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Solar might not always be a green source of energy

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Abstract

Ecuador is undergoing through important changes in its electrical generation system. According to the Ecuadorian Government, by 2017 the country will leap from 53% to 86% hydro-electrical power generation by incorporating new plants, becoming a country almost carbon neutral. This also changes how we look at other electricity generating systems that can be called renewable or green. This paper discusses whether solar energy sources, such as PVs, can be eligible or not, depending on its potential to create important environmental liabilities, or by using life cycle analysis data of the system to establish when it becomes beneficial. Based on the fact that a green energy source is replaced by another green energy source, two carbon emission scenarios will be analyzed (actual energy mix scenario and 2020 energy mix scenario) to determine if the country can call solar energy beneficial.

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Keywords: Solar energy; BIPVs; LCA; carbon emissions.

1. Introduction

Sustainable Development has been defined by the Brundtland Report (World Commission on Environment and Development, Our Common Future), released in October 1987, as “development that meets the needs of the present

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without compromising the ability of future generations to meet their own needs" [1]. In this sense, Ecuador has taken important steps towards a de-carbonization of its economy by investing in renewable energy sources, such as hydroelectric, and in the coming years the country will cut down significantly CO2 emissions from electric energy generation [2]. However, this is not enough; the national energy mix should be based on a variety of different types of energy generation systems to ensure resilience and continuous supply. However, as with any technology, systems need to be compared and contrasted across all stages of their lifecycle to ensure that the most ideal one is utilized. Then, it becomes necessary to look at the Life Cycle Stages of energy generation: Upstream Processes, Operational Processes and Downstream Processes.

Worldwide it has being recognized that the building sector is both energy and carbon intensive, since it consumes up to 40% of the global final[2] energy and releases 50% of the annual global emissions [3,4]. At the same time, international climate-change regulatory regimes (e.g. Kyoto Protocol 1998; EU 2030 climate & energy framework) set ambitious targets to progressively reduce carbon emissions to the smallest possible count. Due to its importance, such ambitions include buildings. The total lifetime carbon emissions (LC) of a building account for its embodied carbon (EC) (e.g. emissions from material manufacture and transportation) and the operating carbon (OC) (e.g. emissions from lighting and heating) [5], the first one being the upstream processes for parts and materials of a building and the second one being the operational processes of a building. This differentiation becomes highly relevant for the Ecuadorian case, since OC is not significant in buildings because of the renewable energy generation sources that supply the energy for the country and the low demand of energy in its operation as it will be seen later. The present work will focus on solar energy for local generation in buildings, or Building-integrated photovoltaics (BIPV), due to the fact that they come initially with high LC and this "debt" must be paid first before producing green energy. Finally, these panels will become an important environmental liability for a country that has no possibility to renew the technology for any additional use.

2. Current state of the national energy matrix and the national demand in Ecuador

2.1 Energy generation mix

In 2013 the country produced 70.179 kilobarrel of oil equivalent (kBOE) from secondary generation sources in different transformation centers, from which petroleum represents 79.2% and 20.8% corresponds to electricity. Green House Gas emissions (GHG), corresponding to carbon dioxide CO2, methane CH4, nitrous oxide N2O) increased in 5.4% from 2012 to 2013. This represents 46.3 million tons of CO2 equivalent, where the transport sector contributes with 44% of emissions and power stations and industry contribute with 13% and 12.6% respectively [2].

Electricity generation meant a production of 23,258.6 GWh. The generating structure is broken down into the following components: 51% thermoelectric, 47.5% hydroelectric and 1.5% non-conventional renewable energy (wind, solar and biomass) [2].

2.2 Demand

The greater energy demand in the country is found in the transport sector with 49%, followed by industry 18%, residential 12%, own consumption 12%, commercial and public services 4% and no energetic use[3] 3%. Since the energy used in transport is mainly gasoline or diesel, the biggest carbon footprint of the country comes from this sector. The only relevant case of electric energy consumption for transportation is found in the public transportation system of the city of Quito, the "Trolebus" [2].

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[2] Final energy consumption includes all the energy supplied to the final consumer. It is usually disaggregated into the final end-use sectors: e.g. industry, transport, households, services and agriculture.

[3] Asphalts, solvents, etc.