Australian National University

ANU ENERGY CHANGE INSTITUTE

ANNUAL REPORT

2017

CONTENTS

Front cover image: Dr Matthew Brookhouse and Kyoto Prize winner Professor Graham Farquhar

MESSAGE FROM THE DIRECTOR

This past year has been momentous for energy in Australia, and the national debate over energy policy is still playing out as we approach the end of this year. The continuing paralysis that has arisen from government policy uncertainty over the alignment of climate and energy policy continues to stifle the progress of energy reform, and the decarbonisation and our economy.

This year the ECI has been very active in contributing its ideas and expertise towards national energy issues. ECI members made key contributions to a series of government enquiries, and we played an active role in the Finkel *National Electricity Market Review*. Other submissions include to: the *Senate Select Committee into the Resilience of Electricity Infrastructure in a Warming World*; the *Standing Committee on the Environment and Energy Inquiry into Modernising Australia's Electricity Grid*; *Implications of Climate Change for Australia's National Security*; and Australia's *2017 Climate Review*.

We have also been active in putting forward research outcomes and solutions to national energy issues. The proposals for harnessing off-river pumped hydro through the evaluation of potential sites around the country by Prof Andrew Blakers and his team is one example of a major contribution by ECI members. In addition there have been many commentaries in the media and in discussion forums such as The Conversation, where ECI members played a prominent role in the continuing energy debate.

The ECI has taken a national leadership role by proposing the formation of the Energy Research Institutes Council for Australia (ERICA) which involves seven universities. A primary goal is to partner with Australia's *Mission Innovation* program in the Department of Environment and Energy whose role is to double national investment in renewable energy as part of the Paris climate agreement.

The ECI has also held a series of forums and roundtables to discuss issues of national importance, including the Symposium on the Nuclear Fuel Cycle, and on the Finkel Review, as well as hosting discussions on Danish renewable energy, the US energy sector (with the Director of NREL, Dr Martin Keller), and the European electricity system.

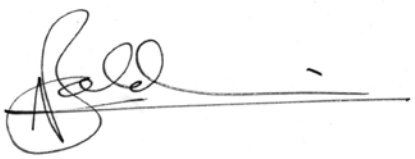
We have also continued our productive engagement with the ACT Government, and are now a proud supporter of the *Renewables Innovation Hub* located adjacent to the ANU campus near Barry Drive.

The ECI continues to expand its research activities, and this year we introduced two new research clusters – in *Energy for Development* and in *Sustainable Transport* – as well as combining and repositioning others including new capabilities in hydrogen technologies under *Renewable Fuels*. Together there are now 19 research clusters in the extensive ECI portfolio.

We also expanded our international engagement, through our role in the newly established $20m Australia-Germany Energy Transition Hub between the University of Melbourne, and ANU where Prof Frank Jotzo is co-director. The ECI also established a research MOU with the Industrial Technology Research Institute of Taiwan which has a strong energy technology component.

Locally, we saw the commencement in earnest of the ANU Energy Master Plan with an external consultant being appointed to deliver the plan by mid-2018. The ECI is a key participant and a partner with the Facilities and Services Division, and we will provide our expertise as part of the planning team over the coming year.

Finally, I would like to thank Kylie Catchpole who is handing over to James Prest as Education Convenor, and foundation Executive member Elmars Krausz who is handing over to Yun Liu after many years of high-level contributions to ECI. We hope you will continue to engage with the range of ECI activities outlined in this annual report, and invite you to attend this year's annual flagship event – *Energy Update*. As usual Ian Cronshaw from the International Energy Agency in Paris will present the *World Energy Outlook* 2017, and you will hear directly from Australia's Chief Scientist Dr Alan Finkel about implementation of the *National Electricity Market Review*.



Professor Ken Baldwin
ECI Director

HIGHLIGHTS

From ECI Open Day 28 November 2016 to ANU Solar Oration 29 November 2017.

ECI Open Day
28 November 2016

The ECI Open Day provides a platform for exchanging ideas for ANU based researchers and stakeholders working in the field of energy change. 2016 highlights included presentations on new engagement with renewable energy companies - Union Fenosa and CWP Renewables, the latest research by ECI members including the importance of security in energy technologies, and pumped hydro storage.

ANU Energy Update
29 November 2016

The annual ECI flagship event Energy Update brought together Australian researchers, policymakers, industry and members of the public to provide news on the latest world energy trends. Attended by almost 500 people the event was opened by the Hon Josh Frydenberg, Minister for the Environment and Energy.

Ian Cronshaw of the International Energy Agency presented the IEA's perspective on the World Energy Outlook (WEO) 2016, followed by a keynote address by Jean Jacquinot, Senior Adviser to the Director General of ITER, the international fusion energy program. Panels of expert speakers also presented their perspectives on two key WEO themes: Climate Change Response Post Paris Climate Agreement, and Dominantly Renewable Energy Futures.

Nuclear Fuel Cycle Symposium
April 2017

ECI hosted a symposium reviewing the report of the South Australian Government's Nuclear Fuel Cycle Royal Commission. A communique from the symposium called for a national discussion on nuclear options, including mining, power generation and waste storage, to help address Australia's and future economic prospects. The communique also urged governments to remove laws that prohibit nuclear fuel cycle activities, which thereby constrain free and open discussion.

The symposium was hosted by ECI in collaboration with Engineers Australia, the Australian Academy of Science and the Australian Academy of Technology and Engineering.

The Finkel Review Explained
June 2017

A panel of ANU Energy Change Institute experts and stakeholders from industry and government shed light on the long-awaited report by Australia's Chief Scientist, Dr Alan Finkel into the National Electricity Market. Chaired by Prof Ken Baldwin, the panel delved into the four key outcomes for securing the future of Australia's National Electricity Market: increased security, future reliability, rewarding consumers and lower emissions. The panel consisted of ECI members Professor Quentin Grafton, Honorary Associate Professor Hugh Saddler, and Dr Matt Stocks, along with Mr Dan Harding from the ACT Government and Dr Nathan Steggel from Windlab. The event was a sold-out success.

Josh Frydenberg at the 2016 ANU Energy Update

Full house at the Finkel Review Explained event

The United States Energy Transition
July 2017

Director of the United States National Renewable Energy Laboratory (NREL), Dr Martin Keller delivered a public lecture on the US Energy Transition. Dr Keller also took part in a two-day visit to ANU meeting with energy researchers, and participated in a roundtable discussion on energy issues.

Dr Martin Keller, Director, US National Renewable Energy Laboratory

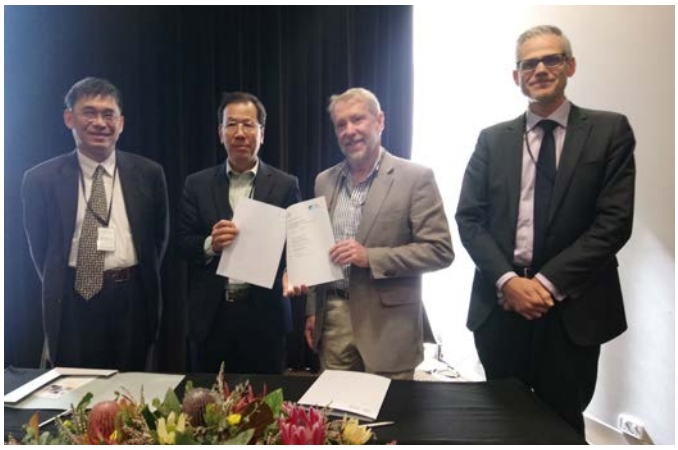
A New Energy Research Institutes Council for Australia (ERICA)
August 2017

The directors of Australia's major energy research institutes announced the formation of a new Energy Research Institutes Council for Australia (ERICA) to provide research-led advice on the nation's energy future.

The Council combines research expertise from the Universities of Queensland, Sydney, New South Wales, Monash, Melbourne, Adelaide and the ANU. The aim of the Council is to provide: collective national capacity across a broad spectrum of cutting-edge energy research, in both specialised and inter-disciplinary fields; high-level advice to government based on energy policy research; an over-the-horizon perspective on future energy opportunities and challenges that can only be informed by cutting-edge research; and a research touch point for industry and government on energy issues of national and international significance.

ANU – Taiwan sign MOU
September 2017

Taiwan's Industrial Technology Research Institute (ITRI) formalised their relationship with ANU with the signing of an MOU by ECI Director Prof Ken Baldwin and ITRI Deputy Director General Dr Ren-Chain Wang. A delegation from Taiwan also visited ANU taking part in an energy roundtable discussion and a tour the ECI's research facilities.



MOU signing between the Australian National University and Taiwan's Industrial Technology Research Institute, Australia-Taiwan Joint Energy and Minerals, Trade and Investment Cooperation Consultations (JEMTIC) © Department of the Environment and Energy

European Union Experts Roundtable
September 2017

The ECI and the Delegation of the European Union to Australia hosted two experts from the EU to discuss a move *Towards 50% renewables by 2030: a view from the European control room*. Stefan Arent, an economist working for the German Federal Network Agency and Marta Mendoza Villamayor, an electrical engineer working for the European Network of Transmission System Operators addressed an audience from government, academia, industry and consular offices.

HIGHLIGHTS

Coming Up

Energy Change Institute Open Day
30 October 2017

ECI Open Day showcases ANU energy research. Highlights of the program this year include a report on the pumped hydro prospects for Australia, and a focus on two new ECI research clusters: Energy for Development and Sustainable Transport. Winners of the Icon Water/ Actew AGL endowment awards will also be announced. The formal presentations will be followed by tours of the world-class ANU energy laboratories.

