



THE UNIVERSITY OF
MELBOURNE

—
Melbourne
Energy
Institute

Annual Report 2018



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Message from the Director

We often use the term Business As Usual in the energy sector.

BAU emissions trajectories. BAU solar uptake. BAU demand. And almost always we get it wrong.

So relative to recent experience, was 2018 BAU?

Well, we had some pretty big wobbles in the electricity system, but thankfully not a state-wide blackout. Tick.

The Commonwealth and the States fought a lot. Tick.

And we lost another Prime Minister who tried to integrate energy and environmental policy. Tick.

But the Commonwealth Energy Minister at the time was then promoted to Treasurer.

Que?

Clearly, the laws of economics and physics do not apply in all realms.

Thankfully, our diverse membership of the Melbourne Energy Institute can help their engineer-of-a-Director navigate our remarkable energy world. I am particularly proud of two, new initiatives that my colleagues established and led.

First, the MEInetwork18 brought our graduate students and industry professionals together to participate in a wide ranging tour of the energy sector. The MEInetwork18 provided several, tailored education activities to our graduate students and industry. Networking and job preparation for our students are also key aspects of this program.

Second, MEI held its inaugural Symposium on 12th December, showcasing the University's multi-disciplinary energy research to the community. The Symposium was a resounding success, with our students and staff presenting to large and engaged audiences across the day.

At the same time, and as this Annual Report attests, MEI's researchers got on with their day (and night) jobs of researching the energy system. I draw your attention to the section *Students of MEI* in particular. Our students are truly better, stronger and faster than their supervisors, and an impressive group.

Finally, I must express MEI's sincere gratitude to all of our supporters. There are too many to name here, but they are listed in this Report, and we could not have made it through 2018 without them.



Professor Michael Brear

FTSE, FIEAust

Director, Melbourne Energy Institute

An introduction to the Melbourne Energy Institute

The Melbourne Energy Institute (MEI) engages with the University's energy sector partners in industry and government.

Since the Institute was launched in 2010, it has delivered influential, interdisciplinary research on the challenges of transitioning towards a low carbon energy system.

The University of Melbourne and MEI

The University of Melbourne undertakes world-leading research in many disciplines. It has the largest research expenditure of any Australian university, and the largest cohort of research students in Australia. Our researchers work with the community, industry and government on some of the world's most pressing challenges.

MEI has over 300 specialists across Architecture, Economics, Engineering, Health, Law, Planning, Science and Social Science. They include a former Chief Scientist of Australia, several recipients of Australia Day Honours, several Fellows of Learned Academies and numerous Fellows of Professional Societies.

MEI staff work together in four programs:

- Energy Systems
- Energy Technology
- Energy, Community and the Region
- The Environment and Energy Resources

Working with MEI

MEI works closely with industry and government. Collaborative research and knowledge transfer are central to MEI's work, and we welcome new partners.

Our current partners include Arup, the Asian Development Bank (ADB), AusNet Services, AEMO, the Department of Defence, CitiPower/Powercor, the City of Melbourne, Energy Australia, Ford, GE, the Grattan Institute, Mitsubishi Heavy Industries, Powershop, Siemens and the Victorian State Government.



Highlights of 2018

MEInetwork19

MEInetwork is a unique program that gives participants a comprehensive and multi-disciplinary overview of the energy sector as it faces the challenges of reliability, affordability and reducing emissions. The MEInetwork was started by MEI in 2018, and provided education activities to both our graduate students and industry professionals. Industry networking and increased job preparedness for our students are intended co-benefits of the program.

MEI is very grateful to our program partners Powershop Australia, the State Government of Victoria, the City of Melbourne, CitiPower/Powercor, ARUP, AEMO and Siemens, whose contributions made the program both financially viable and deeply relevant.

More information about MEInetwork18 and other public engagement activities can be found later in this report.

Below: Energy industry professionals and University of Melbourne graduate students participating in the Energy Systems short course, part of the MEInetwork18 program



MEI Symposium 2018

MEI held our inaugural Symposium on 12th December 2018, showcasing the University's energy research across MEI's four programs: Energy Systems; Energy Technology; Energy, Community and the Region; and the Environment and Energy Resources.

The Symposium was a resounding success with over 400 graduate students, staff and industry professionals from across the country attending to hear about the breadth of energy research that the

University is undertaking. As an end-of-year event, the Symposium was also an opportunity to celebrate the past year's accomplishments.

The morning opened with Audrey Zibelman, CEO of AEMO, delivering her keynote speech to a full house on *Navigating the Transition to the Fourth Energy Revolution*. Several MEI-affiliated academic staff and graduate students then presented to large audiences. Other graduate students also took part in an extensive poster

exhibition. In all, about 50 graduate students presented their research at the MEI Symposium.

Read more about the MEI Symposium 2018 and other public engagement activities later in this report.

Below: Audrey Zibelman, CEO, AEMO, delivering her keynote speech on navigating the transition to the fourth energy revolution to a full house - having to be streamed into the adjacent overflow theatre.



