



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

BUSINESS SCHOOL
ENERGY CENTRE

The Energy Centre Annual Report

May 2018-2019



Annual Report to The Energy Education Trust of New Zealand



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)
- **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 overview

Dr Anna Berka completed her term as Research Fellow in January 2019.

Visiting Doctoral candidates

- **Fengtao Guang**, North China Electric Power University, Beijing, China (October 2018-October 2019)
- **Ming Yi**, China University of Geosciences, Wuhan, China (August 2018-August 2019)

Visitors

- Chuo University visitors, 11 September 2018 - overview of our research into renewable energy & NZ's progress towards 90% renewable electricity by 2025
- Chiyoda/Mitsubishi visitors, 19 September 2018. Completing a study for ERIA <http://www.eria.org/about-us/history/> on hydrogen supply and demand potential in ASEAN + 6 (total 16 countries)
- **Marc Rosen**, Faculty of Engineering and Applied Science, University of Ontario (December 2019)
- Four staff and two post-graduate students visited from Charles University, Prague: **Miroslav Palansky, Tereza Malirova, Milan Scasny, Jan Weinzettel, Vojtech Maca and Evzen Kocenda**; January-March 2019. Their visit was supported the EU-funded project Global Excellence in Modelling of Climate Change and Energy (GEMCLIME). The Energy Centre participates in GEMCLIME as an external partner.

Graduate Summer Internships

- **Isabela Li** – Assisted **Selena Sheng**, Experimental Study of Congestion Pricing and the Role of Public Information, Faculty Development Research Project
- **Sherry Li** – Assisted **Selena Sheng**, Experimental Study of Congestion Pricing and the Role of Public Information, Faculty Research Development Project. Sherry Li completed a literature review, assisted with data entry
- **Ajith Viswanath Sreenivasan** – Assisted **Selena Sheng**, Development of IPT roadway charging systems, MBIE project. Ajith developed an optimisation model of stationary and dynamic EV charging infrastructure
- **Sofia Schroder Langhaeuser** – Assisted **Kiti Suomalainen**, Calculating the hourly solar radiation and PV output for various installation sizes for all roofs and suburbs of Auckland. Sofia calculated the hourly solar radiation and PV output for various installation sizes for all roofs and suburbs of Auckland
- **Alina Derevyaga** – Assisted **Steve Poletti** with research on the NZ electricity market

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Cover photo: *Tāwhirimātea and children* by **Cliff Whiting**, reproduced with kind permission from MetService.

In Māori mythology, Tāwhirimātea is the god of weather, including wind, storms and thunder and lightning.

Research

BEC 2060

Dr Kiti Suomalainen leads a five-year collaboration with Business New Zealand, assisted by Associate Professor Golbon Zakeri and Basil Sharp.

Collaboration with the Paul Scherrer Institute, Switzerland, produced a baseline model, TIMES-NZ, of New Zealand's energy system. In July, Basil and Kiti attended the first BEC2060 Scenarios Project Workshop themed "Help us shape the future of NZ's Energy Sector". The workshop brought together 60 stakeholders from business, academia and government – split into groups, for a day to explore the critical uncertainties around energy in New Zealand over the next 40 years.

Kiti attended a formal training on TIMES software at Chalmers University of Technology, followed by a visit to the Paul Scherrer Institute, Switzerland, for an intensive research workshop set up specifically for collaboration on the TIMES-NZ model. Kiti also attended the 41st IAAE International Conference on Transforming Energy Markets, in the Netherlands. Over 500 international participants attended from all over the world. Conference participants included academics, policy makers, consultants and representatives from energy businesses, giving the opportunity to discuss the cutting-edge hot topics in energy economics internationally.

All supply-side resources and technologies are now characterised in TIMES-NZ, as well as all energy end-use demands from five main sectors: residential, services, industrial, agriculture and transport. The model will allow us to explore a wide range of topics concerning the NZ energy system, such as the impact of government's decision not to release offshore blocks for oil/gas exploration, competition for water, impact of climate change on hydro resources and the power system, and the impact of different carbon policies across the energy sector. Results will be disseminated through the BEC2060 network in mid-2019.

Under the agreement, the Centre will analyse scenarios proposed by Business NZ and, conditional on feasibility, requests by energy companies. TIMES-NZ will provide a useful vehicle for further developing contacts with energy sector.

An immediate spin-off from TIMES-NZ has been the opportunity to offer "part four" projects to final-year students in the Faculty of Engineering. This year Kiti and Golbon are supervising four "part four" student projects that will test model sensitivities to a range of parameters that bring uncertainty to the model, such as the cost of alternative technologies and changes in the pattern of energy demand.

A research proposal submitted by Golbon (PI), Kiti (AI), and Basil (AI) to the MBIE Endeavour fund passed the first round of assessment and will advance to the final round. The aim is to

develop and apply the TIMES-NZ model within the context of government's net-zero carbon proposal. Assessment will be in terms of cost under conditions of uncertainty, such as variations to hydro-lake inflows.

Dr Tom Kober from the Paul Scherrer Institute will present our results from the TIMES-NZ model at the International Energy Workshop in Paris on 3-5 May 2019. Tom will also visit the Energy Centre for a week in May, giving a seminar on Tuesday 7 May 2019, and providing training on TIMES modelling. He will also give a seminar and attend various meetings with investors and other partners in Wellington on 8 May 2019.

Energy Efficiency

Dr Le Wen leads the energy efficiency project in collaboration with MBIE. Statistics New Zealand has provided access to confidential firm-level data including energy use by type, energy management, employment, and annual financial data. Extracting these data in a form for statistical analysis is a slow, laborious process. Factors affecting energy efficiency, such as firm size and firm-level energy management will characterise energy use and energy efficiency in New Zealand's industrial and trade, primary industry and services sectors. Preliminary results are expected in June 2019. Empirical evidence on energy efficiency will be of use to the BEC 2060 project, business and government officials.

Transport

Dr Selena Sheng leads the Centre's collaboration with the Engineering Faculty on the MBIE funded project Development of IPT Roadway Transportation Systems. Collaboration includes scientists from the University of Auckland, Victoria University of Wellington and GNS Research. Applications for a PhD scholarship to develop optimisation models for the project have closed and the preferred applicant will join the team shortly, provided visa conditions can be met.

In parallel to the IPT project Selena is collecting data on factors that might have an impact on the uptake of EVs, including: size of household, number of driving-alone drivers, number of public transport users, population with higher qualifications, households without cars, households with more than two cars, median household income, percentage of females and percentage of children. The study also plans to examine the impact of charging infrastructure locations on EV uptake.

