



MELBOURNE
ENERGY INSTITUTE



Melbourne Energy Institute Annual Report *2011*



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<http://www.energy.unimelb.edu.au>

Contents

Background.....	1
Message from the Director.....	2
Governance	3
New Capability.....	5
Knowledge Transfer	6
Engagement and Profile	7
Energy Futures Seminar Series 2011	9
MEI Energy Futures Library	11
Master of Energy Systems.....	12
Energy Research Overview	13
Research.....	15
Research Hubs	23
Energy Production	27
New Funding Initiatives	29
Expenditure	32

Background

Concerns about energy resource security, the adverse environmental impacts of energy production and inequities in access to energy services are crucial to national and global policy considerations. The increasing recognition that our energy systems need to be made more sustainable, environmentally benign and adaptable, while also providing reliable and affordable supply to more and more people, presents a daunting challenge. In particular the prospect that rising greenhouse gas concentrations are contributing to unprecedented and potentially irreversible climate change makes redesigning our energy systems one of the most important challenges of our time. Framing clear pathways to

a more certain energy future is inherently interdisciplinary. Such pathways must be informed by a deep understanding of emerging technologies, market economics, resource prospects, environmental impacts, regulatory frameworks and social equity issues. The delivery of such pathways requires new research strategies that transcend traditional lines of enquiry to link the many different ways of thinking that inform how modern societies work and prosper. The Melbourne Energy Institute engages researchers across seven faculties at the University of Melbourne to help meet this challenge. It is one of a family of five interdisciplinary institutes that together comprise the Melbourne Research Institutes.



Message from the Director

In 2011, in the second year of operation, the Melbourne Energy Institute (MEI) continued our program of expanding the University's energy research portfolio, contributing to new programs in energy market design and market regulation, on the social justice and health impacts of energy technologies, and establishing new research infrastructure in the area of carbon capture and storage and geothermal energy. Building on the University's outstanding existing strengths in areas such as photovoltaic materials, carbon capture, automotive engineering and energy resources, these new MEI-sponsored programs generated some \$5 million in new funds.

The MEI has established a new Centre for Geological Carbon Storage in the School of Earth Sciences, funded by the State Government and the CO2CRC. The MEI committed to supporting the energy market component of the University's Centre for Market Design in collaboration with Business and Economics and Department of Treasury and Finance.

We continue to be delighted with the response to our highly successful Energy Futures Seminar Series which we ran in partnership with the Grattan Institute. Engaging industry and government around critical future energy challenges, the program received significant media coverage. Audience attendances typically in the 300-500 range speak to the popularity of the program.

In 2011, we established an external Advisory Board. We are particularly grateful to the board members for their commitment to our program, and especially our Inaugural Chair, Simon Holmes a Court.

Looking forward, 2012 will see a number of exciting developments. Under the leadership of A/Prof Michael Brear our new Masters in Energy Systems commences. We are exploring how to capitalise on numerous expressions of interest to link with partner institutes and organisations both nationally and overseas, and we are committed to continue to build programs in international development in our neighbourhood, particularly in Timor Leste and Indonesia.



Prof Mike Sandiford

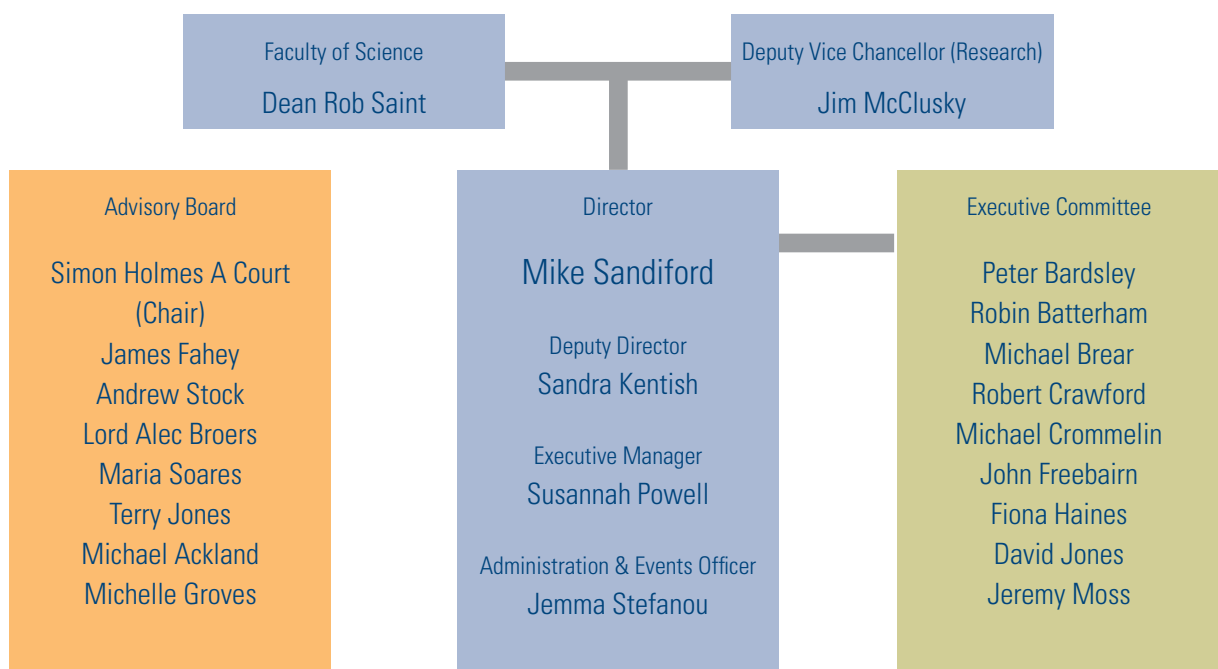
Governance

During 2011 the MEI Advisory Board and Executive Committee was established.