Highlights of 2018

Dr. Reihana Mohideen presents her research to the United Nations Women's Policy Expert Group

Dr. Reihana Mohideen, Leader of our Energy, Community and the Region Program, presented her research at the UN Women's Policy Expert Group Meeting in New York in November 2018. As an international development specialist in energy systems, Dr. Mohideen discussed how integrating gender equity considerations into technology design, and drawing women into this process,

creates more equal employment opportunities in South Asia.

This report is the beginning of an ongoing research project to field test gender equality and social inclusion. Ultimately, Dr. Mohideen's findings will form part of two major initiatives: the Secretary General's report to the General Assembly in 2019, and reports from several intergovernmental

panels to UN member states, with the latter being linked to the work on the Commission on the Status of Women and the Committee to End Discrimination Against Women (CEDAW).

Below: Dr. Mohideen presenting her research at the UN Women's Policy Expert Group Meeting in New York in November 2018



The Australian Academy of Technology and Engineering elects Prof. Michael Brear as a Fellow

In October 2018, Prof. Michael Brear, Director of MEI, was inducted as a fellow of the Australian Academy of Technology and Engineering (ATSE). ATSE is an independent thinktank that determines how technology, engineering and science can solve

complex problems facing Australia and the world today.

Fellows are elected by their peers given their contributions to their chosen field. As a specialist in energy and transport, Prof. Brear

joins a distinguished group of Fellows from the research sector, industry and government, including numerous CEOs, current and previous Commonwealth Chief Scientists and Vice-Chancellors.

Prof. Pierluigi Mancarella awarded 2018 Newton Prize

Prof. Pierluigi Mancarella, Leader of MEI's Energy Systems Program, has been awarded the prestigious 2018 Newton Prize for an international project on power system resilience. The Newton Prize is an annual £1m (\$1.8m AUD) fund in the UK for science and innovation partnerships that collaborate internationally to address global development challenges. Five recipients were awarded the 2018 Newton Prize at the Royal Society in London last year.

The prize was awarded for work on resilient planning of low-carbon power systems in countries vulnerable to environmental hazards. The project used new mathematical models to strengthen energy infrastructure to withstand extreme weather and natural disasters.

Prof. Mancarella said "the Newton Prize will enable further improvement of our advanced resilience assessment and planning tools and, importantly, facilitate

their application to more developing countries which face varying threats related to extreme weather and natural hazards."

The team is now also developing resilience planning tools for the Australian energy system. This research is particularly relevant to system planning for extreme weather events, as experienced over the 2018/19 summer period.

MEI's research programs

Energy Systems

Leader: Professor Pierluigi Mancarella

The Energy Systems program considers how different energy technologies interact with one another. The program includes the analysis and optimisation of energy networks, wholesale and retail energy markets, and energy system planning.

Capabilities

- Energy network, system and market integration of renewable energy sources
- Distributed energy resources and smart grids
- Integrated energy networks and multi-energy systems (electricity, fuels, heat, cooling, transport)
- Risk and resilience assessment of future energy systems
- Demand modelling using randomised control trials, big data and machine learning
- Retail energy markets and consumer behaviour
- Wholesale energy market design and operations

Key Personnel

Prof. Lu Aye	Prof. Pierluigi Mancarella
Prof. Michael Brear	Prof. Chris Manzie
A/Prof. David Byrne	Dr. Leslie Martin
A/Prof. Robert Crawford	Prof. Nando Ochoa
Prof. Rob Evans	Prof. Kate Smith-Miles
Prof. Ross Garnaut	Dr. Claire Vincent
Prof. Terry Jones	
Prof. Chris Leckie	

RESEARCH HIGHLIGHT

AusNet collaboration: Opportunities for Distributed Energy Resources in low inertia power systems

The Australian electricity system is experiencing unprecedented changes due to the increasing penetration of renewable energy sources such as wind and solar PV. These changes fundamentally challenge traditional operational practices in a network to date dominated by conventional thermal generators. In particular, there is a need for reviewing the adequacy of the existing requirements for provision of frequency control ancillary services (FCAS), as well as for considering new potential providers of such services *in lieu* of conventional generators.

In this context, this collaborative project between MEI and AusNet Services aims to examine FCAS requirements, challenges and opportunities in a low-carbon, low-

inertia NEM, and the opportunities for Distributed Energy Resources (DER) connected to distribution networks to provide FCAS as well as other services, e.g., for voltage and reactive power control.

This ongoing project involves careful modelling of real AusNet networks with DER, and looks at how aggregates of resources such as batteries, PV and wind farms can provide FCAS whilst also considering network constraints and local network support. The project results will describe fundamental technical interactions between distribution networks and the transmission system. This will inform potential changes in system design and regulations, and underpin the creation of new business models for DER.

Energy Technology

Leader: Professor Richard Sandberg

The Energy Technology program brings together researchers who investigate different energy technologies. This program examines several forms of renewable and low emission power plant for stationary and mobile applications, as well as energy storage and fuels.

