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Design of New Renewable Energy Utilization Technology in Islamic Boarding Schools

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Abstract

Solar power applications developed in Islamic boarding schools are lighting and farming using hydroponics. the results of the research on solar power public roads, each component works properly according to their respective specifications and the sensor detects the presence of objects 0.5 meters, 1 meter, and 1.5 meters from the sensor until the buzzer sounds for a few seconds. The results of the research on solar hydroponic plants with AC motors in testing AC motors using an inverter have a weakness if the inverter is used for 24 hours it will damage faster, choosing an inverter that does not match the specifications of the motor will also have an impact on the motor itself, in this case, it is necessary to be considered for the selection of the inverter to be used. However, using two motors at the same time will reduce the impact of damage more quickly to components because the motors work alternately by setting the dc programmable timer. In both solar power applications based on the results of investment analysis, the costs are quite cheap because they reduce the bill for payment each month and can return the capital for making the application.

Keywords

New renewable energy, Islamic Boarding School, PLTS, hydroponics

INTRODUCTION

The utilization of photovoltaic (PV) technology can be utilized in various applications that require electrical energy. Applications using PV technology such as solar home systems, solar street lighting, solar-powered water pumps, and farming activities using solar power are the right choices for now [1-5]. The current use of solar power also needs to be developed in educational institutions that have enormous potential because they have advantages including the potential for charismatic human resources and role models for trust in their environment, institutional potential with extensive land resources, and large market potential due to social relations. Good ones around it, namely Islamic boarding schools [6-8], Islamic boarding schools that have grown and become part of social culture have opportunities as economic drivers through increasing agricultural potential in the context of economic empowerment of Islamic Boarding School. So, the development of solar power provides benefits and is very supportive for the community and educational institutions, especially Islamic boarding schools in the form of improving economic, social, and cultural conditions as well as a form of introducing technology to students as a tangible form of technology transfer to the community [9-11]. Some applications of solar power that are very suitable to be developed in Islamic boarding schools are lighting and activities that have recently been made extra-curricular activities and economic recovery, namely farming using hydroponic technology [12-18].

The application of street lighting using solar power is very helpful for Islamic boarding schools in remote areas that are difficult to pass by conventional electricity or PLN, with solar power there is no need to bother to supply electricity with electrical energy sources from PLN and save costs in electricity payments [19] -23]. However, the installation of street lighting must also be monitored and a security system provided so that it is not easy to be stolen as in the case of theft that has occurred, namely by installing a proximity sensor and buzzer as a sign that someone is climbing [24-27]. The next use of solar power is to grow crops using the hydroponic nutrient film system (NFT) method, which is a hydroponic system that uses the circulation of plant nutrients with the help of a water pump. Nutrients are channeled at the top of the installation so that nutrients will continuously hit the plant roots. The material that is often used in this installation is polyvinyl chloride pipe (PVC) with a recirculation technique [16-18].

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However, the continuous use of water pumps causes the payment of expensive electricity bills and when conventional electricity or PLN goes out it obstructs the circulation of water flowing through the plants causing the plants to wither to death, therefore the use of solar power as a source of electrical energy is very helpful in this case so that does not depend on the PLN electricity source and saves the cost of spending on electricity bills. At the design stage, it is necessary to test the use of two different motors, namely a DC motor and an AC motor.

The application of solar power utilization in the Islamic Boarding School environment that will be discussed in this study is solar street lighting which has a proximity sensor and buzzer as security so that the panel components are not climbed and stolen, in addition to farming with the hydroponic nutrient film system (NFT) solar method. namely a hydroponic system that uses the circulation of plant nutrients with the help of a water pump with a solar energy source where the use of solar energy can save the cost of spending electricity bills from water pumps. It is hoped that this research will provide benefits and help introduce new renewable energy technology, namely solar power to students and help the Islamic Boarding School economy.