The Executive Committee is made up of representatives from the Faculties of Engineering, Law, Arts, Science and Economics Architecture, Building & Planning.

MEI's Inaugural Advisory Board Meeting was held on the 20th October 2011.

Organisational Structure



Advisory Board



Simon Holmes A Court (Chair)

Chairman
Hepburn Wind; Embark Australia



Maria Soares

Corporate Responsibility Manager
BP Australia



James Fahey

Partner
Mallesons Stephens Jaques



Terry Jones

Business Development - Smart Networks
SP Ausnet



Andrew Stock

Director Executive Projects
Origin Energy



Michael Ackland

Vice President of Strategy & Growth
GE Australia & New Zealand



Alec Broers

Chairman Board of Directors
Diamond Light Source UK



Michelle Groves

Chief Executive Officer
Australian Energy Regulator

A full list of biographies is available at www.energy.unimelb.edu.au.

New Capability

During 2011, the MEI helped facilitate a number of senior appointments that have significantly strengthened the University's energy research leadership. These include:

Prof John Burgess (Honorary Professorial Fellow, Chemical Engineering, University of Melbourne) has wide-ranging experience as a senior executive and research leader in industry at BHP Billiton; as an academic in chemical engineering; and as a member of various advisory boards and committees. He has also run his own consulting business. His experience includes eight years as a prize-winning industrial researcher, three years as an academic undertaking basic research, and nine years as a general manager of research at BHP Billiton - the largest industrial research facility in Australia at that time.

Dr Richard Aldous (CEO of Cooperative Research Centre for Greenhouse Gas Technologies CO2CRC) has a background in resource development, technology research and executive management, in both industry and government. He works with a number of international resource companies including BHP Billiton, Newcrest, Iluka and WMC. For the last 10 years prior to joining CO2CRC he was Deputy Secretary for the Department of Primary Industries (Victoria), and held responsibilities for geological survey, energy technology innovation, energy policy, investment attraction and the regulation of mining, oil and gas, and pipelines.

Dr Malte Meinshausen (Senior Honorary Research Fellow, School of Earth Sciences, University of Melbourne) is both an academic on climate science and a long-term scientific advisor to the German delegation at the United Nations Framework Convention on Climate Change negotiations. He has been taking part in the UNFCCC negotiations since 2000 and was closely involved in the design of various accounting rules for the international emissions trading as recently as Durban, December 2011.

Prof Roy Neel (Visiting Professorial Fellow, University of Melbourne) is currently Chief of Staff for former Vice President Al Gore, overseeing his climate change advocacy programs, national and international political relationships and liaison with his clean energy business interests. Neel is also an Adjunct Professor of Political Science at Vanderbilt University. Neel served as Vice President Gore's Chief of Staff in the White House, later moving to the West Wing as President Bill

Clinton's Deputy Chief of Staff, where he managed the day-to-day operations of the White House. Between 1994-2000 Neel was President and Chief Executive Officer of the U. S. Telecom Association, representing the Bell operating companies. Neel also served as a corporate director of Amtrak, the United States passenger rail system.

Dr Matthias Raab (Program Manager for Carbon Storage, CO2CRC) is an experienced scientist and project manager with extensive international credentials in successful, high profile and complex projects in industry and academia. He has a proven record in managing the system life cycle of high value added products and services. Matthias has 17 years of experience in commercial and R&D environments with major sector clients. Matthias holds specific interests in project management and innovation in the resource and energy sectors.

A/Prof Tim Rawling (Director of Infrastructure Development, AGOS - Australian Geophysical Observing System) has recently researched development of regional/crustal-scale 3D and 4D geological models as well as new exploration methodologies involving 3D modelling and finite element simulation. Tim's background is in structural geology and IT and he has previously worked as a consultant exploration geologist, as the manager of the 3D modelling and simulation programs at GeoScience Victoria (DPI), as the MCA funded lecturer at the University of Melbourne, a commercial programmer and as a researcher at Monash University and the University of Arizona.