ANU Energy Update
29 November 2017

Highlights of the upcoming Energy Update include: an opening address by the Honorable Mark Butler, Shadow Minister for Climate Change and Energy; 2017 *World Energy Outlook* presented by Ian Cronshaw from the International Energy Agency in Paris; a keynote address by Australia's Chief Scientist, Dr Alan Finkel; and panel discussions on the WEO themes, *China's Energy Outlook* and *Making Sense of Australian Gas Policy*.

Dr Alan Finkel, Australia's Chief Scientist

ACT Government/ANU Solar Oration: The Australian Energy Transition
29 November 2017

Australia is in the midst of a major energy transition, from fossil fuels to renewable energy. Ms Audrey Zibelman, CEO of the Australian Energy Market Operator (AEMO), will discuss the intersection of the rise of renewables, grid stability and emission reductions.

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

MISSION

The ANU high-flux solar simulator, with Ms Lindsay Yue and Prof Wojciech Lipinski in the background. Photo credit: ACT Govt.

A key solution to the challenge of climate change is a world-wide shift to low-carbon forms of energy. Energy change that drives this transformation to a clean economy will also offer wider benefits to society by increasing economic productivity, and by improving energy access and security.

The ECI provides authoritative leadership in energy research, education and public policy through a broad portfolio ranging from the science and engineering of energy generation and energy efficiency, to energy economics, regulation, security, sociology, policy and security.

A defining feature of the ECI is that we are both technology and policy neutral. That is, we undertake research and education in key areas of energy technology and energy policy without favouring one particular area over another. This can and should create an open forum for good ideas leading to energy change.

GOVERNANCE

Photo credit: Ian Dick flickr

The ECI comprises approximately 150 academic staff and their postgraduate research students, bringing the total complement close to 300 researchers.

The wider ECI membership meets twice a year: at the Annual Business Meeting (ABM), which establishes the activity for the coming year; and at the ECI Open Day which presents research highlights to the ECI stakeholder community.

ECI Executive

Operationally, the ECI is governed by an Executive comprising representatives from ANU Colleges:

Professor Ken Baldwin – Director
ANU College of Science

Professor Andrew Blakers (*vice Dr Matthew Stocks*)
ANU College of Engineering & Computer Science

Professor Kylie Catchpole – Education Convenor
ANU College of Engineering & Computer Science

Associate Professor Llewelyn Hughes (*vice Dr Paul Burke*)
ANU College of Asia & the Pacific

Professor Elmars Krausz (*vice Associate Professor Colin Jackson*)
ANU College of Science

Professor Yun Liu
ANU College of Science

Dr James Prest (*vice Professor Tom Faunce*)
ANU College of Law

Dr Igor Skryabin – Business Development Manager
ANU College of Science

Professor Sylvie Thiebaux (*vice Professor Saman Halgamuge*)
ANU College of Engineering and Computer Science

The Executive meets regularly throughout the year as required.

The strategic directions of the ECI are reviewed each year when the Executive meets with the ECI Advisory Board.

ECI Advisory Board

Professor Armin Aberle – CEO
Solar Energy Research Institute of Singapore

Dr Gordon de Brouwer – Secretary
Department of the Environment and Energy

Dr Stephen Bygrave – Executive Director
Climate Change and Sustainability, ACT Environment, Planning and Sustainable Development Directorate

Mr Stephen Devlin – General Manager Assets Division
ActewAGL

Mr Ian Farrar – Board Member
Former Chair and CEO of the Joint Coal Board

Professor Mark Howden – Director
ANU Climate Change Institute

Professor John Poate – Colorado School of Mines
Member of the US National Renewable Energy Laboratory Advisory Board

EDUCATION

Master of Energy Change students at their Careers and Networking Evening, August 2017

Master of Energy Change

A key to addressing climate change is a world-wide change to carbon-free forms of energy.

Energy change also offers a number of other benefits to society: it not only facilitates the transition to a sustainable economy, but also improves energy access and security and increases energy productivity for the benefit of the wider economy.

Currently there are relatively few practitioners with a broad understanding of the many issues involved, or the skills needed to contribute to, this complex growth area.

The Master of Energy Change equips the next generation of energy decision makers with the knowledge and skills to help drive and lead the energy revolution.

Addressing the challenges of energy change requires innovative, interdisciplinary approaches. The Master of Energy Change provides a strong basis in the fundamentals of economics, governance, policy, sociology and technology related to energy change, whilst also giving students the flexibility to focus on areas of energy innovation most relevant to their professional needs, interests and skills.

As the need for energy change grows, demand for these skills will only increase.

The degree comprises two foundational and 46 elective courses. The foundational courses are:

- Principles of Energy Generation and Transformation
- World Energy Resources and Renewable Technologies

These courses are aimed at providing students who do not have a technical background with an understanding of the principles underpinning energy technologies.

The course “Principles of Energy Generation” was specifically developed for this degree. The program now involves almost all ANU Colleges.

The remaining subjects are grouped into the key discipline areas of:

- Energy regulation and governance
- Energy economics
- Climate change
- Environmental sustainability
- Specific energy technologies (solar, nuclear etc.)
- Energy sociology and risk

In addition to the formal coursework, MEnCh students can participate in the wider activities of the ECI, which include seminars presented at the ANU, conferences and workshops engaging with government and industry, and other outreach programs with the wider community. Carefully targeted promotion of the Master of Energy Change remains the key to advancing this program.

2017 Master of Energy Change Convenor
Professor Kylie Catchpole
T +61 2 6125 0874
E kylie.catchpole@anu.edu.au
W energy.anu.edu.au/education/master-energy-change

EDUCATION

New Course in 2017

Integration of Renewable Energy into Power Systems and Microgrids

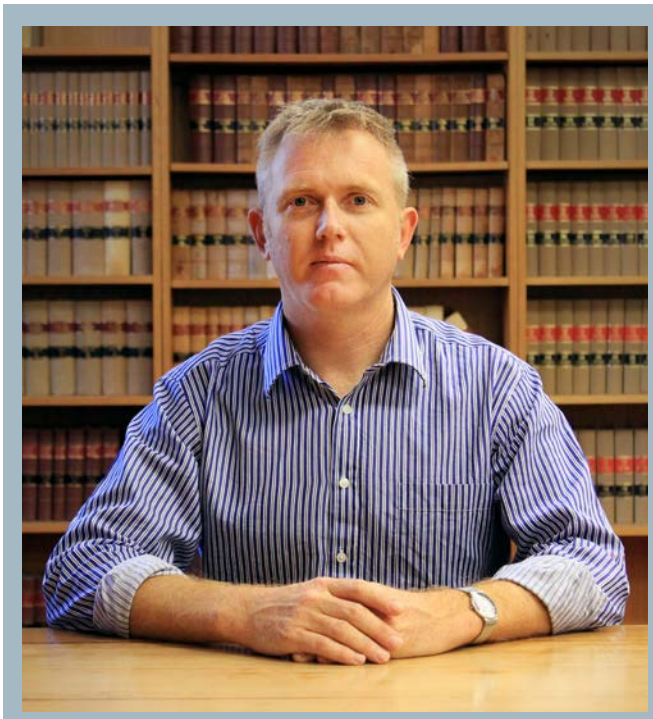
This course aims to provide a strong understanding of power systems, their operation and control and particularly of issues related to the integration of distributed renewable generation into the network. The content focuses on technical aspects of traditional and renewable electrical power generation, power transmission and distribution, power network stability, management and control, electricity market operations and smart grid technologies with particular emphasis on the integration of renewable generation onto the network at both transmission and distribution level and the challenges and opportunities associated with that.

Professional Short Courses

The Energy Change Institute regularly runs short courses and briefings for government departments, companies and NGOs. Short courses are designed to provide updates on recent advances in energy technologies and the social, policy, economic and governance aspects of energy change for policy makers and industry professionals. They can be tailored to meet the needs of a specific audience, and scheduled over consecutive days or spread over weeks.

In 2017 the ECI conducted an Energy Masterclass for senior personnel primarily from the Department of Defence. The aim of the Masterclass was to review recent advances in disruptive energy technologies and discuss options for energy futures and strategies of energy.

Professional Short Course Convenor
Dr Igor Skryabin
T +6125 3917
E igor.skryabin@anu.edu.au
W energy.anu.edu.au/education/professional-short-courses



New Convenor for Master of Energy Change in 2018

Dr James Prest from the College of Law will be convening the Master of Energy Change program from 2018. Dr Prest brings 22 years' experience as an environmental and natural resources lawyer (including roles at a top tier commercial firm, plus the Department of Prime Minister and Cabinet, and Parliament House) to his work with ECI. As a Member of the IUCN Commission on Environmental Law, he has many international links, with active collaborations with researchers in USA, Germany, Spain, Japan, Indonesia. His research has a strong focus on comparative environmental law, with an emphasis on renewable energy and climate change law, examining the legal and policy barriers to increased investment in renewable electricity generation. His various research projects involve comparative review of national and sub national law and regulation for the energy and transport sectors.

Find out more about the Master of Energy Change degree:

Dr James Prest

T + 61 2 6125 1689
E james.prest@anu.edu.au
W energy.anu.edu.au/education/master-energy-change

Energy and the environment – tackling the definitive challenge of our time

Ram Parameswaran looked all over the world before choosing to study the Master of Energy Change degree at ANU.

