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TEM#101

Hybrid Power Plants: Challenges and Opportunities

Participants' introductory slides



Dr. Mohammad Amin
Norwegian University of
Science and Technology

Dr. Mohammad Amin is an Associate Professor at the Department of Electric Power Engineering at NTNU. He received the Ph.D. in Engineering Cybernetics from Norwegian University of Science and Technology (NTNU), Trondheim, Norway in 2017.

Previously, he was a Senior Research Associate in the Dept. of Electrical and Computer Engineering at Illinois Institute of Technology, Chicago from 2017 to 2019. Dr Amin's research activities mainly focus on power electronics application to power system, distributed generation, renewable energy integration, HVDC transmission, FACTS, microgrid, smart grids, hybrid or fully electric vehicles, and robust control theory for power electronics system.

Link to the webpage <https://www.ntnu.edu/employees/mohammad.amin>

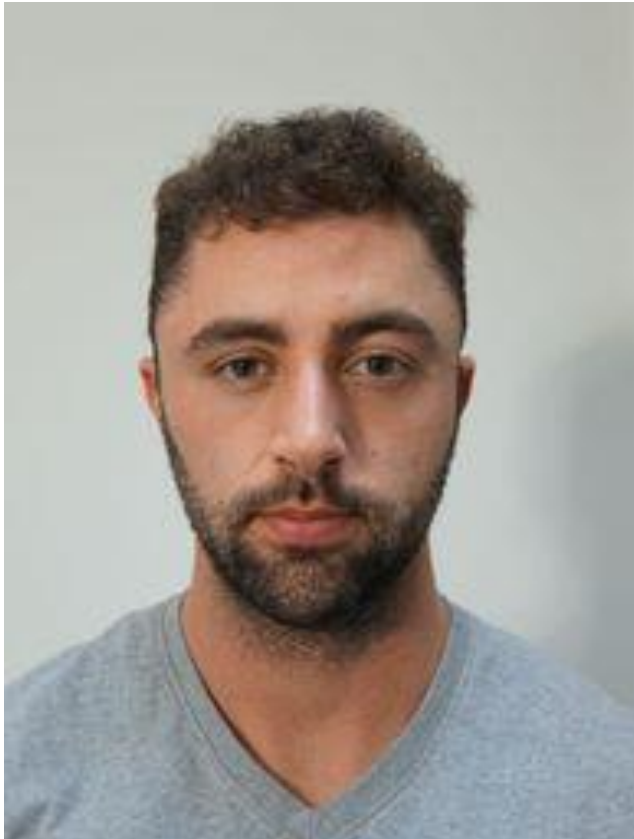
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Kate Anderson
National Renewable
Energy Laboratory

Kate Anderson leads the Modeling & Analysis Group at the National Renewable Energy Laboratory (NREL). Kate is the program lead for the development of NREL's [REopt](#) model, used to evaluate cost-optimal selection and sizing of behind-the-meter energy assets for grid-connected and off-grid hybrid energy systems. Kate's work includes providing technical assistance on EE and RE technologies to meet energy goals, valuing energy resilience, and evaluating the gap between energy modeling and deployment.

Kate has a B.S. in aerospace engineering from MIT, an M.S. in Renewable Energy Systems Technology from Loughborough University, and is pursuing a Ph.D. in Advanced Energy Systems at Colorado School of Mines. Prior to joining NREL, Kate launched satellites as a captain in the U.S. Air Force.



Dr. Aaron Barker
NREL

As a Senior Researcher at NREL, Aaron's research focuses on the development of systems engineering and financial modelling tools; particularly for hybrid renewable energy projects.

Having previously worked on Marine Renewable Energy projects, including the development of software for modelling operations and maintenance strategy for offshore wind, Aaron now develops modeling and analysis software for hybrid systems.

