



THE UNIVERSITY
OF AUCKLAND

BUSINESS SCHOOL

The Energy Centre

Annual report for 2009



THE ENERGY CENTRE'S MISSION:



To provide research policy analysis and educational programmes to help business and government confront energy issues of national significance to New Zealand.

The Energy Centre will accomplish this mission by:

- Undertaking energy research and business and policy analysis and reviews that examine energy-related issues important to New Zealand's future.
- Reporting our findings and observations to the energy sector, government and academic communities.
- Providing energy-related education that creates future leaders for academia, business and government.
- Offering The University of Auckland Business School as a respected neutral venue for deep dialog about critical issues and problems facing New Zealand's energy future.

1. INTRODUCTION



Associate Professor and Head of Department Basil Sharp joined the department of Economics in 1991. His research interests span the field of resource economics and law and economics. He has a specific interest in developing microeconomic foundations to analyse mechanisms for allocating natural resources, treaties and institutional structures in general. He has also applied non-market valuation methods to a range of environmental problems in New Zealand. His current research focuses on the application of economic models to natural resource management and policy.

The Energy Centre's research programme focused on three broad areas: energy markets, resource and environment markets, and transport economics.

The Centre's Advisory Group provides programmatic advice on research priorities for the year ahead. Research needs and opportunities are also based on conversations with partner companies, the energy sector, transport organisations and government agencies. The Centre has important cross-disciplinary linkages with the School of Engineering, Engineering Science, the Transport Research Centre, and the School of Geography and Environmental Science.

The research-policy nexus is an essential attribute of Centre activities. Meetings and seminars provide a bridge for business and government agencies to engage with the Centre's programme. Stakeholder participation ensures policy relevance. Reports, media releases and submissions to government on proposed policy are underpinned by research.

2. EDUCATION

The Energy Centre staff contribute to education in three areas:

- Courses spanning the fields of market regulation, market design, energy economics and environmental economics.
- Supervision of honours, masters and PhD research.
- Presentations are made through the University's Continuing Education programme, local student organisations and community extension programmes.

Through the Department of Economics, staff associated with the Energy Centre offered three courses in the field of energy economics and environmental economics. Also of relevance are courses related to network industries and regulation. Programme developments included collaboration with the School of Engineering to develop a Masters of Energy and preparation for the launch of the first Summer School in Energy Economics. Outreach education programmes addressed issues around sustainable energy supply.

Courses in energy economics

Two energy-related courses were offered in 2009. ECON 372: Resource and Energy Economics, with 45 students enrolled. ECON 783: Special Topic in Energy Economics, a post-graduate course with 15 students enrolled. These will be offered again in 2010.

Masters of Energy

The creation of an interdisciplinary Masters of Energy is moving ahead with cooperation between the Dean of Engineering and the Dean of the Business School. The planned

Masters (likely start in 2011) will be based in the Engineering Department and will contain at least one core energy and resource economics course. It will be open to students from science, engineering and business. The proposed Masters has a significant research component.

Eco-Minds

The Eco-Minds event from 25 to 29 May 2009 was hosted by The University of Auckland (organised by Dr Rob Kirkpatrick from the Energy Centre and Dr Lesley Stone from the Office of the Vice-Chancellor), Bayer and the United Nations Environmental Programme (UNEP). A total of 25 students from nine countries participated in the week-long event, representing New Zealand, Australia, China, India, Indonesia, Korea, Singapore, Thailand and the Philippines. The University of Auckland Vice-Chancellor Stuart McCutcheon chaired the opening session, which included an address from the Governor-General.

Eco-Minds addressed the issue of "Sustainable energy supply: Challenges and opportunities", using the New Zealand electricity system as a case study. Students visited the Huntly coal-fired station and the E3P combined cycle gas turbine plant run by Genesis. They also visited Mighty River Power's Karapiro Hydro, Contact's Wairakei Geothermal and participated in a virtual wind presentation by Meridian. Technical presentations included the aspirations of sustainability balanced against the practical challenges of running a secure and reliable power system.

Summer School in Energy Economics

Planning commenced for the Summer School in Energy Economics, which was subsequently held in February 2010. The programme was advertised using email contacts, The University of Auckland CECIL student lists, student associations, the list of Energy Education Trust New Zealand scholarship recipients and personal contacts throughout New Zealand.

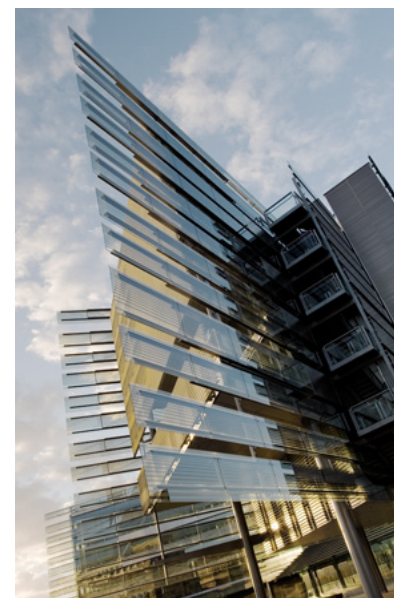
New Zealand electricity market primer

David Young, Bart van Campen, Steve Poletti and Golbon Zakeri collaborated during 2009 to write a 35 page "primer" on the New Zealand electricity market. The idea is to provide students new to the field with a readable introduction to the technical details of the market. The draft of this primer was distributed to all students in energy courses in 2009 and will be revised again in 2010 to reflect forthcoming changes to the market.

