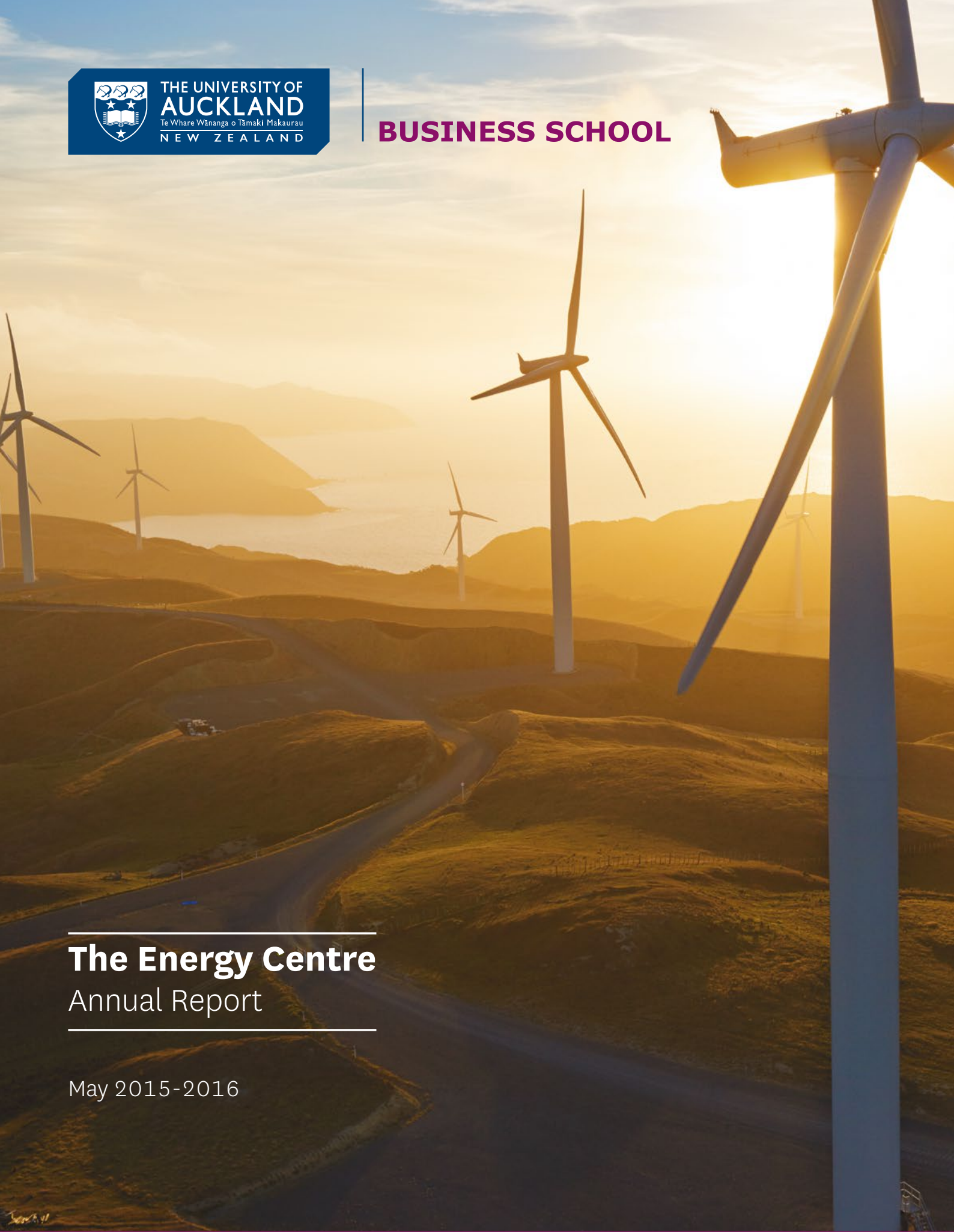


THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

BUSINESS SCHOOL

The Energy Centre
Annual Report

May 2015-2016

Annual Report to The Energy Education Trust of New Zealand

Contents

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:

Mr Bart van Campen (Engineering Science)

Dr Tony Downward (Engineering Science)

Frank Duffield (Honorary Fellow)