Selena is project leader, in collaboration with Dr. Addison Pan from the Department of Economics, on a project Experimental Study of Congestion Pricing and the Role of Public Information, funded by the Faculty Research Development Fund.

Student participation in the experiment continues from late April. Results from lab experiments are expected to contribute to discussions on, and policies related to, congestion pricing in Auckland.

Energy policy

Dr Anna Berka worked on Policy strategies for inclusive renewable energy in Aotearoa New Zealand funded by the Public Policy Institute, with Stephen Poletti, Julie MacArthur, Steve Matthewman and Margia Bargh. Part of the project involved identifying best practices based on country comparative work. The other part involved organising a 'Forum on local and community energy' of stakeholders to discuss what energy policy changes are required to enable civic participation in New Zealand's low carbon transition. The Forum was held on 24 August in Wellington with a wide range of practitioners, industry and representatives from MBIE, MfE and BRANZ.

Solar

Solar in the Pacific was accepted by MFAT and has been published online by the NZ Institute for Pacific Research. As a continuation of our research on energy in Pacific islands, Kiti and Golbon are supervising two "part four" student projects that will investigate investment and divestment pathways for centralised, grid-based energy systems in island states. Preliminary results will be presented at the European Climate Change Adaptation conference in Lisbon, Portugal, 28-31 May 2019.

The Solar tool was used in a Master of Energy (ENG721) assignment. The assignment asks students to complete an assessment of the economics of investing in solar for a house located in Mt Eden. Students estimated the consumption level required for a positive net present value and explored the economics of investing in a battery.

Kiti worked with a Master of Energy student, Sofia Schroder Langhaeuser, on the Centre's solar assessment tool to increase the time resolution from annual radiation to hourly for 12 representative days of the year – one for each month. She has also included a PV panel model, which allows a more accurate conversion of solar radiation to power. Sofia will continue to work with Kiti as a Summer Intern.

Collaboration with Mercury Energy has been frustrated by inter alia changes in personnel at their solar plant. A MOU has been signed with Vector which will govern access to their customer data that we need for Solar Tool validation. Solar City has approached the Centre to collaborate on a similar project using their customer data.

Postgraduate Research Update



Economies with a larger share of renewables were found to have higher levels of energy efficiency

Mahsa Moshrefi

Mahsa successfully defended her PhD Efficient Consumption of Energy: the role of energy mix. The thesis shows that energy mix (fossil fuels, renewables) is closely related to efficient consumption of energy in 28 OECD economies. Economies with a larger share of renewables were found to have higher levels of energy efficiency. Mahsa graduated PhD on 29 April 2019 and is lecturing at RMIT Melbourne.

Milad Maralani

Milad's research examined the economy-wide impact of introducing electricity saving technology at the Tiwai Point aluminium smelter. The technology was developed by the Faculty of Engineering. Considering that the smelter consumes around 14% of New Zealand's electricity, the economy-wide impact of the smelter being able to moderate its use of electricity had surprisingly little impact. Mahsa graduated PhD on 29 April 2019 and is currently employed by NZ Institute of Economic Research.

Melody Meng

Social Impact Components of Renewable Energy Investment

Melody's thesis brings together themes from social impact investment and renewable energy investment for use in case studies drawn from China and New Zealand. Melody will defend her PhD proposal in May 2019.

Lingli Qi

Benefits, Barriers and Design of New Zealand's Emissions Trading Scheme (ETS): Integrated Energy-Environment-Economy Analysis

Lingli is completing a dynamic model of the New Zealand economy, spanning 2013-2050, that will enable her to analyse the impact of including all sectors into the ETS. Once operational the model will simulate a range of carbon price scenarios. The second paper will include an analysis of the rebound effect (improvements in energy efficiency offset by an increase in energy consumption) and its impact on achieving carbon reduction targets.

Wenwen Zhang

Energy and Environmental Economics

Using decomposition analysis, Wenwen identified factors (such as GDP, industrial structure, energy mix and population) influencing energy use in China over the period 1978-2015. Gains in the efficient use of energy and changes in energy mix are playing a dominant role in the increased use of energy.

Wenwen is studying at the University of California (Los Angeles) and returns to the Centre in August 2019. She has completed

a multi-regional dynamic model covering 30 provinces of China that includes 13 sectors and seven air pollutants. National and sub-national carbon policies will be explored to estimate their impact on the economy and environment.

Publications

Downward, A., Chowdhury and S., Jayalath, C. An investigation of route-choice in integrated public transport networks by risk-averse users. *Public Transport*, 2019. <https://doi.org/10.1007/s12469-019-00194-0>.

Downward, A. and Philpott, A. (2018). Market power and forward prices. *Economic Letters*, vol. 166, issue C, 6-9.

Habibian, M., Downward, A. and Zakeri, G. (2018). Multistage Stochastic Demand-side Management for Price-Making Major Consumers of Electricity; available from *Optimization Online*.

Habibian, M., Zakeri, G., Downward, A., Anjos M. and Ferris, M. "Co-optimization of demand response and reserve offers for a major consumer", to appear, *Energy Systems*, DOI 10.1007/s12667-018-0312-x.

Hoicka, C. and MacArthur, J. "From tip to toes: Mapping community energy models in Canada and New Zealand". *Energy Policy* 121: 162-174, June 2018.

MacArthur, J. and Matthewman, S. (2018). "Populist resistance and alternative transitions: Indigenous ownership of energy infrastructure in Aotearoa New Zealand". *Energy Research and Social Science* 2018:43.

Sheng, M. and Sharp, B. (2019). Commuter's Transport Mode Preferences and Social Network Effects in New Zealand: An Instrumental Variable Approach, *Journal of Transport Economics and Policy*, ranked as an A journal by the Australian Business Deans Council (ABDC).

Sheng, M. and Sharp, B. (2019). Aggregate road passenger travel demand in New Zealand: A seemingly unrelated regression approach. *Transportation Research Part A: Policy and Practice*, 124, 55-68. DOI: 10.1016/j.tra.2019.03.005 *Transportation Research Part A: Policy and Practice* is a leading journal in the field of transport economics and is ranked as an A* journal by the ABDC list. It has a recent impact factor of 3.026, and a five-year impact factor of 3.809.

Suomalainen, K., Eysers, D., Ford, R., Stephenson, J., Anderson, B. and Jack, M., Detailed comparison of energy-related time-use diaries and monitored residential electricity demand, accepted for publication in the *Journal of Energy and Buildings*.

Zakeri, G. and Pritchard, G. (2018). A review of simulation usage in the New Zealand electricity market, *Springer Proceedings in Mathematics and Statistics*, (2018) 231, pp. 23-37.

