



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

The Energy Centre

Annual Report

May 2014-2015



Annual Report to The Energy Education Trust of New Zealand

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Introduction

The Energy Centre aligns its programmes in support of 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 programmes draw on, and benefit from, the enthusiasm and expertise of numerous individuals across campus. We acknowledge the following sustained contributions:

Dr Kiti Suomalainen

Dr Steve Poletti (Economics)

Dr Golbon Zakeri (Engineering Science)

Dr Tony Downward (Engineering Science)

Dr Rob Kirkpatrick (Engineering)

Dr Geoff Pritchard (Statistics)

Mr Bart van Campen (Engineering Science)

Dr Sam Malafeh (Economics)

Professor Mark Greer (Dowling College, USA)

Mr Frank Duffield (Honorary Fellow)

PhD supervisions have increased to six establishing the largest concentration of candidates in the Business School. Each candidate is working on topics that are applied and of relevance to New Zealand.

Dr Sam Malafeh graduated in May 2014.

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*. Mina is examining the seasonal correlation between hydro, wind and sun radiation to figure out any feasible time and suitable locations for solar contribution. She is going to use SWEM (developed by the Centre) to find the impact of the large solar and wind generation on the electricity market considering market power, price, and potential effects on the distributors.

Maralani, Milad, *The Potential Impact of Industrial Energy Savings on The New Zealand Economy*. Milad is developing an energy-economy model to show the potential impact of introducing more energy efficient technology at Tiwai Point Aluminium Smelter on the electricity market, economic output and welfare in New Zealand. His research is part of an MBIE funded project in collaboration with the Faculty of Engineering.

Moshrefi, Mahsa, *Energy Efficiency and Energy Policies*. Mahsa's research will provide estimates of relative energy efficiency across OECD countries, noting the impact of energy mix on efficiency. She is negotiating access to confidential data held by Statistics New Zealand that will enable detailed study of energy within manufacturing and primary sectors of the New Zealand economy.

Shafiee, Hamed, *New Zealand Gas Market and the Global Evolution of LNG Pricing System*. Hamed recently joined the Centre's PhD group. He plans to study approaches that could improve price discovery in the New Zealand natural gas market using long-term and spot LNG contracts; optimising the natural gas supply portfolio of the

country with less pressure in national reservoirs and storage; and evaluating the possibility of utilising LNG derivative contracts in order to insure an appropriate supply of natural gas in a low-priced and timely manner.

Mashinchi, Sina, *Energy-Environment-Economy Modelling*. Sina will use and adapt for application to New Zealand a complex econometric model developed at Cambridge University for analysing macroeconomic effects, sectoral effects, and distribution and economic welfare effects for a range of climate change policies.

Sheng, Mingyue (Selena), *Commuter's Journey to Work Travel Behaviour: A Spatial Econometric Analysis*. Selena submitted her PhD in late 2013 and was on maternity leave through April 2015. Reviewer comments, received in May 2014, recommended further research which is now underway.

We are extremely grateful for the support and guidance provided by: Amanda Stanes, who resigned from the Business School late 2014; Dinah Towle as co-ordinator for the Energy Centre; the Business School's Marketing and Communications team, and the Advancement team for their pivotal contributions toward the translational pathway from the desks of our research team to external stakeholders.

In addition to supporting the Chair in Energy and Resource Economics, the Trust funds the post-doctoral position (Dr Kiti Suomalainen) and three PhD scholarships for students in Business and Economics. Additional funding to support research came from The Royal Society of New Zealand, The Ministry of Business, Innovation and Employment (MBIE) and a share of revenue arising from contributions to the Master of Energy programme taught out of the Faculty of Engineering.

Achievements

Programmatic achievements through May 2015 are listed below against Key Performance Indicators (KPI) in Appendix A. Proposed KPIs for the period ending May 2016 are listed in Appendix B.

2.1 Research

Electricity

The programme of work aimed at analysing the relationships between seasonal wind patterns and hydro inflows, and investigating their spatial correlations with electricity demand, led by Dr Suomalainen, is complete and has been published in *Applied Energy*. A further paper, showing that New Zealand can achieve its target of 90 percent renewable sources of electricity with currently consented renewable energy projects by 2025 has been submitted to *Energy Policy*.

To the best of our knowledge the design of contracts between land owners and wind farm generators has not yet been studied. Towards the end of 2014 we initiated a project, in collaboration with Engineering Science, aimed at optimal contract design in an uncertain environment, recognising that the wind is often not blowing and market prices are variable. A working paper on this topic is available.

