THE UNIVERSITY OF MELBOURNE

Melbourne Energy Institute

RESEARCH CAPABILITIES AND IMPACT

ABOUT THE MELBOURNE ENERGY INSTITUTE

The Melbourne Energy Institute (MEI) delivers influential, interdisciplinary research on the transition to a clean energy system. We work with the community, industry and government on some of the world's most pressing energy challenges.

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.

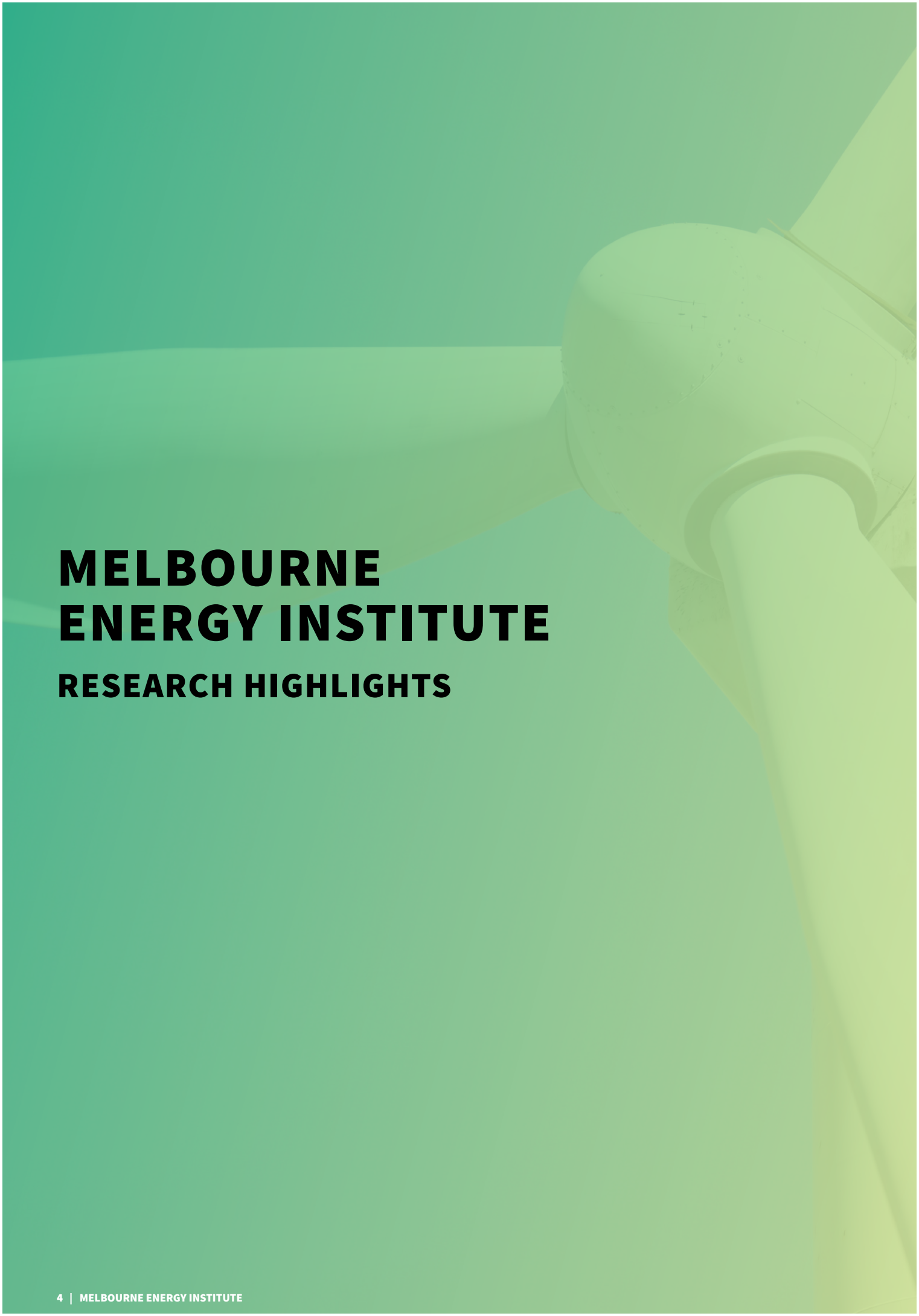
MEI has over 300 specialists across Architecture, Economics, Engineering, Health, Law, Planning, Science and Social Science. They include a former Chief Scientist of Australia, several recipients of Australia Day Honours, several Fellows of Learned Academies, and numerous Fellows of Professional Societies.

