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The Sun, Energetic option for Universidad Tecnológica de Salamanca

El Sol, una opción de Energía para la Universidad Tecnológica de Salamanca

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Abstract

For the Universidad Tecnológica de Salamanca it has been necessary and very important its building become sustainable, therefore, the sun is an energy option to achieve it, this study shows the use of clean energy to produce electrical energy, the objective is to use the photovoltaic effect using technology and regional suppliers, so that when it is a sunny day, electricity is generated and when this resource is not available, the service of the electricity company, CFE in Mexico provides it. It begins by locating within the globe the point where the SFVI (interconnected photovoltaic system) will be installed, in this case latitude 20.577136 and longitude -101.232293, there are two requirements prior to meeting, which has to do with the selection of the location, the first It refers to technical aspects, such as solar resources, type of terrain and the shadows that could be generated in the place, according to the fulfillment of legal requirements and necessary permits for the selected place. The criteria used in the Interconnected photovoltaic system are shown, to achieve sustainability for Universidad Tecnológica de Salamanca.

Systems, Photovoltaics, Energy

Resumen

Para la Universidad Tecnológica de Salamanca ha sido necesario y muy importante hacer que su edificio sea sustentable, por lo tanto, el sol es una opción de energía para lograrlo, en este estudio se muestra el uso de las energías limpias para generar electricidad, el objetivo es utilizar el efecto fotovoltaico utilizando la tecnología y proveedores regionales, para que cuando sea un día soleado se genere energía eléctrica y cuando no esté disponible este recurso, se continúe con el servicio de la compañía eléctrica, que en México es CFE. Se empieza por ubicar dentro del globo terráqueo el punto donde será instalado el SFVI (sistema fotovoltaico interconectado) en este caso latitud 20.577136 y longitud -101.232293 (Google maps), existen dos requerimientos previos a cumplir, que tiene que ver con la selección de la ubicación, el primero se refiere a aspectos técnicos, como son recurso solar, tipo de terreno y las sombras que se pudieran generar en el lugar, segundo el cumplimiento de requerimientos legales y permisos necesarios para el lugar seleccionado. Se muestran los criterios utilizados en el sistema fotovoltaico Interconectado, para lograr la sustentabilidad en la universidad tecnológica de Salamanca.

Sistemas, Fotovoltaicos, Energía

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Introduction

In Mexico, we are at a point in history where we must take one of two paths, regarding the use of energy to support the development of the nation, each with its own characteristics, which will define the way forward:

1. Fossil fuels, as power generators (currently in use).

Their contribution was very important during the industrial revolution and to support the development of the country, however, to generate electricity, it is necessary to burn them, that is, to use them as fuel, but they will inevitably produce polluting gases, which are poisonous if they are breathed and are factors also of climate change that the world today is suffering. A very important factor is that their end is near, that is, they have a limit, and the planet has also been damaged, hopefully the damage will be reversible.

2. Natural sources as power generators (awaiting growth).

Accustomed to the use of fossil fuels, it has been complexed to change power generating systems to natural sources, their main operating characteristics are that, in general, they are intermittent, that is, they are not always available. They do not produce gases that damage the environment, natural sources are free, they have no limit, they are inexhaustible.
Paradoxically, the sun is the origin of the two options mentioned, fuels are the result of millions of years of storage of solar energy on earth and it is also the origin of alternative energies (wind, hydro, biomass, etc.).

The average consumption of electricity in the institution is 637.83 KWH per day (19,135 KWH per month), we are classified in GDMTH rate (high demand medium hourly voltaje) (CFE, 2021). It is therefore a three-phase system at 220V and 60 Hz.

It is proposed that the PV modules be placed in an armed structure as a roof to shade the cars in an institution parking lot.

Taking the sun as a source of clean energy to provide electricity to the university, the use of photovoltaic modules is required, the selected modules have the following features:

385 Wp module, model ET - M672385WW

Maximum Power (Pmax)	385 W
Power Tolerance	0 to + 5 W
Rated Voltage (Vmpp)	40.8 V
Rated Current (Impp)	9.44 A
Open Circuit Voltaje (Voc)	49.1 V
Short Circuit Current (Isc)	9.92 A
Fire Rating	Class C
Structural Load	5400 Pa
Máximum Series Fuse	20 A
Maximum System Voltaje	DC 1000 V
Maximum Field Wring (Copper Only)	4 mm^2

Tabla 1 Datos de placa del módulo FV
Fuente: ACROSSOL ET SOLAR 2021

The most economical and reliable system in Mexico is the one interconnected to the network, for domestic rates from the DAC rate and for commerce or industry, a cost-benefit study must be carried out to make such a decision.