"I believe that 'energy and the environment' is the definitive challenge of our time. I wanted a masters program that would equip me with the skills to address this challenge. I was looking all around the world, and was drawn to the ANU Master of Energy Change because of the breadth of courses and research areas it offered," said Ram.

After completing undergraduate degrees at ANU in Science and Economics, Ram worked as a researcher at the Justus Liebig University in Giessen, Germany performing data analysis on catchment water quality in Germany, Africa and South America.

Back in Australia, Ram credits the Master of Energy Change program with giving him invaluable exposure to the renewables sectors domestically and around the world. In particular Ram notes the 'School on Energy' summer-school program in South Africa that he took part in, and the Masters research project he is undertaking, as two great opportunities that have come out of the program.

"The research project, on residential battery storage, is being run in conjunction with the ANU, the ACT Government, and the global battery manufacturer Panasonic. I find the opportunity to work with these partner organisations to be invaluable, and a true highlight of my MEnCh (Advanced) program," said Ram.

Ram now works at Beast Solutions, a Canberra-based energy consultancy where he gets to work on a broad range of projects including strategic energy advisory and master planning, renewable energy system design and development, and the implementation of innovative technologies such as zero-emissions public transport.

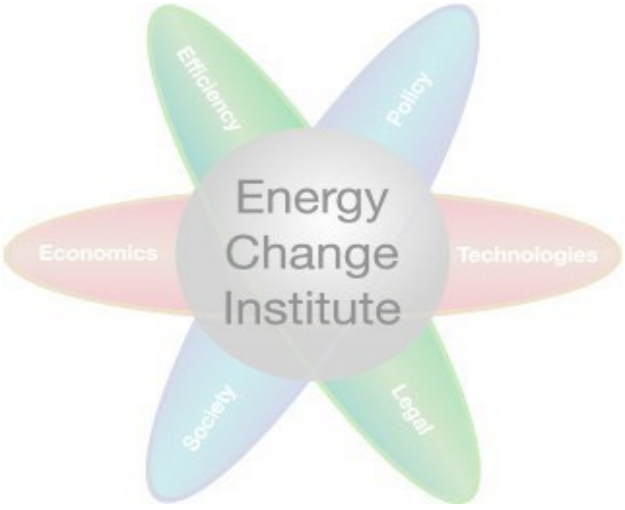
"Beast Solutions has a long-standing relationship with the ANU and the ACT Government, which I find greatly complements my Masters coursework and research."

RESEARCH

The expanded ECI research program covers a broad spectrum from energy science and engineering to implementation expertise in the economic, legal, sociological and policy issues surrounding energy change. This broad portfolio of research activity is unique in the country.

The ECI continues to add new researchers to its portfolio. The number of staff members is approximately 150, which together with PhD students yields close to 300 researchers in total.

This year two new research clusters – Energy for Development and Sustainable Transport – were added to the ECI portfolio, bringing the total number of clusters to 19.



> Artificial Photosynthesis

> Carbon Capture & Storage

> Energy & Security

> Energy Economics & Policy

> Energy Efficiency

> Energy for Development

> Energy Regulation & Governance

> Energy Sociology & Risk

> Energy Storage & Recovery

> Energy-Water Nexus

> Enhanced Oil & Gas Extraction

> Fusion Power

> Nuclear Science

> Renewable Fuels

> Smart Grid

> Solar Photovoltaics

> Solar Thermal

> Sustainable Transport

> Wind Energy

To find out more, go to energy.anu.edu.au/research

Energy for Development

Energy poverty, or the lack of access to modern energy services, is a significant global development challenge. Modern energy services facilitate economic activity and the delivery of key public services, including health, education and infrastructure services. Clean cooking technologies reduce the incidence of respiratory disease and enable women and children to spend less time searching for fuel wood. The Sustainable Development Goals recognise the importance of energy for development. Goal seven aims to ensure access to affordable, reliable, sustainable, and modern energy services for all.

The Energy for Development cluster at the Energy Change Institute was established in 2017 to bring together ANU researchers working on energy and development issues. Research on energy for development at ANU is undertaken in a number of Colleges, and is often of an interdisciplinary nature. The Crawford School of Public Policy is home to expertise on the relationship between energy and economic growth and development. Through the Arndt-Corden Department of Economics, research is undertaken on energy consumption, subsidisation, energy access and on renewable energy development - particularly in Indonesia. The Development Policy Centre undertakes similar research in the Pacific islands. Another focus of research across the University relates to energy consumption by the poor and the design of programs aimed at expanding access to modern energy services. Research on this topic is ongoing at the Fenner School for Environment (with an Africa focus) and the Crawford School (with a Pacific focus). The ANU College of Engineering and Computer Science also has an interest in design of appropriate technology for expanding access to modern energy services.

Modern energy services facilitate economic activity and the delivery of key public services, including health, education and infrastructure services.

In 2017, researchers from ANU continued research on energy and economic growth as part of a DFID-funded consortium led by the University of California Berkeley and Oxford Policy Management. David Stern was theme leader of Theme 1: “The linkages between electricity supply and economic growth”. David presented the results of his research with Paul Burke and Stephan Bruns at a workshop in Washington D.C. late last year.

Cluster Members:

Cluster Convenor, Dr Matthew Dornan
Dr Paul Burke
Professor Stephen Howes
Professor Frank Jotzo
Dr Arianto Patunru
Dr Digby Race
Associate Professor Budy P Resosudarmo
Professor David Stern

$57M boost to hydrogen energy storage

The Energy Change Institute is a partner of the ACT Government’s hydrogen pilot made possible by significant industry investments worth approximately $57M. We have been fostering relationships with local and international companies, including ActewAGL, Global Power Generation and Neoen.

ANU finds 22,000 potential pumped hydro sites in Australia

The ANU completed an audit of 22,000 potential sites across Australia for pumped hydro energy storage, which can be used to support a secure and cheap national electricity grid with 100 per cent renewable energy.

The zero-emissions grid would mainly rely on wind and solar photovoltaic (PV) technology, with support from pumped hydro storage, and would eliminate Australia's need for coal and gas-fired power.

Lead researcher Professor Andrew Blakers said the short-term off-river pumped hydro energy storage (STORES) sites combined had a potential storage capacity of 67,000 Gigawatt-hours (GWh) – much more than the capacity required for a zero-emissions grid.

"Australia needs only a tiny fraction of these sites for pumped hydro storage – about 450 GWh of storage – to support a 100 per cent renewable electricity system," said ECI member Professor Blakers.

"Fast tracking the development of a few of the best sites by 2022 could balance the grid when Liddell and other coal power stations close.

"Pumped hydro storage, including Snowy 2.0, can be developed fast enough to balance the grid with any quantity of variable wind and solar PV power generation, including 100 per cent renewable energy.

"We found so many good potential sites that only the best 0.1 per cent will be needed. We can afford to be choosy."

The Australian Renewable Energy Agency (ARENA) provided $449,000 to support the ANU-led study.

STORES sites require pairs of reservoirs at different altitudes, typically ranging from 10 hectares to 100 hectares, in hilly terrain and joined by a pipe with a pump and turbine. Water is pumped uphill when wind and solar energy is plentiful, and electricity is available on demand by releasing the stored water through a turbine.

Co-researcher Dr Matthew Stocks said that off-river pumped hydro storage typically delivered maximum power for five to 25 hours, depending on the size of the reservoirs.

"Like all hydro power, it can go from zero to full power in about one minute," said ECI member Dr Stocks.

"Annual water requirements would be much less than half that of the current fossil fuel system because wind and PV do not require cooling water."

Co-researcher Mr Bin Lu said all of the potential STORES sites were outside national parks and urban areas, and each site had a storage potential range of 1–300 GWh.

"Pumped hydro – which accounts for 97 percent of energy storage worldwide – has a lifetime of 50 years, and is the lowest cost large-scale energy storage technology."

Sustainable Transport

Transport is the second largest source of carbon emissions in Australia after electricity production. The transport sector will need to change significantly for Australian and international greenhouse emission targets to be achieved.

The coming shift to light electric vehicles will dramatically change the energy landscape.

Sustainable transport policy

Research within the Crawford School of Public Policy involves examining the policy settings required to achieve a sustainable transport sector. A particular focus is given to policies to encourage the adoption of efficient and low-carbon transport technologies. Ongoing research includes identifying factors that affect the fuel efficiency of aircraft fleets. Work is also being done on the effects of fuel prices on road transport outcomes such as vehicle choices, fuel use, emissions, traffic congestion, and road safety. This research is international in scope.

Renewable energy for transport

The 100% Renewable Energy group in the Research School of Engineering researches the deployment and integration of renewable energy working towards carbon-neutrality throughout Australia's economy. Electricity will be the easiest sector to reduce emissions through use of renewable power. As electricity emissions approach zero, electricity is likely to be the primary enabler for reduced transport emissions through electrification of transport.

Electric vehicles

The coming shift to light electric vehicles will dramatically change the energy landscape. While much more energy efficient, electric vehicles will increase electricity consumption. The location and timing of electric vehicle charging could lead to increased stress on the transmission and distribution systems.

