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Role of computers in stimulating sustainable development: an example in efficient utilization of wind energy

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Abstract

As we all know today, sustainable development is closely related to renewable energy. Renewable energy technologies are being developed in order to leave human beings with cleaner environmental and long lasting energy resources owing to the use of computers for numerical simulations and optimization studies. Among various sources, wind energy is achieving cost parity with fossil fuels, in recent years, owing to the fast technological developments. The pleasing increase in wind energy harnessing has, nevertheless, introduced new challenges to the wind energy community. Every day, hundreds of wind turbines are erected at different locations and it is foreseen that in the near future, there will not be enough space to erect new turbines. The remedy for this situation is to increase the wind turbine size and design new families of airfoils. Larger turbines are, however, prone to higher wind shear and turbulence loads from the atmospheric boundary layer (ABL), causing severe external loads. As a consequence, advanced and detailed numerical simulations have become important tools for design and optimization of wind turbines and wind farms.

The use of computers can facilitate developing advanced numerical tools for prediction and analysis of flow behaviour in different applications within wind energy. Computers can be used in a broad range of applications from wind turbine simulations in the atmospheric boundary layer to simulation and modeling of wind turbine wakes and wake interactions as well as design and aerodynamic assessment of wind turbine airfoils with the aim of improving the performance of not only individual wind turbines, but the entire wind farm.

While making complex flow physics more understandable, the more advanced numerical flow-prediction models obtained by recent powerful computers will reduce the uncertainty associated with the wind energy production, which is achieved by simulating details of the fluid flow. A direct financial concequence will be for instance reduction of interest rates for the bank loans associated with wind energy investments and eases the financing of wind farm productions, therby promoting wind power as an alternative to the conventional fuels. As an example, harnessing only 1% more power by employing more advanced numerical models results in achieving a sizeable reduction in the cost of energy (CoE), through increased annual production with fixed CAPEX and OPEX. Particularly in Denmark, this means moving towards the goal of 50% CoE reduction by 2050, as seen in the Megavind's vision [1]. It should be noted that here we address only economic and environmental, and not the social, aspects of sustainability.

Reference

[1] *Denmark - supplier of competitive offshore wind solutions, Megavind's Strategy for Offshore Wind Research, Development and Demonstration,* megavind report, December 2010.