Knowledge Transfer

During 2011 the MEI, engaged with a range of research, government and industry organisations. These include participation in seminars, collaborative events and research partnerships with the following organisations:

- Grattan Institute
- Australian National Low Emissions Coal Research & Development (ANLEC R&D)
- CSIRO
- Australian National University
- Bureau of Meteorology
- University of Chicago
- Vanderbilt University
- Postdam Institute for Climate Impact Research
- Democratic Republic of Timor-Leste (RDTL): Secretary of State for Natural Resources, Environment, and National Disasters Management
- National University of Timor-Leste (UNTL)
- Philippines National Renewable Energy Board
- E.ON Energy Research Centre of ANTH Aachen University
- India Institute of Science Bangalore
- Community Advocacy Panel (CAP)
- Department of Treasury and Finance
- Australian Electricity Market Operators (AEMO)
- General Electric
- IBM
- TRUenergy
- Hepburn Wind
- BrightSource Energy
- Sustainability Victoria
- Department of Primary Industries
- Department of Transport
- Alternative Technologies Australia
- Beyond Zero Emissions
- The Australian Institute of Energy
- Young Energy Professionals
- The Graeme Wood Foundation
- Brown Coal Innovation Australia (BCIA)
- AuScope
- National ICT Australia Ltd (NICTA)
- Bureau of Meteorology
- Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC)
- Geoscience Victoria
- Granite Power Limited
- Greenearth Energy
- Panax Geothermal
- Geotech Engineering
- Direct Energy

Engagement and Profile

In 2011 the MEI expanded its Energy Futures Seminar Series through a partnership with policy think-tank, the Grattan Institute. Hosting with the Grattan Institute the series brought industry, government and academia around critical future energy research issues putting these into the public domain for community debate and policy scrutiny.

MEI also launched two new lecture series in 2011 including: Global Perspectives and Special Public Lecture Series. International and local experts came together to discuss energy policy, social impacts, innovation and energy technologies. Experts included Prof Ross Garnaut AO (Vice Chancellors Fellow & Professorial's Fellow of Economics, University of Melbourne), Prof Michael Grubb (Chair of Climate Strategies, Cambridge University), Prof David Rapson (Department of Economics, University of California), Prof Madhu Khanna (Department of Agriculture and Consumer and Economics, University of Illinois) and Prof Gus Nathan (Director Centre for Energy Technology, University of Adelaide).

The MEI's invitation only workshops have complimented our public engagement program, enabling targeted areas of government and industry to gain specialised understanding of the University's energy research capabilities, helping to foster partnerships that have resulted in new research programs and funding opportunities for the University of Melbourne. Our other engagement activity is summarised in the following points:

- In 2011 the MEI launched the Energy Futures Library and released its first publication, the Renewable Energy Technology Cost Review.
- In 2011 the MEI participated in national and international energy conferences including: Four Degrees or More Conference held at the University of Melbourne; ALL Energy Australia Conference, Melbourne; [Y]ESON Conference in Sydney; Carlton Connect at the University of Melbourne.
- The MEI website provides a constant public presence that communicates to external parties the University's energy research capabilities, MEI's new initiatives, public events and other news related to the University's energy research activity and programs. Our online subscriber base grew from 600 in 2010 to 2494 people (415% increase) and our website received an average of 2272 hits per month.

2011 Highlights

In 2011 the MEI made significant progress in broadening the University profile as an important new voice in energy research. The MEI did this through:

- Attracting confirmed funding of \$5 million to new interdisciplinary energy research programs with a further \$3 million pending.
- Facilitating the establishment of important new centers engaging with energy research including the Centre for Geological Carbon Capture and Storage.
- A high profile public Energy Futures Seminar Series in partnership with the Grattan Institute.
- Establishment of the MEI Technical Paper Series and/or Energy Futures Library.
- Supporting the development of a new interdisciplinary Masters of Energy Systems program led by A/Prof Michael Brear.



Energy Futures Seminar Series 2011

Carbon emissions: subsidies, incentives and taxes - what makes effective policy? - 30 March 2011

Mr Adam Morton	Environment Writer, The Age
Prof John Daley	Chief Executive Officer, Grattan Institute
Mr Tristan Edis	Energy Research Fellow, Grattan Institute
Prof Robin Batterham AO	Kernot Professor of Engineering, University of Melbourne
Mr Roger Beale AO	former Secretary of Commonwealth Department of Environment (1996-2004)
Hon Greg Hunt MP	Liberal Party of Australia
Senator Christine Milne	Australian Greens
Mr Matthew Warren	Chief Executive Officer, Clean Energy Council

Sustainable Energy - at what cost? - 25 May 2011

Mr. Robyn Williams (AM)	Science Journalist, The Science Show, ABC
Mr Patrick Hears	Energy Research Fellow, Melbourne Energy Institute
Mr Andrew Stock	Executive General Manager, Origin Energy Australia
Mr Terry Teoh	Power Project Developer, Pacific Hydro
Prof Mary O'Kane	NSW Chief Scientist & Scientific Engineer, and Chair of Australian Centre for Renewable Energy Board
Mr Ric Brazzale	Managing Director, Green Energy Trading
Dr Jenny Hayward	Research Scientist in Energy Technology, CSIRO
Mr Tristan Edis	Energy Research Fellow, Grattan Institute

The Future of Wind Energy in Australia - 20 July 2011

Ms Anna Skarbek	Executive Director, ClimateWorks Australia
Mr Graham White	Regional Manager (Pacific), GL Garrad Hassan
Mr Ken McAlpine	Director of Policy & Government Relations (Asia Pacific), Vestas Wind Systems
Mr Jonathan Upson	Senior Development Manager, Infigen Energy
Ms Kate Redwood	Director, Hepburn Wind

