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Diagnosis and proposed energy saving and efficient use of energy in a University Center

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Abstract:
The diagnosis of electrical energy consumption was made in a University Center of the University of Guadalajara network located in the northern part of the state of Jalisco, in this study the general profile of energy consumption was analyzed [1], it was performed a visual inspection of the facilities recording the energy consumption of the equipment, detailed review of the history of the electricity bill, the identification of the areas of opportunity for saving and efficient use of electric energy and the presentation of energy saving proposals .
When applying this methodology of energy diagnosis, it has been found that the areas of opportunity for saving and efficient use of electric energy are lighting and air conditioning systems.
Regarding lighting systems, the replacement of current lighting equipment with better efficiency equipment has been recommended considering the necessary lighting conditions for each work area (NOM-025-STPS-2008) [2]; It is estimated that with the replacement of obsolete luminaires, a decrease in energy consumption in lighting of up to 40% will be achieved. In addition, the installation of autonomous solar luminaires has been recommended in public lighting and common areas.
In air conditioning systems it has been recommended to update maintenance activities within the preventive maintenance plan to increase the efficiency of the equipment.
In addition, it is necessary to recommend measures that do not require investment such as an awareness campaign to prevent computer equipment and areas with lighting being turned on at the end of activities and avoid bad practices for the use of air conditioning. Also, being located in a region with a global solar irradiation of 6.2 kW / m2, the installation of photovoltaic systems has been recommended, taking advantage of renewable energy and reducing greenhouse gases.

Key Word*:Energydiagnosis, energysaving, electric bill, photovoltaic system.*

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I. Introduction

Electricity in all its manifestations, in recent years has played a very important role in the development of humanity since it is present in all the activities that are carried out and largely determine the quality of life of people, it is This is why various institutions around the world have focused on optimizing the generation and use of this resource. Renewable energies such as wind, maritime, solar and biomass energy are proof of the advances that have been made in this field as they reduce the environmental impact of conventional forms of energy generation. Strategies have also been created for the efficient use of the energy already produced, that is, the rationalization of energy consumption by implementing strategies for efficient use of energy without affecting the safety, comfort and productivity of users, these strategies are It is very important for the institutions since saving electricity is technically feasible, economically profitable and socially beneficial [3].

The interest of the University Center of the North (CUNorte) of the network of the University of Guadalajara to carry out a work plan and collaborate in the efficient use and use of electric energy for this purpose, some measures will be carried out to rationalize energy and consequently there will be a decrease in consumption and demand, thus obtaining a lower cost in the payment of electric billing. For this it is necessary to prepare an energy diagnosis of the facilities of the University Center since it helps to determine exactly the energy balance of the main consumers, that is, it helps to identify the areas of opportunity for saving and efficient use in the consumption of the electric energy.

The energy diagnosis to be prepared will be a level I diagnosis, which consists of performing a visual inspection of the facilities by reviewing and recording the energy consumption of the energy consuming equipment, the current energy situation, detailed review of the history of the electricity bill, the identification of the areas of opportunity for saving and efficient use in the consumption of electric energy and the presentation of energy saving proposals that can be achieved by modification in operating habits, waste correction or by the incorporation of technologies efficient [4].

II. Methodology

The energy diagnosis was made in CUNorte of the University of Guadalajara, which is located in the northern area of Jalisco in the municipality of Colotlán. This University has different buildings dedicated to academic, administrative, sports, cultural and recreational activities, Figure 1 shows the distribution of the different buildings that make up the University Center.