METHOD

Energy Needs Study

The study of design and investment in this research is to provide an understanding of the cost or economics of engineering which aims to calculate the costs required for installation and manufacture of the research and to find out the energy expended or generated so that the research process runs smoothly and following the target [29-31][40 -41]. The study of energy needs that will be discussed in this study includes the calculation of the energy released by the load, namely LED lamps on PJUTS with a capacity of 32 watts according to SNI[22][31-33] for 24 hours. At the load of the hydroponic plant system, namely AC and DC pumps that work alternately with a capacity of 32 Watt for 24 hours. To determine the specifications of the solar modules used in Solar Street Lighting (PJUTS) and hydroponic plants by calculating the energy requirements of a total one day of use, which is 12 hours, in Indonesia the maximum solar radiation measurement is 5 hours a day or 24 hours. Regarding autonomous days in Indonesia, namely the condition of the length of the day if the weather is bad for several days or where the sun is not optimal so that the solar module cannot obtain sufficient energy supply, in Indonesia itself, the determination of the autonomy day is for 3 days [27-33] :

$$\text{Energy Requirement (Wp)} = \text{Total power consumption (Watt)} \times \text{total usage for a day (hours)} \times 3 \tag{1}$$

$$\text{Radiation maximum 5 hours} = \frac{Energy\ Needs}{5} \tag{2}$$

From the above calculation, after knowing the energy requirement (Wp) from the solar module, then determining the battery capacity as a storage of electrical energy used at a certain time, the battery capacity can be determined as follows:

$$E = P \times t \text{ (Wh)} \tag{3}$$
$$E = V \times I \times t \text{ (Wh)} \tag{4}$$

(E) is the energy requirement of the solar module, (V) is the voltage from the battery after calculating the need for solar modules and batteries, then proceed with calculating the energy costs incurred. The calculation of the energy costs incurred by the load can be seen in the following equation or the annual production kWh has a value of [27-35]:

Daily Production kWh :

$$kWh = \frac{VxI}{1000} \times t \text{ (hours)} \tag{5}$$
$$A\ kWh = \text{daily production} \times 365 \tag{6}$$

Then calculate the battery charging with the same formula as above, after calculating the energy costs incurred using the above formula, which is calculating the percentage of energy used.

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Operational and Maintenance Cost

Planning must also pay attention to operational and maintenance costs because they have different components and tools, so a study of operational and maintenance costs is needed. The operational and maintenance costs of PLTS carried out per year are generally calculated at 1 to 2% of the total initial investment. Determination of the percentage of 1% based on the state of Indonesia only experiences two seasons, namely the rainy and dry seasons so that the maintenance costs are not like a country that has four seasons. Then the operational and maintenance costs each year are [30-39]:

$$M = 0.01 \text{ x Total investment cost} \tag{7}$$

Following the Regulation of the Minister of Energy and Mineral Resources Number 28 of 2016 concerning the Tariff of Electricity Provided by PT PLN (Persero) as last amended by Regulation of the Minister of Energy and Mineral Resources Number 3 of 2020, if there is a change in the realization of macroeconomic indicators (exchange rate, Indonesian Crude Price/ICP, inflation, and Coal Standard Price/HPB), which is calculated every quarter (For the Second Quarter Period using the realization from November 2020 to January 2021), an adjustment will be made to the electricity tariff (tariff adjustment). Based on the above regulations, public street lighting is subject to a tariff of Rp. 1,444/kWh and household customers Rp. 1,114/kWh [31-34][42]. Based on the provisions of the Regulation of the Minister of Energy and Mineral Resources No. 17 of 2018 regarding the purchase of electricity by the State Electricity Company (PLN) from the Solar Power Plant, electrical energy from the Solar Power Plant is set for 6.83/kWh, which is six point eighty-three US cents per kilowatt an hour or 914 /kWh.

Payback Period

The payback period is how long it takes to be able to return the value of the investment through the income or revenue generated in a project, the return on investment funds is calculated using a discount factor by calculating how many years the net cash flow, the cumulative present value, which is estimated to be equal to the cost of the investment. Initially, in this case, the decision making a project is feasible or not, among others, if the project investment will be considered feasible if the payback period has a shorter period than the project life or if the project investment is not worth the value if the payback period is longer than the project life. However, this study calculates how long it takes to return the investment value by calculating the following formula:

$$\text{Payback Period} = \frac{Amount\ of\ Investment}{Net\ Cash\ Flow} \tag{8}$$

PLAN AND DESIGN

Solar Street Lighting

Research on the use of new and renewable energy in Islamic boarding schools has several stages that are integrated into the entire process during operation. The research stages are in the form of emerging potentials or the use of new renewable energy that has not been maximally utilized, which is then reviewed so that this potential becomes an opportunity and is useful in progress in the economic, social, and cultural fields and of course in educational institutions. The potential that arises can be studied in a design. The design and design will determine the application or product to be made such as the specifications for each component, namely PJUTS (Solar Street Lighting) lighting and hydroponic plant media with solar power sources. Figure 1 below is the design and design of the PJUTS that will be made:

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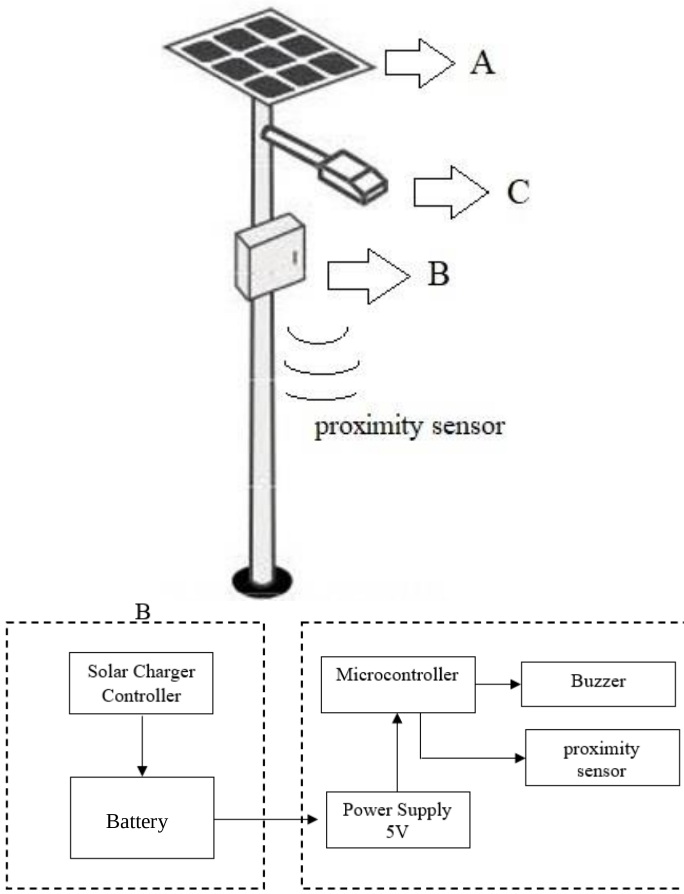

Figure 1. PJUTS with Security System

The design and design of the solar street lighting security system (PJUTS) in Figure 1 part A is a solar module that has the function of converting solar energy into electrical energy which will be stored in the battery through the solar charger controller which regulates charging on the battery as well as usage on the load. In panel box part B the microcontroller gets a source from the battery via a 5V DC power supply which is then connected to a proximity sensor or ultrasonic sensor which functions to detect the presence of objects without physical contact and in this study, it has the function of knowing someone is climbing a pole when someone is climbing the PJUTS pole with a distance of approximately 1, 5 meters, the proximity sensor detects and sends a signal to the buzzer then at the same time the buzzer sounds which indicates a warning sign. In part C, namely, DC LED lamps as lighting, using DC LED lamps to save power and reduce the use of additional components, inverters, while with a capacity of 32 watts according to SNI.

Determining the specifications of the solar module for solar street lighting, the energy requirements used by the load from a total of one day of use, which is for 12 hours, and in its use from measurements of solar radiation in Indonesia, it is obtained a maximum of 5 hours, then:

Energy Requirement (Wp) = Total load usage power (Watts) x total usage for a day (hours)

Radiation maximum 5 hours $= \frac{Energy\ requirements}{5}$

Energy Requirement (Wp) = 32 (Watts) x 12 for a day (hours) x Reserves For 3 Days

= 1152

Radiation maximum 5 hours $= \frac{1152}{5}$

= 230.4 Wp

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The calculation above shows that the solar module capacity requirement is 230.4 Wp to adjust and make it easier to find in the conditions on the Indonesian market, the solar module power is determined with a capacity of 250 Wp. After calculating the capacity of solar energy in planning a solar street lighting system, it requires a storage area for electrical energy that functions at a certain time so that the electrical energy produced by solar power can be used directly or stored in batteries. Calculation of solar energy storage can be determined from the energy calculated on the needs used, which is 1152 Wh and the voltage from a battery with a capacity of 12 V can be determined as follows:

E = P x t (Wh)

E = V x I x t (Wh)

1152 = 12 x I x t (Wh)

It = 96 Ah

The calculation of the required battery capacity above is obtained at 96 Ah, by adjusting the needs and making it easier to find purchasing batteries in the Indonesian market, the battery is determined from a solar module with a capacity of 100 Ah. The capacity of solar modules and batteries in solar street lighting when has been calculated, then the next step is to calculate the details of the price and other supporting components, this is needed to calculate the investment study of the research project being carried out. The following Table I details the price and other supporting components:

TABLE I
PRICE DETAILS AND OTHER SUPPORTING COMPONENTS

No.	Component	Unit price	Amount	Total price
1	250 wp. solar module	Rp. 1,600,000	1	Rp. 1,600,000
2	100 Ah battery	Rp. 1,580,000	1	Rp. 1,580,000
3	35 Watt lamp	Rp. 300,000	1	Rp. 300,000
4	Solar Charger Controller	Rp. 1,000,000	1	Rp. 1,000,000
5	Light poles	Rp. 500,000	meters	Rp. 5,000,000
6	Microcontroller and sensors	Rp. 300,000	1	Rp. 300,000
7	Cable	Rp. 35,000	meters	Rp. 520,000
Total price				Rp. 10,300,000

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Solar Hydroponic Plants

The design and design of the use of new, renewable technology for growing lettuce with the nutrient film system (NFT) method of solar hydroponic systems are shown in Figure 2 below:

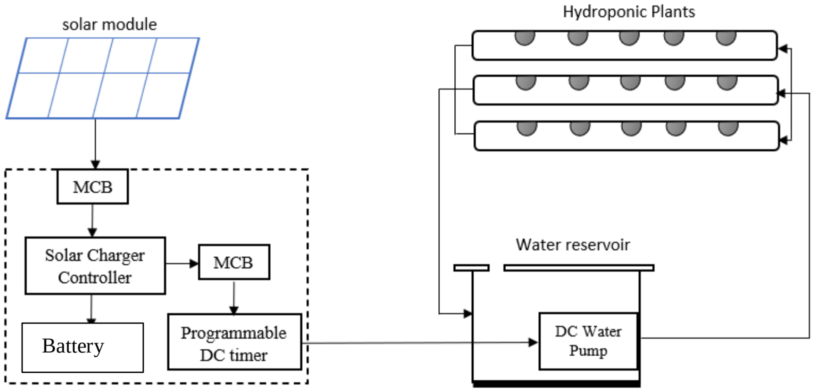

Figure 2. Solar Hydroponic Plant Series Using DC Motor

The design and design of a solar hydroponic plant circuit using a DC motor in Figure 2 above, namely the solar module converts sunlight into electrical energy then the power generated by the solar module is regulated by the solar charger controller for charging the battery and using power at the load, the programmable DC timer functions as a flame regulator on/off the DC motor so that the motor is given a pause to stop for some time to do watering/distribution of water from water reservoirs to hydroponic plants which are done repeatedly. Both Mini Circuit Breakers (MCB) has a function in the event of a short circuit in the system below or as a protection system for the solar hydroponic plant circuit. In Figure 3, a series of solar panels using an AC motor is as follows:

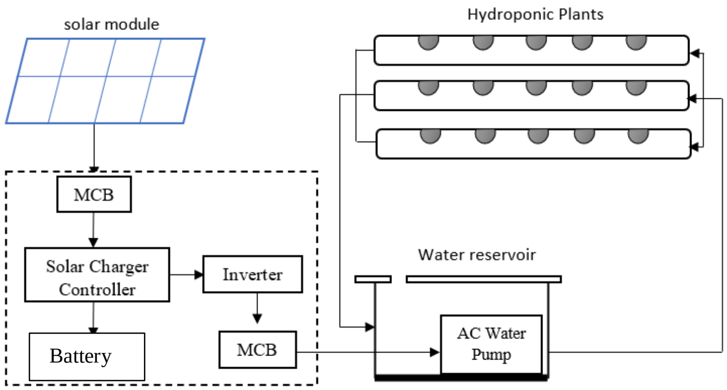

Figure 3. Solar Hydroponic Plant Series Using AC Motor

The design and design of a solar hydroponic plant circuit using an AC motor in Figure 3 above, namely the solar module converts sunlight into electrical energy then the power generated by the solar module is regulated by the solar charger controller for charging the battery and using power at the load, the inverter converts direct current The DC generated by the solar module becomes alternating current ac which is used by the ac motor pump to do watering/distribution of water from water reservoirs to hydroponic plants which are done repeatedly. Both Mini Circuit Breakers (MCB) has a function in the event of a short circuit in the system below or as a protection system for the solar hydroponic plant circuit. Next, use two ac and DC motors to alternate with each other as shown in Figure 4 below:

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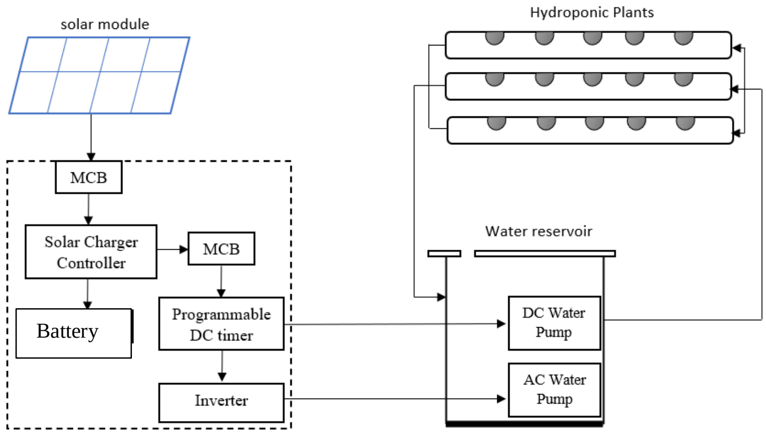

Figure 4. Solar Hydroponic Plant Series Using AC and DC Motor

The above circuit uses ac and DC motors, the two motors turn on alternately, using two motors with a programmable DC timer, which aims to limit the time the motor works so that the DC motor can still rest and vice versa with an ac motor so that the motor and inverter components are durable for use. The two motors work alternately by setting the time on the desired programmable DC timer as needed. In determining the specifications of the solar module for hydroponic plants using solar power, the energy requirements used by the load from a total of one day of use are for 12 hours, and in use from measurements of solar radiation in Indonesia is obtained a maximum of 5 hours, then:

Energy Requirement (Wp) = Total load usage power (Watts) x total usage for a day (hours)

Radiation up to 5 hours $= \frac{Energy\ requirements}{5}$

Energy Requirement (Wp) = 25 (Watts) x 12 for a day (hours) x Reserves For 3 Days

Radiation up to 5 hours $= \frac{900}{5}$

=180 Wp

The calculation above shows the need for a solar module capacity of 180 Wp to adjust and make it easier to find in conditions on the Indonesian market, the solar module power is determined with a capacity of 200 Wp. After calculating the capacity of solar energy in planning a solar street lighting system, it requires a storage area for electrical energy that functions at a certain time so that the electrical energy produced by solar power can be used directly or stored in batteries. Calculation of solar energy storage can be determined from the energy calculated on the needs used, which is 900 Wh and the voltage from the battery with a capacity of 12 V can be determined as follows:

E = P x t (Wh)

E = V x I x t (Wh)

900 = 12 x I x t (Wh)

It = 75 Ah

The calculation of the required battery capacity above is obtained at 75 Ah, by adjusting the needs and making it easier to find purchasing batteries in the Indonesian market, the battery is determined from a solar module with a capacity of 80 Ah. The capacity of solar modules and batteries in solar street lighting when has been calculated, then

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the next step is to calculate the details of the price and other supporting components, this is needed to calculate the investment study of the research project being carried out. The following Table II details the price and other supporting components:

TABLE II
PRICE DETAILS AND OTHER SUPPORTING COMPONENTS

No.	Component	Unit price	Amount	Total price
1	180 wp solar module	Rp. 1.850.000	1	Rp. 2,100,000
2	80 Ah battery	Rp. 1,560,000	1	Rp. 1,800,000
3	Solar Charger Controller	Rp. 1,100,000	1	Rp. 1,100,000
4	Inverter	Rp. 1.950.000	1	Rp. 1.950.000
5	DC timer	Rp. 450,000	2	Rp. 900,000
6	AC Motor	Rp. 660,000	1	Rp. 660,000
7	DC Motor	Rp. 780,000	1	Rp. 780,000
8	MCB	Rp. 100,000	2	Rp. 200,000
9	Cable	Rp. 35,000	meters	Rp. 520,000
Total price				Rp.10.10.000

RESULT

In the results of the study, details of the materials needed in the process of designing and installing Solar Street Lighting (PJUTS) and gardening were carried out with the solar hydroponic nutrient film system (NFT) method, namely the circulation of plant nutrients using a water pump as follows.

