



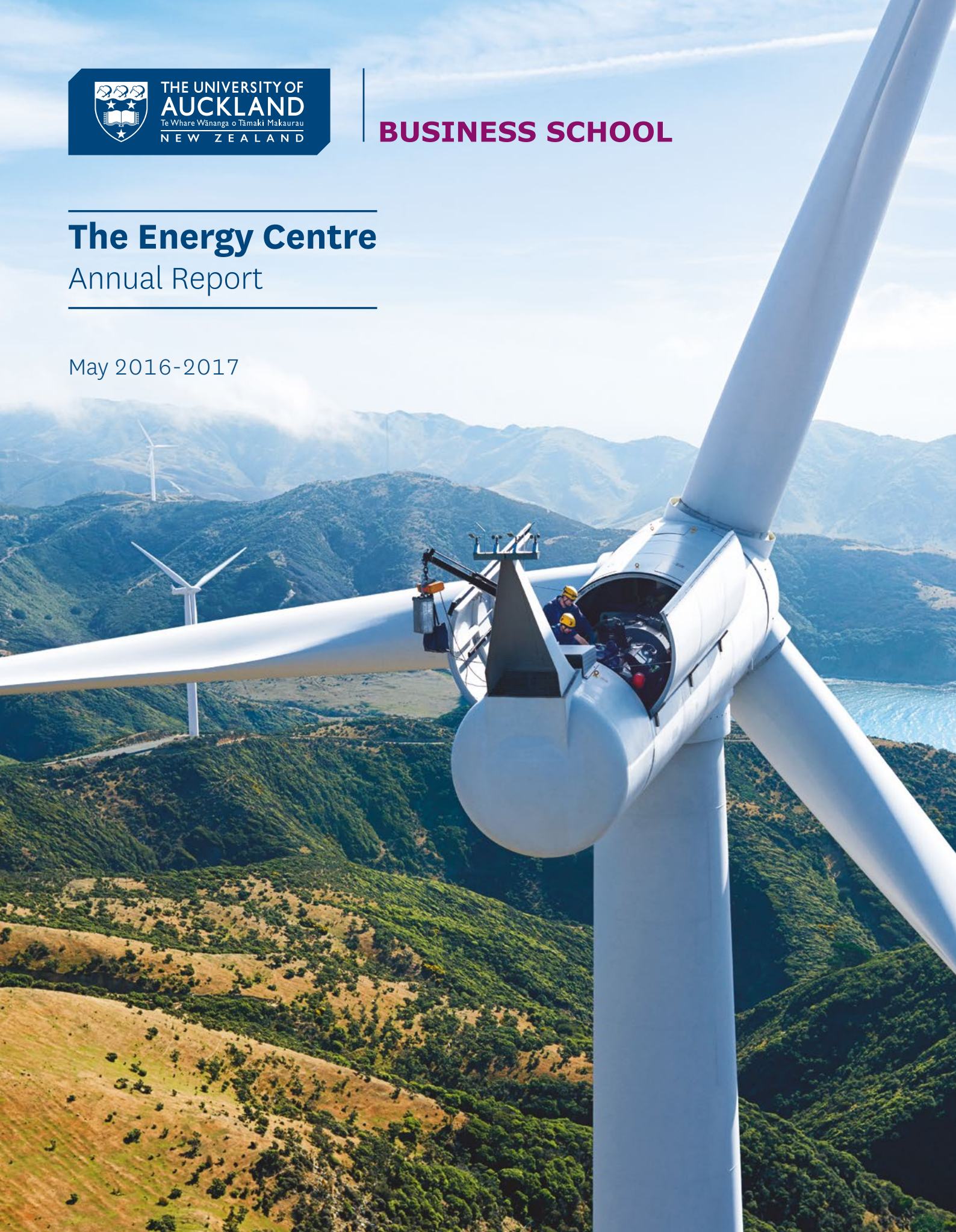
THE UNIVERSITY OF
AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

BUSINESS SCHOOL

The Energy Centre

Annual Report

May 2016-2017



Annual Report to The Energy Education Trust of New Zealand

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Introduction

The Energy Centre aligns its programmes with the following strategy:

- Undertake independent research and business and policy analysis on energy related issues important to New Zealand's future
- Carry out research that is cross disciplinary, drawing upon as appropriate, economics, engineering and the physical, environmental and social sciences
- Act as a bridge for open and informed dialogue between the energy industry, government and the community
- Provide energy related education that creates future leaders for academia, business and government

The Centre's programme draws on, and benefits from, the enthusiasm and expertise of numerous individuals across campus. We acknowledge the following sustained contributions:

- **Bart van Campen** (Engineering Science)
- **Dr Tony Downward** (Engineering Science)
- **Anna Berka** (Research Fellow)
- **Dr Julie MacArthur** (Political Studies)
- **Professor Mark Greer** (Dowling College, USA)
- **Dr Stephen Poletti** (Department of Economics)
- **Dr Mingyue Sheng** (Research Fellow)
- **Dr Kiti Suomalainen** (NZEET, Post-Doctoral Fellow)
- **Dinah Towle** (Business School)
- **Dr Le Wen** (Research Fellow)
- **Associate Professor Golbon Zakeri** (Engineering Science)
- **Vincent Wang** (Research Assistant, School of Environment)

Staff updates

Anna Berka, Research Fellow, is completing her PhD thesis, inclusive energy governance and the costs and impacts of community energy, at the University of Helsinki, Finland.

Bart van Campen contributed to an MFAT/NZAID project, Geothermal Capacity Building in Indonesia, from October 2016 to March 2017.

Kiti Suomalainen completed her post-doctoral position with the Centre to take up a Post-Doctoral position at the University of Otago. Kiti continues on a part-time basis, working on the Auckland solar project through September 2017.

Le Wen, Research Fellow, is continuing her research into the seasonal and spatial effects of wind generation on electricity prices.