Energy Education Trust New Zealand PhD scholarships

The selection committee unanimously recommended the following scholarships:

- Stephan Hassold (improved energy efficiency by modelling different vehicle types for PT scheduling).
- David Dempsey (development of numerical models to explain and predict geothermal activity across the Taupo volcanic zone). David already holds a Bright Future Top Achiever Doctoral Scholarship.
- Christina Walter (improved modelling of geothermal fields).



3. RESEARCH

The Energy Centre aimed its research at contemporary and emerging issues and contributing to industry strategies and public policy debate. These priorities were based on conversations with industry, the energy sector and government. We look forward to the Centre's Advisory Group playing a strategic role in setting future priorities.

Post-doctoral scholarship

A joint application with Dr Golbon Zakeri to The University of Auckland for post-doctoral research was successful. Anthony Downwards will receive funding as a research fellow (2010-11) and work on a project titled, "Mechanism design in electricity and gas markets".

PhD students

- Helen Huang (Economics) defended her PhD proposal on "Regulation of electricity distribution networks". She is presently doing an internship at the Commerce Commission.
- John Patrick O'Sullivan (Engineering Science) is developing models for wind analysis in complex terrains such as New Zealand.
- Anthony Downwards (Engineering Science) is finalising his PhD thesis on "Modelling strategic behaviour in hydro-dominated electricity markets".
- Sam Malafeh (Economics): "Energy for Maori: Access, contracts and pricing for renewable energy assets in Maori controlled land areas".
- Samuel Frederick Harding (Mechanical Engineering): "Understanding the

behaviour of New Zealand wave energy characteristics".

- Javad Khazaei (Engineering Science): "New Zealand electricity market for integration of wind power via stochastic programming".
- Luke Sutherland-Stacey (Physics): "Improved rainfall prediction for hydro-storage management with particular focus on Waikato hydro scheme".
- Ian Milne (Mechanical Engineering): "Analysis of tidal turbine performance in New Zealand and suitability as renewable energy for New Zealand".
- KC Wong (Information Systems and Operations Management): "Impact of New Zealand Emissions Trading Scheme on the wholesale electricity markets".

Honours/masters dissertations completed in 2009

- Medium-term price forecasting: An application to the New Zealand electricity market – Richard Wilks (supervised by Erwann Sbai).
- Responsiveness of the optimal rotation of pinus radiata forests to New Zealand unit prices – Karla Gardiner (supervised by Basil Sharp).
- The short term dynamic of EUA spot price – Michael Hart (supervised by Basil Sharp).

Energy research

New Zealand electricity market

Following the Commerce Commission's release of the Wolak Report, the Energy Centre organised a series of workshops to discuss the report. Shortly after the report was released, the Centre released a joint

press statement with the Electric Power Optimization Centre (EPOC) which was reported in the *New Zealand Herald* and the *National Business Review*.

A more detailed report was forwarded to the Minister suggesting policy options in light of the Wolak Report. After the release of the Ministerial Review in August 2009, the Energy Centre made a detailed submission on the proposed changes.

David Young, Golbon Zakeri and Tony Downward analysed the report's recommendation that the SOEs "swap" assets (recommendation 17 of the report). Their initial results suggest that such a swap does not always increase competition, as was hoped. The Electricity Commission expressed interest in the findings and contracted the group to write a report discussing the results. This report was subsequently expanded and submitted as a research article to the *Energy Journal*.

Agent-based modelling of alternative market models for the New Zealand electricity network

David Young has finished coding software to run simulations of the New Zealand electricity market. This model uses an 18 node approximation of the New Zealand transmission network. However, the existing transmission data is six years out of date, so he is now using more recent data from Transpower and the Electricity Commission to calibrate the parameters of the model before running simulations. With this model, he hopes to investigate the impact of asset swapping, and the impact of increasing amounts of wind generation in New Zealand.



Mechanism design for incorporating intermittent generation

David Young, Golbon Zakeri and Javad Khazaei continue to work on a project that compares the outcomes of a one-settlement market (like New Zealand currently has) and a two-settlement market when there is significant wind generation uncertainty. The latter involves the use of a stochastic optimisation algorithm, designed by the EPOC group, as an alternative to the current design. We are collaborating on this project with Professor Shmuel Oren at the University of California, Berkeley, and expect to submit a paper on this research in 2010.

New Zealand forestry initiative

Rob Kirkpatrick, Bart van Campen and Basil Sharp examined issues surrounding large forestry initiatives to assist New Zealand's transition period towards a low-carbon future, alongside the Emissions Trading Scheme (ETS) in its current or a modified form. A forestry initiative would allow the Government some flexibility to smooth the transition and potentially modify the ETS, while maintaining public focus on the importance of New Zealand's climate response.

