THE UNIVERSITY OF MELBOURNE

Melbourne Energy Institute

Annual Report 2024

Contents

Editor

Anita La Rosa
mei-info@unimelb.edu.au

Published by the Melbourne Energy Institute in February 2025

Views expressed are not necessarily endorsed or approved by the University. The information in this publication was correct at the time of printing. The University reserves the right to make changes as appropriate. For further information visit: www.energy.unimelb.edu.au

Message from the Director

Dear friends of the Melbourne Energy Institute, welcome to MEI's 2024 Annual Report. This was another, very busy year for MEI, with many significant achievements for our colleagues across the University. This Annual Report highlights many of them.

Whilst 2024 marks a period of sustained and significant growth of MEI's research and impact, I am most proud of two initiatives.

1. **MEI's diverse engagement program across industry, government and academia**

   This includes our many, carefully curated seminars, short courses and our annual Symposia. We cannot hope to improve any complex system without enhancing our shared understanding of it. This is not a matter of ideology but of shared learning, and therefore something that a fine university should strive to provide.

   Our many events with AEMO, industry and many others had this sole intent, and I sincerely thank all who participated.

2. **MEI's work with the University to support younger academic staff**

   Whilst many of us discuss and debate energy, far fewer really focus on aspects of this very complex topic. MEI has therefore been working with the University to support the next generation of academic staff who specialise in aspects of the energy system.

   This includes several new hires in 2024 whose achievements will become clear in the years ahead. I am really looking forward to seeing what these wonderful, younger colleagues will achieve.

Also, I have recently informed the University of my wish to step down as Director at the end of February, 2025. I have thoroughly enjoyed working with and learning from many wonderful people across industry, government and academia since I started as the Director of MEI in September 2016.

Most importantly, I must thank the MEI team for their outstanding support, both of MEI's mission and personally. I couldn't have hoped for better colleagues. I also thank all outside and inside the University who supported MEI during my Directorship.

I will shortly be resuming my academic life as a 'normal' Professor of Mechanical Engineering, focusing more on my own teaching, research and consulting. I have some new and exciting initiatives planned, so I very much look forward to continue working with many of you in the years ahead!

All the best,

Professor Michael Brear
FTSE, FCI, FIEAust
Director, Melbourne Energy Institute

About the Melbourne Energy Institute

The Melbourne Energy Institute brings together world-leading energy research from more than 300 experts across the University of Melbourne. We work in partnership with industry, government and the community on some of the world's most pressing energy challenges.

Our work explores the systems, technologies and materials needed for the transition to cleaner energy and transport. MEI brings together University of Melbourne research capabilities across four areas:

Energy Systems

Power Generation and Transport

Heavy Industry and Resources

Energy Materials

We work with many leading organisations in Australia and overseas, and we welcome joint proposals, directly funded research, PhD internships and broader, strategic collaborations.

Contact us at mei-info@unimelb.edu.au to find out more.

Meet the team

MEI is run by a team of dedicated staff who look after the Institute's research programs, stakeholder engagement, and communication activities.

Professor Michael Brear
FTSE, FCI, FIEAust
Director

Anita La Rosa
Institute Manager

Franca Tomaras
Events Coordinator

Josey Biasol
Administration and Events Assistant

Professor Kathryn Mumford
Program Leader Heavy Industry and Resources, and Head of Department, Chemical Engineering

Professor Pierluigi Mancarella
Program Leader Energy Systems, and Chair Professor of Electrical Power Systems

Associate Professor Wallace Wong
Program Leader Energy Materials, and Associate Professor, Chemistry

Professor Richard Sandberg
Program Leader Power Generation and Transport, and Chair of Computational Mechanics

Dr Adrian Panow
Director Major Projects

MEI's partners

Collaboration and knowledge transfer with industry and government are the cornerstone of MEI's work. Our partners are supported by the institution making the largest investment in research of any Australian university and with the country's largest cohort of research students. Some of MEI's industry partners include:

Industry partners

Government partners

Academic partners

Highlights of 2024

Two and a half times more clean energy needed to get to 2030 emissions goals

The Commonwealth Government's expanded Capacity Investment Scheme (CIS) will install an additional 32 GW of renewables and storage by 2030. This more than doubles the wind, solar and storage that we have built over the last 20 years in just six or so years. But it isn't enough to get us to the Government's legislated 2030 greenhouse gas abatement target.

Read more →

We can't say yet if grid-breaking thunderstorms are getting worse – but we shouldn't wait to find out

On 13 February 2024, six transmission line towers in Victoria were destroyed by extreme wind gusts from thunderstorms. The intense winds also knocked trees onto local power lines or toppled the poles. In all, about 500,000 people lost power. Some people went without electricity for more than a week.

Several intense thunderstorm events have made news in recent years. Perhaps the most far-reaching storms were those in 2016, when all of South Australia lost power for several hours after extreme winds damaged many transmission towers. So, are these storms getting worse as the climate changes? And how can we make our grid more resilient to extreme weather?

Read more →

Renewable-powered carbon capture set to scale

Extracting carbon dioxide from the air, to then turn it into something else, is energy intensive and costly, posing barriers to commercialisation and uptake as a climate-solution. Led by Professor Kathryn Mumford, researchers at the University of Melbourne have now engineered a novel approach for direct air capture (DAC) that addresses these challenges.

The process combines liquid-based carbon dioxide absorption with the use of patented, engineered 'nanocatalysts' working at lower temperatures, using less energy, and enabling the process to run using renewables, such as solar. The technology is now set to be tested in a 3-year, pilot-scale project with industry, to create a scalable solution for use in Australia and internationally.

Read more →

Highlights of 2024

Cut through the noise on nuclear power

The average Australian can be forgiven for being confused by the debate on nuclear power. It is very hard to separate ideology, politics and facts. But it may be a mistake to flatly rule out nuclear power when the final cost of a fully renewable system is also far from clear.

Read more →

Flying high: How supercomputers predicting roughness in jet engines can help cut carbon emissions

Jet turbine blades start out slick and smooth, carefully designed and manufactured for high aerodynamic performance. But very quickly, once they start flying, heat and speed see the blade surfaces degrade; which leads to them needing more fuel for each turn and reducing their life. Now, University of Melbourne researchers, together with General Electric Aerospace, have pioneered supercomputer simulations with groundbreaking implications for increasing engine efficiency, and cutting emissions.

Read more →

Safe and efficient hydrogen liquefaction and plant design

With funding from the Australian Renewable Energy Agency (ARENA), and in partnership with Future Energy Exports CRC, the University of Western Australia and industry, University of Melbourne researchers are helping make hydrogen processing and storage more cost competitive and safe.

