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Article

Analysis of the installation of photovoltaic panels interconnected to the electrical grid to illuminate the parking lot of the Higher Technological Institute of Huatusco

Análisis de instalación de paneles fotovoltaicos interconectados a la red eléctrica para iluminar el estacionamiento del Instituto Tecnológico Superior de Huatusco

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Abstract

Solar energy is the main source of life on the planet; directs the biophysical, geophysical and chemical cycles that maintain life on earth. The sun supplies us with food through photosynthesis, it is used to generate electrical energy. The solar radiation that falls on the earth can be actively used, through the implementation of photovoltaic modules or cells, from which electrical energy can be obtained to illuminate different areas. The present investigation shows the different electrical variables of these modules interconnected to the electrical network and how the connection is derived to illuminate the parking lot of the Higher Technological Institute of Huatusco (ITSH).

Objetivos: análisis de instalación, iluminación led, energía renovable, ahorro de energía		
Objetivos	Metodología	Contribución
Análisis de instalación, iluminación led, energía renovable, ahorro de energía.	Uso de energía renovable Análisis de consumo mediante software	Iluminación led a través de energía solar Reducción de consumo de recibo de energía eléctrica.

Solar, Energía, Electricidad

Resumen

La energía solar es la fuente principal de vida en el planeta; dirige los ciclos biofísicos, geofísicos y químicos que mantienen la vida en la tierra. El sol nos suministra alimentos mediante la fotosíntesis, se utiliza para la generación de energía eléctrica La radiación solar que incidente en la tierra puede aprovecharse activamente, a través de la implementación de módulos o celdas fotovoltaicas, de los cuales se puede obtener energía eléctrica para iluminar diferentes áreas. La presente investigación muestra las diferentes variables eléctricas de estos módulos interconectados a la red eléctrica y de cómo se deriva la conexión para iluminar el estacionamiento del Instituto Tecnológico Superior de Huatusco (ITSH).

Objectives: installation analysis, LED lighting, renewable energy, energy savings		
Goals	Metodología	Contribución
Installation analysis, LED lighting, renewable energy, energy savings.	Use of renewable energy Consumption analysis using software.	LED lighting through solar energy Reduction of electricity bill consumption.

Solar, Energy, Electricity

Area: Development of strategic leading-edge technologies and open innovation for social transformation

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Introduction

Photovoltaic solar energy is defined as the process of obtaining electrical energy using photovoltaic panels. Photovoltaic modules or collectors are made up of semiconductor diode devices, which, upon receiving solar radiation, undergo a chemical process that excites the electrons in the modules, causing electrons to jump; this is known as the photoelectric effect. This phenomenon generates a potential difference across the ends of the conductors. The result is a direct current (DC) voltage that can be harnessed and transformed into an alternating current (AC) voltage, which can then be fed into the electrical grid or an interconnected system. (Sánchez, 2011).

The fascinating world of lighting is art, technique, and science all at once. Today, electric lighting plays a fundamental role in all human activities, and all disciplines and professions depend on it to a large extent, even those that are predominantly daytime. It is difficult to imagine today's world without modern lighting systems. (Rivero, 2018)

The electricity used by the Huatusco Higher Technological Institute (ITSH) comes from the Federal Electricity Commission (CFE). The parking lot generates 36 kWh/month.

Development

Currently, the Huatusco Higher Technological Institute (ITSH) consumes approximately 1,320 Wh/day for parking area lighting, which increases the cost on its electricity bill. With the installation of solar panels, a portion of the consumed MWh can be generated on-site, with the remainder being fed back into the Federal Electricity Commission (CFE) grid, thus reducing the cost of the electricity bill.

LED lighting

In LED lighting, the drivers are responsible for maintaining a completely constant current to prevent changes in junction temperature, efficiency, color rendering, and lifespan. New doped materials and improved phosphor coatings are generating efficiencies exceeding 200 lm/W. (Rivero, 2018)

Installations connected to the electrical grid

These are installations where the energy generated by the photovoltaic array is delivered directly to the distribution grid. This type of installation does not have batteries or regulators, only the photovoltaic elements and the inverter. The inverter must have a system for measuring the energy consumed and delivered, capable of interrupting or resuming the supply depending on the field status of the module and adapting the alternating voltage produced by the inverter to the grid's power phase.

