Monash Sustainable Energy Informatics Expertise

Sarah Goodwin
Director, Grid Innovation Hub
Control room design, smart and microgrid visualisations, Senior Lecturer HCC

Markus Wagner
Theme Lead, Sustainable Energy Informatics
Wind farm design, turbine placement to minimise wake effects, A/ Prof DSAI

Ariel Liebman
Director, Monash Energy Institute, Prof DSAI
Integrated System Planning, Market Modelling, Renewables & Storage Grid integration

Hao Wang
ARC DECRA Fellow / Senior Lecturer DSAI
Reliable Integration of Distributed Low-Carbon Energy Resources, EV grid integration

Bernd Meyer
Associate Dean Sustainability
Biodiversity footprint of renewable energy
Prof, DSAI

Yolande Strengers
MuEI Theme Lead, Consumers
Leading social and community engagement
Digital Energy Futures, Prof, HCC

Carsten Rudolph
Directory for Research of the Oceania Cyber Security Center, Prof SSC
Smart Grids and DER/PV Inverter Cybersecurity

Terrence Mak
Lecturer, DSAI
Grid Operation, Planning and Security, Optimisation and Machine Learning/AI

Terrence Mak
Lecturer, Malaysia School of IT
Emerging Topics in Wind Farms

Monash Energy - Major Projects and Initiatives

Monash Net Zero Initiative ($135m)

Received the United Nations Momentum for Change award (2018)

Energy efficiency

Campus electrification

Microgrid

Offsetting

Renewable energy

Reliable Affordable Clean Energy for 2030 CRC (~$350m)

RACE for Networks

Optimising Australia's electricity grid with customer distributed energy resources

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monash.edu/energy-institute

OUR ENERGY INITIATIVES

Monash Net Zero Initiative ($135m)

Reliable Affordable Clean Energy for 2030 Networks Program (~$350m)

Woodside Monash Energy Partnership ($40m)

Grid Innovation Hub ($6m)

MISSION

To secure the transition towards a future consistent with a 1.5-degree trajectory (Net Zero grid by 2035 & economy by 2040) through interdisciplinary people-centric research into clean energy with Monash's partners.

PEOPLE

Over 200 academics and professional energy enthusiasts from across Monash.

ARC ITTC Optima ($8m)

Australian Government Australian Research Council

agl

Bringing together various inter-disciplinary fields with advanced optimisation technologies.

Grid Innovation Hub ($6m)

X-ELIO

PSC

Undertaking high quality interdisciplinary research to address increasingly complex challenges faced by the Australian energy sector.

Woodside Energy ($66.5m)

Woodside Energy

Developing a state-of-the-art 'living laboratory' and long-term research partnership to support Australia's low-carbon energy transition.

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Application of Advanced Short Term Power Generation Forecasting

Worley Pty Ltd, Monash University, Palisade Investment Partners Ltd

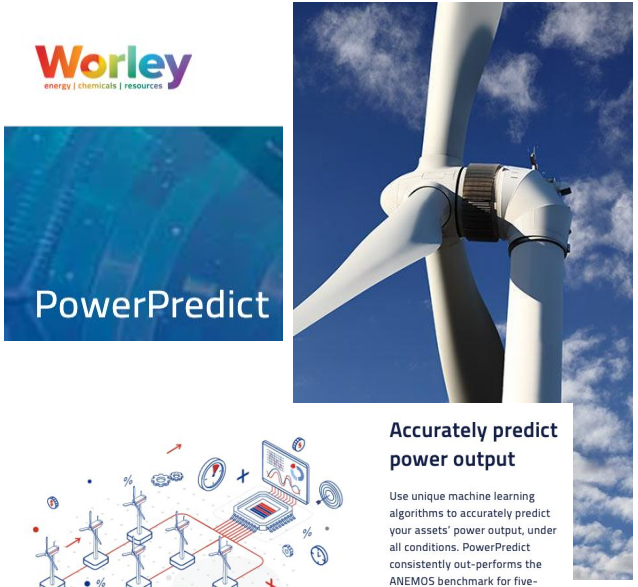
Challenge Sustainably integrating wind and solar power into the national electricity grid requires precise forecasting of power output from wind and solar farms

Our solution

- a spatio-temporal ML prediction framework that considers cross-series information (within a farm), lagged variables and external variables such as wind speed/solar irradiance and forecasts.
- A sparse vector autoregressive framework to handle many wind turbines, solar panels and farms and both linear (VAR) and non-linear ML regression methods can be incorporated into the framework in an ensemble approach.