Read more →

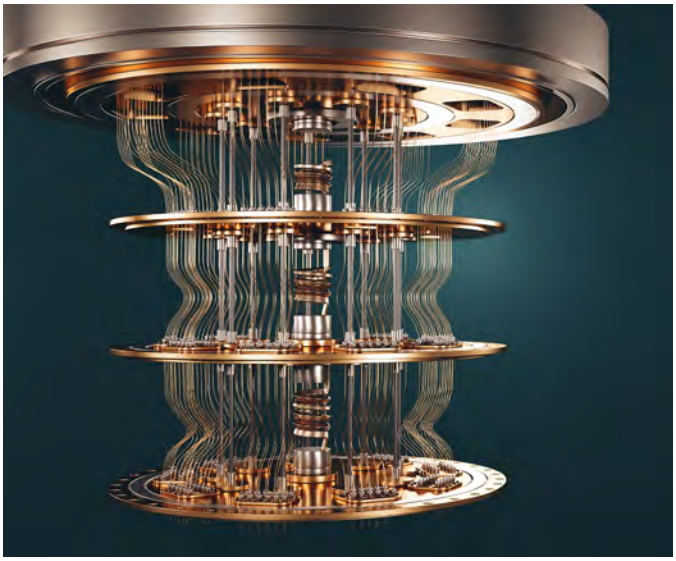
Energy beyond the sea: New research centre to support growth in offshore wind

Capturing the stronger, more consistent, winds at sea is already delivering clean energy in several other countries. As we establish a domestic industry, the new Australian Centre for Offshore Wind Energy (ACOWE), a partnership between several Australian universities, brings together multidisciplinary research capability to support its success. Read more →

Using sunshine twice: Is agrivoltaics a win-win for Australian farmers?

Agricultural and solar farming could increasingly cohabit the same patch of land – supporting industry growth, efficient land use, increased sustainability and providing a supply of clean power to farming businesses and their communities. Now, researchers at the University of Melbourne are exploring how agrivoltaics could benefit viticulture and horticulture in our uniquely Australian environment.

Read more →



Quantum leaps for the energy transition

Quantum computing is transforming the way we solve complex problems, rapidly surpassing classical computing's step-by-step logic. By leveraging probabilities rather than binary sequences, quantum systems can accelerate breakthroughs in AI, financial modelling, supply chain optimisation, and molecular analysis — all with the potential to fast-track the transition to net zero. Pioneering work at the University of Melbourne's IBM Quantum Hub is now enabling quantum algorithms to contribute to the decarbonisation, democratisation and decentralisation of energy.

Read more →

MEI Research Programs

Energy Systems

Exploring how energy technologies interact with one another, society and the environment.

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

Capabilities

- Energy network, system and market integration of renewable, fossil and nuclear energy sources
- Distributed energy resources and smart grids
- Integrated energy networks and multi-energy systems
- Security, reliability and resilience assessment of future energy systems
- Retail energy markets and consumer behaviour

Impact

- Collaborations with the Australian Energy Market Commission (AEMC) and the Australian Energy Regulator (AER) on power system resilience and reliability
- Integrated electricity-gas-hydrogen modelling for the Future Fuels CRC
- Development of transmission network planning methodology for National Grid ESO, Great Britain
- The Net Zero Australia Project with the University of Queensland and Princeton University

Research Centres

Centre for Market Design

Melbourne Centre for Law and the Environmental

Power and Energy Systems Group

Thermodynamics Laboratory

Program Leader

Professor Pierluigi Mancarella

Researchers

Professor Lu Aye

Professor James Bailey

Professor Robin Batterham

Professor Howard Bondell

Professor Michael Brear

Professor David Byrne

Professor Robert Crawford

Dr Christopher Hall

Dr James Helal

Professor William Ho

Professor Glenn Hoetker

Professor Chris Manzie

Associate Professor Leslie Martin

Professor Brendon McNiven

Dr Reihana Mohideen

Professor Nando Ochoa Pizzali

Associate Professor Behzad Rismanchi

Professor Prakash Singh

Professor Kate Smith-Miles

Power Generation and Transport

Investigating renewable and low emission power plants for stationary and mobile applications.

The Power Generation and Transport program investigates several forms of renewable and low emission power plants for stationary and mobile applications. This includes advanced wind, solar, gas turbine, reciprocating engine and energy storage technologies.

Capabilities

- Gas turbines and reciprocating engines
- AC and DC power electronics, electrical generators and drives
- Conventional, hybrid, electric and nuclear powerplant for land, sea and air
- Wind, solar PV and energy storage dynamics and optimisation
- Transport, storage, and use of hydrogen and other clean fuels
- Low drag vehicles for land, sea and air
- Advanced computational methods and machine learning in energy applications

Impact

- Improved aircraft engine aerodynamics for General Electric Aerospace
- More accurate design tools for heat transfer in thermal and nuclear power generation with MHI
- Propulsion, engines and fuels for Ford and DST Group
- Hydrogen and clean fuel combustion with Caterpillar and Siemens Energy

Research Centres

ARC Centre for Exciton Science

Fluid Mechanics Group

Peter Cook Centre for CCS Research

Thermodynamics Laboratory

Australian Centre for Offshore Wind Energy (ACOWE)

Program Leader

Professor Richard Sandberg

Key Researchers

Professor Robin Batterham

Dr Graeme Beardsmore

Professor Michael Brear

Professor Mark Cassidy

Associate Professor Shiao Huey Chow

Professor Shyamali Dharmage

Professor Lloyd Hollenberg

Associate Professor David Keith

Associate Professor Leslie Martin

Professor Chris Manzie

Professor Jason Monty

Professor Guillermo Narsilio

Dr Farzad Poursadegh

Associate Professor Behzad Rismanchi

Associate Professor Robyn Schofield

Professor Mark Stevenson

Associate Professor Mohsen Talei

Professor Yinghui Tian

Dr Claire Vincent

Professor Rachel Webster

Associate Professor Yi Yang

MEI Research Programs

Heavy Industry and Resources

Accelerating decarbonisation of the heavy industry and resources sectors.

The Heavy Industry and Resources program focuses on research that accelerates the decarbonisation of those sectors. The program studies clean fuels, storage and production; carbon dioxide capture and utilisation; and industrial electrolysis.

