Curriculum vitae for
Enrico Antonini

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GENERAL RESEARCH INTERESTS AND STRATEGY

- Primary research goals:
  - Facilitate large-scale deployment of wind power generation in future energy systems
  - Understand the fundamental mechanisms of wind power generation from turbine to global scale
  - Develop computational techniques to model, control and optimize fluid flows with applications to wind energy
- Primary research areas:
  - Fluid dynamical modelling
  - Atmospheric and wind energy sciences
  - Energy system engineering
  - Optimization and data science

EDUCATION

Doctor of Philosophy - *University of Toronto, Toronto, Canada*   09.2014 - 09.2018
- Mechanical and Industrial Engineering
- Thesis supervisors: Prof. Cristina Amon, Dr. David Romero
- Thesis topic: CFD-based Methodology for Wind Farm Layout Optimization

Master of Science - *University of Padua, Padua, Italy*   10.2010 - 03.2013
- Mechanical Engineering (final grade: 110/110, with honours)
- Thesis supervisors: Prof. Ernesto Benini, Prof. Jens Nørkær Sørensen, Dr. Marco Raciti Castelli
- Thesis topic: Development of a Prescribed Expanding Vortex Wake Model for HAWTs

Bachelor of Science - *University of Padua, Padua, Italy*   10.2007 - 09.2010
- Mechanical Engineering (final grade: 110/110, with honours)
- Thesis supervisors: Prof. Alarico Macor, Dr. Antonio Rossetti
- Thesis topic: Optimized Management of a Power-Split Transmission for Agricultural Tractors

RESEARCH EXPERIENCE

Postdoctoral Research Scientist - *Carnegie Institution for Science, Stanford, USA*   03.2019 – present
- Studied the physics of wind power extraction for regional-scale wind farms
- Investigated physical parameters that control wind farm power extraction

Postdoctoral Fellow - *University of Toronto, Toronto, Canada*   10.2018 – 01.2019
- Implemented and applied a CFD-based optimization methodology for wind farm layouts

Research Assistant - *University of Toronto, Toronto, Canada*   09.2014 - 09.2018
- Developed and improved CFD wind farm models
- Formulated an innovative CFD-based optimization methodology for wind farm layouts

Research Engineer - *University of Padua, Padua, Italy*   04.2013 - 08.2014
- Developed BEM and vortex-wake models for vertical-axis wind turbines
- Applied aero-structural optimization approaches to vertical-axis wind turbines

Graduate Student - *University of Padua, Padua, Italy*   09.2012 - 03.2013
- Validated an innovative vortex-wake model for horizontal-axis wind turbines
- Compared and assessed different numerical models for horizontal-axis wind turbines

Exchange Student - *Technical University of Denmark, Copenhagen, Denmark*   03.2012 - 08.2012
- Developed state-of-the-art BEM model for horizontal-axis wind turbines
- Proposed an innovative vortex-wake model for horizontal-axis wind turbines

TEACHING EXPERIENCE

Guest Lecturer - *University of Toronto, Toronto, Canada*
- Wind Power   Fall 2018

Teaching Assistant - *University of Toronto, Toronto, Canada*
- Fluid Mechanics I   Fall 2016
- Alternative Energy Systems   Fall 2016, Fall 2017
- Wind Power   Fall 2017, Fall 2018
- Thermal Energy Conversion   Winter 2018

MENTORED STUDENTS

Omri Tayyara - Master of Engineering at University of Toronto   2018
- Project: CFD Modeling of After-market Rotor Attachments on Wind Turbines
- First position after degree: PhD student at University of Toronto

Danyal Rehman - Bachelor of Applied Science at University of Toronto   2017
- Project: Wind Farm Power Optimization using Adaptive Yaw Control
- First position after degree: Master/PhD student at MIT

Harmit Komal - Master of Engineering at University of Toronto   2016
- Project: Modelling Wind Turbine Wakes in Complex Terrain
- First position after degree: Project Engineer at Environment and Climate Change Canada

Adithya Dhoot - Master of Applied Science at University of Toronto   2016
- Project: Wind Farm Layout Optimization using Probabilistic Inference
- First position after degree: Software Engineer at Autodesk

PROFESSIONAL SERVICE

Topic Editor - *Sustainability, MDPI*   12.2020 - present
- Providing support for the journal's Special Issues
- Promoting the journal during conferences

Member of search committee - *Carnegie Institution for Science, Stanford, USA*   10.2020 - present
- Represented early career scientists in the search for three faculty hires

Judge for Student Presentation Award - *AGU Fall Meeting, San Francisco, USA*   12.2019
- Judged and provided feedback on students' poster and oral presentations

Web developer - *University of Toronto, Toronto, Canada*   10.2016 - 01.2019
- Designed and maintained the website of the research group

