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Research and development of renewable energy: Prototype of LED street lighting from solar energy

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ABSTRACT

To investigate the model of streetlight and electricity generation from solar cells in Rajabhat Maha Sarakham University were invented. The electricity set by 30-Watt 120 mm.-length- LED streetlamps. The solar panels included solar cell of 80 Watts with 12 V 45 Ah batteries. The automatic lighting control system consisted of the height of electricity poles as 6 meters, settling on the 6 meter-width – the street in 6 areas (A – F zones). Distance between each pole is 13 meters of 60 poles. The solar cell panels are able to generate average voltage value ranged from 12.06 – 14.08 Volt and the charging ability into the battery was 0.79 – 4.72 Amps. The LED's average voltage value was 10.04 - 11.95 Volts, and the electricity flow through the LED light was 0.18 – 1.22 Amps. Moreover, the average luminance was 186 – 340 Lux and the research also found that the quantities of solar cell energy storage was higher than the energy consumption which could be concluded that there are enough energy for the LED during the night-time. A rapid return on investment and added benefits due to energy savings through LEDs and needs-based light adjustment are determined. A contribution towards the goals of "Clean Power" and "Vision Zero", continental combines LED light expertise from the automotive educational institute with manufacturing experience for the high volume of production and highest quality requirements. Intelligent streetlight control improves road safety and reduces emissions.

Keywords: Research and development, renewable and solar energy, prototype the LED street lighting, business management and economics for an educational institute, survey and action on experimental research.

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INTRODUCTION

Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which concentrate in a limited number of countries [1]. The major types of renewable energy sources are Biomass—include: Wood and wood waste, Municipal solid waste, Landfill gas and biogas, Ethanol, Biodiesel, Hydropower, Geothermal, Wind, and Solar. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air [2].

Solar power expects to become the world's largest source of electricity by 2050, with solar photovoltaic and concentrated solar power contributing 16% and 11% to the global overall consumption, respectively [3]. This energy supplies the combination of electric current and electric potential that deliver the circuit [4]. The first solar cell constructed by Charles Frits in the 1880s [5]. Photovoltaic (PV), also known as solar PV, has evolved from a pure niche market of a small-scale applications towards becoming a mainstream electricity source [6]. Solar panels on the roof have the correct orientation or angle of inclination to take advantage of the sun's energy [7].

Solar panels, also known as modules, contain photovoltaic cells made from silicon that transform incoming sunlight into electricity and not heat. (" Photovoltaic" means electricity from light — photo = light, voltaic = electricity) [8]. The inverter turns the DC electricity generated by the solar panels into 120-volt AC that can put to immediate use by connecting the inverter directly to a dedicated circuit breaker in the electrical panel [9].

A LED lamp or LED light bulb is an electric light for use in light fixtures that produces light using light-emitting diode (LED). The most efficient commercially available LED lamps have efficiencies of 200 lumens per watt (lm/w), commercially available LED chips have efficiencies of over 220 lm/w [10]. The light output of single LEDs, as their name suggests, run as diodes and run on direct current (DC), whereas mains current is alternating current (AC) and usually at much higher voltage than the LED can accept[11]. These circuits contain rectifier, capacitors and may have other active electronic components, which may let the lamp to dim [12].

The use of Solar Powered LED Street Lights has become an interesting topic of research as well as application in the commercial world. Most of the common High Intensity Discharge (HID) lamps, often High-Pressure Sodium (HPS) lamps replace by more low powered Light Emitting Diode (LED) lamps. A basic solar-powered LED streetlight system component are: Solar Panel, Lighting Fixture – LED lamp, Rechargeable Battery, Controller, and Pole. The operations the LED bulb control by a control circuit either by using sensors such as Light Dependent Resistor (LDR) [13] (Fig. 1).

a) Solar LED Street Light | b) 30 Watt Led Streetlight | c) Public Lighting on DC smart grid | d) Grid Com, Somerset Group Bring Smart Street Lighting Sensory Network

Fig. 1: Modified the LED Street Lighting producing process in this research project

In this research study,
the idea of designing a new system for the streetlight that do not consume huge amount of electricity
and illuminate large areas with the highest intensity of light is concerned each engineer working in this field.
Energy efficient technologies and design
mechanism can cut cost of the street lighting drastically in Rajabhat Maha Sarakham University (RMU).

Materials and Methods

Research Project Aims

To invent and modify the prototype system of solar street lighting using renewable energy and the power generating electricity from solar cells for using the prototype LED street lighting systems for illumination in the campus area of the RMU Campus

Research Procedures

Step I: Determine Power Consumption Demands

The first step in designing a solar PV system is to find out the total power and energy consumption of all loads as follows:

1. Calculating total Watt-hours per day for each appliance used
2. Calculating total Watt-hours per day needed from the PV modules

Multiplying the total appliances Watt-hours per day times 1.3 (the energy lost in the system) to get the total Watt-hours per day which must offer by the panels.

Step II: Size the PV Modules

Different size of PV modules would be produced different amount of power. The peak watt (Wp) produced depends on size of the PV module and climate of site place, the sizing of PV modules, calculating as followed:

1. Calculating the total Watt-peak rating needed for PV modules
2. Calculating the number of PV panels for the system

Normally, the calculating formula as:

Size the PV Modules = (Number of Watts of Load)/ (Inverter Performance Efficiency)

There are three main things to consider in order to the choosing of a Solar panel or create was calculated a Solar system. To calculate the energy, we will use over time, just multiply the power consumption by the hours of intended use. The 20W in this example, on for 2 hours, will take 20 x 2 = 40 Watt/Hour from the battery. An easy way to lower power usage is to swap out halogen lights for LED lights. LED lights generally use 80% less energy for a similar light level. We have a range of 12V LED lights.

Step III: Inverter Sizing

An inverter was used in the system where AC power output need. The input rating of the inverter should never be lower than the total watt of appliances. The inverter size should be 25-30% bigger than total Watts of appliances. For grid tie systems or grid connected systems, the input rating of the inverter should be same as PV array rating to allow for safe and efficient operation.

Step IV: Battery Sizing

Deep cycle battery is specifically designed for discharge to low energy level, to find out the size of battery, calculate as follows calculating total Watt-hours per day used by appliances, and dividing the total Watt-hours per day used by 0.85 for battery lost voltaic.

Battery Size = Total LED Lamp Current × Operating Hours

Step V. Solar Charge Controller Sizing

Solar charge controller has enough capacity to handle current PV array. According to standard practice, the sizing of solar charge controller is to take the short-circuit current (Isc) of the PV array, and multiply it by 1.3 (Solar charge controller rating = Total short-circuit current of PV array x 1.3).

Designed of Equipment Dimensions

Step I: Set up the solar at the top of your house where the most sunlight is available during the day.

The solar panel connects with the solar charge controller for charging of the battery and prevents it from overcharging. It also prevents the reverse flow of charge during the night when no charging takes place. The power generated in the battery is 12-volt DC voltage and you have to convert it to AC current.

Step II: Electricity Production by Solar Energy

Using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into electric current using the photoelectric effect with solar photovoltaic and concentrated solar power contributing 16 and 11 percent to the global overall consumption, respectively. Concentrating Solar Power (CSP) systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam.