Capabilities

- Renewable integration into mining process
- Hydrogen to clean fuel conversion and safety
- Industrial electrolysis for carbon dioxide conversion and hydrogen production
- Carbon capture and storage (CCS)
- Sub-surface storage of hydrogen
- Resource law

Impact

- GeoCQuest project on CCS with BHP, Stanford and Cambridge
- Advisory to the Australian Government's updated National Hydrogen Strategy
- Provision of expert advice to the Australian Government's Hydrogen Guarantee of Origin scheme
- Novel Direct Air Capture - mineralisation (DAC-MIN) process for carbon dioxide abatement

Research Centres

Melbourne Centre for Law and the Environment

Peter Cook Centre for CCS Research

Thermodynamics Laboratory

Advanced Separation Technologies Group

Clean Energy Lab

Program Leader

Professor Kathryn Mumford

Key Researchers

Professor Robin Batterham

Dr Joe Berry

Professor Peter Cook

Dr Glen Farivar

Dr Eirini Goudeli

Professor Ralf Haese

Professor Sandra Kentish

Dr Aaron Li

Associate Professor Gang Li

Professor Tuan Ngo

Professor Jacqueline Peel

Professor Richard Sandberg

Professor Colin Scholes

Associate Professor Mohsen Talei

Dr Helena Wang

Associate Professor Yi Yang

Dr Ali Zavabeti

Energy Materials

Discovery and optimisation of materials for energy applications.

The Energy Materials program focuses on the discovery and optimisation of materials for energy applications. This includes materials for energy generation, storage, transport and consumption such as hydrogen electrolysis, batteries, solar energy conversion and lighting.

Capabilities

- Materials and device optimisation in solar photovoltaic technologies
- Energy materials design aided by theory and computation
- Developing next-generation catalysts for carbon dioxide reduction
- Novel materials and processes for gas separation and capture

Impact

- Development of >30% solar cell efficiencies and 30c/Wp capital costs at scale, as part of the Australian Centre for Advanced Photovoltaics
- Collaboration with JinkoSolar on advanced passivated contact solar cell architectures
- Use of nanomaterials to improve the performance of solar windows with ClearVue PV
- Improvement of performance and reduce cost of anode materials in batteries for the Future Battery Industries CRC in conjunction with industry partners including Syrah Resources

Research Centres

ARC Centre of Excellence in Exciton Science

ARC Training Centre in Future Energy Storage Technologies

Experimental Condensed Matter Physics Group

Integrated Computational Materials Engineering Group

Program Leader

Associate Professor Wallace Wong

Key Researchers

Dr Christian Brandl

Associate Professor James Bullock

Professor Amanda Ellis

Professor Ken Ghiggino

Dr Carol Hua

Professor David Jamieson

Professor Sandra Kentish

Professor Dan Li

Associate Professor Gang Li

Associate Professor Wen Li

Dr Tesfaye Molla

Professor Paul Mulvaney

Professor Kathryn Mumford

Professor Greg Qiao

Associate Professor Colin Scholes

Professor Martin Sevior

Professor Trevor Smith

Seed funded projects

The Melbourne Energy Institute's seed funding program supports University researchers when they wish to initiate significant, energy-related research projects and raise external research funding.

MEI provided cash and in-kind support for the following seed funding initiatives that either commenced or were ongoing during 2024.

Project	Lead researcher/s
Understand and mitigate bubble effects on industrially applicable water electrolysis	**Dr Aaron Li**, Chemical Engineering, Faculty of Engineering and Information Technology **Dr Glen Farivar**, Electrical and Electronic Engineering, Faculty of Engineering and Information Technology
Carbon capture technologies program submission	**Professor Kathryn Mumford**, Chemical Engineering, Faculty of Engineering and Information Technology **Dr Aaron Li**, Chemical Engineering, Faculty of Engineering and Information Technology **Professor Sandra Kentish**, Chemical and Biomedical Engineering, Faculty of Engineering and Information Technology **Professor Ralf Haese**, Earth Sciences, Faculty of Science
Evaluating battery and supercapacitor performance	**Dr Glen Farivar**, Electrical and Electronic Engineering, Faculty of Engineering and Information Technology
Investigating the potential of Se/Si tandem photovoltaic cells	**Professor Paul Mulvaney**, Chemistry, Faculty of Science **Associate Professor James Bullock**, Electrical and Electronic Engineering, Faculty of Engineering and Information Technology **Dr Di Yan**, Electrical and Electronic Engineering, Faculty of Engineering and Information Technology
Turbine design-tool improvement through machine-learning	**Professor Richard Sandberg**, Mechanical Engineering, Faculty of Engineering and Information Technology
GasMap: Observations of methane anomalies over Australia using TROPOMI	**Professor Peter Rayner**, Earth Sciences, Faculty of Science
ITEM-UX: Integrated transport and energy management for users	**Dr Patricia Lavieri**, Infrastructure Engineering, Faculty of Engineering and Information Technology
Smart geothermal industrial loop	**Professor Rachel Webster**, Physics, Faculty of Science
DAC2Fuel	**Associate Professor Dalton Harvie**, Chemical Engineering, Faculty of Engineering and Information Technology


Vestas

Students of MEI

Supporting early career researchers is central to MEI's mission and growth. Meet some of our talented students working on the transition to cleaner energy.

Electric vehicle drivers get home from work and plug their cars into a 240V power outlet to charge overnight. Sounds simple, right? Not quite. Distribution companies are concerned about the impact that widespread adoption of EVs may have on the electricity network.

Through her research project, PhD student **Jing Zhu** is aiming to facilitate increased EV adoption by eliminating the technical and economic impacts of their usage on power distribution networks.

Stemming from a deep desire to develop sustainable transport systems that contribute to liveable cities, PhD student **Elham Hajhashemia**'s research explores the intersection of transport, energy demand management, and user behaviour. Her findings on charging behaviour can help unlock the full potential of electric vehicles by informing policies that promote sustainable charging practices.

Efficient hydrogen-fuelled electricity generators can power homes or businesses with reduced or no carbon emissions. PhD student **Joel Mortimer**'s research uses a novel 3D printed direct injection and ignition system to convert a diesel generator to hydrogen, and then tests different techniques to improve its efficiency.

While the UN Paris Agreement doesn't expressly regulate coal's extraction or consumption, is it having a meaningful influence on the laws which govern Australia's greenhouse emissions from coal? This is the question explored in **Ella Vines**' PhD, whose thesis finds that the Paris Agreement is guiding relationships between specialised legal spheres in significant ways.

Heating and cooling account for 40% of Australian energy consumption, making this a sector we need to decarbonise quickly. Can Fifth-Generation District Heating and Cooling (5GDHC) be part of the solution? **Kristian Gjoka**'s PhD puts forward a methodological framework to find out.

Machine-learning methods have the potential to improve fluid dynamics modelling, including on transition and turbulence flow. **Yuan Fang**'s research applies machine-learning to provide engineers with quicker, more precise feedback during the product design phase. This can contribute to the design of lighter and smaller engines, potentially reducing both fuel and emission.

Sustainable buildings are characterised by their benefits for the environment, the economy and the people who use them. **Praddeep Gobinath**'s research explores how smart control approaches can improve the overall sustainability of heating, ventilation and air conditioning in commercial buildings.