The suggested initiative requires direct government participation in the proposal and for the Government to be the holder of the carbon permits generated. Although it is preferred for the Government to focus on policy and the "market" on implementation, the long-term nature of climate change challenges makes government involvement mandatory.

A parallel report on "Large forests for carbon, conservation, tourism, employment" has been created by Williams Land and Boffa Miskell Ltd, including a GIS analysis on the availability of land in New Zealand for a major forest to contribute to New Zealand's carbon balance. Both reports will be submitted to the Government.

Transport research

Research fellow

In August 2009 we were delighted to announce the appointment of Dr Judith Wang (pictured on page 7) as Research Fellow in Transport Economics. Judith has lectured in transport economics and more recently worked with transport consultants Booz and Company, based in Auckland, on transport projects. Being well connected in the Auckland

transport scene, Judith will take a leadership role in promoting and developing the Centre's transport research programme.

Upper North Island Transport Study

The Energy Centre successfully led the Upper North Island Transport Study (UNITS) application to The University of Auckland's cross-faculty research fund. The proposal was developed by staff from the Energy Centre, the New Zealand Centre for Supply Chain Management in the Department of Information Systems and Operations Management, the Faculty of Engineering and the Department of Geography. The UNITS team was among ten groups selected by the University to take part in the Research Wonders Campaign, a programme aimed at promoting research that is relevant and of interest to the public. Filming and interviews took place on 2 November 2009 and the video will be housed on a YouTube channel for the University.

UNITS will be implemented in two stages. Stage one aims to scope out what is known about transportation and infrastructure in the upper North Island, including existing and projected demand for transport services, population growth and passenger transport, public transport, urban settlement patterns, and the environmental impacts of transportation.

Three seminars were organised by the Energy Centre:

- Richard Paling, of Richard Paling Consulting Ltd, presented the results from the National Freight Demand Study conducted for the Ministry of Transport.
- John Davies, Manager Transport Analysis at the Auckland Regional Council, gave an overview of the newly developed integrated land use/transport planning model of the Auckland region. Catherine Murray, Strategic Policy Analyst in the social and economic team at the Auckland Regional Council, gave an introduction to the Economic Futures Model and explained its linkage to the integrated land use/transport planning model.
- James Bevan, Senior Planner for Latitude Planning Services Ltd, and Grant Smith, Director of Gabites Porter Traffic and Transportation Engineering and Planning, talked about the development of the Waikato Regional Transportation Model (WRTM). The presentation outlined the development of the WRTM as a shared service and its potential as a strategic

decision-making tool, along with its use in reviewing the Waikato Regional Land Transport Strategy.

External stakeholders attending the seminars included Ports of Auckland, KiwiRail, ARTA, ARC, New Zealand Transport Agency, NIWA and transport consultants. A summer student intern turned these seminars into a summary document for a seminar in May 2010.

Public transportation

Professor Mark Greer has been reworking a public transportation model over the past couple of months. Mark is an honorary research fellow at the Centre and his research is aimed at improving the ability of the model to predict public transport ridership.

Research publications and reports

Van Campen, B. "Demand side response in hydro-dominated electricity systems", paper presented at ELAEE conference, Santiago de Chile, 22 to 24 March 2009.

Sbai, E. and Simpson, M. "Forecasting of nodal electricity demand in New Zealand", submitted to *New Zealand Economic Papers*.

Sharp, B. "Energy resource evaluation model – literature review", *NIWA Report*, April 2009, p. 48.

Young, D. "Endogenous investment and pricing under uncertainty," *The BE Journal of Theoretical Economics*, Vol. 10: Issue 1 (topics), Article 1.

Nan J., Sheng S. and Sharp, B. (2009). "New Zealand's Emissions Trading Scheme", *New Zealand Economic Papers*, 43(1): 69-79.

Kirkpatrick, R., van Campen, B. and Young, D. *Wholesale electricity market reform in light of the Wolak Report: Some suggestions*, report submitted to the Ministry of Economic Development, June 2009.

Poletti, S. "Government procurement of peak capacity in the New Zealand electricity market", forthcoming *Energy Policy*.

Greer, M., van Campen, B. "Influences on public bus ridership: The case of Auckland", paper submitted to *Journal of Transport Economics and Policy*.

Greer, M. "Impact of labor unions on airline efficiency", to appear in *Transportation research, Part A: Policy and practice*.

Zakeri, G., Downwards, A. and Young, D. *On the welfare implications of swapping generators' assets in New Zealand*, a report to the Electricity Commission, August 2009. Kirkpatrick, R., Poletti, S. and van Campen, B. Submission on discussion paper "Improving electricity market performance", to MED-ETAG, September 2009.

Zakeri, G., Downwards, A. and Young, D. "Swapping generators' assets: Market salvation or wishful thinking", submitted to the *Energy Journal*, December 2009.

Jiang, N., Sharp, B. and Sheng, M. (2009). "Emission caps: Competing for the climate change cup in 2009?", *EcoNZ@Otago*, 23, 5-7. www.business.otago.ac.nz/econ/econz

Sharp, B. "Hidden resources and economic growth", *CAENZ*, University of Canterbury, Issue 48, 6-7.