Selena Sheng recently completed her PhD in transport economics. Selena collaborates with the Transport group in the Faculty of Engineering. Her research focuses on transport mode choice, impact of urban design and intelligent transport systems.

Stephen Poletti returned from research and study leave to resume teaching in Semester Two, 2016.

Vincent Wang, Research Assistant, School of Environment, is assisting with development of a web map tool for public access to the Energy Centre's solar potential assessment results.

The Centre hosted visits from:

- **Steve Heinen**, a doctoral student at the University College of Dublin during Semester Two in 2016.
- **Yishuai Ren**, a PhD candidate from the Business School of Hunan University, Hunan, China, continued his research at the Energy Centre. His visit is funded by the China Scholarship Council.

Harry Masters, an Energy Centre Summer Research Scholar from La Trobe University, Melbourne has completed his study of the economic value of water in New Zealand.

Three PhD candidates are working on energy related topics that are applied and relevant to New Zealand. Each student has opted to present their thesis research with publications; with an expectation that three potentially publishable papers will be submitted to international journals.

Postgraduate research

BCom Honours

Harry Kelyer, Impact of Storage and Embedded Generation on Local Electricity Markets (Supervisor: Basil Sharp).

PhD research in progress

Mina Bahrami Gholami, The impact of large solar and wind generation on the New Zealand electricity market (Supervisor: Stephen Poletti)

Mina's thesis examines opportunities for, and impacts of, inserting solar generation into the New Zealand electricity market. Different scenarios of renewable electricity development are used to simulate the impact of power market on electricity prices.

Milad Maralani, Potential Impact of Industrial Energy Savings on the New Zealand Economy (Supervisors: Basil Sharp and Golbon Zakeri).

Milad has completed an economic model showing the impact of technological change on energy consumption. The thesis follows on from his research into the economic impact of electricity conservation at the Tiwai Point smelter.

Mahsa Moshrefi, Energy Efficiency and Energy Policies (Supervisors: Basil Sharp and Erwann Sabai)

Mahsa's first paper provides estimates of the impact of energy mix on efficient energy consumption in 28 OECD countries. Countries with a higher share of renewables in their energy supply also tend to use energy more efficiently. Her second paper estimates efficient consumption in end-use sectors of the economy.

PhD completions

Sina Ahmadzadeh Maschinchí, Energy-Environment-Economy Modelling (Supervisors: Basil Sharp and Stephen Poletti)

In July 2016, Sina presented his research paper on Environmental Tax Reform (ETR) and New Zealand Economic Performance: Modelling with E3ME to the Annual Conference of New Zealand Economists in Wellington. This paper, co-authored with Basil Sharp and Stephen Poletti, was Winner of the 2016 New Zealand Economic Policy Prize, deemed to have made the best contribution to analysis of economic policy in or applied to New Zealand. This paper analyses potential environmental and macroeconomic impacts of environmental tax reform in New Zealand using a global macro-econometric model that links the world's economies to their energy systems and associated emissions.

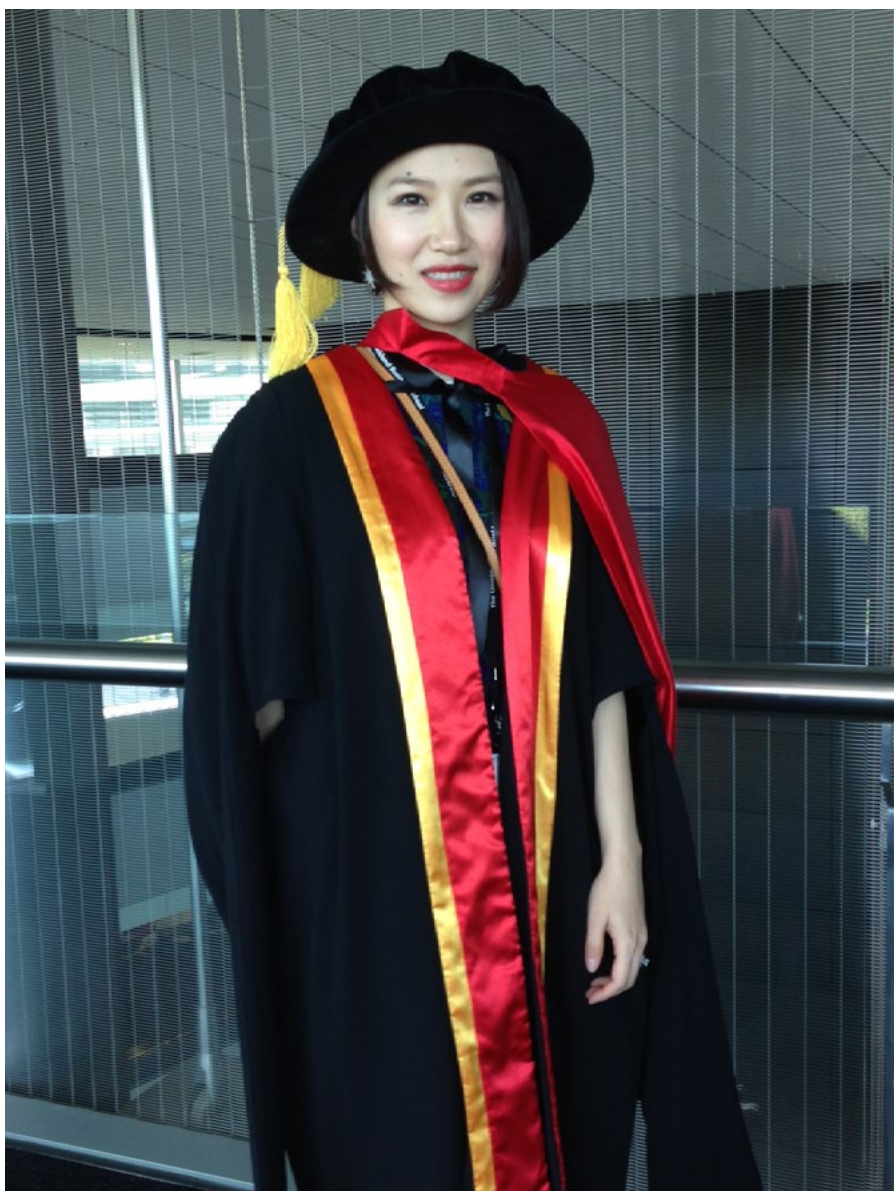
A number of different scenarios investigated the performance of the New Zealand emissions trading scheme (ETS) and other complementary mitigation policies over commitment period 2021-2030. Higher carbon prices, especially in the early years, would be necessary to achieve the ambitious GHG emissions target in New Zealand. The results also suggest that a combined ETS and carbon tax approach with revenue recycling could lead to significant economic benefits. A double dividend effect could be achievable, if government recycles the revenues from carbon taxes efficiently.