The Future of the Electricity Network in Australia - 26 August 2011

Ms Michelle Groves	Chief Executive Officer, Australian Energy Regulator
Mr Craig Oakeshott	Senior Manager in Strategy and Economics, AEMO
Prof Hugh Outhred	Professorial Visiting Fellow, University of New South Wales
Dr Tony Morton	Principal Power Systems Engineer, Senergy Econnect Australia
Dr Chris Dunstan	Research Director, Institute for Sustainable Futures, University of Technology Sydney

The Future of Transport in Australia - 25 October 2011

Prof Roy Neel	Chief of Staff for former Vice President Al Gore, Adjunct Professor of Political Science at Vanderbilt University
Ms Fiona Calvert	Director of Strategy & Resource Efficiency Policy, Department of Transport
Prof Nicholas Low	Professor of Environmental Planning, University of Melbourne
Mr Patrick Hears	Energy Research Fellow, Melbourne Energy Institute
Mr William McDougall	Principal Public Transport Practice Leader, Sinclair Knight Merz

The Future of Solar Power in Australia - 16 November 2011

Mr Tony Wood	Director of the Energy Program, Grattan Institute
Mr Tristan Edis	Energy Research Fellow, Grattan Institute
Dr David Jones	Program Coordinator of VICOSC, Bio21 Institute, University of Melbourne
Mr Andrew Dyer	Non-Executive Director, BrightSource Energy
Mr Stefan Jarnason	Technical Director, Suntech Power Australia
Prof. Mike Sandiford	Director, Melbourne Energy Institute, University of Melbourne

“Four Degrees or More” Conference

The conference **Four Degrees or More? Australia in a Hot World** was held at the University of Melbourne in mid-July, during the week following the launch of the Federal Government’s Carbon Tax package. Sponsored by MSSI, the Melbourne Energy Institute, and the Monash Sustainability Institute, with further support from the Purves Environmental Foundation, the conference ran over two and a half days, attracted more than 400 people, and was prominent in the national media for almost a fortnight.

The conference had two goals. It aimed to refocus public attention on the core objective of national and international climate policy, which must be to contribute to a global reduction of emissions that is fast enough to lead to a safe future climate. The conference was based on the scientific consensus that the aggregate emissions reduction targets of developed and developing countries - adopted following the weak outcomes at and since Copenhagen, in 2009 - would most likely lead to average global warming of four degrees Celsius above preindustrial levels by 2100.

Then a cluster of Australia’s finest climate scientists, including Prof David Karoly from University of Melbourne, Dr Penny Whetton from CSIRO, Prof Will Steffen from ANU and Prof David Griggs from Monash, followed with detailed predictions of the likely impacts on Australian climate (rainfall, temperatures, extreme events). A range of others – economists (including Prof Ross Garnaut, the Conference’s second keynote speaker), physical scientists, social scientists, lawyers and geographers – considered the implications for Australian farming, cities, and security, before turning to the difficult questions surrounding the limits to adaptation and the opportunities for mitigation.

MEI Energy Futures Library

Renewable Energy Technology Cost Review

The Garnaut Review Update commissioned the first paper the Renewable Energy Technology Cost Review which looked at how innovation in wind and solar energy production will shape the future cost of zero-carbon technologies. The paper undertakes a review of current and future costs of three forms of renewable energy technology by comparing data from a range of international and Australian-specific studies, taking care to compare data on the same basis of financial assumptions (discount rates) and resource quality.

The purpose was to compare the absolute costs and the rate of decrease in costs, and to understand the reason for differences between the studies.

The Australian-specific datasets are the 'Australian Energy Generation Technology Costs' report by the Electric Power Research Institute (EPRI), and the 2010 dataset used by the Australian Energy Market Operator (AEMO), largely based on the EPRI data with a review from ACIL Tasman.

The Renewable Energy Technology Cost Review is available at www.energy.unimelb.edu.au



Master of Energy Systems

The University of Melbourne has launched this new graduate program to train specialists who understand the 'technology and business of energy'.

The Master of Energy Systems has been developed in close consultation with industry in response to rapid changes to today's global energy sector. It addresses the growing need for graduates with cross-disciplinary skills spanning technology, business and policy. Graduates will evaluate the performance of energy systems, inform energy-related investment decisions, develop and implement policy, and manage greenhouse gas and pollutant reporting, regulation and compliance.

The program is led by University specialists in engineering, science, business and economics. Graduates will acquire the skills to make informed decisions about energy issues that incorporate technical, economic, environmental and social considerations. The program has close links with industry and potential future employers.

A multi-faculty Steering Committee, chaired by A/Prof Michael Brear from the School of Engineering, led the degree development and continues its delivery and administration. The degree will be commencing in first semester 2012, with student enrolment exceeding expectations. These students come from a broad range of backgrounds, including many studying part-time whilst working across in the energy sector.

