Highlights and New Initiatives

Ken Baldwin, ECI Director
Research clusters

A wide spectrum of Energy research:

- Technologies
  - Artificial Photosynthesis
  - Energy Storage and Recovery
  - Enhanced Oil and Gas/ CCS
  - Fusion Power
  - Nuclear Science
  - Renewable Fuels
  - Smart Grid
  - Solar PV
  - Solar Thermal
  - Wind Energy

- Energy Economics and Policy
- Energy Efficiency
- Energy and Security
- Energy for Development
- Energy-Water Nexus
- Energy Regulation and Governance
- Energy Sociology and Risk
- Sustainable Transport

>$100 M Energy Research Facilities
>300 Staff and Students
Appointment of Dr Lachlan Blackhall

• Entrepreneurial Fellow
• Head of the $8m Battery Storage and Grid Integration Program – jointly funded by ACT Government and ANU
Highlights

Bruny Island smart battery trial: first research results revealed

Sustainable Transport: Energy Conversations event with Australian Institute of Energy
Sold out crowd at Renewables Innovation Hub. Largest crowd yet at Energy Conversations event.
Roundtable - Dr Allison Macfarlane
former Chair of the US Nuclear Regulatory Commission to President Obama

ANU-invented solar technology helps University reduce emissions
Enhancing research through partnership with JWLand – joint DEE secondment to ECI for research

Prosser bursary: exclusively for Master of Energy Change students
Dr Alan Finkel, Australia’s Chief Scientist: keynote speaker at ANU Energy Update, November 2017

MOU: ECI – NREL (National Renewable Energy Laboratory) in the USA
Public Policy

‘Cooma Forum’ – Snowy 2.0 renewable energy research roundtable organised by Mike Kelly MP for Eden-Monaro

National Energy Guarantee public lecture with Clare Savage, Energy Security Board
2017 ANU Media and Outreach Awards:
• Professor Ken Baldwin, Professor Andrew Blakers, Dr Christian Downie and Professor Frank Jotzo: joint winners of Improving the Quality of Public Debate Award.
• Professor Andrew Blakers received a second honour - Impact Award for Reach and Influence.

Professor Graham Farquhar AO named 2018 Senior Australian of the Year.

Professor Chennupati Jagadish won the 2017 Nayudamma Award from the Nayudamma Centre for Development Alternatives in India.
• Arup consultants appointed
• ECI and Facilities & Services in expert partnership to advise Arup
• CWP Renewables funded a 5 student team to undertake research projects supporting EMP
• ECI researchers engaged to:
  – Supervise students
  – Contribute ideas to the EMP
  – Embed research projects in the EMP
• 264kW PV ‘sliver’ cells installed, developed from ANU research
• Completion by end 2018
Energy Research Institutes Council for Australia

11 University-based research institutes: (+ UTS?):

- Centre for Energy Technology, University of Adelaide
- Centre for Sustainable Energy Development, University of Sydney
- Deakin Energy, Deakin University
- Energy Change Institute, Australian National University
- Fluid Science and Resources Division, University of Western Australia
- Fuels and Energy Technology Institute, Curtin University
- Future Energy, University of Tasmania
- Melbourne Energy Institute, University of Melbourne
- Monash Energy Materials and Systems Institute, Monash University
- University of Queensland Energy Initiative, University of Queensland
- UNSW Energy Institute, University of New South Wales
ERICA will provide:

1. National capacity across a broad spectrum of cutting-edge energy research, in both specialised and inter-disciplinary fields;

2. High-level, evidence-based, energy policy advice to government;

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; and

5. A research-led education network for students and young researchers.
Agendas

• Engage with Mission Innovation (aim to double RE R&D spend by 2020 based on 2005 $108m)

• Provide research-led advice to the AEMO Advisory Board (via Michael Brear, MEI)

• Establish an Energy Research Conference
  – first scheduled for February 2019 at ANU

• Contribute to government reviews
Education

James Prest  MEnCh Convenor
Igor Skryabin  Research and Business Development
Coordinated by the ECI