There are three main components of an SFVI, which are as follows:

- Solar panels (convert solar radiation into electricity)
- Power inverter (converts current from DC to AC)
- Bidirectional meter (measures how much electricity is consumed from the electrical network and “discounts” the electricity that is delivered to the network).

Below is a diagram of how an SFVI is constituted (ENERCEN, 2013):

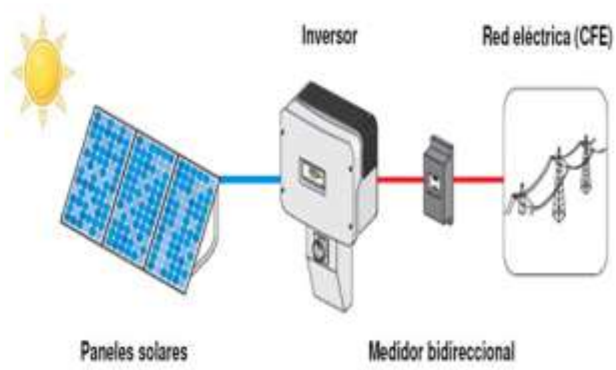

Figura 1 Diagrama de un SFVI
Fuente. ENERCEN

Hypothesis

The sun is an option, an energy source to supply energy consumption at the Technological University of Salamanca, the average daily consumption of electrical energy can be taken from the sun's energy through a SFV interconnected to the national electricity grid, that generates environmental and economic benefits.

Methodology

We will use a very simple method to calculate the number of 385 Wp modules.

The goal is 717.8 KWH per day. What is the average consumption of the institution?

The 385Wp module will generate per day: 385W per HSP (peak solar hour).

The HSP for latitude of 20.577136 ° and longitude of -101.232293 °, is 6.12 hours according to the NASA page where the data was obtained (https://power.larc.nasa.gov/data-access-viewer/).

So, what a module will generate is the following:

	Kw	Hsp	Energy / Dia
Module	0.385	6.12	2.12058
Goal			637.83

Table 2 KWH production, of a PV module
Source: Own Elaboration 2021

Clean energy systems are forecasts, which are based on weather conditions and weather forecasts.

That is, because the PV modules generate electrical energy only when there is sun, our forecast according to NASA statistics for the specific place is 6.12 hours per day.

Calculation of the number of PV modules.

To calculate the number of modules, the goal is simply divided by the daily production of each module, in this case: 637.83 / 2.12058 = 300.78, in this case we choose the even number 300 modules.

Shadow Analysis

The study of shadows is an activity of vital importance when you have the location and inclination of the photovoltaic arrangement, in our case the orientation of the modules is towards the south and the inclination is determined by the latitude of the place for the spring equinox and they must add 15 ° or subtract according to the solstices, summer and winter.

That is, the inclination for the FVI system to be more efficient is the following according to the table:

Position of the sun	MFV inclination
Spring Equinox	Equal to latitude 20.5°
Summer solstice	Latitude – 15° = 5.5°
Winter solstice	Latitude + 15° = 35.5°

Table 3 Angle of inclination
Source: Own Elaboration 2021

To develop the shadow study, we took an online simulator called 3D Sun Path that has the following link as a link: http://andrewmarsh.com/apps/staging/sunpath3d.html, as shown in the following figure, using the simulator online, for the latitude of 20.577136 ° and the longitude of -101.232293 ° we have:

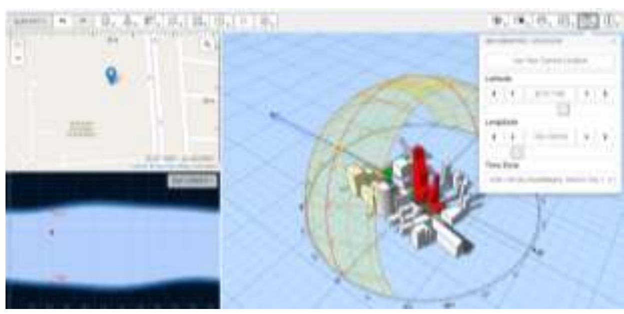

Figure 2 Project location
Source. Own Elaboration

This simulator can be linked with SketchUp to perform the shadow analysis, that is, the prototype is made in SketchUp and exported to this simulator to take the important shadow points, for the northern hemisphere, it is the position of the sun and the shadow projected on the summer solstice and winter solstice.

