3 Design Revision

After the validation process by experts, there are several things that the validator suggested to revise the tool design. So, we revised the tool's design according to the suggestions given by the validators. In the validation results, there are no significant findings, so no revisions are made to the design (Roemintoyo & Budiarto, 2023).

3.1.4 Trial

At this stage, we test the electrical equipment system that has been constructed and verify whether it operates according to plan. After testing, there were no significant concerns. Solar panels can charge the battery, as seen from the indicators, and the load in the form of lights can be turned on correctly. The charging current will automatically cut off when the battery voltage reaches the upper limit. But when the battery voltage decreases, automatically, the electric current from the solar panel will recharge the battery (Peri Pirdaus, 2024).

The solar charge controller regulates the settings on the electrical system of this eco charger. The solar charge controller has a screen and menu buttons that can be accessed using a human-machine interface system. The picture of the solar charge controller is as follows:



Fig. 2. Solar Charge Controller

Solar panel poles are installed on the roof poles of the canteen at the Politeknik Penerbangan Palembang, which can be exposed to sunlight from morning to evening to obtain optimal lighting to store energy. As seen in Figure 3.



Fig.3. Installation of solar panel eco charger

The electric current produced by this solar panel is a maximum of 0.5 amps, enough to charge a battery with a capacity of 3.5 amps per hour. The battery can be fully charged in six hours. The current produced is in the range of 0.3 to 0.5 amps. A stable current of this size is also safe for the battery. The results of changes in the battery charging current can be seen in Figure 4.

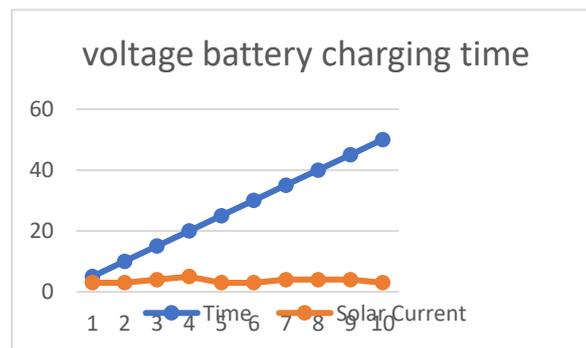


Fig.4. Current from SCC at battery charging

A complete image of the eco charger can be seen in Figure 5.



Fig.5. Eco Charger Ready to use

3.2. Development Stage of Solar Panel Pole

The stages of solar panel pole development that have been carried out are as follows:

3.2.1. Solar panel pole design

At this stage, we make a shape design according to the conditions in the Politeknik Penerbangan Palembang canteen, which will be developed according to needs and functions. The design drawing of the solar panel pole can be seen in the following picture:

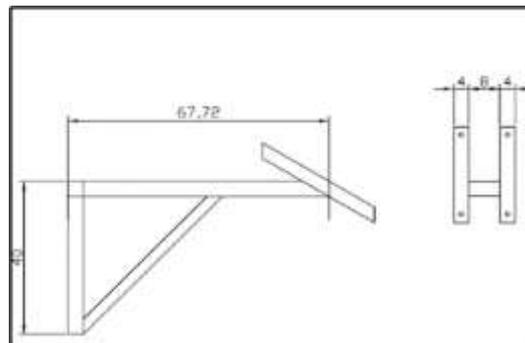


Fig.6. Solar panel pole design

The design of this pole is in the form of a right triangle with a pole length of 40 cm and a support pole easel length of 67.7 cm while the length of the solar panel support is 25 cm with a distance of 8 cm. Solar panel poles use 4x4 mm hollow iron, while pole supports use 4x2 mm hollow iron. The solar panel supports use 3x3 mm elbows. This pole is painted navy blue to prevent rust. All work on solar panel support poles is carried out at the Politeknik Penerbangan Palembang general workshop.