Solar cells and LEDs have the potential to drastically reduce energy consumption and emissions worldwide. **Shi Tang**'s research focuses on enhancing the efficiency of these technologies through innovative materials and fabrication techniques, laying the foundation for more affordable renewable energy and significant cuts in electricity consumption.

Low-temperature geothermal energy presents a clean, constant power source with great potential for industrial use. **Belay Gulte Mino**'s research investigates how low-temperature heat lying just below the Earth's surface in the Gippsland basin, could be harnessed, while protecting nearby aquifers and the surrounding body of rock.

What if we could rethink the design of high-rise buildings, so they store energy while managing water? **Arezoo Boroomandnia**'s research explores Micro Pumped-Storage (MPS) systems, where rooftop water tanks store renewable energy and collect rainwater. With savings in energy, water, emissions, and even space, her work could transform entire cities — starting with Melbourne — into sustainable, climate-resilient ecosystems.

Distribution companies need new ways to meet the technical demands of the growing rooftop solar, small-scale energy storage and electric vehicles across Australian suburbs. **Angela Simonovska**'s research explores how smart meter data can combine with AI, to support distribution companies in optimising real-time power flows disrupted by distributed energy resources (DER).

Engagement

Featuring researchers, policy-makers and industry experts, our regular seminars, public lectures and annual Symposium go behind the scenes on how our energy markets and systems operate, dissecting technical challenges and delving into energy policy.

MEI Seminar Series

The MEI Seminar Series provides participants with the foundations to better understand the Australian energy system. This includes the technologies that support it and the markets and systems within which it operates. Each year, the focus is turned to one of our primary energy vectors, cycling through the major topics of electricity, natural gas, and energy commodities. In 2024, the focus once again turned to the electricity supply chain.

MEI Seminar Series 2024: Electricity Supply Chain

2 May 2024
Seminar #1: System overview - from generation to customer
Chris Mock, Manager – Engineering Strategy, Australian Energy Market Operator (AEMO)

4 June 2024
Seminar #2: Transmission and distribution networks
John Theunissen, Electrical Engineer

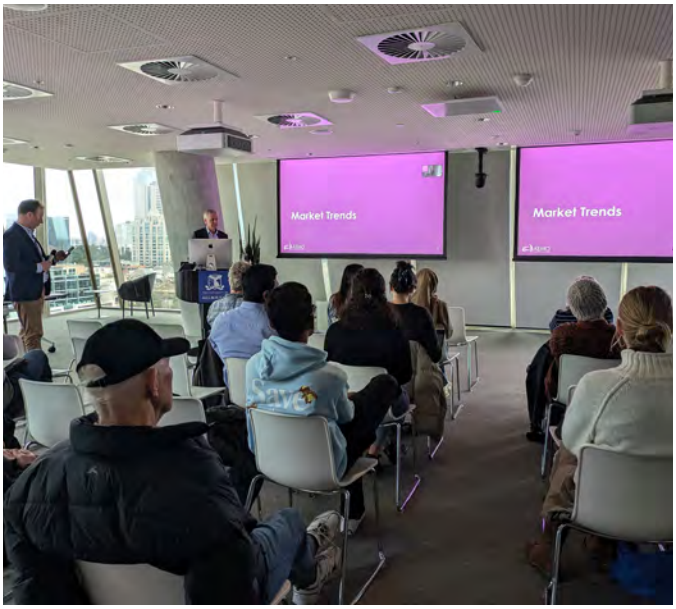
17 July 2024
Seminar #3: Wholesale markets
Paul Austin, Group Manager Reform Delivery, Australian Energy Market Operator (AEMO)

7 August 2024
Seminar #4: Financial markets
Rob Koh, Equity Research Analyst, Morgan Stanley

5 September 2024
Seminar #5: Energy markets in an isolated grid
Cameron Owens, Head of DER and Engineering, Future Energy, Synergy

8 October 2024
Seminar #6: Enabling the DER revolution - from dynamic pricing to virtual power plants, energy communities, and microgrids
Professor Pierluigi Mancarella, Chair Professor of Electrical Power Systems, and Melbourne Energy Institute Energy Systems Program Leader, University of Melbourne

7 November
Seminar #7: Energy communities and microgrids
Carman Bas, Electrical Engineer (Renewables), Energy Australia



Paul Austin, Group Manager Reform Delivery at the Australian Energy Market Operator (AEMO), discussing wholesale electricity markets.

Professor Pierluigi Mancarella, Chair Professor of Electrical Power Systems, and MEI's Systems Program Leader, exploring Distributed Energy Resources (DERs) in distribution networks.

MEI Energy Systems Short Course

MEI's Energy Systems Short Course teaches skills in analysing the financial, technical, and environmental performance of energy projects. The course centres on practical, hands on, modelling exercises. Participants develop their own spreadsheet models, and learn how to answer questions such as: Is a proposed wind farm or gas turbine a good investment? What is the probability that it will earn a commercial rate of return? What is the best financing structure for the project?

The 2024 Short Course was taught by **Dr John Burgess**, a University of Melbourne Honorary Professorial Fellow, with the assistance of **Jonathan Anderson**, a Senior Engineer working in the energy sector. Among the attendees were graduate students from the University of Melbourne and professionals from MEI's industry partners.

Congratulations to participants of MEI's 2024 Energy Systems Short Course.

MEI Symposium 24

Anna Skarbek, CEO of the Climateworks Centre, was the opening plenary speaker at MEI'S 2024 Symposium.

Each year, the MEI Symposium showcases the multidisciplinary energy research taking place throughout the University of Melbourne. It provides a space for collaboration, as well as an opportunity to celebrate the past year's accomplishments.

In 2024, MEI's annual symposium once again showcased diverse research for a clean energy future. It convened many hundred attendees, who heard from 26 energy experts across MEI's 4 research programs.

Matching ambition by design: Opening plenary discussion

Five systemic shifts are required to accelerate the transition to net-zero energy, and simultaneously, prepare Australia to become a renewable energy superpower. This was the thesis put forward by **Anna Skarbek**, CEO of the Climateworks Centre and the Symposium's opening speaker.

From new energy market rules and stronger integration of energy efficiency in planning, to financial and reporting instruments which favour climate-safe investments, Anna laid out critical steps to enable electrification while growing Australian exports of renewable energy and clean commodities.

Four research streams each shared five breakthrough areas of research

Session 1: Energy Systems

Chaired by MEI's Energy Systems Program Leader, **Professor Pierluigi Mancarella**, this stream looked at how clean energy technologies integrate with one another, society and the environment.

The session's keynote, delivered by the University's **Professor Kate Smith-Miles**, explored a range of methods for better decision making to optimise energy system performance (and the merits of ditching spreadsheets!).