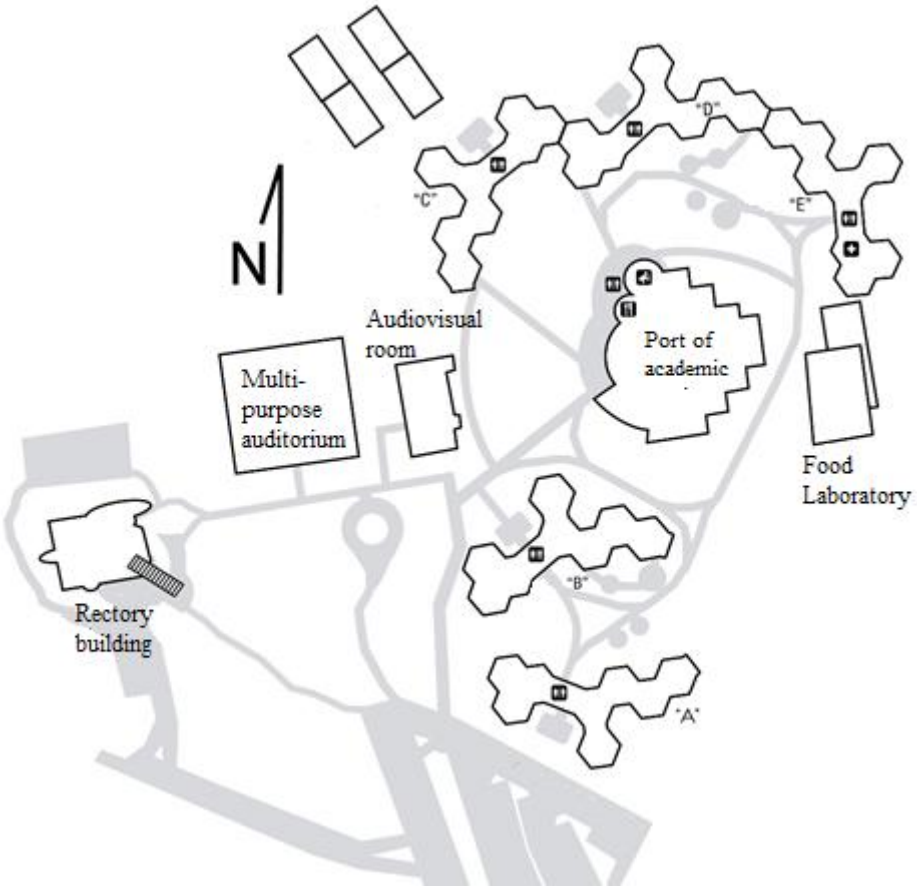


Figure 1. CUNorte sketch
Source: Own creation

The distribution of the buildings according to the activities that are developed there and that are important for the realization of this work is:

Teaching activities:
• Building A
• Building B
• Building C
• Building D
• Building E

Research and development activities:
• Building 6 (Food Laboratory)
• Building 7 (Port of academic services)

Administrative activities:
• Building 8 (Rectory building)

Cultural, sports and leisure activities:
• Multi-purpose auditorium
•Audiovisual room

Each building has different electrical energy consuming equipment, such as: air conditioning systems, lighting system, pumps and compressors, computer and projection equipment, among others (refrigeration equipment, photocopying, screens).
The University Center has a High Demand rate in Medium Hour Voltage (GDMT) in the new tariff scheme where the cost of the energy consumed depends on the time during the course of the day [5].

Information Collection

In the collection of the information, a visual inspection of the facilities is carried out, reviewing and recording the energy consumption of the energy consuming equipment, in each of the buildings located in the University Center.
Table 1 shows the annual consumption of air conditioning systems per building as well as the cost of energy. In these buildings academic and administrative activities are developed, so that thermal comfort for a better working comfort must be maintained between 17 and 27 ° C [6], for this reason and taking into account the climatic conditions of this region all spaces The Center's enclosures have an air conditioning system that is in constant operation, which implies that there was a high energy consumption. It can be found that in the port of academic services (building 7) there is the highest energy consumption this is due to the fact that there are the largest number of academic staff offices as well as the University Center library.

Table 1. Air conditioningconsumption.

Building	Consumption Kwh/Year	Cost $
A	25,607.13	37,802.57
B	25,607.13	37,807.57
C	1,495.23	2,207.33
D	34,171.46	50,445.68
E	24,111.90	35,595.24
7	90,052.13	132,939.63
8	22,024.96	32,514.39

Source: Created from registered data

The University Center for the type of activity that takes place in each of the spaces is necessary to have adequate lighting levels to ensure the best conditions for students and staff. There is an exterior lighting system that works around 8:30 pm to 8:00 am, approximately 12 hours during the 365 days of the year and the interior lighting works in the university's work calendar that is 7 am at 9 pm for 317 days of the year. These conditions imply a high energy consumption presented in table 2, for the period observed.