Integrated delivery of all aspects of Energy Change

Grown to approx. 23 students

50/50 domestic / international

- Solar PV/thermal/nano
- Wind Energy
- Nuclear Science
- Fusion Energy
- Enhanced Oil/Gas Extraction
- Carbon Capture & Storage
- Hydrogen Fuel Cells
- Artificial Photosynthesis
- Biosolar
- Smart grids
7 new starters in Semester 1 2018.
Total Number of students currently active in the program – 23 students as at 15/6/2018;
Split between Master of Energy Change standard and MENCH Advanced = 7 out of 23 in Advanced.
New Exchange agreement with École Polytechnique

- one of the most prestigious and selective French grandes écoles, specialising in science, engineering and innovation
- Agreement signed between ANU and EP
- EP staff visited May 18
- ANU students to start at EP in 2019 at beginning of French academic year
Photo: Department of Defence staff attend a short course on Energy
Industry Engagement

Igor Skryabin,
Research and Business Development Manager
The Australia-Indonesia Centre is a joint research venture between the two countries, with the ECI co-leading the Energy research cluster.

- ~$2M Energy Research Program with about $0.8M allocated to ANU

2018 Highlights

- Completion of all projects
- Final Cluster Workshop 19 July at ANU, 20 July - Monash
- Links to the EMP
- Planning of AIC Stage 2

Meeting with Indonesian Ministry of Energy and Mineral Resources. From left: Bintan, Igor Skryabin (ECI), Retno Gumilang Dewi, Ken Baldwin (ECI), Ir Adhi Wibowo, Max Richter, Ariel Liebman (AIC), R&D staff member, Rajab Khailpour, Agus Nurhudooyu
Renewable Hydrogen Program

- ACT Hydrogen Focus Group: ACT Govt, ANU, Evo Energy, GPG, Neoen
- $75k/year over 20 years GPG funding of ECI research confirmed
- $1.2M for ANU H2 research and demonstration
- EDL & Dept of Industry: Regulatory and Policy Reform to facilitate existing biogas injection technology into gas distribution networks – College of law + RSPE
Outreach

Sarah Wilson,
Communications Manager
<table>
<thead>
<tr>
<th><strong>Digital communications</strong></th>
<th><strong>Events</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Website (almost double number of visitors from 2015 to 2017)</td>
<td>- Regular ECI seminars, roundtables &amp; public lectures</td>
</tr>
<tr>
<td>- E-newsletter</td>
<td>- Timely events e.g. National Energy Guarantee</td>
</tr>
<tr>
<td>- Social media – Twitter and Facebook</td>
<td>- ECI Open Day and ANU Energy Update</td>
</tr>
<tr>
<td>- ANU networks</td>
<td></td>
</tr>
<tr>
<td>- Master of Energy Change – videos</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Media relations</strong></th>
<th><strong>Target policy community directly</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- ECI commentary on issues and events – media releases</td>
<td>- Promote short courses</td>
</tr>
<tr>
<td>- Pitch thought leadership / opinion pieces to media</td>
<td>- Policy submissions</td>
</tr>
<tr>
<td>- Pitch media interviews around key events</td>
<td>- Tailored briefings</td>
</tr>
</tbody>
</table>

**Success measures:** Website visitation, database size, email open rates, social media followers, event attendance, quality and coverage of media coverage, access to policy stakeholders, ultimately consideration of energy change research in public policy
Media generated by ECI members for the six months between 1 Dec 2017 and 31 May 2018 reached a total audience of more than 10 million people (Isentia Media Monitoring). An increase of three million people compared to same six monthly period in 2016 -17.
Building our reach within the wider community

- More than 4,300 people (and growing) receive our regular e-newsletter
- Diverse audiences: Federal & ACT Government, industry, ANU staff, students, diplomatic and general community
- High attendance levels (usually sold out) at ECI events
- Partnerships e.g.:
  - Mike Kelly, Federal Member for Eden-Monaro - Snowy 2.0 renewable energy prospects roundtable
  - ACT Government – Climate Strategy Roundtable
  - South East Region of Renewable Energy Excellence (SERREE)
  - ACT Renewables Innovation Hub

Solar PV & wind are on track to replace all coal, oil & gas within two decades
Prof Andrew Blakers & Dr Matthew Stocks

We must fix the foundation of our energy policy to get out of the current mess
Prof Frank Jotzo, Salim Mazouz, Dylan McConnell & Hon A/Prof Hugh Saddler

Tesla’s ‘virtual power plant’ might be second best to real people power
Dr Hedda Ransan-Cooper et al.