Aaron received his B.S. in Civil engineering from University College Cork in 2013, and his Ph.D. in Renewable Energy from University College Cork in 2019



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WIND ENERGY TECHNOLOGIES OFFICE

**GENERAL
DYNAMICS**



Bret Barker

GD supporting U.S
Department of Energy

I support the U.S. Department of Energy in the Wind Energy Technologies Office with management of the Distributed Wind Program. The Distributed Wind Program addresses the research challenges and opportunities for wind technologies of all scales connected at electricity distribution voltages (nominally 70 kV) and in microgrid (grid connected and isolated) applications. In this role I oversee multiple initiatives that are directly and indirectly related to wind hybrid power system R&D, and inform U.S. contributions to [IEA Wind Task 41: Enabling Wind to Contribute to a Distributed Energy Future](#). Factsheets for relevant projects linked below.

[Microgrids, Infrastructure Resilience, and Advance Controls Launchpad \(MIRACL\)](#)
[Tools Assessing Performance \(TAP\)](#)
[Defence and Disaster Deployable Turbine \(D3T\)](#)
[Competitiveness Improvement Project \(CIP\)](#)



E. Ian Baring-Gould
National Renewable Energy
Laboratory

My work at NREL has focused in three primary areas; applications engineering for distributed Renewable Energy (RE) technologies, assistance in the implementation of renewable technologies for both developed and rural markets, and educational outreach for renewable energy technologies, primarily wind. Relating to hybrid power systems, I have worked on smaller scale isolated and islanded networks (typically between 10kW and 10MW) since the mid 1990's considering technology, policy and regulatory frameworks.

I currently lead the [distributed wind research program](#) at NREL and am a co-operating agent of [IEA Wind Task 41, Enabling Wind to Contribute to a Distributed Energy Future](#) and am a principle on the [MIRACL project](#). As part of my work in smaller scale power system for energy access I was also a leader in the development of the [Quality Assurance Framework for Microgrid Power Systems](#). A [full Bio](#) can be found at on the NREL web site.

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DTU Wind Energy
Department of Wind Energy



Kaushik Das

Technical University of Denmark

- PhD in Wind Energy, DTU Wind Energy
- Researcher at DTU Wind Energy
- Main research activity involves sizing, operation, control, energy management system and grid services of Hybrid Power Plants. Leading and involved in multiple national and international research projects.
- Other research includes integration of renewables to power systems, weather dependent power systems, ancillary services

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Ir. Matthijs DOCLO
ENGIE Laborelec

Msc. in Electromechanical Engineering with 3+ years of experience. Project Engineer in ENGIE Laborelec's Storage Lab and Future Collectivities & Homes Lab.

Main expertise: Renewable energy communities (reference project H2020 [MUSE GRIDS](#)), storage integration, ancillary services for storage and RES.

Currently leading research projects on hybridization of different energy storage technologies and hybridization of wind and storage.

matthijs.doclo@engie.com

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NERGICA

Renewable
Energy Research
and Innovation



Ege Dundar
UQTR

Doctorate in Material and Energy Science with a background in chemical engineering. My interests lie in renewable energy and the use of computational methods to complement experimental work in the description of various phenomena.

Description of interests and projects I was involved in can be found [here](#) and [here](#).

I am interested in this TEM mainly to learn about the latest developments in microgrid technology involving wind, solar, storage, and other technologies, and hybrid power plant systems in general.

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DTU Wind Energy
Department of Wind Energy



Katherine Dykes

Technical University of Denmark

- Section Head, DTU Wind Energy, System Design, Operation and Control
- Research on design, operation and control of wind farms – now with increased focus on renewable energy power plants (hybrids and more).

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**Associate Prof. Dr.
Thomas Ebel
CIE/SDU**

- 1995 PhD in Solid State Chemistry, magnetic materials and Electrochemistry, University Münster, Germany
- 1995-2008 Head of R&D Aluminium Electrolytic Capacitors at Siemens later Epcos now TDK, Heidenheim/Milano, Germany/Italy
- 2008-2018 Managing Director FTCAP now Mersen, Capacitors, Husum, Germany
- Since 8/2018 Head of Electrical Engineering SDU and the Centre for Industrial Electronics (CIE), Sønderborg, Denmark
- Expert in Energy Storage (Aluminium Electrolytic, Metalized Film and Supercapacitors and Li-ion batteries)
- Close cooperation with many Wind power manufacturers like e.g. Enercon, Nordex, Senvion

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- Relevant HPP Project e.g. <https://netzpatron.de>



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PLANAIR
Ingénieurs conseils en énergies et environnement



I am representing the IEA Wind Task 11 and coordinating this TEM with the organising committee. My background is in mechanical engineering with a focus on isolated renewable energy systems, especially wind.