Wang, JYT. "Appraisal of factors influencing public transport patronage in New Zealand", the 32nd Australian Transport Research Forum, Auckland, New Zealand, September 2009.

Raith, A., van Houtte, C., Wang, JYT. and Ehr Gott, M. "Applying bi-objective shortest path methods to model cycle route choice", the 32nd Australian Transport Research Forum, Auckland, New Zealand, September 2009.

Wang, JYT., Raith, A. and Ehr Gott, M. (2010). "Tolling analysis with bi-objective traffic assignment", in Ehr Gott, M., Naujoks, B., Stewart, T. and Wallenius. J. (eds), *Multiple criteria decision-making for sustainable energy and transportation systems*, Lecture Notes in Economic and Mathematical Systems 634, Springer Verlag, Berlin, pp.117-129.

Conference presentations

Steve Poletti, "Government investment in the electricity market", Far Eastern and South Asian Econometric Society Meeting, Singapore, July 2008.

Steve Poletti, "Government procurement of peak capacity in the electricity market", The Summer Workshop in Industrial Organization and Management Strategy, Singapore, July 2008.

Steve Poletti, "Market power and security of supply in the electricity market", 2nd International Association of Energy Economics Asian Conference, Perth, 5 to 7 November 2008.

Bart van Campen prepared a paper on "Demand side response in hydro-dominated electricity systems", accepted by the IAEE conference in Santiago, Chile, March 2009.

Basil Sharp led a panel discussion, "Resource and environmental management in a carbon constrained world", at the 11th Annual

National Power Conference, Auckland, 23 to 27 February 2009.

Bart van Campen, "New Zealand electricity market, Wolak Report and proposed regulatory changes", Norges Vassdrags-og Energidirektorat (NVE - Norwegian Electricity Commission), Norway, 13 August.

Bart van Campen, "Energy and electricity markets in New Zealand", guest lecture GEOLOGY 703 Geothermal Science, 22 October.

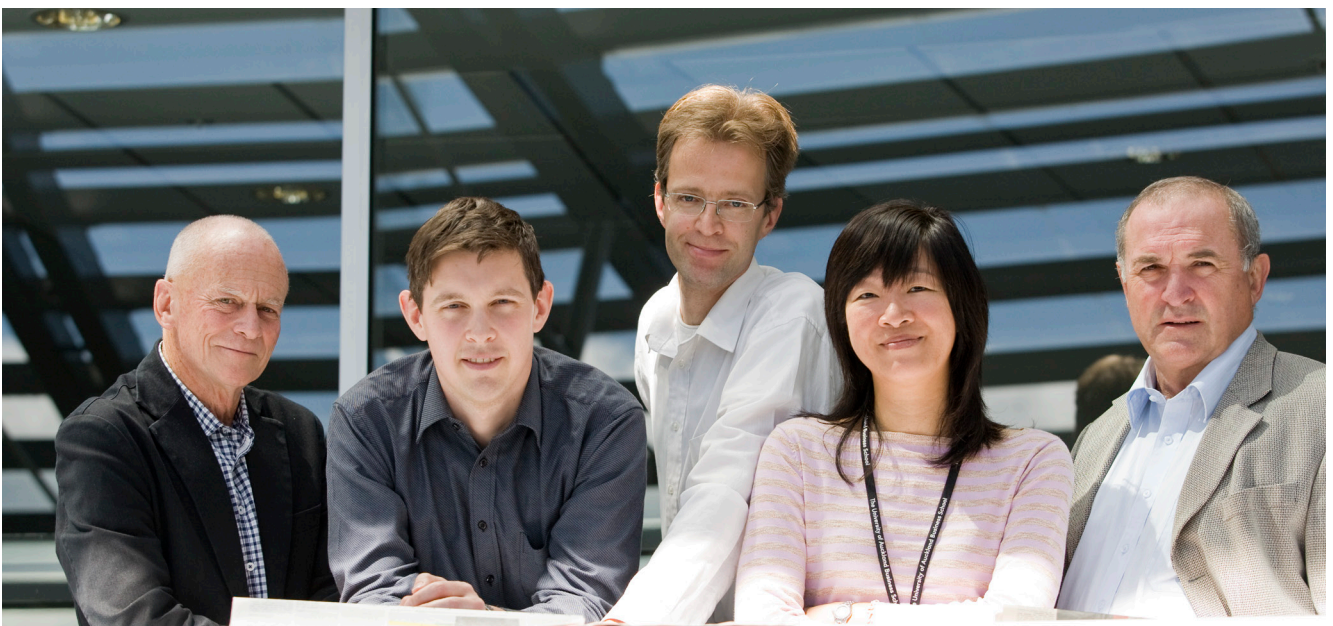
Bart van Campen, "Smart metering and thinking on energy", with H. Byrd, the New Zealand Green Building Council, 29 October.

Basil Sharp and Sam Malafeh, "Geothermal energy development: Economics and policy", Geothermal Workshop, Rotorua, 16 to 19 November.

Basil Sharp, "Future of clean energy - developments and trends", Clean Energy Summit, Auckland, 1 to 2 December.

