

# The Energy Centre

## Annual Report 2012



# THE ENERGY CENTRE ANNUAL REPORT TO THE ENERGY EDUCATION TRUST OF NEW ZEALAND MAY 2013



**Director and Professor of Energy and Resource Economics, Basil Sharp joined the department in 1991. Basil Sharp's research applies economics to the real world challenges of energy and natural resources. He is particularly interested in addressing energy-related issues that confront New Zealand, engaging industry and policy makers.**

The Energy Centre's mission is to provide research, policy analysis and educational programmes to help business and government confront energy issues of national significance to New Zealand.

In 2010 the Centre undertook to align its programmes in support of the following strategy:

1. Undertake independent research and business and policy analysis on energy-related issues important to New Zealand's future.
2. Research that is cross-disciplinary, drawing upon as appropriate economics, engineering and the physical, environmental and social sciences.

3. Act as a bridge for open and informed dialogue between the energy industry, government and the community.

4. Provide energy-related education that creates future leaders for academia, business and government.

Key performance indicators (KPIs) are set around the strategy and this annual report is structured along the lines of key result areas.

## 1. INTRODUCTION

Many groups and individuals contributed to the Centre's achievements during the 2012/13 period. Cross-disciplinary research is an over-arching theme and we acknowledge the following sustained contributions:

- Dr Steve Poletti (Economics)  
Dr Golbon Zakeri (Engineering Science)  
Dr Tony Downward (Engineering Science)  
Dr Rob Kirkpatrick (Engineering)  
Dr Geoff Pritchard (Statistics)  
Dr Hugh Byrd (Architecture)  
Mr Bart van Campen (Engineering Science)  
Mr Sam Malafeh (Economics)  
Professor Mark Greer (Dowling College, USA)  
Mr Frank Duffield (Honorary Fellow)

In addition to supporting the Chair in Energy and Resource Economics, the Trust funds the post-doctoral position (recently filled by Dr Kiti Suomalainen) and three PhD scholarships for students in business and

economics. Funding to support research came from The University of Auckland's competitive funding pools, the Marsden Fund, Pure Advantage, Genesis Energy and a share of revenue arising from its contribution to the Master of Energy programme taught out of the Faculty of Engineering.

The Centre's Advisory Group met twice (May and October 2012) over the past 12 months to provide programmatic advice and assist with building connections with business. Minutes from each meeting have been forwarded to the trustees.

The Centre's research programme combines both "blue sky" and applied projects. The former involve longer lead times and have an emphasis on contributions to knowledge, while the latter are motivated by contemporary challenges facing business and government. Translating research into value-adding outcomes, whether academic or applied, is a central strategy. In this respect, The University of Auckland Business School's Advancement team played a pivotal role in the translational pathway to raising the Centre's public profile and level of engagement with stakeholders and the community.

## 2. RESEARCH AND POLICY

The research portfolio is designed around two broad themes: electricity, which has received sustained effort from the Centre's inception, and more recently, oil and gas markets.

### 2.1 ELECTRICITY

#### Supply

Seventy seven per cent of New Zealand's electricity comes from renewable sources, the second highest in the OECD. Installed capacity of renewable sources is dominated by hydro (58 per cent), followed by geothermal (13 per cent) and wind (5 per cent). Increasingly, geothermal and wind sourced electricity will feature in supply if the government's goal of 90 per cent by 2025 from renewable sources is to be achieved. Research has focussed on variable generation, spatial distribution of renewable sources, correlation between wind and water inflows, and the capacity of the market to handle variability. The following two initiatives are aimed at addressing these questions.

#### Renewable energy workshops

The Centre's grant from the Faculty Research Development Fund was used to fund two separate events titled Economics of Change: Towards a Renewable Energy Future on 28-30 August 2012 and 24-25 January 2013. Researchers from the UK and US shared their experiences with, and knowledge of, the challenges associated with the introduction of renewable sources of electricity into power

systems. The programme included a mix of "blue sky" research seminars, and sessions open to business and the public.