My task within IEA Wind is to foster information exchange by holding 4 TEMs per year, gathering experts on a given topic to initiate worldwide collaboration. Check out my presentation, which will be uploaded on the [community page](#), if you'd like to find out more about our activities.

I am a project manager in renewable energies at Planair SA, Switzerland, and also a member of the secretariat of the Swiss Wind Energy Association.

Nicolas El Hayek

Planair SA – Switzerland
Task 11 Operating Agent

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[Suisse Eole](#)



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Will Gorman

University of California, Berkeley
Lawrence Berkeley National Lab

Will Gorman's research focuses on the integration of variable generation into the electric power system, the economics of distributed energy resources, and the application of energy storage within electricity systems.

Many of his current research projects are investigating both the electricity market values and costs of pairing storage with wind and solar resources as compared to siting these technologies separately.

Will has his M.S. in Energy and Resources from the University of California, Berkeley.

[LBNL webpage](#) | [Twitter](#) | [LinkedIn](#)

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Jennifer King
Senior Research Engineer
National Renewable Energy Laboratory
jennifer.king@nrel.gov

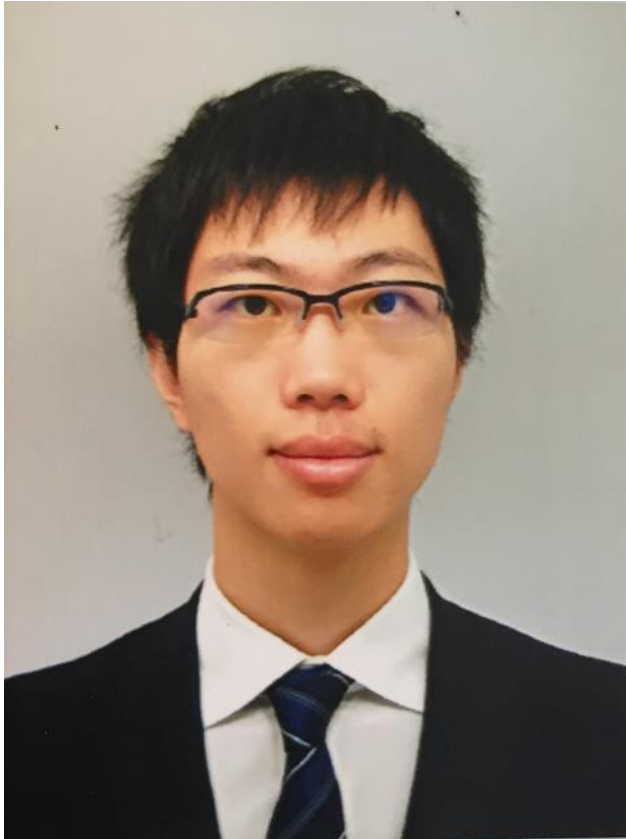
Jennifer King is a Research Engineer at the National Renewable Energy Laboratory working at the National Wind Technology Center on hybrid system modeling and control. This includes developing model and real-time distributed optimization capabilities for wind farm control, optimally designing and operating utility-scale hybrid power plants as well as developing a control frameworks for large-scale autonomous energy systems. Jen obtained her PhD in Aerospace Engineering and Mechanics from the University of Minnesota in 2016 where her primary focus was on reduced-order modeling for wind farm control. Her current research focus areas are in reduced-order modeling, distributed control/optimization, and co-design.





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HITACHI
Inspire the Next



Reo Kontani

Hitachi Power Solutions

Received the B.S. degree in engineering and M.S. degree in technology management from the University of Tokyo, Japan.

Work for [Hitachi Power Solutions](#) Co., Ltd. and engaged in wind development, data analysis, and business evaluation.

Eager to know how to develop wind farms after transferring to Feed-In-Premium scheme.

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Dr. Peter Lilienthal
HOMER Energy by UL

Dr. Peter Lilienthal is the CEO of HOMER Energy. Since 1993, he has been the developer of the National Renewable Energy Laboratory's HOMER[®] hybrid power optimization software, which has been used by over 250,000 energy practitioners in 193 countries. NREL has licensed HOMER Energy to be the sole world-wide commercialization licensee to distribute and enhance the HOMER model.