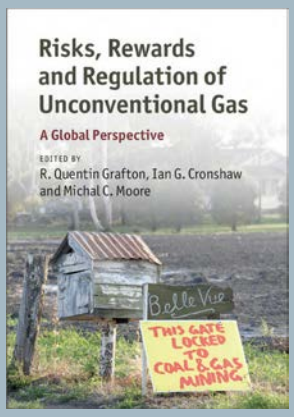
Synthetic fuels

Liquid fuels have high energy density compared to batteries. Air travel and heavy transport (ships, long haul trucks) will therefore be difficult to electrify directly. Synthetic fuels can be produced from electricity through reactions driven from hydrogen and the capture of carbon dioxide enabling conversion of renewable electricity to transport fuels.

Cluster Members:
Cluster Convenor, Dr Matthew Stocks
Professor Andrew Blakers
Dr Paul Burke
Dr Grace Chiu
Professor David Stern

Risks, Rewards and Regulation of Unconventional Gas A Global Perspective

Edited by: R. Quentin Grafton, Ian G. Cronshaw and Michal C. Moore



The global energy transition from carbon-intensive to renewable fuels has increasingly demanded a better understanding of the causes and consequences of the rapid development of unconventional oil and gas. Focusing on key countries including the United States, Canada, China, Argentina, the United Kingdom and Australia, this book consists of case studies and in-depth analyses that weigh up the risks and rewards at regional, national and global scales.

ANU – Melbourne to lead new energy transition hub

The Australian National University and The University of Melbourne will lead the Australian side of a new bilateral research collaboration with top German institutions to build economic and technological opportunities from the global transition to clean energy.

Prime Minister Malcolm Turnbull noted the new Energy Transition Hub, expected to be worth more than $20 million at full funding stage, at the 2017 G20 meeting in Hamburg.

The Energy Transition Hub will generate collaborative and world-leading research to help the technical, economic and social transition to new energy systems and a low emissions economy.

It will bring together researchers from ANU, The University of Melbourne, and Germany's Potsdam Institute for Climate Impact Research (PIK), Münster University's Centre of Applied Economic Research, and the Mercator Research Institute of Global Commons and Climate Change (MCC).

Researchers from Murdoch University, RMIT, Monash University, the German Aerospace Centre DLR, DIW and the Hertie School of Governance will also be involved, with the Hub open for further partners. It will include more than 60 Australian researchers and industry partners.

The initiative will kick off with joint research on strategic scenario analysis of energy transition issues.

The international board of the Energy Transition Hub will be chaired by prominent economist Professor Ross Garnaut AC. Associate Professor Malte Meinshausen from the Australian-German Climate & Energy College at The University of Melbourne, and ANU Professor Frank Jotzo from the Crawford School of Public Policy will be co-directors.

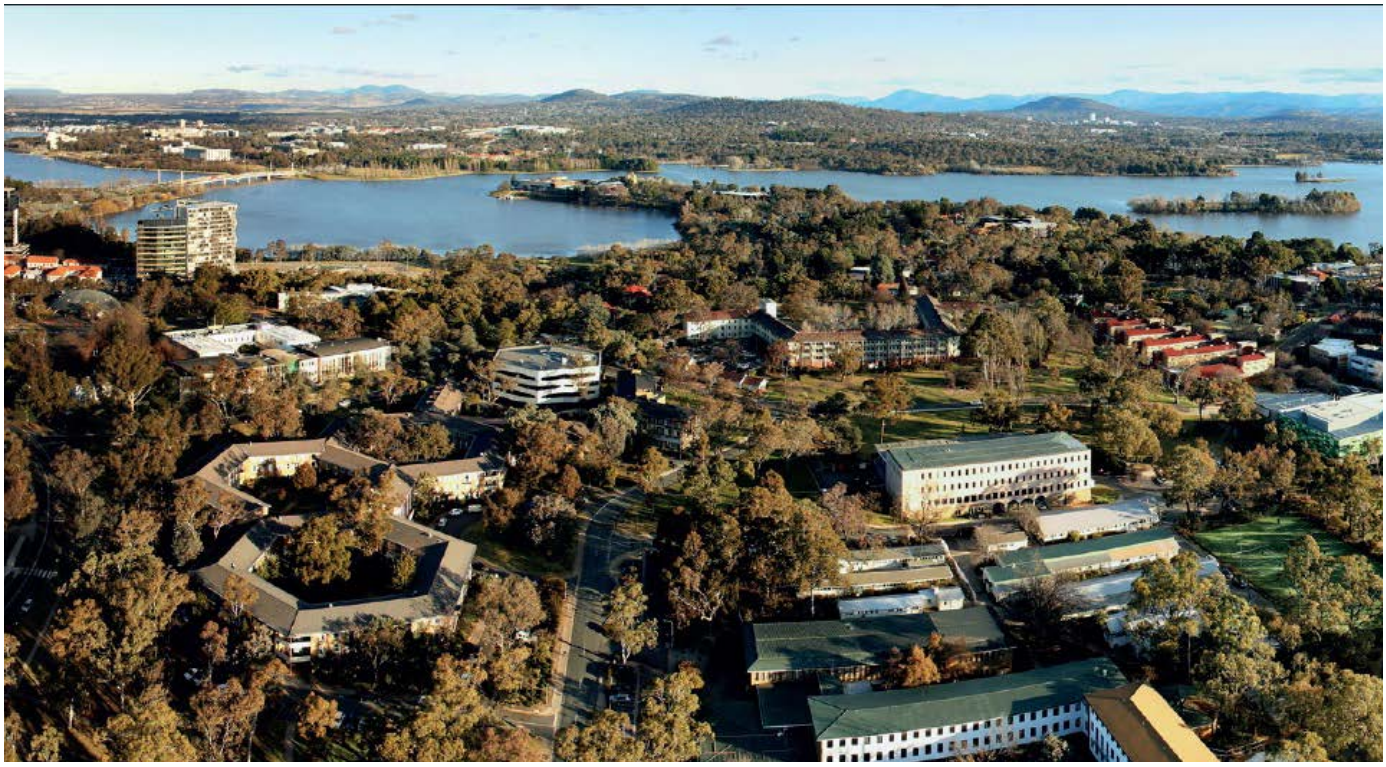
ANU Vice-Chancellor Professor Brian Schmidt AC said ANU expertise would help the world transition to low emissions technology.

Professor Schmidt was a member of the Australia-Germany Advisory Group, which included science and research cooperation as a major theme of its recommendations to Prime Minister Turnbull and German Chancellor Angela Merkel in its 2015 report.

"The Energy Transition Hub is an example of collaboration between Australia's leading universities, government and industry, fostering an important bilateral relationship. ANU is proud to be a leader in the kinds of research that will help build a sustainable future for our planet," Professor Schmidt said.

For more information: energy-transition-hub.org

ANU ENERGY MASTER PLAN



Aerial view of ANU campus.

This year the University approved funding to develop an Energy Master Plan (EMP) in parallel with the Heritage Master Plan and the overarching Campus Master Plan.

In a unique partnership, the ECI will join with the ANU Facilities and Services Division (F&S) led by their new Director Andy Sharp (the architect of the Curtin University energy plan) to create an Australian world-class, energy efficient, low-carbon, least-cost campus.

The ECI and F&S bring together experts in solar generation, smart grids, power engineering, heat storage and management, energy pricing/contracts/regulation, carbon accounting, and water sustainability.

The Energy Master Plan will:

- be a unique, research-led partnership of expertise between the ANU Energy Change Institute, and the Facilities and Services Division
- create a living test-bed that will provide a high-profile environment for research and education
- include gas, water, thermal and electricity energy vectors, and will involve energy savings, efficiency, generation and storage
- create an ANU electricity micro-grid that will provide a demand management facility for the ACT by the Territory's largest customer

To oversee the EMP establishment process, the University appointed Arthur Petsas from Inceptio Group to develop the EMP team. The team will comprise an external consulting firm (able to access external energy expertise), F&S, ECI experts and ANU student interns working together to create the EMP. The goal is to have the Plan completed by the middle of 2018, to mesh with the Campus Master Plan scheduled for delivery at the end of the year.

As the plan develops, we will take advantage of opportunities to accelerate the adoption of energy-saving and energy generating initiatives. One such opportunity is the recent installation of 400 kilowatts of 'sliver cell' solar panels on ANU roofspaces, employing a home-grown technology developed here at ANU. This is just one example of the research-led philosophy of the EMP.

Sliver cell solar panel installation on the Anthony Low Building, ANU.

ACT RENEWABLES INNOVATION HUB

A careers and networking evening for Masters of Energy Change students was held at the Renewables Innovation Hub in August 2017.

The Energy Change Institute is an inaugural partner of the ACT Government's Renewable Energy Industry Development Strategy. As part of this the ECI is a key supporter of the Renewables Innovation Hub, a space designed specifically for the renewable energy and clean-tech industry, located within Canberra's CBD and close to ANU.

The Hub was established in November 2016, through funding from the ACT Government's Renewable Energy Innovation Fund to attract, connect and serve the ACT's thriving renewable energy industry.

The Hub provides a flexible, collaborative co-working and office space to drive the development of the clean energy industry in the ACT and deliver on the ACT Government's vision for the Territory as 'an export-oriented hub for renewable energy innovation and investment.'

Businesses based at the Renewables Innovation Hub range from 1-2 person start-ups to large multinationals. From wind, solar and storage technology companies through to investment entities and government consultants. The Hub also has the capacity to host events of up to 300 people.

The Energy Change Institute, as the major research and educational partner of the Hub, uses the venue for a variety of public events.

