

Bart M. Doekemeijer

WIND FARM CONTROL EXPERT · CONTROL ENGINEER · PHD

Boulder, CO, United States of America

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“When you can't change the direction of the wind – adjust your sails.”

Qualifications Summary

A wind energy enthusiast with 5 years of experience in the areas of wind turbine and wind farm control. Is considered ambitious, organized, goal-oriented and hard working, with a passion for interdisciplinary collaboration. Experienced with field experiments and industry-driven consultancy experience. His research topics include closed-loop wind farm control, wind farm modeling, flow estimation, turbine control, and wind farm optimization.

Experience

National Renewable Energy Laboratory

Boulder, CO, USA

POSTDOCTORAL RESEARCHER

Jan. 2021 - current

- Tasks include developing novel wind farm control solutions, industrial consultancy work, and field experiments

Delft University of Technology

Delft, The Netherlands

POSTDOCTORAL AND GUEST RESEARCHER

Aug. - Nov. 2020

- Tasks include the continuation of my doctoral research, supervising students, and knowledge transfer to new Ph.D. students.

Delft University of Technology

Delft, The Netherlands

PH.D. IN CONTROL ENGINEERING: “CLOSING THE LOOP IN MODEL-BASED WIND FARM CONTROL”

Aug. 2016 - July 2020

- Promoters: prof. dr. ir. J.W. van Wingerden, prof. dr. ir. M. Verhaegen
- This thesis investigates wind farm power maximization in a model-based closed-loop framework. Firstly, open-loop wake steering is evaluated on an onshore wind farm, highlighting inaccuracies in the wind farm model and leading to situational losses in energy yield. Secondly, this thesis shows that turbine power and vane measurements can be used to calibrate the model online to maintain model accuracy. This is tested in high-fidelity simulation, showing an energy yield increase of 1.4%. Finally, this thesis explores using dynamic models for control. This dissertation greatly advances the status quo of wind farm control and their commercial applicability.

Education

Delft University of Technology

Delft, The Netherlands & Boulder, USA

MASTER'S DEGREE IN SYSTEMS & CONTROL ENGINEERING

Sep. 2014 - June 2016

- “Cum laude” in major programme, with a GPA of 8.9/10.
- Master's dissertation performed at University of Colorado Boulder in the group of prof.dr. L. Y. Pao on the topic of wind farm control.
- Relevant coursework: Scientific Programming (C & Fortran), Nonlinear System Theory, Optimization, Robust Control, Multivariable Control, System Identification, Subspace Identification, Predictive Control, Reinforcement Learning, Fuzzy Logic, Neural Networks.

Delft University of Technology

Delft, The Netherlands

BACHELOR'S DEGREE IN AEROSPACE ENGINEERING

Sep. 2011 - July 2014

- “Cum laude” in major programme, with a GPA of 8.2/10.
- “Cum laude” in minor programme: Applied Physics.

Skills

Programming MATLAB (expert), Python (intermediate), Simulink (intermediate), LaTeX (intermediate), C++ (basic), Bash (basic)
Software FLORIS, WFSim, SOWFA, OpenFOAM, OpenFAST, Git, TORQUE/SLURM, High Performance Computing
Languages Dutch (native), English (fluent), French (conversational).

Honors & Awards

2020	Review editor , Frontiers in Energy Research – Wind Energy	N/A
2020	Organizer for invited sessions , American Control Conference 2018, 2019, 2020, 2021	Various, USA
2019	Invited speaker , Wind Energy Systems Engineering workshop (WESE)	Pamplona, Spain
2019	Excellent Student Paper Award , IEEE Conference on Control and Applications 2019	Hong Kong, China
2016	PhD Best Poster Award (1st place) , TUDelft Energy Initiative: Poster Event	Delft, The Netherlands

Key Engineering Projects

European Horizon 2020 project: “Closed-Loop Wind Farm Control” (CL-Windcon)

Delft, The Netherlands

CORE PARTNER, AND LEAD FOR SEVERAL DELIVERABLES

Nov. 2016 - Nov. 2019

- This project addressed the advanced modeling and the synthesis of open- and closed-loop control algorithms for a wind farm by treating the entire farm as a comprehensive real-time optimization problem. The synthesized control solutions were validated leveraging high-fidelity data from simulation, scaled wind tunnel experiments, and field testing. Main responsibilities included the development of the open- and closed-loop control algorithms, leading the wake steering campaign of the field experiment at a commercial onshore wind farm in Italy, high-fidelity validation of controllers in SOWFA, and project management.