It is also possible to modify the azimuth to show the exact location and position of the photovoltaic system, which in this case was for a roof of the parking lot of the Technological University of Salamanca.

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The critical point of long shadow at winter solstice is shown in the following figure:

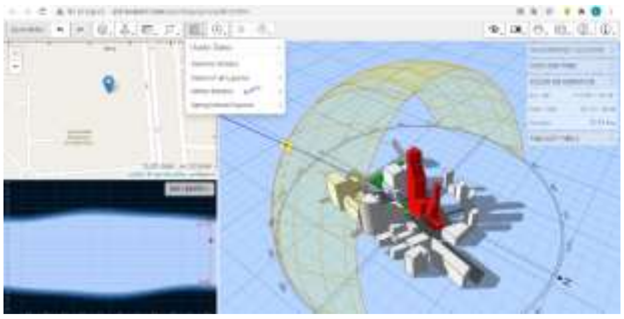

Figure 3 Winter solstice, long shadows
Source. Own Elaboration

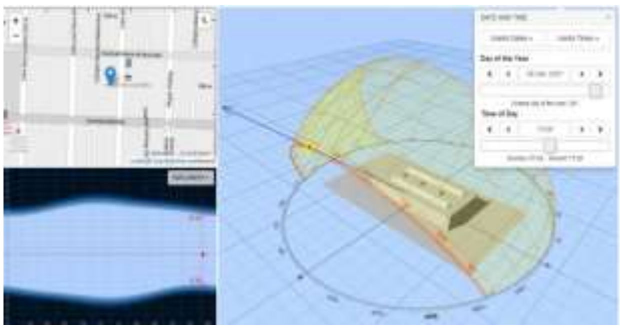

Figure 4 Winter solstice, long shadows, exported from sketchup
Source. Own Elaboration

Inverter Types

String inverters will be used, interactive with the electrical network, with MPPT maximum power point tracker, to make the system more efficient, which will have the function of synchronizing the DC wave converted to AC to the electrical network, as well as defining the where the energy demand of the University is fed, if it is from the network or the SFVI and follow the point of maximum power that the interconnected PV system can deliver.

Calculation of inverters number

According to the area available for parking, the dimensions and the geometric arrangement of the modules, it was decided to use 5 string inverters.

Arrangement of inverters and PV modules

When distributing 300 modules in 5 inverters, 60 modules must be connected to each inverter, so the power of each inverter will be: 60 by 385 W or 23.1 KW.

With this inverter power, a FRONIUS Symo 20.0 - 3 480 inverter has been selected, with the following nameplate data according to the following table:

Input Data CD	**SYMO 20.0-3 480**
Recommended PV Power (kWp)	16.0 - 26.0
Maximum rated input current (MPP1/MPP2)	33.0 A / 25.0 A
Maximum current (MPPT 1 + MPPT 2)	51 A
Maximum allowable short-circuit inrush current (MPPT 1/MPPT 2)	49.5 A / 37.5 A
Rated input voltage	685 V
Operating voltage range	200-1000 V
Start-up voltage	Start-up voltage
MPP voltage range	450-800 V
Maximum input voltage	1000 V
Maximum permissible DC conductor	6 AWG copper, 6 AWG aluminum
Fuse holders integrated in CD	6- y 6+
Maximum short-circuit input current per terminal	15A

Table 4 PV module nameplate data
Source: Fronius Manual 2018

Number of PV modules in series

For the number of modules in series, what is in control is the voltage, according to the table between 450 and 800V. this is between 450V / 40.8V = 11 and 800V / 40.8V = 19 adjusts to the integer.

As they are not multiples of 60, there are two options 12 modules and 15 modules, which comply with the provisions of the inverter and module plate data.

Number of PV modules in parallel

For the number of modules in parallel, what commands is the current, according to the table for MPP1 33 / 9.44 = 3 the integer is taken.

