EUMEDGRID e-Infrastructure Forecasts Micro-Scale Wind Farms in Minutes, Not Weeks

How much electricity can a wind turbine produce? This depends greatly on its location. Finding an answer requires studying the seasonal most prevailing wind patterns, the air turbulence and other variables for a specific geographic site under consideration. Weather data sets can be huge, leading to many challenges regarding modelling, simulation and visualization of such a problem.

Figure 1: Zaafarana wind farm in Egypt

The EUMEDGRID e-Infrastructure is helping to get answers fast. "Wind turbines operate for whatever period, and beneficiaries demand to know how much energy they will produce and what their ROI will be before wherever they are installed, especially on complex terrain" says Ashraf Hussein, Professor of Scientific Computing, Ain Shams University, Egypt. "Using EUMEDGRID e-Infrastructure and our in-house tailored numerical models, we can now answer these questions quickly enough to identify potential markets for wind energy, especially in our country, to meet aggressive renewable energy goals."

In this context, Dr. Ashraf's team in Ain Shams University, Egypt have conceived a computational framework for modelling and simulation of micro-scale (and early meso-scale) wind farms using massively parallel high performance computing platforms. The wind turbines installed in the wind farm are modelled by the actuator disk method using the Virtual Blade Model (VBM). This model considers the presence of the wind turbines' rotors implicitly through source terms in the momentum equations. In addition, an efficient parallel algorithm for implementing the VBM through the actuator disk method was developed and integrated with the parallel Computational Fluid Dynamics core simulation engine.

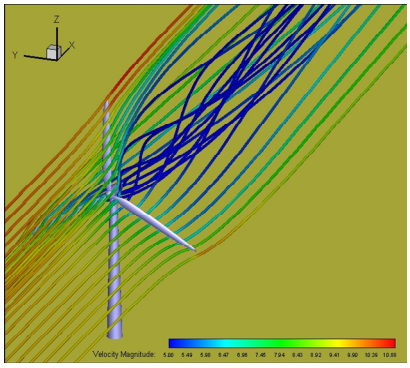

Figure 2: Streamlines past Tjaereborg WT installed on micro-scale wind farm, wind speed at hub-height = 10m/s

Forecasting of such wind farms can therefore be performed within the decision making time. In addition, important topics which are yet to be fully understood can also be studied and analyzed, such as the interaction between the wind turbines themselves and the terrain of the wind farm, independent of its complexity. The scalability analysis for the present framework was carried out using IBM Blue Gene/L with up to 1054 computing nodes. Following this, some real simulations were carried out using the EUMEDGRID e-Infrastructure through the grid interface provided by the Egyptian Universities Network (EUN), the Egyptian partner in EUMEDGRID-Support project.

This research proved that EUMEDGRID e-Infrastructure is at date one of the most important resources that researchers in Mediterranean countries can rely on to carry out such environmental simulations with large domains and/or sophisticated models.

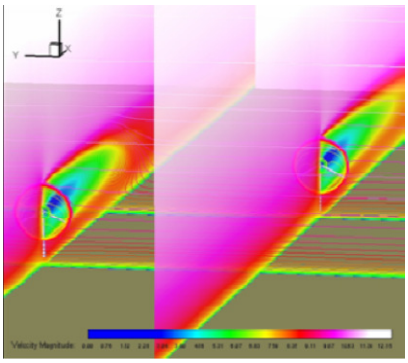

Figure 3: Simulation of two rows Tjaereborg WTs installed on micro-scale wind farm, wind speed at hub-height = 10m/s

References

1. http://www.eumedgrid.eu/
2. Hussein A. S. and El-Shishiny H., "Modeling and Simulation of Micro-Scale Wind Farms using High Performance Computing," to be published in the International Journal of Computational Methods, World Scientific, June 2012.