Yue (Bonnie) Wang, Analysis of impact on New Zealand's Economy of the New Zealand Emissions

Trading Scheme (Supervisors: Basil Sharp, Stephen Poletti, and Golbon Zakeri)

Bonnie developed a computable general equilibrium (CGE) model to assess the impacts of the ETS on the New Zealand economy. This model includes a forestry sector that determines optimal forest rotation age, timber yield and carbon sequestration. The forest sector becomes the sole source of carbon credits to other sectors within the economy requiring credits to cover their emissions. Under this scenario, the price of carbon is around NZ\$25 per tonne. Bonnie was a runner-up at the Joint Graduate School in Dairy Research and Innovation Seminars in June 2016.

Selena Sheng



Achievements 2016-2017

Programmatic achievements through May 2017 are listed below against Key Performance Indicators (KPI) in Appendix A. The impact of Energy Centre activities is presented in Appendix C. Impact has been defined as “contribution to, and beyond academia, involving interactions with internal and external stakeholders for the mutually beneficial exchange of knowledge and understanding of issues and challenges facing the energy industry, government and community”.

Peer reviewed articles

Batstone, S., G. Pritchard and G. Zakeri. Non-invasive test scheduling of the grid over live electricity markets, *Interfaces* 2016.

Berka, A. A comparative analysis of the costs of onshore wind energy: is there a case for community specific support? *Energy Policy*, 2016.

Berka A., Berka J., Roberts D., Phimister E., Msika J. A comparative analysis of the costs of onshore wind energy: Is there a case for community-specific policy support? *Energy Policy*, 2017.

Flores-Quiroz, A., R. Palma-Behnke, G. Zakeri and R. Moreno. A column generation approach for solving generation expansion planning problems with high renewable energy penetration, *Electric Power Systems Research*, 2016.

Suomalainen, K., V. Wang, B. Sharp, *Rooftop solar potential based on LiDAR data: Bottom-up assessment at neighbourhood level*, Journal of Renewable Energy, 2017.

Wu, A. Philpott and G. Zakeri. Investment and generation optimization in electricity systems with intermittent supply, *Energy Systems*, 2016.

Zakeri, G., J. Khazaei and S. Oren. Single and Multi-settlement Approaches to Market Clearing under Demand Uncertainty, *Operations Research*, 2016.

Working papers

Energy Centre has registered with EDIRC network (Economics Departments, Institutes and Research Centres in the World) <https://edirc.repec.org/> enabling staff to contribute and have access to working papers from an international database used by over 13,789 institutions in 231 countries.

Berka A., and E. Creamer. *Taking stock of the local impacts of community energy: a review and research agenda*.

Gholami, M., S. Poletti, G. Pritchard and G. Zakeri. *Solar PV in a Hydro-based Grid- A New Zealand case study*.

Poletti, S. and J. Wright, *Real-Time Pricing and Imperfect Competition in Electricity Markets*.

Sheng, S. and B. Sharp. *Aggregate Road Passenger Travel Demand in New Zealand*.

Sheng, Mingyue Selena and B. Sharp. *The Influence of Urban Forms on Transit Behaviour in the Auckland Region*.

Wen, L. and B. Sharp. *The Spatial Analysis of Wind Generation on Nodal Prices in New Zealand*.

Presentations

Berka A., *Taking stock of the local impacts of community renewable energy: a review and research agenda*, OERC Seminar, Dunedin, October 2016.

Downward, A. *Electricity markets and renewable integration*, Curso-Seminario Desafios Energéticos, University of Chile, 19 January 2017.

Gholami, M. and S. Poletti, *Solar, Wind, and Market Power in a Hydro Based Grid*, 39th IAAE conference, Bergen, 19-22nd June, 2017

MacArthur, J. *Community Power Policies in Canada and the United Kingdom*, IPSA World Congress of Political Science, Poznan Poland, 23-28 July 2016.

MacArthur, J. *The impact of free trade on renewable energy policy design*, New Zealand Political Studies Association Annual Conference, Hamilton, University of Waikato, November 2016.

MacArthur, J. and S. Sewerin. *Renewable Energy Policy Dismantling in Aotearoa/New Zealand*, Australia and New Zealand Public Policy Network Conference, Flinders University, Adelaide, 30 January- 2 February 2017.

Maralani, M. and B. Sharp. *The Potential Impact of Industrial Energy Savings on The New Zealand Economy*, EcoMod Conference, Lisbon, Portugal, July 2016.

Mashinchi, S. *Environmental Tax Reform (ETR) and New Zealand Economic Performance: Modelling with E3ME*, Association of New Zealand Economists. The paper was co-authored with Basil Sharp and Stephen Poletti, July 2016.

Poletti S. and J. Wright, *Welfare Implications of Consumers Switching to Real Time Pricing Plans with Imperfect Competition in Electricity Markets*, 1st IAAE International Eurasian conference, Baku, August 28-31st, 2016.