Step III: Designed automatic ON/OFF times

The system provides with automatic ON/OFF times which for dusk to down operation and overcharge/deep discharge prevention cut-off with LED indicators. PV installations can use for many years with little maintenance or intervention after their first set-up.

Step IV: Modern LED Lighting Solutions

Modern LED lighting solutions are advancing rapidly and can deliver significant energy saving potentials. Increasing efficacy, optimized luminaries design and flexible lighting control enable enhanced performance at lower cost for different lighting and traffic conditions for supporting implementation LED lighting systems.

Step V: Maintenance of this Research Project

This project focused on:

Quality criteria: to describe essential aspects such as luminance, light color, color rendering, light distribution, flicker, glare and others.

Luminance: The luminous flux (measured in lumens or lm) is the total amount of radiation emitted by a given light source that is visible for the human eye.

Luminous Intensity: The luminous intensity (measured in candela, or cd, with 1 cd = 1 lm/square radian) represents within a given solid angle from the light source.

Luminance (measured in lux, or lx, with 1 lux = 1 lm/m^2): Minimum luminance criteria specified for the different street classification with complex traffic situations range from 7.5 to 50 lx.

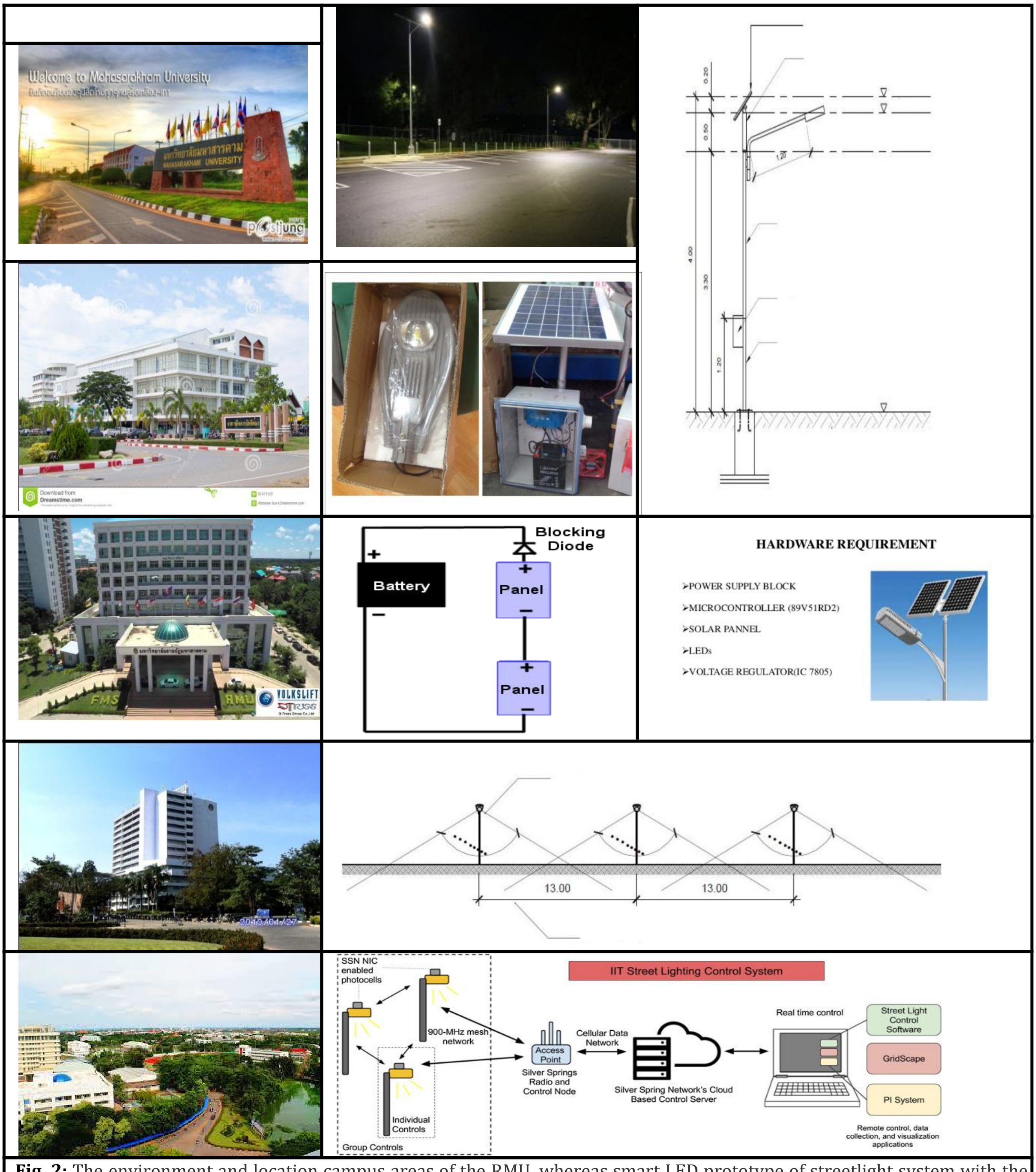


Fig. 2: The environment and location campus areas of the RMU, whereas smart LED prototype of streetlight system with the

electricity production by solar energy were designed

Using a relay to act as an ON/OFF switch was controlled. Automatic streetlight system circuit designed. The system basically consists of a LDR, Photoelectric sensor, Power supply, Relays and Micro controller (Figure 2).
In Fig. 2, the environment and location campus areas of the RMU, whereas smart LED prototype of streetlight system with the electricity production by solar energy with the prototype of LED Street Lighting by solar renewable energy are provided.
Step VI: The solar energy components that make up a complete solar power system.
Solar-powered photovoltaic (PV) panels convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun.
The Roof System: In most solar systems, solar panels are placed on the roof. An ideal site will have no shade on the panels, especially during the prime sunlight hours of 9 am in three months; August, September, and October in the year 2017 were measured.
Solar panels: Solar panels, also known as modules, contain photovoltaic cells made from silicon that transform incoming sunlight into electricity rather than heat. (" Photovoltaic" means electricity from light — photo = light, voltaic = electricity.).
Inverter: The inverter is typically located in an accessible location, as close as practical to the modules. Since inverters make a slight noise, this should be taken into consideration when selecting the location.

Designing Project

The design of the solar street lighting system consists of an electric pole made of round steel pipes of 4 inches in diameter and 6 meters in height. The LEDs use a 30-watt light bulb, a lamp length of 120 millimeters, a brightness of 5,000 lumens. 120-degree brightness install the light towers each 13 meters apart. The solar panel and control box are available, size 35x45x20 cm3. The control is divided into 2 parts: the working part in the day and the working part in the night. Daytime workplaces are composed of photovoltaic panels. Electricity to the battery second part works at night. Using a battery to store electricity from the solar cell to Ah 45 will provide 540 watts of power, which will be sufficient to supply the load of the LED bulb for 12 hours. The solar panel was installed in 60 Electric Poles at the RMU in six zones (Zone A-F) via the LED solar streetlight.