Zakeri, G., Pritchard G, Bjørndal E. and Bjørndal M. (2018). Pricing wind: A revenue adequate, cost recovering, uniform price auction for electricity markets with intermittent generation, to appear in *INFORMS Journal of Optimization*, DOI 10.1287/ijoo.2018.0002.

Zhang, W.W., Sharp, B. and Xu, S.C. (2019). Does Economic growth and energy consumption drive environmental degradation in China's 31 provinces? New evidence from a spatial econometric perspective, *Applied Economics*, ranked as an A journal by the Australian Business Deans Council (ABDC).

Wilson, P., Sharp, B., Williams, G. and Suomalainen, K. Polynesian pathways to a future without electricity grids.

<https://www.nzpr.ac.nz/research/polynesian-pathways-to-a-future-without-electricity-grids/>

Working Papers

Moshrefi, M., Sharp, B. and Nepal, R. Does Energy Mix Matter? - Impact of Renewables on Productive Efficient Consumption of Energy in OECD Economies, (under review) *Energy Policy*, ranked A by the ABDC.

Sheng, M., Sreenivasan, A.V., Sharp, B. Wilson, D. and Ranjekar, P. (2019). Economic Analysis of a Dynamic Inductive Power Transfer Roadway Charging System under Public-Private Partnership – Evidence from New Zealand. Submitted to a special issue on the Sustainable Development Goals and Technology Policy of the journal *Technological Forecasting and Social Change*, ranked A by the ABDC.

Wen, L. Sharp, B. and Sbai, E. Spatial Econometric Estimation of the Merit-Order Effect of Wind Penetration and its Implication for Wind Farm Investment Decisions in New Zealand, (revise and resubmit) *The Energy Journal*, ranked A by the ABDC.

Yongxiu, H., Fengtao, G., Wen, L. and Sharp, B. Energy intensity and its differences across China's regions: Combining econometric analysis and decomposition analysis", (revise and re-submit) *The Energy Journal*, ranked A by the ABDC

Yongxiu, H., Fengtao, G., Wen, L. and Sharp, B. Structural decline in the growth rate of China's electricity consumption through energy efficiency improvements and industry transition, (revise and resubmit) *The Energy Journal*, ranked A by the ABDC

Presentations and conferences

Berka, Anna. Flaxroots' energy innovation in New Zealand: A baseline study and research agenda' at: 'Community renewable energy in global perspective I: Inclusive Energy governance' panel, July 2018, 25th World Congress of Political Science, Brisbane.

Berka, Anna. "The institutional foundations of orchestrated socio-technical transitions:

learning from comparative governance of civic renewable energy", at ETH Academy for Energy and Sustainability, June 2018, Appenzell and in the "Governing Novel Technologies" Panel, 25th World Congress of Political Science, Brisbane.

Downward, Tony, presented a paper "SDDP with stagewise-dependent objective coefficient uncertainty" applied to hydro-scheduling problem at the International Symposium on Mathematical Programming in Bordeaux, France, July 2018, slides are available: <http://www.epoc.org.nz/ismp.html>.

Filippova, O. and Sheng, M. (2018). Impact of proximity to Bus Rapid Transit on nearby property values in Auckland. Selena presented this work in The 59th Annual Conference of the New Zealand Association of Economists, Auckland University of Technology, Auckland, 27-29 June 2018.

MacArthur, Julie (with Anna Berka and Claudia Gonnelli), 2018 'Flaxroots' energy innovation in New Zealand: A baseline study and research agenda', Towards Sustainability Transitions in the Anthropocene: beyond behaviour change? BRANZ, Royal Society of New Zealand, Wellington, 6 August 2018.

MacArthur, Julie (with Steve Matthewman), 'Populist resistance and alternative transitions: Indigenous ownership of energy infrastructure in Aotearoa New Zealand' World Congress of Political Science, Brisbane, 21-26 July 2018.

MacArthur, Julie (with Christina Hoicka), 'Beyond the co-operative turbine: Forms and functions of community energy in Canada and New Zealand', World Congress of Political Science, Brisbane, 21-26 July 2018.

MacArthur, Julie, gave an invited public talk 'Hot Air and Hard Choices: Climate Change Politics in New Zealand' at the University of Auckland Winter Week Lecture Series on 4 July 2018.

Meng, Melody. Financing renewable energy: at the intersection of social and environmental return to understand social impact investment, was presented at the ISIRC 2018 Conference, 3-5 September 2018 in Heidelberg.

Meng, M. Social Impact Components of Renewable Energy Investment, ABEN Conference in Auckland, December 2018. <https://aben.org.au/conference/2018-aben-conference/>

Sheng, M., Li, Y. and Pan, S. (2018). Gender Inequality in the Renewable Energy Sector: Evidence from New Zealand. Selena presented this work in The 10th Biennial Gender, Work & Organisation Conference 2018 held by Macquarie University, Sydney, Australia, 13-16 June 2018.

Sheng, M. & Sharp, B. (2018). Economic Growth and Transport Carbon Dioxide Emissions in New Zealand: A Cointegration Analysis of the Environmental Kuznets Curve. Selena received the best presentation award at The ICSEET 2018: 20th International Conference on Sustainable Energy Economics and Technology. Tokyo, Japan, 28-29 May 2018.

Sheng, M., Sreenivasan, A.V., Covic, G.A., Wilson, D. and Sharp, B. (2019). Inductive Power Transfer Charging Infrastructure for Electric Vehicles: A New Zealand Case Study. This paper has been accepted for a poster presentation under "Optimisation/Economics" category of the "Wireless Power Week": IEEE MTT-S Wireless Power Transfer Conference (WPTC) and IEEE PELS Workshop on Emerging Technologies: Wireless Power, 17-21 June 2019, London, organised by Imperial College London and Eindhoven University of Technology. Selena's co-author Dr Wilson (Faculty of Engineering) will present the paper.

Sheng, M., Sharp, B. and Yi, M. Transport emissions, road energy consumption, and economic growth: a cointegration analysis of the environmental Kuznets curve in New Zealand. This paper has been accepted for a poster presentation at the Energy and Society in Transition: 2nd International Conference on Energy Research and Social Science, 28-31 May 2019, Tempe, organised by the Arizona State University, USA. This International Conference on Energy Research and Social Science is the premier global forum for exploring the nexus of energy and society. The 2019 conference will highlight the intersection of on-going and future changes in the energy sector and global society.

Selena is presenting at The 2019 Triennial Symposium on Transportation Analysis (TRISTAN), 17-21 June 2019, Hamilton Island, Australia, organised by the University of Queensland. The title of her presentation is "Experimental Study of Congestion Pricing and the Role of Public Information". This is a joint work with Dr Addison Pan from the Department of Economics.