Dr Julie MacArthur (Political Studies)

Professor Mark Greer (Dowling College, USA)

Dr Steve Poletti (Department of Economics)

Dr Kiti, Suomalainen, (NZEET, Post-Doctoral Fellow)

Dinah Towle (Business School)

Dr Le Wen (Research Associate)

Dr Golbon Zakeri (Engineering Science)

Photo: Chris Sisarich
Cover photo: Chris Sisarich

Sina Maschinchi, Mina Gholami, Hamed Mohammad Shafiee, Mingyue Sheng, Sam Malafeh, Milad Maralani

Dr Le Wen joined the Centre as a Research Associate. Le has a PhD in Economics from The University of Auckland and has taught resource economics in the Economics Department of Auckland University of Technology before joining the Energy Centre. Her research expertise is in the field of applied economics and econometrics.

Dinah Towle, Group Services Coordinator, joined the team in 2015. Dinah has made a material contribution to the Centre's activities, enabling further outreach and assisting with administrative functions.

Basil Sharp returned from Research and Study Leave in July 2015. Steve Poletti started his twelve-month Research and Study Leave beginning July 2015.

The Centre hosted the visit of Steve Heinen, a doctoral student at University College Dublin, and member of the Energy Institute and the Electricity Research Centre, during semester 1, 2016.

Five 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.

PhD Completions

Sheng, Mingyue (Selena), *Commuter's Journey to Work Travel Behaviour and the Aggregate Road Passenger Travel Demand in New Zealand.* (Supervisor: Basil Sharp)

Empirical results show that the values of income elasticity for petrol and diesel cars are 3.99 and 3.45 respectively; indicating that demand for these cars can be expected to increase as incomes increase. Price elasticities for petrol cars and buses were -0.61 and -0.26 respectively; suggesting that a 10% increase in the price of petrol cars and bus transport would result in demand falling by 6.1% and 2.6% respectively. The empirical results deliver some important policy implications in terms of achieving a reduction in the demand for both petrol and diesel cars, and also promoting the use of public transport.

PhD research in progress

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

Milad continued to work closely with the School of Engineering's Light Metals Research Group (LMRG) and staff at the Tiwai Point Aluminium Smelter. His presentation to Smelter staff, and a Board member, in November 2015 was very well received. A paper based on his findings was presented at the international conference on economic modelling in Boston, USA (July 2015). He also presented his research to the Energy Economics group at TU Dresden (our collaborating centre) in Germany (June 2015). The heat exchanger technology designed by LMRG enables NZAS to reduce electricity use by up to 40%; aluminium production decreases by 70% and the cost of production increases by 25%. Milad's second paper shows that a decrease in electricity demand as a result of using the new technology will decrease the electricity price in New Zealand. This leads to more investment into energy intensive industries and disinvestment in the services and renewable energy sectors.

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

Mahsa's first paper estimates the level of energy efficiency in 28 OECD countries and will be submitted to an international journal. She finds that economies deriving their energy from renewable sources tend to rank higher in terms of energy efficiency. Her second and third papers will focus on energy efficiency in New Zealand. Services, Industrial and Primary sectors of the economy will be studied, each having a different profile of energy use. Energy use data collected by Statistics NZ will be matched with firm level economic data to examine the impact of business level decisions on patterns of energy use and gains in energy efficiency.

Maschinchi, Sina, *Energy-Environment-Economy Modelling* (Supervisors: Basil Sharp and Steve Poletti).

Sina's thesis analyses the potential environmental and macroeconomic impacts of implementing alternative greenhouse gas (GHG) mitigation policies using a model developed by Cambridge University. His first paper finds that the NZ ETS with a carbon tax coupled with revenue recycling could lead to significant economic benefits. His second paper investigates the linkage between the level of CO2 emissions from Light Petrol Vehicles and key variables using seasonal data from 2005 to 2014. The study aims to assess the effectiveness of fiscal policies to influence decarbonising policies in the transport sector.

Gholami, Mina, *Opportunity of solar power in New Zealand; and the impacts of the large potential contribution of solar and wind on the New Zealand's electricity market* (Supervisors: Steve Poletti and Basil Sharp).