Speakers included:

- Professor Jim Bushnell, Haas School of Business, University of California, Davis: Allocation and leakage in cap and trade markets for CO<sub>2</sub>.
- Professor Rodrigo Palma, Director of the Center for Energy, University of Chile: Transmission expansion decision-making and pricing in Chile.
- Professor Shmuel Oren, Industrial Engineering and Operations Research, University of California at Berkeley: A historical perspective and business model for load response aggregation based on priority service.
- Professor Yves Smeers, Professor of Energy Economics, Université catholique de Louvain (Center for Operations Research and Econometrics): Incomplete market stochastic generation capacity expansion models.
- Professor Richard Green: The long-run impact of wind power on electricity prices and generation capacity.
- Professor Eddie Anderson: Competitive bidding with a reservation price and an execution price.
- Steve Poletti: The University of Auckland Agent-Based-Model of the NZ electricity market: An overview and some open problems

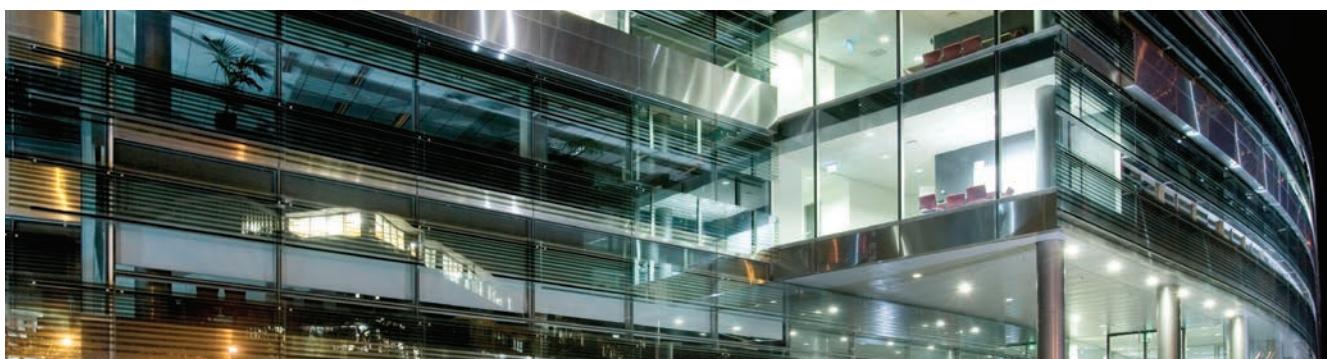
- Professor Peter Cramton: Long-term Investment and the Transformation to Renewables.

- Professor Andy Philpot: Risk and competition in hydro-dominated electricity market.
- Sam Malafeh: Geothermal energy development.

Researchers from across the University and industry stakeholders participated in the workshop. Two public lectures were given:

- Professor Richard Green: Reforming the British Electricity Market for Low-Carbon Generation.
- Professor Peter Cramton: Promoting Cooperation in International Climate Negotiations Long-term Investment and the Transformation to Renewables.

Centre associates have embarked on new research initiatives following the two concentrated workshops involving contributions from internationally renowned economists and mathematical modellers. Synergies and collaborations were developed over the course of the two seminars that put researchers at the Centre and the Electric Power Optimisation Centre in a better position to meet forthcoming challenges related to energy and resources and to compete for external research funds. The workshop further cemented relationships between the Centre and several world-renowned research centres, including UC Berkeley, Universite Catholique de Louvain, University of Maryland, and the University of California, Davis.



## Wind energy

A statistical model based on wind speed data and electricity generated by the Tararua Wind Farm was used to quantify relationships between water inflows and electricity generating potential at different sites throughout New Zealand. The models revealed a low positive correlation between wind and water inflows in major catchment areas (viz. Waitaki and Waikato catchments). This research is now being extended to examine the optimal location of wind farms.

Nodal pricing in the electricity market is determined by the highest bidder. Given the low cost of electricity generation from wind farms it seemed highly plausible that wind farms can change the merit order resulting in lower nodal prices. An econometric model confirms this hypothesis and results were presented to the NZ Wind Energy Association.

## Solar

Vector and Genesis are in the process of rolling out solar packages to a limited number of Auckland households. In anticipation of the growing interest in solar, Hugh Byrd (Architecture and Planning), Nirmal Nair (Engineering) and Basil Sharp (Economics) were successful in obtaining a Cross-faculty Research Grant to assess the potential of

solar in Auckland. Results were presented to a public seminar in July 2012, showing a return of 3 per cent on investment with no subsidy, rising to around 9 per cent with a feed-in subsidy, similar to that offered in many European countries.

A second event, co-hosted with the New Zealand Asia Institute, was based on a visit by a team from the University of Tokyo. The lecture The Future of Solar Technology was open to the public and attracted more than 150 participants. This seminar dovetailed nicely with our earlier presentation and reinforced our findings that the future of photovoltaics in New Zealand is most likely to be based on distributed as opposed to concentrated sources of solar generation under consideration in Japan.