Sharp, B. *Integrating Renewable Sources of Electricity*, University of Auckland Research Excellence Forum, 8 June 2016.

Sharp, B. *Sustainability Dialogue*, the University of Auckland, Business School, 26 July 2016.

Sharp, B. *The economic impact of flooding and liquefaction, energy efficiency, and the integration of renewable sources of energy*, University of Auckland Business School's Ballot Box Series: Auckland – The Sustainable City, September 2016.

Sharp, B. *New Zealand's Renewable Electricity Market: Evolution and Innovation*, Invited Presentation, The 7th Asia-Pacific Innovation Conference (APIC 2016), Fukuoka, Japan, November 2016.

Sharp, B. *New Zealand's Electricity Market: Production and Innovation*, Round Table Discussion, The 7th Asia-Pacific Innovation Conference (APIC 2016), Fukuoka, Japan, November 2016.

Suomalainen, K., V. Wang, B. Sharp, *Rooftop solar potential based on LiDAR data: an Auckland case study*, Otago Energy Research Centre Seminar Series, 4 May 2017.

Van Campen, B., J. Lawless, S. Darm, and J. Randle. *Can geothermal regulation enhance technical innovation and promote the geothermal roadmap – Case studies from NZ and Indonesia*, Conference Paper Indonesian International Geothermal Conference (IIGCE-2016); Jakarta, August 2016.

Van Campen, B. and H. Petursdottir. *Geothermal Sustainability Regulation in Iceland and New Zealand*; Conference Paper European Geothermal Congress 2016, Strasbourg, France, September 2016.

Van Campen, B., and R. Archer. *Geothermal Resource Management and Reporting: Learning from (NZ) Petroleum Regulator Experience*; Conference Paper European Geothermal Congress 2016, Strasbourg, France; October 2016.

Van Campen, B., P. Sanchez-Alfaro, S. Puschel-Lovengreen and P. Dobson. *Geothermal Costs and Policy Impacts in Chile and Latin America*. New Zealand Geothermal Workshop, Auckland, November 2016.

Van Campen, B., J. Lawless, J. Randle and S. Darma. *Can Geothermal Regulation Enhance (Technical) Innovation - Evidence and Case Studies from NZ and Indonesia*. 38th New Zealand Geothermal Workshop, Auckland, November 2016.



Photo: Chris Sisarich

Van Campen, B., P.Carvajal, A. Prieto, A.Akamine. *Opening New Frontiers for Geothermal Generation in Colombia, Peru and Ecuador: Resource, Regulation & Capacity Building*. 38th New Zealand Geothermal Workshop, November 2016.

Van Campen, B., P.Sanchez-Alfaro, S.Puschel-Lovengreen, P.Dobson: *Geothermal Costs and Policy Impacts in Chile and Latin America*. New Zealand Geothermal Workshop, Auckland, November 2016.

Wen, L and B. Sharp, *Effect of Wind Power on Nodal Prices in New Zealand*, Cambridge Econometrics, University of Cambridge, 15 June 2016.

Research seminars

The following research seminars enabled staff and colleagues to share and discuss their research:

- *A revenue adequate, cost recovering uniform pricing mechanism for wind*, Golbon Zakeri, 26 May.
- *Analysing Big Data on Smart Meters*, Agate Ponder-Sutton, Massey University, 13 July.
- *The Spatial Analysis of Wind Power on Nodal Prices in New Zealand*, Le Wen, 18 August.

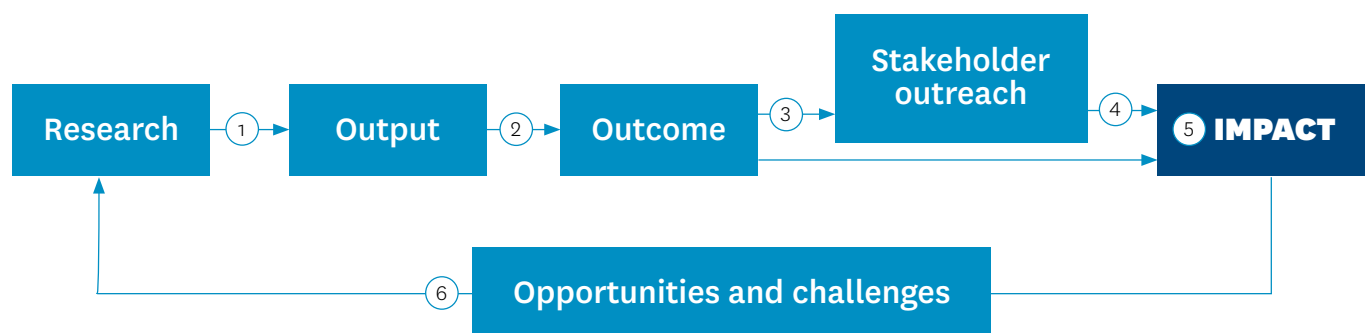
- *Rooftop solar potential with LiDAR data – update and future research opportunities*, Kiti Suomalainen, 22 September.
- *The impact of large solar and wind generation on the New Zealand electricity market*, Mina Bahrami Gholami, Energy Centre, 19th October.
- *Empowering Electricity? Understanding the promises and pitfalls of community renewables*, Julie MacArthur, 23 November.
- *Residential space heat electrification in a system with high penetration of wind - A planning analysis* by Steve Heinen, visiting from the University College of Dublin, 14 December.
- *Aggregate road passenger travel demand in New Zealand* by Mingyue Selena Sheng, 22 March.
- *Energy Storage Solutions for Networked and Distributed Power Systems*, Edward Lyons, 26 April.