As part of this session, presenters also explored techno-economic assessments and electric grid stability, along with residential energy decarbonisation and hydrogen for energy storage.

Session 2: Energy Materials

MEI Program Leader, **Associate Professor Wallace Wong**, chaired the Energy Materials discussion, ans focused on the discovery and optimisation of materials for energy applications.

The session started with the University's **Professor Amanda Ellis**' keynote, looking at the evolution of battery technologies and how improving graphite anodes can improve performance.

Researchers also presented pioneering work in semiconductor nanocrystals, new cell architecture for solar photovoltaics, advanced spectroscopic techniques and proton transport.

Session 3: Power Generation and Transport

Director of the Australian Centre for Offshore Wind Energy, **Associate Professor Shiaohuey Chow**, chaired this session. It focused on renewable and low emission fuels for both stationery and transport energy.

The session was kicked-off by keynote speaker, **Dr. David Harris,** Chief Research Consultant from CSIRO Energy, who delved into technology pathways for sustainable energy systems. It explored hydrogen as an energy carrier, enabling technologies in gasification and supply-chain linkages, and the need for practical, industrial demonstrations.

David was followed by presenters discussing the potential of geothermal energy across the Gippsland region, assessment of long-term trends in wind energy density off the Australian coastline, and the next frontier in aircraft engines.

Session 4: Heavy Industry and Resources

Chaired by **Associate Professor Colin Scholes** on behalf of Heavy Industry and Resources Program Leader, **Professor Kathryn Mumford**, this session focused work accelerating decarbonisation in these sectors.

The session began with a keynote from **Barry Hooper, Executive Director from KC8 Capture Technologies**, who discussed the company's work in commercialising, cost-effective, chemical carbon capture for use by fossil fuel energy and heavy industrial sectors.

Barry's talk was followed by presentations on high temperature hydrogen electrolysis, cryogenic hydrogen, and carbon-negative ammonia or green hydrogen production from the air!

MEI Poster Competition 2024

As part of MEI Symposium 24, post-doctoral research fellows and post-graduate students participated in our Poster Competition, presenting their own research aligned to MEI's Research Programs.

MEI Poster Competition winners

Oral Presentation Winners	Poster Winners
Energy Materials	
Winner: Dr Zifei Chen, *PhD Graduate* **Topic:** A general nucleation model for semiconductor nanocrystals	**Winner: Donghyuck Park,** *PhD Student* **Topic:** Improved lithium-ion battery cathode performance via chemically modified carbon black
Energy Systems	
Winner: Dr. Sleiman Mhanna, *Senior Research Fellow* **Topic:** Future electricity and hydrogen systems: Long-duration storage options for Australia	**Winner: Luke Woolcock,** *PhD Student* **Topic:** Detecting oscillatory instability in weak grids a gain and phase based approach
Heavy Industry and Resources	
Winner: Dr. Andre Chambers, *Postdoctoral Research Fellow* **Topic:** A high pressure, high temperature electrolysis rig with optical access for bubble imaging	**Winner: Arash Momeni,** *PhD Student* **Topic:** Catalytic membrane application in direct air capture using amino acid salts
Power Generation and Transport	
Winner: Marco Rosenzweig, *PhD Student* **Topic:** Pushing the frontiers of supercomputing for next-generation aircraft engines	**Winner: Kha Meng Ng,** *PhD Student* **Topic:** How do biomethane impurities affect combustion appliances?

The Poster Competition at MEI Symposium24.

Engagement

Public seminars, lectures, and workshops

During 2024, MEI held numerous public seminars, lectures and workshops that informed broader collaboration and debate. Local and international experts from both industry and academia were invited to share diverse perspectives on the shift toward cleaner energy and transportation systems. This includes discussions on the short and long term effects of energy policies and technological advancements.

AEMO Quarterly Dynamics webinars

Delivered in partnership with the Australian Energy Market Operator (AEMO), this webinar series sheds light on the findings of AEMO's Quarterly Energy Dynamics reports, examining emerging trends across Australia's electricity and gas markets. MEI has become a key dissemination point for the findings of the quarterly report via the seminars, which are presented by **Kerry Galloway**, Manager - Market Insights from the Australian Energy Market Operator (AEMO).

View the recordings of all AEMO Quarterly Dynamics webinars →

MEI public lecture: Bubble-free capillary water electrolysis — A new approach to industrial water electrolysis

13 February 2024

MEI was pleased to host a public lecture with **Professor Gerhard F. Swiegers**, Australian Research Council Industry Laureate Fellow from the University of Wollongong, on the topic of renewable, or green, hydrogen.

Renewable hydrogen will play a critical role in the future decarbonisation of our economy, particularly of the so-called 'hard-to-abate' sectors like heavy transport, steel, chemicals, and aviation. However, it is presently not cost-competitive with fossil fuels due to the poor energy efficiency of state-of-the-art commercial water electrolysers. This presentation described a remarkable new technology that promises to deliver cost-competitive renewable hydrogen. The technology employs an electrochemical cell architecture in which water is fed by capillary action to the electrodes, allowing for direct production of hydrogen without the formation of gas bubbles.

View the recording →

Short Course: Operating envelopes and their implementation

13 March - 14 March 2024

Australia is the first country in the world where residential customers are being offered flexible export limits in which export limits (for solar PV) are not fixed but vary throughout the day according to what the poles and wires can withstand. Such flexible export limits are also known as operating envelopes (OEs).

The 2-day short course on operating envelopes and their implementation was delivered by the Power and Energy Systems Group and the Melbourne Energy Institute at the University of Melbourne. The course covered fundamental, advanced, and practical aspects related to the use of operating envelopes OEs by distribution companies. Speakers included the University of Melbourne's **Professor Nando Ochoa**, Professor of Smart Grids and Power Systems, **Professor Pierluigi Mancarella,** Professor of Smart Grids and Power Systems, **Dr Arthur Givisiez**, Research Fellow in Smart Grids, **Alex Guinman**, Senior Operational Systems Engineer, Intelligent Grid Enablement Team at Energy Queensland, and **Liam Mallamo,** Future Networks Engineer at SA Power Networks.

This course was provided free of charge and delivered fully online.

View the course module recordings →

Energy Futures Public Forum: US and Australian journeys on the road to net zero

1 May 2024

Australia and the United States are both on the journey to a net-zero energy system. This is a transformative journey, and we are not yet half-way there. Energy is a fundamental underpinning of our modern lives and what this transformation looks like was explored at a public forum on 1 May 2024, jointly hosted by the Melbourne Energy Institute and Grattan Institute.