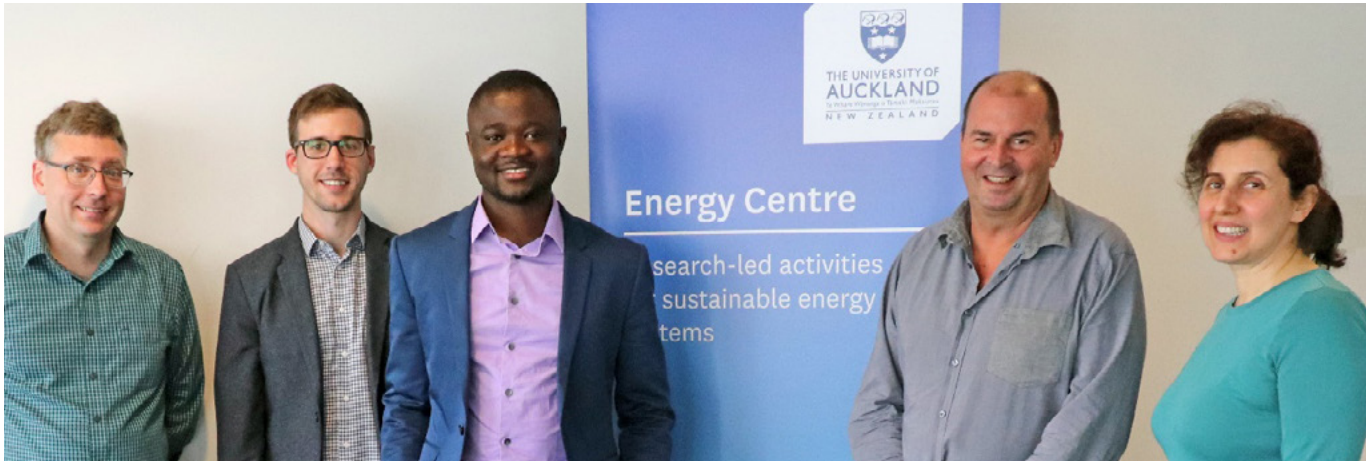
Suomalainen, K. and Sharp, B., Clean Slate Energy Planning – Summary of survey results, Asia-Pacific Energy Leaders' Summit, 1 November 2018, Wellington, New Zealand. This survey on the future of energy systems was sent to all attendees of the APEL summit.

Umam, M. F., Campen van, B. Drilling manpower and equipment transfer from petroleum to geothermal industry: a preliminary study on skill assessment; PROCEEDINGS, The 6th Indonesia International Geothermal Convention & Exhibition (IIGCE) 2018; Jakarta, August 2018.

Zakeri, Golbon, was invited to speak at the University of Wisconsin-Madison on August 6 2018 as a guest of the Industrial Engineering Department.

Zakeri, Golbon was plenary speaker at the Winter School of Energy programme, to be held in Kvitfjell, Norway, March 2019. Golbon was interviewed for the documentary "Powering New Zealand", episode 5.

Energy Centre Research Seminars



Andrew Eckert, David Brown, Richard Boampong (University of Alberta), Steve Poletti and Golbon Zakeri (Energy Centre)

The government's zero-carbon proposal presents a challenge for electricity generation

The Energy Centre co-hosted a research presentation training with the Centre for Learning and Research in Higher Education arranged for Energy Centre staff and PhD students. The objective of the workshop was for staff to develop a short 'easy to understand' PPT of their research in a format suitable for a general public audience such as Summer School.

Sustainable energy: approaches, methods and examples, Professor Marc A. Rosen, University of Ontario Institute of Technology, 4 December 2018.

Worldwide Universities Network (WUN) Project

A WUN grant supported collaboration with the Department of Economics, University of Alberta, and the Energy Centre. WUN aims to support Interdisciplinary Research, in this case two workshops aimed at renewable electricity.

Renewable Energy and Electricity Markets, University of Alberta, May 24th, 2018

Alberta has massive deposits of coal and is the leading producer of oil in Canada. Switching to renewables will be a challenge. Good wind resources are available in the south-west, close to the Rockies. Achieving the provincial government's goal of 30% by 2030 will require incentives – funded by taxpayers and consumers – to invest in renewable technology. Lessons from other jurisdictions (California, Great Britain and Texas) point to a need for government to approach the challenge with care. Incentives can adversely affect the fiscal position of government, market power can affect the efficiency of auctions and competitive outcomes, incentivised investment has implications for network capacity and reductions in greenhouse gases may fall short of expectations.

Alberta has recently turned its attention to promoting renewable sources of electricity. The provincial government

has set a target of 30% renewable by 2030. The plan is to add 5,000 MW of renewable energy capacity by 2030. To achieve the target the Alberta Electricity System Operator is running renewable generation capacity auctions. Wind is the most likely source of renewables in Alberta. Presentations at the 24 May workshop focused on large-scale renewables policy – viz. wind and solar – and wholesale markets. Steve Poletti presented a paper on New Zealand's greenhouse gas emissions policy and challenges. Basil Sharp presented a departmental seminar on wind energy development in New Zealand.

Renewables and market power workshop, University of Auckland, 1 August 2018

Three visiting academics, Assistant Professor David Brown, Professor Andrew Eckert and Richard Boampong, Post-Doctoral Fellow, from the University of Alberta contributed to a workshop Renewable Electricity and Market hosted by the Energy Centre. The workshop drew a large interest, attracting over 50 in attendance, from business, academia and postgraduate students. Our visitors met informally with Energy Centre researchers to share current research themes and explore the possibilities of future collaboration.

The government's zero-carbon proposal presents a challenge for electricity generation, particularly if intermittent sources such as wind replace fossil fuel sources. There is limited opportunity for expanding hydro in New Zealand and our lakes will play a major role in meeting demand. This raises an important research question on market design given uncertainty of supply. The issue of market power has been a focus of attention in Alberta with reverse auctions for generation capacity; and in New Zealand with the exercise of market in the retail market. Although evidence suggests the existence of market power – in Alberta and New Zealand – more research is required to identify and explain price formation in the market.

Research Grants

GEMCLIME is a 2.2 million Euro funded project – through 2020 – involving London School of Economics, Oxford University, Toulouse School of Economics, Charles University (Czech Republic) and Fondazione Eni Enrico Mattei (Italy). Only EU countries are eligible for funding (known as beneficiaries); The Energy Centre (University of Auckland) along with Harvard, University of Singapore, Yale, University of Maryland, Arizona State University and Australian National University are partners.