Business School Award

The Energy Centre received the inaugural award for its contributions to 'Productivity and Sustainability'. The citation follows:

Led by Professor Basil Sharp, the Energy Centre was founded in 2004 and has established itself as the go-to centre for analysis of the economics and sustainability of New Zealand's energy resources. It has been an exemplar of how centres can work with industry partners and, in so doing, generate the external funding they need to support a critical mass of PhD students and research fellows. It has also been an exemplar of inter-faculty cooperation, building particularly strong links with the university's School of Engineering, but also with its Faculty of Science and with a network of related research centres around the world. In recent times, the Energy Centre has generated important publications, both academic and policy-related, that contribute to our understanding of the cost-efficiency of dairy farming, the role of royalties in the development of geothermal energy, the impact of wind and hydro resources on electricity demand and pricing, and the solar potential of Auckland city. Please join me in congratulating Professor Basil Sharp and his colleagues in the Energy Centre on their strategic impact in a field of great importance to our economy and society.

Energy Centre Research Impact Assessment



- ① Research findings (publications, presentations)
- ② Communications and interactions
- ③ Skills and knowledge level enhancement
- ④ Feedback from stakeholders
- ⑤ Influence - business, society, public policy
- ⑥ Opportunities and challenges

Notes on time-lags:

(Excerpted from Engagement and Impact Assessment Consultation Paper, Australian Research Council, 2016.)

"It has been estimated that the average time for translating research in the biomedical and health sciences into societal benefit is 17 years".

(Slote Morris, Z., Wooding, S. & Grant, J, 2011. *"The answer is 17 years, what is the question: understanding time lags in translational research"*, Journal of the Royal Society of Medicine, 104 (12), pp. 510-520.

"Other analyses have found shorter periods for the realisation of research impact – with a review of the REF (UK's Research Excellence Framework 2014 – a national assessment of research impact) impact case studies estimating 'three to nine years for research to have an impact on society' ". Kings College London and Digital Science, 2015, *The nature, scale and benefits of research impact*, p. 45.

International network and collaboration

The Centre's programme on renewables (wind, geothermal, hydro and solar) and market design continues to provide a solid foundation for research informed contributions to our international collaborators. In addition to providing opportunities for research, participation in these networks has contributed to growth in inquiries for post graduate research in the Centre.

Energy Research Institute Network (ERIN)

Basil Sharp contributed to an ERIN funded project Integrative Strategy and Policies for Promotion of Appropriate Renewable Energy Technologies in Lower Mekong Basin Region. The project report is now available on the Economic Research Institute for ASEAN and East Asia's website.

www.eria.org/RPR_FY2015_21.pdf

ERIA Research Project Report 2015, No. 21 Integrative Strategy and Policies for Promoting Appropriate Renewable Energy Technologies in Lower Mekong Basin Region With Special Focus on Vietnam, P115. Edited by Venkatachalam Anbumozhi Nguyen Anh Tuan.

Business NZ Energy Council

Collaboration with the Business NZ Energy Council was discussed with Dr Steve Batstone and John Carnegie. The proposal is to have the Energy Centre maintain and develop the Council's modelling tool described at:

www.bec.org.nz/projects/bec2050

Collaborative Research bids

Two collaborative bids were submitted to MBIE:

Economic opportunities and environmental implications of energy extraction from gas hydrates

Funding requested (pa) \$ (excluding GST)
\$1,533,918 (\$7,669,590 total over five years)

Because the gas hydrate system is an important factor in determining the stability, chemistry and biology of seafloor environments, these recent developments mean there is an urgent need to evaluate the potential environmental impacts of producing natural gas from or beneath gas hydrates. Similarly, there is a need to understand socioeconomic implications of gas hydrate production in New Zealand. Such considerations should take into account opportunities for, and concerns of, Māori and the wider public amid future energy markets in the transition to a lower-carbon energy landscape. Using study sites on New Zealand's Hikurangi margin, we have defined four research aims that address these needs: Determine New Zealand-specific frameworks (geological and economic) for energy production from (and through) gas hydrates;

Predict the geo-mechanical responses at the seafloor and wellbore induced by production drilling; Investigate the impact that changes in seafloor stability and/or methane flux could have on marine ecosystems; and Incorporate Vision Mātauranga and deliberative community engagement into gas hydrate science to explore potential for growth of Māori economies and broad socioeconomic implications of resource extraction. By addressing these aims we will describe the economic opportunities, balanced with environmental and societal implications, of producing energy from (or through) gas hydrates in New Zealand.

Lead partner: Geological and Nuclear Science (GNS)

Development of robust IPT pavement systems for electric vehicles

Funding request (pa) \$2,365,191.00 (excl. GST)
(\$11,825,955.00 total over five years)

New Zealand is going electric. The Government has set a target of 64,000 electric vehicles on the road by 2021, doubling every year. The benefits are clear: no vehicle emissions, clean air, low noise cars running on renewable energy. But uptake is held back by "range anxiety" – the fear that a purely electric vehicle will run out of charge before journey's end. This is a reasonable concern, since the first EVs have had a restricted range.

The research addresses both these issues by proposing charging roadways – inductive power transfer from the road to the vehicle while it is stationary or moving. This is challenging research. Although it builds on NZ's world-leading IPT expertise, it requires clever science to develop new magnetic materials that can withstand being buried in the road surface and still deliver sufficient power to the cars above, 10- 30 cm away, through asphalt surfacings; and last for 10-15 years.

Lead partner: Faculty of Engineering



Photo: Chris Sisarich

Outreach



ENERGY MATTERS 2017
The University of Auckland Business School | Energy Centre Speaker Series

Dear (XXXXX_NAME),

Please join me for the first event in this year's series featuring Mark O'Malley, Professor of Electrical Engineering at University College Dublin (UCD) and a recognised world authority on energy systems integration and in particular grid integration of renewable energy.

Supply demand balance in an Integrated Energy System

As energy systems have evolved from small isolated simple energy systems into continental scale integrated energy systems, the supply demand balance principle is a fundamental law underpinning and shaping their evolution. In an integrated energy system, supply demand balance is across all energy centers (e.g. heat, fuel, electricity) across scales/infrastructure (e.g. gas, heat, electricity networks) with and/or without storage capability and with all the consequential losses.