The event featured a key address from **Allison Clements**, Commissioner of the US Federal Energy Regulatory Commission (FERC). This was mirrored with input from the Australian perspective through a panel discussion featuring **Sally McMahon**, Commissioner at the Australian Energy Market Commission (AEMC), and **Professor Pierluigi Mancarella**, Energy Systems Program Leader and Chair of Electrical Power Systems at the University of Melbourne. The forum was moderated by **Tony Wood**, Energy and Climate Change Program Director at Grattan Institute, and hosted by **Professor Michael Brear**, Director of the Melbourne Energy Institute.

View the recording →

Short Course: Foundations of the energy system - A consumer advocacy toolkit

May – December 2024

This free, knowledge-building course provided new and existing consumer advocates with foundational knowledge on the ongoing transformation in the energy industry and markets. The course was supported by the Energy Consumers Australia's Grants Program.

The training was primarily delivered by the University of Melbourne's **Professor Pierluigi Mancarella**, as well as other relevant national and international speakers. The course provided participants with the first principles of major socio-techno-economic issues associated with the energy transition, as well as basic knowledge of the major decision-making processes to effectively influence government, regulatory and industry policies.

The 2024 course was a pilot program, with the potential to continue in future years.

Read the course guide →

Allison Clements, Commissioner of the US Federal Energy Regulatory Commission (FERC), during the Energy Futures Public Forum.

Engagement

MEI public lecture: Recent developments in U.S. climate policy

10 October 2024

The Melbourne Energy Institute hosted a public lecture by **Dr Karl Hausker** of the World Resources Institute to discuss the recent developments in U.S. climate policy.

Passage of the 2022 Inflation Reduction Act (IRA) was a major step forward for the U.S. on the path to meeting its NDC target for 2030 under the climate treaty, and toward its goal of net-zero emissions by 2050. The IRA addresses emissions in nearly all sectors of the economy and provides incentives for carbon dioxide removal.

During this lecture, Dr Hausker placed the IRA in context given the history of U.S. climate policy, assessed progress in its implementation, and explored implementation challenges expected in the decade ahead. Topics also included the impact of the 2024 elections, surging electricity demand, large buyer interest in nuclear and other clean/firm power, and debates over U.S. fossil fuel production and exports.

View the slides →

Let's tax carbon and other ideas for a better Australia with Professor Ross Garnaut

23 October 2024

How can Australia lead the global shift to a low-carbon economy and secure its future as a full-employment, renewable energy superpower?

The Melbourne Energy Institute, the Superpower Institute, and the Faculty of Business and Economics hosted a forum where **Professor Ross Garnaut AO** shared key ideas from his latest work, *Let's Tax Carbon: And Other Ideas for a Better Australia.*

In this thought-provoking discussion, Professor Garnaut explored how Australia can lead the global transition to a low-carbon economy, securing its future as a full-employment, renewable energy superpower.

Professor Garnaut reflected on the history of Australia's economic policies, offering a critical assessment of the current approach to climate and energy reform. Central to the discussion was his proposal for a Carbon Solutions Levy, a bold new approach to holding major polluters accountable while spurring innovation and driving industrial development in a low-carbon economy. The forum also featured **Aruna Sathanapally**, Grattan Institute's CEO, **Professor Beth Webster**, Director of the Melbourne Institute for Applied Economic and Social Research, and **Professor Peter Dawkins**, Emeritus Professor of Economics at the Mitchell Institute, Victoria University.

Dr Karl Hausker explaining developments in U.S. climate policy

MEI public lecture: Paradigm change of power system operation and control

22 October 2024

The Melbourne Energy Institute hosted a public lecture by **Professor Janusz Bialek** of the Imperial College London. Since their inception at the end of the 19th Century, technical characteristics of power systems have been determined by the physics of synchronous machines (SMs) that convert the primary energy produced by thermal/hydro/nuclear power stations into electricity. However, the traditional power plants are increasingly being replaced by wind/PV plants and batteries which are connected to the grid asynchronously by means of power electronics (controllable inverters). This means that the power system technical characteristics are increasingly being determined by the control algorithms of inverters rather than the physics of SMs, and this has profound consequences for power system operation and control. The presentation by Professor Bialek discussed those changes and especially the question to what extent inverters can replace synchronous machines.

View the recording and slides →

Short Course: Advances in hosting capacity

10 – 12 December 2024

The short course on advances in hosting capacity provided a thorough international overview of the fundamental, advanced, and practical aspects of assessing the ability of existing electricity distribution infrastructure (the poles and wires) to accommodate distributed energy resources, such as rooftop solar PV and electric vehicles.

Globally, the adoption of distributed energy resources (DER) like rooftop solar panels and electric vehicles is on the rise. However, distribution companies, responsible for managing the poles and wires, face a significant challenge - the existing infrastructure was never designed to support the widespread integration of these new technologies.

This 3-day short course was delivered by the University of Melbourne's Power and Energy Systems Group and the Melbourne Energy Institute, in collaboration with the State University of Campinas (UNICAMP, Brazil), Energy Research and Analytics (ERA, Brazil), Center for Energy Transition (CENTRA) at Adolfo Ibáñez University (Chile), the Electric Power Energy Institute (EPRI, USA), and VoltMind (Australia).

Read the course guide →

Professor Janusz Bialek discussing changes to power system operation and control.

Engagement

Popular articles

The following lists a selection of articles authored by MEI researchers and Fellows. The articles appeared in *Pursuit*, an academic research publication by the University of Melbourne, and *The Conversation*, a leading publisher of research-based news and analysis.

We can't say yet if grid-breaking thunderstorms are getting worse - but we shouldn't wait to find out

The Conversation, 28 February 2024

By Associate Professor Andrew Dowdy, Dr Andrew Brown, Associate Professor Andrew King, Dr Claire Vincent, Professor Michael Brear, Professor Pierluigi Mancarella, and Professor Todd Lane, University of Melbourne

Extreme winds from thunderstorms have downed transmission towers from Victoria to Western Australia in recent years. What's going on?

Supercharged thunderstorms: Have we underestimated how climate change drives extreme rain and floods?

The Conversation, 9 May 2024

By Associate Professor Andrew Dowdy, University of Melbourne, Dr Conrad Wasko, University of Sydney, Associate Professor Jennifer Catto, University of Exeter, Dr Seth Westra, University of Adelaide

Why have we seen so many extreme floods in recent years? Climate change is supercharging thunderstorms, adding moisture and heat.

Sky-high vanity: Constructing the world's tallest buildings creates high emissions

The Conversation, 10 May 2024

By Dr James Helal, University of Melbourne and Associate Professor Dario Trabucco, Università Iuav di Venezia

The pursuit of 'vanity height' in skyscrapers is driven by aesthetic appeal and the status of being 'the tallest'. Redefining how we measure building heights can help cut the environmental cost.

Why knock down all public housing towers when retrofit can sometimes be better?

