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HYDROGEN CAPACITY FOR USE IN PUBLIC TRANSPORTATION USING THE EXCESS ELECTRICITY GENERATED BY PHOTOVOLTAICS FROM ROOFTOPS IN THE URBAN AREA OF CUENCA, ECUADOR

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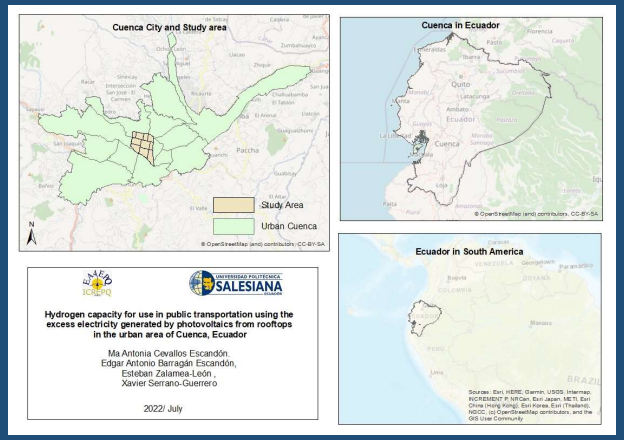
ABSTRACT

The drawback of renewable technologies is the lack of coupling with energy demand, to reduce these drawbacks is by applying hydrogen as an energy vector. Hydrogen obtained from renewable energy sources could be stored and used when required, directly or in fuel cells. This work focuses on determining the hydrogen potential that can be obtained using photovoltaic plants in urban areas. In the city of Cuenca, with the renewal of the public transport vehicle fleet, it was reduced to 475 units, which emit 112 tons of CO_2 and burn 11,175 gallons of diesel per day. The analysis determines the photovoltaic energy that is produced by implementing photovoltaic panels in the Historic Center of Cuenca, Ecuador.

INTRODUCTION

During the last few years, the efficient use of resources as energy has become very important. In the face of increasing pressure on fossil fuels and oil prices, fossil fuels will continue to be the basis of global economic development. Cities must consider new supply options to meet their needs and ensure their resiliency without the resources to maintain and upgrade. This project analyses the impact of replacing conventional public transport with vehicles powered by hydrogen produced by electricity from photovoltaic solar systems placed in urban areas. The case in the historic center of Cuenca (Ecuador) has been analysed. The objective is to determine how much energy can be obtained from photovoltaic solar panels



METHODOLOGY

The study area is delimited with the geographic information obtained from (Urgilés Ortiz & Yánez Iñiguez, 2018).. Then the radiation of usable energy is estimated and with the help of reduction factors that consider, among others, the efficiency, architecture, inclination or orientation, the technical potential is established. Once this potential is defined, the possible production of hydrogen by electrolysis is analyzed. Finally, it is established whether the hydrogen produced would allow the substitution of public transport vehicles.

Photovoltaic solar energy potential.
- Delimit the study area.
- 1.55 km2

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Usable Solar Energy
- Calculation of irradiation. technical potential.
- 1528,51 kWh/m2

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Technical Potential.
- Reduction Factors

Fr= 0,62 nR=0,14

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Hydrogen production
- 3.157.125,08 kg

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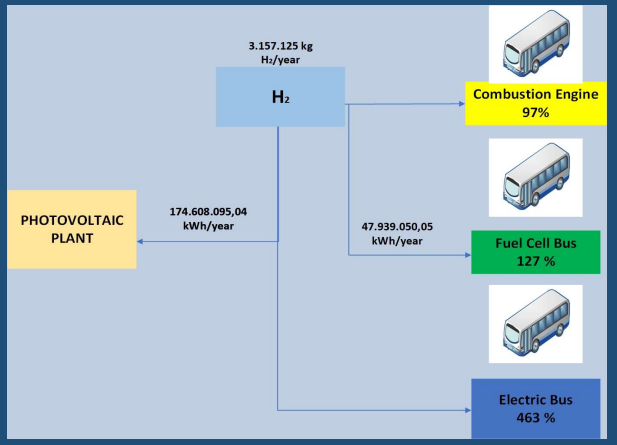
End uses of Hydrogen.
- Substitution percentage

RESULTS

Implementing the photovoltaic system
- 1,69$/W
- Total= 138,926,807.90 W

The production cost of H2
- 1,77 $/kg
- Total= $5,588,111.39.

Replace 100% of the bus fleet (475 units)
- 1,500,000 $/unit
- Total= $712,500,000



IMPLICATIONS

Environmental implications: The environmental analysis focuses on quantifying the CO_2 emissions avoided by changing the technology used for public transportation. To calculate the amount of CO_2 emitted, we have the relationship that 1 litter of diesel generates 2.65 kg of CO_2 (Roncero, 2009), so that for the 5,710,124.82 lt/year, 15,121,830.76 kg is generated of CO_2. To produce 1 kg of hydrogen requires around 10-12 litters of water. If 11 lt/kg of H_2 is taken as a reference value, based on the demand for kg of hydrogen from the bus fleet, 3,261,065 kg/year, 35,871,715 lt/year of water is needed.

Economic implications: For an economic analysis, the total power capability of the system will be considered, accordingly to the energy produced (212,974,794.51 kWh.

Social Implications: Among the advantages of hydrogen vehicles, whether for direct use or through batteries, it can be said that:

- Does not generate contamination.
- Refueling time is short (3 to 5 min).
- Maintenance is minimal and simple.
- Hydrogen vehicles are silent and zero pollution.

Among the disadvantages of hydrogen vehicles, it can be said that:

- The network of hydrogen service stations is insignificant.
- Currently there is not a wide variety of hydrogen vehicle models.
- Fuel cell vehicles, due to their components, such as hydrogen tanks, lead companies to develop only fairly large models.

CONCLUSIONS

Hydrogen is a fuel that can be produced on a scale necessary for use in all modes of transportation. In the future, H2 will allow the full use of solar, wind, and hydropower, enabling the transition to a post-fossil age.

Ecuador is a privileged country in terms of solar energy resources due to its geographical location. In the city of Cuenca, public transport faces great challenges, such as the constant growth of the vehicle fleet, which causes traffic jams and environmental pollution. The transportation system consists of 475 buses that circulate in the city, emitting around 112 tons of CO_2 and burning 11,175 gallons of pollutant diesel per day. Regarding the environment, the use of H_2 is feasible since it does not generate greenhouse gases and does not affect environmental factors (atmosphere, water, soil and biotic component).