Photovoltaic module

The main function of a photovoltaic module is to capture and convert solar radiation into electrical voltage. Modules can be connected in series or parallel. When connected in series, the total voltage is the sum of the individual voltages of each module. The output voltage will be equal to the voltage of a single module. When connected in parallel, the total voltage is the same as that of a single module. Therefore, the number of modules connected in series determines the voltage, and the number of modules in parallel determines the current that can be supplied to a load.

Investor

It is responsible for converting the continuous voltage produced by the photovoltaic generator to the electrical characteristics required by the loads to be powered.

Methodology to be used

5.79 are the peak solar hours of the City of Huatusco, specifically in the parking area of ITS Huatusco.

$$(5.79\ )(5.32\ A) = 31.20\ Ah7día \quad [1]$$

This data is for use with a 45° tilt angle.

Each panel consumes 100W

$$(100\ W)(12\ h) = 1{,}200\ Wh/día \quad [2]$$

$$(1{,}200\ Wh/día)(1.1) = 1{,}200\ Wh/día \quad [3]$$

$$(1{,}200\ Wh/día)(1.1) = 1{,}320\ W \quad [4]$$

$$\frac{(1{,}320\ W)}{(18.78)} = 95.79\ Ah/día \quad [5]$$

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The number of panels in parallel

$$\frac{\left(95.79\frac{Ah}{día}\right)}{\left(31.20\frac{Ah}{día}\right)} = 3\ paneles \quad [6]$$

100 W with twelve hours of use

$$(100\ W)(12\ h) = 1{,}200\ Wh/día \quad [7]$$

We added 10% security

$$\left(12{,}000\frac{Wh}{día}\right)(1.1) = 13{,}200\ Wh/día \quad [8]$$

$$\frac{\left(13{,}200\frac{Wh}{día}\right)}{22.64} = 583.03\ Ah/día \quad [9]$$

Number of panels in parallel

$$\frac{583.03\frac{Ah}{día}}{31.20\frac{Ah}{día}} = 18.68 = 19\ paneles \quad [10]$$

Box 1

Table 1
Calculation of the number of parking posts at ITSH

Parking length	80 meters
Parking width	44 meters
Total area	3,520 m²
Projected light output	20 lx
Luminous flux	9000 lm
Power input	100 W
Number of lamps per pole	2 de 50 W
Lamp height	3.65 m
Length, space 2H	7.3 m
Width, space 3H	10.95 m
Space 4H	14.6 m
Sidewalk length	5.83 m
Street width	2.40 m
Actual space	It is decided with design
Number of poles	14.03
Coefficient curve	
Forward	1
Forward	2

Source: Own Elaboration

The Instituto Tecnológico Superior de Huatusco is located at Avenida 25 poniente No. 100 Colonia Reserva Territorial, Huatusco, Ver. (Google/maps, 2025)

The dimensions of the parking lot are shown in.
Figure 1.

Box 2

Figura 1
West Zone Dimension
Source: Own Elaboration

The utilization factor yielded

Box 3

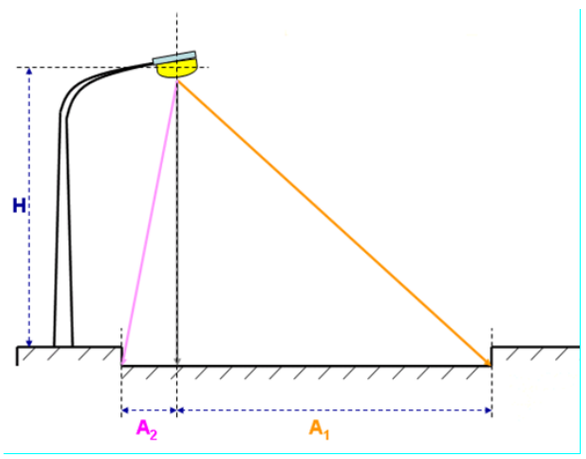

Figura 2
Utilization factor
Source: Own Elaboration

The coefficient curve is shown in Figure 4, which gives us a value of.