MEI researchers work together in four programs:

- Energy Systems
- Hydrogen and Clean Fuels
- Power Generation and Transport
- Energy Materials

OUR PARTNERS

We at the Melbourne Energy Institute are proud to work alongside our industry and government partners. Collaborative research and knowledge transfer are central to our work.



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RESEARCH HIGHLIGHTS

LAUNCH OF NET ZERO AUSTRALIA: A GROUND-BREAKING STUDY

The Net Zero Australia (NZAu) project is a two-year collaboration that analyses how Australia can achieve net zero emissions by 2050.

NZAu is coordinated in partnership by the University of Melbourne, the University of Queensland, Princeton University and management consultancy Nous Group.

The study is undertaking granular analysis of scenarios that explore distinct pathways to net-zero emissions by 2050, which range from 100% renewable energy to one which includes significant carbon capture and storage.

It assesses the impacts of each scenario on emissions, infrastructure, costs, employment, land use, air pollution and other important outcomes at a high level of geographic resolution. It will also analyse how Australia might export clean energy and low emission products, and thus contribute to the global decarbonisation task.

Project sponsors include APA Group, Dow, Future Energy Exports CRC, Future Fuels CRC, the Minderoo Foundation and Worley.

The project will run into 2023 with interim findings available at: **netzeroaustralia.net.au**

PROJECT EDGE: FACILITATING MARKET PARTICIPATION FROM THE EDGE OF THE GRID

Australia has the highest uptake of residential solar photovoltaic panels (PV) in the world. These and other Distributed Energy Resources (DER) are presenting new opportunities for owners to provide energy and other services to wholesale markets.

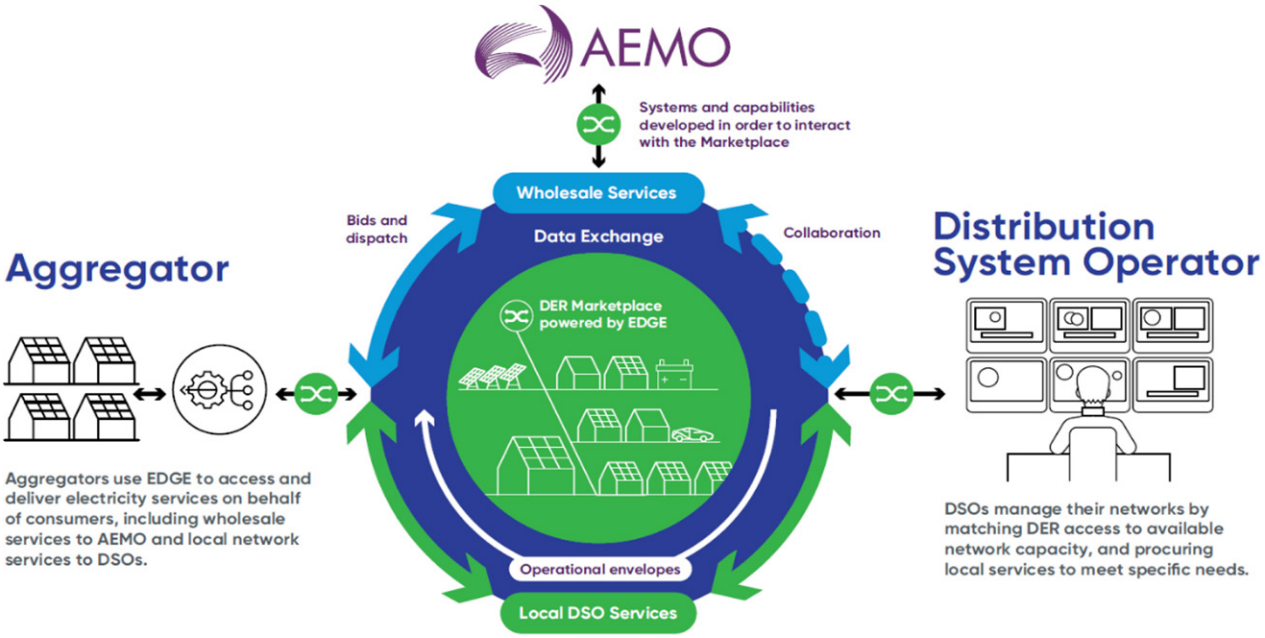
However, as the volume of DER participating in such markets increases, it is becoming more necessary to ensure the integrity of the distribution network, guaranteeing that voltages and power flows remain within limits.

One challenge for distribution companies is that they are not permitted to directly manage DER or aggregators. Project EDGE is therefore demonstrating the use of so-called operating envelopes that are intended to better facilitate DER market participation from the 'edge' of the grid.

