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Campus Verde Initiative

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Abstract

The UDENAR Campus Verde Initiative is a project at Universidad de Nariño (Colombia) combining an electric bicycle fleet, a photovoltaic charging system, and a grid injection system of the unused energy for self-consumption. Members of the university use the electric bicycles for daily commuting. The bicycles use a photovoltaic charging system in a solar parking located on campus. The bikes charge while parking, taking advantage of the sunny hours. A grid injection system was implemented to better use the energy not supplied for charging from the photovoltaic solar panel array located on the roof of the bicycle parking space. A 12,5 kWp photovoltaic system and fleet of 60 bicycles are reducing estimated emissions by 6.38 Ton CO₂ and 7.08 Ton CO₂ respectively for each year of use. Energy consumption, distance traveled, usage time, and others are variables are measured to characterize the usage habits of the cyclists.

1. INTRODUCTION

Alternative sources of energy are an important topic in the agenda of most of governments and organizations. In particular, Nariño department (at southwest of the country) has begun to develop some related projects as the "Sustainable Rural Energization Plan for the Department of Nariño 2013-2030" [2]. This plan develops a comprehensive energy and socioeconomic diagnose of the rural sector, establishes focalized energy policy guidelines, and proposes an innovative methodology for the formulation of economic, technic, environmental, and social sustainable projects by using clean energy sources [3]. Another project is the "Analysis of Energy Opportunities through Alternative Sources in Nariño," whose objectives include identifying the feasibility of renewable sources such as biomass, wind, and solar in the region [1]. Using this information, a feasible zone is chosen to design a solution using the local resources use with a design for the energy management through an information structure (i.e., with the smart grid concept). As part of these efforts, we proposed "Campus Verde Initiative", a project that aims to combine an electric bicycle fleet, a photovoltaic charge system in a bicycle parking, and a grid injection system of the remaining energy for self-consumption. The bicycles use a photovoltaic charging system in a parking place located at the main university campus, which works while the students go to class, taking advantage of the sunny hours.

2. SOLAR RESOURCE CARATERIZATION

Previous projects [1] have developed solar, wind, biomass and, hydro maps that allows us to design alternative energy solutions for any place in Department of Nariño. The average solar radiation for the proposed solution at the university campus (San Juan de Pasto) is over 231.5 W/m² and 5.2 sunshine hours per day. This information is available at geolternar.udenar.edu.co.