Steve Poletti, "Market power and security of supply in the electricity market", International Association of Energy Economists, European Meeting, Vienna, 7 to 10 September.

Pictured: (from left) Basil Sharp, David Young, Bart van Campen, Judith Wang, Rob Kirkpatrick



4. EXTENSION ACTIVITIES

Extension activities functioned as a learning network for stakeholders and academic research who share common interests in the field of energy. The New Zealand Energy Future Forum and an international workshop on energy and water provided a platform for the presentation of research and policy reviews.

New Zealand Energy Future Forum

Following on from discussions and submissions around improvements in the New Zealand electricity market (NZEM), the Energy Centre organised a discussion workshop on New Zealand's energy future on 3 November 2009. This focused on the linkages between electricity, gas and climate change markets as the Ministry of Economic Development is preparing its new Energy Strategy. Invitees originated from industry, academia and government, but were invited to participate on a personal basis with the discussions under the Chatham house rule.

Three presentations covered important areas of New Zealand's energy future, including forestry and biofuels, gas and electricity. Brief discussions surrounding the presentations indicated a reasonable consensus that the NZEM is in quite good shape and most medium-term economic generation projects (geothermal, hydro, wind) are not disadvantaged under different future carbon-price scenarios.

However, there was general agreement that power prices are set at the margin, largely by

gas prices, and more attention to investment, flexibility, price dynamics and competition in the gas market is warranted. Transport and the use and import of liquid fuels were generally identified as larger issues in New Zealand's future due to economic vulnerability to oil price rises, volatility and balance-of-payment effects.

Discussants also agreed on the potential of New Zealand forestry under different future energy and carbon scenarios as carbon storage, fibre, timber and fuel source. Concerns were discussed that despite this potential, the present trend was for a continuation of insufficient private forestry investment of a scale to warrant present or medium-term future investment in processing facilities (milling, fibre or energy), leading to a chicken-and-egg cycle which would be likely to limit New Zealand's ability to develop this potential. No agreement could be reached on how to break this cycle. Government is inclined to leave such investments to the market.

A presentation highlighted some elements that will be contained in the updated New Zealand Energy Strategy (before year's end), including:

- The new strategy will focus on security of supply, affordability and environmental responsibility, with the overriding goal of maximising economic growth.
- The 90 percent renewable electricity target by 2025 will remain as ambitious but achievable.

- Climate change is a key environmental issue, but local environmental effects of energy developments are also important.

Subsequent discussion focused on whether policy settings would lead to New Zealand using its resources optimally. Opinions differed between those more hesitant about a bigger leadership role of government, preferring a focus on markets with government in the role of providing regulatory frameworks and certainty, and those preferring stronger government leadership in this area. Curiously enough, most with a government background were in the former camp while most of those with a business background were in the latter.

The attendees agreed the open, neutral format of the day's discussion was worthwhile and universities should play a role in fostering these types of discussions.

PECC Workshop

The PECC 2009 seminar, "The Water Energy Nexus", was held at the Business School from 8 to 10 December 2009. The seminar was financed by the French Government, Veolia Water and New Zealand PECC. Participants came from a wide range of economies, including China, the United States, Chile, France, New Caledonia and Fiji. From the local industry, we had presentations by William Meek (Mighty River Power), Dr Stuart Simmons (Geothermal Institute) and John Huckerby (Aotearoa Wave and Tidal Energy Association).



APPENDIX: Luke Sutherland-Stacey - student report

Energy Education Trust New Zealand Doctoral Scholarship 2009

Status update

The first year of my PhD work is now over. My registration was confirmed in September. This year we have focused on field work to provide data for subsequent modelling efforts. We have also built a small (12 CPU) computer cluster and implemented a local modelling test bed based on the public domain Numerical Weather Prediction (NWP) Weather Research and Forecast model. We are working on assimilation of rain radar data into NWP models with a focus on prediction of severe weather and the implications of better forecasts for industry (eg, hydropower) and the public.

Field work:

This year's field work in Mangakino with Mighty River Power has come to an end. We were streaming radar observations via the internet, and they were available to the general public. An example of the data stream is available, along with a link to live data from our other radars: http://www.rainradar.co.nz/mangakino_example/PPI_animation.html Presently we are analysing the dataset to prepare a report on the utility of rain radar data compared to a rain gauge network for hydrological modelling in the immediately surrounding catchments. In particular it may be that the existing rain gauge network had problems quantifying the areal accumulation during convective events.

Conference papers:

- New Zealand Meteorological Society Conference, Auckland, 2 to 4 September 2009, "Towards variational assimilation of

X-band rain radar data in New Zealand", by L. Sutherland-Stacey, P. Shucksmith and G. Austin.

- Water New Zealand conference, Rotorua, 21 to 23 September 2009, "Modelling applications of high resolution rain radar", by L. Sutherland-Stacey and P. Shucksmith. This paper received the Young Modeller Award (best modelling paper for which the presenter was under 35).
- WSN 09 Conference, Whistler, Canada, 28 September to 4 November 2009, "Nowcasting flash floods in mountainous terrain using small local radars, mesoscale models and distributed hydrological models", by G. Austin, P. Shucksmith and L. Sutherland-Stacey.

