Optimal Wind Farm Power And Wind Turbine Selection On The Basis Of Wind Turbine Characteristics

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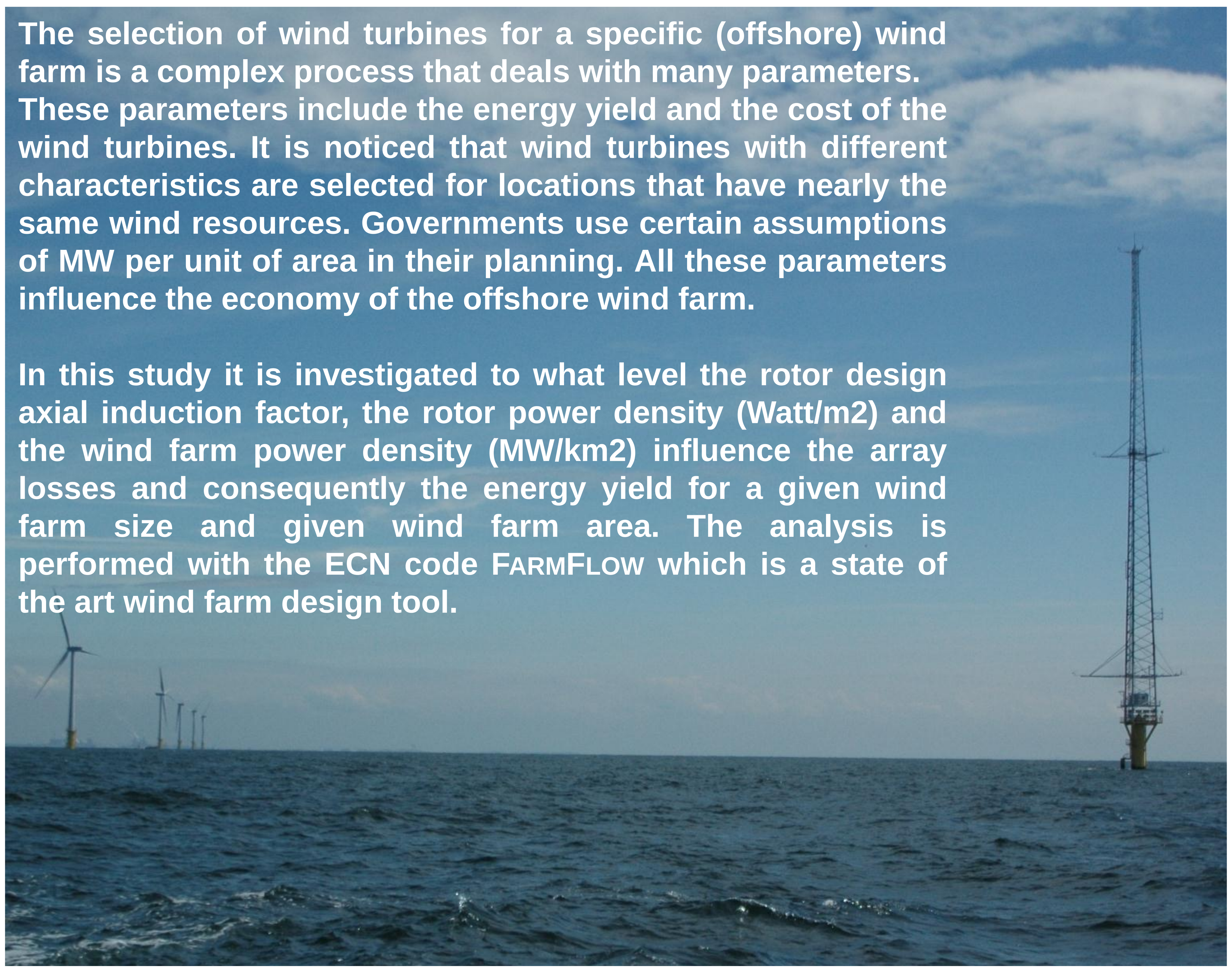
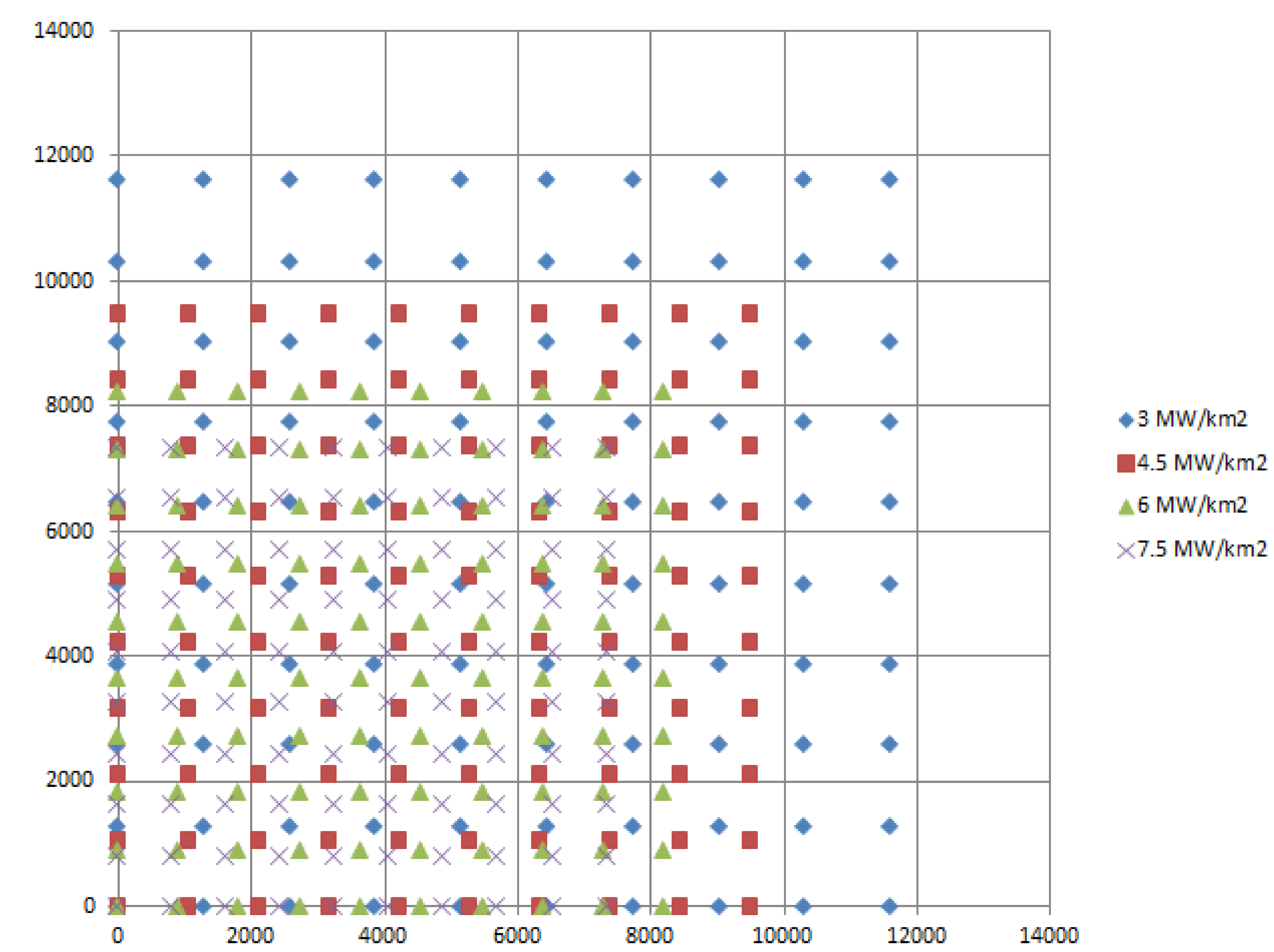
Introduction



