**SEVENTH FRAMEWORK PROGRAMME**
**THEME 3**
**ICT - INFORMATION AND COMMUNICATION TECHNOLOGIES**

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| **Project acronym:** | AEOLUS |
| **Project full title:** | Distributed Control of Large-Scale Offshore Wind Farms |
| **Project reference:** | **224548** |
| **Start date:** | 1 May 2008 |
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# Deliverable no.: 2.3a

**Title:** Decentralized dynamic modelling with Parameters - Addendum

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| **Lead beneficiary of this deliverable:** | AAU |
| **Author(s):** | Torben Knudsen |
| **Participant(s):** | |
| **Work packages contributing to the deliverable:** | WP2 |
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**Summary:**
In D2.3 wind flow models including changing average wind and direction and also changing power references on more than one upwind turbine are investigated for prediction of wind on down wind turbines. The purpose of D2.3A is to update the wind flow models in D2.3 using experimental data as simulated data is used in D2.3. As the received data at the end of the project is very limited only one of the models in D2.3 can be investigated. This is covered in D2.5A with good results considering the limited amount of data.

# Decentralized dynamic modelling with parameters - Addendum - D2.3A

Torben Knudsen

**Summary**

In D2.3 wind flow models including changing average wind and direction and also changing power references on more than one upwind turbine are investigated for prediction of wind on down wind turbines. The purpose of D2.3A is to update the wind flow models in D2.3 using experimental data as simulated data is used in D2.3. As the received data at the end of the project is very limited only one of the models in D2.3 can be investigated. This is covered in D2.5A with good results considering the limited amount of data.

This report is deliverable 2.3A in the project *Distributed Control of Large-Scale Offshore Wind Farms* with the acronym *Aeolus*.

In deliverable 2.2 (Knudsen and Soltani, 2009) transfer functions were made that predicted the down wind effective wind speed from upwind effective wind speed for turbines placed along the average wind direction. The data used for this was experimental data from the OWEZ wind farm in normal operation.

The aim of D2.3 (Soltani et al., 2010) was to extend these models to include upwind power set point, changing average wind direction and speed and to do this in a adaptive fashion. As experimental data with power reference excitation was not available the data was simulated using the SimWindFarm simulator in the version with frozen turbulence. Models included in D2.3 are:

**Section 3.1.1** Model with out power reference exactly like in D2.2 i.e. with the wind turbines along the wind direction. And also a model where the wind direction is screw to the turbine row.

**Section 3.1.2** As in section 3.1.1 above but with adaptive parameter estimation.

**Section 3.2.1** As in section 3.1.1 but with power reference excitation.

**Section 3.2.2** As in section 3.1.2 but with power reference excitation.

**Section 4.1.2** Models where more upwind turbines in different directions are used to predict down wind wind speed. The models also include power reference excitations.

The purpose with D2.3A was to update all these models and investigations with real experimental data.

As explained in D2.5A (Knudsen, 2011) the project has by the time of writing received three data sets with power reference excitation. These data sets are with wind direction aligned with the wind and only excitation of one front turbine. Further, the investigation in D2.5A suggests that the conditions for two of the data sets might not be as specified. This leaves the project with one data set extending for approximately 15 min or 900 samples where there is power set point excitation of one upwind turbine in the wind direction. Consequently, models with screw inflow or more upwind turbines can not be investigated also 900 samples is considered to little to show the effect of adaptive estimation. This means that only the model in section 3.2.1 with wind flow along the row can be updated. This is done in D2.5A where it is shown that the dynamic effect off upwind power set point changes can be modelled in a satisfactory way considering the low number of samples. These results motivates further investigation if more data and resources for analysis can be obtained. Notice that there is no need to update the model in section 3.1.1 with wind direction along the row because this is covered in D2.2.

# References

T. Knudsen. Amendment to validated dynamic flow model. Confidential, AAU, 2011. Deliverable no.: 2.5A.

T. Knudsen and M. Soltani. Preliminary dynamic model. Confidential, AAU, 2009. Deliverable no.: 2.2.

M. Soltani, S. M. Shakeri, J. Grunnet, T. Knudsen, and T. Bak. Decentralized dynamic modeling with parameters. Confidential, AAU, 2010. Deliverable no.: 2.3.