Capabilities

- Carbon capture and storage (CCS)
- Conventional and alternative fuels and emissions chemistry
- Gas turbine, reciprocating engine, hybrid and electric powertrain dynamics and optimisation
- Wind turbines/farms, solar PV and energy storage dynamics and optimisation
- Low drag vehicles for land, sea and air
- Materials for advanced photovoltaics, displays, lighting, and high temperature applications
- Advanced computational methods and machine learning in energy applications

Key personnel

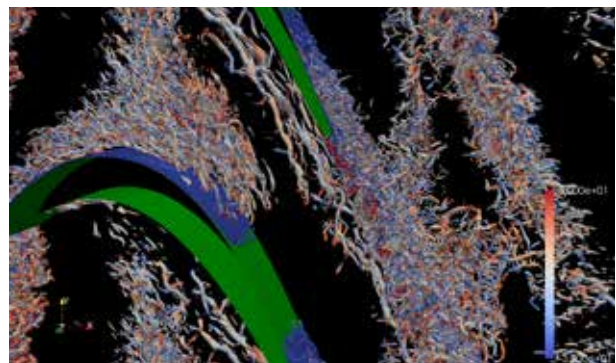
Prof. Robin Batterham	Prof. Paul Mulvaney
Prof. Michael Brear	Dr. Guillermo Narsilio
Prof. George Franks	Prof. Richard Sandberg
Dr. David Jones	Prof. Graham Schaffer
Prof. Sandra Kentish	Prof. Geoff Stevens
Prof. Dan Li	Prof. Paul Webley
Prof. Chris Manzie	Prof. Rachel Webster

RESEARCH HIGHLIGHT

General Electric collaboration: Enhancing gas turbine efficiency with machine learning techniques

In 2015, gas turbines (GT) consumed approximately 8.2 billion litres of aviation fuel in the Australian air transport sector alone, and GTs produced 20% of Australia's total electricity. Therefore, any technology advances which increase GT efficiency can save significant money and have a tremendous impact on the economy and environment.

One approach to achieve these gains is to enhance our capability to model unsteady flow fields in GTs using Computational Fluid Dynamics (CFD). A number of complex flow phenomena such as a boundary layer transition, shock waves, turbulent wake mixing and wake-wake interactions take place in GTs, and modelling all of these phenomena is a challenging task. In our project, novel machine learning techniques, such as Gene Expression Programming (GEP), have been developed and used to gain an in-depth understanding of the flow physics and improve the predictive accuracy of models. As part of a longer-term campaign, we have so far focused on modelling turbulent wake-mixing because it can contribute significantly to efficiency loss.



GEP uses biologically inspired natural selection and evolution to extract meaningful physical insights and create novel models from 'gold standard' high-fidelity data sets. Preliminary results have shown that this approach is a promising avenue to enhance the efficiency of GTs as the models developed enhance prediction more than models that are traditionally used for product design. Indeed, the current project has found that the novel data-driven models provide error reductions of up to 80% over industry-standard models. Importantly, these dramatic improvements are even achieved when the newly developed models are applied to cases with significantly different operating conditions from the case they were trained on, suggesting robustness of approach.

This technique of model development can also be applied to other devices such as wind turbines, steam turbines, bluff bodies and possibly even for supersonic and transonic flows.

Energy, Community and the Region

Leader: Dr Reihana Mohideen

The Energy, Community and the Region program examines how individuals, communities and states rely on and interact with energy technologies and energy systems. Examination of equity and national development are features of this work.

Capabilities

- Delivering social, environmental, gender and human rights impact assessments
- Socio-technical modelling and evaluating consumer behaviour, energy services and energy markets
- Analysing big data, including social media and historic economic data
- Analysing emerging energy technology trends, including access and uptake in Asia

Key personnel

Dr. Jonathan Balls
A/Prof. David Byrne
Dr. Sangeetha Chandra-Shekeran
Dr. Brendan Duffy
Prof. Ross Garnaut
Prof. Lee Godden
Prof. Fiona Haines
Dr. Leslie Martin
Dr. Reihana Mohideen

RESEARCH HIGHLIGHT

Asian Development Bank collaboration: Energy technology innovation in South Asia - Implications for gender equality and social inclusion

Dr. Reihana Mohideen, Leader of our Energy, Community and the Region Program, has recently published her working paper addressing how energy systems and services in South Asia can improve women's economic empowerment and well-being. This paper is the beginning of an ongoing research project that will also include a pilot program to field test gender equality and social inclusion.

Asia's energy transition is being driven by rising energy demand and the commitment to cut greenhouse

gas emissions. Developing Asia has much to gain from this energy transition since parts of Asia will otherwise experience the most dramatic and damaging early manifestations of climate change. The transition will also mitigate other issues, such as air pollution and traffic congestion, and benefit the preservation of natural assets, agricultural production and food security. As a result, the energy transition has important implications for gender equality and social inclusion (GESI) in the region.

MEI's research programs

Environment and Energy Resources

Leader: Dr Robyn Schofield

The Environment and Energy Resource Program examines the interactions between our energy systems and the natural and human environment. This program examines energy resource extraction and use, and how current energy systems influence environmental and human health, including the legal and economic implications and opportunities.