The selection of wind turbines for a specific (offshore) wind farm is a complex process that deals with many parameters. These parameters include the energy yield and the cost of the wind turbines. It is noticed that wind turbines with different characteristics are selected for locations that have nearly the same wind resources. Governments use certain assumptions of MW per unit of area in their planning. All these parameters influence the economy of the offshore wind farm.

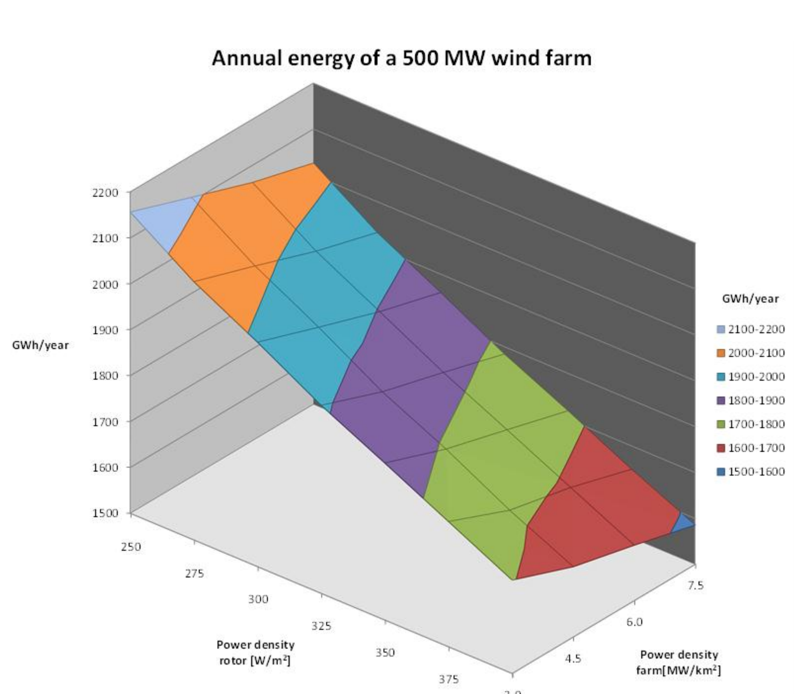
In this study it is investigated to what level the rotor design axial induction factor, the rotor power density (Watt/m2) and the wind farm power density (MW/km2) influence the array losses and consequently the energy yield for a given wind farm size and given wind farm area. The analysis is performed with the ECN code FARMFLOW which is a state of the art wind farm design tool.

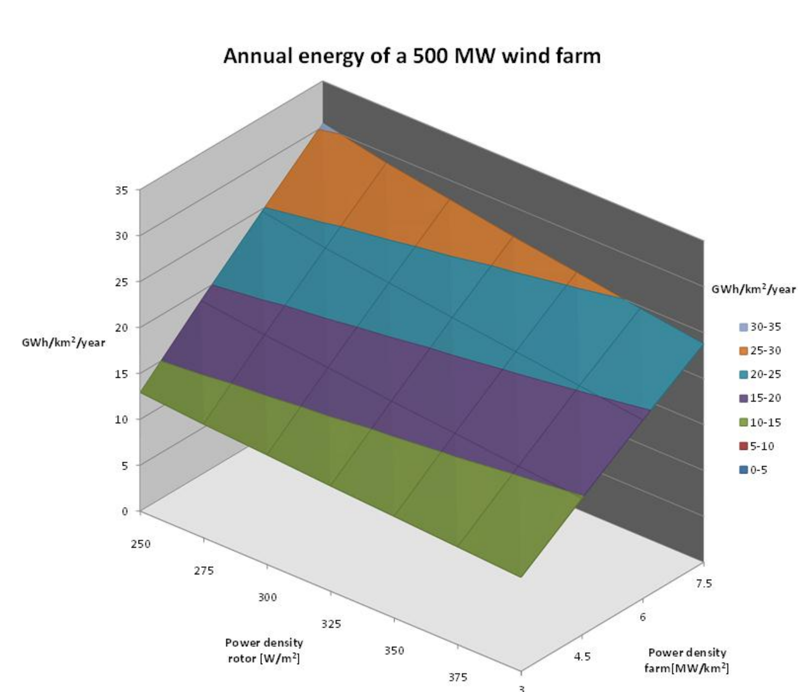
Wind Farm Configurations



A generic wind farm lay-out is sketched above. The wind conditions used in the study is representative of the North Sea. The lay-out of the wind farm is based on a triangular grid with varying angles to deal with the pre-dominant wind directions in the North Sea area.

Simulation Results





The simulations are performed with ECN code FARMFLOW on generic wind turbines with rate power varying between 3 to 7.5 MW/km^2. The rotor diameter is determined by the power density which is varied between 250 and 400 W/m^2. The performance of the rotor is determined on the basis of a choice of the design axial induction factor, that is where the rotor is operated at below rated power.

Numerical simulations are performed to create wind power stations that generate the required power at the lowest cost of energy. Not knowing all the cost related data an intermediate step could be to determine whether there is a maximum of the function E_{yield} TWh/km^2 where the density of turbines is varied and where the power density of the rotor is varied.

The maximum of this function is found at the minimum power density of the rotor (because of lowest rated wind speed, which results in highest capacity factor) and at the minimum density of turbines (because of lowest wake losses, assuming that cable losses are negligible with respect to wake losses).

Acknowledgements

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References

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