The Nationals should support carbon farming not coal
Prof Andrew Hopkins

ANU Energy Change Institute: energy.anu.edu.au
Women in Energy Network

New ANU-wide initiative to support women working within the field of energy

Encourage and foster an inclusive environment

ANU staff are encouraged to come along to our inaugural meeting today: 1.30 – 2.30pm in this room.

All staff welcome to attend.
ECI Grand Challenge

Ken Baldwin, ECI Director
The Grand Challenge Scheme

• Visionary: “invests in transformative research that will impact on the world’s most intractable problems”

• Reputational: “enhancement of the reputation of ANU as a world leader in globally important interdisciplinary research”

• $10m over 5 years – perhaps doubled with leveraging

• ECI GC runner up in the first year 2017

• Given $0.5m in 2018 for Interim GC + $0.2m industry

• 2019 proposal underway for September 2018 decision
Primary energy demand, 2035 (Mtoe)

The Asian Century

Source: International Energy Agency
Research themes

1. Asian Supergrid

Changing the way we trade with the Asia-Pacific based on our comparative advantages:

- bountiful renewable energy
- large land space
- strong resource base
- geopolitical stability

2. Zero-carbon energy-rich export products and fuels

Australia’s

- ANU expertise in
  - Energy
  - Asia-Pacific
### Project teams

#### Theme 1

1. **Indigenous and community engagement with renewable energy industries**
2. **Policies for renewables and storage in India and Indonesia**
3. **International legal and policy frameworks to manage cross-border trade in electricity and renewable energy**
4. **Economic, policy and technical challenges for exporting electricity**
5. **Economic, policy and technical challenges for exporting renewable energy refined metals and products**
6. **Economic, policy and technical challenges for exporting hydrogen and hydrogen vectors**

<table>
<thead>
<tr>
<th>Project Team</th>
<th>Disciplines</th>
<th>Project Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Zsuzsanna Csereklyei**</td>
<td>Economics (Physics, Engineering)</td>
<td>10. Anna Nadolny** Engineering, Science</td>
</tr>
<tr>
<td>7. Kathryn Thorburn**</td>
<td>Political Science (Indigenous governance)</td>
<td>15. Alireza Rahbari Engineering</td>
</tr>
<tr>
<td>8. Robin Purchase ** non-ANU based</td>
<td>Chemistry (Outreach)</td>
<td>16. Ali Shirazi Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17. Tory Bridges Social Science</td>
</tr>
</tbody>
</table>
ANU Grand Challenge Scheme Delegate
Deputy Vice Chancellor, Research & Innovation

Governance Board: Zero Carbon Asia-Pacific
Mick Cardew Hall (Chair), Ken Baldwin, suggest: Sally Wheeler, Sara Bice, Sylvia Tulloch

Challenge Operational Team: Ken Baldwin, Emma Aisbett, ECI Administration

Steering Committee: Zero Carbon Asia-Pacific
Ken Baldwin (Chair), Emma Aisbett, Project Convenors, CWP & Evo Energy Reps, Karen Jackson, ECI Exec Representatives

Project 1
Janet Hunt
Convenor
Research
Project Investigators

Project 2
Paul Burke
Convenor
Research
Project Investigators

Project 3
James Prest
Convenor
Research
Project Investigators

Project 4
Matt Stocks
Convenor
Research
Project Investigators

Project 5
John Pye
Convenor
Research
Project Investigators

Project 6
Wojciech Lipinski
Convenor
Research
Project Investigators

Emma Aisbett– Team Leader
Challenge Program Funded Research Staff
ECI Collaborations