Manufacture and Installation of Solar Street Lighting (PJUTS)

The first manufacture and installation of solar street lighting is to prepare solar modules, cables, solar charger controllers, batteries, panel boxes, Arduino nano, power supply, buzzer, LED and all components can be seen in the following figure:

Figure 5. Manufacture of Solar Module Supports and Cables and Connectors

Installation of solar street lighting, starting with the manufacture of a supporting frame for solar modules and the required components such as cables, connectors, and equipment to connect solar modules with cables. of 250 Wp which is placed on support using aluminum. After installing the solar module support, proceed with the installation of the battery and solar charger controller in Figure 6 as follows:

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Figure 6. Battery Installation (Dry Battery) with Solar Charger Controller

Figure 6 above is the installation of a battery from a solar street lighting with a battery capacity of 12 V 100 Ah and a solar charger controller 10 A 12/24 V DC. The battery and solar charger controller are installed and connected to the solar module using a 4mm PV1-F cable with a distance of 7 meters. After installing the components, the installation and manufacture of the security system are then carried out and seen in Figure 7 below:

Figure 7. System Circuit with Arduino Nano, Proximity Sensor, Power Supply, and Buzzer

Figure 7 above is an alarm circuit consisting of a power supply, Arduino nano microcontroller, proximity sensor, and buzzer. The circuit above is placed on the panel box and connected to the battery. Table I below is a data retrieval of the power of LED lamps for solar street lighting with a power of 32 Watts which is carried out for 24 hours to get the current, voltage, and power values. The following is a data table of current, voltage, power, and cost of using an AC pump for 24 hours which can be seen in Table III below.

TABLE III
DATA TABLE OF CURRENT, VOLTAGE, POWER, AND COST OF USING AN AC PUMP FOR 24 HOURS

Time	Volts (V)	Ampere (I)	Watts (W)
7:00 AM	227	0.14	32
8:00 AM	228	0.16	36
9:00 AM	227	0.16	36
10:00 AM	227	0.15	34
11:00 AM	229	0.17	39
12:00 PM	229	0.17	39
1:00 PM	229.5	0.17	39
2:00 PM	229	0.15	34
3:00 PM	227	0.14	32
4:00 PM	227	0.14	32
5:00 PM	227	0.15	34
6:00 PM	228	0.16	36
7:00 PM	228	0.17	39
8:00 PM	229	0.15	34
9:00 PM	229.5	0.16	37
10:00 PM	227	0.16	36
11:00 PM	227	0.17	39
12:00 AM	227	0.14	32
1:00 AM	228	0.15	34
2:00 AM	228	0.15	34
3:00 AM	228	0.14	32
4:00 AM	227	0.15	34
5:00 AM	228	0.16	36
6:00 AM	227	0.16	36
Total Power			848

Table 3 above is a table of LED lamp load usage for a full 24 hours with a total power consumption of 848 Watt, from the data above it is used to determine power expenditure data for one year. Then the power expended for one year is as follows:

Daily Production kWh :

$$\text{kWh} = \frac{VxI}{1000} \text{ x t (hours)}$$

$$= \frac{848}{1000}$$

$$= 0.848 \text{ kWh}$$

Following the Regulation of the Minister of Energy and Mineral Resources Number 28 of 2016 concerning the Tariff of Electricity Provided by PT PLN (Persero) as last amended by Regulation of the Minister of Energy and Mineral Resources Number 3 of 2020. Based on this regulation, for public street lighting, the price of 1 kWh is subject to a tariff of Rp. 1.444/kWh. Then the cost needed for a day / 24 hours:

kWh Daily Production x Price per kWh: 0.848 kWh x Rp. 1,444 = Rp. 1,224 (USD 0.082)

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In the calculation of the daily production kWh above, the cost required in one day or for 24 hours is Rp. 1,224, then in a year the costs incurred or generated are as follows:

Total Cost for One Year: A kWh = Rp. 1,224 x 365

= Rp. 446,760 (USD 29.80)

Electrical energy (kWh) produced by solar street lighting for a year is Rp. 446,760, after knowing the power generated for a year, then calculate the operational and maintenance costs as follows:

M = 0.01 x Total investment cost

= 0.01 x Rp. 10,300,000

= Rp. 103,000 (USD 6.87)

The calculation of the total cost of using solar energy for public street lighting for a year is Rp. 446,760 (USD 29.80). If the total investment for solar street lighting and total operating costs for a year is Rp. 10.300.000 (USD 685.67) to calculate how long it takes to be able to return the value of the investment through the income or receipts generated in a project, the return on investment is calculated using a discount factor by calculating how many years the net cash flow of the estimated cumulative present value will be equal to The cost of the initial investment is as follows:

$$\text{Payback Period} = \frac{\text{Amount of Investment}}{\text{Net Cash Flow}}$$

= Rp. 10.300.000 / Rp. 446,760

Payback Period = 23 years

Calculation of the initial investment amount of Rp. 10.300.000 000 (USD 685.67) then if the income from electrical energy produced by solar street lighting each year is Rp. 446,760 (USD 29.80) then the Payback Period is in the 23rd year.