Basil Sharp attended the Annual Meeting of GEMCLIME in Gothenburg (Sweden) on 25 June 2018. There are at least two benefits from a being a partner in GEMCLIME. First, the Centre will be able to draw on the experience of research underway at EU-based universities. Second, as a partner, we will be able to host visits from academics from leading universities in Europe and the UK. The Charles University research team visit in February 2019 opened up possibilities for future collaboration, including leveraging off TIMES-NZ.

Kiti Suomalainen was awarded \$2,421 from the International Central Network and Partnership Grant programme to further develop research on integrated energy systems modelling capability (TIMES-NZ) and establish partnerships within the Asia Pacific region. This will allow Kiti to visit TIMES modelling colleagues at the National University of Singapore and – with co-funding from CSIRO and the Energy Centre – also visit TIMES modellers at CSIRO in Newcastle and at Monash University, Melbourne. She will give a public seminar at each of the institutions and present the TIMES-NZ energy systems model, connect with other TIMES modellers, and explore opportunities for collaboration.

Kiti submitted an application for funding for the Royal Society's Catalyst Seeding Fund on building New Zealand's zero-carbon energy economy modelling capabilities. The main objective of the proposed project is to strengthen and deepen our existing collaboration with Charles University's (CUNI) Environmental Economics group at CUNI's Environment Center, in Prague, Czech Republic, and leverage on their experience with energy systems modelling. Through bilateral research visits, a conference session in Auckland and a meeting with other TIMES modellers organised alongside the conference, we will further develop research capability around the TIMES-NZ model in New Zealand, and further strengthen this partnership that will allow us to enhance the TIMES-NZ model.

Le Wen and Basil Sharp received a Northern Hemisphere Summer School Scholarships (NHSRS) 2019 award, "Achieving net-zero carbon emissions in New Zealand", funded by the University of Auckland. The scholarships offer an opportunity for students from key northern hemisphere partner universities to experience research at the University of Auckland. Scholarships are competitive. Yiqing Wang, a major in Economics and Mathematics, at Pennsylvania State University was awarded a 2019 NHSRS. Yiqing will work with Le on quantifying factors (e.g., emission factor, fuel structure,

energy structure, energy intensity, economic growth and population) that influence energy-related GHGs emissions.

Le is leading an application to the Marsden Fund. The application includes collaboration with the Energy Group with Vienna University of Technology. Energy efficiency improvement (EEI) is a central concern for many countries because it contributes to energy savings and reduction in greenhouse gas emissions. However, potential energy savings from EEI may not be fully attained due to the rebound effect. Previous analyses have not fully considered the impact of targeting EEI. Le's collaborating project aims to develop robust theoretical models, apply these models to measure energy efficiency and the rebound effect.

Selena Zhang (AI) is assisting Dr Stefania Mattea (PI) and Basil Sharp (Mentor) for an application of Marsden Fund Fast-Start Grant 2019. Basil was external examiner for Stefania's PhD. The proposed project is entitled "Sustainable technology adoption in New Zealand: Consumer preferences for electric vehicles". This research will provide estimates of the values that car owners place on interventions to increase the uptake of EVs and reduce car emissions. Findings will contribute to New Zealand energy and transport policies.

Selena has been invited to join a team led by Associate Professor Ming Yi (School of Economics and Management, China University of Geosciences) for an application to the National Science Foundation of China. The proposed project "The Construction, operation mechanism and policy combination of market-oriented green technology innovation system" will provide a theoretical basis for exploring feasible technological routes in the new era of green development and contribute to the policy of green technology innovation.

The Energy Centre contributed towards a five-year University of Auckland bid, in collaboration with the Faculty of Science and GNS Science, entitled "Gas hydrates: economic opportunities and environmental implications". The bid into MBIE was successful and provides funding for a three-year PhD scholarship in economics.

Julie MacArthur received a University of Auckland Early Career Research Excellence Award for her work examining the politics and development of local renewable energy in diverse national contexts. The award was accompanied by a \$28,000 research grant to examine the role of women as employees, corporate leaders and policymakers in New Zealand's energy sector.

Tony collaborated with Nirmal Nair and Leo Yang Liu in a Science for Technological Innovation grant application: Data-driven grid operation strategy to enable high penetration of renewables.

*As a partner,
we will be
able to host
visits from
academics
from leading
universities in
Europe and
the UK*

Education and outreach

Education

The Centre contributed to the following courses:

CIVIL 770 Transport System Economics (Selena Zhang)

ENG 721 Resources (Stephen Poletti, Basil Sharp, Bart van Campen)

ECON 372 Energy Economics (Stephen Poletti)

Student project supervision

Four "Part 4" Engineering projects (Golbon and Kiti)

Three Master of Energy projects (Kiti and Basil)

Outreach

Innovation, communities and participation in low-carbon energy transition, 19 July 2018

The Energy Centre co-hosted a seminar with the University of Auckland's Public Policy Institute by Dr Christina Hoicka from York University, Toronto. Dr Hoicka's talk explored how energy users and communities are participating in a low-carbon energy transition by mapping out the developing services and options for participation in a low-carbon transition. We received 149 registrations for this event, including many from local government.

Energy Matters

Energy Matters – Zero carbon economy panel discussion, 1 October 2018

Speakers:

- John Mauro, Chief Sustainability Officer, Auckland Council
- Dr Amelia Sharman, Principal Advisor, Interim Climate Change Committee
- John Carnegie, Business NZ
- Professor Caroline Saunders, Director of Agribusiness and Economics Research Unit, Lincoln University

<https://www.business.auckland.ac.nz/en/about/our-research/bs-research-institutes-and-centres/energy-centre/energy-matters/energy-matters-speaker-series-past-speakers.html>

This event drew a broad participating audience from government, industry and academia due to its relevance to NZ's upcoming Net Zero Carbon bill. We had 195 registrations with 114 in attendance. As a result, we intend holding another similar event in 2019 after the bill is introduced into parliament.

Media

NZ 'complacent' over climate change, *New Zealand Herald*, 26 July 2018

Storms spark solar energy focus, *New Zealand Herald*, 16 June 2018

Net-zero carbon requires serious innovation, *Newsroom*, 4 May 2018

Spark of hope for electricity prices, *New Zealand Herald*, 23 October 2018

Excessive profits for energy generators, *Uninews*, October 2018

Renewables, market power may force electricity generation market change - academic, *Sharechat.co.nz*, 17 September 2018

Power generators banked \$5.4 billion in extra profits in 2010-16 - report, *New Zealand Herald*, 14 September 2018

Power generators 'made \$5.4 billion in excess profits', *Stuff.co.nz*, 14 September 2018

Urgent need for massive solar injection, *Scoop Politics*, 14 September 2018

Policy strategies for inclusive renewable energy in Aotearoa (New Zealand), *Public Policy Institute*, 6 December 2018 by Anna Berka, Julie MacArthur, Steve Matthewman, Stephen Poletti and Maria Bargh.