Dr Suomalainen's leadership in wind energy research has been outstanding and will continue albeit at a smaller scale. Expanding her involvement into solar energy will broaden her research portfolio in renewable energy. She is leading a programme of work focussing on the solar potential of Auckland and the potential role of electric vehicles for storing excess solar energy. This is a very timely initiative considering the decreasing costs of solar power and the recent announcement on battery innovations by Tesla and the interest of stakeholders, including electric vehicle manufacturers, Auckland Council and Vector.

On the demand side, work continues in collaboration with Engineering on the project aimed at estimating the benefits of introducing innovative energy saving technology at Tiwai Point. Milad Maralani has developed a model for estimating the benefits and the results are to be presented in Wellington on May 26 to industry and public sector officials.

Energy efficiency

A working paper *Energy Efficiency in OECD Economies: Does Renewable Energy Matter?* by Mahsa Moshrefi and Basil Sharp is being revised before submission to *Energy Economics*. Mahsa's research shows that energy efficiency in New Zealand has tapered off in recent years, due primarily to the dominant role of oil in the economy. Her findings were presented to MBIE in November 2014. Her research has resulted in a collaborative project with MBIE to undertake a similar study using New Zealand data.



Oil and gas

Progress on the development of New Zealand's oil and gas resources was hindered by access to data, increased administrative load, and crowding out by other projects. We now have the makings of a reasonably good data set on imports, exports and royalties flowing to government. To date it has not been possible to obtain detailed data on the source/destination of New Zealand's oil imports/exports. We are however close to obtaining agreement with MBIE and Statistics New Zealand to allow access to confidential data on energy use in manufacturing and primary industries and the source (quantity and value) of oil imports. These data should provide a basis for mapping energy flows, by type, in at least two sectors of the economy.

Cross faculty engagement

On-going:

Large scale electricity energy storage at Tiwai Point Aluminium Smelter and savings for the New Zealand grid; funded by MBIE (\$1.9 million over three years), in collaboration with the Faculty of Engineering.

New application:

Application in collaboration with the Faculty of Engineering, *Hazards and Infrastructure*, (\$2.3 million over four years): to examine the benefits of integrating communication and energy supply systems.

In addition we have on-going research collaborations with Engineering Science and the Faculty of Science.

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-Special Issue* (accepted March 2015).

Khazaei, J., G. Zakeri, and S. Oren. Market Clearing Mechanisms under Demand Uncertainty", under review, *Operations Research*.

Khazaei, J., G. Zakeri, and G. Pritchard. The effects of stochastic market clearing on the cost of wind integration: a case of New Zealand electricity market", under review, *Energy Systems*.

Malafeh, S. and B. Sharp, Sustainable Geothermal Development: The Role of Royalties, (revise and resubmit) *Energy Policy*.

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*, (accepted, March 2015);

Sánchez-Alfaro, P., G. Sielfeld, B. Van Campen, P. Dobson, V. Fuentes, A. Reed, R. Palma-Behnke, and D. Morata; Geothermal Barriers, Policies & Economics in Chile – lessons for the Andes; *Renewable & Sustainable Energy Reviews* (resubmitted-with-revisions), March 2015.

Suomalainen, K., G. Pritchard, B. Sharp, Z. Yuan and G. Zakeri. Correlation analysis on wind and hydro resources with electricity demand and prices in New Zealand, *Applied Energy*, p.54.

Suomalainen, K. and B. Sharp Electricity Sector Transformation and Renewable Energy Policy in New Zealand (under review) *Energy Policy*.

van Campen, B. and K. Rai; Geothermal Policy and Regulation – Cases from Chile, Kenya, Philippines, New Zealand; IRENA/Geothermal Institute Working Paper; May 2015

van Campen, B., J. O'Sullivan, and K. Rai; Geothermal Capacity Needs Assessment Methodology; IRENA/Geothermal Institute Working Paper; April 2015;

Young, D., Poletti, S.J; Browne, O; 'Can Agent-Based Models Forecast Spot Prices in Electricity Markets? Evidence from the New Zealand Electricity Market' (revise and resubmit) *Energy Economics*.

Young, D., Poletti, S.J; Browne, O; Will Wind Kill Energy-Only Electricity Markets? Submitted to *Economics of Energy and Environmental Policy*.

Academic workshops

Reasonably frequent workshops were held over the period; at least 2 were based on PhD research, and a further 2 involved the Centre's research collaborators from Dresden.

Conference presentations

Cleland, N., G. Zakeri and B. Young. 2014. Reserve constraints in electricity markets effects on large scale integrated consumers, *Proceedings of IEEE Innovative Smart Grid Technologies (ISGT)*.