Mina is studying the reliability of solar power in the New Zealand electricity market and simulating the impact of large solar and wind integration. Results show that PV generation integrates well alongside the expansion of wind generation in the northern part of the North Island. In contrast large wind power better integrates into supply in the South Island and southern part of the North Island. One interesting result from the simulation, based on dry years 2003 and 2008, higher electricity prices are found to correspond with more solar availability. Seasonal patterns of hydro, as the key generating resource, is negatively correlated with the seasonal pattern of electricity price.

Wang, Yue (Bonnie), *Application of impact on New Zealand's economy under the New Zealand Emissions Trading Scheme (NZ ETS)* (Supervisors: Basil Sharp, Steve Poletti and Golbon Zakeri).

Bonnie has developed a model that specifically includes forestry as a source of carbon permits. The model examines the impact of a range of climate policies on land use and the NZ economy. Two broad policies are analysed; carbon tax and the ETS. Land use change between forestry and agriculture is assessed through three scenarios: forestry as the only source of carbon permits; government sells surplus Kyoto permits (so-called "hot air" from eastern Europe) along with forestry; and, government supplies surplus Kyoto permits at no cost to industrial emitters of GHG. If New Zealand were to rely entirely on forestry as the source of carbon permits the price of carbon is estimated at NZ$23/t. The ETS has a positive impact on abating GHG emissions (-13% falls from baseline without the ETS) and afforestation. More land is switched to forestry use from agriculture at this price.

Achievements

Programmatic achievements through May 2016 are listed below against Key Performance Indicators (KPI) in Appendix A. Proposed KPIs for the period ending May 2017 are listed in Appendix B.

Research

Electricity

Solar

Kiti Suomalainen led the Centre's project assessing the solar potential of Auckland City. Lidar (radar) data were provided by Auckland Council which enabled us to profile buildings, calculate elevations, clearly see buildings and roads and even trees, select buildings based on their aspect, buildings left in shadows, and so on. These data were then used to estimate Auckland's solar potential, examine the prospect of decentralised electricity supply and the implications for lines companies. Preliminary results were presented at Energy Matters March 30th 2016.

The Centre was awarded two University of Auckland Summer Scholarships in 2015. Both projects contributed to the Centre's solar energy programme. John Knowles, a third year student in Applied Mathematics, completed his project *The Impact of Emerging Technologies on Electricity Distributors in Auckland*. Lines companies will have to adapt their business models to sustain profitability of their assets when emerging technologies, such as distributed solar power generation, enter the market. This finding was further elaborated by Dr Tony Downward in his Energy Matters presentation. Daniel Lee, a BCom student at The University of Melbourne, completed his project *Economics of Residential Roof Top Electricity Generation*. Daniel's project shows that the economics of private investment in solar is marginal, yielding a rate of return of 3-4%. Cost and feed-in tariff are two obviously important parameters.

Optimal Wind Farm Contracts

Wind farms are contributing around 5% of New Zealand's electricity supply and this contribution is likely to grow in the near term. Contracts linking land owners and generators base payments to land owners on a number of factors viz. installed capacity and actual electricity generated. The question of optimal contract design has not been studied. Golbon Zakeri, Regan Baucke and Basil Sharp developed a mathematical model to answer this question using actual wind velocity data and whole sale electricity prices.

Photo: Chris Sisarich

Oil and Gas

We now have time series data of New Zealand's oil exports/imports, oil and gas policy, and royalty regime. Data on production, reserves, GDP and government expenditure were collected for leading oil and gas producing economies. These data will be updated on an on-going basis. Basil Sharp's contribution to *Cheap Oil Poses a Problem for Central Bank Policymakers* (NBR, January 22 2016) was based on these data.

Cross-faculty engagement

Collaboration with the Engineering School's Light Metals Research Group (LMRG) continues: *Large scale energy storage at Tiwai Point Aluminium Smelter;* Funded by MBIE ($1.9 million over 2015-2017). The heat exchanger designed by LMRG is being installed in one of the pot lines and data collected from the experiment will be used in Milad Maralani's PhD research.

Joint application to MBIE's competitive funding round with the Engineering School on network resilience was not successful.

Peer reviewed articles

Burnell, J., B. van Campen, N. Kortright, J. Lawless, J. McLeod, K. Luketina, and B. Robson. Sustainability of TVZ Geothermal Systems: The Regulatory Perspective; *Geothermics-TVZ Special Issue,* August 2015.