MPP2 25 / 9.44 = 2 the integer is taken.

Therefore, you have two options:

1. MPP1 with 12 modules in series and three chains in parallel. MPP2 with 12 modules in series and two chains in parallel.
2. MPP1 with 15 modules in series and two chains in parallel. MPP2 with 15 modules in series and two chains in parallel.

The two arrangements work well, but for reasons of space in the structure, option 2 was chosen).

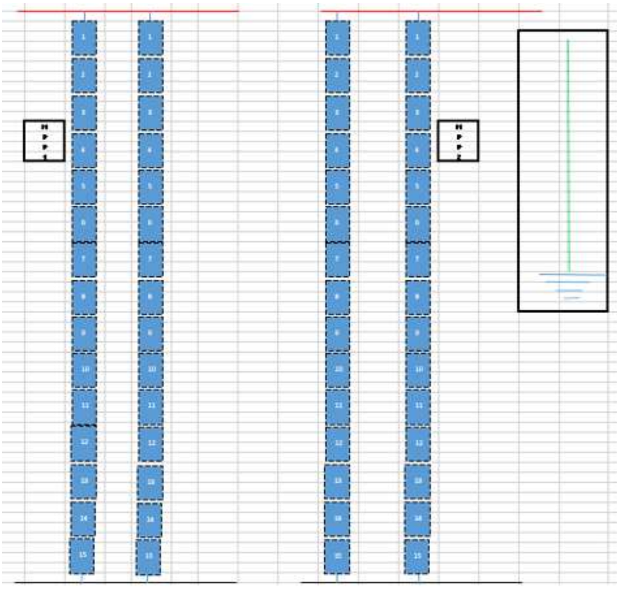

Figure 5 Final arrangement by inverter
Source. Own Elaboration

Basic security conditions.

– The photovoltaic installation must be considered as part of a component of the electrical network.

– The inverter must meet the required specifications of the electrical grid.

– The safety of the operators must always be taken into account (there may be unknown active parts).

– Photovoltaic installations must not deliver energy to an unprotected power line.

– The inverter must be disconnected automatically as soon as a fault appears.

– There should be an easy disconnect point (front switch) that is accessible to the employees of the electric company at any time.

– The inverters must operate with a power factor equal to one.

– Electrical isolation must be carried out between the photovoltaic installation and the grid.

– If the inverter output signal exceeds the predefined conditions for operation (over / under voltage, over / under frequency) the inverter should automatically disconnect from the grid.

– The new connection will be made possible after a certain time (3 minutes normally), time that the network control and protection system wait to try a new connection. (SolarPlak, 2010)

Results

Using solar energy, you have the following:

In summary, the SFVI that provides electrical energy, taking the sun as a source, to supply the institution with 637.83 KWH of average daily consumption consists of 300 modules of 385 Wp, 5 inverters of 16 to 26 KW, with a 2x15 arrangement for the MPP1 and 2x15 for MPP2, for each inverter to follow the maximum power point.

The photovoltaic modules are oriented towards the south with an inclination of 20.5 °.

The photovoltaic array was built as a roof to provide shade for the cars in the Salamanca Technological University parking lot.

The installed capacity of the SFVI is 115.5 KW. The following figures show evidences of the system working.

Figure 6 SFVI installed
Source. Own Elaboration

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Figure 7 Final arrangement 1
Source. Own Elaboration

Figure 8 Final arrangement 3
Source. Own Elaboration

Figure 9 Inverter injecting power from PV modules 11:00 a.m
Source. Own Elaboration

Acknowledgment

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Conclusions

1. The sun is a source of clean energy, currently from this year the SFVI began to be used, which converts solar energy into electrical energy.

2. The criteria for designing an SFVI that use sunlight are actually simple and have to do with the coupling of the technical characteristics of both the PV modules and the string inverter.

3. Fossil fuels expire and will soon cease to be used; we must promote the use of clean energy.

4. Leaving a clean planet for future generations is also part of this project.

5. The energy provided by the sun is free, it is very expensive not to use it, in addition to the benefit of zero emissions, which we are waiting to use.

6. Last but not least, given the uncertainty of a guideline that encourages the use of clean energies, this project has wanted to demonstrate that there are actually economic and ecological benefits with the use of clean energies over energies. fossils.

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