Web site statistics

1 May 2018 – 30 April 2019, including all traffic to the Energy Centre subdirectory.

Page title	Page views
Energy Centre	3336
Summer school in energy economics	1607
Auckland rooftop solar potential	1073
Our people	885
Researchers	800
Publications	758
Our research	528
Our research centre	501
Study options	445
Professor Basil Sharp - Director	386

Country	Sessions
New Zealand	3253
United States	354
India	215
Australia	167
China	121
Iran	172
United Kingdom	100
Indonesia	101
Netherlands	77
Germany	60



e-Horizon

May 2018

The first and second articles of the May edition were most popular:

- ‘Tumbling costs for wind, solar, batteries are squeezing fossil fuels’, Bloomberg.
- ‘5 solar innovations that will make engineers giddy’, Renewable Energy World.
- The audience for e-Horizon is now made up of over 3,700 subscribers.

We had over 1,200 articles opened from New Zealand followed by 55 from Australia.

September 2018

Over 43% of recipient subscribers (over 3,800) opened this newsletter with the following articles:

- What is the circular economy?
- Transition to a circular economy
- Invitation to attend Energy Matters panel discussion on Zero Carbon Economy (most visited)

The screenshot shows the May 2018 issue of the e-Horizon newsletter. The header includes the University of Auckland Business School logo and the Energy Centre logo. The main title is 'e-Horizon' with the tagline 'Energy | Education | Environment | Economics'. The featured article is 'Tumbling Costs for Wind, Solar, Batteries Are Squeezing Fossil Fuels' by Bloomberg, with a summary of the latest BNEF study. Other articles include '5 Solar Innovations That Will Make Engineers Giddy' and 'Customer-Centric Energy Transformation'. A sidebar on the right lists 'In this issue' and 'Subscribe' information.

Documentary film screening: Point of No Return, 15 August 2018

Kiti was approached by directors Quinn Kanaly and Noel Dockstader regarding the screening of their latest documentary at the DocEdge festival, Point of No Return. The feature film tells the behind-the-scenes story of the world's first solar-powered flight around the world. Conversations led to the idea of organising a separate screening at the University, targeted at students but free for all interested. Over 80 people attended. The screening was followed by a Q&A Skype session with the directors.

The poster for World Environment Day 2018, dated 5 June 2018, features a large image of a crumpled plastic bag. Text on the poster includes: 'Energy Centre acknowledges World Environment Day', 'Kiwis use around 1.6 billion plastic bags a year, which comes to almost 200,000 barrels of oil.', 'A plastic bag is used on average for just 12 minutes, but can last for hundreds of years in the waste stream.*', 'What can you do? Recycle or refuse. Say no to plastic bags.', and 'BEAT PLASTIC POLLUTION'. Logos for the University of Auckland, Business School, and UN Environment are at the bottom.

World Environment Day, 6 June 2018

During the first two weeks of June, Energy Centre acknowledged World Environment Day with a post displayed in the LED/TV screens in the Business School speaking to the UN's 2018 theme on reducing plastic pollution.

Plastic Free July

The poster for Plastic Free July features a background image of a beach with a reusable cup and a coffee cup. Text includes: 'Invitation to all Business School staff Plastic-free July', 'Enjoy a \$1 Discount on hot drinks at The Deli.', 'Join our effort to help the environment...', 'The Business School and The Deli are offering staff and PhD students \$1 discount on take-out hot drinks purchased in July. Instead of having a take-out cup, bring your own reusable mug or use one of ours.', and 'You will be in the draw at the end of the month to win a prize from our sponsors.' Logos for the University of Auckland and Business School are at the bottom.

Following the same theme for WED, the Energy Centre collaborated with the Business School on a joint campaign with The Deli to encourage staff to reduce plastic waste. Staff were offered a \$1 discount if they brought along reusable cups for their take-out coffee. The Business School and The Deli funded the discount. Approximately 350 coffees were purchased by staff under this scheme in July. The Business School will provide reusable cups for staff to use on a permanent basis.

Generating Ideas

The poster for Generating Ideas features a background image of a house with solar panels. Text includes: 'Did you know? AUCKLAND ROOFS COULD GENERATE 1.8 TIMES THE CITY'S POWER DEMAND.*', 'Sustainable energy: good for you, good for the environment', and 'Energy Centre Generating Ideas'. Logos for the University of Auckland and Energy Centre are at the bottom.

In August, Generating Ideas poster campaign, aimed at raising awareness of energy-related issues to the Business School, featured a quote from Kiti, Energy Centre Research Fellow. This poster was displayed on the LED screens in the Business School.



EXCESSIVE PROFITS FOR **ENERGY** GENERATORS

In the seven years from 2010 to 2016, power generators pocketed an extra \$5.4 billion in profits over and above what they would have if the wholesale electricity market was truly competitive.

A new report by Dr Stephen Poletti, *left*, a senior lecturer in energy economics at the Business School, used computer modelling to simulate how energy traders in generator firms behave in the wholesale market, and compared it to how they would behave if the market was competitive – that is, if generators were forced to always sell power at cost. The simulation also factored in hydro dam water level data.

He demonstrated that the model was reliable and robust by checking simulated prices against actual prices.

The model showed that ‘market power rents’ – the excess profits that generators are able to make – are substantial.

Stephen prefers a system like the one used by US company PJM.

“In the PJM system, generators have to offer power at the cost of production,” he says. “This would lower prices for consumers.

“If prices are too low for new investment to meet future demand growth, long-term contracts for new generation could be auctioned off.”

The full report can be read on the Energy Centre website at www.business.auckland.ac.nz.

8 THE UNIVERSITY OF AUCKLAND NEWS FOR STAFF



Energy Spotlight, 29 November 2019

Energy Spotlight was a new initiative aimed at sharing our research with stakeholders. This provided an opportunity for participants to comment on research findings, and suggest topics to that could enhance the impact of our research. Research Fellows gave a brief overview of their research results of relevance to business, government and the community.

In preparation for these presentations, we attended a series of workshops run by the Centre for Learning and Research in Higher Education, University of Auckland on how to present research to a non-academic audience (with the use of 10 slides within a time limit of 10 minutes) – a valuable future resource for the Centre.