Cleland, N., B. Young and G. Zakeri. Boomer-Consumer: a model for load consumption and reserve offers in reserve constrained electricity markets, *Computational Management Science,* 12 (4), 519-537, 2015.

Note: Nigel's PhD research was supported by the Energy Education Trust of NZ.

Downward, T., D. Young and G. Zakeri. Electricity Retail Contracting under Risk-aversion, *European Journal of Operations Research*, 2016.

Poletti, S.J., Young, D., and O. Browne. 'Market Power and System Cost: the long run impact of large amounts of wind electricity generation', *Energy Policy,* 2016.

Puschel-Lovengreen, S., R. Palma-Behnke, B. van Campen. Systematic Tool to Plan and Evaluate Demand Side Strategies during Sustained Energy crises in Hydrothermal Power Systems; *International Journal of Electrical Power and Energy Systems* - IJEPES-D-13-01820R1, October 2015.

Suomalainen, K. and B. Sharp. Electricity sector transformation in New Zealand: A sustainability assessment approach, *Journal of Renewable and Sustainable Energy*, 2016.

Suomalainen, K. and B. Sharp. Clean Power, Doing More With Less, *University of Auckland Business School Review*, 19(1), 49-57, 2016.

Working Papers

Baucke, R., G. Zakeri, B. Sharp and K. Suomalainen. *Optimal Contract Design with Uncertain Payoffs*.

Wen, L. and B. Sharp, *The Effect of Wind Power on Nodal Prices in New Zealand*.

Presentations

Steve Poletti: Welfare Implications of Consumers Switching to Real Time Pricing Plans with Imperfect Competition in Electricity Markets, February 2016, National University of Singapore.

Basil Sharp, New Zealand's Energy Futures, Winter Week on Campus 2015, Centre for Continuing Education, July 10th, 2015.

Kiti Suomalainen, and Basil Sharp, Solar PVs to charge EVs in Auckland – Potential for a community based approach, Proceedings, of Asian Conference for Sustainability, Energy and the Environment, Kobe, June 11-14, 2015.

Basil Sharp, *Understanding Electricity Markets* presented *Renewable energy and the effects on spot prices and investment decisions* to the Eastland Group, January 21-22 Gisborne.

Basil Sharp, *Renewable Energy and the Effects on Spot Prices and Investment Decisions* September 24th organised by NZX.

Note: Participants used the *NZ Interactive Electricity Market Simulator*, developed by the Centre.

Basil Sharp, *Integrated Renewables into Grid: is it Time to ACT now in Asia? Singapore International Energy Week*, 30th October, 2015.

Golbon Zakeri: electricity economics, Institute for Physics and Mathematics, UCLA, January 11-15, 2016.

Golbon Zakeri: plenary speaker, Stochastic Variational Analysis workshop (IMPA, Brazil) March, 2016.

World Environment Day, open forum hosted by the Energy Centre to discuss the opportunities and challenges associated with New Zealand's environment, June 5th, 2015.

Basil Sharp, International Energy Economics Institute of Japan, *The Effect of Wind Power on Nodal Prices in New Zealand*, April 19th, 2016.

Celebrating Research Excellence

The Energy Centre was selected along with 10 other University Centres, to display its current research at the 2015 Research Excellence Awards. Basil Sharp and Kiti Suomalainen attended our stand and fielded inquiries. The event was hosted by the Deputy Vice-Chancellor (Research) Distinguished Professor Jane Harding

and opened by John Spencer, the Tertiary Education Commission Chair. The event was attended by over 300 staff, students, donors and friends of the University.