## Electricity demand

### Residential demand

In 2012 the Centre entered into a commercial agreement with Genesis Energy to analyse energy savings associated with its "Tomorrow Street" initiative. Thirteen homes in Devonport signed up to an 18-month programme aimed at exploring energy savings through the use of new products and services, including solar panels, home energy management, smartphone apps and electric vehicles.

Beginning in June 2012 and running through April 2013, the data showed an average of 17 per cent in electricity savings compared to the same period in 2011. Our results were presented to the public and the Genesis Board on 6 December 2012.

On a related project, the Centre is continuing to work on a larger sample of Genesis customers comparing consumption of households with smart meters and variable tariffs with those not having access to smart meters and variable tariffs.

### Industrial demand

NZ Aluminium Smelters (NZAS) expressed an interest in using Shell Heat Exchanger (SHE) technology to manage load, contribute to heat recovery and recycling. In April 2013 the Centre teamed up with the Faculty of Engineering's Light Metals Research Centre (LRMC) and submitted a bid (\$2.4 million) to MBIE to fund a project that will examine the technical feasibility and economics of the SHE. NZAS has offered to co-fund the research. The NZAS plant at Tiwai consumes 15 per cent of New Zealand's electricity. Dynamic load management offers benefit to the company through avoiding high prices and to the economy by releasing electricity to the grid.



## 2.1 OIL AND GAS

There is considerable need to undertake research into the role of liquid fuels in the economy and the opportunities for developing oil and gas resources in New Zealand. Energy Matters was designed to capture the public's attention on the importance of this topic and provide a back drop for research in 2013/14. Four students (three PhD and one honours) have started research projects related to oil and gas markets.

## 2.2 GREEN GROWTH

Steve Poletti and Basil Sharp completed their case studies of green growth opportunities for New Zealand. Vivid Economics, a UK-based consulting firm with links into the London School of Economics, provided an overview of international markets and trends. The report included a foreword from Professor Lord Nicholas Stern, IG Patel Professor of Economics and Government and Chair of the Grantham Research Institute on Climate Change and the Environment, LSE.

A summary of findings was presented to politicians in Wellington and senior officials from the MBIE and the Ministry for the Environment. The Chair of the Pure Advantage Trust, Rob Morrison, also met with Ministers Steven Joyce and Bill English to present a summary of findings. Public launches of the report were held in Auckland and Wellington on 15 and 16 November. Radio interviews and an interview on TV1's Breakfast programme were also scheduled.

### Outcomes

Centre associates contributed to five publications, eight conference presentations, and two working papers.

### Publications

Byrd, Hugh, Anna Ho and Basil Sharp. Emerging energy technologies: Implications on urban form, (Revise and resubmit, Energy Policy).

Khazei, J., A. Downward and G. Zakeri. Modelling counter-intuitive effects on cost and air pollution from intermittent generation, (accepted) Annals of Operations Research.

Khazaei, J., G. Zakeri, and G. Pritchard. Simulating the effects of stochastic programming market mechanism for dispatching wind for the NZEM, (accepted) Energy Systems.

Craigie, D, A. Philpot, G. Zakeri, and M. Todd. Demand response through pak shaving, (under review) Operations Research Letters.

Poletti, S. and B. Sharp (in association with Vivid Economics, UK) Green growth: opportunities for New Zealand, Report prepared for the New Zealand Green Growth Research Trust, Final report, November 2012, p.310.

### Conference presentations

Oung, D, S.J. Poletti and O Browne. "Can agent based models forecast spot prices in electricity markets?" 35th IAEE International Conference: Energy Markets Evolution Under Global Carbon Constraints: Assessing Kyoto and Looking Forward, 24-27 June 2012, Perth.

Poletti, S.J., D. Young, and O. Browne. "Market power in electricity markets. Evidence from New Zealand", 35th IAEE International Conference, 24-27 June 2012, Perth.

Van Campen, Bart. Consideraciones Ambientales y Políticas Energéticas: ?el caso de Nueva Zelanda. Presentation on NZ

climate change and renewable energy policies for an audience of Generadores Chile and Sofofa (Chilean Electricity Generator and Industry Association, respectively).

Basil Sharp, New Zealand's oil and gas reserves as a pathway to a low carbon economy, Advantage NZ: 2013 Petroleum Conference, 29 April, SkyCity Auckland Convention Centre.