Cleland, N., G. Zakeri, G. Pritchard and B. Young. 2014. Integrating Consumption and Reserve Strategies for Large Consumers in Electricity Markets, *Computational Management Science*.

Poletti, S.J., O. Browne and D. Young. Presentation "Does Wind Kill Energy Only Markets". International Energy Workshop, Paris. June 19–21, 2013. Paper available on-line www.internationalenergyworkshop.org/docs/IEW%202013_1E4Poletti.pdf

Poletti, S.J., "Green Growth and Poverty Reduction in NZ", Sustainability Conference, Massey University, Albany Campus, 13-15 November 2013, presentation and on panel for session "Poverty and sustainability".

Suomalainen, K. and B. Sharp. 2014. Energy Issues, Challenges and Opportunities in New Zealand, The 1st Meeting for Energy Research Institute Network (ERIN), 6 September, Bandar Seri Begawan, Brunei Darussalam.

van Campen, B.; Comparison of Geothermal Regulation between Chile, Philippines and New Zealand; presented at World Geothermal Congress, Melbourne, April 2015.

van Campen, B., A. Prieto and A. Vidal; Opening session & discussion for 'Foro Latinoamericano', a Latinamerican side-event to World Geothermal Congress 2015 to stimulate information exchange and networking on geothermal opportunities in Latin America; April 2015.

van Campen, B., R. Archer, and M. Allen; Roundtable with Chilean NZGW Delegation - side-event to New Zealand Geothermal Workshop to stimulate NZ-Chile/Latin America information exchange and networking on geothermal opportunities in the region; Auckland, November 2014.

van Campen, B., J. O'Sullivan, and B. Lynne; Andean Geothermal Policymakers Workshop; organized by Geothermal Institute, Centro de Excelencia en Geotermia de los Andes (CEGA) and the International Renewable Energy Agency (IRENA); Santiago de Chile, 19-23 May 2014.

Public forums

Basil Sharp delivered the keynote speech *Research Frontiers in Energy: Policy, Economics, Security and the Environment* at the opening ceremony of the Graduate Conference at Uniten in Kuala Lumpur, Malaysia, on April 8. Uniten is a private university with a particular focus on engineering and energy. The Director of the Economics Institute hosted the visit which included a site visit to their smart grid laboratory where experiments can be run that simulate the impact of intermittent electricity supply (such as wind) and consumer response to tariffs. Uniten built a solar powered car that competed in the trans-Australia race a few years ago. Basil had an opportunity to learn about student PhD research projects and provide feedback on the empirical methods being used.

While in Kuala Lumpur, Basil presented a seminar *New Zealand's Approach to Sustainable Electricity* to staff at Tenaga Nasional Berhad (TNB). TNB is Malaysia's principal electricity supplier. The CEO of TNB and Chair of the TNB Board also attended. There was a high level of interest in the structure of New Zealand's electricity market, particularly around market design, partial privatisation and the integration of renewables.

The 2014 Vice-Chancellor's Lecture Series involved research leaders from the Faculty of Engineering and the Business School discussing new and emerging research in renewable and

sustainable energy. "Renewable energy resources are a critical issue of our time as New Zealand strives to be at the forefront of new science and technology that will allow us to live in more sustainable ways," said University of Auckland Vice-Chancellor Professor Stuart McCutcheon. "I'm pleased that the theme of this year's Vice-Chancellor's Lecture Series is such an important one and that the series focuses on advanced and innovative research that will help shape our future." The series is an annual event that provides an opportunity for research centres across the University to promote their work to the public. The Centre contributed to the 2014 series with *Latest and smartest ideas for a greener NZ*.

Dr Zakeri, *Creation and Utilisation of Demand Response in Electricity Markets*, Tuesday 14 October, 5-6pm

Dr Poletti, *Green Growth – New Zealand's Future?* Tuesday 21 October, 5-6pm

Both presentations attracted a good turnout and a number of unsolicited compliments from the general public.

On May 5 2014 the Centre had an opportunity to display its research programme at the University of Auckland's Celebrating Research Excellence Evening. Perhaps one of the main spin-offs from participating in the event is that we now have an up to date set of banners and material to display at other events, such as Energy Matters.





2.2 Education

Courses

Econ 372 Energy Economics, undergraduate course on the development and optimal utilisation of energy resources, 68 students enrolled.

Econ 783 Energy Economics, post graduate course focussing on electricity markets, 7 students enrolled.