Given this strong initial enrolment, the University now plans to grow the cohort whilst refining the degree design. The ultimate aim is to establish the Masters of Energy Systems as the preferred graduate offering in energy in the region.



Energy Research Overview

Prof Robin Batterham AO, Kernot Professor of Engineering

I have recently had the pleasure of working within the MEI simultaneously with my positions as Chair of the International Energy Agency Expert Group on Science for Energy and on the Executive of an OECD project on International Collaboration in Science and Technology for Global Challenges (energy included).

The overwhelming perspective is that here at the University of Melbourne we are getting it right by actively fostering cross disciplinary collaboration and involvement of researchers with end users.

We have a world awash with splendid science and numerous incentives targeting the challenge of lower emissions, yet worldwide emissions continue to grow. What we can make of some fall off in the rate of increase here in Australia remains to be seen.

Market incentives for deployment of new technologies have succeeded in terms of dragging through investment in wind and solar photovoltaics (PV). Yet, installed costs are not competitive and subsidies are still needed despite a modest price on carbon emissions. Much faster cost reductions are required. Linking the leading edge research and development with a limited number of companies interested in dominating world markets with compelling products requires the genius of a rare breed of people – people we can find here at the University of Melbourne.

Solar

Given Australia's insolation, solar has to be in the running for long term emissions reduction. In my opinion however, matching grid parity for more than a small part of the demand is still years away and the power delivered worldwide by solar is miniscule compared with that from hydrocarbons.

The opportunity is to swing some of the effort going into silicon based PV into printable PV. While the efficiency of these novel devices as developed here jointly with CSIRO is still lower than silicon based PV, the potential to be much cheaper is realisable. The key is to develop modified printing techniques suitable for massive production runs. This will inevitably also require modification of the formulations currently used for printable photovoltaics.



Geothermal

Deep geothermal is well known for its potential with delivery suggested of 10% of the world's energy by 2030. Much has been learnt but much remains, for example predicting the safety of deep geothermal following the experience of triggering a small earthquake in Basel. It remains to be seen if the impressive flow rates achieved by some companies (but not others) can be achieved more consistently. This is a key focus for collaborative work here within MEI.

Equally, while hot rock sites are known, they tend to be remote from the grid. Is geothermal "under power lines" possible? To date, the economics of deep geothermal tends to require temperatures of around 200°C. If however we target ~140°C, we could see the hot water as energy input to existing power stations (coal or gas) and district heating systems where they exist. The advantages of this combination are significant.

Joining the dots

Until storage becomes much cheaper, we must be more imaginative in how we combine different energy sources. Wind and solar thermal have different time scales and various combinations may be considered, for example wind sharing the same molten salt thermal storage as a solar thermal installation.

Of great importance and very neglected by comparison is what we can do to change the way existing power stations (coal and oil) operate. How can the economic turn down ration be improved and, importantly, the heat used to dry (brown) coal be drastically reduced? The economic life of many of our coal assets, particularly those proliferating around the world, means we must see coal and gas as a bridge for possibly 30 to 50 years. Turn down ratio and rapid response are key to utilising existing coal fired power stations in a grid with much higher levels of renewables.

There is a breakthrough coming from basic science at the University of Melbourne on force chain modelling that suggests physical dewatering of coal (especially brown coal) can be much enhanced. Fleissner was on the right track but didn't try the combination of compression with shear. Adding this aspect to most of the upgrading processes makes sense.

We are going through an energy revolution and there will be no single winner in either supply, distribution, utilisation or efficiency of use. More collaboration and connecting the R&D with end users is what is needed and the MEI is well placed to make a significant contribution.

Prof Robin Batterham AO
Kernot Professor of Engineering

“We are going through an energy revolution and there will be no single winner in either supply, distribution, utilisation or efficiency of use. More collaboration and connecting the R&D with end users is what is needed and the MEI is well placed to make a significant contribution.”

Prof Robin Batterham

Research Facilitating the PV Revolution

The emphasis on sustainable energy has encouraged a dramatic increase in the efficiency and decrease in the cost of photovoltaic (PV) solar panels. Some projections now suggest rooftop PV panels (PVs) will approach grid parity in many locations in terms of cost of the electricity generated. Even without parity, as electricity prices rise, the popularity of PVs is likely to increase significantly as householders seek to offset at least some portion of this price rise. The need to develop an optimal regulatory regime that can best accompany the increasing presence of PVs in the electricity market is critical.

A new collaboration between the Melbourne Energy Institute (MEI), the School of Social and Political Sciences (SSPS) and the Melbourne School of Land and Environment (MSLE) aims to map such a regime, one able to withstand the rigour of the challenges ahead. These regulatory challenges are substantial and complex encompassing not only technical but also political and social concerns. Some lessons for optimal regulation can be gleaned from jurisdictions with significant

experience with PVs, such as Germany and California. However, substantial Australian-based knowledge is critical.