Confidential research project with an industrial partner

Delft, The Netherlands

LEAD ROLE

Oct. 2018 - Nov. 2019

- Responsibilities included sparking interest by a company visit, planning and executing the technical work of the consultancy project, and close collaboration with one team member. Allowed the further development of soft skills such as project planning, team coordination, and interdisciplinary discussions. Also yielded a thorough understanding of the relevant challenges in the research field.

Confidential research project with an industrial partner

Boulder, USA

SUBCONTRACTED BY NREL AS A RESEARCH SCIENTIST

Jan. 2017 - May 2017

- Was subcontracted by the U.S. National Renewable Energy Laboratory (NREL) to work in a confidential research project for an industrial partner. Two months were spent at the National Wind Technology Center in Boulder, Colorado. This collaboration not only strengthened the link between TUDelft and NREL, but also gave practical insights and a better understanding of the industry needs.

Publications

BOOK CHAPTERS

1. * B M Doekemeijer, S Boersma, J R Annoni, P A Fleming, and J W van Wingerden. Wind plant controller design. In Paul Veers, editor, *Wind Energy Modeling and Simulation; Volume 1: Atmosphere and plant*, Energy Engineering, chapter 7. The Institution of Engineering and Technology (IET), 2019a. ISBN 978-1-78561-521-4

JOURNAL PUBLICATIONS

10. * B M Doekemeijer, S Kern, S K Kanev, B Salbert, J Schreiber, F Campagnolo, C L Bottasso, S Maturu, S Schuler, F Wilts, T Neumann, G Potenza, F Calabretta, F Fioretti, and J W van Wingerden. Fields experiments for open-loop yaw-based wake steering at a commercial onshore wind farm in Italy. *Wind Energy Science Discussions*, pages 1–22, 2020a
9. * B M Doekemeijer, D C van der Hoek, and J W van Wingerden. Closed-loop model-based wind farm control using FLORIS under time-varying inflow conditions. *Renewable Energy*, 156:719–730, 2020b. ISSN 0960-1481
8. * B M Doekemeijer and J W van Wingerden. Observability of the ambient conditions in model-based estimation for wind farm control: A focus on static models. *Wind Energy*, 2020. Early view
7. * B M Doekemeijer, S Boersma, L Y Pao, T Knudsen, and J W van Wingerden. Online model calibration for a simplified LES model in pursuit of real-time closed-loop wind farm control. *Wind Energy Science*, 3(2):749–765, 2018a
6. J A Frederik, B M Doekemeijer, S P Mulders, and J W van Wingerden. The helix approach: Using dynamic individual pitch control to enhance wake mixing in wind farms. *Wind Energy*, n/a(n/a), 2020a. Early view
5. H Mendez Reyes, S K Kanev, B M Doekemeijer, and J W van Wingerden. Validation of a lookup-table approach to modeling turbine fatigue loads in wind farms under active wake control. *Wind Energy Science*, 4(4):549–561, 2019
4. S Raach, B M Doekemeijer, S Boersma, J W van Wingerden, and P W Cheng. Feedforward-feedback wake redirection for wind farm control. *Wind Energy Science Discussions*, pages 1–18, 2019
3. S Boersma, B M Doekemeijer, S Siniscalchi-Minna, and J W van Wingerden. A constrained wind farm controller providing secondary frequency regulation and potential power maximization: an LES study. *Renewable Energy*, 134:639–652, 2019b. ISSN 0960-1481
2. A Rott, B M Doekemeijer, J Seifert, J W van Wingerden, and M Kühn. Robust active wake control in consideration of wind direction variability and uncertainty. *Wind Energy Science*, 3(2):869–882, 2018
1. S Boersma, B M Doekemeijer, M Vali, J Meyers, and J W van Wingerden. A control-oriented dynamic wind farm model: WFSim. *Wind Energy Science*, 3(1):75–95, 2018a

TUTORIAL PUBLICATIONS

3. * B M Doekemeijer, P A Fleming, and J W van Wingerden. A tutorial on the synthesis and validation of a closed-loop wind farm controller using a steady-state surrogate model. In *American Control Conference (ACC)*, pages 2825–2836, 2019b
2. J W van Wingerden, P A Fleming, T Göçmen, I Eguinoa, B M Doekemeijer, K Dykes, M Lawson, E Simley, J R King, D Astrain, M Iribas, C L Bottasso, J Meyers, S Raach, K Kölle, and G Giebel. Expert elicitation on wind farm control. In *Science of Making Torque from Wind (TORQUE)*, 2020. In review
1. S Boersma, B M Doekemeijer, P M O Gebraad, P A Fleming, J R Annoni, A K Scholbrock, J A Frederik, and J W van Wingerden. A tutorial on control-oriented modeling and control of wind farms. In *American Control Conference (ACC)*, pages 1–18, 2017