Making and Installing Hydroponic Plants with the NFT (Nutrient Film System) Method

The process of making and installing hydroponic plants using a nutrient film system (NFT) was first carried out, namely making a place from the hydroponic plant itself, hydroponic plants made using PVC pipes amounted to 3 pipes, each pipe has a length of 2.5 inches or 6,35 cm. In each pipe, 18 holes function as a place for laying hydroponic plants to be planted, and can be seen in Figure 8 below.

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Figure 8. Hydroponic Plant Pipe

Furthermore, the manufacture of water reservoirs or wells that function as water reservoirs and mix fertilizer with water, in addition to the water reservoir there is also an ac motor with a specification of 25 watts and an output of 3800L/h. The ac motor to pump water from the reservoir is then channeled to the hydroponic plant through a small pipe which can be seen in Figure 9.

Figure 9. Water reservoir and AC motor

The source of electrical energy obtained by the AC motor is in the form of solar power, to get maximum electrical energy, the placement of the solar module must get solar energy optimally without being hindered by anything, then the laying of the solar module is placed on the rooftop so that sunlight can directly hit it. the solar module and is not blocked by any object, the placement of the solar module can be seen in the following figure 10.

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Figure 10. Hydroponic Plant Pipe

The use of power data collection uses an AC pump with a power of 25 Watt which is carried out for 24 hours every one hour to get the current, voltage, power, and usage costs of the AC pump used. The following is a data table of current, voltage, and AC pumps usage power for 24 hours which can be seen in Table IV below.

TABLE IV
DATA TABLE OF CURRENT, VOLTAGE, POWER USAGE OF AC PUMP FOR 24 HOURS

time	Volts (V)	Ampere (I)	Watts (W)
7:00 AM	225	0.12	27
8:00 AM	224.5	0.13	29
9:00 AM	227	0.11	25
10:00 AM	227.5	0.12	27
11:00 AM	226	0.12	27
12:00 PM	225.5	0.14	32
1:00 PM	226	0.13	29
2:00 PM	227	0.12	27
3:00 PM	225	0.12	27
4:00 PM	224.5	0.14	31
5:00 PM	226.5	0.11	25
6:00 PM	224.5	0.12	27
7:00 PM	225	0.12	27
8:00 PM	225	0.13	29
9:00 PM	226	0.11	25
10:00 PM	224.5	0.12	27
11:00 PM	225	0.12	27
12:00 AM	224	0.12	27
1:00 AM	224.5	0.13	29
2:00 AM	225	0.11	25
3:00 AM	226	0.13	29
4:00 AM	225	0.12	27
5:00 AM	224.5	0.13	29
6:00 AM	226	0.11	25
Total Power			660

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Table 4 above is a table of motor lamp load usage for a full 24 hours with a total power consumption of 660 Watt, from the data above it is used to find out data on power expenditure for one year. Then the power expended for one year is as follows:

Daily Production kWh :

kWh $=\frac{VxI}{1000}$ x t (hours)

$=\frac{660}{1000}$

= 0.66 kWh

Following the Regulation of the Minister of Energy and Mineral Resources Number 28 of 2016 concerning the Tariff of Electricity Provided by PT PLN (Persero) as last amended by Regulation of the Minister of Energy and Mineral Resources Number 3 of 2020. Based on this regulation, household customers are Rp. 1.114/kWh. Then the cost needed for a day / 24 hours:

kWh Daily Production x Price per kWh: 0.66 kWh x Rp. 1.114/kWh = Rp. 735 (USD 0.049)

In the calculation of the daily production kWh above, the cost required in one day or for 24 hours is Rp. 735, then in a year the costs incurred or generated are as follows:

Total Cost for One Year:

A kWh = Rp. 735 x 365

= Rp. 268,275 (USD 17.90)

Electrical energy (kWh) produced by solar hydroponic plants for a year is Rp. 268,275, after knowing the power generated for a year, then calculate the operational and maintenance costs as follows:

M = 0.01 x Total investment cost

= 0.01 x Rp. Rp.10.10.000

= Rp. 100,100 (USD 6.68)

The calculation of the total cost of using solar hydroponic energy for a year is Rp. 268,275. If the total investment for solar street lighting and total operating costs for a year is Rp. 10,010,000, (USD 666.37) then to calculate how long it will take to be able to return the investment value through income or revenue generated in a project, the return on investment is calculated by using the discount factor by calculating how many years the estimated net cash flow cumulative present value will be equal to the cost of the initial investment as follows:

Payback Period $=\frac{\text{Amount of Investment}}{\text{Net Cash Flow}}$

= Rp. 10,010,000/Rp. 268,275

Payback Period = 37 years

The calculation of the initial investment amount is Rp. 10,010,000, (USD 666.37) so if the income from electrical energy produced by solar street lighting is Rp. 268,275 (USD 17.90) then the Payback Period is in the 37th year.