The diverse expertise brought together by MEI allows for an in-depth understanding of the technical issues involved within Australia. The collaboration with Social and Political Sciences and Land and Environment means that this technical knowledge can be developed through a grounded understanding of the political and social challenges particular to Australia. The team will use funds supplied by a University Interdisciplinary Seed Grant to develop stronger linkages through the University and to bring together key industry and government stakeholders. The project will develop a preliminary regulatory strategy to govern the expected rise in PV usage throughout Australia, with a view to securing major funding in the years ahead to consolidate and extend this strategy that can facilitate an optimal presence of PV solar.

A/Prof Fiona Haines
School of Social and Political Sciences



Climate Change, Energy and Justice in Timor Leste - Social Justice Initiative

This project provides an overview of the energy options for Timor-Leste at both a national and local level. As a country with little energy infrastructure and pressing development needs, establishing access to an effective, reliable and safe set of energy resources is one of the most important development goals for the people of Timor. Without access to energy resources people will continue to miss out on important goods such as health services, economic opportunities, education and a safe environment.

Understanding the type of energy infrastructure that is suited to Timor-Leste involves political, institutional and technical considerations. In our study we consider the technical options that could provide both a national solution and one suited to the district of Ainaro in particular. We employ this dual focus so as not to exclude the needs of rural areas when developing a national strategy. Yet conducting research on the range of energy options best suited to Timorese conditions also requires us to engage with a broader set of questions regarding the likely social justice impacts of the different energy options and the environmental impact of each option. These two considerations – the social justice and the environmental impacts – are crucial to understanding which energy options best suit Timor-Leste.

Social justice considerations matter because, ultimately, energy provision has to be of benefit to people and communities. Ensuring the optimal balance of energy options depends in part on development priorities. For instance, given that in some rural areas, energy will continue to be a limited resource, what are the most important uses for energy, particularly electricity? Given the choice between powering lighting, telecommunications, health services, businesses or cooking, what would be the best use of resources? We pay particular attention to who would benefit most from the provision of a particular resource in an attempt to ensure equal access to energy resources. Installing a national grid,

while necessary for national development, is more likely to benefit those living in or near towns than those in remoter areas. Similarly, if concerns for child and maternal health are to determine where and to what extent resources are allocated, then a greater emphasis might be placed on improved cookstove technology. One important part of the research is to identify the way in which different energy options impact on local people and communities. While this seems like a simple and necessary criteria to adopt when evaluating energy options, considerable care needs to be taken in identifying what important needs actually consist of. In this report we adopt a modified version of the capability approach, developed by Amartya Sen, to need identification.

This research assesses a range of energy options available for meeting energy needs in Timor-Leste, including:

- Extending the national grid using diesel and heavy-oil powered generators
- Employing a mix of large-scale renewable technologies to power the grid
- Cultivating Jatropha for domestic biodiesel
- Developing local energy sources in rural communities to power isolated micro-grids
- Rolling out solar home systems at a household level in off-grid areas
- Rollout of domestic biogas digesters to households
- Providing improved cook stoves to households throughout the country

Dr Jeremy Moss
Nossal Institute for Global Health and Faculty of Arts

Wind Farm Syndrome

The MEI has formed an interdisciplinary group to investigate the controversial and emotive issues associated with wind turbines and noise. In particular the group will focus on health issues and infrasound. Infrasound is low frequency sound below the normal frequency range of human hearing. It is held by some that infrasound causes a range of symptoms including dizziness, nausea, insomnia, pressure and pain in ears and eyes, problems with memory and concentration, irritability, loss of energy and motivation, pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease and headache or migraine.

The group will evaluate existing data and possibly collect more if required. The group includes specialists in audiology, psychology, and acoustics and the human body. This group can further draw on associates in auditory physiology and wind turbine technology.

The group aims to investigate issues which have not been covered by other research groups. The field has been well investigated already but the gap between an irate rural population and the proponents of wind farms is widening. It has become clear that the issue is not limited to establishing if there are any mechanisms for cause of the raft of reported symptoms and infrasound as such. The aim is to survey the social and psychosocial aspects as well as the technical and scientific data to attempt to bridge this gap.

The group includes Prof Richard Dowell Head of the School of Audiology, Dr Simon Cropper of the Department of Psychology and Prof Peter Seligman, Biomedical Engineer, ex Cochlear Ltd, maker of the Bionic Ear.

Prof Peter Seligman
Honorary Professorial Fellow



Future Transport Scenarios

Partial or total electrification of vehicles is widely seen as an inevitable step to counter the effects of greenhouse gas emissions and heavy reliance on the exhausting oil reserves.

This project aims to identify the scenarios of different vehicle configuration, considering the economic appeal to the consumer and the associated CO₂-e output (including both tailpipe and embedded emissions) over the vehicle lifetime. The basis of the study was a Class-E gasoline-fuelled vehicle, which historically represents the most common car on Australian roads, and a diesel Class-B vehicle, which is predicted to overtake the larger vehicle in popularity based on recent trends.

Simulation models of these vehicles were developed and validated against experimental and recorded data to allow accurate estimates of the fuel economy under legislative and real-world driving cycles. The vehicle model was then systematically altered to obtain increasingly electric variants including mild hybrid, parallel hybrid, plug-in hybrid and full electric vehicle configurations, with the resulting fuel and electricity usage recorded over the same drive cycles.