INDUSTRIAL EXPERIENCE

Research Engineer - *Sheridan College, Oakville, Canada*   10.2018 - 01.2019
- Studied the performance of innovative vertical axis wind turbine using CFD models
- Provided preliminary assessment of several improvements of the prototype model

Software Engineer - *NuPhysics Consulting Ltd., Toronto, Canada*   03.2016 - 04.2017
- Developed software programs and simulators for CFD applications
- Led research and development area

COMPUTER PROFICIENCY

- Scientific programming: MATLAB, Python, Fortran, C++, Java
- Computational Fluid Dynamics: OpenFOAM, Ansys Fluent, Ansys CFX, WRF
- Mechanical Design: Ansys, SolidWorks, Gambit
- Website programming and design: HTML, CSS, JavaScript, PHP

HONOURS AND AWARDS

- Bachelor's degree *cum laude* (with honours)   09.2010
- Master's degree *cum laude* (with honours)   03.2013

GRANTS, FELLOWSHIPS, AND SCHOLARSHIPS

- Gates Ventures postdoctoral funding (**US$ 253,380**)   03.2019 - 03.2023
- Metcalfe family graduate fellowship for sustainable energy research (**CA$ 6,000**)   09.2017 - 08.2018
- Hatch graduate scholarship for sustainable energy research (**CA$ 20,000**)   09.2016 - 08.2018
- University of Toronto MIE graduate student travel grant (**CA$ 900**)   11.2016
- University of Toronto MIE graduate scholarship (**CA$ 139,843**)   09.2014 - 09.2018
- Erasmus programme scholarship (**€ 1,800**)   03.2012 - 08.2012

JOURNAL REFEREE

- Joule
- Energy
- Applied Energy
- Renewable Energy
- Energy Conversion and Management
- Journal of Wind Engineering & Industrial Aerodynamics
- Journal of Cleaner Production
- Wind Energy
- Energies
- Sustainability
- Journal of the Atmospheric Sciences
- TCSME
- IMECE

PROFESSIONAL MEMBERSHIPS

- Member of the American Society of Mechanical Engineers (ASME)
- Member of the American Geophysical Union (AGU)

TRAINING AND WORKSHOPS

- How to conduct an inclusive search in STEM   2020
  Carnegie Institution for Science, Stanford, USA
- Lab training for measuring the performance of a two-stage air compressor   2018
  University of Toronto, Toronto, Canada
- Lab training for measuring head losses in pipe systems   2016
  University of Toronto, Toronto, Canada
- Ethics in research   2015
  University of Toronto, Toronto, Canada

PUBLICATIONS

Journal articles

9. **E.G.A. Antonini**, K. Caldeira, "Spatial constraints in large-scale expansion of wind power plants", ***Proceedings of the National Academy of Sciences***, Vol. 118, No. 27, p. e2103875118, 2021.
8. A. Dhoot, **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Optimizing wind farms layouts for maximum energy production using probabilistic inference: Benchmarking reveals superior computational efficiency and scalability", ***Energy***, Vol. 223, p. 120035, 2021.
7. **E.G.A. Antonini**, K. Caldeira, "Atmospheric pressure gradients and Coriolis forces provide geophysical limits to power density of large wind farms", ***Applied Energy***, Vol. 281, p. 116048, 2021.
6. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Optimal design of wind farms in complex terrains using computational fluid dynamics and adjoint methods", ***Applied Energy***, Vol. 261, p. 114426, 2020.
5. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Improving CFD Wind Farm Simulations incorporating Wind Direction Uncertainty", ***Renewable Energy***, Vol. 133, pp. 1011-1023, 2019.
4. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Continuous Adjoint Formulation for Wind Farm Layout Optimization: A 2D Implementation", ***Applied Energy***, Vol. 228, pp. 2333-2345, 2018.
3. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Analysis and Modifications of Turbulence Models for Wind Turbine Wake Simulations in Atmospheric Boundary Layers", ***Journal of Solar Energy Engineering***, Vol. 140, No. 3, p. 031007, 2018.

2. **E.G.A. Antonini**, G. Bedon, S. De Betta, L. Michelini, M. Raciti Castelli and E. Benini, "An Innovative Vortex Model for Dynamic Stall Simulations", *AIAA Journal*, Vol. 53, No. 2, pp. 479-485, 2015.
1. G. Bedon, **E.G.A. Antonini**, S. De Betta, M. Raciti Castelli and E. Benini, "Evaluation of the Different Aerodynamic Databases for Vertical Axis Wind Turbine Simulations", *Renewable & Sustainable Energy Reviews*, Vol. 40, pp. 386-399, 2014.