Table 2. Lightingconsumption.

Building	Consumption Kwh/Year	Cost $
A	24,798.21	36,608.40
B	24,654.54	36,396.31
C	24,798.21	36,608.40
D	24,798.21	36,608.40
E	25,853.61	38,166.44
6	2,248.70	3,319.65
7	83,404.42	123,125.93
8	7,932.88	11,710.93
9	8,784.00	12,967.40

Source: Created from registered data

We can see from table 2, that in the teaching areas (building A, B, C, D and E) the consumption is practically the same, since these buildings are classrooms and have a schedule of activities from Monday to Friday of 07:00 to 21:00 hours. But we can note that building 7 (service port) is the one with the highest energy consumption due to lighting, reaching 36% of the total consumption, this is because in this area the library is located and it provides continuous service 14 hours and they are mostly reading areas so lighting conditions are high (400 lux) [7].

Table 3 shows the energy consumption of the pumping systems both for irrigation of the green areas and for the services of the Center. There is also the energy consumption for water extraction. It has pumping equipment for the irrigation of green areas that are approximately 8 hectares so there are 8 pumps of different capacity which have a consumption of 32,348.05 kWh / Year.

Table 3. Consumption of pumps.

	Consumption Kwh/Year	Cost $
Outside area	32,348.00	47,753.87

Source: Created from recorded data.

Table 4 shows the consumption of different equipment located in office work areas, common areas, photocopying and printing areas and computer centers. It can be seen that in building 7 there is a higher consumption and it is because in the library there are two computer centers for students to consult and send their activities.

Also in building 8 the energy consumption is high, it can be explained because here the greatest amount of administrative activities and attention to students in terms of academic services are developed.

Table 4. Consumption in severalbuildings

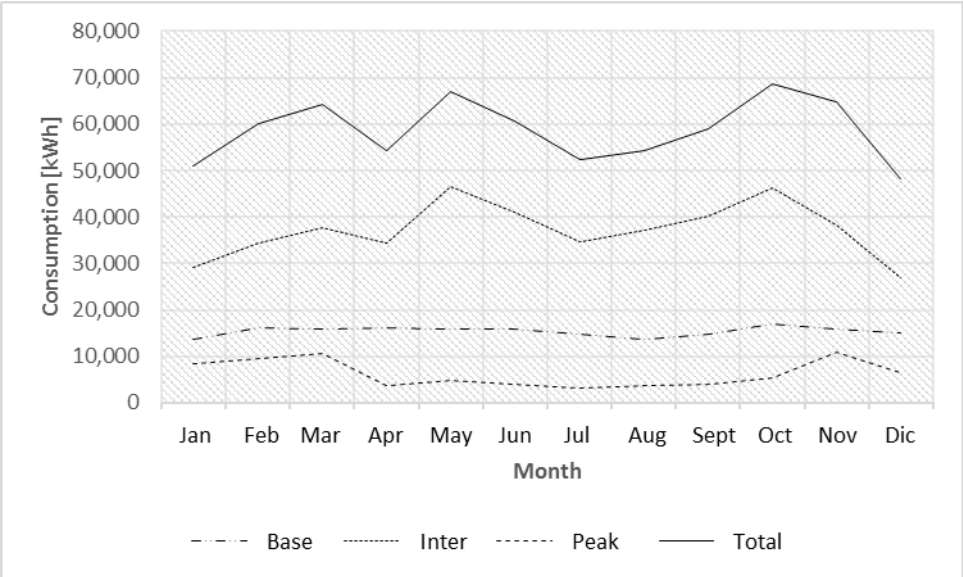
Building	Consumption Kwh/Year	Cost $
A	5,722.21	8,447.42
B	4,141.67	6,114.15
C	7,463.39	11,017.85
D	6,554.93	9,676.73
E	12,797.86	18,892.87
6	7,875.73	11,626.56
7	44,624.15	65,876.49
8	31,436.66	46,408.43

Source: Created from recorded data.