Sam Malafeh and Basil Sharp. "Sustainable development of geothermal resources: an economic alternative" at Stanford Geothermal Workshop, Stanford University, USA, 13 February 2013.

Sam Malafeh and Basil Sharp. "Sustainable development of geothermal resources: an economic alternative" at 34th New Zealand Geothermal Workshop, Auckland, New Zealand, on 20 November 2012.

Sam Malafeh and Basil Sharp. "Geothermal development: Challenges in multiple access scenario (Unitisation)" at two conferences:

- International conference on green technology and ecosystems for global sustainable development in Tuzla, Bosnia and Herzegovina on 28 May 2012.
- International 100 per cent renewable energy conference and exhibition in Istanbul, Turkey, on 28 June 2012.

### Working papers

Pusschel, Sebastian and Bart van Campen. Value of Wind Energy in Chilean and New Zealand Electricity Markets.

Yang, M and Sharp, B. Impact of wind energy on nodal electricity prices.



### 3. EDUCATION

#### PhD students supported by the Trust

Reports on students supported by the Trust, and based in other faculties, have been forwarded to the Director of the Centre and summaries reported to the Trust. The following students are supported by the Trust and enrolled in the Faculty of Business and Economics late 2012.

Name	Topic
Maralani, Milad	International gas markets
Mashinchi, Sina	The asymmetric effects of oil shocks on OECD economies
Moshrefi, Masha	Econometric analysis of oil markets



#### PhD students not supported by the Trust

Name	Topic
Malafeh, Sam	Sustainable development of geothermal resources
Tang, Kai	Low carbon economy
Sheng, Selena	Choice of transport mode in Auckland

Oliver Browne (recipient of Trust UG scholarship) left the Centre in August 2012 to begin his PhD studies at the University of Chicago. Chicago is easily within the top 10 universities in the USA and Oliver goes on a full University of Chicago scholarship.

#### Honours students

Name	Topic
Clough, Sam	Comparing different computer agent based algorithms to model electricity price
Liang, Qiunan	Forecasting electricity demand in New Zealand
Parekh, Sandeep	Resilience of New Zealand's energy infrastructure
Webster, Gareth	Oil and gas development – government royalty regimes



#### Courses

Centre academics contribute to a total of five courses on offer to students - two undergraduate (300 level) and three postgraduate (700 level):

- ECON372 Energy and Resource Economics
- ECON373 Environmental Economics
- ECON782 Regulation & Competition Policy
- ECON 783 Energy Economics
- ENG721 Energy Resources

#### Summer School

The Centre's week-long Summer School in Energy Economics ran from 18-22 February. Forty five participants enrolled. The programme was reported to the Trust at its meeting on 24 February 2013.

#### University Summer Scholarship

Jed Armstrong completed a summer scholarship (funded by The University of Auckland) on water economics. His project report Potential Role of Water Markets in New

Zealand's Water Governance System was forwarded to Government officials working on water resource management reform.

#### Outcomes

- Six PhD and four honours students undertaking energy-related research topics.
- Sustained very good enrolments in energy related courses offered in the Business School and Faculty of Engineering.
- Continued interest from students, and participation by industry, in the Summer School in Energy Economics.
- An annual licence to the software supporting the agent based teaching tool (NZIEMS), used in the Summer School to give participants experience with electricity trading, was sold to NZX. The electricity market simulator was funded by a University Teaching Improvement Grant awarded to Drs Zakeri and Poletti. The software was designed and developed by Dr David Young (Post-Doctoral Fellow) and Dr Anthony Downward.

## 4. ADMINISTRATION

The Centre's Advisory Group met twice – May and October 2012 – to provide advice on the Centre's research programme. Greater engagement by the Advisory Group was evident in 2012/13 and in the words of the Chair, "I felt today was a break through meeting". The Advisory Group endorsed the need to focus on liquid fuels and innovations occurring on demand side electricity management. In the case of liquid fuels, the Energy Matters initiative is aimed at providing the context for more serious commitment in 2013/14. The Director reported to Trustees at every meeting over the period.

The Centre took the initiative to develop a closer working relationship with the Scholarships Office.

## 5. STAKEHOLDER RELATIONS

### Business

A presentation was given to the Senior Management Team at MRP on the Centre's mission and programmes of work. MRP identified two contemporary issues – water rights and transmission pricing – where the Centre could contribute analysis. Research is underway in both areas.