CONFERENCE PUBLICATIONS

13. * B M Doekemeijer, P A Fleming, and J W van Wingerden. Model-based closed-loop wind farm control for power maximization: a large eddy simulation study. In *Conference on Control Technology & Applications*, pages 284–289, 2019c. ISBN 978-1-7281-2767-5
12. * B M Doekemeijer, S Boersma, J W van Wingerden, and L Y Pao. Joint state-parameter estimation for a control-oriented LES wind farm model. *Journal of Physics: Conference Series*, 1037:032013, 2018b
11. * B M Doekemeijer, S Boersma, L Y Pao, and J W van Wingerden. Ensemble Kalman filtering for wind field estimation in wind farms. In *American Control Conference (ACC)*, pages 19–24, 2017
10. * B M Doekemeijer, J W van Wingerden, S Boersma, and L Y Pao. Enhanced Kalman filtering for a 2D CFD NS wind farm flow model. *Journal of Physics: Conference Series*, 753(5):052015, 2016
9. J A Frederik, B M Doekemeijer, S P Mulders, and J W van Wingerden. On wind farm wake mixing strategies using dynamic individual pitch control. In *Science of Making Torque from Wind (TORQUE)*, 2020b. In review
8. D C van der Hoek, B M Doekemeijer, L E Andersson, and J W van Wingerden. Predicting the effect of wake steering on the annual energy production of a large wind farm using high-fidelity simulations and Gaussian process regression. In *Science of Making Torque from Wind (TORQUE)*, 2020. In review
7. L E Andersson, B M Doekemeijer, D C van der Hoek, J W van Wingerden, and L Insländ. Adaptation of engineering wake models using Gaussian process regression and high-fidelity simulation data. In *Science of Making Torque from Wind (TORQUE)*, 2020. In review
6. S Boersma, B M Doekemeijer, T Keviczky, and J W van Wingerden. Stochastic model predictive control: Uncertainty impact on wind farm power tracking. In *American Control Conference (ACC)*, pages 4167–4172, 2019a
5. B Ritter, E Mora, A Schild, B M Doekemeijer, and U Konigorski. Adaptive master-slave Cubature Kalman filters subject to state inequality constraints for wind turbine state estimation. In *American Control Conference (ACC)*, pages 3482–3487, 2019
4. S Boersma, V Rostampour, B M Doekemeijer, W van Geest, and J W van Wingerden. A constrained model predictive wind farm controller providing active power control: an LES study. *Journal of Physics: Conference Series*, 1037:032023, 2018b
3. S Boersma, V Rostampour, B M Doekemeijer, J W van Wingerden, and T Keviczky. A model predictive wind farm controller with linear parameter-varying models. *IFAC Conference on Nonlinear Model Predictive Control*, 51(20):241–246, 2018d. ISSN 2405-8963
2. S Raach, S Boersma, B M Doekemeijer, J W van Wingerden, and P W Cheng. LiDAR-based closed-loop wake redirection in high-fidelity simulation. *Journal of Physics: Conference Series*, 1037:032016, 2018
1. S Boersma, P M O Gebraad, M Vali, B M Doekemeijer, and J W van Wingerden. A control-oriented dynamic wind farm flow model: WFSim. *Journal of Physics: Conference Series*, 753(3):032005, 2016

Extracurricular Activities

PhD Faculty Council

Delft, The Netherlands

BOARD MEMBER

Nov. 2017 - Jan. 2020

- The 3mE PhD Council organizes monthly events for approximately 300 PhD students of the Faculty of Mechanical, Maritime and Materials Engineering. This council enables people to learn, connect, and improve their PhD experience at the Delft University of Technology.
- Leading role in organizing, among others: monthly lunch lectures, a 4-week meditation workshop, annual sports day.

CU Boulder's International Festival Committee

Boulder, USA

SUBCOMMITTEE CHAIR

Sep. 2015 - Apr. 2016

- Volunteered at several activities focused on celebrating diversity and bringing students from different backgrounds together. One major activity was "IFest 2016", a yearly recurring festival organized by and for students. This festival typically attracts over 6,000 guests and is free to the public. Throughout the day, nationalities from all over the world were represented by students hosting their country's personalized booth. Furthermore, there were various cultural performances by student groups.
- Responsibilities included chairing two subcommittees, supervising 10 CU students, communicating with external student groups, organizing the contents and layout of the day, and designing graphics to publicize the event.

Personal Interests

- Self development
- Photography & graphical design
- Motorcycling
- Retro videogames
- Fitness, sports
- Hiking
- Culture and personal beliefs
- Tutoring, teaching
- Human psychology