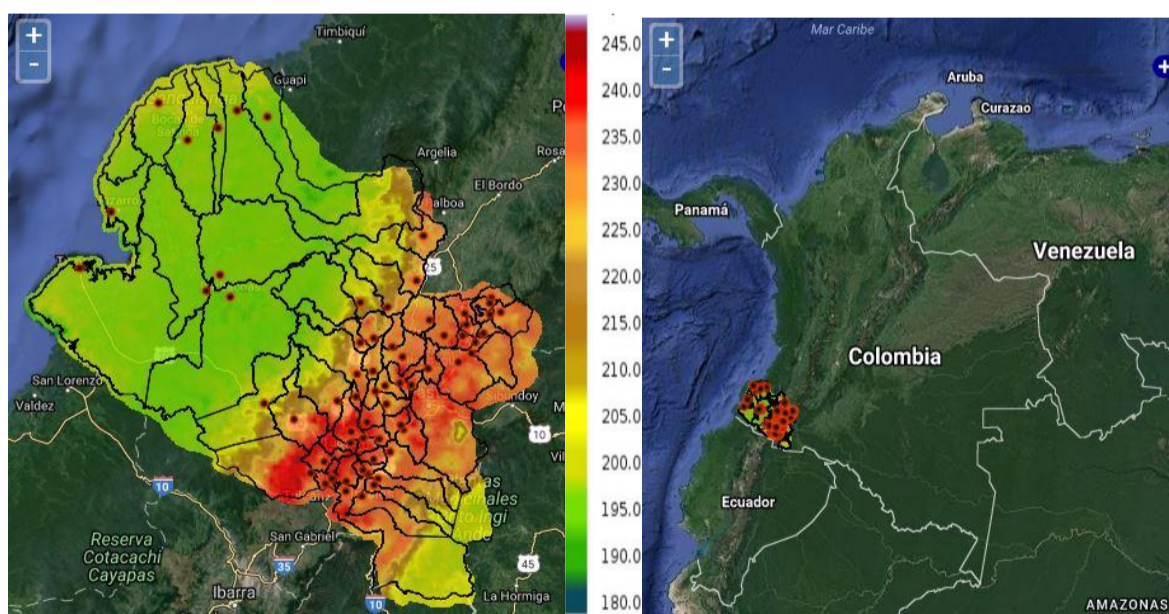


Fig. 1: Figure Solar map in Nariño State, Colombia (W/m²). Available in geolternar.udenar.edu.co

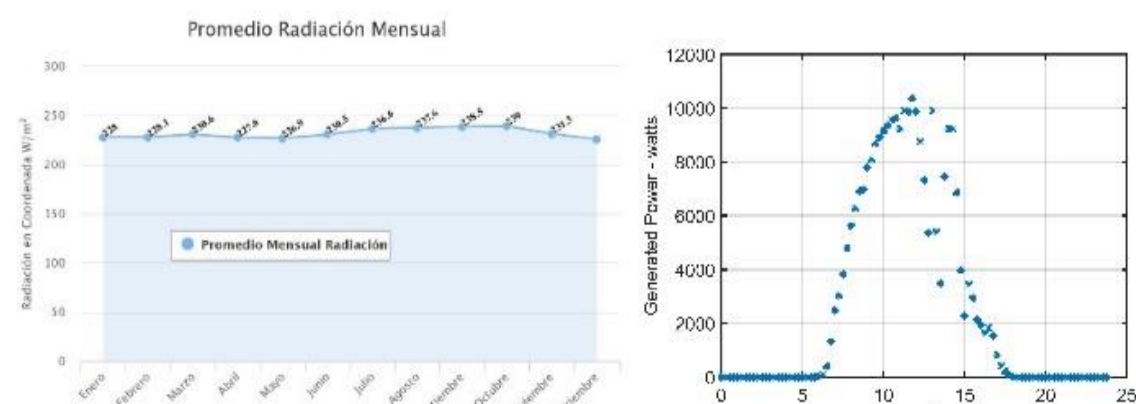


Fig. 2: (left) Annual radiation averages on Campus of Nariño University, (right) Average energy supplied by the PV system in one day.

3. SOME INTERESTING NUMBERS

The estimation for the avoided CO₂ emissions using the fleet of 60 bicycles are:

Estimated fuel consumption avoided - two buses				
Users Bicycles	No. of avoided Bus routes	Gallons of fuel per route (avoided)	Gallons of fuel per day (avoided)	Days of use per year
60	2	1	4	203

Benefits per ton of CO ₂ avoided by lower consumption of fossil fuel				
Gallons of fuel avoided per year	Estimated CO ₂ produced by each Diesel Gallon in Tons	Tons of CO ₂ avoided / Year	Tons of CO ₂ avoided /Month	Estimation (20 years)
812	0,008730265	7,08897518	0,590747932	141,7795036

On the other hand, the generation of clean energy through the photovoltaic system located on the roof of the parking lot of the bicycles and charging stations is:

Benefits by generated energy				
Installed capacity (kW)	Sunshine hours per day	Generated energy per day (kWh)	Days of generation	Generated energy per year (MWh)
12,5	5,2	65	364	23,66

Benefits by generated energy – equivalent CO ₂ Tons				
Marginal Factor of Emissions Tons CO ₂ /MWh	Performance ratio	CO ₂ Tons avoided /Year	Co ₂ Tons avoided /month	Estimation (20 years)
0,388	0,695	6,3801556	0,7566	127,603112



Fig. 3: (left) Bicycle Fleet at Campus of Nariño University, (right) Roofed solar panels on the parking place.

We expect that this experience can be replicated in different villages along the department of Nariño as part of the "Rural Electrification Plan" described in Colombian Peace Agreements.

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5. REFERENCES

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