Several innovations will be demonstrated through trials that will test these operating envelopes and the trading of local services. This is crucial to understand the complexity, interactions and challenges that distribution companies will face globally as they accommodate the widespread adoption of DER. Project EDGE will also inform ongoing efforts on future electricity market design, particularly for so-called 'two-sided' markets.

Project EDGE is a world-first project that brings together the spectrum of relevant stakeholders across the electricity value chain: customers, DER owners, aggregators, distributors, the system/market operator, and researchers.

The project was awarded funding by the Australian Renewable Energy Agency (ARENA), and is an ongoing project between partners AusNet Services, Mondo, the Australian Energy Market Operator (AEMO) and the University of Melbourne.



DSO - the Distribution System Operator is a role that the Distribution Network Services Provider transitions to as they dynamically manage capacity and operate the network to optimise value to customers and the energy system, including increased hosting of DER

ZERO EMISSION ENERGY LABORATORY

The Zero Emission Energy Laboratory (ZEE Lab) is an initiative coordinated by the Melbourne Energy Institute that connects research and industry to codevelop solutions and innovations for a clean energy transition.

Areas of research include wind and solar forecasting, utility-scale energy storage, updated software for renewable-rich grids, advanced hydrogen technologies, and technologies for hydrogen and electrified transportation.

The ZEE Lab Internship Program offers talented graduate students paid placements with industry hosts, with the aim of creating new technologies, establishing clean tech jobs, supporting clean energy and transport start-ups, and offering training and employment opportunities in the energy sector.

The initiative is supported by the State Government's *Victorian Higher Education State Investment Fund* as well as support by industry partners.