Papers:

We are currently working on a number of different papers, all naturally rain-radar themed (see radar image below which will appear in a future publication). The figure shows the development and mature stages of a thunderstorm. It perhaps serves to demonstrate the heterogeneities associated with real precipitating hydrometers - which is after all a recurrent theme through our research.

Dr Geoff Austin Supervisor comments

1. General progress

Luke has been working on a number specific issues which together are designed to contribute to the improved forecasting of hazardous weather particularly floods in steep terrain. He

has made good progress in the following:

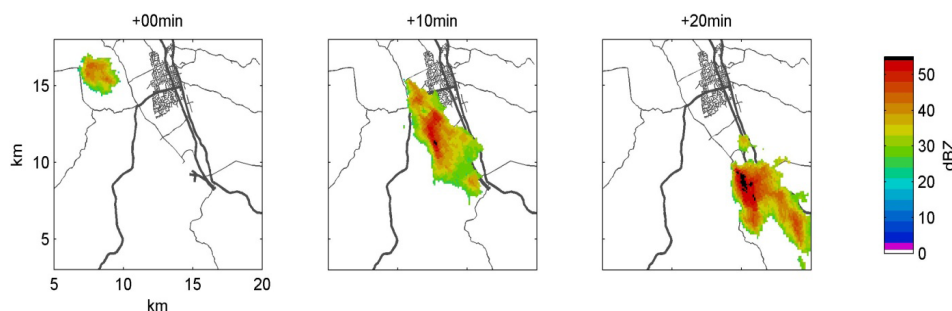
- He has worked with a fellow student to install and operate our mobile radar in a hilly location in the central North Island and has obtained a valuable data set that will be key to the project. We were fortunate that we captured data from a flooding event.
- He has written code which constitutes the first step of integrating weather radar rainfall information into our Mesoscale Numerical Model (WRF), which we hope will allow improved forecast accuracy.
- He has set up and proved our new Linux network of 12 computers with WRF.

2. Planning and milestones

He has achieved the objective outlined above which put him significantly ahead of the thesis timeline. He has been somewhat held up by the lack of national network radar data from NIWA. However, we are visiting the relevant people there and assume we will be able to unblock the situation. He has co-authored three conference papers which have been well received. We are working on two journal papers.

3. Overall supervisor satisfaction and other remarks

Luke is a very bright student and achieves a great deal in little time. I am entirely satisfied with his performance and am sure he will produce a good thesis in a timely way which will contribute significantly to the understanding of the subject.



Time lapse radar reflectivity of a thunderstorm which formed over Tokoroa on 16 September 2008. The left frame was measured at 18:03. Locations of roads are indicated with solid gray lines - the confluence of roads around (14,15) is the town of Tokoroa. The radar was located outside the plotted region to the south-west (0,0).

APPENDIX: Helen Huang - student report

Work done from March 2008 to October 2009:

1. Visited the University of Birmingham, United Kingdom. Supervised by Professor Richard Green, April to June 2008. Collected data from various sources, edited and analysed data using Microsoft Excel and statistical software Eviews, broadly studied the regulation regimes in the electricity networks in the UK.
2. Attended conferences:
 - Energy and Economics Conference, Toulouse, France, June 2008.
 - The 3rd PhD Conference at The University of Auckland Business School, October 2008.
3. Attended some useful courses:
 - Four-day Incentive Course in Electricity Regulatory Economics at the University of Birmingham. Taught by Professor Richard Green, June 2008.
 - Three-day Efficiency and Productivity Analysis Course at the University of Queensland, Australia. Taught by Professor Tim Coelli, October 2008.
4. Two phone interviews to discuss the quality of the service incentive regulatory scheme in the Netherlands:
 - One with a staff member from the energy regulator, Robert Haffner.
 - Another with academic staff member Ype Wijnia from Delft University in the Netherlands, June 2008.
5. Assisted with the Default Price-Quality Project for electricity and gas in the Commerce Commission of New Zealand in 2009. Mainly focused on the analysis of the quality standards issues and the price issues in the regulation of the electricity distribution networks in New Zealand. The papers I assisted with were published by the Commerce Commission: "Initial reset of the DPP – the discussion paper" was published in June 2009 and "Initial reset of the DPP – the

draft decisions paper" was published in September 2009.

6. Drafts of these chapters have been done during this period:
 - UK part: An empirical study on the quality of service incentive regulatory scheme in the UK, July to December 2008.
 - New Zealand part: A study on the quality of service regulation in New Zealand – experiences from the practice, January to August 2009.

What I have been working on and am going to do:

- An empirical study on the quality of service regulation in the electricity distribution networks in New Zealand: September to October 2009.
- Policy suggestions: November 2009.
- Attending the New Zealand Postgraduate Conference in Wellington: November 2009.
- Completing a draft of the thesis: December 2009.
- Revising: January 2010 to March 2010.
- Submit: 31 March 2010.

Dr John Panzar Supervisor comments

1. General progress

Helen began her PhD studies in March 2009. Since that time she has succeeded in identifying a highly researchable, policy relevant topic: the regulation of service quality in electric distribution systems. In addition she has collected and analysed extensive panel data sets on electric distribution companies in New Zealand and the United Kingdom.