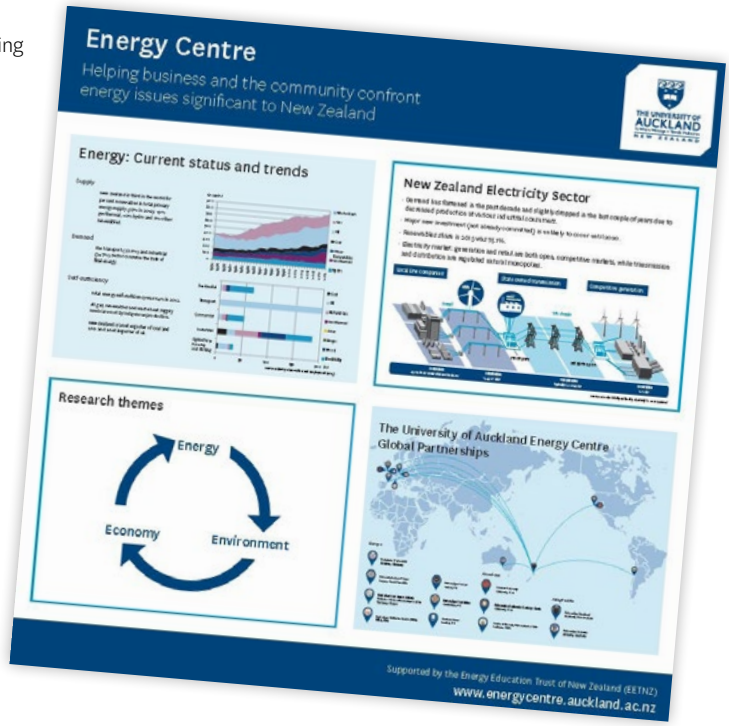
For this event, we provided:

- power point presentation entitled *Research Frontiers in Energy: Policy, Economics, Security and Environment*
- poster entitled *Helping business and the community confront energy issues significant to New Zealand*
- Energy Centre fact sheet – objectives, background, ongoing research and outputs
- 3 pull-up banners:
  - Research-led activities for sustainable energy systems
  - Helping business and the community confront energy issues significant to New Zealand
  - Connecting with leading energy research institutes to bring excellence to New Zealand

Research Seminars

In 2016, Energy Centre resumed its regular research seminar series inviting staff and colleagues to share their research:

- February 18, *The Impact of Emerging Technologies on Electricity Distributors in Auckland* by John Knowles, our University of Auckland Summer School student.
- March 17, *Smart integration of future domestic heaters in energy systems with high shares of variable renewables - an investment model assessment*, Steve Heinen, visiting PhD candidate from University College Dublin.
- April 27, *Geothermal vs petroleum regulation and reporting*, Mr Bart van Campen, Energy Centre.



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 attended the second meeting of ERIN 28th September 2015 in Jakarta at the Economic Research Institute for ASEAN and East Asia. The workshop focussed on Energy Efficiency and Conservation Policies. With the exception of Lao PDR, fossil fuels are expected to provide a large share of electricity supply to large metropolitan centres in East Asia. Network development, infrastructure investment and market design are widely recognised as priorities given a growing recognition of the challenge associated with integrating renewables into supply and the potential impact of disruptive technologies. The latter is particularly relevant to investment in asset specific infrastructure. Economies with isolated communities, viz. Indonesia and the Philippines, face a more complicated challenge in getting basic electricity services to remote locations. Their governments are turning to community generation based on proximate renewables, including solar, small scale hydro and, to a lesser extent, wind.

The Energy Centre is contributing to an ERIN funded project *Integrative Strategy and Policies for Promotion of Appropriate Renewable Energy Technologies in Lower Mekong Basin Region*. The project involves collaboration with researchers from Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam, and will run over 2016-2017. The contract is held by Viet Nam and Basil will contribute using his experience on renewables and market design in 2017. The first team meeting was held in Hanoi, February 26-27, 2016, and Basil presented an overview of how to estimate the levelised cost of electricity supply from renewable sources.

Other initiatives

Joint application with the Geothermal Institute, through Uniservices Ltd, was made to the Ministry of Foreign Affairs and Trade to be listed as a provider of professional services across energy sectors, including geothermal energy. The purpose is to provide appraisal and peer review services through the NZ Aid Programme.

Basil Sharp met a ministerial delegation, accompanied by Tim Anderson, Trade Commissioner Indonesia, on 25 November to discuss:

- Regulatory frameworks to promote geothermal development
- How to decide invest in exploration
- How to determine electricity tariffs for different sized geothermal power plants
- Risk allocation during geothermal exploration
- Latest technology/methodology for reservoir modelling

Basil Sharp joined representatives from faculties of Engineering, Science and Arts in a meeting with the Director of Promotion Agreements at Conacyt University to explore opportunities for PhD and Masters research students (fully funded) to study at The University of Auckland. Conacyt's primary interest is in the field of energy (technology and economics) and there appeared to be an appetite on both sides of the table to build a relationship between the two universities.