Electric billing analysis

Graph 1 shows the historical consumption of the last year of electricity consumption of the University Center. It is found that there is an annual consumption of 704,530 kWh, having a uniform consumption behavior in each month with an annual monthly average of 58,710 kWh. It can also be noted that the highest energy consumption is during the interim schedule, this is because academic activities take place during this schedule.

It can also be seen in graph 1 that the periods where there are breaks in academic activities if energy consumption is reduced, having a higher energy consumption in the month of May, where the use of more hours begins to be used cooling systems.



Graph 1. Total energy consumption per month during the last year
Source: Creation from historical invoice data

Measures to implement

To reduce energy consumption, the information collected is analyzed, finding that the highest energy consumption is located in the lighting and air conditioning systems. For this reason recommendations are made to reduce consumption.

The main recommendation that is made for air conditioning systems is the replacement of obsolete units with units of better efficiency in their operation, in addition to making the appropriate dimensioning for the space, since those found are of a capacity greater than the required. Table 5 shows the estimated savings with the replacement of conditioning units, only the change of air conditioning is carried out in the teaching buildings A, B, D, E, Port of Services and administrative building.
It is estimated that a saving of 81,936 kWh per year will be achieved, obtaining 11.6% of the Center's annual consumption.

Table 5. Saving estimate of the proposal for air conditioning

Building	Consumption Kwh/Year	Proposal Consumption (Kwh/Año)	Proposal Savings (Kwh/Año)	Proposal Savings $
A	25,607.13	15,497.54	10,109.59	14,924.30
B	25,607.13	15,497.54	10,109.59	14,924.30
D	34,171.46	24,061.87	10,109.59	14,924.30
E	24,111.90	14,002.31	10,109.59	14,924.30
7	90,052.13	59,723.37	30,328.76	44,772.89
8	22,024.96	10,723.37	11,169.00	16,488.26

Source: Created from recorded data.

To reduce the energy consumption without changing the lighting conditions of the work areas, it was found that the existing luminaires are: T12, T8 and spiral fluorescent. For these luminaires, it is recommended to replace them with T8 LED Tube and LED 19 for spiral fluorescents. Table 6 shows the estimate of energy savings when replacing this type of luminaires.

It is intended to achieve a saving of 83,207.51 kWh per year achieving an 11.8% savings in lighting consumption. It should be noted that in the first stage the replacement is carried out in the teaching buildings (A, B, C, D and E) and in the service port building.

Table 6. Savings estimate of the lighting proposal

Buiding	Consumption Kwh/Year	ProposalConsumption (Kwh/Year)	Proposal Savings (Kwh/Year)	Proposal Savings $
A	24,798.21	9,307.14	15,491.07	22,868.73
B	24,654.54	9,244.67	15,409.87	22,748.85
C	24,798.21	9,307.14	15,491.07	22,868.73
D	24,798.21	9,307.14	15,491.07	22,868.73
E	25,853.61	9,690.11	16,163.49	23,861.39
7	83,404.42	36,351.31	47,053.11	69,462.24

Source: Created from recorded data.

The University Center because of its location has a solar resource of 6.2 kW / m^2 which makes it with a high solar potential as shown in Solargis [8], also within the University of Guadalajara there is the University Program for Energy Transition that promotes the generation of photovoltaic energy in buildings of the University Centers [9]. Currently, a generation silver is being built in the CUNorte with a capacity of 150 kW, which will generate approximately 305,505 kWh annually that will impact the Center's energy consumption by 27%.

