NUMERICAL ANALYSIS OF MULTI-TURBINE POWER SPECTRUM WITH THE NEW METHODOLOGY

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INTRODUCTION

Significance of wind turbines broadens the scientific works related to efficient usage of wind farms which is on the planning phase and not constructed yet, in terms of selecting the region of application, number of turbines in the region of interest and location of these units. Power output is another concern that we have to deal with. However due to the lack of wind speed data for the entire region modeling the power output based on a single data obtained from a point inside the area of interest will not provide the well organized wind turbine farm in terms of aggregated power output. The conventional way of calculating the power spectrum is far beyond the real. The new method is illustrated and the algorithm is given. Methodology and the idea are simply based on a fact that "single data can only be applicable for a single point" then we have to find a velocity data for every point that we want to place a turbine. Indeed, these data will be the time shift of the original data. Then as a result of this fact each point on the region will have a different velocity at a specified time interval. Furthermore power output from a cluster of wind turbines also will not be unique even though the turbines are unique in terms of size, geometry, control principles and efficiency.

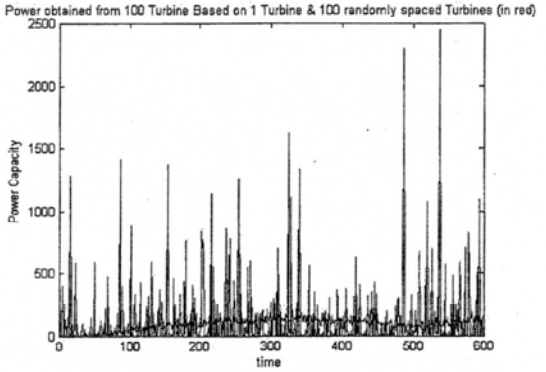
Problem Definition & Methodology

This project basically describes the methodology to generate qualified estimate of the time series of the aggregated power generation from wind turbine units which are randomly distributed in an area where limited wind time series are available. This is often the situation in a planning phase where you want to simulate well organized expansions in a power system with wind power. Therefore, you need to be able to simulate a time series of the aggregated power generation from a cluster of wind turbines on the basis of the time series of the wind speed in a single point or alternatively on the basis of a time series of the power generation from a single unit.

The definition of the problem is simple: How we could explain the power in time distribution of a wind turbine farm that consists of N number of wind turbines which are

randomly placed. The basic and rough way of defining the power for a farm is simply using the main equation that relates the power to the cube of velocity.

The goal is to define a more accurate method of identifying the aggregated power generation for randomly placed wind turbines based on a given velocity data. The distance and velocity of the units on entire area are allocated randomly in terms of X and Y coordinates such that algorithm defines a new randomly selected point for each turbine.



The following graph illustrates the smoothing effect for power capacity in space and time as a result of proposed model which provides more realistic results in comparison with the conventional calculation technique.

Results & Discussion

The methodology which is given in this project is the qualified evaluation of the power output for a wind farm. The single time series wind speed data is assessed in order to obtain the spectral power of a wind turbine farm. The conventional way of estimating the power spectrum is the multiplication of the power obtained from a single wind data with the number of turbines under consideration in the region of interest and related graphs are given through the project. Disadvantage of this calculation is that it does not deal with the time shift of velocity from one turbine to another. Nevertheless, due to the distance among the wind turbines the velocity and so the power (which is proportional to cube of velocity) is not the same at the same time.