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Implementation of solar panels and photovoltaic systems as an alternative for efficient energy saving at Universidad Nacional Abierta y a Distancia-UNAD

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Abstract. The Universidad Nacional Abierta y a Distancia- UNAD, is a public, educational organization of the National Order that through the conception and practice of Distance Education was not affected in the development of activities in the time of pandemic, according to its solid technological infrastructure to promote the virtuality.

One of the principal changes implied by the preventive isolation because of COVID-19 was to reassess the context of the management system and the expectations and demands of the stakeholders, generating new opportunities and risks as a result of the sanitary situation. This situation, strengthening the commitment of the Environmental Management System with climate change based on the sustainable development objectives and the 2019-2023 internal development plan, which refers within its main goals, to the installation of 8 solar tables and 2 photovoltaic systems for outdoor lighting in different locations, in addition to operational control activities that contribute to mitigating the impacts of the activities associated with the work at home and on-site modality, giving environmental legal compliance and expanding the scope to ISO 14001:2015 certification in new centers, thus promoting new challenges that have allowed the positioning in good environmental practices of the University at the national level.

Keyword:

Sustainable Development Goals, Energy, photovoltaic lighting systems, carbon footprint

1. Introduction

The Universidad Nacional Abierta y a Distancia, (UNAD) is an educational project that was created by Law 52 of 1981 as a national public institution attached to the Ministry of National Education and transformed by the Congress of the Republic through Law 396 of August 5, 1997, into the Universidad Nacional Abierta y a Distancia UNAD. It was created with the purpose of designing and implementing academic programs with the pedagogical strategy of distance education, in accordance with local, regional, national and international needs and in line with the challenges and demands of Colombian society. Since its inception in April 1982, the University has been characterized by its commitment to communities and populations that have not had access to technical, socio-humanistic and community training. Also, for its contribution to the recovery of social fabric, the generation of workspaces and training for citizen participation.

It is for this reason that UNAD's mission is to contribute to education for all through open, distance and virtual learning environments, through pedagogical action, social projection, regional development and community action, inclusion, solidarity, research, internationalization and innovation in all its expressions, with the intensive use of technologies, to promote and accompany autonomous, meaningful and collaborative learning, generating culture and entrepreneurial spirit that in the framework of the global society and knowledge promotes sustainable economic, social and human development of local, regional and global communities with quality, efficiency and social equity [1].

In order to achieve these organizational objectives and to guarantee the fulfillment of its mission, UNAD has defined the Integrated Management System - IMS as the organizational management tool that from the continuous evaluation of its structure seeks the continuous evolution of the systems that constitute it, in order to meet the needs of stakeholders, not only students, graduates and applicants, but all those organizations that are benefited and impacted by the services and educational products they generate, as well as their social action with the communities. One of these systems seeks to address the impact generated by academic and administrative activities in compliance with organizational management, serves as an organizational tool for the review, control and mitigation of environmental aspects evaluated in terms of life cycle in the provision of services provided by the entity and, in turn, aims to prevent environmental impacts, identify risks and opportunities, complying with current legislation and providing a solid foundation for sustainable development objectives at all levels.

Being aware of the impact of its management, UNAD has been making a reading of the context, both internally and externally, which allows it to measure the extent to which its activities in compliance with the organizational mission can affect the environment. It is in this assessment of the external context, where a reading of the 17 Sustainable Development Goals is made, which were formulated in the 2030 Agenda on Sustainable Development by the United Nations Organization UN, from the global problems and in which the Environmental Management System welcomes within the formulation of its Environmental Management programs, relevant to 7 of these (Goal 4: Quality education, Goal 6: Clean water and sanitation, Goal 7: Affordable and non-polluting energy, Goal 9: Industry, innovation and infrastructure, Goal 9: Industry, innovation and infrastructure, Goal 10: Environment, innovation and sustainable development, Goal 11: Environment and sustainable development, Goal 11: Environment and sustainable development, Goal 12: Environment and sustainable development, Goal 13: Environment and sustainable

development. Goal 9: Industry, innovation and infrastructure, Goal 11: Sustainable cities and communities, Goal 12: Responsible production and consumption, and Goal 13: Climate action). One of the strategies used to carry out this approach is through the definition of project 31 of the "Development Plan 2019-2023 More UNAD, more country", called "Sustainable Campus" and whose objective is to strengthen the environmental physical infrastructure in the centers that present high environmental risk associated with the university's own practical component and implement innovation systems for the use of energy resources of non-polluting origin for the development of the university's own activities [2].