Outreach

With Dinah Towle's assistance the Centre was able to expand its outreach programme to include *e.Horizons* and *Generating Ideas*.

Energy Matters

BEC2050 Energy Scenarios: Navigating Energy Futures to 2050; 19 October, John Carnegie (Business NZ) and Dr Stephen Batstone (Sapere).

Business NZ sponsored this study of Unlike previous presentations, this seminar was based on a study of two potential future scenarios. The level of community attendance was comparable with earlier seminars.

Disruptive technology: theme for 2016

A disruptive technology is a new emerging technology that unexpectedly displaces an established one. Whereas sustaining technologies correspond to well-known technologies that undergo successive improvements, disruptive technologies may still lack refinement, often have performance problems, yet have the potential to alter the way we live and work, and lead to entirely new products and services. Energy storage and renewable energy are two of the twelve potentially economically disruptive technologies listed by the McKinsey Global Institute.

Disruptive technologies and solar potential in Auckland 30 March, 2016, Kiti Suomalainen and Tony Downward.

Kiti's research has focussed on wind and solar energy. The price for a lithium-ion battery pack in an electric vehicle has decreased by 40 percent since 2009 and the price for a photovoltaic cell has decreased by 85 percent since 2000. Both technologies have the potential to impact the lives of billions of people, whether in electric mobility, distributed generation, or by bringing access to electricity to places with no access to the power grid. What could these developments mean in terms of solar power generation in Auckland? Estimates of the rooftop solar potential for Auckland used LiDAR (Light Detection and Ranging) data provided by Auckland Council. With a 3D model of the city, including rooftops, trees and topography, and solar tracking software, the annual solar radiation of Auckland rooftops was calculated with a resolution of four points per square meter. This information can be used to compare rooftop solar potential per suburb, or relate it, for example, to census data on building type, household size or income, with potential insights for energy companies and policy makers. Dr Tony Downward's presentation followed. Tony highlighted the implications of distributed solar electricity for lines companies; noting in particular the challenge of feed-in pricing and the risks associated with asset value.

This event drew over 100 registrants (20% staff and students, 80% from industry including 60% alumni). The talk was an excellent opportunity to engage the public with our research. We received direct positive feedback from several attendees including a company proposal for future collaboration.

World Environment Day, 6 June 2015 Seminar

Energy Centre marked World Environment Day with an informal discussion led by our staff on:

- Has New Zealand kicked the CO2 habit?
- What is the prospect for global action on climate change?
- Is the quality of New Zealand's environment improving?

Over 60 staff and students from the University attended. Our event was fully sponsored by Ricoh, All Good Drinks and Papas Pizza.

Our event was registered with, and acknowledged by, UNEP with receipt of a certificate of appreciation.

Auckland Business School Sustainability Week, 4-8 April 2016

Auckland Microfinance Initiative (AMI) Somu competition on a renewable energy fund in Nepal, Tuesday 5 April

Kiti Suomalainen participated in the Somu Energy Case Competition as a member of the judging panel. The Somu Energy competition is an engaging way for students to contribute to a vital initiative – access to clean energy. The competition challenges students to come up with strategies for pitching the Somu Clean Energy Fund to potential investors. In the national stages of the competition, students will be able to execute these strategies in the real market.

Four teams of 2-4 students participated. Teams were judged on their presentation and contents. This includes the quality of the slides and the how well the pitch was delivered. Content was judged on how well the contestant understood the company, market and how much relevant information was used during the presentation. As this is a pitch for investors, judges will be focusing on how investors can benefit from investing into this fund.

Greening our University and reducing our footprint at the Business School, Thursday, 7 April 2016

Dinah Towle presented the newly developed Energy Centre outreach initiatives including:

- *Generating Ideas* e-posters
- Celebrating International World Days, e.g. World Environment Day Seminar and World Water Day poster
- *e-Horizons*

Also presenting was Charlotte Blythe, University of Auckland's Sustainability and Environment Coordinator, giving an overview of environment measures within the University.