The tests were used to estimate the total operating costs and environmental impact of each vehicle type under different component pricing and emissions scenarios for Australia. This is believed to be the most comprehensive study conducted for the future of Australian passenger transport, and highlighted the relative risk and reward of different vehicle technologies in both financial and environmental terms.

The work was submitted as a two-part journal paper in December 2011, and will also be presented at the SAE World Congress in Detroit in May, 2012.

A/Prof Chris Manzie
Department of Mechanical Engineering



A Comprehensive Environmental Assessment Model

Knowledge of the impacts that human activities have on the environment is of growing importance. The ability to identify these impacts is critical for achieving significant environmental improvement. However, current approaches for quantifying these impacts are insufficient for providing the level of detail and information needed to make the best and most informed decisions. Existing approaches are limited by parameters of assessment, data availability and quality or completeness. An assessment model based on national economic and environmental data is able to resolve many of these issues.

This project will develop a tool that provides a much clearer view of the indirect consumption of a broader range of natural resources (such as raw materials, energy and water) and emissions (greenhouse gases and pollutants) of any product, system or process and the associated environmental impacts, based on the latest available national economic and environmental data.

This project will also provide the information needed to inform the design and development, comparison and selection of appropriate and optimal solutions for reducing environmental impacts of building construction, energy production and supply, communication, food production and transport.

Stage 1 involves developing a series of commodity-level environmental flow models. Stage 2 will integrate these models into an assessment tool to assess indirect environmental impacts. Stage 3 will test and validate the assessment tool.

This work is essential for informing the complex decisions that are needed to meet the challenging environmental goals across a range of disciplines and is at the forefront of development of methodologies for environmental impact assessment on a global level.

Dr Robert Crawford
Faculty of Architecture, Building & Planning



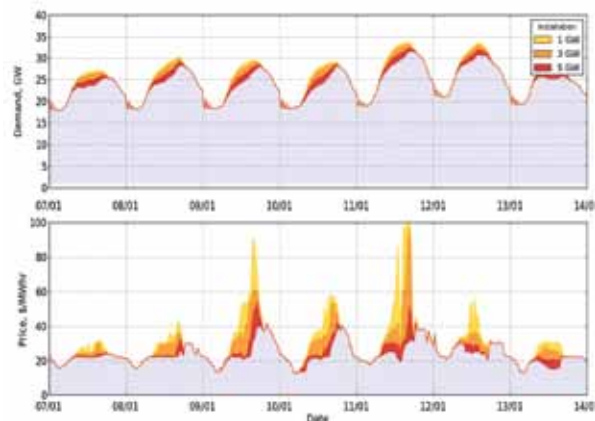
The Merit Order Effect: The Impact of PV on the Wholesale Electricity Market

The design of policies to assist the transition to low emission electric power production presents significant challenges. Policies such as Feed-in Tariffs that are designed to accelerate deployment of renewable energy remain controversial. They have been criticised for the impact they have on consumer electricity prices, as well as the method by which such costs are distributed across the consumer base.

However, there are mechanisms by which renewables can potentially impact electricity prices which may offset the Feed-in Tariff cost impost levied across consumers. A key offset for renewable generation is through the so-called 'merit order effect'. In electricity markets that use a merit order dispatch system, generation capacity is ranked by the price that it is bid into the market. Demand is then met by dispatching electricity according to this rank, from lowest to highest bid. The last capacity dispatched sets the price received by all generation, ensuring the lowest cost provision of electricity. A consequence of this system is that significant deployments of low marginal cost electricity generators, including renewables, can reduce the cost of electricity, (a phenomenon known as the 'merit order effect').

The addition of significant levels of renewable generating capacity into electricity grids has been shown internationally to markedly reduce wholesale spot prices for electricity. In Australia, this prospect has been recognised in concern expressed by some coal-fired generators that delivering too much renewable generation would reduce wholesale electricity prices.

The purpose of this study is to analyse the potential impact of PV on the wholesale electricity spot price in the Australian National Electricity Market, as an investigation into assessing the extent to which the merit order effect may offset the costs associated with PV incentives and policies (such as Feed-in Tariffs). It has been found that for 5GW of capacity, comparable to present per capita installation of photovoltaics in Germany, the reduction in wholesale prices would have been worth in excess of A\$1.8 billion over 2009 and 2010, all other factors being equal.



Modelled impact of PV on demand and price in selected period summer 2010

The findings have implications for policies, including Feed-in Tariffs, illustrating that they could deliver net savings to consumers, contrary to prevailing criticisms that they are a regressive form of taxation.

Mr Dylan McConnell
School of Earth Sciences

Comminution - Industrial processes and energy efficiency

Comminution is the process in which solid materials are reduced in size by crushing, grinding or other processes. It has many industrial applications particularly in the mining and mineral sectors. Commintion is notoriously inefficient with up to 98% of the applied energy typically wasted. The return available in increased investment in stirred or tumbling mill technologies will not be realised without a better understanding of where the energy “goes”. Our research has shown that, within a granular material, force chains are capable of storing vast amounts of energy in their contacts without particles breaking.

