Closed-loop wind farm control

van Wingerden, Jan-Willem; Pao, Lucy; Fleming, Paul

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BOOK OF ABSTRACTS

WESC2017 – Wind Energy Science Conference
Technical University of Denmark, Lyngby
June 26th – 29th, 2017

Preface

Wind Energy Science Conference 2017 (WESC-2017) is held at the Technical University of Denmark in Lyngby during June 26-29, 2017. This conference is the first of a series of bi-annual conferences launched by the European Academy of Wind Energy (EAWE). The purpose of the conference is to gather leading scientists and researchers in the field of wind energy to present their latest findings. The conference aims at covering all scientific topics in wind energy, comprising from most fundamental aspects to recent applications. It provides a world-wide forum for scientists to meet each other and exchange information of all aspects of wind energy, including aerodynamics, turbulence, wind resource assessment, wind farms and wakes, aero-serve-elasticity, loads, structural mechanics, control, operation and maintenance, generator technology, grid integration, structural design and materials, new concepts, as well as community acceptance, environmental aspects, and economics.

This volume of abstracts comprises all presentations of the conference, including two plenary lectures, and nearly 370 contributed papers, presented in either oral sessions or during 13 mini symposia. The abstracts are sorted chronologically after the day of presentation, corresponding to the way they appear in the conference programme. At the end of the book you will find a list of presenting authors, listed alphabetically, and the page number where their abstract appear.

I like to thank the scientific committee and the local organizing committee for their work with the evaluation and selection process. In particular, I thank Marianne Hjorthede Arbirk for her invaluable help in preparing the conference and this book of abstracts.

Jens N. Sørensen, chairman WESC-2017
Lyngby, June 2017

WindFarms2017 - Wind-power plants: interaction, control and integration:

Closed-Loop Wind Farm Control

Jan-Willem van Wingerden[a], Lucy Pao[b], and Paul Fleming[c]

For wind farm control, the current practice in industry is that every turbine has its own wind turbine controller that will optimize its own performance in terms of power output, load mitigation, and/or reference tracking. However, in several national American and European[1] research projects, researchers from industry and academia have shown that if you lower the power set point of the first turbine in a row of turbines you can increase the total amount of energy captured in that row by 2%. These control results were mainly obtained by using engineering models and simplistic scaled wind tunnel experiments. In more recent studies,[2] it has been shown that the success of these methodologies highly depend on the atmospheric conditions, the quality of the model, and the variability of the flow within a wind farm. In this presentation, we will present a closed-loop control framework that can mitigate the inevitable uncertainties present in the control-oriented models and that is robust against the time-varying behaviour.

In this presentation, we will develop this framework for the Active Power Control (APC) problem. APC can be used to balance the total power generated by wind farms with the power consumed on the electricity grid. With the increasing penetration levels of wind energy, there is an increasing need for this ancillary service. In this presentation, we show that the tracking of a certain power reference signal provided by the transmission system operator (TSO) can be significantly improved by using feedback control at the wind farm level (a typical result is given in Fig. 1b). We propose a simple feedback control law[3] (see Fig 1a) that significantly improves the tracking behaviour of the total power output of the farm, resulting in higher performance scores. The effectiveness of the proposed feedback controller will be demonstrated using high fidelity computational fluid dynamics simulations of a small wind farm.

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[a] Delft University of Technology, Delft, 2628CD The Netherlands (e-mail: j.w.vanwingerden@tudelft.nl)
[b] University of Colorado, Boulder, CO 80309 USA (e-mail: pao@colorado.edu)
[C] National Renewable Energy Laboratory, Golden, CO 80401 USA (e-mail: paul.fleming@nrel.gov)

[1] CL-Wincon, H2020 project
[2] Boersma et al, *American Control Conference*, (2017).
[3] Wingerden et al., *IFAC world congress,* (2017)

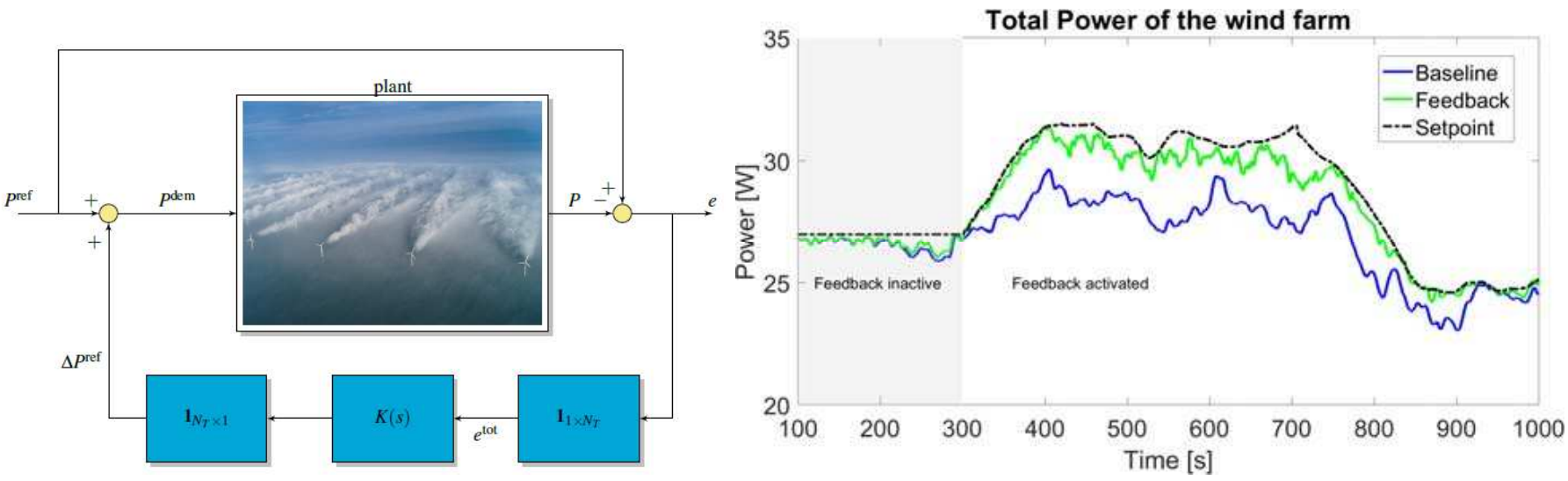

Figure 1: (a) Proposed closed loop control architecture. (b) Total Power of the wind farm with and without the proposed feedback control

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