3.2.2 Validation of Solar Panel Prop Pole Eco Charger

Once the design of the solar panel support pole is created, the next step is to validate the design. Validators are people who are experts in their respective fields. The design of this solar panel pole was validated by an electrical and mechanical expert at the airport, namely M. Indra Martadinata, S.SiT, MAP. who is a graduate of airport mechanical and electrical engineering and has also worked

at several airports in Indonesia as well as a lecturer at the Palembang Aviation Polytechnic. Validators provide good grades and are declared to meet scientific and safety standards (Luh Nyoman Gita Acyuta Dewi et al., 2024).

3.2.3 Design Revision

After the validation process by experts, there are several things that the validator suggested to revise the tool design. So, we revised the tool's design according to the suggestions given by the validators. In the validation results, there is a suggestion for the buffer to be changed so that it can support strongly when exposed to wind loads. This is just happening because very strong winds can cause poles to collapse (Rajeev et al., 2019).

3.2.4 Trial

At this stage, we test the unit that has been made and whether it runs according to what has been planned. After testing, there were no significant concerns. The image of the eco charger unit that was tested can be seen in the following image:



Fig.7. Installation of the eco charger support pole



Fig.8. Eco charger installed in the canteen

3.3 Trial Use

At this stage, it is tested directly according to the desired use. The trial was carried out as a whole, namely for the support pole and the electrical system. The first trial was conducted in the courtyard of the Politeknik Penerbangan Palembang airport laboratory. From the eco-charger test results, it can work well, as seen from the indicator on the mobile phone that charges the battery. Next, we moved the eco charger to the airport laboratory building to try it with an iPhone-type mobile phone with a different port (Muhseen et al., 2020). Likewise, we tested using a micro USB port, and the result was that the eco charger worked well. The placement of this eco charger is actually on the Palembang Aviation Polytechnic campus. This canteen is our destination for eco charger delivery because many employees visit during breaks and meals. The placement of the eco charger and its wearer by the user can be seen in the following image:



Fig.9. The Eco-Charger is used by users

3.4 Evaluation Stage

This stage is carried out after all stages from the beginning to determine the obstacles faced when this product is implemented directly to users. From the trial results, the product can function according to the purpose of using this tool, namely, charging the cell phone battery through a USB connecting cable. Cadets can also better understand how eco chargers and solar power plants work, which is renewable energy. The voltage coming out of the USB solar charger is very stable. The voltage deviation range is very small, only around 0.01 volts. It is very good with a voltage deviation of this size because it is far below the permitted voltage ripple tolerance. The results of observations of voltage changes with charging process time can be seen in Figure 10.

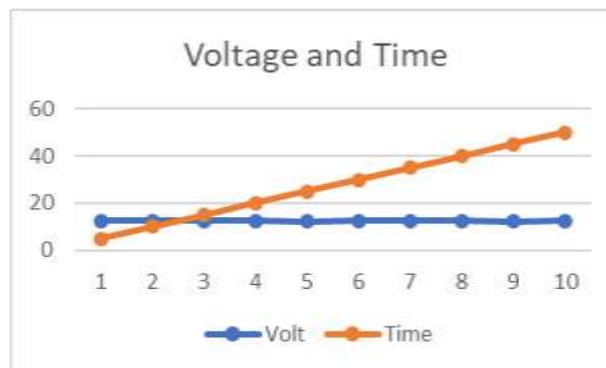


Fig.10. Charger voltage at charging time

The development of this eco-charger is in line with research conducted by previous researchers, stating that the output voltage on the charger originating from solar panels is very stable, so it is safe to use (Okubanjo et al., 2022). Research conducted (Samanvita et al., 2022) states that solar panel chargers can charge mobile phones in public places using coins as payment. In addition to the cell phone charger, the panel can also be used for other power supplies, such as RFID, so that it is more efficient (Kadam et al., 2022). Mobile solar charger is also used for use in vehicles so that it is easy to carry everywhere easily by fabricated from silicone scarf (Venkataraman et al., 2022).

4. Conclusion

The development of eco chargers with solar power as a learning medium for students has been successful and can be used to charge all types of mobile phones that use USB ports. The output voltage is very stable and suitable for charging all types of mobile phones. This charger is very safe because it has a solar charge controller that can automatically adjust the incoming and outgoing voltages.

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