Results and Discussions

Circuit Testing and Equipment

Using an 80 Watt solar panel to fully charge as 12 Volts 45 Ah battery to bring the voltage supplied to the 30W 200VAC lamp, the effect of charging the charge, and the effect of the payload on three times a day, at 1.00 pm from August to October, 2017.
Statistically significant analyzed with the linear equation of the voltage values at the Zone A-F indicates that of equation as y = ax + b, meanwhile y is the voltage value and x is each solar cell point, the determination efficient predictive value (R^2) predicted.
In terms of the EC entering the battery, the A01 - A08 has an average of 4.72 ± 0.18 ampere peak currents charged to the battery. The smallest battery life is 3.35 ± 0.24 amp (Table 1, Fig. 3).

Table 1. The Values of Voltage on the Solar Panels (V) and Charging Electrical Current into Battery (Amp) at the the Zone A-Street Righting Lamp

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
A01	11.77	11.85	12.38	12±0.27	3.68	3.31	3.08	3.35±0.24
A02	13.17	12.57	15.51	13.75±1.26	4.88	4.84	4.46	4.72±0.18
A03	12.71	12.28	12.71	12.56±0.20	4.82	4.36	4.12	4.43±0.29
A04	13.61	12.41	12.79	12.93±0.50	4.61	4.66	4.74	4.67±0.05
A05	12.44	12.2	12.76	12.46±0.22	4.30	5.09	4.43	4.60±0.34
A06	13.21	12.4	12.83	12.81±0.33	4.40	4.21	4.12	4.24±0.11
A07	13.06	12.39	12.81	12.75±0.27	4.06	4.43	4.12	4.20±0.16
A08	12.62	12.14	12.69	12.48±0.24	4.43	4.06	4.12	4.20±0.16

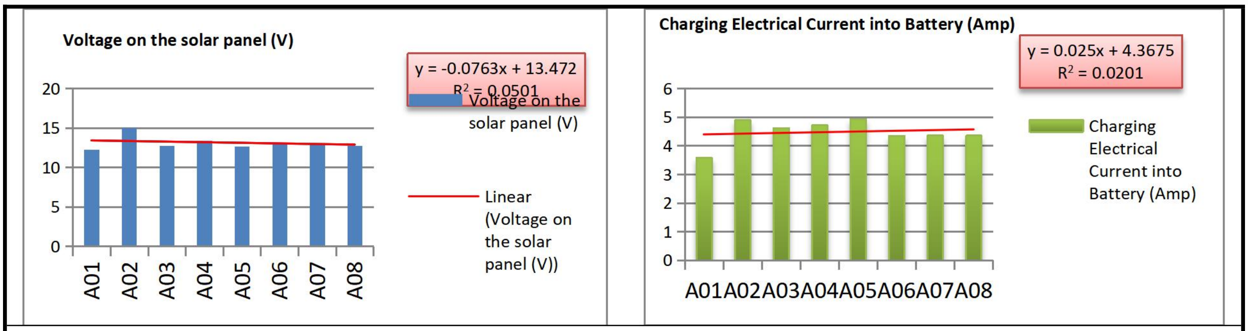


Fig. 3: Voltage at the solar panel and electric current into the battery at zone A

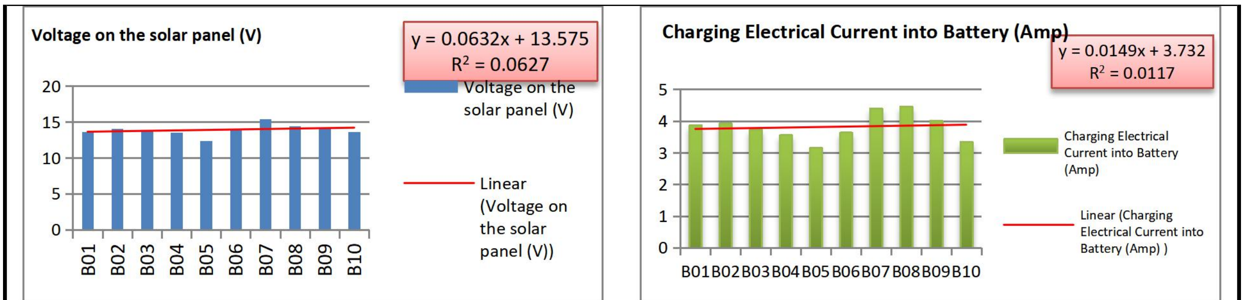
At the Zone A indicates that of equation as y = -0.076x + 13.47, decreasing. The determination efficient predictive value (R^2) indicates that of 5% of the variance was attributable in EV source to the six voltage solar panels. Therefore, R^2 indicates that of 2% of the variance EV from average solar cell energy source.

At the B01 - B10 zone has an average of charging currents. Maximum battery consumption is 3.42 ± 0.98 amp. The average battery charge is 2.74 ± 0.90 amp.

At the Zone B indicates that of equation as y = 0.063x + 13.57, increasingly. The R^2 value indicates that of 6% and 1% of the variance in EV source from average solar cell energy source in batteries for the EC (Table 2 and Figure 4)

Table 2. The Voltage on the Solar Panels (V) and Charging Electrical Current into Battery (Amp) at the Zone B-Street Righting Lamp**s**

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
B01	13.36	12.78	13.75	13.29±0.39	2.37	4.28	2.05	2.9±0.98
B02	14.14	12.82	13.73	13.56±0.55	2.33	4.26	2.72	3.10±0.83
B03	13.59	12.27	13.71	13.19±0.65	2.78	3.99	2.75	3.17±0.57
B04	13.41	12.23	13.36	13±0.54	2.39	3.81	2.62	2.94±0.62
B05	12.44	11.62	12.17	12.07±0.34	2.06	4.67	2.15	2.96±1.20
B06	13.95	12.67	13.64	13.42±0.51	2.06	4.02	2.16	2.74±0.90
B07	15.96	12.77	13.52	14.08±1.36	2.94	4.80	2.54	3.42±0.98
B08	14.66	13.02	13.67	13.78±0.67	2.85	4.91	2.22	3.32±1.14
B09	14.30	13.13	13.68	13.70±0.47	2.39	4.42	2.43	3.08±0.94
B10	13.66	12.58	13.37	13.20±0.45	2.82	4.77	2.15	3.24±1.11



Gig. 4: Voltage at the solar panel and electric current into the battery at the Zone B

At the Zone C01 - C09 has an average of greatest current charged to the battery as 4.37 ± 0.29-amp average charge to battery charger at 3.32 ± 0.1 min 0.14 amp.