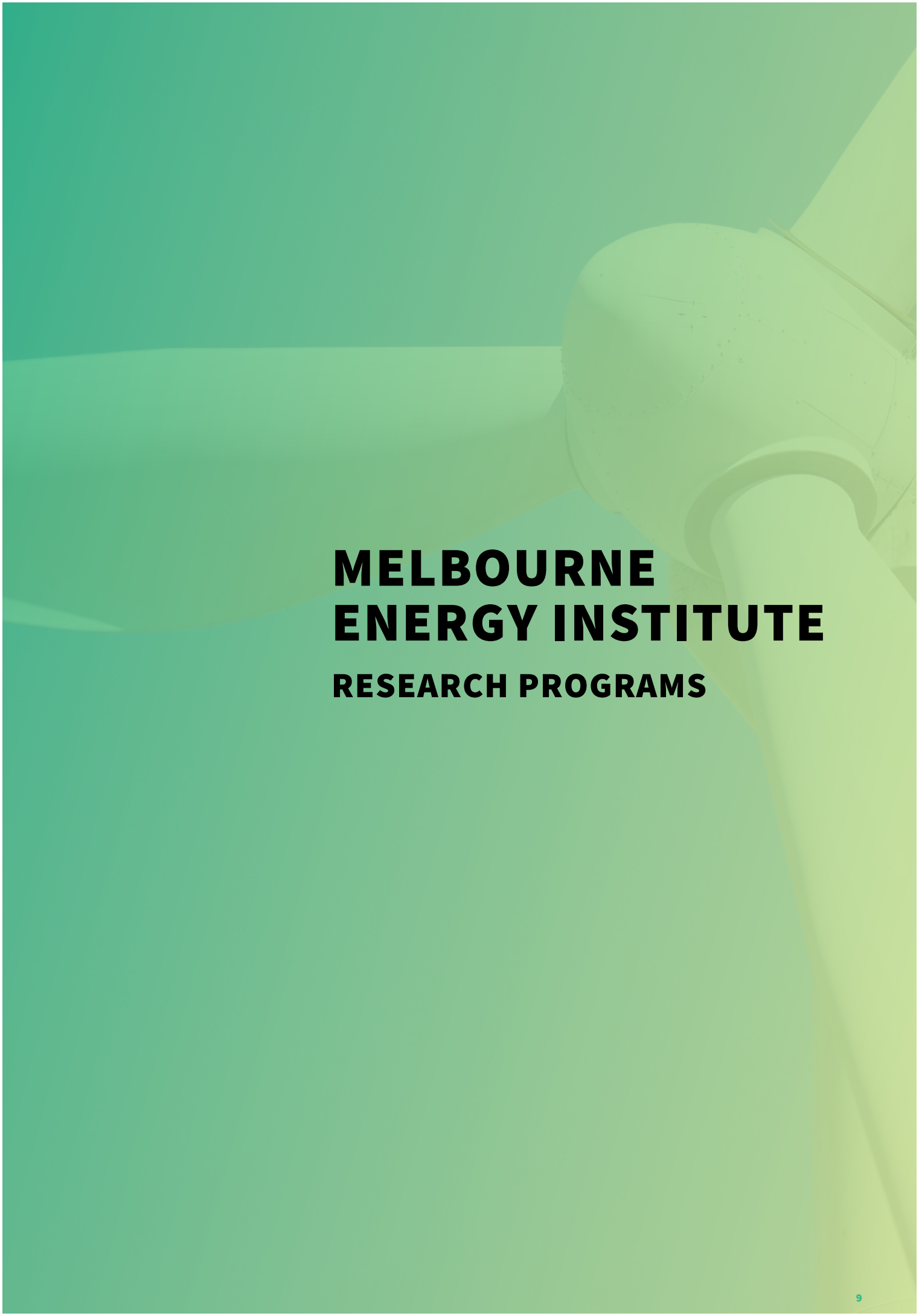
AVIATION IMPACT ACCELERATOR INITIATIVE

The Melbourne Energy Institute has joined an international group of experts in aerospace, economics, policy, and climate science, who are building the Aviation Impact Accelerator, an interactive evidence-based simulator that allows you to explore scenarios for achieving net zero flight.

The main goal is to create an interactive, open-source, whole system model that can map the pathways and accelerate the journey to zero emission flight. By making the trade-offs of different choices visible, the model will help shape good decision-making; enabling increased confidence in delivery and scale up, guiding innovation and infrastructure development, and driving investment and policy action.

Researchers at the University of Melbourne have joined the project's Systems Modelling Team that will integrate sub-models from the other sub-teams, namely the propulsion, fuel, airport, emissions and economic and policy teams, into a whole-system user interface.

The Aviation Impact Accelerator is an initiative led by Cambridge University, supported by the World Economic Forum, the Prince of Wales' Sustainable Markets Initiative, and others.



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RESEARCH PROGRAMS

ENERGY SYSTEMS

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 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 behaviours control trials, big data and machine learning

IMPACT

- Modelling work on future system security and energy markets commissioned by the Finkel Review
- AEMO demand and reserves forecasting using AMI data and machine learning approaches
- Collaborations with AEMC and AER on power system resilience and reliability
- Integrated electricity-gas-hydrogen modelling for the Future Fuels CRC

POWER GENERATION AND TRANSPORT

The Power Generation and Transport Program brings together researchers who investigate 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

- Carbon Capture and Storage
- 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
- Advanced computational methods and machine learning in energy applications
- Atmospheric chemistry
- Public health impacts of air pollution

IMPACT

- Propulsion, engines and fuels for Ford, DST Group and MHI
- Improved aircraft engine aerodynamics for General Electric
- Modelling of real-world, solar PV performance across Australia with AEMO
- Operational forecasting of wind and solar farm power generation with Meridian Energy Australia and others

HYDROGEN AND CLEAN FUELS

The Hydrogen and Clean Fuels Program integrates research into production, distribution and use of hydrogen in the energy system. The program studies electrolysis and clean fuel production, as well as hydrogen and clean fuel distribution and use in industrial and transport applications.

CAPABILITIES

- Process engineering and techno-economics of hydrogen production from renewables and fossil fuels with carbon capture and storage (CCS)
- Advanced gas turbine and reciprocating engine systems running on hydrogen and hydrogen-derived fuels
- Assessment of hydrogen integration into the natural gas network, including Power to Gas (P2G) concepts
- Catalysis and process engineering of converting hydrogen to clean liquid fuels
- Sub-surface storage of hydrogen
- Resource economics
- Resource law

IMPACT

- Reciprocating engine research with hydrogen for Caterpillar, Ford and other partners
- Support to the Council of Australian Government's (COAG) National Hydrogen Strategy
- Provision of expert advice to the Hydrogen Energy Supply Chain (HESC) Project
- Optimisation of integrated energy systems featuring hydrogen for the Future Fuels CRC and other partners

ENERGY MATERIALS

The Energy Materials Program assembles researchers working in materials science and engineering, and 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

- 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
- Graphene materials in low-energy electronics and energy storage
- Materials and device optimisation in thin film solar technologies

IMPACT

- Reduce energy consumption of separation processes for BHP, Masan and Ekos
- Developing organic and earth-abundant inorganic thin film solar photovoltaic technologies for ACAP
- Improve performance and reduce cost of anode materials in batteries for the Future Battery Industries CRC in conjunction with industry partners including Syrah Resources and AnteoTech
- Computational materials design for lightweight structural components in electric vehicles for Ford Motor Company.

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