In particular the demand side in an integrated energy system is no longer seen as a single consuming entity but rather as an entity that potentially can derive an energy service from a choice of energy centers (e.g. hybrid cars), can self-supply (e.g. photovoltaics) can supply others and can store energy for later use. This trend is gaining traction but the direction of travel and the end result is very unclear. The component parts of this uncertainty are regulatory, economic, political and technological.

Mark will discuss the potential role of demand and/or storage in a future integrated energy system, share research results, and highlight the need for a more comprehensive, inter-disciplinary, international and collaborative research and demonstration programme.

About Mark O'Malley

Mark is the Professor of Electrical Engineering at University College Dublin (UCD), founding Director of the Electricity Research Centre and Director of the UCD Energy Institute, a multidisciplinary multi-institutional, industry supported research activity.

He is a Member of the Royal Irish Academy and a fellow of the Institute of Electrical and Electronic Engineers. Mark is recognised as a world authority on energy systems integration and in particular grid integration of renewable energy. He has active research collaborations in Europe, the United States and China, is Director and co-founder of the International Institute for Energy Systems Integration, and co-ordinator of the European Energy Research Alliance Joint Programme in Energy Systems Integration.

Register here

Please register online by 15 March 2017.

Event details

Speakers: Professor Mark O'Malley

Date: Thursday 16 March 2017

Time: 6pm for a 6.30pm start
Light refreshments will be served at 6pm
Approximate end time 7.45pm

Venue: The University of Auckland Business School
Lecture Theatre 1000B
Level 10, Owen G. Glenn Building, 12-14 Whitson Road, Auckland.

Other Business School events

[f](#) [t](#) [i](#) [o](#) [u](#)

Energy Matters

Energy Matters 2016-17 built on last year's theme of renewable electricity.

The future of electricity generation and consumption: Centralised, decentralised and hyper-connectivity

Dr Lawrence Jones, Edison Electric Institute, Washington, USA, 5 October 2016

Over 130 people registered for the event, the majority being from industry. On 4th October, Dr Jones gave a presentation directed at 30 public sector attendees co-hosted by the Ministry of Business, Innovation and Employment in Wellington.

Dr Jones highlighted international energy market developments, the role of policy and the challenges facing markets with the emergence of digital technology.

Supply demand balance in an Integrated Energy System

Professor Mark O'Malley, University College of London, 16 March 2016

Professor O'Malley discussed the potential role of demand and/or storage in a future integrated energy system, sharing research results, and highlighting the need for a more comprehensive, inter-disciplinary, international and collaborative research and demonstration programme.

The event attracted over 120 registrants with a good mix of industry and academia many of whom participated in lively debate.

During his visit, Professor O'Malley met with members of the Labour Party, senior executives of the Electricity Authority and Transport; and presented a seminar on Energy Systems Integration, co-hosted by Business NZ Energy Council, to over 30 industry members.



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In this issue

Water is a precious resource - acknowledgement by the Energy Centre on World Water Day, 22 March 2017

What's happening in emerging nations regarding renewable energy investments

Why the future belongs to decentralised renewables, not centralised hydrogen and mega-scale nuclear

Energy Matters: Supply demand balance in an integrated energy system

March 2017

Water is a precious resource - acknowledgement by the Energy Centre on World Water Day, 22 March 2017

Subscribe

Opinion pieces

The following articles:

- *Why a market for water-use rights makes sense*, B. Sharp, the University of Auckland Business School Monthly Newsletter, June 2016.
- *The power of power*, J. MacArthur, Faculty of Arts News, the University of Auckland, 30 June 2016.
- *A generation of lost opportunity*, B. Sharp, The New Zealand Herald, 11 July 2016.
- *NZ plugs into the renewable movement*, featuring B. Sharp, *Sunday Star Times*, 3 July 2016.
- *Carbon tax could lower emissions and GST*, Sina Mashinchi, the University of Auckland Uninews, July.
- *Nuclear's role in our low-carbon future*, B. Sharp, the University of Auckland Business School Monthly Newsletter, November 2016.
- *Carbon taxes and the NZ economy*, featuring Sina Mashinchi, Greater Auckland website, 17 November 2016.

e-Horizons

The Energy Centre circulated 3 editions of e-Horizons (July, December 2016 and March 2017). The newsletter is circulated to a growing number of over 1,700 subscribers worldwide, mostly from New Zealand, Australia, UK, USA and China. The most popular articles were:

- *Water is a precious resource*, Professor Basil Sharp, YouTube video.
- *Simulation brings global 100% renewable electricity system alive for the first time*, Lappeenranta University of Technology.
- *Toyota vs Tesla - can Hydrogen Fuel-Cell Vehicles compete with electric vehicles?*, Energy Post.
- *Solar power is contagious. These maps show how it spreads*, Vox.

Generating Ideas

Four e-posters were displayed on the Level 1 LED screen (seen by 115,000 visitors per week), TV screens located on each floor of the Business School and made available for download on our website. These posters promote good environmental practice in the University and offer soundbite energy-relevant facts about New Zealand. The posters are available for download on the Energy Centre website.

- Solar, June 2016
- Electricity use, September 2016
- Wind, November 2016
- Hydro, March 2016

Did you know?

**OVER THE LAST TWO YEARS,
THE NUMBER OF SOLAR POWER
CONNECTIONS IN NEW ZEALAND
HAS MORE THAN TRIPLED TO 9606.**

*Electricity Market Information

Sustainable energy:
good for you, good for the environment

Energy Centre **Generating Ideas**




Did you know?

**RENEWABLES ARE THE FASTEST
GROWING ENERGY SOURCE TODAY.
WIND SUPPLIES OVER 5% OF
NEW ZEALAND'S ELECTRICITY DEMAND*.**

*Ministry of Business, Innovation and Employment

Sustainable energy use:
good for you, good for the environment

Energy Centre **Generating Ideas**




Did you know?