Helen's standard PhD enrolment period would end in March 2010. However, she spent considerable time at the New Zealand Commerce Commission during 2008 and 2009. (She recently took up a permanent

position there.) Helen also spent several months in 2008 visiting the University of Birmingham. Both of these experiences have greatly enhanced her practical knowledge of the industry. However, they involved substantial time away from Auckland.

2. Planning and milestones

Helen's visit to the UK facilitated the completion of the basic research for the first half of her thesis: an empirical analysis of quality of service regulation in the UK. An early version of this work was presented at the Business School's PhD Conference at the end of 2008.

Because of the time spent at the NZCC, Helen's progress on the "New Zealand half" of her thesis has been somewhat slow. She has collected and begun to analyse the relevant data. A preliminary version of this portion of the thesis will be presented at the New Zealand PhD Conference in Wellington.

3. Overall supervisor satisfaction and other remarks

I am very pleased with the hard work and dedication that Helen has demonstrated during her dissertation research. She has become a de facto expert on this topic, highly sought after by the Commission for her analytical skills and work ethic. Ultimately, her employment there will result in a better thesis. However, in the short run it will more than likely mean that she will not complete the thesis until later in 2010.

APPENDIX: John O'Sullivan - student report

Department:

Engineering Science Department,
The University of Auckland

Supervision team:

Main supervisor – Dr Rosalind Archer
Other advisors – Professor Richard Flay

Provisional title of thesis:

Using CFD to simulate wind flow in complex terrain for energy production

Date:

6 October 2009

The past six months have been very productive for me. Apart from my research, I've attended conferences, visited other universities, collaborated with other academics and prepared my first publication. The next six months is shaping up to be even more engaging. The following is a summary of both what I've achieved and what's on the horizon.

The first major goal of the past six months was to have my status as a PhD candidate confirmed. As part of the process, I prepared a detailed proposal for my research which was a great way to focus and record my work from the previous year. I then presented my proposal in a seminar to the department and discussed it with an advisory panel. It was a good experience, good practice and nice to be officially confirmed.

In April I attended two conferences, both held in Wellington. The first was the National Energy Research Institute (NERI) conference. It was a one-day conference covering a wide range of energy-related topics. There was plenty of interesting information and it was good to hear about various issues and new technologies in other disciplines of energy research. The highlight for me was the keynote presentation by Professor Paul Callaghan, in which he encouraged the scientific community to take a leadership role in increasing New Zealand's prosperity through research, development and innovation.

The second conference, just a few days later, was the New Zealand Wind Energy Conference, which is organised by the New Zealand Wind Energy Association. It is New Zealand's premier wind energy event and was extremely

interesting and useful. Again, the keynote speakers were superb. Fernando Caller of Iberdrola Renovables gave an inspiring presentation of how their approach to wind energy had proven both sustainable and economically rewarding. Similarly, Steve Sawyer of the Global Wind Energy Council was very interesting and described the global perspective on wind energy and New Zealand's position. It was also a great opportunity to meet people in the industry.

In June, I returned to Spain for a brief holiday and again used the opportunity to visit colleagues. Professor Antonio Crespo and his team at UPM (Universidad Politecnica de Madrid) welcomed me again and we spent a very interesting day discussing wind modelling for energy production. It was a good opportunity to reinforce the relationship and to talk about the possibility of collaboration. On my return from Spain I stopped in California and visited Professor Parviz Moin at Stanford University. It was an excellent meeting and it was great to discuss my research with a world leader in the field and have him encourage me to continue in the direction I've chosen. He also encouraged me to apply to attend the prestigious Stanford CTR (Center for Turbulence Research) Summer Programme. This is a biennial summer research programme that the website describes as follows:

"The objective of this programme is to promote the development and evaluation of new ideas in turbulence research. It is expected that novel ideas and preliminary results generated during the summer programme will be of sufficiently high calibre to lead to publications and to provide the grounds for new research in the participants' home institutions."

The applications are due in December and I'm currently preparing my submission. I will be planning to study the application of new techniques to model the wind's interaction with the ground in complex terrain. It's an important topic because most of New Zealand's wind farms are in complex terrain. Stanford will be an excellent place to study for a month as they have experience with the techniques and are very interested in their application to wind flow. Another positive aspect of my research over the last six months has been my increasing collaboration with Paul Behrens from the

physics department. We are now comparing his recorded measurements of wind flow with my computational models. I'm currently working on reporting the results so that we're able to submit them for presentation at a conference early next year, possibly the New Zealand Wind Energy Conference in Palmerston North.

My most significant achievement of the last six months has been the preparation of my first publication. I have finished preparing the paper and it's now being reviewed by my advisors and other colleagues here at The University of Auckland. I'm proud of the work and think it will make a good contribution to the computational modelling of wind energy.

Abstract

In computational wind engineering the neutrally stable atmospheric boundary layer (ABL) is increasingly simulated using the standard k-epsilon model. The application of boundary conditions that are inconsistent with the profiles used at the inflow boundary causes streamwise gradients in the solution and prevents the simulation of a horizontally homogeneous boundary layer. These problems are overcome by applying a simple extension of the shear stress boundary condition at the top of the domain and by using one-dimensional models to generate inflow profiles in equilibrium with the ground boundary condition.