International MOUs

- USA
  - NREL
- ITRI
  - Taiwan
- E-P
  - France
- CIEMAT
  - Spain
- Australia-Germany Energy Transition Hub

Corporate

- New Co.'s
- CWP
- Actew AGL

Government

- ACT Govt.
- Federal Govt.
- ARENA

Energy Transition Hub

Australia-Indonesia Centre

ECI GC

ECI

Corporate
Grand Challenge: Project 4
Economic, policy and technical challenges for exporting renewable electricity

GC fellows - Ali Shirazi, Chathurika Mediwaththe, Bin Lu, Anna Nadolny, Tory Bridges, Ashkay Shanker and Emma Aisbett

19 June 2018
The Asian Renewable Energy Hub

Pure energy play
6 GW wind  
3 GW solar  
3.3 GW HVDC to Indonesia/Singapore

Stage 1: 3GW  
2 GW wind + 1 GW solar  
Connected to Pilbara region  
Capex ~A$5B

Stage 2: 6GW  
4 GW wind + 2 GW solar  
Australia to Jakarta & Singapore  
Capex ~A$15B
Australia’s comparative advantage

- Wind
- Solar Photovoltaics
- Solar Thermal
Research focus and outcomes

• Technology push feasibility:
  – Medium term energy generation traces for Wind, PV, CSP
  – Pumped hydro site search for Australia and Indonesia
  – Cost assessment for generation and storage
  – System optimization – using least cost energy, 100% cable utilisation or demand matching
  – Determine the socio-political and environmental issues of technology siting

• Demand pull:
  – Future electricity demand in Indonesia, Singapore and other major Asian markets
  – Does the HVDC cable help satisfy demand from projected electricity growth (power vs energy)?

Public position papers
1. North West Australian wind, PV, CSP and pumped hydro (including Indonesia) resource assessment and development of 10 year time series energy traces.
2. Social, political and environmental barriers to utility-scale electricity import and pumped hydro in Indonesia.
Grand Challenge: Project 1
Indigenous community engagement with renewable energy industries

GC fellows — Lily O’Neill, Kathryn Thorburn, Janet Hunt and Emma Aisbett

19 June 2018
Asian Renewable Energy Hub

Native title determinations and claimant applications
June 2018

Native title determinations (425)
Native title claimant applications (243)
Research questions and outcomes

• How might large scale renewable energy projects such as AREH contribute more positively to Aboriginal socio-economic development in remote Australia?
• What mechanisms are there, beyond the Native Title Act, to encourage collaborations across industry and traditional owner groups which will encourage such development?
• What can Australian Aboriginal groups, and the renewable energy industry, learn from experiences internationally in mutually beneficial development?
• What role is there for government policy in encouraging best practice, and positive outcomes, in this space?

Public position papers
1. Best practice in Native Title agreement making – drawing on National and International evidence
2. Identifying risks and opportunities of large scale renewable energy projects on Indigenous estates
Project 2: Policies and institutions for RE uptake in India and Indonesia
• Utility scale RE deployment
• Similarities and differences
  – India vs Indonesia
• Policies and regulatory mechanisms
• Success and failures
  – Design considerations and features
  – Lessons learnt
India solar and wind tariffs, capacity

Utility scale solar PV installed capacity (MW) & Median tariff

Onshore Wind installed capacity (MW)
Project 3: International legal and policy frameworks for international electricity trade

James Prest
Tom Faunce, Don Rothwell, Edward Aspinall
Emma Aisbett, Grace Soutter, Jinnie Widnyana
International electricity trade as an important policy tool to support deployment of RE in the Asia-Pacific

International experience and existing legal frameworks
- Pluri/bi-lateral trade
- Asia connectivity
- Interactions with existing regional trade agreements

Platforms, processes, institutions, rules to optimise electricity cooperation in the Asia-Pacific, including Australia
Outcomes