**MORE THAN HALF OF NEW ZEALAND'S
ELECTRICITY IS FROM HYDRO GENERATION,
GIVING OFF NO GREENHOUSE GASES*.**

*Energy Efficiency and Conservation Authority

Sustainable energy:
good for you, good for the environment

Energy Centre **Generating Ideas**




Did you know?

**LEAVING A PROJECTOR ON OVERNIGHT
IN THE BUSINESS SCHOOL USES
UP THE SAME ENERGY AS
100 LIGHT BULBS!***

*Business School Techsite

Sustainable energy:
good for you, good for the environment

Energy Centre **Generating Ideas**




World Environment Day, 6 June 2016

The Energy Centre marked World Environment Day with a poster highlighting water as being one of New Zealand's most valuable assets.

Our comments focused on the deterioration of water quality and uneven distribution of rainfall throughout New Zealand suggesting the need to set sustainable limits for water use; maximise the economic benefits of use and improve water quality innovatively.

World Water Day, 22 March 2017

The campaign to acknowledge World Water Day included production of a two minute YouTube clip featuring Basil Sharp commenting on the economic value of water in New Zealand having received over 1,100 views. This was accompanied by a poster circulated to Energy Centre stakeholders and also featured on the international events map on the World Water Day website.

Both posters for World Environment Day and World Water Day were circulated electronically to over 2,000 internal and external stakeholders and displayed in the Business School atrium to an



audience of over 115,000 weekly visitors.

Energy Economics Summer School 28 February-2 March 2017

The 2017 Energy Economics Summer School 28 February-2 March, newly formatted into four days. Over 60 participants registered with an increasing number of industry attendees. The week's lectures culminated in group discussions on civil ownership models in New Zealand, with

participants presenting individual case studies to the audience. Feedback from the evaluations confirmed participants found the four days beneficial, with diverse, topical learnings about the different aspects of the energy sector with a good mix of academic and industry content. In particular, students appreciated the opportunity to gain first-hand knowledge from industry speakers; and participants from industry benefited from the diverse range of topics and depth of knowledge offered.



Renewable Energy Project Management May 2017

Twenty participants from ASEAN countries will attend a two-week long course on renewable energy. Attendees are sponsored by MFAT and employed by energy agencies in their respective countries. Basil Sharp contributed a four-hour session on the economics of renewable energy, May 11.

Website

Analytics of the Energy Centre website show 'The Summer School' page as being the most popular, followed by 'Energy Matters Series'. Recent updates to the website have included journal articles and a media section.

Education

The Centre contributed to the following courses:

CIVIL770 Transport System Economics (Selena Zhang)

ENG721 Resources (Stephen Poletti, Basil Sharp, Bart Van Campen)

ECON 372 Energy Economics (Stephen Poletti)

Plans for 2017-18

Research

Civic and community energy

A new thematic strand at the Energy Centre focusses on the comparative costs, local impacts and governance of community-owned renewable energy projects in the context of a broader renewable energy transition, as well as the occurrence and feasibility of these ownership models in New Zealand. It is currently led by Anna Berka and Julie MacArthur, and enabled by a three-year Marsden Grant won by Julie MacArthur.

Solar

Kiti Suomalainen continues to lead the Centre's project assessing the solar potential of Auckland City assisted by Vincent Wang who is currently developing a platform and tool to link the solar potential to street addresses. This will allow home owners to investigate the relative merits of investing in solar and will be made available to the public on the Energy Centre website.

Basil Sharp is working on a proposal "Polynesian pathways to a future without electricity grids" with NZ Institute of Economic Research. The bid into MFAT builds on earlier initiatives to replace diesel generated electricity with solar. A number of island states are investing in solar; the challenge of grid asset management remains.

Transport

Selena Sheng's research focus for 2017 will be on spatial modelling and intelligent transport

systems. Her current working papers are: commuter's transport mode preferences and network effects; influence of urban forms on transit behaviour in the Auckland region; and, policy instruments for an environmentally sustainable road transport network. Selena collaborates with the Faculty of Engineering and Auckland Transport. The results from her research will contribute to an assessment of the energy implications of current transport practice and provide insights into the development of future transport projects, including smart transport systems.

Wind

The Wind Energy Association is expecting wind to contribute up to of 20 percent of New Zealand's electricity supply in the near term. Le Wen's research into the seasonal and spatial effects of wind generation on electricity prices are relevant to investment analysis and market design. The spatial impact is of particular interest as an increase in wind generation at a given site leads to a decrease in price at the point of injection into the grid and spills-over to put downward pressure on prices at other nodes.

Cross-faculty engagements

On the research front, the Centre will continue its collaborations with the Faculty of Engineering, particularly in transport. Deeper engagement will depend on the outcome of the funding proposal with MBIE.

GIS has become a critical component of applied research (wind, transport and solar) and we expect to continue collaborations with the School of Environment.

Teaching into Faculty of Engineering courses (CIVIL770 and ENG721) will continue.

Critical success factors for 2017-18 are listed in Appendix A.

Outreach

Energy Matters will continue through May 2018. Our September 2017 speaker, Professor John Mathews from Macquarie University will be presenting on energy and resources.

In 2018 we are proposing smart transport as a theme for Energy Matters.

Education

Course offerings in Energy Economics within the Department of Economics will continue as for 2017 and at least two PhD completions are anticipated.

Case competition

The Centre is planning to run a student competition, in collaboration with the Management Consulting Club, 31 July 2017. The proposed topic is Market Design for Integrating Solar in the Network.