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DISCUSSION

Component Testing on Solar Street Lighting

Tests on each component are carried out to determine whether each component is functioning properly or properly, especially the components, namely the solar module, battery, and solar charger controller. Testing using an AVO meter is to measure the power from the solar module and whether it is following the specifications listed on the module, in the test the solar module has a VOC voltage of 21.8 V according to the specifications listed on the module, as well as testing the battery and solar charger controller when solar The charger controller charges the battery when the battery is fully charged. After testing with panel components, testing of security or alarm circuits which include power supply, Arduino nano microcontroller, proximity sensor, and buzzer, testing is carried out by attaching objects 0.5 meters, 1 meter, and 1.5 meters away from the sensor until the buzzer sounds for a few seconds. The solar module can be seen in Figure 10, namely 1 solar module with a capacity of 100Wp. The results of the investment analysis show that the capital for making solar street lighting applications will return, namely in the 23rd year or the Payback Period in the 23rd year. The solar module can be seen in Figure 10, namely 1 solar module with a capacity of 100Wp. The results of the investment analysis show that the capital for making solar street lighting applications will return, namely in the 23rd year or the Payback Period in the 23rd year. The solar module can be seen in Figure 10, namely 1 solar module with a capacity of 100Wp. The results of the investment analysis show that the capital for making solar street lighting applications will return, namely in the 23rd year or the Payback Period in the 23rd year.

Hydroponic Plant Testing Using the Solar Energy NFT (Nutrient Film System) Method

This study also provides suggestions when the motor used is a DC motor, it is necessary to give a programmable DC timer so that the motor is given a time lag to stop pumping water with the aim that the motor is not damaged quickly due to continuous use as in previous studies [14][15]. However, if you use two motors at the same time, it will reduce the impact of damage more quickly on components because the motors work alternately by setting the programmable DC timer. The results of the investment analysis show that the capital for making solar hydroponic plant applications will return, namely in the 37th year or the Payback Period in the 37th year. if you use two motors at the same time it will reduce the impact of damage more quickly on the components because the motors work alternately by setting the programmable DC timer. The results of the investment analysis show that the capital for making solar hydroponic plant applications will return, namely in the 37th year or the Payback Period in the 37th year. if you use two motors at the same time it will reduce the impact of damage more quickly on the components because the motors work alternately by setting the programmable DC timer. The results of the investment analysis show that the capital for making solar hydroponic plant applications will return, namely in the 37th year or the Payback Period in the 37th year.

CONCLUSION

Research on the use of new, renewable technologies using solar power as electrical energy is very helpful for Islamic boarding schools in many ways, one of which is solar street lighting and farming using solar hydroponic plants. The results of the research on solar street lighting on each component function properly according to their respective specifications and the proximity sensor detect the presence of objects within 0.5 meters, 1 meter, and 1.5 meters from the sensor until the buzzer sounds for a few seconds. Furthermore, research on solar hydroponic plants using ac motors in testing ac motors using inverters has a weakness if the inverter is used for 24 hours it will reduce the life of the inverter or the inverter will be damaged faster, In addition, choosing an inverter that does not match the specifications of the motor will also have an impact on the motor itself, in this case, it is necessary to pay attention to the selection of the inverter to be used. However, if you use two motors at the same time, it will reduce the impact of damage more quickly on components because the motors work alternately by setting the

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programmable DC timer. In both solar power applications, based on the results of the investment analysis, the costs are quite cheap because they reduce the monthly payment bill and can return the capital for making the application. if you use two motors at the same time it will reduce the impact of damage more quickly on the components because the motors work alternately by setting the programmable DC timer. In both solar power applications, based on the results of the investment analysis, the costs are quite cheap because they reduce the bill for payment each month and can return the capital for making the application. if you use two motors at the same time it will reduce the impact of damage more quickly on the components because the motors work alternately by setting the programmable DC timer. In both solar power applications, based on the results of the investment analysis, the costs are quite cheap because they reduce the bill for payment each month and can return the capital for making the application.

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