• **Project 2:**
  – Zero-carbon policy settings for the electricity sector: learning from India and Indonesia (December 2018)
  – *Institutions for zero-carbon electricity: what can be learned from India and Indonesia?* (December 2018)

• **Project 3:**
  – Options for International Energy Trade Agreements with Asia (August 2018)
  – Policy Design Considerations in South East Asian Electricity Trade (December 2018)
Project 5:
Economic, policy and technical challenges for exporting renewable-energy-refined metals and products

GC Fellows:
Mahesh Venkataraman
Alireza Rahbari
Zeba Anjum
Zsuzsanna Csereklyei

Other members:
Andrew Blakers
Joe Coventry
Frank Jotzo
Wojciech Lipiński
Matt Stocks

Project convenor:
John Pye

Energy Change Institute, Open Day, 2018
Tuesday, 19th June 2018
Iron and Steel makes up 4% of our global 50 Gt/y CO₂-eq emissions.

Australia is the world #1 exporter of iron ore and metallurgical coal.

Can Australia develop, and then benefit from, new zero-carbon technologies to process iron ore using renewables?

H₂-reduction of this ore would require ≈1500 TWh/y of electricity — 7× NEM

Equivalent to 700 GW PV or 240 GW of CSP

State-of-the-art 1475 kg CO₂e/tCS ≳ theoretical min 1371 kg/t
Technoeconomic evaluation of the state-of-the-art technologies and quantifying Australia’s advantage of the co-location of resources

**Electrowinning**
TRL 4

**Pyroelectrolysis**
TRL 1-2

H₂-based reduction
SSAB+LKAB+Vsattenfall pilot plant under construction
Project 6:
Economic, policy and technical challenges for exporting hydrogen and hydrogen vectors

GC Fellows:
Mahesh Venkataraman
Robin Purchase
Kaveh Khalilpour
Tory Bridges

Other members:
Andrew Blakers
Kylie Catchpole
Yun Liu
Yongyui Yin
Wojciech Lipiński
John Pye
Joe Coventry
James Prest

Project convenor:
Ronald Pace

Energy Change Institute, Open Day, 2018
Tuesday, 19th June 2018
Potential markets for clean Hydrogen

- **LNG alternative**
  - 20% replacement of current LNG exports
  - ≈ 29 million Mt/y

- **Clean Steel**
  - H₂-based reduction of 20% of current iron ore exports:
  - ≈ 5.3 million Mt/y

- **Fertilisers**
  - Replacing fossil-based H₂ in ammonia production
  - ≈ 0.3 million Mt/y of H₂

- **Automotive**
  - Global projected FCEV capacity: 500,000 vehicles by 2050
  - ≈ 0.1 million Mt/y
Technology evaluation and levelised cost analysis for production of H₂ in the Pilbara region

A more structured literature review through analysis of publications using graph theory.

Socio-political, market and community acceptance of clean H₂ technologies
Renewable Steelmaking (Project 5):
1. Technology feasibility of a net-zero emission iron and steel industry in Australia (September 2018)
2. Renewably-powered steelmaking: policy, trade and market requirements for success in Australia (September 2018)

Renewable H₂ production (Project 6):
1. Social Network Analysis of the evolution renewable H₂ research (September 2018)
2. Socio-economic impact and policy aspects of renewable H₂ production in the Pilbara region (October 2018)
3. Technology feasibility and technoeconomic analysis of production and export of H₂ and H₂ vectors in the Australian context (December 2018)
Outlook

Ken Baldwin, ECI Director
Outlook

- Aim to win the 2018 Grand Challenge
- Support the establishment of the Battery Storage and Grid Integration research team program
- Participate in Aust./German Energy Transition Hub
- Engage with ERICA to contribute to national agenda
- Support ANU/ACT hydrogen technology program
- Prepare phase 2 of the Australia-Indonesia Centre
- Help deliver the 2018 ANU Energy Master Plan
- OSA Light, Energy and Environment Congress in Singapore, November 2018
- First Energy Research-only conference Feb. 2019
ANU Energy Change Institute

Open Day

Thank you very much!