Dr. Lilienthal was the Senior Economist with International Programs at NREL from 1990 – 2007. He was one of the creators of NREL's Village Power Program. He has a Ph.D. in Management Science and Engineering from Stanford University. He has been active in the field of renewable energy and energy efficiency since 1978. This has included designing and teaching courses at the university level, project development of independent power projects, and consulting to industry and regulators. His expertise is in the economic and financial analysis of renewable and micro-grid projects.

www.homerenergy.com

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A large, stylized green graphic at the bottom of the slide, resembling a mountain range or a series of overlapping hills.



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UPPSALA
UNIVERSITET



Oskar Lindberg
Uppsala University

PhD student researching on increased utilization of the electricity grid with combined wind and PV power parks in Sweden. M.Sc. in Sociotechnical Systems Engineering and B.A. in Business and Economics.

Research gate:

https://www.researchgate.net/profile/Oskar_Lindberg2

Linkedin:

<https://se.linkedin.com/in/oskrlndbrg>

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& RENEWABLE ENERGY**
WIND ENERGY TECHNOLOGIES OFFICE



Nate is the Technology Manager for Offshore Wind R&D within the US Department of Energy, Wind Energy Technology Office. In this role, he is the federal lead for the offshore demonstration projects, the offshore R&D consortium, relevant awards, and lab projects related to developing and validating design tools & conceptual designs for offshore turbines and foundations.

Nate has been working for 22 years in the maritime industry in ship research and development, design, and construction. Nate is a Naval Architect & Marine Engineer from Webb Institute with a Master's degree in Business Administration from George Washington University.

Nate McKenzie
US Department of Energy



Dr. Caitlin Murphy
NREL

Caitlin Murphy is a Senior Energy Analyst within the Strategic Energy Analysis Center at the National Renewable Energy Laboratory (NREL). Her primary research involves using quantitative analysis methods to evaluate how technology innovation and end-use [electrification](#) could impact the evolution and operation of the U.S. energy system.

Within NREL's Economics and Forecasting Group, [Caitlin](#) leads capacity expansion model development and analysis, with a primary focus on hybrid renewable energy systems. She takes a holistic view of hybrid systems, focusing more on their purpose and benefits than on specific technology combinations. She is currently co-leading an opportunities analysis for high-priority hybrids R&D for the U.S. Department of Energy.

Caitlin received her B.S. in Earth Science from the Massachusetts Institute of Technology in 2007, and her Ph.D. in Geophysics from Caltech in 2012.