A presentation of electricity conservation arising from the Tomorrow St initiative was well received by the Genesis Board and the CEO Albert Brantley.

A presentation of the Centre's research capacity and programme was given to the New Zealand Wind Energy Association.

### Government

In collaboration with the School of Engineering, the Centre has run two courses on the economics of infrastructure for the CFO and second-tier managers at Auckland Council.

Engagement with MBIE officials on topics related to oil and gas, and assistance with honours research projects.

### International

Bart van Campen has been working on the MFAT-sponsored Geothermal Capacity Scoping Project with Geothermal Institute and Energy Centre support. Four countries were visited to estimate physical geothermal potential, state of development of geothermal projects, extent of local capacity and expertise, potential for The University of Auckland/NZ Geothermal Institute to contribute to capacity building (training). From March to May, visits were carried out to Chile, Peru, Argentina and Papua New Guinea.

### Community

Mineral resource development is a key initiative of government. There is, however, a great deal of public apprehension about the role of minerals in wealth and employment creation. Energy Matters, launched in February 2013, is focusing on oil and gas development with the aim of educating the public and raising the level of debate on energy development. Energy Matters has received broad publicity, throughout the alumni network, IPENZ, government departments and at Koru lounges. The series has attracted around 100 registrations at each event. Follow-up round table discussion sessions are used to connect speakers with business and government. In

February, Sir Anthony Brenton (lead speaker in Energy Matters) travelled to Wellington and gave presentations to MFAT officials, the British High Commission and IPENZ.

### Outcomes

On the international front, we are attracting an increasing number of overseas students into the Energy Masters and Geothermal PhD students (especially from Chile; potentially from Peru, Papua New Guinea and Argentina). Collaborative projects are being worked out with the University of Chile, Pontificada Universidad Católica (Chile) and potentially one or more Peruvian universities.

Energy Matters has lifted the Centre's public profile and contributed to community's understanding of oil and gas development.

We have increased engagement with energy businesses and energy associations.

Basil Sharp and Frank Duffield, New Zealand's Oil and Gas reserves can be part of Low Carbon Future, NZ Herald, 8 May 2012.

Basil Sharp, Water rights needs to be traded to find their best use, New Zealand Herald, 5 September 2012.

Basil Sharp, Value of oil and gas to economy not understood , Energy News, 30 April 2013.

## 6. STRATEGY 2013/2014

The following broad themes are proposed for 2013/14, conditional on funding and expected contributions from postgraduate students and academic associates.



## **6.1 RESEARCH AND POLICY**

In 2013/14 the plan is to maintain the two policy related themes. The existing programme of work on electricity will continue with some additional topics including the impact of geographic concentration on the market and potential externalities associated with location. Research effort into renewable sources of electricity will benefit from Dr Kiti Suomalainen's experience in this field. On advice from the Advisory Group, effort will be directed - starting at a broad level - toward oil and gas markets.

### **Electricity markets**

The Labour Party's proposal to reform the electricity market is likely to create a lot of public interest and debate. The Centre is well-placed to provide a neutral venue for discussion and assessment of the proposal to put a single buyer in place. The agent-based model developed by the Centre could be used to simulate the impact of the proposal on generators, investment and prices. This will need to be approached cautiously, given the lack of detail. One possibility under consideration is to run a research workshop on the topic followed by a public seminar early in the New Year.

The contract with Genesis on electricity conservation and demand side management will run through 2013. The intention is to use results for a paper to be submitted to an international journal. Considerable effort will be devoted industrial demand side management should the bid into MBIE turn out to be successful.

### **Oil and Gas**

The foundations for a more intensive research effort into oil and gas have been laid by Energy Matters. Additional momentum will follow from three PhDs and a number of honours projects. It is proposed that the initial focus should be on quantifying and reporting on the role of liquid fuels in the economy.

## **6.2 EDUCATION**

The suite of energy-related courses and the Summer School will again be on offer in 2013/14. We are reaching capacity in terms of postgraduate supervision and will focus on closer student-supervisor engagement that aligns with the Centre's strategic direction.

## **6.3 ADMINISTRATION**

No changes are envisaged here. The Director of the NZ Wind Energy Association has expressed an interest in joining the Centre's Advisory Group.

## **6.4 STAKEHOLDER RELATIONS**

Initiatives in 2012/13 to lift the Centre's profile and engage with the community, including Energy Matters, conference presentations, Herald opinion pieces and industry newsletters, have been very successful. A further public series is being planned for 2014.



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