In 2017 the ECI hosted a Careers and Networking Evening for Master of Energy Change students.

In 2018 the ECI, in conjunction with the Hub, will be hosting a series of quarterly public lectures designed to brief industry, government and the community on the latest ECI research.

Find out more about the Hub here: 2degreeshub.com

Street view of the Renewables Innovation Hub

PUBLIC POLICY

The ECI continues to engage in the development of public policy through its extensive relationships with government departments and agencies.

This year's public policy highlights included:

International

- Dr Igor Skyrabin convened a one-day session on energy sources as part of the Australia Awards South and West Asia funded program 'Strengthening Energy Security, South Asia'. The session for middle-level and senior public servants from South Asia was held at ANU, and included presentations by Dr Matt Stocks and Prof Ken Baldwin.
- ECI is a co-lead organisation of the Energy Cluster of the Australia-Indonesia Centre. Dr Igor Skyrabin, on behalf of the ECI, contributed to the Australia-Indonesia future leaders program, delivering sessions on renewable electricity and energy public policy from a state and territory-level perspective.
- Dr Igor Skyrabin, through the APEC Energy Working Group, supported a successful APEC project application - "Integrated energy system planning for equitable access to sustainable energy for remote communities in the APEC regions using North Sulawesi as a pilot project/test bed". The Australian-Indonesia Centre's Energy Cluster is expected to commence this project in 2018.

Federal Government

- Senate Select Committee into the Resilience of Electricity Infrastructure in a Warming World – February 2017. Submissions by:
  - Prof Ken Baldwin and Dr Evan Franklin
  - Prof Andrew Blakers, Dr Matthew Stocks and Mr Bin Lu on Pumped Hydro Energy Storage to support a 50 – 100% renewable electricity grid.
  - The ANU Solar Thermal Group (Dr John Pye, Dr Joe Coventry and Prof Wojciech Lipinski).
- Professor Ken Baldwin and Dr Evan Franklin provided a submission to the Independent Review into the Future Security of the National Electricity Market - March 2017.
- The ECI provided a submission to the Standing Committee on the Environment and Energy Inquiry into Modernising Australia's Electricity Grid – April 2017.
- The ECI supported by Engineers Australia, the Australian Academy of Sciences and the Australian Academy of Technology and Engineering held a Nuclear Fuel Cycle Symposium to discuss and analyse the South Australian Royal Commission in to the Nuclear Fuel Cycle. Following the Symposium a Communique was released in April 2017.
- The ECI in conjunction with the Climate Change Institute provided a submission to the 2017 Review of Climate Change Policies Discussion Paper. Prof Andrew Blakers and Dr Matthew Stocks provided a joint submission and Dr Paul Burke provided an individual submission to this review, May 2017.
- The ECI was part of a broader ANU submission to the Senate Inquiry on the Implications of Climate Change for Australia's National Security – August 2017.

Energy Research Institutes Council for Australia (ERICA)

This year ECI Director Ken Baldwin played a pivotal role in establishing the Energy Research Institutes Council for Australia (ERICA) – a peak body representing energy research in this country.

Motivated by a perceived lack of research-led vision in the energy sector that is needed to prevent 'surprises' in energy foresighting, ERICA was formed in August this year to provide:

1. Collective national capacity across a broad spectrum of cutting-edge energy research, in both specialised and inter-disciplinary fields
2. High-level advice to government based on energy policy research
3. An over-the-horizon perspective on future energy opportunities and challenges that can only be informed by cutting-edge research
4. A research touch point for industry and government on energy issues of national and international significance.

ERICA combines energy research from The Australian National University Energy Change Institute, the University of Queensland Energy Initiative, the University of Sydney Centre for Sustainable Energy Development, the University of New South Wales Future Energy Institute, the Monash University Energy Materials and Systems Institute, the University of Melbourne Energy Institute, and the University of Adelaide Centre for Energy Technology.

Its first role was to present evidence at the Standing Committee on the Environment and Energy Inquiry into Modernising Australia's Electricity Grid, and one of its members sits on the Australian Energy Market Operator (AEMO) Advisory Board. But ERICA's key role is to advise the Mission Innovation program in the Department of Environment and Energy on doubling Australian investment in renewable energy research.

PUBLIC POLICY

Individual contributions

ECI researchers contribute to public policy development through their individual research expertise as part of their everyday activities – particularly in the disciplines of economics, law, sociology and policy. Amongst many individual achievements throughout the year, ECI researchers contributed to the following areas of public policy:

The role of storage in Australia's Future Energy Supply Mix

Professor Quentin Grafton was part of an Expert Group that authored a study on the Role of Storage in Australia's Future Energy Supply Mix. The study was produced by the Australian Council of Learned Academies (ACOLA), October 2017.

The Role of Energy in Foreign Policy

Dr Christian Downie provided a submission to the Department of Foreign Affairs and Trade Foreign Policy White Paper on the Role of Energy, Australian Government, February 2017.

Fusion Power

A/Prof Matthew Hole and the Australian ITER Forum provided a submission to the Draft 2016 National Research Infrastructure Roadmap, January 2017.

A/Prof Matthew Hole and the Australian ITER Forum provided a submission to the Climate Change Policies Review - Discussion Paper, May 2017.

Carbon Farming and Emissions Reduction

Dr Paul Burke provided a submission to the Review of the Carbon Farming Initiative and the Emissions Reduction Fund, September 2017.

Five ANU experts appointed to international body on fusion research

Dr Cormac Corr, Associate Professor Matthew Hole, Professor John Howard, Dr Clive Michael and Dr Matt Thomson have been appointed to the International Tokamak Physics Activity, the programmatic research framework in support of ITER science (ITER is the world's largest fusion experiment).

The appointments, in the topical groups of Diagnostics, Energetic Particle Physics, and Scrape-Off-Layer / Divertor, further consolidate Australian science participation in the ITER project. A cooperation agreement was signed between the ITER Organisation and the Australian Nuclear Science and Technology Organisation, on behalf of the Australian fusion science community in September 2016.

ANU Public Policy

The University has a major role in providing expertise to governments and the wider community through its Public Policy Fellows program in which the ECI is a major player, contributing five Public Policy Fellows.

Currently the ECI has five Public Policy Fellows:

Professor Ken Baldwin
Director, Energy Change Institute
ANU College of Science

Professor Andrew Blakers
ECI Solar Photovoltaics
College of Engineering and Computer Science

Professor Quentin Grafton
ECI Energy Economics and Policy
Crawford School of Public Policy

Professor Frank Jotzo
ECI Energy Economics and Policy
Crawford School of Public Policy

Professor Warwick McKibbin
ECI Energy Economics and Policy
Crawford School of Public Policy

EVENTS

The ECI organised and hosted many public events in 2016 and 2017, ranging from public lectures by eminent speakers of global standing, to seminars and discussions of a technical nature, engaging experts and practitioners in the field of energy change in discussions around science, technology and policy.

More information about these events can be found at energy.anu.edu.au/news-events

Flagship events

2016 ANU Energy Update
29 November 2016

The annual ANU Energy Update brought together Australian researchers, policymakers, industry and members of the public to provide an update on the latest world energy trends from the International Energy Agency World Energy Outlook. Jean Jacquinot, Senior Adviser to the Director General of ITER, the international fusion energy program, was a keynote speaker.

From left: Mark Howden, ANU, Frank Jotzo, ANU, Patrick Suckling, DFAT Anna Skarbek and baby, ClimateWorks

2016 ACT Government/ANU Solar Oration: The Carbon War: a dispatch from the front lines
29 November 2016

Jeremy Leggett, founder of Solarcentury and SolarAid, and Chair of Carbon Tracker, sees energy in society as being in a state of global civil war. He discussed the light side, dark side and many side-less people caught in the crossfire.

ECI Open Day
28 November 2016

ECI Open Day showcased the latest in energy research at ANU to key stakeholders, with ECI participants and industry collaborators giving presentations on their work.

Meetings

ECI Annual Business Meeting
17 May 2017

The ECI Annual Business Meeting is an opportunity for ECI members to participate in setting the directions of the ECI over the coming year. This year Vice-Chancellor Brian Schmidt provided the keynote address, and outlined the importance of energy research as a key part of the University's research portfolio.

ECI public lectures, seminars and symposiums

How Denmark's Samsø became the World's first 100% Renewable Energy Island

Public lecture hosted by ECI, South East Region of Renewable Energy Excellence (SERREE) and the Royal Danish Embassy, 13 February 2017.

The Age of Consequences

Hosted by ANU ECI and Breakthrough National Centre for Climate Restoration, 5 April 2017.

Film screening followed by audience Q&A. Panel members: Sherri Goodman (Founder, CNA Military Advisory Board). Retired Admiral Chris Barrie (Honorary Professor, ECI), Ian Dunlop (Former Chair, Australian Coal Association) and Air Vice Marshall Mel Hupfield, AO, DSC.

From left: Ken Baldwin, Sherri Goodman, Mel Hupfield, Chris Barrie and Ian Dunlop.

The Nuclear Fuel Cycle in Australia

Hosted by ECI, Engineers Australia, the Australian Academy of Science and the Australian Academy of Technology and Engineering, 11 April 2017.

National symposium analysing the South Australian Nuclear Fuel Cycle Royal Commission report.

Energy Conversations: Renewable Hydrogen

Hosted by ECI and the Australian Institute of Energy (Canberra branch) 5 May 2017.

