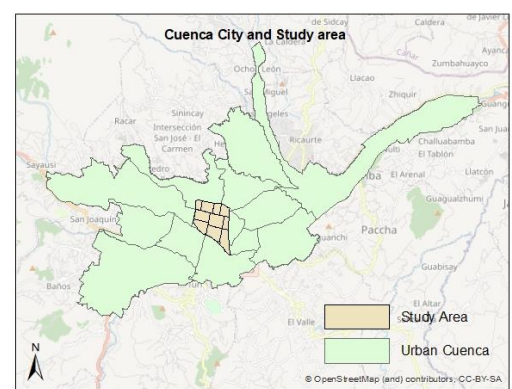




ABSTRACT

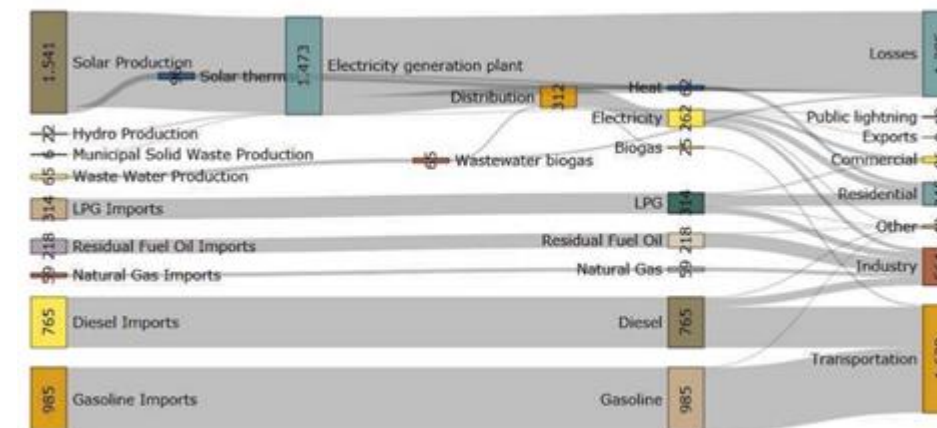
In underdeveloped regions, energy requirements are increasing, and Ecuador has been subsidizing fuels for over 50 years to help low-income families. This study focuses on energy self-supply in Cuenca, Ecuador as alternative energy source. The results show that photovoltaics (PV) in buildings is the best option, with potential to supply the entire power requirements in the city, 22% of industrial high-consumption buildings, and only requiring around 7m² of roof for a single-family home. PV technology could also meet the total power requirement for higher education buildings, but grid limitations pose a challenge.

INTRODUCTION



- Cities are responsible for 80% of global energy requirements and carbon emissions.
- Energy efficiency measures should be applied first to reduce this impact, followed by the integration of renewables in cities and buildings to achieve low energy requirements.
- To accomplish this, it's necessary to determine the energy requirements, special-temporal requirements, resource availability, and the ability to combine resources and demands according to each context.
- Equatorial Andean cities located in valleys with good climate conditions have two-way benefits for energy self-supply: no need air conditioning or heating requirements, and relatively stable solar resource availability due to regular climate conditions.
- An extensive analysis of these climate characteristics and conditions has been performed previously.

Energy sources capability inside city-limits border



Five main technologies were identified for supplying energy requirements, and a proposal for conducting these sources to meet demand was presented in a Sankey diagram.

Solar PV capability for power energy self-supply on Mixed-residential use buildings



Proposed solar PV integration on a six-floor mixed-use building with 654.5 m² of roof space and an annual power requirement of 66.8 MWh could cover 99.7% of the power requirements and up to 27.9% of expected demand with EV chargers and conversion of combustion equipment

RESULTS

Solar PV capability for power energy self-supply on Industrial building



Solar potential on an industrial building in Cuenca was analyzed in 2017. With 48,241.0 m² of PV capture surface, it's possible to supply around 22% of the power requirements, reaching 8560.0 MWh and solving the consumption of at least 17,000 citizens

Solar PV capability for power energy self-supply on Single-family dwelling



A single-family house with 4 inhabitants consuming 160 kWh monthly on average can be powered by a 1.36 kWp PV installation, consisting of four solar panels on its roof facing east with an 18° slope. The first residential installation in the city generated an 1810 kWh production in the first year, resulting in surpluses on net-metering with the utility, and the reduction of the billed energy reached almost to 0 after the installation of bidirectional metering equipment.



A university building complex in the Universidad de Cuenca was analyzed for a PV system design, considering grid limitations and the annual power consumption to be covered of 135 MWh. The originally designed installation was for 86.8 kW, but due to the 75 kVa electric transformer limitation, the final PV installation could reach 78.0 kWp installed with 192 PV panels. The PV system could cover close to 79.8% of the 2019 energy requirement.

CONCLUSION

- PV technology can supply 9% of the total energy requirements in 2016, which is the total electricity consumption of that year, and can be multiplied by three if the fuel consumption in the city would be changed to electricity.
- Different building typologies were analyzed to estimate the amount of power that can be obtained through PV technology, including industrial buildings, mixed-use buildings, single-family homes, and educational buildings.
- Single-family homes have the potential to cover their entire power requirement with a small portion of their roofs, which can support reaching energy surpluses to feed other typologies such as industrial buildings.
- Transforming transport systems from fossil fuels to Evs is necessary to reduce fuel consumption and its economic and environmental impact, with the potential of being fed on buildings .

For more details, please visit:



- **METHODOLOGY** This report estimates the available renewable sources within the city borders of Cuenca, Ecuador.
- Previous research has determined the overall city energy potential and potential on different building typologies, with solar energy and PV technology as the main alternative for energy self-sufficiency.
- A comparison of PV potential has been performed between industrial, mixed-use, and single-family dwelling building typologies.
- The case studies show the highest to lowest PV potential in this equatorial Andean city.
- The report also presents recent work on achieving power neutrality, demonstrating the capability of PV technology on buildings for supplying power demands.