Based on this general objective and in accordance with the objectives of sustainable development addressed in this, the Environmental Management System of the SIG studied the implementation of a renewable energy solution that would contribute to the commitments and goals of the Program for Saving and Efficient Use of Electrical Energy - PAUEE [3]. This solution consists of the installation of eight solar picnic tables in four University sites, the JCM National Headquarters and three Distance Education Centers located in three important cities of the country, whose purpose will benefit the Human Platform that works in these centers, as well as the students who come to the centers for the development of activities of University Life. This is the piloting of a clean energy solution that seeks to raise awareness of the benefits of this type of technology among the users of the educational services provided by the institution. Similarly, within the implementation of this installation, the installation of two photovoltaic lighting systems powered by the panels of the solar tables is conceived, which allows to reduce costs in the lighting system that is currently arranged in two of the parking lots of these headquarters and thus achieve economic efficiency.

The operation of these systems (picnic tables and photovoltaic luminaire) is based on the use of solar energy, which is stored in batteries by means of an energy controller, to be used to charge electronic elements and illuminate open spaces.

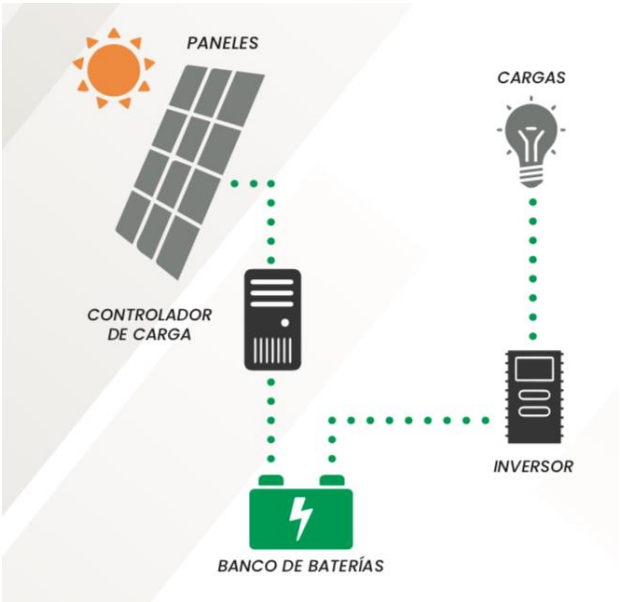

Figure 1. Connection diagram of the solar system with batteries.

The solar picnic table uses the photovoltaic solar energy system in its structure, which provides the energy for electronic devices such as laptops, cell phones or tablets to receive

a continuous charge, using the sun as a renewable source with countless benefits, one of them, as a representative green symbol that reduces the carbon footprint of the University in the city since for every kilowatt hour (kWh) that is generated by photovoltaic solar energy, the emissions of CO2 are reduced by 0.6 kg, which means that for every kilowatt hour (kWh) generated, 0.6 kg of CO2 are prevented from reaching the atmosphere, causing damage to the ozone layer and generating global warming [4].

Figure 2. Example of a solar table for charging portable equipment.

The sizing of the picnic table, according to the specifications of the distributor (FOGO Solar Energy) is based on an array of solar panels totaling 200 peak watts, which produce on average: 200W x 4h = 800Wh per day. This energy is sent to and managed by a MPPT (Maximum Power Point Tracker) charge controller that tracks the solar panels' highest power point. The charge controller reduces the voltage of the panels and increases the current to charge the battery bank. During the presence of solar radiation, this energy produced by the panels is sent to the connected loads or appliances. Surplus energy is sent to the batteries. This energy is sent to a lithium battery that can store up to 1200Wh, and be used up to 900Wh per day. In order for this energy to be used by the electronic devices, it passes through an inverter that converts the DC energy from the batteries and delivers it to AC. This inverter is in turn connected to 4 outlets on each table.