The Conversation, 24 May 2024

By Associate Professor Trivess Moore, Dr David Kelly, and Professor Ralph Horne, RMIT University, and Professor Robert Crawford, University of Melbourne

Our research shows decisions on the fate of public housing towers that are based on a proper process of considering all the evidence could go either way: demolish and rebuild, or retrofit.

How many 20-minute neighbourhoods does Melbourne really have?

Pursuit, 31 May 2024

By Dr Kerry Nice, Dr Sachith Seneviratne and Professor Mark Stevenson, University of Melbourne

Walkable cities are gaining traction. Our Map of the Month shows which Melbourne suburbs are walking distance to childcare, pharmacies and GPs.

Why Melbourne's e-scooter ban is a wrong turn away from safe, sustainable transport

The Conversation, 16 August 2024

By Professor Mark Stevenson, University of Melbourne and Dr Ferdinand Balfoort, Charles Darwin University

Shared e-scooters have safety features that private e-scooters lack, but accident data don't distinguish between them, nor tell us about the economic and environmental harms of other transport modes.

Why hurricanes like Milton in the US and cyclones in Australia are becoming more intense and harder to predict

The Conversation, 11 October 2024

By Associate Professor Andrew Dowdy, University of Melbourne, Dr Liz Ritchie-Tyo, Monash University, Dr Savin Chand, Federation University Australia

With Hurricanes Helene and Milton reminding us of the destructive force of such storms, the tropical cyclone forecast for Australia is for an average number but with a higher risk of severe cyclones.

Severe thunderstorms are sweeping through southern Australia. But what makes a thunderstorm 'severe'?

The Conversation, 17 October 2024

By Dr Andrew Brown, Associate Professor Andrew Dowdy, University of Melbourne

This week, unusually widespread thunderstorms are expected to bring rain, hail and intense winds to swathes of southern Australia. Here's why – and what threat they can pose.

The extreme floods which devastated Spain are hitting more often. Is Australia ready for the next one?

The Conversation, 6 November 2024

By Dr Conrad Wasko, University of Sydney; Associate Professor Andrew Dowdy, University of Melbourne, and Dr Seth Westra, University of Adelaide

To prepare for more intense floods supercharged by climate change, we have to build infrastructure able to tolerate new extremes.

It's time to put Australia's car dependency in reverse

Pursuit, 25 November 2024

By Professor Mark Stevenson, Dr Kerry Nice, Dr Sachith Seneviratne, Humberto Barrera-Jimenez and Associate Professor Jason Thompson, University of Melbourne

Repurposing our streets away from a focus on cars is crucial to creating more accessible and sustainable cities.

From sand to superposition: A key step towards a powerful silicon quantum computer

Pursuit, 27 November 2024

By Dr Alexander Malwin Jakob and Professor David Jamieson, University of Melbourne

A major obstacle to quantum computing has been overcome by modifying a common industrial method to create large arrays of single atoms in a silicon chip.

Communications

Using various communications channels, MEI contributes to the national energy debate by presenting a range of views on relevant and critical industry issues.

energy@melbourne: MEI's monthly e-newsletter

MEI's monthly external newsletter, energy@melbourne, is our key communication tool. The e-newsletter has a subscriber list of over 6,000 individuals from industry, government, academia, and the wider community. All public engagement initiatives are promoted through this newsletter, as are MEI researchers' projects and successes, and other relevant industry news. Read the 2024 editions of energy@melbourne below.

energy@melbourne: February 2024
energy@melbourne: March 2024
energy@melbourne: April 2024
energy@melbourne: May 2024
energy@melbourne: June 2024
energy@melbourne: July 2024
energy@melbourne: August 2024
energy@melbourne: September 2024
energy@melbourne: October 2024
energy@melbourne: November 2024
energy@melbourne: December 2024

Media

The MEI Director and Program Leaders are often called on by media to provide expert commentary relating to the Australia's energy sector. In 2024, numerous interviews were given by members of the Melbourne Energy Institute, and many of these were syndicated across multiple publications Australia wide. The following provides a snapshot of some of the interviews and media articles featuring MEI.

Bowen's electricity plan still far short of a $5trn task

The Australian Financial Review, 1 January 2024
Op-ed by Professor Michael Brear, University of Melbourne

What caused Victoria's power outage?

ABC, 14 February 2024
Interview with Professor Michael Brear, University of Melbourne

ABC Drive

ABC, 23 May 2024
Interview with Professor Michael Brear, University of Melbourne

ABC Drive

ABC, 20 June 2024
Interview with Professor Michael Brear, University of Melbourne

Nuclear debate is getting heated, but whose energy plan stacks up?

Sydney Morning Herald, 24 June 2024
Interview with Professor Michael Brear, University of Melbourne

Engagement

Social media

MEI's research work in advancing the energy transition reached a sizable audience through its digital communications in 2024. A website refresh, launched in September, improved user experience, for the 10,000 site visitors in the last quarter of 2024. Over the 12 month period from 1 January to 31 December, the MEI website attracted more than 36,000 visits (a 180% increase from 2023), from more than 20,000 individuals (a 160% increase from the previous year). Half of these were new visitors, demonstrating a growing audience for the University's energy research and innovation, with the majority visiting in the lead up to the Symposium 24. MEI's 6,000 strong newsletter subscribers were also well engaged over 2024, with 67 email campaigns each attracting above average open rates. Likewise, MEI's LinkedIn content delivered 90,000 impressions through its existing following of 4,000, with 780 of these new followers gained in 2024. A further 39,000 LinkedIn impressions came from paid promotion to new audiences for key campaigns in 2024.

Government submissions

Researchers at the Melbourne Energy Institute have provided a number of submissions to government in response to key issues impacting the Australian energy sector.

