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BIONATURE

On the Wind Turbines Assessment by Real Options Technique in Israel

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Ideas | Overview

- **The limitation factor for using of the local energy resources in Israel is the persistent one that causes different economics participants to develop the ‘green’ technologies**
- **The wind turbines installation constitutes undoubtedly an important trend of their efforts in this area**
- **Many methods are elaborated for assessment of the investment projects in the industry and energetics**

Ideas | Overview

- One of the methods, extensively applied to the investments evaluation, presents the standard discounted cash flow method, using the net present value criterion
- The technique of real options analysis is broadly used nowadays in many investment projects of renewable energy for their efficiency estimating
- The research develops the real options analysis facilities for evaluation of the wind turbines efficiency and profitability in Israel

Overview

- **Israel currently operates one wind farm in Asanyia Hill in the Golan Heights, with an installed capacity of 6 MW (10 turbines at a height 50 meters including blades, each with a capacity of 600 kW), consumption of about 5 thousand families**
- **The duty cycle of the wind farm operating reaches 97%, and electricity selling consists 1 million US $ a year**
- **Wind energy potential of Israel is restricted due to moderate- or poor-wind velocities' areas, and is limited to the areas with sufficiently high average wind speed, some of which are being opposed by green groups on landscape conservation grounds**
- **The economic output of wind turbine field is a function of its electric power output and market energy prices, when the electric power output is a function of the equipment used and wind velocity statistics**

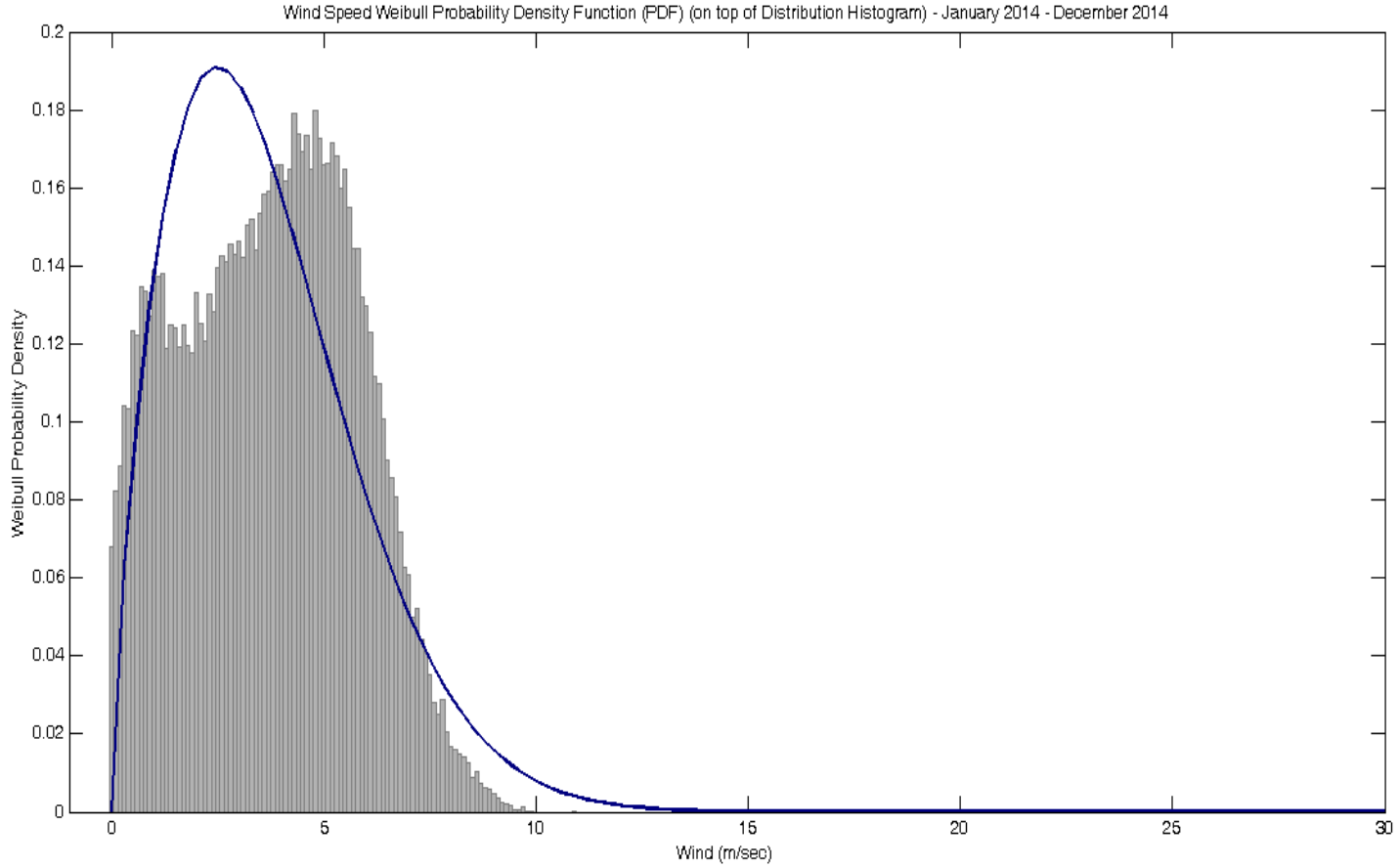
Statistic Estimation Results

- **The research based on the wind velocity distribution at the Golan Heights region, using the data of the Meteorological Service of the Israel Ministry of Transport and Road Safety, collected by the Merom Golan meteorological station, one of the 84 Israeli stations which is situated at the given area for the 2014 year**
- **The data include 52,066 observations during this period of time, the sample values of the wind speed, one observation for every 10 minutes, 144 values per day**
- **The Weibull distribution function was used as the common accepted most appropriate function describing the wind speed statistical frequencies at a given location in most of the world. This information is essential for the planning of the wind turbine optimal configuration**

