SUSTAINABLE ENERGY FOR PANAMA WITHIN THE FRAMEWORK OF THE KYOTO PROTOCOL: A STOCHASTIC ANALYSIS OF DIFFERENT OPTIONS

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Overview

The interest in the green energy has recently intensified because of the need to implement climate change mitigation policies as the Kyoto protocol, reduction of fossil fuels dependence, concerns on energy security and the restructuring of the electricity markets. The Clean Development Mechanism (CDM) of the Kyoto protocol involves non-annex-1 countries encouraging the establishment of renewable energy projects as well as other activities for greenhouse gas (GHG) mitigation in developing countries. Moreover, the article 12 of the Kyoto Protocol envisages two objectives for the CDM: cost efficient abatement of GHG emissions and contribution to sustainability of the host countries. After ratification of the Kyoto protocol by the government of Panama in 1999 the amount of renewable energy projects to be implemented as well as the international interest to invest on GHG mitigation projects considerable increased. Netherlands was the first country to sign an agreement with Panama to transfer the CO_2 ton avoided emissions. These attempts have been followed by Finland, Canada, Spain and Italy. In order to attract new investment in renewable projects the Government of Panama passed Law No. 45 of August 4, 2004 to supply a number of incentives for the construction and development of new hydroelectric plants and other renewable energy projects. Although a wide range of eligible CDM projects can lead to creditable reductions of GHG emissions, this research focus on renewable energy CDM (RE-CDM) projects. These projects besides contribute to GHG mitigation, their employment provide multiple benefits to the host countries. Nevertheless, several obstacles prevent the profitable realization of these projects. For instance, the volume of emission reductions from RE-CDM projects is much smaller than other type of potential CDM projects, high initial investment and transaction cost. Therefore, it is useful to assess the economic feasibility of renewable energy projects in non-anex-1 countries such as Panama and how the trade of the Certified Emission Reductions (CERs) will influence the profitability of these projects. This study consists of two parts. Firstly, we investigated the economic options of renewable projects carry out by independent power producer and finally, we evaluated the residential projects.

Methods

We formulated a stochastic Net Present Value (NPV) model to analyze the financial return of renewable energy projects. The proposed model relies on the probability distributions and statistical techniques. There are several factors that influence the revenue from renewable projects such as the energy output, retail prices, CERs prices, spot prices and cost of the installed system. Therefore, the probability distributions were applied to reproduce their stochastic behavior. The NPV calculation depends on the initial investment, the total accumulated cash-flow and the discount rate. The cash-flows are the costs and the benefits associated to the project. In our model, the discount rate, costs, benefits as well as the variables used in their calculation were represented as probability distributions. It is important to note that both the distribution and the parameter values critically affect the results of the simulation. For that reason, the input distributions were carefully selected based upon available data. The simulations were performed using Monte Carlo techniques. To ensure the appropriated accuracy of the simulation results 10,000 trials were running. Furthermore, we calculated the emission factor for the Panamanian wholesale electricity market. Due to the differences between typical sources of supply for off-grid and grid-connected electricity was necessary to calculate different baseline for each. For the grid-connected RE-CDM projects, we used the combined margin approach since most of the renewable energy projects will have some influences on the operating margin in the short term and the build margin in the long term. The combined margin was found to be equal to 0.64 CO_2 ton/MWh. The off-grid small CDM projects were assessed using a diesel-based baseline (0.88 ton/MWh). The estimated reduction in CO_2 achieved by the employment of a renewable energy project is calculated by multiply the annual generation of the RE-CDM project by the emission factor.

Results

The simulation results demonstrated that the profits obtained using the CERs scenario are bigger than the ones using governmental supports as the energy generation increases. Besides, the governmental grants are essential for very small scale renewable projects which cannot absorb the transaction costs. These costs are prohibitively high compared to the volume of the CERs expected to be

generated by the projects. The projects generating less than 1600 CERs per year will not be able to cover the transaction cost associated to CDM process.

Despite the higher baseline to calculate the CO_2 avoided emissions (0.88 tCO_2e/MWh) for off-grid projects, the volume of CERs from the bundled solar systems are smaller than the hydro and wind systems (see Fig.1). The certainty levels to cover the transaction costs for 500 kW hydro, wind and solar system are 99%, 88% and 55 % respectively. The bundled solar system as well as other very small scale CDM projects will find difficulties to participate in the clean development mechanism. The volume of CERs obtained from the wind generation exhibits high variability due to the wind regime and its stochastic behavior. For all studied cases, the incomes from the sale of carbon credits are bigger for hydroelectric projects as well as these projects are more profitable.

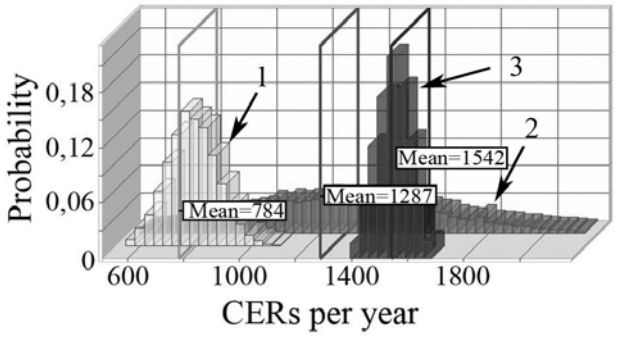

Fig. 1. The Volume of CERs per year (Installed Capacity 500 kW).
1. Solar Generation 2. Wind Generation 3. Hydro Generation

Conclusions

The small scale RE-CDM projects can assist to meet the growing electricity demand in a sustainable manner while directly mitigating the emissions of the greenhouse gases. Nevertheless, these projects face several barriers that make them less attractive for the investors such as less volume of CERs, high initial investment and transaction costs.

In order to encourage the implementation of RE-CDM projects, several alternatives should be considered such as payment of a premium for CERs from renewable energy projects, additional support mechanism like Feed in Tariffs (FiT), choosing the appropriate baseline methodology as well as less transaction costs. Otherwise, the clean development mechanism is likely to produce a limited effect on the support of renewable energy technologies.

In the case of homeowner projects using net metering, the simulation results confirmed the importance of choosing the appropriated PV system or wind turbine capacity that matches the household energy consumption, bigger capacities are worthless. Feed in tariffs as support mechanism can provide the best returns for the PV and wind system homeowner projects.

In spite of some hurdles, the trading of the carbon credits are still very important tool to reach greenhouse gases emission targets, address global warming problems and support renewable energy development. In the near future, it is expected that they will play a significant role in the electric sector.

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