Capabilities

- Air quality and health impacts
- Environmental chemistry and fluid dynamics
- Geology and geochemistry of oil, gas and other basin resources including carbon storage
- Modelling of the carbon cycle and climate change
- Resource economics
- Resource law

Key personnel

Prof. Peter Cook
Prof. Michael Crommelin
Prof. Shyamali Dharmage
Prof. John Freebairn
Prof. Lee Godden
Prof. Ralf Haese
Prof. Stephan Matthai
A/Prof. Malte Meinhausen

Prof. Jason Monty
Prof. Peter Rayner
Prof. Mike Sandiford
Dr. Robyn Schofield
Prof. Mark Stevenson
Prof. Doreen Thomas
Dr. Claire Vincent

RESEARCH HIGHLIGHT

BHP collaboration: The Peter Cook Centre for CCS Research

In March, the Peter Cook Centre hosted an international one-week workshop by the GeoCquest consortium on the role of small-scale geological heterogeneity on multiphase flow and carbon trapping in sedimentary rocks. Representatives from Stanford University, Cambridge University, the CO2CRC, the University of Melbourne and BHP, the funding partner, came together to present and discuss research progress thus far and future work within the GeoCquest project.

Another international project supported by the Petroleum Technology Research Centre (Canada) also commenced in April. This is studying the consequences of water uptake into a reservoir CO₂ stream, leading to potential dry-out and salt precipitation at the injection point of the Aquistore CO₂ storage site. The project will develop strategies to avoid salt precipitation in the future and thus to ensure more sustainable CO₂ injection.

The highlight of the year was the Peter Cook Centre's participation at the world's largest CCS conference, the Greenhouse Gas Technologies conference (GHGT-14), held here in Melbourne last October. Over 1000 delegates



from industry, government and academia presented and discussed recent developments for the CCS industry. The Peter Cook Centre had a strong presence at this event, including hosting tours at the University and the presentation of 25 scientific contributions to the meeting. The response from meeting delegates to our efforts was very strong, and new partnerships in research and teaching have resulted.

Finally, and now in its third year, a one-week intensive course on geological carbon storage was given by Dr George Carman to professionals and post-graduate students in July. The course was fully booked. Dr Carman is a highly experienced petroleum geologist who also served as the Subsurface Storage Director for the Victorian CarbonNet project. The course covered a large range of technical and scientific aspects pertinent to geological carbon storage.

Students of MEI

MEI has numerous talented graduate students working on important energy projects. Meet some of our wonderful students whose work is contributing to a more sustainable energy transition.

Ms. Han Wang

Han Wang is a second-year electrical engineering PhD student asking: how can we economically integrate distributed energy resources into the electrical grid while maintaining reliability of supply?

Han's project aims at answering this multifaceted question by researching the requirements for sourcing multi-energy flexibility from distributed energy systems.



Ms. Paris Hadfield

Paris Hadfield is a final year PhD student asking: can cities achieve meaningful change towards decarbonising the energy system, and if so, how?

While attempting to answer this question, Paris is also tutoring Masters of Urban Planning students, and interning as a researcher at the Resilient Melbourne Delivery Office.



Mr. Daniel Marshman

Daniel Marshman submitted his PhD thesis in 2018, and is set to enter the energy market thanks to his compelling research.

His work looks at achieving abatement and integrating renewable generation sources in electricity markets, focusing on the operational and investment time-frames.



Ms. Fateme Fahiman

Fateme Fahiman is a data scientist about to submit her thesis on Machine Learning techniques for time-series forecasting with application to Smart Grids.

While she finishes her PhD she also works part-time on demand and wind generation forecasting projects for AEMO.



Ms. Angela Rojas

Angela Rojas is a PhD candidate working on modelling socio-technical configurations to explore energy transition pathways.

She is an Automation and Electronics Engineer with a Master degree in Environmental Engineering from the University of Melbourne, where she studies in the Infrastructure Engineering Department.



Mr. Rob Ryan

PhD candidate Rob Ryan's research aims to understand the different factors, natural and anthropogenic, influencing air quality around Australia.

Mr Ryan presented at the MEI Symposium 2018, explaining why we should care about nitrogen oxides in the urban environment.



Ms. Catherine Kain

Catherine Kain comes from a background of business and property, so her research into energy efficiency naturally comes from a property developer's perspective.

Her work considers whether developers can integrate greater energy efficiency into their apartment developments and market this initiative for a competitive advantage.



Mr. Stephen Pollard

PhD candidate Stephen Pollard's research explores the concept of the carbon neutral city and the different ways it is being imagined and enacted at local levels.

At the MEI Symposium 2018, Stephen won best oral presentation in the Environment, Community and the Region theme.



Public engagement

MEI's engagement activities have provided forums for academia, community, industry, and government to discuss critical energy issues. The success of these activities supported MEI in its aim to build the Institute's profile and engage more strongly with key external stakeholders.

Energy Futures Seminar Series

Run quarterly in partnership with policy think-tank the Grattan Institute, the Energy Futures Seminar Series presents a range of views on the immediate and longer term impacts of energy policy and technological change.

The 2018 seminars were as follows.

ENERGY FUTURES SEMINAR #1

What does a truly sustainable electricity network look like?

Date: 11th April 2018

Summary: Our expert panel presented a range of views on the immediate and longer term impacts of changes in energy policy and technology.

Speakers

David Blowers, Energy Fellow, Grattan Institute

Merryn York, Chief Executive, Powerlink

Rob Amphlett Lewis, EGM Strategy and Regulation, Ausgrid

Andrew Stock, Honorary Enterprise Professor, Chemical and Biomolecular Engineering, The University of Melbourne

Moderator

Maxine McKew, Hon Enterprise Professor, Melbourne Graduate School of Education, The University of Melbourne



ENERGY FUTURES SEMINAR #2

National Energy Guarantee – why is it so important?