Statistic Estimation Results

- **The Weibull probability distribution function (PDF) is defined, concerning a random variable of the wind speed *X*, by two parameters. They are a *shape parameter k* (dimensionless) and a *scale* parameter *λ* (m/s for the wind speed), which together determine the PDF form**
- **The PDF parameter values are significant for choosing the optimal location for the wind turbine, as well as for selecting most efficient turbine, which imply the wind farm efficiency**
- **For fitting the observed data of the given location to the PDF we used the method of the maximum likelihood estimators. The corresponding Weibull PDF for the wind speeds distribution at the Merom Golan site, together with their distribution histogram, is shown here:**

Statistic Estimation Results



Statistic Estimation Results

- **Estimated annual parameters of the wind Weibull distribution were found to be: k =1.7228 and λ =4.1206 m/s. In addition kurtosis (a measure of the PDF sharpness) to be 2.1757, and skewness (a measure of the PDF asymmetry) as 0.0574, were calculated to demonstrate the specific type of the Weibull PDF**
- **The main meaningful statistical parameter for planning of the wind turbine installation, the speed mean, was obtained of 3.73 m/s, with standard deviation of 2.03, with a positive right-skewed tail. This finding, in accordance to the Israeli Cooperative for Renewable Energy conclusions, indicates the possibility of wind energy exploitation in the investigated region**

THE REAL OPTIONS ANALYSIS FOR THE WIND ENERGY EXPLOITATION'S ESTIMATION

- In recent years, the real options analysis (ROA) technique is widely applied in many studies for valuation of renewable energy investment projects (as at Lee and Shih, Kumbaroğlu, Madlener and Demirel, Boomsma, Meade and Fleten, Menegaki). We apply the ROA approach for the valuation of wind energy turbines. In particular, we capture the value of the follow-on investment opportunities which add value to the investment
- We found in our study on the basic Black-Scholes model of a financial market, because we focus on the missing value of the option to abandon in an environment where it is impossible to estimate the standard deviation by the numerical tools
- We analyze the feasibility of installing an additional turbine field in the Asanyia Hill in the Golan Heights, in order to extract value from wind. We have based our investigation on the achieved results of the wind turbines construction and exploitation in Israel

THE REAL OPTIONS ANALYSIS FOR THE WIND ENERGY EXPLOITATION'S ESTIMATION

- **The decision to build the field which encompasses many turbines can be divided into two stages: in the 1st stage, we build one unit. After building and operating which may take few years, the 2nd decision on building the turbine field is taken based on electricity price at this stage.**
- **We model the uncertainty over future electricity prices as a price of an underlying asset of a real option using Black-Scholes formula for the call option value**
- **We apply the technique of real option valuation following Brealey et al., where we input the data:**

THE REAL OPTIONS ANALYSIS FOR THE WIND ENERGY EXPLOITATION'S ESTIMATION

INPUT DATA FOR THE BLACK-SCHOLES OPTION VALUE CALCULATION

Data for the Black-Scholes Option Value	
Cost of the 1st stage's one turbine building	50
Annual turbine's profit in the 2nd stage	0.2
Present value of 50 turbines' profit over 20 years = Stock Price now (S_0)	114.7
Cost of the 2nd stage's for each turbine construction	1.2
Number of turbines in the 2nd stage (entire field)	50
Cost of the 2nd stage's 50 turbines building = Exercise Price of Option (K)	60
Number of Periods to Exercise in years (T)	2
Compounded Risk-Free Interest Rate (r)	0.02
Standard Deviation of prices of energy or electricity (annualized σ)	0.031

les option value calculation

e current value of the field, S_0 114.7 million $US, which is the present value of 20 years future operation with annual profit of 0.2 million $US per

THE REAL OPTIONS ANALYSIS FOR THE WIND ENERGY EXPLOITATION'S ESTIMATION

- **Traditional calculation for an uncertain cash flow applies just the expected values of the cash flow from the project without the possibility to abandon. Given our empirical assumptions, this yields a loss of 1.3 million $US instead of any profit, meaning the project becomes not worthwhile.**
- **Contrariwise, applying the proposed real option analysis, which reveals the value of the option to abandon the 2nd stage running as well, we turn the project just to become profitable and worthwhile. The value of the real option increases depending volatility to be either 57.05 million $US or 59.50 million $US depending on future volatility, and the profit is either 7.05 million $US or 9.48 million $US, respectively**

Thank you!