Benefit

- increased renewable energy penetration on the network due to improved dispatchability of renewable generation
- reduction in Frequency Control Ancillary Services (FCAS) payments by generators resulting from the failure to meet dispatch targets



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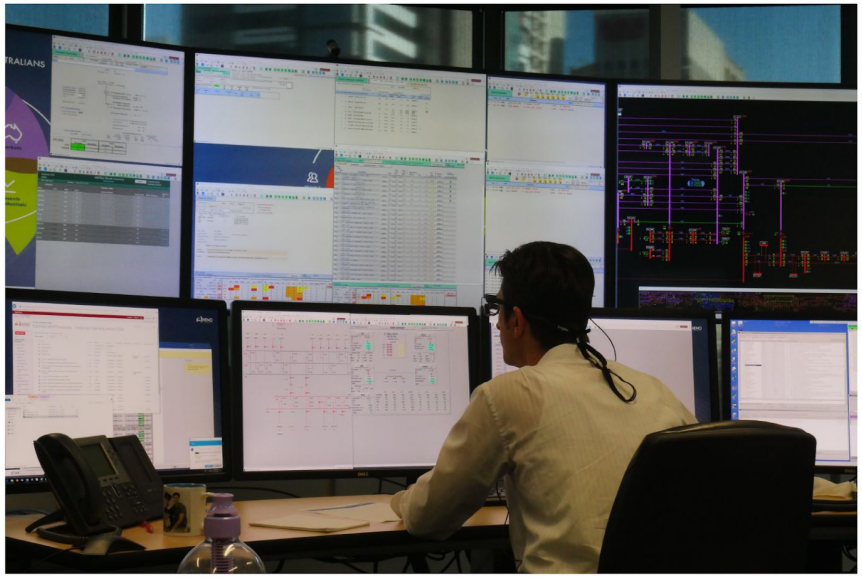
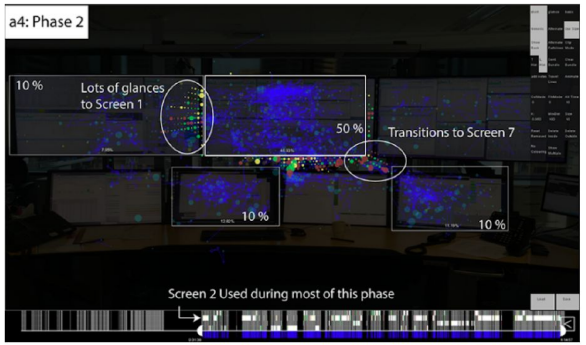
Dr Christoph Bergmeir profile, Media release, #ARENA project info

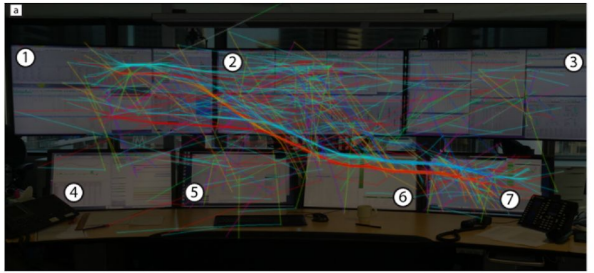
Commercial Product:
https://www.worley.com/what-we-do/our-technology/digital-products/powerpredict

Reducing cognitive load on Australian Energy Market Operator's (AEMO) control room operators

Sarah Goodwin
Director, Grid Innovation Hub
Control room design, smart and microgrid visualisations







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- Monitoring eye movements and health data to determine cognitive stress.
- Identifying and innovating pathways to reduce cognitive load and stress on operators.

Lead Researchers: Dr Sarah Goodwin (link), **Immersive Analytics Research Group** (video: link)

JiGSTEP™; Planning for resilience, community preferences, a cost towards 100% renewable electricity systems

FIT Sustainable Energy Informatics and Opturion Pty Ltd

Challenge

- Planning the future high wind and solar electricity dominated grid requires tradeoffs between size and location of storage and transmission for major transformation of the grid.
- Best modelling tools today designed 25 or more years ago and cannot solve modern Integrated System Plans. Best approach is costly, inaccurate, user intensive, slow and sub-optimal leaving money and time on the table.