EVENTS

The Finkel Review Explained

Hosted by ECI, 20 June 2017.

ECI panel members: Professor Quentin Grafton; Honorary Associate Professor Hugh Saddler; and Dr Matt Stocks. Also Mr Dan Harding, ACT Government and Dr Nathan Steggel, Windlab.

Professor Ken Baldwin at the Finkel Review Explained

The United States Energy Transition

Hosted by ECI, 26 July 2017.

Public lecture by Dr Martin Keller, Director, National Renewable Energy Laboratory, USA.

The United States Energy Transition – 26 July 2017

Master of Energy Change Careers and Networking Evening

Hosted by ECI, 21 August.

Prospective employers addressed current Master of Energy Change students.

Smart Grid and Beyond: a Modelling and Control Perspective

Seminar by Professor Xinghuo Yu, RMIT, 6 September 2017.

Energy Policy and Law Under the Trump Administration

Hosted by ECI and the Australian Institute of Energy, 4 August 2017.

Professor Lincoln Davies, Presidential Endowed Chair in Law, College of Law, University of Utah.

Roundtables

Climate Change and National Security

Sherri Goodman, former US Deputy Secretary of Defense for Environmental Security, and Ian Dunlop, former Chair of the Australian Coal Association, addressed a group of people from government, academia and NGOs about the critical national security and defence risks associated with climate change. Hosted by the Energy Change Institute, the Climate Change Institute and the Breakthrough Centre for Climate Restoration. April 2017.

US Energy Transition

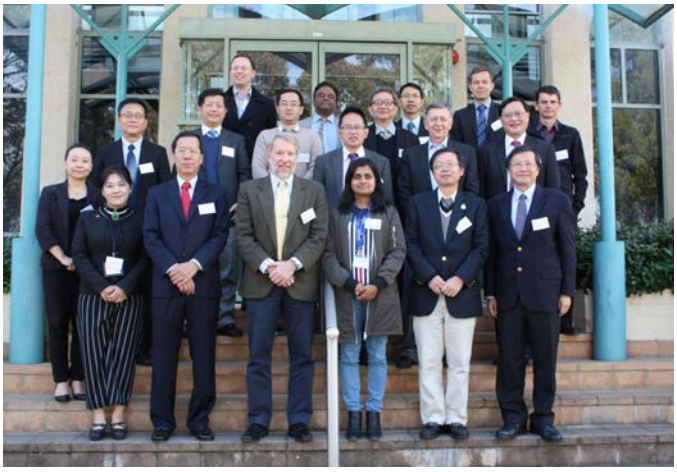
Dr Martin Keller, Director of the United States National Renewable Energy Laboratory (NREL), took part in a two-day visit to ANU, meeting with energy researchers and taking part in a roundtable discussion. The roundtable allowed for an exchange of perspectives from both countries on the integration of high levels of renewable energy into the national electricity network as we move towards a decarbonised economy. July 2017

European Union Energy Experts

The ECI and the Delegation of the European Union to Australia hosted two experts from the European Union to discuss a move 'Towards 50% renewables by 2030: a view from the European control room' Stefan Arent, an economist working for the German Federal Network Agency and Marta Mendoza Villamayor, an electrical engineer working for the European Network of Transmission System Operators. September 2017

Australia - Taiwan Energy Roundtable

Energy leaders from Taiwan took part in a roundtable discussion with ECI members. The Taiwan delegation included executives from the National Energy Program Phase II, Industrial Technology Research Institute, the National Tsing Hua University, the National Taiwan University of Science and Technology, the Metal Industries Research and Development Centre and the Taipei Economic and Cultural Office in Australia. September 2017.



ECI and Taiwan roundtable participants at ANU

OUTREACH

Part of ECI's mission is to disseminate information on energy change through outreach activities. The following list gives a sample of the types of activities ECI members have been involved in.

International engagement

Australian - Kazakhstan Energy Forum, Astana, Kazakhstan

An ECI delegation comprised of **Dr Kaveh Rajab Kalipour, Professor Wojciech Lipinski, Dr Igor Skryabin** and **Dr James Prest** attended the Australian – Kazakhstan Energy Forum. The Australian Ambassador to the Russian Federation, His Excellency Mr Peter Tesch and Mr Bolatbek Sultangazin, Chairman of the Kazakhstan Science Fund opened the Forum in Astana, Kazakhstan. The ECI delegation also presented at the Future Energy Forum and took part in the 5th International Conference on Nanomaterials and Advanced Energy Storage Systems.

ANU formalised its relationship with Taiwan's Industrial Technology Research Institute (ITRI) with the signing of an MOU by the ECI's Director **Professor Ken Baldwin** and Deputy Director General Dr Ren-Chain Wang.

Dr James Prest collaborated with energy law and policy researchers from three top Tokyo universities at a Japan – Australian Dialogue on Energy Policy & Regulation in Tokyo, Japan. The workshop's theme centred on redesigning energy policy and regulation to promote innovation and achieve deep carbonization in Australia and Japan.

Professor Frank Jotzo led a senior delegation of presidents and vice-presidents from Bavarian based universities as well as some Bavarian politicians, on a tour of the ECI showcasing our world class facilities and discussing the research taking place.

Japanese MP, Ms Yuko Obuchi, met with the Solar Thermal Group at the Australian National University to learn about hydrogen and solar energy research in Australia. **Professor Wojciech Lipinski** led Ms Obuchi on a tour of energy and materials laboratories in the Research School of Engineering and introduced teams of ANU researchers from the Research School of Engineering, the College of Law and the Energy Change Institute.

Dr Igor Skryabin attended the Asia Clean Energy Forum in Manila, The Phillipines. At the forum Dr Skryabin presented a paper "Energy Technology Assessment to enable uptake of renewables."

Dr James Prest participated in the APEC 3rd Asia-Pacific Energy Sustainable Development Forum in China delivering a paper entitled 'Legislative responses to technologically-induced electricity market disruption: Embracing 'Clean' Coal or encouraging Clean Energy?'.

Community engagement

Professor Ken Baldwin attended the opening of the Maoneng Mugga Lane Solar Farm. Located in Tuggeranong, Canberra, the 13MW photovoltaic park houses over 53,000 solar panels injecting energy into ActewAGL's distribution network, meeting the electricity demands of approximately 3,250 ACT households.

Ken Baldwin, ECI and Morris Zhou, Group Executive Chairman, Maoneng Group

Industry engagement

Professor Ken Baldwin is a Board member of the South East Region of Renewable Energy Excellence (SERREE) including the ACT and surrounding areas.

Dr Igor Skryabin is a Board member of the Australian Photovoltaic Institute, an Advisory Board member of the APEC Asia-Pacific Solar Energy Centre in China, a member of the NSW Energy and Resource Knowledge Hub, and a member of the organising committee of 2016 Asia-Pacific Solar Research Conference as well as leader of the "Energy in the Asia-Pacific" research stream of the conference.

Professor Quentin Grafton is a member of FE2W (Food Energy Environment Water), an international, non-profit association with 40 members from universities, multilateral organisations and non-government organisations committed to addressing the world's food, energy, environment and water challenges.

MEDIA

The media is a key partner helping the ECI to engage and educate the wider community on topics relevant to energy change.

ECI members regularly provide expert commentaries on news relevant to energy technology and energy policy. Below are some examples.

Decarbonisation of energy

"Indonesia's fuel subsidy cuts prevented even worse traffic jams", 2 October 2017, Dr Paul Burke, The Conversation.

"Renewables will be cheaper than coal in the future. Here are the numbers", 27 September 2017, Prof Ken Baldwin, The Conversation.

"How Trump could undermine the US solar boom", 21 September 2017, A/Prof Llewelyn Hughes, The Conversation.

"The true cost of keeping the Liddell power plant open", 8 September 2017, Prof Frank Jotzo, The Conversation.

"Biofuels breakthroughs bring 'negative emissions' a step closer", 30 August 2017, Prof Andrew Hopkins, The Conversation.

"FactCheck Q&A: is coal still cheaper than renewables as an energy source?", 14 August 2017, Prof Ken Baldwin, The Conversation.

"Solar is now the most popular form of new electricity generation worldwide", 3 August 2017, Prof Andrew Blakers, The Conversation.

"Three charts on: the incredible shrinking renewable energy job market", 3 April 2017, Dr Paul Burke, The Conversation.

"New coal plants wouldn't be clean, and would cost billions in taxpayer subsidies", 2 February 2017, Prof Frank Jotzo, The Conversation.

"Ill wind is blowing in energy and climate policy" 2 February 2017, Prof Frank Jotzo, The Sydney Morning Herald.

Finkel Review

"Politician's must see bigger picture when debating power supplies", 16 June 2017, Honorary Prof John Hewson, The Age.

"Energy solutions but weak on climate – experts react to the Finkel Review, 9 June 2017, Honorary A/Prof Hugh Saddler, The Conversation.

Explainer: what is a 'low emissions target' and how would it work?", 8 June 2017, Prof Frank Jotzo, The Conversation.

"Australia needs a properly functioning National Energy Market", 7 June 2017, Prof Brian Schmidt, Prof Ken Baldwin and Prof Frank Jotzo, The Australian Financial Review.

Energy security

"To avoid crisis, the gas market needs a steady steer, not an emergency swerve", 27 September 2017, Prof Andrew Hopkins, The Conversation.

