EUROMECH Colloquium 576

"Wind Farms in Complex Terrains"

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The increasing need for renewable energy in Europe has led to the growth of wind farms both off-shore and over complex terrains. For the latter, hills, forestry and general surface inhomogeneities make the wind-resource assessment more challenging than in off-shore sites. There are several open issues that are now being investigated by the wind-energy community to improve the current evaluation methodologies and, simultaneously, to increase the physical understanding of such complex flow scenarios. EUROMECH Colloquium 576 was motivated by the need to bring together researchers actively working in the wind-energy field, to compare the available experimental, numerical and analytical techniques, and to propose new improvements. Wind energy is a relatively new field that combines both fundamental and applied fluid dynamics.

In total, 50 participants were present at Colloquium 576: 16 from Sweden, 9 from The USA, 8 from Germany, 5 from Denmark, 3 from The UK, 2 from Italy and Belgium, 1 from Canada, Israel, Netherlands, Norway and Portugal. Various fundamental and applied aspects of the site-assessment process were discussed, with a particular focus on the effects of complex terrains (forests, hills, inhomogeneous surface roughness, etc.) on the available wind resource and prediction using current evaluation methods. Recurring issues during discussion were:

1. **Wind turbine wakes:** several methods to simulate wind-turbine wakes and their dynamics were discussed. There is still a visible gap between what industry is currently using and the new research methods. Improved understanding of wake dynamics is leading to faster and more reliable methods and there is clear interest from the industrial world in new developments.
2. **Forestry and topography:** many talks reported experimental results and numerical predictions concerning the effects of forestry and/or terrain complexity. It is clear that more high-quality data are required to develop a better understanding of how flow features near the ground influence wind-turbine wake behaviour.
3. **Atmospheric stability:** the continuous growth of the wind-turbine hub height leads to increasing importance of stability effects, which influence the wake dynamics and the energy production from wind farms. At least 20% of the talks discussed stratification effects, in contrast to just 5 years ago when stratification effects were seldom discussed.
4. **Wind farm control:** several methods are now adopted to control wind farms in order to alleviate fatigue loads or to produce more power. Several control approaches were discussed and compared mostly with numerical simulations, while experimental data from existing farms were reported.
5. **Synthetic turbulence:** with the growth of computational resources, large-eddy simulations have become the most reliable tool to simulate the wind flow over complex terrains with turbines. However, an initial velocity field must be prescribed, ensuring that some characteristic features of the wind field are kept. Several methods have been compared independently by many researchers but further work is needed.
6. **Atmospheric measurements:** measurements in the atmosphere have for a long time been made mostly with cup and sonic anemometers. LIDAR measurements now allow superior spatial coverage and provide information about turbulence characteristics as well as the mean flow. However, their precision is unclear and a comparison with mast data is still required to identify their reliability.

A 100-page book of abstracts was distributed amongst the participants. Many of them appreciated the meeting for its coverage of many interesting topics related to wind energy. The financial support of the Linné FLOW Centre, the Swedish Research Council (VR) and STandUP for Wind is gratefully acknowledged.