Table 3. The Voltage on the Solar Panels (V) and Charging Electrical Current into Battery (Amp) at the Zone C-Street Righting Lamps

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
C01	13.40	12.49	13.21	13.03±0.17	4.56	4.16	4.20	4.30±0.17
C02	13.73	12.88	13.69	13.43±0.29	4.78	4.07	4.27	4.37±0.29
C03	14.13	12.90	13.39	13.47±0.86	3.17	5.27	4.45	4.29±0.86
C04	16.63	12.82	14.16	14.53±0.33	3.28	4.07	3.88	3.74±0.33
C05	13.93	12.31	13.02	13.08±0.14	3.21	3.42	3.07	3.23±0.14

C06	13.81	12.32	12.99	13.04±0.42	3.21	4.06	3.11	3.46±0.42
C07	13.95	12.81	13.38	13.38±0.59	3.77	4.66	3.21	3.88±0.59
C08	12.71	12.03	12.28	12.34±0.06	3.64	3.68	3.53	3.61±0.06
C09	14.20	13.90	14.34	14.14±0.18	3.58	3.13	3.27	3.32±0.18

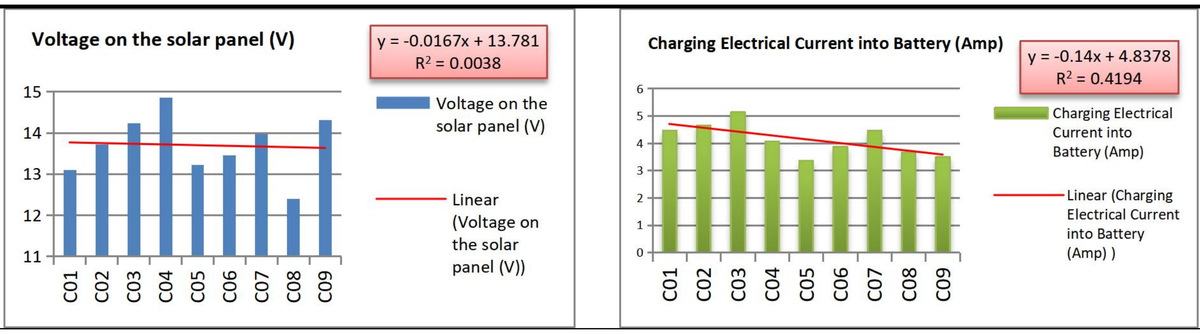


Fig. 5: Voltage at the solar panel and electric current into the battery at the Zone C

At the Zone C indicates that of equation as y = 0.063x + 13.57, increasingly. The R^2 value indicates that of 6% of the variance was attributable in EV source and 1% of the variance was attributable in EV source (Table 3 and Figure 5).

At the Zones D01 - D09 have an average of greatest rated current of 3.75 ± 0.40 amp. The average current charged to the battery is 1.46 ± 0 and the smallest is 0.30 amp.

Table 4. The Voltage on the Solar Panels (V) and Charging the EC into Battery (Amp) at the Zone D-Street Righting Lamps

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
D01	13.73	12.51	13.23	13.15±0.45	3.81	4.29	3.19	3.76±0.45
D02	12.93	11.97	12.71	12.53±0.35	3.68	3.98	3.13	3.59±0.35
D03	12.58	11.94	11.93	12.15±0.60	3.25	3.28	3.13	3.22±0.06
D04	12.32	12.09	12.61	12.34±0.68	3.23	4.62	3.13	3.66±0.68
D05	12.87	12.38	13.06	12.77±0.50	3.33	4.43	3.41	3.72±0.50
D06	13.77	12.51	13.44	13.24±0.40	3.76	4.24	3.25	3.75±0.40
D07	12.76	12.16	12.77	12.56±0.23	3.23	3.75	3.7	3.56±0.23
D08	12.26	12.40	12.43	12.36±0.30	1.75	1.6	1.05	1.46±0.30
D09	11.99	12.86	11.82	12.22±0.32	1.91	1.4	1.13	1.48±0.32

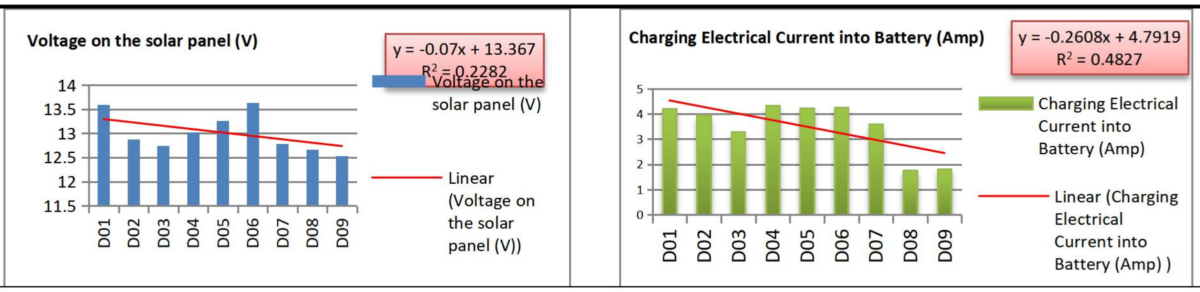


Fig. 6: Voltage at the solar panel and electric current into the battery at the Zone D

At the Zone D indicates that of equation as y = -0.07x + 13.36, depressingly. The R^2 value indicates that of 23% and 48% of the variance was attributable in six voltage solar panels in EV source (Table 4 and Figure 6).

At the Zone E01 - E13, the average battery charge current is 2.85 ± 2.27 amp and the average current charged to the battery is 1.41 ± 0.0. The least is 0.90 amp and y = 0.079x + 12.77, increasingly. The R^2 value indicates that of 46% and 1% of the variance was attributable in EV source in six voltage solar panels of the variance in EV source from average solar cell energy source (Table 5 and Figure 7).

Table 5. The Voltage (V) and Charging Electrical Current into Battery (Amp) at the Zone E-Street Righting Lamp

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
E01	12.56	12.08	12.14	12.26±0.21	1.10	4.11	0.45	1.88±1.59
E02	13.73	12.16	12.32	12.73±0.70	2.93	4.40	0.94	2.75±1.41
E03	12.85	12.23	12.69	12.59±0.26	2.21	4.36	1.45	2.67±1.23
E04	12.65	12.34	13.18	12.72±0.34	1.01	4.66	0.33	2±1.90
E05	13.62	12.20	12.49	12.77±0.61	2.56	3.65	0.35	2.18±1.37
E06	13.5	12.30	13.59	13.13±0.58	2.13	3.84	1.02	2.33±1.15
E07	12.92	12.02	12.43	12.45±0.36	1.76	2.3	0.17	1.41±0.90
E08	13.12	12.27	12.94	12.77±0.36	1.77	4.43	0.13	2.11±1.77
E09	13.07	12.45	13.32	12.94±0.36	1.82	3.95	1.73	2.5±1.02
E10	13.7	12.67	13.95	13.44±0.55	0.70	6.70	1.17	2.85±2.27
E11	13.85	12.18	12.76	12.93±0.69	1.90	3.55	0.22	1.89±1.35
E12	14.04	12.51	13.45	13.33±0.63	1.20	3.18	1.87	2.08±0.82
E13	13.92	12.04	12.33	12.76±0.82	2.09	4.17	0.50	2.25±1.50

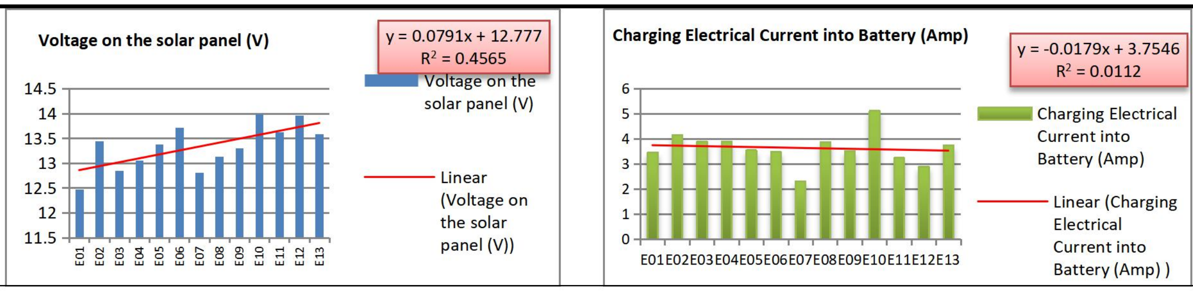


Fig. 7: Voltage at the solar panel and electric current into the battery at the Zone E

At the zone F01 - F11 is the average of the current, charging into the battery, the greatest power is 2.65 ± 2.78 amp and the average electric current that reaches the lowest battery is 0.79 ± 0.18 (Table 6).

