Probabilistic valuation for power generation projects from sugarcane in reserve energy auctions

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ABSTRACT

The power generation from renewable sources is an interesting alternative to the diversification of the energy matrix of a country. This paper presents a probabilistic valuation method for power generation projects from renewable sources. It focuses on biomass plants that use sugarcane bagasse. The main objective is to bring a wider knowledge surrounding projects for investors that participate in energy auctions. Therefore, the highlight is for the net present value that allows us to analyze the financial viability of projects. Two stochastic variables are involved in the problem, the power generation and the energy price in the short-term market. Monte Carlo Simulation and Discounted Cash Flow methods are employed. A case study is carried out for a biomass plant. Sensitivity analysis is presented for different values of investment, bid, and minimum attractive rate of return. For each simulated scenario, the probability distribution of the net present value, the average net present value, and the internal rate of return are calculated. For the analyzed case study, the return of the project is more sensible to the bid value than the investment cost. The proposed method can be used as a tool to assist investors in energy auctions from renewable sources.

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1. Introduction

Brazil has a strong tradition in power generation from hydroelectric plants. In 2009, the electric power supply counted on 74.6% from hydroelectric plants. However, the conflicts of multiple uses of water and the water crisis forced the country to a diversification of its national energy matrix. Nowadays, the hydric, fossil, biomass, wind, import, nuclear, and solar sources are responsible for 61.3%, 16.6%, 8.7%, 7.0%, 5.0%, 1.2%, and 0.1% of the electric power supply; respectively, according to ANEEL [1].

Brazilian incentive program for alternative sources of power generation, established in 2004, has three main goals. The first one is to promote the diversification of the national energy matrix. The second goal is to seek ways to increase the security of the power supply. The third is to enhance the regional and local potentials of the country, as MME [2]. In this context, the renewable sources are an attractive alternative not only for Brazil, but for the whole world.

Power generation projects from renewable sources are subject to random variables that depend on natural phenomena, such as: rain, wind, solar radiation, and harvest period. For these projects, investors should take into account the seasonality of the resources in investment analysis. For example, in a power generation project from sugarcane bagasse, the generation depends on the available bagasse and it is subject to periods of season and off season.

According to Sadorsky [3], the growth of the energy demand and renewable energy sector has contributed to increase the investment in projects that use renewable sources. However, the study of the relationship between risk and return for these projects is still precarious.

Risk is defined as a situation where some events are uncertain [4]. Measurable and manageable risks are those that can be administered in order to achieve specific goals. The risk management can reveal opportunities for improvement in projects [5].

The determinants of risk in the renewable energy sector are presented in Sadorsky [3]. In this research, the objective is to minimize the systematic risk. The systematic risk is that from changes in the macroeconomic scenario affecting the company's assets, such as: inflation, exchange rate, interest rate, oil price, etc. A variable beta model is estimated. The methodology is applied to companies that generate energy from solar, wind, battery storage, and hydrogen fuel cells sources. The author concludes that the systematic risk increases with raises in the oil price and the

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systematic risk decreases with the company sales growth.

Still considering a mix of plants, Tamashiro [6] proposes an optimization model for power generation projects from renewable sources. The objective is the reduction of the risk from power supplementation by wind plants. Nine case studies are presented. They include hydroelectric, wind, and biomass plants. The research seeks to make the best allocation of investments through an optimal portfolio of projects using genetic algorithms. According to the author, the parameters that determine the financial risk of the portfolio are: the investment rate, selling price in the contract, and investment cost. From the results, the revenue maximization is shown by the plant with the largest capacity factor or by the plant with the lowest investment cost.

Most of the energy traded in Brazil happens through of auctions. Souza and Legey [7] study the dynamic of different types of Brazilian energy auctions and the compensation mechanisms of surplus and deficits. They examine the behavior of buyers and sellers participating in energy auctions and propose actions to eliminate gaps in the existing regulatory framework. Hydro, wind, and biomass sources are included in the research. The study shows how the deficits lead to penalty and exposure to the prices in the short-market. Moreover, the authors conclude that long-term contracts decrease the uncertainties of the investors and that the price reduction shows the existence of competition among them.

Nakabayashi [8], Monjas-Barroso and Balibrea-Iniesta [9], Wyman and Jablonowski [10], Fleten et al. [11], Dantas Filho [12], and Amaral and Ribas [13] study the economic viability of power generation projects from renewable sources. The first one refers to photovoltaic generation systems. The next four are related to wind plants. The last two are applied to power generation from sugarcane. Therefore, all of these references are associated with this research, especially the last two.

Nakabayashi [8] presents an economic-financial evaluation of distributed photovoltaic generation systems. The evaluation is done under the residential consumer's perspective. This research includes estimates to the net present value (NPV), internal rate of return (IRR), and payback. A sensitivity analysis of the financial return considering tariff readjustment, percentage of self-consumption, energy price, exchange rate and discount rate is presented. Monte Carlo Simulation (MCS) is employed to estimate the financial return for the years 2015 and 2020. The methodology is applied to 27 Brazilian capitals. According to the author, it is expected that in 2020 the viability of photovoltaic microgeneration goes over 90%.

Monjas-Barroso and Balibrea-Iniesta [9] evaluate projects of investment based on wind power. The evaluation can aim policy makers to know the economic impact of a public support. They consider the power production, investment and production costs, and consumer price index. The real options of the regulatory framework are incorporated in the studies. MCS and binomial method are employed. The study objects are Denmark, Finland, and Portugal from European Union. The authors conclude that the obtained results from both methods are similar. In relation to the public incentives for wind power considering economic terms, Finland, Denmark, and Portugal; in this order, are supported by the government.

Wyman and Jablonowski [10] analyze the economic viability of offshore wind power projects. The objective is to estimate the probabilistic NPV of the projects. Box Behnken method is used for sensitivity analysis considering several variables, such as wind speed, turbine size, electricity price, tax rate, etc. In order to generate characteristic equation for NPV regression techniques are employed. MCS is used to develop probabilistic estimated of NPV. The methodology is applied to projects in the United States. According to the results, most simulations for typical projects in the United States yields negative numbers of NPV. Therefore, according to the authors, it is necessary real reductions in the current costs for offshore wind projects or long-term economic incentives from the government.

Fleten et al. [11] evaluate investments in distributed wind power generation. The objective is to find the limits in electricity price and generator capacity that makes the investment feasible. All input variables are deterministic except the long-term electricity price. For this stochastic variable, a geometric Brownian motion is employed. The model is applied to Norway in an example with small-scale wind power alternatives. The data used in this research are from the Nord Pool financial market. They find, among other things, that the high price volatility increases the value of investment opportunity for large projects.

Dantas Filho [12] presents an analysis of the economic-financial viability for power generation projects from sugarcane. He uses a deterministic approach for the calculation of the NPV, IRR, and payback. The power generation is estimated according to the plants' installed capacity and most likely harvest period. The methodology is applied to four sugarcane plants of São Paulo state. The results show that the power generation from sugarcane for the four studied plants is technically and economically viable and that the costs tend to decrease as the production scale increases. A