The audience included staff, students and industry representatives. Following the presentations, discussions were held on how the Business School could lift its sustainability game. There was general positive feedback on the idea of setting up a team of people within the Business School to address improving its environmental culture.

Opinion pieces

An article entitled *Revealed: The suburbs best for solar panels*, Dr Kiti Suomalainen and Dr Tony Downward, NZ Herald, 29 March 2016 (UABS Facebook, March 30, 2016).

An article entitled *Solar power no easy fix for New Zealand*, Dr Kiti Suomalainen and Dr Tony Downward, UABS Monthly Newsletter, March 2016.

An article entitled *Study suggests better way to meet emissions targets*, Sina Mashinchi, UABS Monthly Newsletter, March 2016.

An article entitled *World Water Day has global, national and local significance*, Sustainability News, April 15 2016 (UABS Facebook 26 April 2016).

e-Horizons

The Energy Centre launched its quarterly electronic newsletter, *e-Horizons*. We selected 3-4 articles from reputable international sources to help our audience learn about innovation and foster conversations relevant to energy, environment, economy and education.

Our audience includes over 1500 local and international (28 countries worldwide) subscribers from academia, public and private sector.

To date we have circulated 2 editions:

December 2015 articles:

- Everything you need to know about the Paris climate change summit and UN talks, The Guardian
- Biggest economies still backing fossil fuels, Climate Network News
- Morocco poised to become a solar superpower with launch of desert mega-project, *The Guardian*
- First-ever sustainable energy roadmap for the Caribbean Island, Worldwatch Institute

March 2016 articles:

- Energy and Disruptive Technologies
  - The Economics of Grid Defection: When and where distributed solar generation plus storage competes with traditional utility services (second highest number with 16 clicks)
  - Disruptive technologies: Advances that will transform life, business and the global economy
- The Solution project – an interactive page showcasing the benefits of a transition to 100% clean, renewable energy worldwide
- Energy Scholarships and Awards, 2016 (highest number of 24 clicks)

The edition was opened by over 30% of the recipients.

Generating Ideas

Five e-posters were displayed on the Level 1 LED Screen (seen by 10,000 visitors each day) as well as TV screens located on each floor of the Business School. These are intended to: Promote good environmental practice in the University:

- Water (July 2015)
- Transport (September 2015)
- Consumer habits (October 2015)
- Paper (May 2016)

Provide energy facts relating to New Zealand:

- Renewable energy (November 2015)
- Geothermal (February 2016)

The Centre collaborated with the University of Auckland's Sustainability and Environment team to align our message to the University's sustainability goals.

www.business.auckland.ac.nz/en/about/our-research/bs-research-institutes-and-centres/energy-centre/energy-centre-generating-ideas.html

2016 Energy Centre Summer School attendees

World Water Day, 22 March 2016

To celebrate World Water Day, this March, we produced an electronic poster with a message of concern relating to NZ's water:
Our challenges:

- Reduce over-allocation
- Improve quality
- Maximise economic benefits from water

Our poster was included on the UN World Water Day map of events:
www.unwater.org/worldwaterday.

Energy Economics Summer School 22-26 February 2016

The 2016 Energy Centre Summer School was held from February 22-26 with around 60 participants again this year, comprising 60% students and 40% others both from industry and the public sector (NZ, Indonesia and Cook Islands). Individuals benefited from learning about the latest trends in renewable energy from research/industry; electricity pricing and structure in NZ; opportunity to network and learn about the Energy Centre's research programme.

This year, we circulated Attendee Evaluation Forms. We received 100% positive feedback regarding course content and satisfaction with the quality of the course. Several attendees benefited from the overview of the energy sector and NZ context that demonstrated opportunities and challenges; others commented on the good range and quality of speakers and the mix of theoretical/practical topics.

Recommended topics for future included other green technologies such as biogas, energy from waste, tidal wave energy; and mini-grids and hybrid systems. Next year, we are planning to condense Summer School into 4 days for practical reasons.

All available presentations can be downloaded from the Energy Centre website.

Student research

Outlines of Centre PhD student theses are now listed on our web site.