Submission to the Senate Select Committee on Energy Planning and Regulation in Australia

Date of publication: November 2024
Lead Academic: Professor Michael Brear, University of Melbourne

Contribution to the Australia Government's 2024 National Hydrogen Strategy

Date of publication: September 2024
Lead Academic: Professor Michael Brear, University of Melbourne

Victorian Energy Jobs Plan

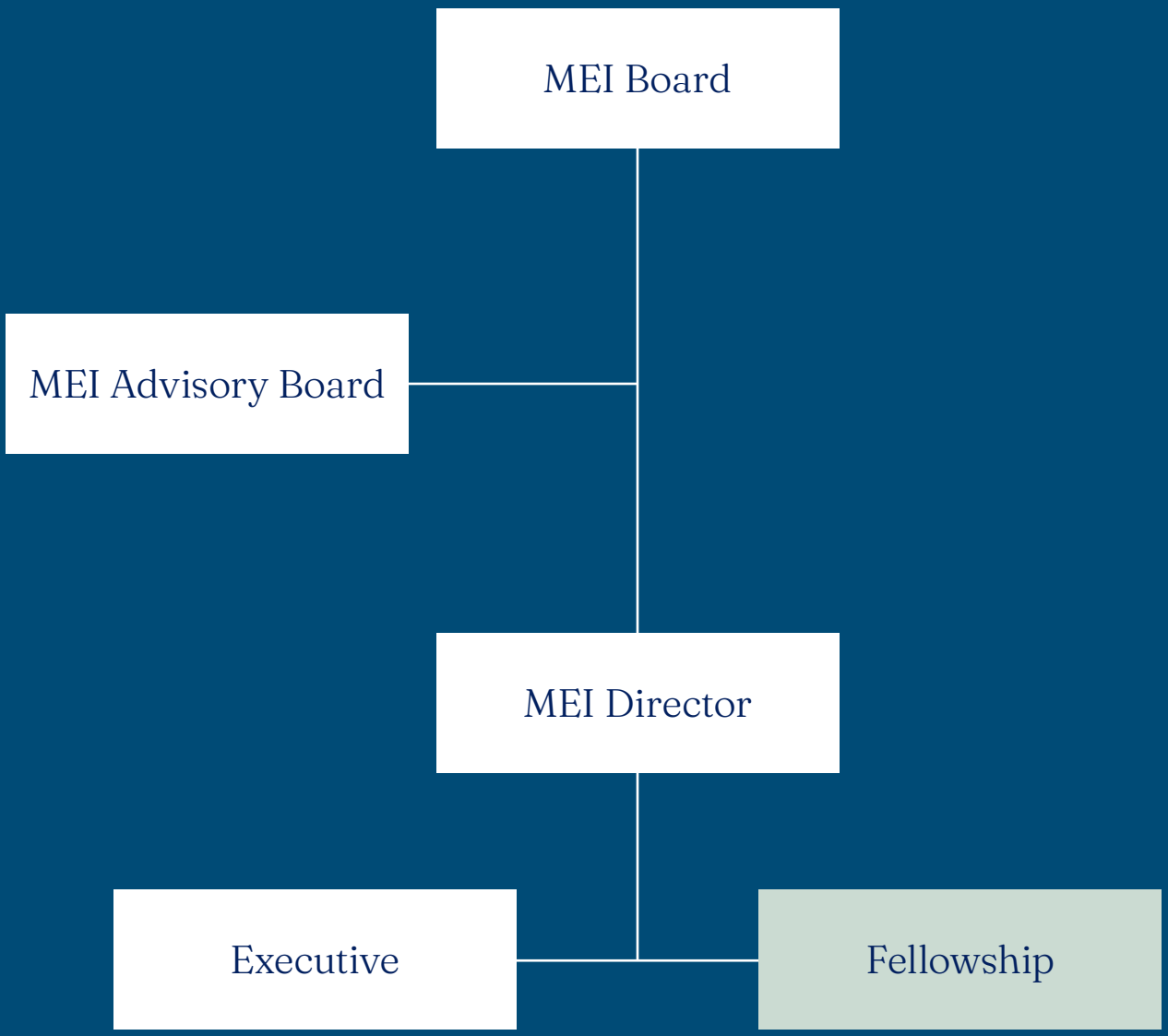
Date of publication: August 2024
Lead academics: Professor Michael Brear, University of Melbourne and Professor Gary Rosengarten, RMIT

Inquiry into the transition to electric vehicles

Date of submission: March 2024
Lead academics: Associate Professor David Keith, Melbourne Business School

Governance

The Melbourne Energy Institute reports to the MEI Board for operational matters. The Institute Director, team of professional staff and the Executive Committee work together to operate MEI, and the Advisory Board and Fellows provide strategic advice.



Governance

MEI Board

Professor Mark Hargreaves, *Pro Vice-Chancellor*, Research Collaboration (Chair)

Professor Frank Vetere, *Deputy Dean (Engagement),* Faculty of Engineering and Information Technology

Professor Andy Martin, *Associate Dean (Research),* Faculty of Science

Advisory Board

Andrew Stock, *Fellow,* Climate Council, and energy transition advisor (Chair)

Michael Bielinski, *Regional Head of Projects (Asia Pacific Region),* Siemens Energy

Mel Cutler, *Sustainability and ESG leader*

Sally Farrier, *Company Director, and utility industry expert*

Tony Wood, *Energy Program Director,* Grattan Institute

Executive Committee

Professor Michael Brear, *Director,* Melbourne Energy Institute (Chair)

Professor Lu Aye, *Professor,* Department of Infrastructure Engineering

Dr James Bullock, *Senior Research and ARC Decra Fellow,* Department of Electrical and Electronic Engineering

Associate Professor Shiaohuey Chow, *Senior Lecturer,* Department of Infrastructure Engineering

Dr Chris Goodes, *Enterprise Professor – Sustainable Resources,* Faculty of Engineering and Information Technology

Professor Ralf Haese, *Professor*, Environmental Geochemistry, Department of Geography, Earth and Atmospheric Sciences

Anita La Rosa, Institute Manager, Melbourne Energy Institute

Professor Pierluigi Mancarella, *MEI Program Leader Energy Systems, and Chair Professor of Electrical Power Systems,* Department of Electrical and Electronic Engineering

Professor Kathryn Mumford, *MEI Program Leader Hydrogen and Clean Fuels, and Head of Department,* Department of Chemical Engineering

Dr Adrian Panow, *Director Major Projects,* Melbourne Energy Institute

Professor Richard Sandberg, *MEI Program Leader Power Generation and Transport, and Chair of Computational Mechanics and ARC Future Fellow,* Department of Mechanical Engineering

Associate Professor Wallace Wong, *MEI Program Leader Energy Materials,* School of Chemistry

Financial summary

University Income	Actuals
Core funding from Deputy Vice-Chancellor (Research)	$1,064,069
Other income	$56,334
Total Income	**$1,120,403**
Expenditure from University income	
Institute staff salaries	$750,471
Administration and general costs	$12,000
Events and communication	$12,000
Research project support salaries	$159,747
Research project seed funding	$87,500
Partnership development	$150,541
PhD scholarships	$0
Other	$0
Total Expenditure	**$1,172,260**
External Income	
ARC	$6,718,000
Industry – direct contract and leveraged	$13,485,000
Government	$20,535,000
Philanthropy	$2,000,000
Total External Income	**$42,738,000**

THE UNIVERSITY OF MELBOURNE

Contact us

Melbourne Energy Institute
University of Melbourne
Level 1, Melbourne Connect
700 Swanston Street, Carlton VIC 3053

mei-info@unimelb.edu.au
energy.unimelb.edu.au

Melbourne Energy Institute

RFQ12562