Date: 16th May 2018

Summary: Held at the State Library of New South Wales, this Energy Futures seminar provided a forum to discuss what the National Energy Guarantee is, why it is considered important and contentious by different people, and what must be done to implement it.

Speakers

Dr Kerry Schott AO, Chair, Energy Security Board

Dr Tim Nelson, Chief Economist, AGL Energy Ltd

Tony Wood, Energy Program Director, Grattan Institute

Moderator

Jennifer Hewett, National affairs columnist for The Australian Financial Review

ENERGY FUTURES SEMINAR #3

The way back to affordable electricity

Date: 24th July 2018

Summary: The third Energy Futures seminar provided a forum to discuss the final report from the ACCC's electricity affordability inquiry, which found that the national electricity market has failed consumers and needs to be reset.

Speakers

Rod Sims, Chair, Australian Competition and Consumer Commission

Dr Leslie Martin, Assistant Professor, Department of Economics, The University of Melbourne

Tony Wood, Energy Program Director, Grattan Institute

Moderator

Emma Richardson, Economist and Manager, Deloitte Access Economics

ENERGY FUTURES SEMINAR #4

Energy policy. Where to from here?

Date: 13th September 2018

Summary: The final Energy Futures seminar for 2018 explored what policies and market structures we need in Australia's transforming energy system, in order to balance energy prices, reliability and emissions.

Speakers

Chloe Munro AO, Professorial Fellow, Monash University

Prof. Ross Garnaut AC, Professorial Research Fellow in Economics at the University of Melbourne and President of SIMEC ZEN Energy

Prof. Michael Brear, Director, Melbourne Energy Institute

Moderator

Tony Wood, Energy Program Director, Grattan Institute

Public engagement

MEInetwork18

MEInetwork is a unique program that gives participants a comprehensive and multi-disciplinary overview of the energy sector as it faces the challenges of reliability, affordability and reducing emissions. The MEInetwork was started by MEI in 2018, and provided education activities to both our graduate students and industry professionals.

Industry networking and increased job preparedness for our students are intended co-benefits of the program.

MEI is very grateful to our partners Powershop Australia, the State Government of Victoria, the City of Melbourne, CitiPower/Powercor, ARUP, AEMO and Siemens, whose

contributions made the program both financially viable and deeply relevant.

The MEInetwork will be run again in future, and it is anticipated that external support will make this program self-sustaining.

Running from July 2018 to December 2018, the three main activities of MEInetwork18 included:



ENERGY SYSTEMS SHORT COURSE

A short course on analysing the financial, technical, and environmental performance of energy projects

10 x 4 hour evening classes
16 July to 29 July



ENERGY SYSTEMS SEMINAR SERIES

Seminars that lead participants through the electricity supply chain

10 evening seminars
Fortnightly from
July to December



ENERGY HACK

An innovation event where teams compete to create the most compelling new energy project or business model

2.5 days
20 October
to 22 October



MEI Symposium 2018

MEI held our inaugural Symposium on 12th December 2018, showcasing the University's multi-disciplinary energy research across MEI's four programs: Energy Systems; Energy Technology; Energy, Community and the Region; and the Environment and Energy Resources.

The Symposium was a resounding success with over 400 graduate students, staff and industry professionals from across the country attending to hear about the breadth of energy research that the University is undertaking. As an end-of-year event, the Symposium was also an opportunity to celebrate the past year's accomplishments.

The morning opened with Audrey Zibelman, CEO of AEMO, delivering her keynote speech to a full house.

Our key note speakers included:

POWER SYSTEM RESILIENCE AND EXTREME WEATHER EVENTS

Prof. Pierluigi Mancarella, *Chair of Power System Engineering*

CONSUMER RESPONSE TO ROAD USE PRICES

Dr Leslie Martin, *Senior Lecturer, Department of Economics*

THE FUTURE OF HYDROGEN IN AUSTRALIA: SOME THOUGHTS

Prof. Michael Brear, *Director, Melbourne Energy Institute*

NAVIGATING THE TRANSITION TO THE FOURTH ENERGY REVOLUTION

Ms Audrey Zibelman, *CEO, Australian Energy Market Operator (AEMO)*

COAL SEAM GAS, CONFLICTED COMMUNITIES AND THE PROMISE OF PROSPERITY

Prof. Fiona Haines, *Professor of Criminology in the School of Social and Political Sciences*

The impressive research of our graduate students was also presented, in many cases to large audiences. Other graduate students took part in an extensive poster exhibition. In all, about 50 graduate students presented their research at the MEI Symposium.