At the Zone F indicates that of equation as y = 0.094x + 12.54, increasingly. The R^2 value indicates that of 28% and 2 % of the variance into Batteries from average solar cell energy source (Figure 8).

Table 6. The Voltage on the Solar Panels (V) and Charging Electrical Current into Battery (Amp) at the Zone F-Street Righting Lamp**s**

Lamp No.	Voltage on the solar panels (V)				Charging electrical current into battery (Amp)			
	Accounting time				Accounting time			
	1	2	3	Average	1	2	3	Average
F01	12.45	12.00	11.84	12.09±0.25	0.94	4.16	0.25	1.78±1.70
F02	13.12	12.05	12.34	12.50±0.45	1.26	3.85	1.35	2.15±1.20
F03	13.12	12.36	12.74	12.74±0.31	2.16	2.75	0.46	1.79±0.97
F04	12.27	12.02	11.89	12.06±0.15	0.58	1.03	0.78	0.79±0.18
F05	12.51	12.59	12.56	12.55±0.03	0.73	3.05	0.96	1.58±1.04
F06	13.63	13.84	13.99	13.82±0.14	1.72	3.19	0.49	1.8±1.10
F07	13.92	12.43	13.57	13.30±0.63	1.05	6.55	0.37	2.65±2.78
F08	12.98	12.13	13.00	12.70±0.40	2.70	3.81	0.82	2.44±1.23
F09	13.71	12.34	13.3	13.11±0.57	0.97	3.82	0.18	1.65±1.56
F10	13.48	12.16	12.71	12.78±0.54	1.19	3.91	0.9	2±1.35
F11	12.32	12.33	13.18	12.61±0.40	0.85	2.95	0.11	1.30±1.20

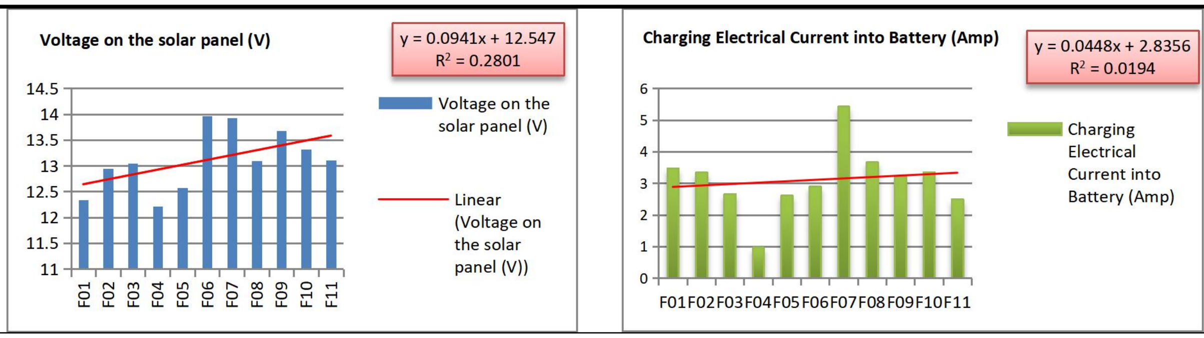


Fig. 8: Voltage at the solar panel and electric current into the battery at the Zone F

From Table 1 to Table 6, and Figures 3-8 show that the solar panel voltage in zone A01 - A08 has an average voltage of 12.93 ± 0.50 Volts. Average voltage Zone B01-B10 has the highest average voltage, the value of 14.08 ± 1.36 Volt. The highest average voltage was 14.53 ± 0.33 Volts. The lowest mean voltage was 12.34 ± 0.06 Volts. Zone D01 - D09 has the highest average voltage of 13.24 ± 0.40 Volts. The average voltage is 12.15 ± 0.6 Volt. E01 - E13 has the highest average voltage of 13.44 ± 0.55Volts. Average voltage, the largest mean voltage is 13.82 ± 0.14 Volt and less than 12.26 ± 0.21 volts and the greatest is 12.06 ± 0.15 Volts in zone F.

The Performances of Solar Cells and the Output Performance (LED Lamps) in the Street Lighting System

To describe the modeling and simulation of photovoltaic street lighting systems and a design concept of the power of LED lighting units proposed to use in areas with moderate solar potential. In finally, determination the contribution value of carbon dioxide emissions by replacing the traditional streetlamps with LED lighting, solar lamps. In this research designed performance solar cells and the output performance (LED lamps) in the street lighting system.

Comparisons between capacitances of battery charge in the daytime and electrical power consumption of LED bulbs at nighttime for the electric voltage (V) for the LED Street lighting at the six zones (A-F) (Table 15). The results given in Table 15 show the mean scores, standard deviation, variance, simple correlation, F-test, and *t*-test was analyzed. Electrical power consumption of LED bulbs at nighttime was estimated using paired comparisons. Using the *t*-test for dependent samples reveal are differences significant at the .001 level for electric voltages at the daytime and the night-time, significantly.

Comparisons between capacitances of battery charge in the daytime and electrical power consumption of LED bulbs at night-time for the electric Current (Amp) for the LED Street lighting at the six zones (A-F) measured of 60 LED Street Lights were measured with the EC. The results given in Table 16 show the mean scores, standard deviation, variance, simple correlation, F-test, and t-test. The statistical significance of the difference between the capacitances of battery charge in the daytime and electrical power consumption of LED bulbs at night-time estimated using paired comparisons, differently.

Comparisons between capacitances of battery charge in the daytime and electrical power consumption of LED bulbs at night time for the electric power (Watt) for the LED Street lighting at the six zones (A-F) measured of 60 LED Street Lights were measured with the EP. The results given in Table 17 show the mean scores, standard deviation, variance, simple correlation, F-test, and t-test. The statistical significance of the difference between the capacitances of battery charge in the daytime and electrical power consumption of LED bulbs at night-time estimated using paired comparisons using t-test for dependent samples show that the differences, differently.