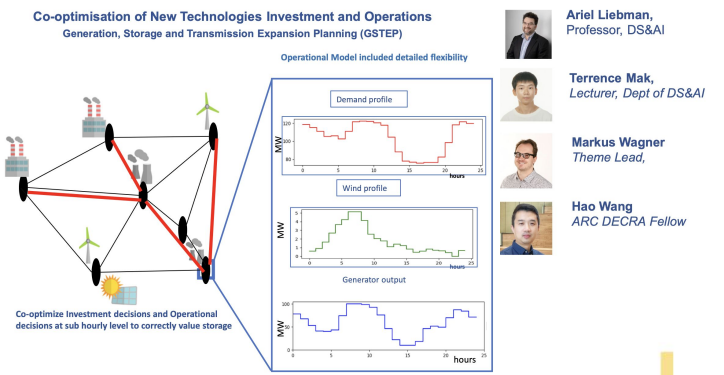
Our solution

Requires new research in a range of disciplines, including:

- Optimisation-based Machine Learning and AI for forecasting and Planning
- Power Systems Engineering and Control Theory - embedded in optimisation models

Benefits are

- For developers - reduces risk to MLF changes and to curtailment due to grid security issues and other generators
- For planners and governments - community concerns can be built into planning at leading to faster and cheaper investment in grids
- For consumers & investors - plans for transmission, storage and generation are robust to major new uncertainties and need to plan for grid security
- Require for analysis of new policy & regulations including new market designs

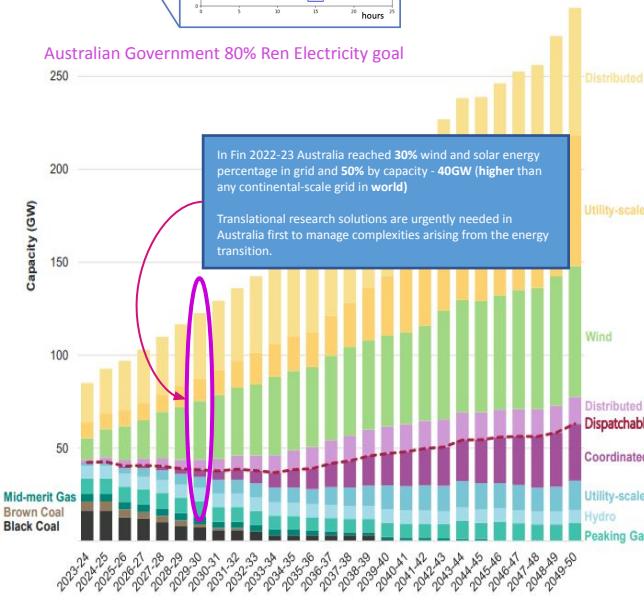


Ariel Liebman, Professor, DS&AI

Terrence Mak, *Lecturer, Dept of DS&AI*

Markus Wagner *Theme Lead,*

Hao Wang *ARC DECRA Fellow*



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Ariel Liebman: https://www.linkedin.com/in/aliebman
Markus Wagner / Hao Wang: markus.wagner@monash.edu, hao.wang2@monash.edu

Wind farm layout optimisation

Challenge custom layouts are needed for the wind resource at hand

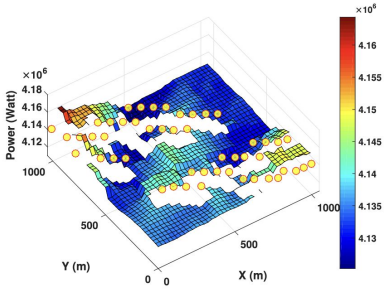
Our solution

- Prize-winning, multi-objective optimisation of layouts
- objectives: energy, space, cabling, …
- constraints: geographical constraints, hardware, …

Benefit

- Minimising levelised cost of electricity for techno-economic decision support

Demonstration of our Turbine Displacement Algorithm and its infeasible area modelling capability.
The image on the left portrays a satellite image of the Woolnorth wind farm in Tasmania, Australia (© 2011 Google). The right images are examples of the the loose adaptation used in the modelling tool, and from left to right model the scenario at 0 (16.9 MW), 5,000 (17.6 MW), and 20,000 (17.7 MW) evaluations. As the considered wind is predominantly from the western direction (between 120° to 225°), the turbines tend to form in staggered north/south columns while leaving space along the east/west directions.



Visualisation of the resources available (wave farm) in a simulated, optimised farm.

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Lead Researcher: A/Prof Markus Wagner (link), project page (link)
Emerging Topics in Wind Farms: Dr Fuad Noman (link)