Congratulations to the following graduate student award winners:

	Energy Systems	Energy Technology	Environment and Energy Resources	Environment, Community & the Region
Best oral presentation	Sebastian Puschel - PhD Candidate, Electrical and Electronic Engineering Presentation title: Frequency response constrained economic dispatch with consideration of generation contingency size	Bolong Zhang - PhD Candidate, Chemistry Presentation title: Luminescent Solar Concentrator: from Fluorophore Synthesis to Device Fabrication	Zebedee Nicholls - PhD Candidate, Australian-German Climate and Energy College, Earth Sciences Presentation title: IPCC Special Report on 1.5 degrees warming: what does it mean for Australia	Stephen Pollard - PhD Candidate, Faculty of Architecture, Building and Planning Presentation title: Reconfiguring energy, community and the region through the Copenhagen Climate Plan
Best poster	Kyriacos Petrou - PhD Candidate, Electrical & Electronic Engineering Poster title: Controlling residential storage for the benefit of customers and networks	Harshal D Akolekar - PhD Candidate, Mechanical Engineering Poster title: Enhancing gas turbine efficiency with machine learning techniques	Sareh Naji - PhD Student, Infrastructure Engineering Poster title: Effects of envelope design variables on indoor environment quality of prefabricated houses in Australia	Will Clarke - PhD Candidate, Mechanical Engineering Poster title: A model based approach to micro-grid control

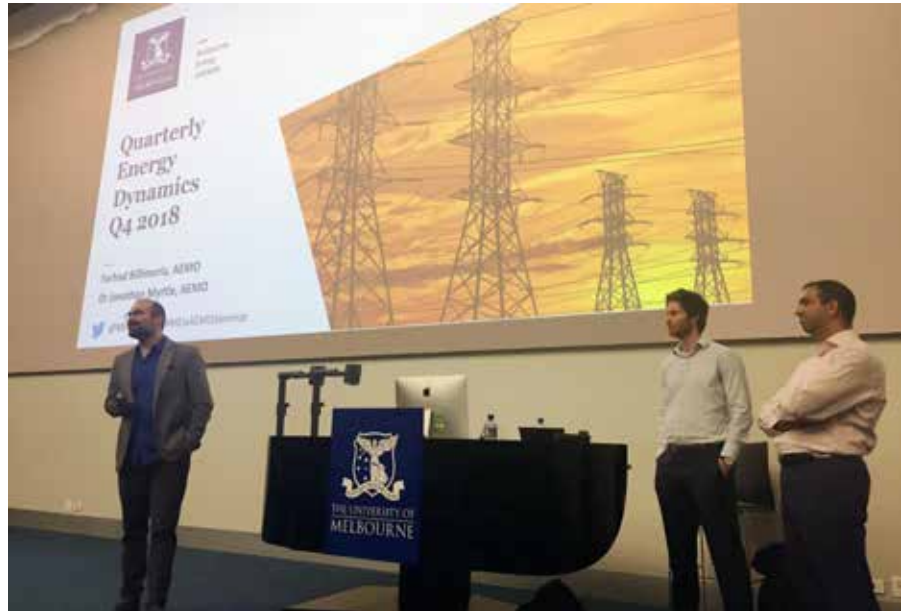
Public engagement

AEMO Quarterly Dynamics seminar series

On a quarterly basis, the Australian Energy Market Operator (AEMO) publishes its Quarterly Energy Dynamics report, providing energy market participants, businesses, consumers, governments and the wider energy community with information on the market dynamics, trends and outcomes.

MEI is honoured to host AEMO's Farhad Billimoria, Senior Markets Analyst, and Dr Jonathan Myrtle, Senior Energy Market Analysts, at a seminar each quarter at the University of Melbourne to discuss key findings from the latest AEMO report.

Each Quarterly Dynamics report has been presented to a packed lecture theatre, with Mr Billimoria and Dr Myrtle facilitating engaging Q&A discussions with the diverse audience, comprising representatives from industry, government, community and UoM.



Left to right: Prof. Pierluigi Mancarella introducing AEMO's Dr Jonathan Myrtle, Senior Energy Market Analyst, and Farhad Billimoria, Senior Markets Analyst, as they present the findings of the Q4 Quarterly Energy Dynamics report to a full house at the University of Melbourne

Public lectures by visiting scholars

TOWARDS A SOLAR ECONOMY

Date: 22nd February 2018

Speaker: Prof. Rakesh Agrawal, Professor Davidson School of Chemical Engineering Purdue University, Melbourne School of Engineering Visiting Fellow

Summary: Prof. Agrawal discussed the challenges associated with the transition from a fossil resource based economy to a solar economy, and his team's interdisciplinary approach for finding potential solutions.

TRENDS AND CHALLENGES IN INDUSTRIAL GAS-TURBINES: THE DIGITAL-TWIN APPROACH

Date: 14th August 2018

Speaker: Prof. Dr. Vittorio Michelassi, Chief Consulting Engineer for Aerodynamics at Baker-Hughes, a GE Company and GE Aviation

Summary: Prof. Dr. Vittorio Michelassi gave an overview of what the potential impact of Scale-Resolving simulations are in the development of Gas Turbines, and the role Academia must play along with industrial partners.

MUSE: A NOVEL INTEGRATED ASSESSMENT MODEL

Date: 3rd September 2018

Speaker: Dr Ivan Garcia Kerdan, Research Associate in the Sustainable Gas Institute at Imperial College London

Summary: Dr Kerdan presented MUSE (**ModUlar** energy system **Simulation Environment**), a new IAM framework developed at Imperial College London. It models the whole energy system with a high degree of technical detail and simulates the behaviour of real investors under different scenarios.