Summer School

Summer School 2015, February 23-27, was the best to date. We had a group of around 60 participants that included consultants, university employees, government officials and students. Presentations spanned the field of energy economics and included, for the first time, a presentation by the University's energy conservation team. A number of participants expressed interest in further study.

PG completions

BCom Honours Dissertations:

Smirnova, A. Economics of Feed-in Tariffs for renewable electricity generation in New Zealand, 2014

Webster, G. The competitive effect of transmission capacity in the 2025 New Zealand electricity market, 2014.

PhD completions:

Nil.

Master of Energy

Energy 721 Resources, a post graduate course covering economic principles; oil, electricity and gas markets. Enrolments

2.3 Outreach

Public seminars

Energy Matters 2014 continued to focus oil and gas development:

31 July, Dr Roland Williams, *Producing Energy for the Asian Market: The Australian Experience*. Presentations were made to stakeholders in Wellington and Hawke's Bay.

8 October, Dr Sean Simpson, *Climate Friendly fuels: A challenge of scale and time*. Sean also gave presentations to Auckland Council's economic development team; in Wellington, Business NZ, economic divisions from within government, and Z Energy; and, Callaghan Innovation in Auckland.

5 March, Dr Claire Spencer, *Political turmoil in the Middle East: Why and what next for the rest of the world?* Claire presented seminars to government officials in Wellington and faculty at The University of Otago.

Going forward, we have formed the view that three Energy Matters presentations is optimal all things considered.

Basil Sharp presented a seminar *NZ's renewable electricity policy and role of wind energy in NZ supply system* at the University of Dresden.

Dr Kiti Suomalainen presented a seminar in November 2014 at the Univerzita Karlova Praze, Czech Republic. This was a contribution to the Centre's collaboration with its European partners.

Basil Sharp presented a seminar in October 2014 on *New Zealand's electricity generation system and market*, translated into Japanese, to an audience of around 40 people.

Opinion pieces

Basil Sharp was interviewed by Nathan Smith of the NBR. The article was titled The advantages and pitfalls of lower oil prices, 3 November, 2014.

www.nbr.co.nz/article/advantages-and-pitfalls-lower-oil-prices-ns-p-164763

Using more natural gas will offset our carbon footprint, Opinion, by Frank Duffield, *The Dominion Post*, 25 April 2014.

Fracking: Is it good for New Zealand? by Basil Sharp, www.ingenio-magazine.com

Newsletter

No progress was made on this initiative. The University's review of administration created a great deal of change and 2014 was unsettling for most.

Contacts data

Ongoing.

Network collaboration

The Centre is a member of the Energy Research Institute Network (ERIN) which is affiliated with the Economic Research Institute for East Asia (ERIA) based in Jakarta. This network has already yielded benefits: invitation to speak at a graduating ceremony at Uniten, Kuala Lumpur; participation on two network events (September 2014 and April 2015); and enhanced prospects for collaboration within East Asia. Outputs from involvement in the network are listed within the report.

Collaboration with the University of Dresden resulted in Basil Sharp visiting Dresden in September 2014 and Dr Suomalainen in December 2014. Our German counterparts visited Auckland in February 2015. There is appetite for collaboration in the future and funding to support a sustained relationship is being explored. Outputs from collaboration to date are listed in the report.

2.4 Administration

The Dean has agreed to the appointment of a research fellow within the Energy Centre. The successful appointee will assist the director with research and share the administration load.

Advisory board

Agreed to discontinue.

EETNZ meetings

The director filed reports to four meetings and attended two.

Plans for 2015-2016

Critical success factors for 2015-16 are listed in Appendix C.

3.1 Research

We are planning to continue with the following research themes: redirecting some effort from wind energy to solar, and lifting our performance on oil and gas. Particular emphasis will be placed on progressing projects to journal submission. We anticipate industry involvement in our solar initiative. Bart van Campen will continue with his research into geothermal energy. Dr Poletti will be on study leave July 2015 through July 2016.

3.2 Education

Courses in energy economics will, most likely, not be offered because of Dr Poletti's absence on leave. Greater effort will be directed at working with PhD students to get their research into good peer reviewed journals and to promote their findings to the public.

3.3 Outreach

Energy Matters will continue through 2016. We expect greater spin-offs from ERIN in the form of research collaborations and staff exchange, possibly with centres/institutes in Indonesia and Malaysia.

3.4 Administration

We hope to appoint a research fellow in the near future to contribute to a lift in productivity and assist with administration.