We had over 100 registrations with 70 in attendance. The audience was a good mix from academia and industry.

Presentations:

- Energy and society in ‘Zero carbon’ New Zealand, Anna Berka
- Current economic opportunities and challenges facing Auckland transport system, Selena Sheng
- Advances in solar research, Kiti Suomalainen
- Wind farm investment in New Zealand, Le Wen

Global Policy Institute

On 17 January 2019 Basil Sharp presented an overview of the New Zealand Energy Sector to a delegation of 10 visitors from the Korea Energy Agency and Global Policy Institute.



Tony Downward is organising the ENR/EPOC Autumn Risk Workshop. ENR (Energy and Natural Resources) is a special interest group of the Operations Research Society of New Zealand.

Basil Sharp presented a four-hour seminar on the Economics of Renewable Energy, to 28 participants from Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, Temor Leste and Vietnam as part of the Renewable Energy Project Management Course funded by MFAT, 12 February 2019.



Summer School in Energy Economics, 18-21 February 2019

This year's Summer School was fully subscribed by December 2019 with over 130 registered for the 100 places offered. New topics/speakers included:

- Net zero carbon, Amelia Sharman, Interim Climate Change Commission
- Hydrogen in the NZ transport sector, Andrew Clennett, Hiringa Energy
- Energy Innovation, James Muir Callaghan Innovation

There were 85 participants at this year's event (40% from academia and 60% from industry/government). Feedback received included the following comments on what participants found most inspiring:

- Opportunity to think about the energy industry in the context of a low emissions economy
- Great overview of NZ energy system
- Discussion of new trends in emerging areas of the energy sector
- Felt like the real future, really stimulating

Over 90% of attendees agreed the course helped deepen their understanding of the subject; found the course intellectually stimulating; the balance of industry and academic speakers was appropriate and the topics matched their expectations.

Programme attached in Appendix B.

MCC Competition



This year's competition topic 'Net zero carbon freight transport by 2050' was launched on 22 March. 55 teams registered for the challenge comprising 208 students. This was the largest number of registrants MCC has had. 39 submissions were received. Kiti and Basil recommended five to go forward to the final. The five finalists presented their case to a panel comprising Tim Henaghan, Norman Godden, Amelia Sharman, NZ Productivity Commission, and Ashita Shasrma, Genesis Energy. Finals were held on Thursday 4 April, 6-9pm.

Winning Team with judges, Tim Henaghan, Amelia Sharman, Norman Godden and Ashita Sharman; Positive Change Consulting (Dylan Sperling, Casey Keiper, Keeha Oh, Ben Seto)



IAEE Conference 2020

Dinah Towle is Project Manager for this event. To date we have completed:

- Invitations to Programme, Organising/ Sponsorship Committee and Scientific Committee
- Website www.iaee2020.nz
- Draft sponsorship proposal
- Draft invitations letters to government dignitaries
- First call for abstracts

Professors Dave Williams and Ron Ripple, representing IAEE, will undertake a site visit 8-10 May, to work with local organisers and inspect facilities at the Business School.

Link to Energy in Transition, 7th IAEE Asian Conference hosted by the Energy Centre:

<https://www.business.auckland.ac.nz/en/about/our-research/bs-research-institutes-and-centres/energy-centre/our-people-5/visitors.html>

Plans for 2019-20

Patterns of energy use have yet to be analysed for sectors of the New Zealand economy

TIMES-NZ

Development and use of the energy systems model, led by Kiti Suomalainen in collaboration with Business NZ, will provide an exciting platform for research and education. Scenario analysis, featuring the prospect of latent technologies and government policy initiatives, will highlight possible future patterns of supply and demand. Results will be available to business and government through the Business NZ network and the Energy Centre's web site. The TIMES-NZ initiative will link up with research teams in Asia and Australia. TIMES-NZ will also provide a tool for postgraduate research. Students will have an opportunity to apply the tool to contemporary challenges.

Energy Efficiency

Le Wen's will focus on analysing the utilisation of energy by business. Patterns of energy use have yet to be analysed for sectors of the New Zealand economy. The project is in collaboration with MBIE. Results will be a useful source of data for MBIE policy analysts and the TIMES-NZ model. On a related project, Yiqing Wang, recipient of a Northern Hemisphere Scholarship, will assist Le on quantifying factors that influence GHG emissions.

Transport

Selena Sheng will continue to lead the Centre's contribution to the MBIE-funded project Development of IPT Roadway Transport Systems as it enters into its third year. Initial outputs in 2018/19 provided a basis for further development of economic models to assess the viability of inductive power technology. Collaboration with the Faculty of Engineering will continue and involve a PhD student. Factors affecting the uptake of EVs in the Auckland region will be estimated, including the location of charging infrastructure. Results of congestion pricing experiments will be available for publication and dissemination in 2019.

Solar

Centre activities in the solar space should regain some momentum in 2019-2020. We expect to have access to solar data from Vector and there is a possibility of obtaining data from Solar City customers. These data should improve the accuracy of the Solar Tool and provide opportunities for postgraduate research.

Natural gas

We expect to have a PhD candidate on board, as part of the GNS Science project, by mid-2019. The candidate will study the NZ gas market and the opportunities for extracting gas hydrates. Outputs from this project will also contribute TIMES-NZ.

Cross-faculty engagements

On the research front, collaborations will continue with the Faculty of Engineering and the Faculty of Science. We expect to supervise Master of Energy student projects leveraged off TIMES-NZ, transport and solar. Teaching into the Faculty of Engineering (CIVIL770 and ENG721) will continue.

Outreach

Energy Matters will continue through 2020. The Centre was approached by Z Energy to host an event on 24 June 2019 and we are planning a second event once the government's climate change bill is available. Energy Spotlight will be held in November 2019. Summer School is scheduled for February 2020.

Education

Course offerings in Energy Economics within the Department of Economics will continue, as will supervision of postgraduate honours and masters students. It is unlikely that we will have any PhD completions in 2020.

Student Case competition

The case competition will be held in March 2020.

IAEE Asian Conference February 2020

The Energy Centre will host this event at the Business School. We expect around 200 participants. IAEE representatives visited the Centre in May to discuss arrangements and visit venues associated with the event.