COMBUSTION RESEARCH FOR CHEMICAL PROCESSING

Date: 15th November 2018

Speaker: Prof. Brian Haynes, Emeritus Professor of Chemical Engineering, University of Sydney

Summary: Combustion is overwhelmingly the main means of delivering heat and power in the process industries and transport. In his presentation, Prof. Haynes discusses focuses on processes in which the desired products are the combustion products themselves.

Public engagement

Popular articles

ENERGY PRICES AND EMISSIONS: COMPARE POLICIES AHEAD OF THE VICTORIAN ELECTION

Author: Prof. Michael Brear, *Director Melbourne Energy Institute and Professor of Engineering, The University of Melbourne*

Summary: Prof. Brear's article in The University of Melbourne's Election Watch publication analysed Energy policy in Victoria, in the lead-up to the Victorian election in November 2018.

<https://electionwatch.unimelb.edu.au/articles/energy-prices-and-emissions-compare-policies-ahead-of-the-victorian-election>

ENERGY TECHNOLOGY INNOVATION IN SOUTH ASIA: IMPLICATIONS FOR GENDER EQUALITY AND SOCIAL INCLUSION

Author: Dr. Reihana Mohideen, *Program Leader for Energy, Community and the Region at the Melbourne Energy Institute*

Summary: Dr. Mohideen discusses how energy systems and services in South Asia can improve women's economic empowerment and well-being.

<https://energy.unimelb.edu.au/news-and-events/news/energy-technology-innovation-in-south-asia-implications-for-gender-equality-and-social-inclusion>

IF ALL ELSE FAILS, DO THE CONVENTIONAL THING

Author: Prof. Michael Brear, *Director Melbourne Energy Institute and Professor of Engineering, The University of Melbourne*

Summary: Prof. Brear discusses how government intervention in the NEM needs to be more coordinated, and warns that without a coherent, national approach we risk reduced reliability, higher prices and missed targets.

<https://pursuit.unimelb.edu.au/articles/if-all-else-fails-do-the-conventional-thing>

HYDROGEN: HAS ITS TIME COME?

Author: Prof. Michael Brear, *Director Melbourne Energy Institute and Professor of Engineering, The University of Melbourne*

Summary: Prof. Brear discusses how the falling cost of renewable energy could be the game changer that makes hydrogen fuel economic.

<https://pursuit.unimelb.edu.au/articles/hydrogen-has-its-time-come>

Government submissions

CLEAN AIR FOR ALL VICTORIANS, VICTORIA'S AIR QUALITY STATEMENT

This submission draws on a wide range of expertise from the University of Melbourne, including the Melbourne Energy Institute, Clean Air and Urban Landscapes Hub, and the Centre for Air pollution, Energy and Health Research.

Based on the current evidence, the group has proposed numerous actions of varying urgency for the State Government to consider to improve air quality and to lower Victorian's exposure to air pollutants.

AEMO INTEGRATED SYSTEM PLAN CONSULTATION

MEI's submission to this process argued that there is need for significant modelling and study of scenarios to ensure the best possible outcomes for the Integrated System Plan. The UoM has significant, relevant experience and capability in these areas drawn from UK studies and work in Australia with AEMO and AusNet Services and therefore was qualified to comment. Authors: Pierluigi Mancarella, Terry Jones, Nando Ochoa and Michael Brear.

www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Round-1-Submissions/Uni-of-Melbourne---MEI-Response-to-AEMO-Integrated-System-Plan-Consultation.pdf

Government submissions (continued)

UNDERWRITING NEW GENERATION INVESTMENT

Response to the Department of Environment and Energy's (DEE's) Consultation Paper on *Underwriting New Generation Investment*

Prof. Michael Brear submitted a response to the Department of Environment and Energy's (DEE's) Consultation Paper on *Underwriting New Generation Investment*.

Communications and media

MEI has devoted resources and expertise to the production and dissemination of the Institute's research through both traditional and digital communication channels. Contributing to the national energy debate and presenting a range of views on relevant and critical industry issues, including energy policy, is one of MEI's key objectives.

ENERGY@MELBOURNE – MELBOURNE ENERGY INSTITUTE NEWS

MEI's monthly newsletter, *energy@melbourne*, is one of our key communication tools. With a subscriber list of over 5000, information about MEI's research as well as important news and events is sent directly to the inboxes of key industry, government, community and academic stakeholders.

OPPORTUNITIES FOR UOM RESEARCHERS - MELBOURNE ENERGY INSTITUTE INTERNAL NEWSLETTER

MEI's internal newsletter communicates news and events to over 1000 subscribers, including students, academics and researchers. In particular, the newsletter aims to promote professional development programs for PhD students and notify them of employment opportunities through MEI's links with industry.

DIGITAL PLATFORMS

The MEI website is an important communication tool, and is regularly updated with information on research projects, important news and upcoming events. On average, the website receives 2000 visitors per month. Following the relaunch of our website in 2018, traffic increased by 80%. MEI also communicates regularly to our followers on LinkedIn, Facebook and Twitter, sharing information about news and upcoming events hosted by MEI.