"The current energy debate is farcical. What does this government stand for?" 19 September 2017, Honorary Prof John Hewson, The Guardian.

"Power crisis demands apolitical leadership", 8 September, 2017, Honorary Prof John Hewson, Fairfax papers.

"Climate change energy impasse shows how our politics is failing", 15 December 2016, Prof Warwick McKibbin, Australian Financial Review.

"When politician's listen to scientists, we all benefit" 21 March 2017, Prof Ken Baldwin, The Conversation.

"South Australia makes a fresh power play in its bid to end the blackouts", 15 March 2017, Honorary A/Prof Hugh Saddler, The Conversation.

"Australia's electricity market is not agile and innovative enough to keep up", 17 February 2017, Honorary A/Prof Hugh Saddler, The Conversation.

"Why did energy regulators deliberately turn out the lights in South Australia?",10 February 2017, Honorary A/Prof Hugh Saddler, The Conversation.

Pumped hydro energy storage

"Want energy storage? Here are 22,000 sites for pumped hydro across Australia", 21 September 2017, Prof Andrew Blakers, PhD candidate Bin Lu and Dr Matthew Stocks, The Conversation.

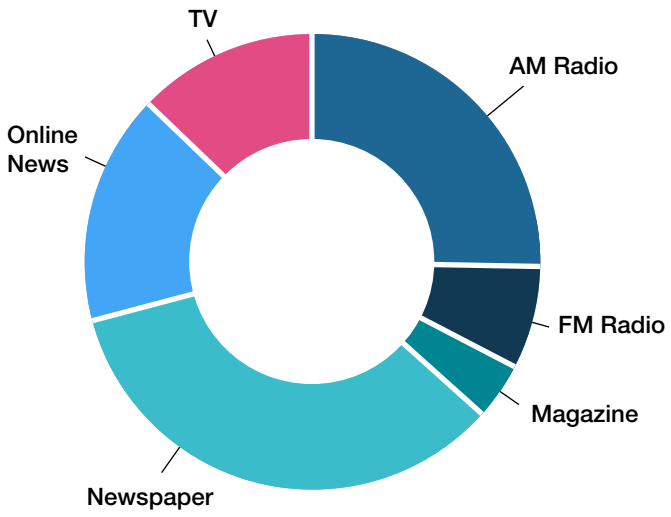
Fusion power

"A new twist on fusion power could help bring limitless clean energy", 17 January 2017, A/Prof Matthew Hole, The Conversation.

Media releases

The ANU publicises ECI research and news via media releases. Coverage generated by an ANU media release can have broad reach. For example in September 2017, the ANU press release – 'Hydro storage can secure 100% renewable electricity' - reached an audience of more than 4.5 million people.

ECI Exec Media Type Breakdown – Volume



Media audience numbers generated by ECI Executive for the 291 days between 1 Jan and 18 Oct 2017 reaching a total audience of 14.5 million people (Isentia Media Monitoring).

Below are some examples of media releases relevant to energy technology and energy policy.

ANU finds 22,000 potential pumped hydro sites in Australia
21 September 2017

A new Energy Research Institutes Council for Australia (ERICA)
17 August 2017

ANU - Melbourne to lead new energy transition hub
7 July 2017

Call for G20 action on energy issues
6 July 2017

ANU identifies possible pumped hydro sites in South Australia
16 June 2017

The way forward from Finkel review of Australia's energy future
9 June 2017

What to expect from Finkel review of Australia's energy future
7 June 2017

Butterfly wings inspire invention that opens door to new solar technologies
18 May 2017

Nuclear options need to be in the energy mix - experts
21 April 2017

New efficiency record for low-cost solar cell
4 April 2017

ANU appoints Simon Corbell Honorary Professor
17 March 2017

Snowy Hydro Expansion - ANU Experts Comment
16 March 2017

Hydro storage can secure 100% renewable electricity
27 February 2017

Communications

ECI Communications in 2017 have been focussed on promotion of ECI research and events, building and supporting ECI membership, strengthening partnerships and connections between ECI members and external stakeholders in government, industry, NGOs and the community and promoting the Master of Energy Change degree.

Our main communication channels have been events, media relations and digital communications, including ANU websites, a regular e-marketing program to our database of 4,000 subscribers and social media (including Twitter: @ANUEnergyChange, and Facebook: ANU Energy Change).

HONOURS AND AWARDS

Dr Paul Burke – Best Paper Award in Economic Papers, 2017

Dr Burke has won Best Paper in Economics Papers by the Economics Society of Australia. The award recognises Dr Burke's 2016 study on Australia's Direct Action scheme to reduce emissions. Dr Burke is a member of three ECI research clusters: Energy Economics & Policy; Energy for Development; and Sustainable Transport.

Professor Graham Farquhar AO – 2017 Kyoto Prize in Basic Sciences

The Kyoto Prize is considered the most prestigious international award for fields not traditionally honoured with a Nobel Prize. Professor Graham Farquhar became the first Australian to win a Kyoto Prize. This award recognises his life's work in plant biophysics and photosynthesis, which has involved research on water-efficient crops and the impacts of climate change. Professor Farquhar is a member of the ECI's Renewable Fuels research cluster.

Associate Professor Matthew Hole – First Australian Appointment at ITER

Associate Professor Matthew Hole was appointed Science Fellow at ITER, the world's largest fusion experiment, which is under construction in the South of France. It is the only such appointment to a scientist outside the ITER member nations; the European Union, Japan, United States, Russia, South Korea, China and India. Associate Professor Hole is Convenor of the ECI's Fusion Power research cluster.

Professor Chennupati Jagadish – Honorary Fellow of the Indian Academy of the Sciences

Distinguished Professor Chennupati Jagadish has been elected an Honorary Fellow of the Indian Academy of the Sciences. Professor Jagadish has had a successful career researching photovoltaics, nanotechnology and semiconductor optoelectronics and is involved in many programs linking Australian and Indian researchers. Professor Chennupati was also part of a team that won the International University of Materials Research Societies (IUMRS) Somiya Award for international collaboration in Materials Science. He also received the Welker Award 2017 at the Compound Semiconductor Week Conference in Germany. Professor Chennupati is a member of the ECI's Solar Photovoltaics research cluster.

Dr Niraj Lal – One of the ABC's top 5 scientists under 40

Passionate about science outreach, Dr Lal shares his enthusiasm with all ages. In 2016 he was named one of the ABC's top 5 scientists under 40 for his research on solar cell nanophotonics. Dr Lal appears on various ABC broadcasts, the Discovery Channel and YouTube. He is a member of the ECI's Solar Photovoltaics research cluster.

Professor Warwick McKibbin AO – Distinguished Public Policy Fellow, 2017

Professor McKibbin was awarded the Distinguished Public Policy Fellow from the Economic Society of Australia. This award recognises Professor McKibbin's outstanding career as an economist with his work having had a major impact both in Australia and internationally. Professor McKibbin is in the ECI's Energy Economics and Policy research cluster.

Australian Academy of Social Sciences appoints two ECI members

Professor Xuemei Bai and Honorary Professor John Hewson were appointed to the Australian Academy of Social Sciences for their contributions to their disciplines and society.

Professor Bai's research focuses on several frontiers of urban sustainability science and policy. Honorary Professor John Hewson is a distinguished business and academic economist, former leader of the Federal Coalition in opposition and an observer and analyst of Australian politics. Professor Bai is a member of the Energy Efficiency research cluster and Honorary Professor John Hewson is a member of the Energy Economics and Policy research cluster.

OUTLOOK

Lake George, wind turbines.

We can but hope that from next year, Australia will have an agreed energy plan that is aligned with its climate and environmental imperatives. This will potentially provide the policy certainty that is desperately needed to unlock the logjam of industry investment in a low-carbon energy future.

The ECI – particularly through the Energy Research Institutes Council for Australia (ERICA) – will work tirelessly to harness its wide-ranging expertise to inform this process. We have a unique combination of discipline areas that can contribute to solving the 'energy trilemma' of affordability, security and sustainability.

The ECI will start local – with the ANU Energy Master Plan for creating a low-carbon, affordable campus – and will move global through our research linkages worldwide. We will continue our strong engagement with industry, and will partner with government (both state and national) to provide the research understanding needed for Australia's energy transition.

Please visit our website (energy.anu.edu.au), subscribe to Twitter (@ANUEnergyChange) and Facebook (ANU Energy Change), and keep in touch through our mailing list for the latest developments.

ADVISORY BOARD MEMBERSHIP

Professor Armin Aberle – Solar Energy Research Institute of Singapore

Armin Aberle is the CEO of the Solar Energy Research Institute of Singapore (SERIS) at the National University of Singapore (NUS) and a professor in the university's Department of Electrical and Computer Engineering. His research focus is on reducing the cost of solar electricity generated with silicon solar cells, both wafer based and thin-film based. His work has covered the full spectrum from fundamental materials research to the industrial evaluation of novel PV technologies at the pilot line level, including the development of novel solar cells, their fabrication in the laboratory, their characterisation, and their computer modeling. He has published extensively and his work has a high impact on the field.