Research Symposium on Sustainability 13 November 2015

Sustainability has been recognised as important for UABS in educating students for the future, undertaking relevant and high quality research, meeting institutional obligations and contributing to business, public policy and the well-being of society. Work on a Sustainability Programme was initiated in March 2016, led by Barry Coates. The Symposium was an important step towards developing coherent clusters of research within the sustainability theme. Academic staff from across the University, PhD candidates and professional staff from the Business School were invited; around 60 participated in the event.

The Energy Centre represented the cluster for Sustainable Energy, with Basil facilitating and Kiti Suomalainen, Stephen Poletti and Milad Maralani presenting their research on renewable resources, investment in renewable energy and energy efficiency, respectively. Cluster presentations were followed by group discussions, and our Sustainable Energy group attracted approximately ten participants, discussing current challenges in solar and wind power, and opportunities of electric mobility.

Website

Analytics show total visits to Energy Centre's website increased last year, except Summer School.
Recent updates to the website have included additional links on home page to scholarships, e_Horizons, and Generating Ideas.

Energy Conservation

Basil Sharp judged entries to the Energy Efficiency and Conservation Authority's annual competition. Over 100 business, public sector organisations and community groups submitted entries. Results are to be announced later in May.

Traffic to the Energy Centre website

April to April	All pages	Scholarships	Summer School	Energy Centre landing page
2015	10564	138	1247	2003
2016	11736	188	990	2560
+/-	11%	26%	-20%	21%

Education

Enrolments in the Master of Energy have remained steady at 33. Energy Centre staff contributed to ENG721 Energy Resources.

Energy Economics courses in the Department of Economics were not on offer owing the Steve Poletti being on study leave.

Plans for 2016-17

Critical success factors for 2016-17 are listed in Appendix A.

Research

The solar research project has been a major success, due primarily to Dr Kiti Suomalainen. This project exemplified the payoffs associated with original applied research. Furthermore, key stakeholders, notably Auckland Council and Mercury Energy, have expressed a keen interest in using the results. Kiti leaves the Centre at the end of May and we are proposing to support her continued involvement in this project, working with Dr Wen and myself to match the solar data up with household socio-economic data. This further builds on the reports of our Summer Scholars.

Government continues to struggle with water management. Considering the role of hydro in electricity supply and increased competition for water from agriculture we are proposing to launch an initiative on the economic value of water management and policy.

Research collaborations, particularly with the Faculty of Engineering, will continue. The MBIE funded project with the LMRG ends in 2017 and we anticipate further collaborations with the Faculty.

Outreach

Energy Matters will continue through May 2017. The theme of disruptive technology will continue, at least through 2016. Our October speaker is with the Edison Institute, Washington D.C..

Education

With Dr Poletti's return from study leave we will be able to offer courses in energy economics. We expect four PhD students to submit by May 2017. This will involve a significant commitment from supervisors.

Administration

As noted earlier, Dinah Towle has enhanced the Centre's capacity to engage with external stakeholders. We expect this momentum to be at least sustained through May 2017.

Appendices

Appendix A: KPIs

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 journal	A
	Academic workshops	2 workshops	A
	Conference presentations	3 presentations	A
	Public forums	2 public forums	A
Education	Courses in energy economics	Not on offer	A
	Summer School	70% satisfaction level	A
	PG completions	2 honours & 1 PhD	A
	Teaching into Master of Energy	Enrolments in energy economics	A
Outreach	Public seminars	At least 4 presentations	A
	Herald opinion pieces	2 submissions	A
	Newsletter	4 newsletters	NA
	Network	2 ERIN meetings	A
Admin.	Meeting with EETNZ	4 meetings	A

Critical Success factors and Key Performance Indicators for 2016-2017

Programme	CSF	KPI
Research	Applied research projects	2 project reports
	Cross faculty engagement	2 cross disciplinary projects
	Peer reviewed articles & reports	2 papers in ranked journal
	Academic workshops	2 workshops
	Conference presentations	3 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 & 2 PhD
	Teaching into Master of Energy	Enrolments in energy economics
Outreach	Public seminars	At least 4 presentations
	Herald opinion pieces	2 submissions
	Newsletter	4 newsletters
	Network	2 ERIN meetings
Admin.	Meeting with NZEET	4 meetings

A = achieved, NA = not achieved

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**

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