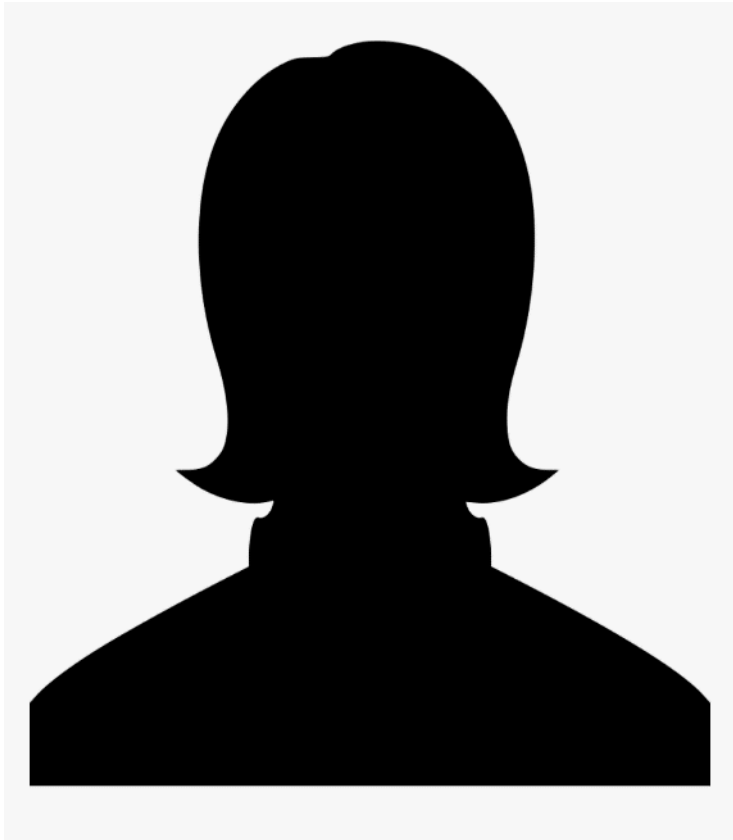
Lennart Petersen
Aalborg University

- Industrial PhD fellow at Vestas & AAU in the field of electrical power systems and renewable energies
- Major experiences in ancillary services by renewables, plant control, real-time hardware-in-the-loop testing
- Passionate about grid integration of emerging technologies such as hybrid power plants.
- [PhD project](#) on sizing, control & operation of off-grid hybrid power plants including wind, PV, battery storage and diesel generation
- Related publications can be found [here](#)

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Dr. Philippe Pognant-Gros
IFPEN

PhD in Systems control theory

Large experience in automotive fields: hybrid powertrain control, inverter control, battery estimation: SoC and SoH, V2X charging control

Since 2018, management of the “EMS project” at IFPEN including:

- Hydro/PV sizing
- EMS pour hybrid plants including Li storages
- Battery models
- Digital platform pour data science, predictions and batteries

This TEM is interesting me

- To learn more about projects sizing: methods, models, ...
- To better understand the drivers for batteries integration

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Andreas Rettenmeier
ZSW

In the past years in the wind energy industry I was able to gain a dozen years of academic experience in applied research in addition to years as a development engineer in the industry. At the ZSW (Center for Solar Energy and Hydrogen Research) I am currently responsible for the construction of a wind energy test site in complex terrain, which was initiated by the WindForS research cluster. The so-called WINSENT test site is an open platform which will be accessible to both the scientific community and the industry.

[WindForS](#)

[WINSENT](#)

[ZSW](#)

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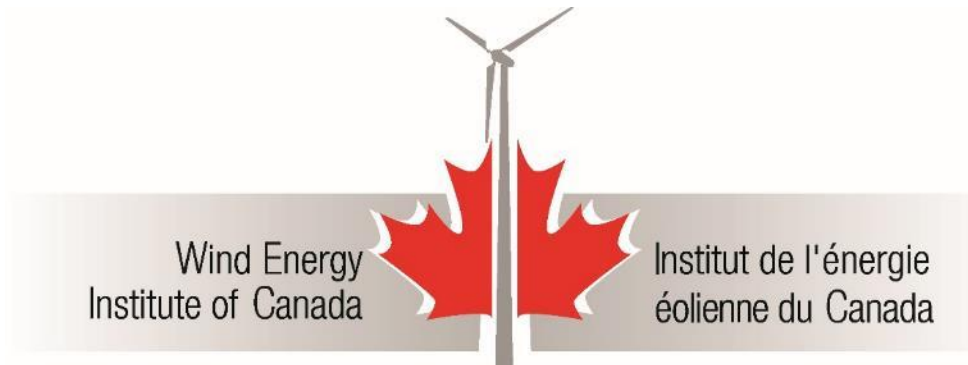
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Dr. Marianne Rodgers
Scientific Director



Eldrich Rebello
Wind Integration
Researcher



The Wind Energy Institute of Canada is a not-for-profit entity formed in 1981 that advances the development of wind energy across Canada through research, testing, innovation and collaboration.

Located in North Cape, Prince Edward Island on Canada's east coast, our site has average wind speeds of 8.2 m/s at 50 m, and numerous icing events per year.

Our facilities consist of a 10 MW wind farm, extensive data logging and meteorological facilities. We are expanding with a 100 kW solar PV array and a 110 kW / 220 kWh storage battery.

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Dr. Pukhraj Singh
Suzlon Energy Limited,
Germany

Over 30 years experience of research, design and product development in the area of power electronics converters, onshore Wind turbines, power quality, revenue energy meters, wind farm grid compliance, Modeling and simulation.

