WAsP CFD in WindPRO

Energy Calculations with CFD

Introduction
Working with wind models for wind farms in mountainous terrain is a real challenge for the wind resource analysts and any numerical models they use. With WAsP CFD in WindPRO, the road to accurate and reliable estimates has become much shorter.

Traditionally, the requirement of highly specialized and trained CFD-professionals has been an absolute must in order to successfully use computational fluid dynamics (CFD) for wind turbine siting purposes and accurate wind farm energy yield estimations. To achieve an acceptable accuracy from the numerical models when running the flow-model, either access to large dedicated computational resources is needed – or alternatively an excessive calculating time has to be endured.

The WAsP CFD model within WindPRO provides a novel approach to the wind resource assessment and siting of wind farms in all types of terrain.

User-friendly
The WAsP CFD module in WindPRO is designed with ‘ease-of-use’ in mind. As a WindPRO user, you can leverage your existing WindPRO and WAsP competences and skills in order to do accurate energy yield estimates - also in complex terrain.

Accessibility
The WAsP CFD module in WindPRO provides direct access to a high-performance computer (HPC) cluster directly from your PC-desktop – but without any initial hardware investment or continuous maintenance costs. While acceptable accuracy in numerical modelling requires large computational resources beyond the capabilities of a high-performance PC, the WAsP CFD module in WindPRO provides fully automated access to the HPC cluster operated and hosted at the WindPRO headquarters in Aalborg, Denmark.

Efficiency
Performing an analysis with the WAsP CFD model in WindPRO is very efficient as you are essentially using the same input-data for your analysis as you would do with a WAsP or ATLAS calculation. WAsP CFD is the natural evolution to the wind data-centric approach in WAsP. You will find that you will use the same well-known approaches in the WAsP CFD – such as the generation of wind statistics (STATGEN) and application of long-term correction methods (MCP). As the WAsP CFD approach is fully automated – you need only to consider that the results are delivered to your desktop within hours after the calculation has been up-loaded to the HPC-cluster.

Accuracy
The entire modelling approach has been optimized to deliver consistent, reproducible and accurate results. Errors from modelling, numerical schemes and user interaction are minimized due to the automated procedures involved. The reverse side of this document describes some of the validation cases conducted for the WAsP-CFD model.

Focussed
Results from the WAsP CFD module in WindPRO are directly integrated into many other WindPRO calculation modules and models. CFD based results can easily be used directly in wake loss calculations, wind resource maps, optimization of layouts, loss and uncertainty evaluations and many other calculations. The wind resource analyst can also use the advanced cross-prediction tools and wind profile evaluations to gain an even better understanding of the on-site wind conditions.

Proven
The WAsP CFD model is essentially a new approach to the challenge of delivering reliable results in complex terrain. All major model components used within the WAsP CFD solution in WindPRO have been developed as dedicated wind turbine assessment and wind engineering tools during many years – and all have proven their worth by years of service. The WAsP flow model and WindPRO have been the leading standards during the last 20 years. The EllipSys3D CFD-solver from DTU Wind Energy (Risø) has set the standards in various industry applications since the mid 1990’s.

Availability
Expected release is March 2013. This first version enables the user to submit calculations to our central ‘Cerebrum’ HPC-cluster. We expect that the next releases will include model data for site suitability assessments, i.e. data such as wind veer, inflow angles, wind shear and turbulence levels.

Environmentally-friendly
All electric power consumed on the high-performance computer-cluster at EMD International A/S is to be delivered from our own wind turbine. We will start erecting the turbine in 2013.

Acknowledgement
WAsP CFD in WindPRO is co-funded by the Danish ‘Business Innovation Fund’ – see more at www.fornyelsesfonden.dk. WAsP CFD is developed in cooperation between Rise DTU, EMD International A/S and Vattenfall A/S, and WAsP CFD will be available via WindPRO and WAsP.
Validation

New and emerging, but already validated: WAsP-CFD is already thoroughly validated as part of an on-going validation process. The validation process has been approached from different directions with three groups of validation cases:

1. Classical cases
   - Focus: fundamental/theoretical behaviour
   - Speed-up versus terrain slope
   - Idealized roughness changes
   - Askervein hill experiment
   - The classical ‘RIX-site’, Portugal

2. Reference cases
   - Focus: quantitative validation of model accuracy
   - 6 sites selected
   - Multiple masts of acceptable high quality
   - Geographically spread
   - Studied in-depth

3. Ad hoc cases
   - Focus: qualitative validation with high volume
   - Any site available to the validation team
   - Flat or complex
   - Compared to WAsP and local mast data

Classical Test Cases

Speed-up versus terrain slope

It is a well-known fact that linearized models like WAsP tend to overestimate speed-up of wind flow in steep terrain. But at which terrain slope does the linearizing approximation break down? The below graph shows this analysis comparing the predicted speed-up of WAsP and WAsP-CFD.

Results show that, already at average slopes of 10° (or 17%), linearized models overestimate speed-up by nearly 10%.

Reference Test Sites

In the initial phases of the WAsP-CFD project a gross list of reference projects was compiled. Eventually the list was abbreviated to six sites with a very large geographical variety, fulfilling the requirements to on-site measurements. Measurements were thoroughly screened and detailed terrain and roughness models were established for each site prior to performing the mast cross prediction analyses presented below for the top-level anemometers.

Results show a clear reduction in cross prediction error using WAsP-CFD for all reference sites demonstrating the improved accuracy of WAsP-CFD.

Ad-hoc Test Sites

The ad-hoc group of projects includes all project types - and not limited to complex terrain - ranging from mountainous terrain in deep forest in Sweden to rolling hills or coastal sites near equatorial Brazil and projects on a flat coastal plain in Pakistan. There are no constraints in terms on number of masts, multiple measuring levels or data quality. Hence, the main outcome for each project is mainly qualitative - does the model converge? Are the results meaningful? How do results compare with WAsP and local mast data?

More than 500 analyses have already been calculated successfully using WAsP CFD.
WAsP 11 (WAsP CFD) – Pre-order

CFD for wind resource assessment in complex terrain

Introduction
Release of WAsP 11 and WindPRO 2.9 is expected during March 2013. It is now possible to pre-order your WAsP 11 license and to enjoy additional benefits by an early sign-up.

Pre-order - WAsP 11
- WAsP 11 (WAsP CFD) licence: €3500,-
- WAsP 11 upgrade from v. 10 / earlier: €525,- / €1000,-
- WindPRO 2.9
  (Free interface to CFD in MODEL, but WAsP 11 is required)

Pre-order – WAsP CFD calculation credits
- WAsP CFD Calculation credit: €200,-
  (one calculation credit will give you accurate results in one tile sized 2 km x 2 km)

Time limited introduction offers
- New WAsP 11 users will receive 2 free WAsP CFD calculation credits per WAsP 11 license. These will be valid in a period of two weeks after you register your WAsP CFD account.
- The first 150 organizations to buy a WAsP 11 license or upgrade will receive 10 free WAsP CFD calculations per organization. These will be valid until one month after the WAsP 11 release.

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All prices are excluding VAT.

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