Refereed conference articles

2. **E.G.A. Antonini**, T. Ruggles, D.J. Farnham, K. Caldeira, "Meeting electricity demand with distributed wind and solar generation: System flexibility drives optimal siting", *Proceedings of the ASME International Mechanical Engineering Congress and Exposition*, IMECE2021-70678, Virtual conference, USA, 2021.
1. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Analysis and modifications of turbulence models for wind turbine wake simulations in atmospheric boundary layers", *Proceedings of the ASME International Mechanical Engineering Congress and Exposition*, IMECE2016-67353, Phoenix, AZ, USA, 2016.

Manuscripts under review or in preparation

2. **E.G.A. Antonini**, T. Ruggles, D.J. Farnham, K. Caldeira, "The quantity-quality transition in the value of expanding wind and solar power generation", **under review**.
1. D.J. Farnham, T. Ruggles, **E.G.A. Antonini**, Lewis, N., Davis, S., Caldeira, K., "Power system transition: Acknowledging uncertainty to limit regrets", **in preparation**.

PRESENTATIONS

Oral presentations

7. **E.G.A. Antonini**, T. Ruggles, D.J. Farnham, K. Caldeira, "Meeting US electricity demand with distributed wind and solar generation: System flexibility drives optimal siting", *ASME International Mechanical Engineering Congress and Exposition*, Virtual Conference, USA, 2021.
6. **E.G.A. Antonini**, K. Caldeira, "How atmospheric pressure gradients and Coriolis forces control the power density of large wind farms", *Wind Energy Science Conference*, Hannover, Germany, 2021.
5. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Computational-Fluid-Dynamics-based Methodology for Wind Farm Layout Optimization", *Seminar Series*, Carnegie Institution for Science, Stanford, CA, USA, 2018.
4. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Continuous Adjoint Formulation for Wind Farm Layout Optimization", 8th *MIE Symposium*, University of Toronto, Toronto, ON, Canada, 2017.
3. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Analysis and modifications of turbulence models for wind turbine wake simulations in atmospheric boundary layers", *ASME International Mechanical Engineering Congress and Exposition*, Phoenix, AZ, USA, 2016.
2. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Enhancement of CFD Wind Farm Simulations through Introduction of Wind Direction Uncertainty", 7th *MIE Symposium*, University of Toronto, Toronto, ON, Canada, 2016.
1. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Implementation and simulation of wind turbines with the OpenFOAM solver using the actuator disk approach", 6th *MIE Symposium*, University of Toronto, Toronto, ON, Canada, 2015.

Poster presentations

6. **E.G.A. Antonini**, K. Caldeira, "How atmospheric pressure gradients and Coriolis forces control the power density of large wind farms", *AGU Fall Meeting*, San Francisco, CA, USA, 2020.
5. M. Hauser, T. Ruggles, C. Henry, K. Caldeira, R. Peer, **E.G.A. Antonini**, "Cost Sensitivity of Electricity Systems to the Shape of Electricity Demand Curve: A Sub-Saharan Africa Example", *AGU Fall Meeting*, San Francisco, CA, USA, 2020.
4. T. Ruggles, D.J. Farnham, C. Henry, R. Peer, L. Duan, **E.G.A. Antonini**, M, Hauser, N. Lewis, J.A. Dowling, K. Rinaldi, S.J. Davis, D. Tong, K. Caldeira, "Electrofuels and curtailment of wind and solar power", *AGU Fall Meeting*, San Francisco, CA, USA, 2020.
3. **E.G.A. Antonini**, K. Caldeira, "Limits of electricity generation from wind: characterizing transitional scales in wind farm power density", *AGU Fall Meeting*, San Francisco, CA, USA, 2019.
2. O. Tayyara, **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "CFD modeling of after-market rotor attachments performance on horizontal axis wind turbines", 9th *MIE Symposium*, University of Toronto, Toronto, ON, Canada, 2018.
1. **E.G.A. Antonini**, D.A. Romero, C.H. Amon, "Continuous Adjoint Formulation for Wind Farm Layout Optimization", 9th *MIE Symposium*, University of Toronto, Toronto, ON, Canada, 2018.

IN THE PRESS

- **How to build a better wind farm**, *Scienmag: Latest Science and Health News*, Jun 28, 2021 [link].
- **Come migliorare il rendimento dei grandi campi eolici del futuro**, *QualEnergia*, Jul 05, 2021 [link].
- **Optimal size for wind farms is revealed by computational study**, *Physics World*, Jul 08, 2021 [link].
- **L'uomo del vento: "Così si ottimizza l'eolico"**, *La Repubblica*, Jul 09, 2021 [link].
- **Weatherwatch: research finds optimal size for windfarms**, *The Guardian*, Jul 27, 2021 [link].
- **Protecting self-driving cars from cosmic rays, size limits for wind farms**, *Physics World podcast*, Jul 29, 2021 [link].