Dr Stephen Bygrave – Executive Director, Climate Change and Sustainability, ACT Environment, Planning and Sustainable Development Directorate

Stephen Bygrave has responsibility for the ACT's 100% renewable energy target, net zero emissions by 2050 target, Energy Efficiency Improvement Scheme, energy policy, climate adaptation, Carbon Neutral Government as well as the ActSmart households, business and schools programs. Stephen has worked on climate change and renewable energy for over two decades in government, academia and the not for profit sector, including two years as a climate analyst with the OECD in Paris. Stephen has worked on some of Australia's leading climate policies including the Renewable Energy Target and the Carbon Pricing Mechanism. Stephen holds a Bachelor of Science with honours, Bachelor of Economics and PhD from the Australian National University. His PhD focused on community renewable energy projects in the Pacific Islands.

Dr Gordon de Brouwer – Secretary, Department of the Environment and Energy, Australian Government

Gordon de Brouwer was appointed portfolio Secretary of the Department of the Environment in September 2013 and is responsible for the design and implementation of the Australian Government's environment, heritage, climate and energy policy. He manages a department with around two thousand staff and operations across Australia and Antarctica, and seven portfolio agencies (Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Clean Energy Regulator, Climate Change Authority, Clean Energy Finance Corporation, Australian Renewable Energy Agency and Sydney Harbour Federation Trust).

Mr Stephen Devlin - General Manager Assets Division, ActewAGL

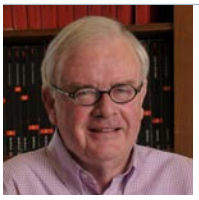
Stephen Devlin is responsible for ActewAGL's energy networks asset strategy and planning functions. He is also responsible for the gas networks business, technical regulatory standards, major customer connections and smart networks developments. He has a breadth of experience in the energy, water and waste sectors, having worked across many facets of the electricity, water, gas and waste industries for 30 years. Stephen holds a Bachelor of Engineering (Electrical), a Master of Business Administration and a Master of Commercial Law.

Mr Ian Farrar – Former Chair and CEO of the Joint Coal Board

Ian Farrar has a distinguished career in senior management in CSIRO and the coal industry. He has a Bachelor of Commerce from ANU. From 2002 until his retirement in 2005 he was Managing Director/CEO of Coal Services Pty Limited (CSPL), Coal Mines Insurance Pty Limited (CMI) and Mines Rescue Pty Limited, as well as Chairman of Coal Services Health and Safety Trust and Injury Prevention and Control Australia Limited. From 1964 to 1992 he held a range of senior management positions within CSIRO, including General Manager (Corporate Resources) and Senior Principal Advisor (Special Projects).

Professor Mark Howden – Director, ANU Climate Change Institute

Mark Howden is also an Honorary Professor at Melbourne University, School of Land and Food. Mark has worked on climate variability, climate change, innovation and adoption issues for over 27 years in partnership with farmers, farmer groups, catchment groups, industry bodies, agribusiness, urban utilities and various policy agencies via both research and science-policy roles. He has over 390 publications of different types. Mark has been a major contributor to past Intergovernmental Panel on Climate Change (IPCC) reports and is a Vice Chair of the IPCC Working Group 2, which addresses Climate Impacts and Adaptation. Recently Mark sat on the US Federal Advisory Committee for the 3rd National Climate Assessment and he participates in several other international science and policy advisory bodies.



Professor John Poate – Colorado School of Mines; Member of the National Renewable Energy Laboratory (US) Advisory Board

John M. Poate is Vice-President for Research and Technology Transfer at the Colorado School of Mines. He previously served as a Harwell Fellow of the UKAEA, Head of the Silicon Processing and Interface Physics Research Departments at Bell Laboratories, Dean of the New Jersey Institute of Technology and CTO of Axcelis Technologies. John has published extensively in several areas of nuclear physics, solid state physics, materials science and engineering. He is a Fellow of the American Physical Society and Materials Research Society, MRS Past-President and the John Bardeen award winner of the The Minerals, Metals and Materials Society (TMS).

EXECUTIVE MEMBERSHIP

Professor Ken Baldwin - ANU College of Science

Ken Baldwin is the Director of the Energy Change Institute at The ANU, and Deputy Director of the Research School of Physics and Engineering. From 2011-13 he was a member of the Project Steering Committee for the Australian Energy Technology Assessment, and in 2015/16 was a member of the Socioeconomic Modelling Advisory Committee to the South Australian Royal Commission into the Nuclear Fuel Cycle. Ken is an ANU Public Policy Fellow, and is a Fellow of the American Physical Society, the Institute of Physics (UK), the Optical Society of America and the Australian Institute of Physics.

Professor Andrew Blakers - ANU College of Engineering and Computer Science

Andrew Blakers is Professor of Engineering at The Australian National University. He was a Humboldt Fellow and has held Australian Research Council QEII and Senior Research Fellowships. He is a Fellow of the Academy of Technological Sciences & Engineering, the Australian Institute of Energy and the Institute of Physics. He has published 200 papers and patents with research interests in the areas of photovoltaic and solar energy systems. He is also interested in sustainable energy policy, and is an ANU Public Policy Fellow.

Professor Kylie Catchpole - ANU College of Engineering and Computer Science

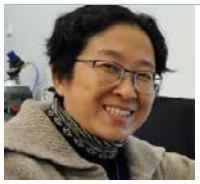
Kylie Catchpole is the education convenor of the Master of Energy Change program. Her research interests are in novel materials for solar cells and solar fuels. She has a physics degree from the ANU, winning a University Medal, and a PhD from the ANU. She was a Post-doctoral Fellow at UNSW and the FOM Institute for Atomic and Molecular Physics, Amsterdam. She has published over 90 papers, and was awarded the John Booker medal from the Academy of Science in 2015.

Associate Professor Llewelyn Hughes – ANU College of Asia and the Pacific

Llewelyn Hughes is an Associate Professor in the Crawford School of Public Policy, and research director at GR Japan, a public affairs consultancy based in Tokyo. His academic work focuses on the regulation of natural resource markets, and the political economy of climate change. Dr. Hughes joined the ANU in 2014 from the Elliott School of International Affairs at George Washington University. He received his Ph.D. from the Massachusetts Institute of Technology, and holds a Master's degree from the Graduate School of Law and Politics at the University of Tokyo.

Professor Elmars Krausz - ANU College of Science

Elmars Krausz graduated with a PhD from the University of Sydney. He has since held research positions at The Australian National University, Oxford University, the University of Virginia, and the University of Sydney before being appointed as Research Fellow at the Research School of Chemistry. He was awarded fellow of the Royal Australian Chemical Institute and was appointed Professor at the Research School of Chemistry in 2002.



Professor Yun Liu – ANU College of Science

Yun Liu graduated from the Xian Jiaotong University, China with her BSc, MSc and PhD. She has since held a position at the National Institute of Advanced Industrial Science and Technology (AIST), Kyushu, Japan (1998-2001) before the commencement of her Postdoctoral Fellow position at the Research School of Chemistry in 2001. She was awarded fellowships of the AIST (1998-1999), the Science and Technology Agency (1999-2001, now renamed as the Fellow of Japan Society for the Promotion of Science) and the Australian Research Council (ARC) Queen Elizabeth II (2006-2010). She was made a fellow of the Australian Institute of Physics (FAIP) and Certified Materials professional (CMP). She was also a member of the Materials of Australia (MMA) and the Society of Crystallographers in Australia and New Zealand (MSCANZ).

Dr James Prest - ANU College of Law

James Prest has 22 years' experience as an environmental and natural resources lawyer - including roles at a top tier commercial firm, plus the Department of Prime Minister and Cabinet, and Parliament House. As a Member of the IUCN Commission on Environmental Law, he has many international links, with active collaborations with researchers in USA, Germany, Spain, Japan, Indonesia. His research has a strong focus on comparative environmental law, with an emphasis on renewable energy and climate change law.

Dr Igor Skryabin, Business Development Manager - ANU College of Science

Igor Skryabin's career has spanned both industry and academia. His major technical contribution has been in the development and commercialisation of solar technologies. Igor has published more than 100 research papers and is an inventor of more than 30 patents and industrial designs, granted in Australia and overseas. Igor is a co-lead/coordinator of the Australia-Indonesia Energy Cluster, Board Member of the Australian Photovoltaic Institute and of the Asia-Pacific Sustainable Energy Centre in China.

Professor Sylvie Thiebaux – ANU College of Science

Sylvie Thiebaux's research interests are artificial intelligence and their optimisation and their applications to smart grids. She leads the CONSORT project in developing and trialling methods enabling consumer-owned battery systems to provide owner value while supporting the grid, with ANU, USyd, UTAS, TasNetworks, Reposit Power, and ARENA. She is an associate editor of the Artificial Intelligence journal, an AAAI Councillor, former President of the board of directors of International Conference on ICAPS, and a former Director of the Canberra Laboratory of NICTA.

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Dr Nicholas White	ANU College of Science

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Professor Wojciech Lipinski	ANU College of Engineering and Computer Science

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Dr Marnie Shaw	ANU College of Engineering and Computer Science
Dr Chathurika Mediwaththe	ANU College of Engineering and Computer Science

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Professor Andrew Blakers	ANU College of Engineering and Computer Science
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Professor Andres Cuevas	ANU College of Engineering and Computer Science
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Dr James Prest	ANU College of Law
Dr Igor Skryabin	ANU College of Science
Dr Hua Xia	ANU College of Science

CONTACT US

The ANU Energy Change Institute
Energy Change Institute
Oliphant Building (#60), Mills Road
The Australian National University
Canberra ACT 2601
T +61 2 6125 4702
E energy.change@anu.edu.au
W energy.anu.edu.au

ANU Energy Change
@ANUEnergyChange

MO_ECI173251