Under the same philosophy of having solar panels isolated from the public power grid, and without wires, solar luminaries are contemplated, which consist of a solar panel that collects the sun's energy and converts it into electricity during the day and stores it in a small internal battery. The solar charge controller and the lithium battery are located inside the lamps. From the batteries the DC power is sent to the LEDs that produce light. These LEDs are arranged in sequence so that in total there are luminaires of different wattages, depending on the number of LEDs connected. These luminaires are completely autonomous and have light sensors to determine when the sun has gone down and turn on their bulbs. This eliminates the need for an operator to activate a switch every day at 6pm to turn on

the lighting. In addition, the luminaire has a built-in motion detector that activates the luminaire at 100% power when a certain number of people pass by. Once 30 seconds have elapsed since the last movement was recorded, the luminous flux is reduced to 30% of its nominal power consumption.

In order to calculate the generation of electric energy from photovoltaic panels, the so-called "peak" hours must be taken into account, which are the hours with the highest irradiation and which normally coincide with midday in Colombia. The Institute of Hydrology, Meteorology and Environmental Studies - IDEAM presents a map available to the public with the average Peak Sun Hours in Colombia. In this way, it is enough to multiply the power of the installation of solar panel systems with the number of Peak Sun Hours, to determine the energy in 1 day.

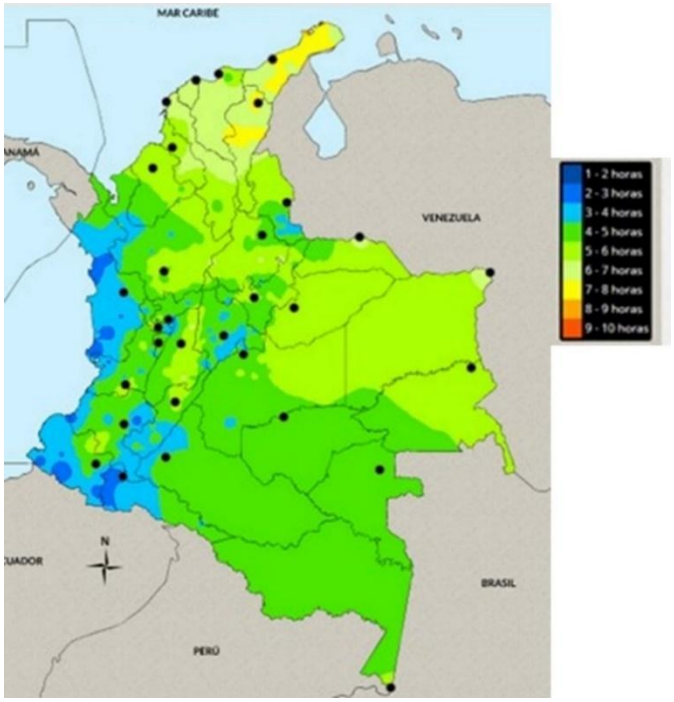

Figure. 3 Brightness Solar Map Republic of Colombia 2014 [5].

In this sense, for the installation of the system of solar panels attached to the picnic tables, with a power of 200Wp each, and that on average will have 4 Peak Sun Hours per day is calculated: 200Wp x 4h = 800Wh per day. This means that after one year, 292KWh/year will be produced. Similarly for the luminaire system, taking into account that each lamp consumes thirty watts (30W) during the 12 hours of absence of sun (6pm to 6am), the energy consumed by each lamp can be calculated: 30W x 12 h = 360Wh day 360Wh day x 365 days = 131.4KWh/year. Taking into consideration that the average cost of electric energy in Colombia is 500 pesos per KWh, it can be calculated that each Picnic Table will save an average of 292KWh * 500COP = 146,000 COP. Likewise, each lamp will save 131.4 KWh per year x 500COP = 65,700 COP.

With these elements we seek to raise awareness of the University's human platform and the users of the services it provides, about the positive impact generated by the use of clean technologies, which allow better management of the resources available to the

organization for the development of its activities, as is the case of photovoltaic solar energy, which is a sustainable and socio economically viable alternative, contributing significantly to the electrical needs of the University, and which becomes a project that gives strength to the environmental culture that has been established by the different actors that make up the Unadista community.

2. Concluding Remarks

UNAD's commitment to photovoltaic solar energy is based purely on the fact of demonstrating from a pedagogical point of view that generating a kW of energy with photovoltaic systems can now be as profitable as generating energy with other conventional means that currently exist and to emphasize that this is not the only thing that makes this technology attractive; but also that for each Kw generated, the emission of large amounts of CO2 into the atmosphere is being avoided, thus reducing the devastating effects of the increase in global warming.

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