In terms of radiation data for solar electric (photovoltaic) systems are often represented as kilowatt-hours per square meter (kWh/m2). Direct estimates of solar energy may also be expressed as watts per square meter (W/m2). The amount of electricity a solar panel produces depends on three important factors: the size of the panel, the efficiency of the solar cells inside, and the amount of sunlight the panel gets, though it will be at a much reduced rate compared to sunny days — usually between 25 and 40%. Figure 9 shows comparisons between the electric power at mid-day and night-time for each six zone. At A02 have the highest electrical power at 64.9 W and in zone A, the higher the electrical charge? For energy use at night from the power (W), it was found that the power poles at B08 have the highest power consumption, and the energy from the solar panel of each panel is higher than the amount of energy consumed at night by every LED lamps.

Monitoring the streetlight are also temperature and humidity. The solar panels designed with the electrical power energy roof system of 80 watts of power can generate voltage across all six zones A-F has an average of 12.06 - 14.06 V and can generate electricity into the battery during daylight hours. The average was between 0.97 - 4.72 Amp. Zone A has the average voltage at the solar cell, much.

The street lighting LEDs in the whole zone have an average of 10.04 to 11.95 Volts and the electric current flows through the LEDs in all zones, with an average of 0.18 to 1.22 Amp for the illumination of the LEDs. The averages are between 186-340 Lux at a height of 3 meters electric poles, which are enough to warrant standardized the engineering of street lighting. All LED lamps can illuminate the street. During the night 12 (hours), it was possible to read the measure obtained from the amount of energy stored in the solar cell at night in use.

A streetlight, light pole, lamppost, streetlamp, light standard, or lamp standard is a raised source of light on the edge of a road or path. When urban electric power distribution became ubiquitous in developed countries in the 20th century, lights for urban streets followed, or sometimes led. Many lamps have light-sensitive photocells that activate automatically when light is or is not needed: dusk, dawn, or the onset of dark weather. This function in older lighting systems could have been performed with the aid of a solar dial. Many streetlight systems are being connected underground instead of wiring from one utility post to another [15].

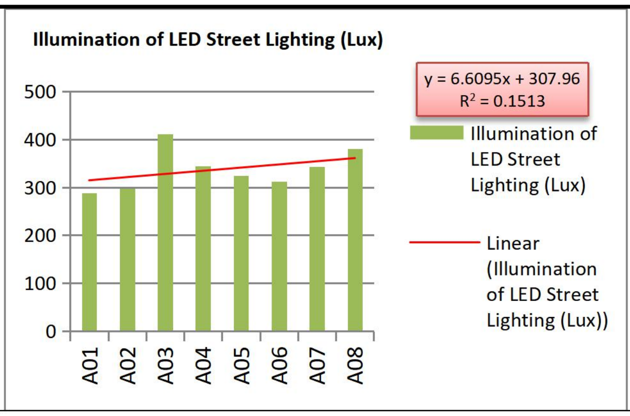


Fig. 9: Graphics of means average for the illumination of the 8-LED Street Lighting Lamps in Zone A with the linear equation y = 6.609x + 307.9, the R^2 value indicates that of 15% of the variance in the illumination, increasingly

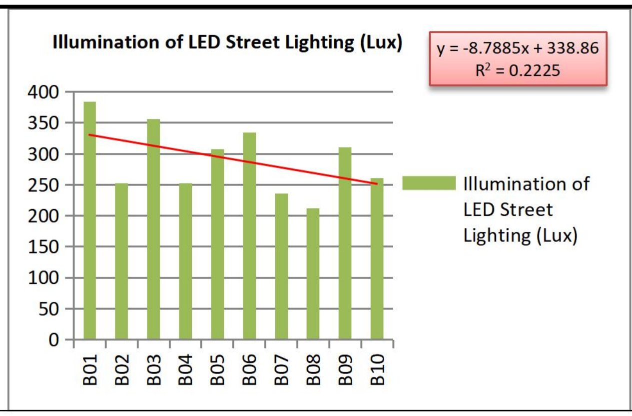


Fig. 10: Graphics of means average for the illumination of the 10-LED Street Lighting Lamps in Zone B with the linear equation y = -8.788x + 338.8, the R^2 value indicates that of 22% of the variance in the illumination, decreasingly

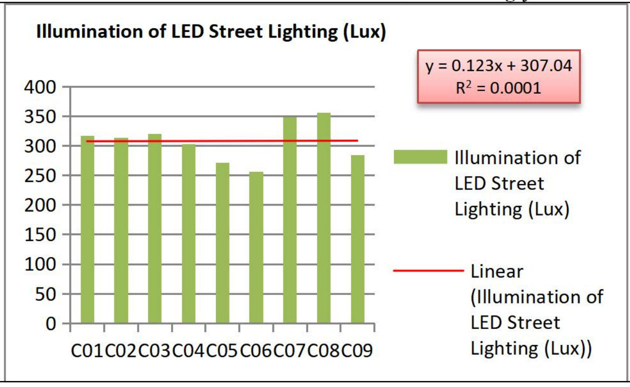


Fig. 11: Graphics of means average for the illumination of the 9-LED Street Lighting Lamps in Zone C with the linear equation y = 6.609x + 307.9, the R^2 value indicates that of 0% of the variance in the illumination, non-significantly.

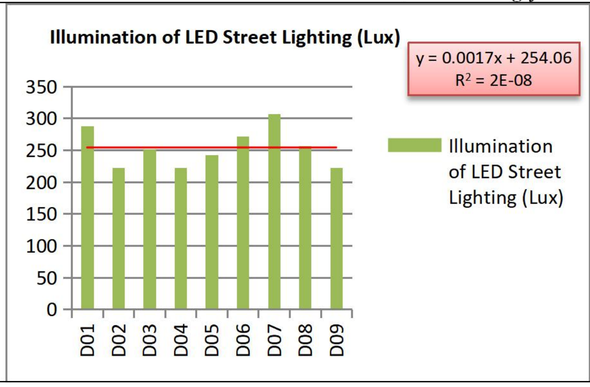


Fig. 12: Graphics of means average for the illumination of the 9-LED Street Lighting Lamps in Zone D with the linear equation y = 0.001x + 254.0, the R^2 value indicates that of 0% of the variance in the illumination, non-significantly.

Fig. 19

Fig. 20

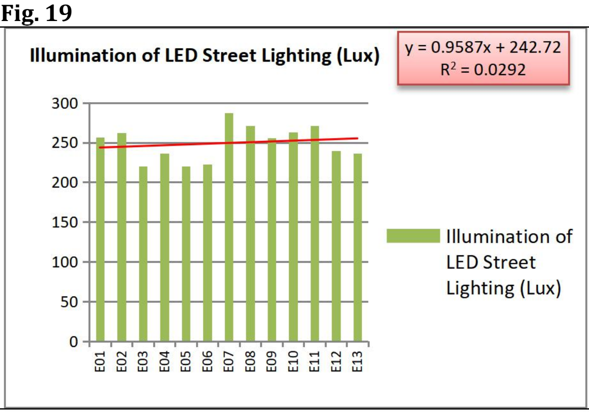


Fig. 13: Graphics of means average for the illumination of the 8-LED Street Lighting Lamps in Zone E with the linear equation y = 0.958x + 242.7, the R^2 value indicates that of 3% of the variance in the illumination, increasingly