Since 2011, as Head of Segment, leading the design of electrical system of onshore wind turbines of Multi Megawatt power rating, Grid compliance, grid integration studies, design of control system and architecture of utility scale Wind–Solar-Battery Hybrid Park.

Interest: sizing of hybrid park, design of hybrid system to meet 100% capacity utilisation factor, certification, optimisation techniques, generation forecast

Linkedin: <https://de.linkedin.com/in/dr-pukhraj-singh-b23714a>



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Brian Smith

Wind Energy Program Manager
National Renewable Energy Laboratory
IEA Wind TCP Vice Chair/U.S Alternate Member

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www.nrel.gov/wind

<https://www.linkedin.com/in/brian-smith-b6958b18/>

Hybrid Power Systems for Wind enthusiast since the early days of remote, isolated, islanded hybrid systems combining wind-diesel systems. Champion of increased focus on hybrid power systems research for wind at NREL and at international level through IEA Wind. NREL/DOE launched the Advanced Research on Integrated Energy Systems (ARIES) research platform at the Flatirons Campus to conduct integrated research that supports the development of groundbreaking new energy technologies, check it out at:

<https://www.nrel.gov/aries/> .



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[Task 11](#)

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Dr. Jan Vedde
European Energy

Jan Vedde has worked with Solar PV in steps of the value-chain (from raw materials purification to PPA and legal barriers). Currently he works with design, development, construction and grid-integration of utility scale PV projects in Denmark and other European markets. He's also engaged in a large scale grid integration battery R&D project focussing on financial modelling and regulatory barriers towards grid integration.

Jan Vedde has a Ph.D. in Physics and have worked with Technical Due Diligence, business development, project management, quality assurance and supplier assessment for 30 years.

He's engaged in the Danish PV Association, Solar Power Europe and contributing member of the IEA PVPS Task 13 "Performance, Operation and Reliability of Photovoltaic Systems".



I am an electrical engineer and got my diploma and PhD in Germany working with energy storage, solar cells and integration of wind energy into the German market. I have also done studies for industry related to the optimal operation planning of power plant portfolios.

From 2010 on I worked as postdoc and researcher for NTNU and SINTEF Energy in Norway; mainly on energy systems, microgrids, electrical/hydrogen vehicles, integration of renewables and hydro power scheduling.

Apparently I am Associated Professor for Sustainable Energy at NTNU, giving several courses and doing research.

Related research projects I was involved in are for example:

[ZEN](#), [Market4RES](#), [eHighway2050](#), [CenSES](#), [TWENTIES](#), [IEA Wind # Task25](#)

Assoc. Prof. Steve Völler
Norwegian University of
Science and Technology

[NTNU](#) # [Twitter](#) # [LinkedIn](#)



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- Msc. Electrical Power Engineering Ghent University/Universidade do Porto
- Solar Research Engineer at ENGIE Laborelec in the Solar Lab (Brussels).
- Responsible for research projects concerning design optimization of utility-scale ground-mounted and floating PV plants
- Innovation engineer for prospective offshore wind/floating PV hybrid projects

[Linkedin](#)

Ir. Andreas Wabbes
ENGIE Laborelec



Amelie Wulff
GE Renewable Energy

- Global Sales Leader Hybrid Solutions for GE Renewable Energy
- Overlooking a portfolio of multi-use technologies and generation assets seeking commercialize hybrid solutions globally to help GE's customers move through the energy transition and towards higher renewable generation penetration
- Holds an M.B.A. University of Utrecht and a B.A. in Economics from Boston College.
- <https://www.ge.com/renewableenergy/hybrid>
- <https://www.ge.com/power/hybrid>



Dr Hong Yue
University of Strathclyde

Dr Yue is a Reader at the Wind Energy and Control Centre (WECC), Department of Electronic and Electrical Engineering, University of Strathclyde. Her research interests are in modelling, control and optimisation of complex systems, with applications to renewable energy systems, biochemical and biomedical systems and process systems.

Her recent research projects in wind energy systems are mainly on hybrid offshore renewable systems, airborne wind energy systems, LIDAR-base wind turbine and wind farm control, and power systems optimisation considering demand side response.

General research interests: modelling of nonlinear dynamic systems, model-based analysis, optimal experimental design, advanced control.

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