Appendices

Appendix A

Outcomes Against Critical Success Factors and Key Performance Indicators

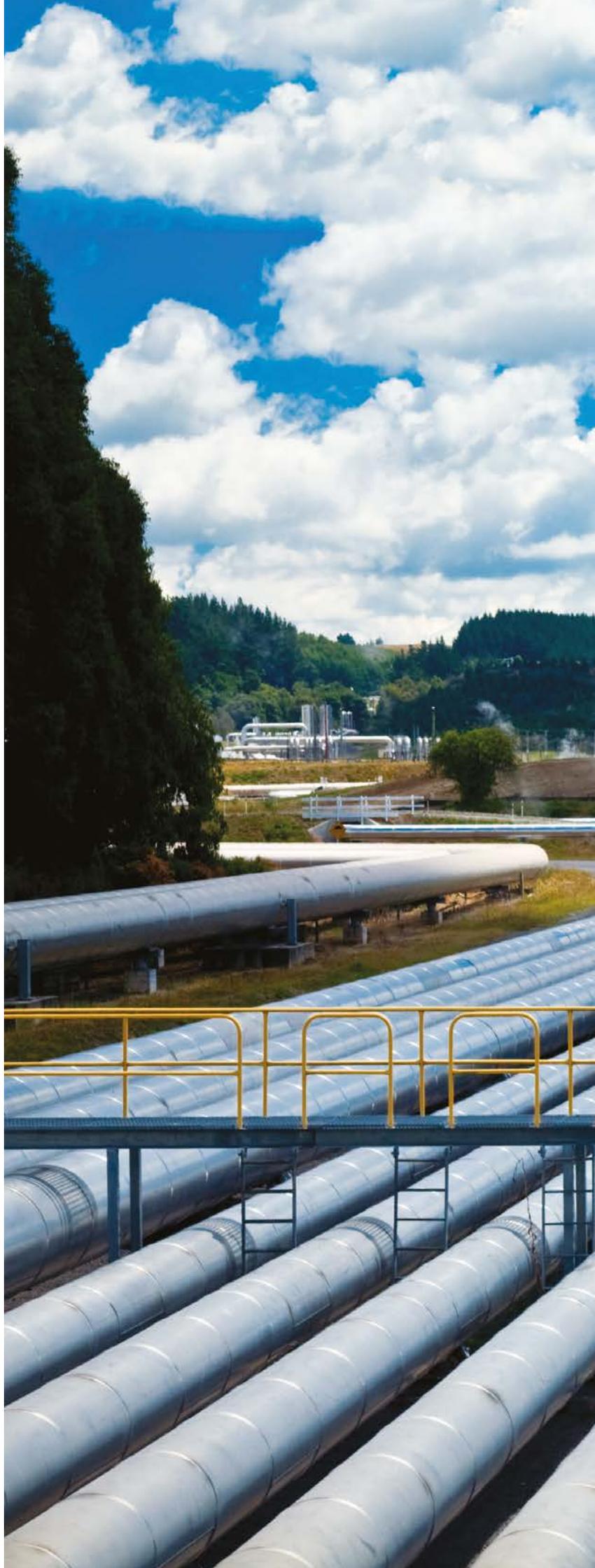
Programme	CSF	KPI	Achievement
Research	Applied research projects	2 project reports	A
	Cross faculty engagement	2 cross disciplinary projects	A
	Peer reviewed articles & reports	2 papers in ranked journals	A
	Academic workshops	2 workshops	A
	Conference presentations	3 presentations	A
	Public forums	2 public forums	A
Education	Courses in energy economics	3 courses evaluated by participants	A
	Summer School	At least 70% level of participant satisfaction	A
	PG research completions	2 honours completions & 1 PhD	A/N
	Teaching into Master of Energy	Enrolments in energy economics	A
Outreach	Public seminar series	At least 4 presentations	A
	Herald opinion pieces	2 submissions	A
	Newsletter	4 newsletters	D
	On line "contacts" data base	Establish data base	N
Admin.	Participation by Advisory Board	2 meetings	D
	Meeting with EETNZ	4 meetings	N

A = achieved; NA = not achieved; D = discontinued by agreement

Appendix B

Outcomes Against Critical Success Factors and Key Performance Indicators

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 journals
	Academic workshops	2 workshops
	Conference presentations	3 presentations
	Public forums	2 public forums
Education	Courses in energy economics	Possibly not on offer
	Summer School	At least 70% level of participant satisfaction
	PG research completions	2 honours completions & 1 PhD
	Teaching into Master of Energy	Enrolments in energy economics
Outreach	Public seminar series	At least 4 presentations
	Herald opinion pieces	2 submissions
	Newsletter	4 newsletters
	Network	2 ERIN meetings
Admin.	Meeting with NZEET	4 meetings







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