Fast Control-Oriented Dynamic Linear Model of Wind Farm Flow and Operation

The aerodynamic interaction between wind turbines grouped in wind farms results in wake-induced power loss and fatigue loads of wind turbines. To mitigate these, wind farm control should be able to account for those interactions, typically using model-based approaches. Such model-based control approaches benefit from computationally fast, linear models and therefore, in this work, we introduce the Dynamic Flow Predictor. It is a fast, control-oriented, dynamic, linear model of wind farm flow and operation that provides predictions of wind speed and turbine power. The model estimates wind turbine aerodynamic interaction using a linearized engineering wake model in combination with a delay process. The Dynamic Flow Predictor was tested on a two-turbine array to illustrate its main characteristics and on a large-scale wind farm, comparable to modern offshore wind farms, to illustrate its scalability and accuracy in a more realistic scale. The simulations were performed in SimWindFarm with wind turbines represented using the NREL 5 MW model. The results showed the suitability, accuracy, and computational speed of the modeling approach. In the study on the large-scale wind farm, rotor effective wind speed was estimated with a root-mean-square error ranging between 0.8% and 4.1%. In the same study, the computation time per iteration of the model was, on average, $2.1 \times 10^{-5}$ s. It is therefore concluded that the presented modeling approach is well suited for use in wind farm control.

General information
Publication status: Published
Organisations: Department of Wind Energy, Integration & Planning
Contributors: Kazda, J., Cutululis, N. A.
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Energies
Volume: 11
Issue number: 12
Article number: 3346
ISSN (Print): 1996-1073
Ratings:
BFI (2018): BFI-level 2
Scopus rating (2018): CiteScore 3.18 SJR 0.612 SNIP 1.156
Web of Science (2018): Impact factor 2.707
Web of Science (2018): Indexed yes
Original language: English
Electronic versions:
energies_11_03346.pdf
DOIs:
10.3390/en11123346
Source: FindIt
Source-ID: 2442069603
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review