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Box 4

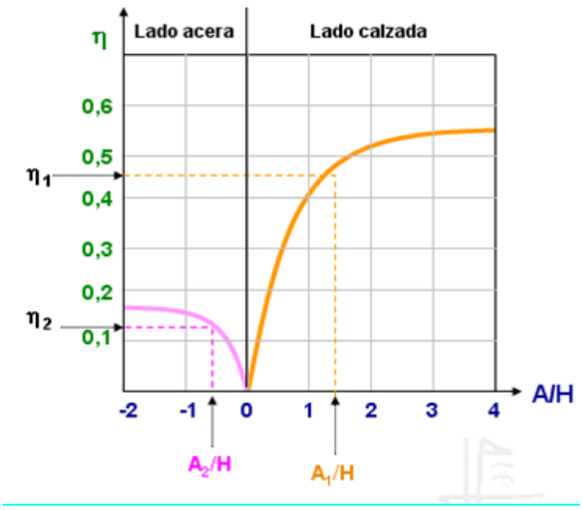

Figura 3
Utilization factor
Source: Own Elaboration

According to the Official Mexican Standard NOM-025-STPS-2008, Lighting conditions in workplaces. In the general outdoor work area: patios and parking lots, the minimum lighting level is 20 lux.

Costs

The proposed system is for an installed capacity of approximately 2 kW.

The price may vary depending on costs, but a proposal has already been prepared.

Box 5

Table 2
System quotation

Quantity	Description	Unit Price	Amount
19	100W solar module	$ 2,070.28	$ 39,335.27
1	Micro inverter with 2 kW power 220 VCA.	$7,270.50	$7,270.50
1	Bus cable end cap for ds3d 10 AWG/12 AWG	$175.86	$175.86
1	Apsystems ecu-r	$4,197.85	$4,197.85
1	Y3 bus cable for DS3D 10 AWG 2.4 m	$805.53	$805.53
8	Anodized aluminum structure cross rail	$1,276.37	$10, 210.98
1	AC combiner box, a micro-inverter arrangement	$2,266. 27	$2,266. 27
1	Engineering services, installation labor	$9,150.00	$9,150.00
		Subtotal	$73,412.
		IVA	$11,745.96
		Total	**$85,158.23**

Source: Own Elaboration

Conclusions

This analysis provides the necessary basis for installing the system. Generally, the monthly savings will be approximately 36 kWh, which, over 30 days, gives us a value of 1080 kWh. At $2.35 per kWh, this results in savings of approximately $2,538 per month, totaling $30,456 over 12 months. Analyzing the data obtained analytically, it is observed that the amount of kWh generated by the panels is specifically sufficient to properly supply the area; the in-depth analysis of the costs will be carried out in the next investigation.

Conflict of interest

The authors of this article decelerate that they have no conflicts of interest. They have no competing financial interests or known personal relationship that could have influenced the work presented in this article.

Author contribution

Ramos-Fuentes, Francisco Javier: conducted the analysis and feasibility study of the system interconnected to the electrical grid of the institute's parking lot

Molina-García, Moises: performed the calculation and sizing of the photovoltaic system, reviewed the data, and analyzed and studied the documented research for publication.

Melchor-Hernández, César Leonardo and Diaz-Cogco Jonathan: performed the general review and correction of the article.

Availability of data and materials

Mexican standards were used to calculated solar powered and evaluate photovoltaic module.

Financing

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Abbreviations

LED Light Emitting Diode

DC Direct current

AC Alternate current

CFE Federal Electricity Commission

ITSH Huatusco Higher Technological Institute

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Antecedents

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Supports

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Differences

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