Appendices

Appendix A: Key Performance Indicators

Outcomes against critical success factors and key performance indicators

Programme	CSF	KPI	
Research	Applied research projects	2 project reports	A
	Cross faculty engagement	2 cross disciplinary projects	A
	Peer reviewed articles and reports	2 papers in ranked journals	A
	Academic workshops	2 workshops	A
	Conference presentations	3 presentations	A
	Public forums	2 public forums	A
Education	Courses in energy economics	3 courses in energy economics	A
	Summer School	70% satisfaction level	A
	PG completions	2 honours and 2 PhDs	NA
	Teaching into Masters of Energy	Enrolments in energy economics	A
Outreach	Public seminars	At least 4 presentations	A
	Herald opinion pieces	2 submissions	A
	Newsletter	4 newsletters	A
	Network	2 ERIN meeting	A
Admin.	Meeting with EETNZ	4 meetings	A

A = achieved, NA = not achieved

Critical success factors and key performance indicators for 2017-2018

Programme	CSF	KPI
Research	Applied research projects	4 project reports
	Cross faculty engagement	2 cross disciplinary projects
	Peer reviewed articles and reports	4 papers in ranked journals
	Academic workshops	6 workshops
	Conference presentations	6 presentations
	Public forums	2 public forums
Education	Courses in energy economics	3 courses in energy economics
	Summer School	70% satisfaction level
	PG completions	2 honours and 2 PhDs
	Teaching into Masters of Energy	Enrolments in energy economics
Outreach	Public seminars	At least 4 presentations
	Herald opinion pieces	3 submissions
	Newsletter	4 newsletters
	Network	2 ERIN meeting
Admin.	Meeting with NZEET	4 meetings

Appendix B: Summer School 2016 Programme

	Monday 22 February	Tuesday 23 February	Wednesday 24 February	Thursday 25 February	Friday 26 February
Venue	Level 0, 040	Level 0, 040	Level 0, 040	Level 3, 310	Level 3, 310
9:00-9:45am	Registration	Wind - Kiti Suomalainen , Energy Centre	Auckland Transport - Peter Clark , Auckland Transport	Solar - Kiti Suomalainen , Energy Centre	
9:45-10:30am	NZ Energy Basil Sharp , Energy Centre	Wind Eric Pyle , NZ Wind Energy Association	Electricity Contract Markets Emily Calvert , NZX Ltd	Battery Storage Edward Robinson and Jonathan Bishop , Vector	COP 21 Paris Barry Coates , University of Auckland
10:30 - 11:00am Morning tea					
11:00 - 11:45am	Oil Markets Basil Sharp	Geothermal Energy Bart van Campen , Energy Centre	Demand side management Lesley Stone , University of Auckland	ABB Infrastructure Kumail Rashid	Energy futures John Carnegie , NZBUS
11:45am - 12:30pm	Oil and Gas Exploration Basil Sharp	Geothermal Industry Mike Allen , Geothermal NZ	Demand side management Milad Maralani and Basil Sharp	Group Projects	Green Growth Rod Oram
12:30-1:30pm Lunch					
1:30 - 2:15pm	Overview of Electricity Market - James Tipping , Trustpower	Gas Markets Bart van Campen , Energy Centre	Lab. Nos 1 (Rm 004) and 5 (016)	Group Projects	Group Presentations 1.30-3pm
2:15-2:30pm	Afternoon tea	Afternoon tea	Simulation game Tony Downward	Afternoon tea	
2:30-3:15pm	Overview of Electricity Market - James Tipping , Trustpower	Electricity market structure and models Tony Downward , Energy Centre		Group Projects	
3:15-4:00pm		Issues in electricity market modelling Golbon Zakeri , Energy Centre			Refreshments 3-4pm
4.00pm	Finish	Finish	4-5pm Refreshments	Finish	Finish

Appendix C: Impact Assessment

Strategic Themes	Outputs	Outcomes	Impacts	
Applied research Undertake independent research and business and policy analysis on energy related issues important to New Zealand's future	7 journals articles 6 working papers 23 presentations at conferences	Successful submissions to leading international journals and conferences; increased engagement through applications relevant to business and policy.	Contributions to discipline, connecting with business and community, strengthening agency capability and improved public policy decision-making	●
Cross disciplinary Carry out research that is cross disciplinary, drawing upon as appropriate, economics, engineering and the physical, environmental and social sciences	Membership of cross disciplinary teams at UoA, Pacific, Indonesia, Southeast Asia, MBIE bids	Invitations by Faculty teams within the University & research units outside the University to collaborate on research projects	Demonstrated synergies from contribution of economics and policy analysis to engineering and science	●
Outreach Act as a bridge for open and informed dialogue between the energy industry, government and the community	3 requests for assistance from industry & academia 7 opinion pieces 3 x e-Horizon newsletters Expansion of website	Growing public perception of Centre as source of independent and forward focussed research and inquiry. Business School Award for contributions to 'Productivity and Sustainability'	Contribution to energy initiatives in NZ and abroad Invitations by Genesis & NZWEA Improved relevance to energy research programmes at other universities Increased awareness of imminent changes in the energy sector 'over the horizon' Validation of EC effectiveness within UoA	●
Education Provide energy related education that creates future leaders for academia, business and government	3 courses in Energy 2 PhD completions 2 Energy Matters 9 internal research seminars 2 international visiting students 93% satisfaction level from Summer School attendees	Recognised relevance of the role of energy in society within University curricula and the broader community.	Skill and knowledge level improvement Rise in educational attainment within energy industry	●

● achieved ● in progress ● not achieved





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The University of Auckland Business School gratefully acknowledges the Energy Education Trust of New Zealand for their support of tertiary education and research in disciplines relevant to New Zealand's present and emerging energy needs.

The largest provider of philanthropic support for energy education in New Zealand the Trust funds:

- The Energy Education Trust Chair in Energy and Resource Economics
- The Business School's Energy Centre
- The 'Energy Matters Speaker Series'
- Post graduate scholarships and research scholarships

The Energy Education Trust funds a wide variety of energy projects and offers 15 scholarships of \$5000 each to undergraduate and honours year students at all participating New Zealand universities.

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