Appendices

Appendix A: Key Performance Indicators

Outcomes against critical success factors and key performance indicators 2018-2019

Programme	CSF	KPI	
Research	Applied research projects	6 project reports	A
	Cross-faculty engagement	2 cross-disciplinary projects	A
	Peer reviewed articles and reports	6 papers in ranked journals	A
	Academic workshops	6 workshops	NA
	Conference presentations	6 presentations	A
	Public forums	2 public forums	A
Education	Courses in energy economics	3 courses in energy economics	NA
	Summer School	70% satisfaction level	A
	PG completions	2 honours and 2 PhDs	NA
	Teaching into Masters of Energy	Enrolments in ME	A
Outreach	Public seminars	At least 4 presentations	A
	Herald opinion pieces	2 submissions	A
	Newsletter	3 newsletters	A
	Network	1 ERIN meeting	A

A = achieved, NA = not achieved

Critical success factors and key performance indicators for 2019-2020

Programme	CSF	KPI
Research	Applied research projects	6 project reports
	Cross-faculty engagement	2 cross-disciplinary projects
	Peer reviewed articles and reports	6 papers in ranked journals
	Academic workshops	4 workshops
	Conference presentations	6 presentations
	Public forums	3 public forums
Education	Courses in energy economics	2 courses in energy economics
	Summer School	>90% satisfaction level
	PG completions	3 honours & masters projects
	Teaching into Masters of Energy	Enrolments in ME
Outreach	Public seminars	At least 4 presentations
	Herald opinion pieces	10 submissions
	Newsletter	2 newsletters
	Network	1 ERIN meeting
	IAEE Conference	200 participants

Appendix B: Summer School 2019 Programme



BUSINESS SCHOOL

Energy Economics Summer School 18-21 February 2019

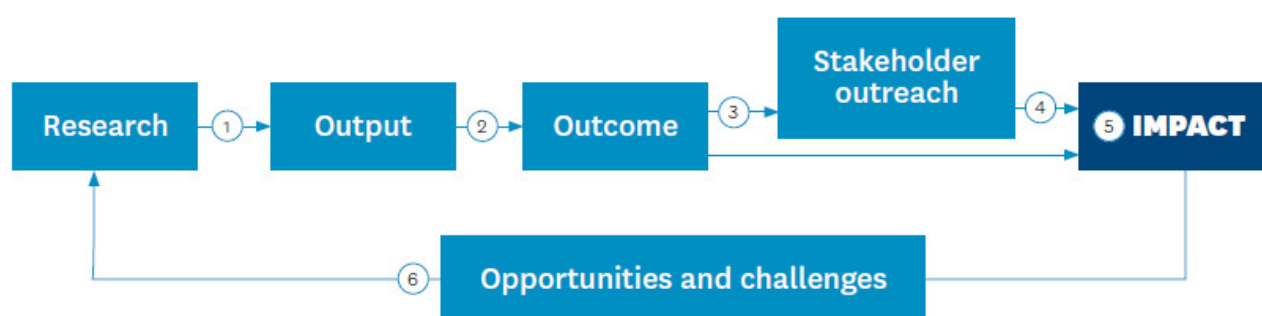
Room 310, Level 3, Sir Owen G Glenn Building, 12 Grafton Road

	Monday 18 February	Tuesday 19 February	Wednesday 20 February	Thursday 21 February
9-9.45am	Registration	Overview of electricity market Steve Poletti , Energy Centre	Issues in electricity market modelling Golbon Zakeri , Energy Centre	Geothermal energy Bart van Campen , Energy Centre
9.45-10.30am	New Zealand energy/global trends Basil Sharp , Energy Centre	Solar energy Kiti Suomalainen , Energy Centre	Distributed generation and battery storage Tony Downward , Energy Centre	Geothermal industry Mike Allen , Geothermal NZ
10.30-11am	Morning tea			
11-11.45am	Energy systems – thinking strategically John Carnegie , Business NZ	Wind energy Kiti Suomalainen/Le Wen , Energy Centre	Electricity distribution in a distributed energy future Steve Heinen , Vector	Local energy innovation Steve Poletti , Energy Centre
11.45am-12.30pm	Net zero carbon Amelia Sharman , Interim Climate Change Commission	Wind energy in New Zealand Grenville Gaskell , NZ Wind Energy Association	Energy innovation James Muir , Callaghan Innovation	Introduction to Taranaki regional energy development Basil Sharp , Energy Centre
12.30-1.30pm	Lunch			
1.30-2.15pm	Transport economics Selena Sheng , Energy Centre	Economics of climate change Steve Poletti , Energy Centre	Smart cities Louise Baker , Opus	Group projects Kiti Suomalainen , Energy Centre
2.15-2.30pm	Afternoon tea			
2.30-3.15pm	Electric vehicles Phil Jones , Sustainable Business Network	Green growth Rod Oram	Simulation game Tony Downward , Energy Centre	Group projects Kiti Suomalainen , Energy Centre
3.15-4pm	Hydrogen in the New Zealand transport sector Andrew Clennett , Hiringa Energy	Refreshments	2 computer labs 8 & 9, Level o, OGGB	Finish at 3.15pm
4pm	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	14 peer reviewed articles 5 working papers 19 presentations at conferences 4 successful bids	Successful submissions to A-ranked international journals, and conferences; working papers revise and re-submit to A-ranked journals; creating networks and contacts; strengthening skills; staying at forefront of energy-related initiatives; and, increased engagement through applications relevant to business and policy.	Contributions to discipline; international recognition of Centre's research programme; enhanced understanding of energy-related choices; bi-lateral flow of information and challenges with stakeholders; improved connections 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 University of Auckland 1 successful MBIE bids	Invitations from Faculty of Engineering and Faculty of Science within the University and research units outside the University to collaborate on research projects.	Demonstrated benefits of the contribution that the Energy Centre can provide through applications of economics and policy analysis alongside engineering and science; targeting of research toward future energy challenges for New Zealand.
Outreach Act as a bridge for open and informed dialogue between the energy industry, government and the community	4 requests for assistance from industry and academia 10 opinion pieces 2 e-Horizon newsletters 2 public outreach events Expansion of website	Growing public perception of Centre as source of independent and forward-focused research and inquiry. Translation of research for public consumption. Increased activity on the Centre's website from New Zealand and overseas.	Contribution to energy initiatives in NZ and abroad. Successful bid to host IAEE conference 2020. Increased awareness of contemporary challenges and imminent changes in the energy sector 'over the horizon'. Validation of EC effectiveness within University of Auckland.
Education Provide energy related education that creates future leaders for academia, business and government	2 courses in Energy 2 PhD completions 3 internal research seminars 4 international visiting students >90% satisfaction level from Summer School	Recognised relevance of the role of energy in society within University curricula and the broader community. PhD graduates successfully entering labour market. Growing interest in postgraduate education from students in New Zealand and overseas.	Skill and knowledge level improvement. Rise in educational attainment within energy industry.



- 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



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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.

www.business.auckland.ac.nz