Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Optimal control of wind-farm boundary layers: effect of turbine response time[1] WIM MUNTERS, JOHAN MEYERS, KU Leuven — Complex turbine wake interactions play an important role in overall energy extraction in large wind farms. Current control strategies optimize individual turbine power, and lead to significant energy losses in wind farms compared to lone-standing turbines. In recent work, an optimal control framework for dynamic induction control of wind farms and their interaction with the atmospheric boundary layer (ABL) was introduced, with the aim of mitigating such losses. The framework applies a receding horizon methodology, in which the ABL state is modeled through large-eddy simulations. Previously, the framework was applied to both fully-developed (Goit and Meyers 2015, J Fluid Mech, 768, 5–50) and spatially developing wind farms (Goit et al. 2016, Energies, 9, 29), for which respective energy gains of 16% and 7% were obtained, albeit at the cost of additional turbine loading variability. Here, we quantify the trade-off between increased power extraction and smoothed turbine dynamics by varying the turbine response time in the control framework. We consider simulation cases restricted to underinduction compared to Betz-optimal induction, as well as cases that also allow overinduction. In addition, efforts on replicating optimized power gains with practical controllers are presented.

[1]The authors are supported by the ERC (ActiveWindFarms, grant no.: 306471)

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Date submitted: 01 Aug 2016 Electronic form version 1.4