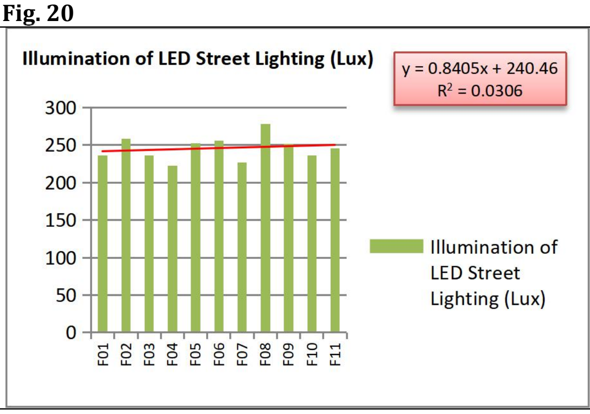


Fig. 14: Graphics of means average for the illumination of the 8-LED Street Lighting Lamps in Zone F with the linear equation y = 0.958x + 242.7, the R^2 value indicates that of 3% of the variance in the illumination, increasingly

Fig. 9 - 14, show an LED street lighting lamp is an integrated light that uses light emitting diodes (LED) as its light source. These are considered integrated lights because, in most cases, the luminaries and the fixture are not separate parts. In manufacturing, the LED light cluster sealed on a panel and then assembled to the LED panel with a heat sink to become an integrated lighting fixture at each zone from the six zones.

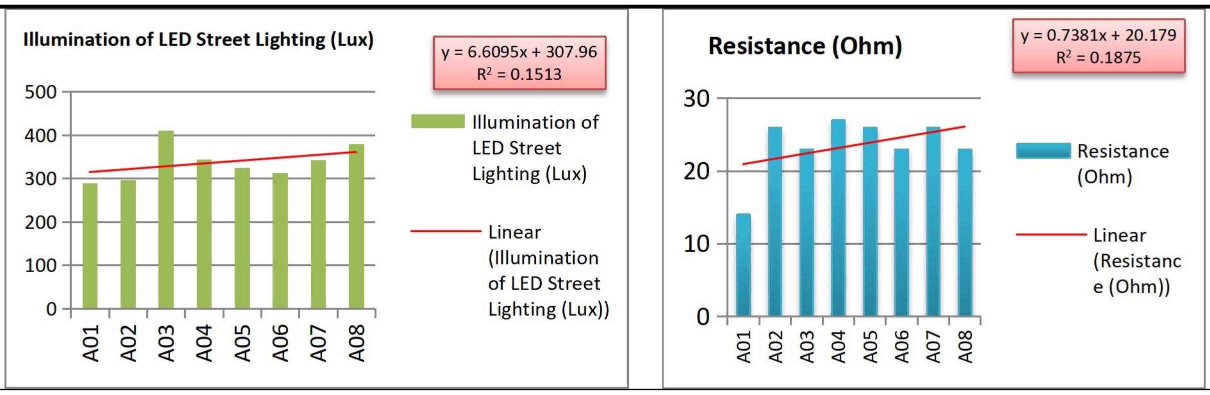


Fig. 15: Graphics of the measuring environmental temperatures and resistance at the Zone A

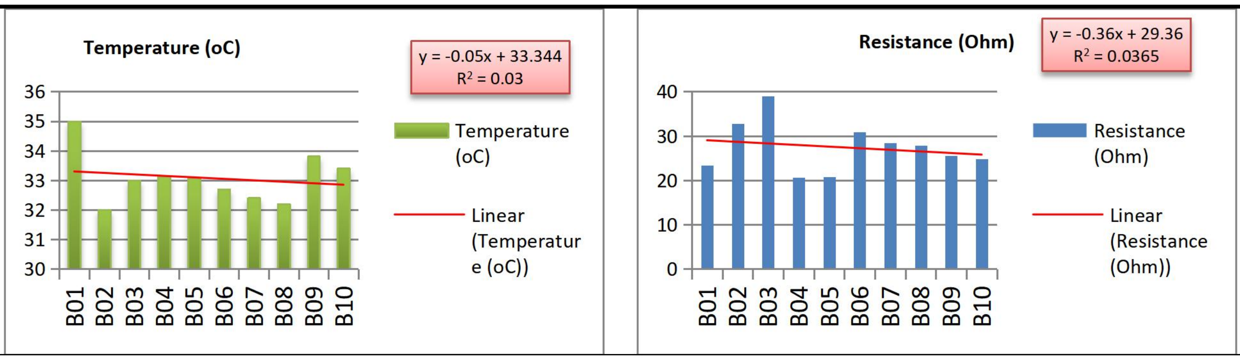


Fig. 16: Graphics of the measuring environmental temperatures and resistances at the Zone B

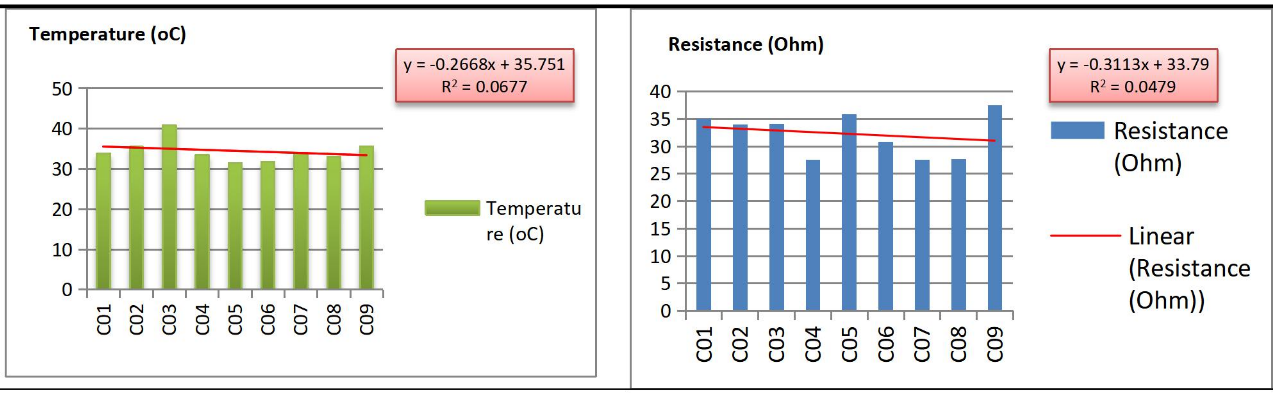


Fig. 17: Graphics of the measuring environmental temperatures and resistances at the Zone C