MEDIA INTERVIEWS - ABC RADIO

Prof. Michael Brear was interviewed on the National radio show *AM* regarding an announcement concerning the installation of 80MWh of utility-scale battery storage in regional Victoria.

www.abc.net.au/radio/canberra/programs/am/victoria-to-install-batteries-for-regional-electricity-grid/9574740

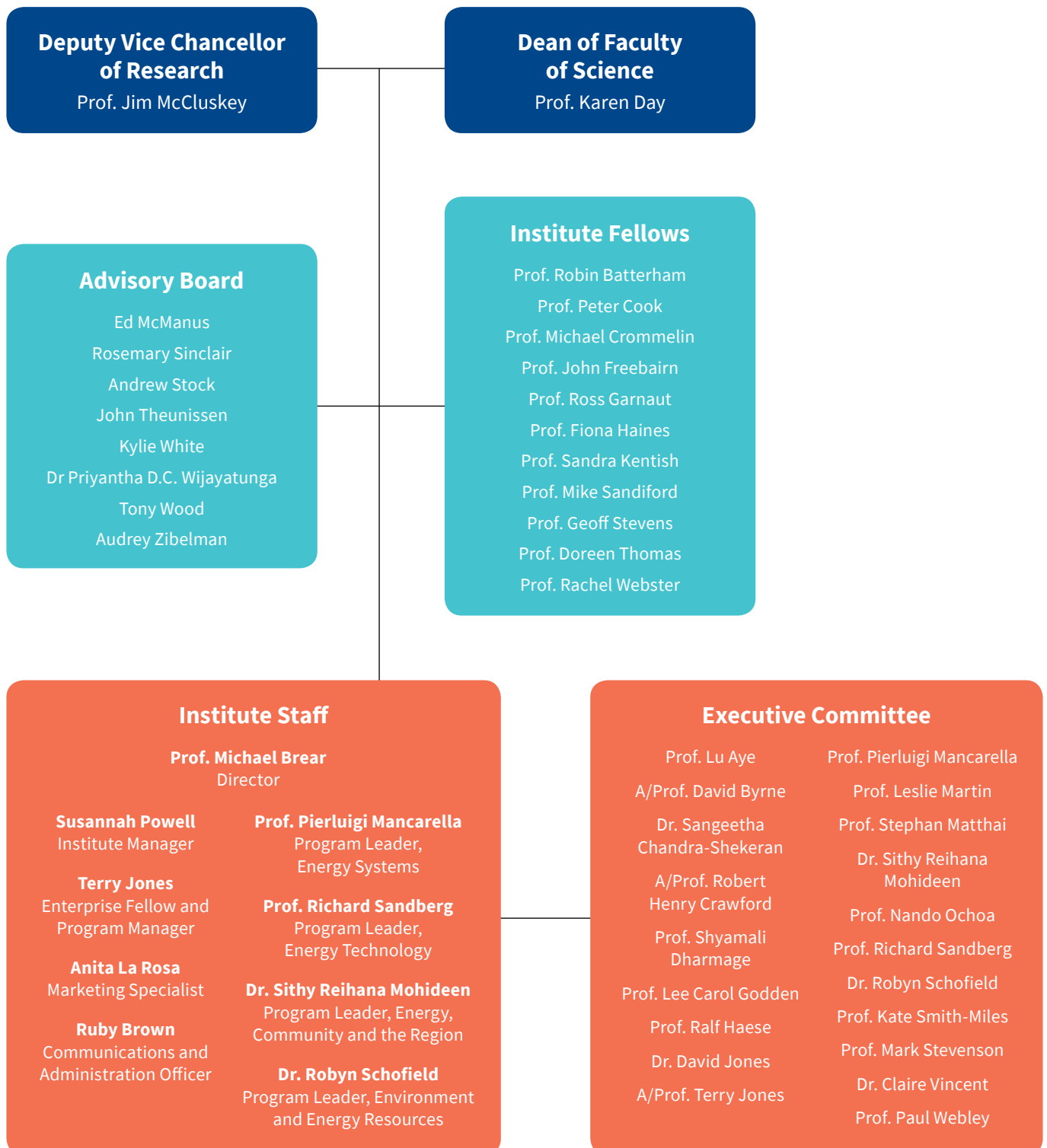
Prof. Michael Brear spoke on ABC Radio's *Overnights* program about the current state of energy policy in Australia. The segment discussed why our bills are rising and how the current state of national politics is a big part of the problem.

www.abc.net.au/radio/programs/overnights/energy-policy-crisis---do-we-have-one/10165156

Governance

The Institute reports to the Deputy Vice Chancellor (Research), Professor Jim McCluskey, for research matters and the Faculty of Science Dean, Professor Karen Day, for operational matters. The Institute Staff and the Executive

Committee operate the Institute, and the Advisory Board and Fellows provide strategic advice. A small team of professional staff support the Director in all Institute activities.



Financial summary

Internal Income	
Core funding from Deputy Vice-Chancellor (Research)	1,094,000
Balance carry forward 2017	5,861
Total Internal Income	1,099,861
Expenditure	
Institute staff salaries	434,531
Administration & general costs	34,004
Events & communication	22,669
Research project support salaries	252,032
Research project seed funding	313,924
Partnership development	41,326
Total Expenditure	1,098,487
Balance end 2018	1,375
External Research Income	
Industry – direct contract and leveraged	3,624,000
Government	3,547,000
Philanthropy	345,000
Total External Income	7,516,000

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