Using this method the impact of the inconsistent boundary conditions is quantitatively assessed. It is shown that inconsistent boundary conditions at the top of the domain result in erroneous streamwise gradients throughout the domain. These errors are reduced by enlarging the domain in the vertical direction but are not removed. The errors are also found in simulations with representative and real ridges present in the domain. The streamwise gradients caused by inconsistent ground boundary conditions are shown to be alleviated by using the inflow profiles proposed by Yang et al. A brief discussion of the impact of the errors for wind energy production is given and the use of the consistent boundary conditions advised.

Dr Rosalind Archer Supervisor comments

1. General progress

John has been a pleasure to supervise this year. He is motivated, independent and is making good progress towards his goals. John has acquired a high level of proficiency with an open source computational fluid dynamics code (OpenFOAM) which is allowing him to create useful and important computational models. I am in some ways the biggest impediment to John's progress towards his PhD goals since I sidetracked him to work on a recently completed consultancy project for Mighty River Power. The project did however use the same fluid dynamics code and helped John build the depth and breadth of skills with the software.

2. Planning and milestones

John has been admitted to full candidacy in the PhD programme in the Department of Engineering, ie, he has passed the initial provisional registration phase. John is currently in Barcelona making an oral presentation on the models he created for the consulting project mentioned above. He is also presenting a poster at the same conference on his wind modelling. He has developed a fruitful collaboration with Paul Behrens who is a PhD student in the physics department under the supervision of Professor Stuart Bradley.

Recent work comparing John's modelling results to Paul's field measurements has shown that the differences between the wind velocities measured by each of Paul's SODAR beams appears to be attributable to the effects of topography on the wind flow. This has

important implications for Paul's work. John is also in the final phases of editing a manuscript for submission to the *Journal of Wind Engineering and Industrial Aerodynamics*. I expect this manuscript will be submitted within the next month. John has research planned on the development of improved "wall functions" to be model flows relevant to wind farm design. This work has the interest and support of staff at Stanford University. John hopes to develop his work in this area to a point where it can be furthered at the Turbulence Summer School Stanford will be hosting in 2010.

3. Overall satisfaction

I am very pleased with John's attitude, conduct and progress. I am looking forward to working with him in the year ahead and am confident that his PhD will ultimately be completed in a timely fashion.

APPENDIX: Javad Khazaei - student report

First year report on "Mechanism design of electricity markets in the presence of uncertainty". Under the supervision of Dr Golbon Zakeri and Dr Geoffrey Pritchard.

In the first year of my PhD, I have taken two graduate courses. On the research side, I have been busy with literature review, my actual research, getting familiar with some needed software and writing reports that I can hopefully use later in my thesis.

I can divide my research progress into two main subjects, which will eventually make two of the chapters of my PhD thesis. The first part is related to an efficiency comparison between the current electricity market in New Zealand and a proposed centrally planned system to find the amount of inefficiency resulting from an electricity market. The second research trend is to design and explore more efficient market clearing mechanisms to overcome the inefficiency mainly resulting from uncertainty.

Production inefficiency of electricity markets with hydro-generation is the title of a joint paper with Professor Andy Philpott, Dr Golbon Zakeri and Ziming Guan. This work was a part of an invited workshop that took place in Sweden in September 2009. This paper will be submitted for publication by January 2010 in a

special issue of *Utilities Policy*. In this paper we have focused mainly on the New Zealand electricity market which is characterised by having large amounts of hydro-electric generation. We have tried in this paper to find and quantify productive inefficiency sources of New Zealand electricity market by comparing it with a corresponding central plan.

The second research trend that I have worked on is comparing supply function stochastic programming model (SFSP) as a proposed one-settlement model with Cournot contracting two-settlement market (CC) as a simplified version of the New Zealand electricity market. In this project Dr Golbon Zakeri, Dr David Young and I try to find out under which situation SFSP is better than CC in terms of equilibrium social welfare in the presence of uncertainty. The first and hardest phase of this project was finding an appropriate model that both represents characteristics of a stochastic programming one-settlement market and is mathematically tractable. We have obtained some interesting results which I was invited to present in this year at the INFORMS conference in San Diego. Unfortunately, because of a United States visa denial I could not travel to San Diego.

Dr Golbon Zakeri Supervisor comments

1. General progress and performance

Javad is a very good and talented PhD student. His research is on the topic of mechanism design for facilitating efficient utilisation of intermittent generation such as wind energy into electricity markets.

2. Planning and milestones

He has made good progress in this first year of his PhD. Specifically, he has so far completed one journal publication which will be submitted to a special issue of *Utilities Policy* by the end of this year. This paper is titled "Production inefficiency of electricity markets with hydro generation".

3. Overall supervisor satisfaction and other remarks

Javad has also developed two other models that deal with incorporating uncertainty in a market in different ways and he is currently investigating these models. This year he has also completed his two required courses for the PhD and he has carried out a literature survey. I think he is well on track to completing on time and I am happy with his progress.

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