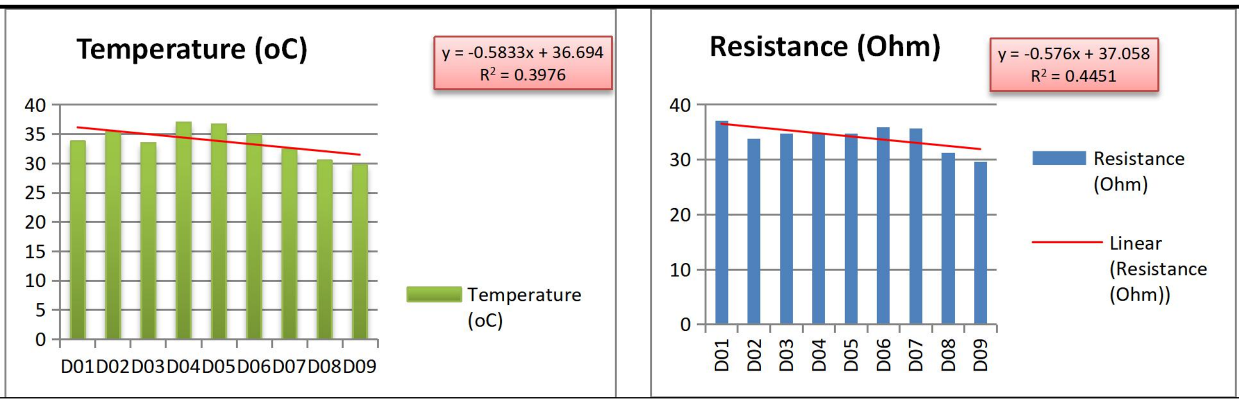


Fig. 18: Graphics of the measuring environmental temperatures and resistance average at the Zone D

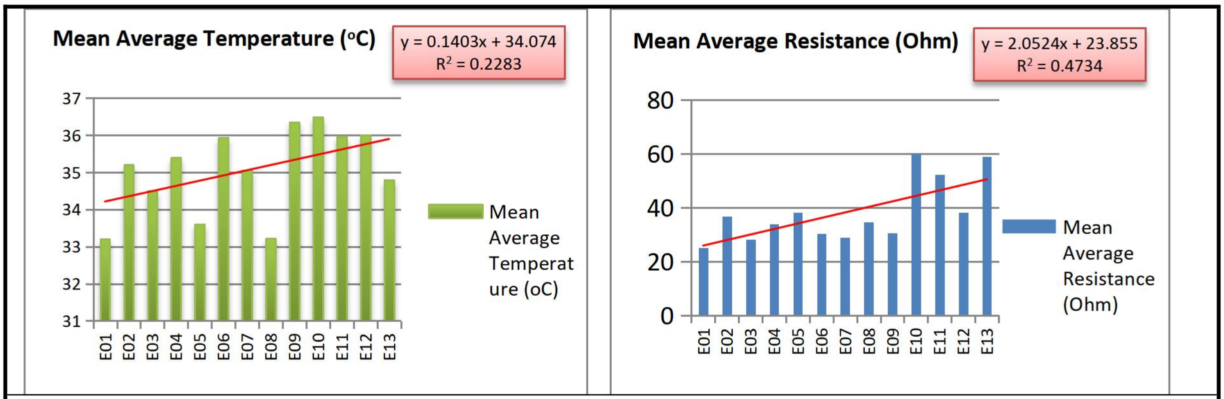


Fig. 19: Graphics of the measuring environmental temperatures and resistance averages at the Zone E

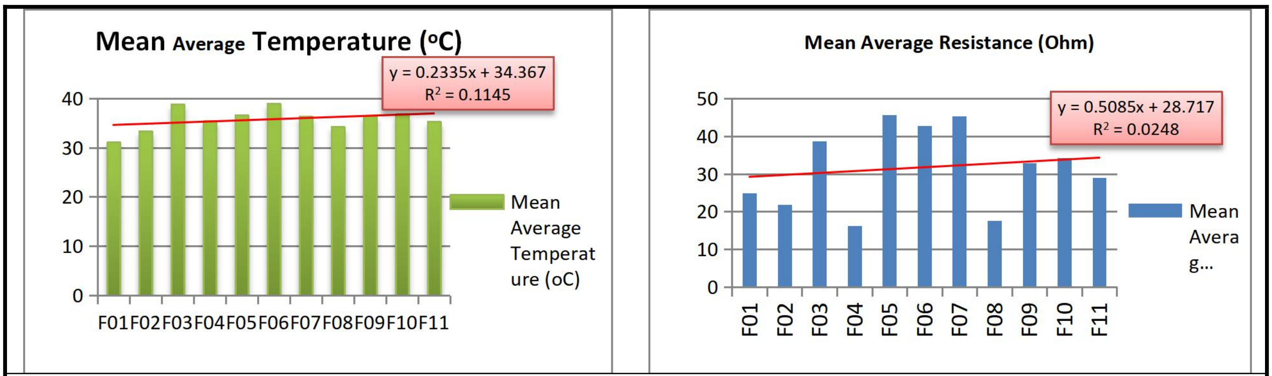


Fig. 20: Graphics of the measuring environmental temperatures and resistance averages at the Zone F

Fig. 15 - 20 showed that the resistance with the solar panel at zone A01-A08 has the highest average value of 26.86 ± 1.81 Ohm. The average value is 13.56 ± 1.67 Ohms. The B01-B10 zone has the highest average value of 26.12 ± 6.65 Ohm. C01 - C09 has the highest average value of 34.13 ± 3.38 Ohm, the lowest mean is 26.50 ± 1.17 Ohm. The D01 - D09 zone has the highest average value of 30.56 ± 6.5 Ohm. 25.26 ± 5.94 Ohm zone E01 - E13 has the highest average resistance of 37.96 ± 22.19 Ohm, the mean of 17.73 ± 8.48 Ohm and the zone of F01 - F11 has the highest average resistance of 13.82 ± 0.14 Ohm, the mean is 12.09 ± 0.25 Ohm.

Exactly, the LED manufacturers that successfully acquire PEA streetlight bids are paid back in energy savings. In other words, successful project bidders are expected to run the project under Energy Service Company (ESCO) models. It is difficult for foreign LED manufacturers to enter the streetlight market, though. Depending on the budget, usually priority was given to local manufacturers, if there were no suitable companies, then open to foreign companies. The LED manufacturer's streetlight products are also expected to meet highway lighting standards. PEA is also involved in LED research and development is currently directing its research towards developing LEDs that emit less heat and offer better color performance [16].

Conclusions

Research and development of renewable energy, focused on the prototype of street lighting for inventing and designing the renewable energy from solar energy on the use of solar cells for street lighting in Maharashtra Rajabhat University campus area, using the 60 electrical poles in six of A – F zones, the concluding research study reported on each subsections as:

Street Light Control System, this design can save a great amount of electricity compared to streetlamps that keep alight during nights. Statistically significant was analyzed with the linear equation of the voltage values at the Zone A-F indicates that of equation as y = ax + b, meanwhile y is the voltage, temperature, resistance values and x is each solar cell point, the determination efficient predictive value (R^2) was predicted. Statistically significance was assessed and evaluated with the Graphics of means average for the illumination of the LED Street Lighting Lamps in Zone A - F with the linear equation (y = ax + b) and the coefficient of determination, denoted R^2 and pronounced "R squared", is a number that indicates the proportion the variance in the dependent variable (Illumination) that is predictable from the independent variable (the LED Street Lighting Lamps).

Zone A has the average voltage at the solar cell. Because Zone A is a clear zone without trees or buildings, and the building blocks the solar panel that the affecting the charging depends on the environmental areas. Does the building cover the solar panel or does the cloud cover the sky? Due to the fact that Zone A solar panels can produce high voltages, resulting in higher charging currents in Zone A batteries than in other zones, it is found that the voltage at the solar panel value corresponds to the charge to the battery, significantly.

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