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Renewable technologies for generation systems in islands and their application to Cozumel Island, Mexico

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ABSTRACT

The electric generation systems on islands are based generally on fossil fuel. This fact and its supply make the electricity cost higher than in systems used in the continent. In this article, we present a review of the renewable energy generation systems on islands. To do it we analysed 77 islands from 45 different countries. This work will allow us to know how the implementation of renewable energy sources could help these islands in developing a renewable and sustainable energy sector, including a reduction of electricity generation cost. This paper shows the results from a study case of the application of renewable energy technology in Cozumel Island, Mexico. This Island is located in front of the Riviera Maya area. The analysis was made through long- term statistical models. A deterministic methodology was used to perform time-series simulations. The simulations shows that for the year 2050 a feasible integration of a system based on wind/PV can be achieved on the Island, reducing the electricity price from 0.37 US $/kW h to 0.24 US$/kW h (2050 scenario). With this scenario, the government will achieve its targets in renewable energy and in the reduction of the emissions of CO_2. This will allow reaching a sustainable electricity sector.

Contents

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1. Introduction

Currently, we are already witnessing serious consequences of the global warming. Policies have been enforced to reduce the effect of these consequences. Renewable Energy (RE) seems to be one of the ways to solve the situation. These policies have focused mainly in two sectors: electricity and heating and cooling. The importance of the transportation sector has been increased recently by policy maker [1].

It is expected that in 2040 the 25% of electricity will be generated through RE. Anyway, that amount of clean energy will not be enough to avoid the 2 °C temperature increase [2]. Reasons for this temperature increase include global population growth, increase of energetics consumption, power demand growth, pollutant emission and global warming. All these events have been drastically increased in the last decades and will continue their growth.

Since 2011, the United Nations (UN) has activated the Small Island Developing States program (SIDS). One of its goals is to reduce the great expenses governments have as consequence of the intensive use of fossil fuels on islands. Taking into account the vulnerability and the small size of the islands, it is extremely urgent to: take advantage of RE's potential, develop energy efficiency and enforce the SIDS program for a sustainable development [3]. Development is not possible without energy, and a sustainable development is not possible without a sustainable energy [4]. Inside its Ten-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP), the UN also promotes the Sustainable Tourism Programme. The reason for promoting this program is that tourism can deplete natural resources, leading to water shortages, loss of biodiversity and land degradation. Tourism also contributes to climate change and pollution growth. Without proper management and protection of the environment and without investing in greening the sector, ecosystems and thousands of magnificent species will suffer [5], among other impacts, especially on islands.

Global actions and programs enforced to reduce global warming and environmental damage have increased the use of renewable energy grids (commonly call micro-grids). This takes place in suburban areas, rural zones or small Island States. These micro-grids, combined with the Information and Communication Technologies (ICT), have activated the distributed renewable energy economy [1].

In this paper a review of several proposals for the application of Renewable Energy Technologies (RETs) on islands and the integration into their electrical grids is presented. Part two reviews the way Island States have approached the integration of the Renewable Energy Sources (RES) and RETs, and their combination with energy storage in the electric grids under various scenarios of power demand. Part three presents a study case: the integration of some RETs into the electric grid in Cozumel Island, illustrating the feasibility of the application of these technologies compared with the actual fossil fuel energy technology. Results of the study case indicate that, even without electricity storage (the possible cost/price reductions or pros and cons of integrating the electricity storage to this proposal, will be part of a future research), Mexico's government can meet its targets in the electric sector within a feasible financial proposal. Part four shows a brief description of the barriers and uncertainties found in the study case. Part five shows the conclusions of this work.

2. Renewable energy sources in Islands

RE's goal is to use an alternative energy source. The natural regeneration source capacity and quantity, in relation with its consumption, would be inexhaustible. The source's exploitation would also produce a very low environmental damage [6]. Islands around the world are, and will always be, very sensitive to the negative global warming impact, so it is necessary take action to avoid or slow down this warming. It is also very important to reduce the global emissions generated by the use of fossil fuels for electricity generation. The government subsidies keep the electricity price within reach of the general population, but this drives high expenses on their budget. The right integration of RETs will help reducing these costs.

The Geographic Information System (GIS) analysis identifies 28,500 tropical islands. Of these islands, 15,900 are considered uninhabited as their average size adds up to 0.65 km^2 [7]. The 11% of the global population lives on islands. Approximately 2000 islands have a between 1000 and100,000 inhabitants [8]. 77 islands from 45 countries are analysed in this paper. 61 of them are in tropical areas or in similar conditions and have a population