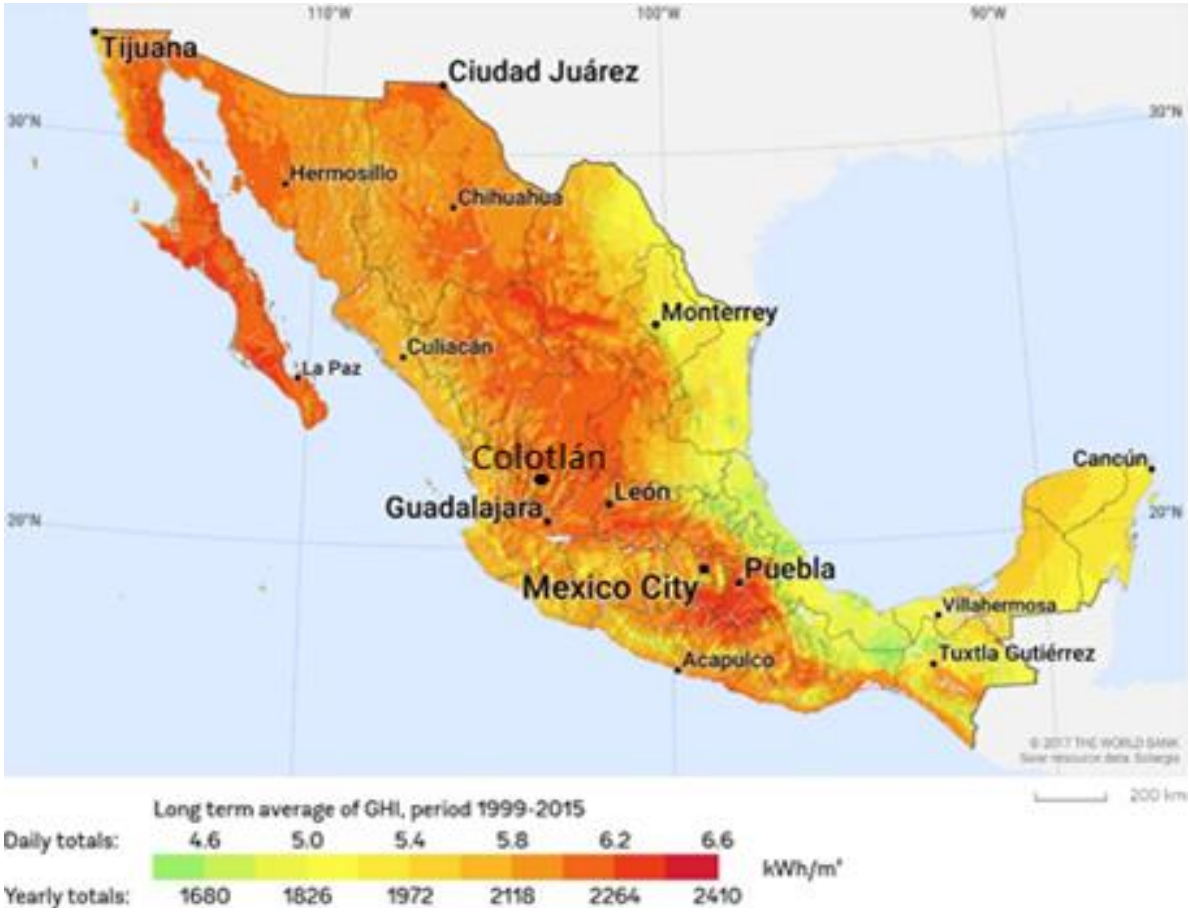


Figure 2. Global solar irradiation in Mexico
Source: Taken from Solargis [8]

III. Result

The results show that it is possible to reduce the energy consumption of the electricity grid by 66%, this percentage of reduction being very significant. In addition to reducing the cost of the electricity bill, there will also be a benefit in the emission of greenhouse gases into the atmosphere.

In addition to the benefit in reducing the energy of the electricity grid, also as an educational institution will have a positive impact on the promotion of technology that promotes the saving and efficient use of electric energy, since the use of LED technology will be promoted to lighting and also the generation of electrical energy from solar energy.

IV. Conclusion

In the elaboration of the energy analysis in the institution it is showing important results that will help reduce the consumption of electric power of the network despite being a type 1 diagnosis, the proposals made imply a change of technology of air conditioning units obsolete and in regards to lighting the change of fluorescent luminaires by LED is suggested.

In addition to the proposals it is found that it is important to carry out energy diagnostics to detect areas of opportunity to improve the efficiency in the consumption of electric energy.

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