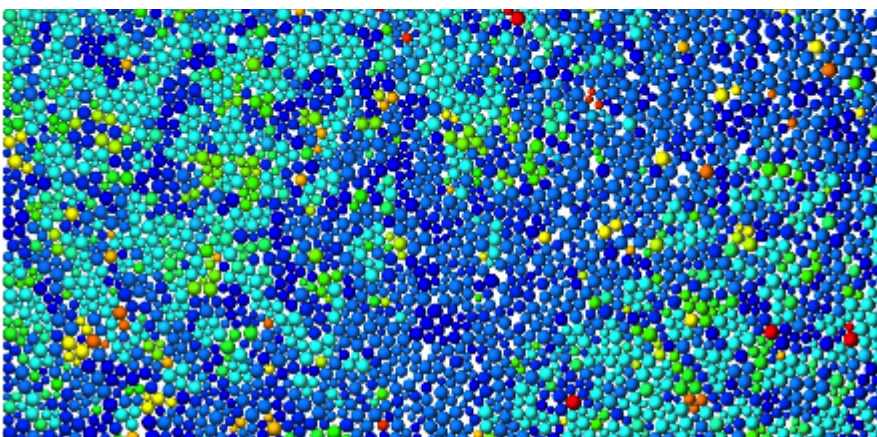
We have investigated the configuration of force chains within a comminution system using the methodology of complex networks. In a recently published article in *Physical Review E* we showed that strong force (high energy) transmission throughout the material appeared to be following pathways akin to shortest path network communication protocols. Furthermore, we found that low-order cyclic structures had the potential to store vast amounts of energy at their contacts.

An ultimate goal of research in granular materials is a universal constitutive model capable of predicting the response and failure of a given material subject to a given loading condition. To make progress towards this goal we consider the shear band to be of great practical and

fundamental interest since it is the underlying mechanism for failure in dense granular materials. Moreover it represents a concentrated region in the sample where the bulk of the stored energy is released. On a large scale this phenomenon translates to the relative movement of two opposing rock faces along two tectonic plates. Understanding this highly dissipative process may hold the key to mitigation and control of damage from earthquakes.

In the article in *Physical Review E* we considered the evolution throughout loading of a grain with respect to its role in force chain and cyclic building block structures. The interaction of all grains was summarised using a complex network allowing the material to be partitioned into different groups of grains following similar evolution rules. The capability to reduce the behaviour of thousands of grains to the behaviour of a small number of communities is of great practical and theoretical use as it helps reduce the complexity of formulating constitutive evolution rules for predictive and control purposes.

A/Prof Antoinette Tordesillas
Department of Mathematics and Statistics



“Taxonomy of granular rheology from grain property networks.” [David M. Walker and Antoinette Tordesillas, *Phys. Rev. E* 85, 011304 (2012)]. The grains in a biaxial compression test can be partitioned into different (coloured) communities according to their role with respect to force chain and 3-cycle structure evolution.

The Zero Carbon Australia Project

The Zero Carbon Australia Project is developing transition plans for getting Australia to zero emissions in ten years using commercially available technology. It is currently being undertaken in partnership with the not-for-profit research and education organisation Beyond Zero Emissions and the University's Melbourne Sustainable Society Institute (MSSI). The project covers the sectors of energy, buildings, transport, land use, industrial processes and coal export. Three Plans (Transport, Buildings and Land Use) are currently in progress.

The Transport Plan

The Transport Plan is managed as a joint project between MEI and Beyond Zero Emissions.

The ZCA Transport Project has been building up a large body of knowledge on Australia's transportation system, and what our future system could look like. Geographic Information System tools are being used to map and analyse passenger and freight movements across Australia. Two key sections of the project well underway include designing a National Rail Network – putting in place fast rail services to over 80% of the population; and modelling the costs and benefits of a 100% electric vehicle fleet.

The ZCA Transport scenario will be compared to the business-as-usual cost of relying on our current system heavily reliant on petroleum and roads, estimated at over \$4 trillion over the next 30 years.

The Land Use Plan

The Land Use, Forestry & Agriculture Plan is managed as a joint project between Beyond Zero Emissions and the University's Melbourne Sustainable Society Institute (MSSI).

The Land Use Plan will provide a comprehensive look at the way Australia can manage its productive capacity, ecological heritage, land use and agricultural emissions into the future. There are many pressing questions involved such as how can

land use mitigate potential dangerous changes in climate? What ecosystem restoration strategies could be used? Can a changed landscape produce adequate food and fibre and which source will be prioritised? How much sustainable bioenergy can be produced? What are the solutions and which might become future problems?

The project is due to be completed in early 2013.

The Buildings Plan

The Zero Carbon Australia Buildings Plan aims to demonstrate that there are no technical barriers to zero emission buildings in Australia. The Buildings Plan will seek to quantify the maximum reduction in energy consumption achievable by implementing cost effective energy efficiency measures in all existing and new buildings.

This report will not be aimed at making each building energy self-sufficient (zero net energy consumption) and it is assumed that each building will connect to a 100% renewable energy grid as outlined in the Stationary Energy Plan. It will identify the maximum feasible contribution from distributed onsite electricity generation using solar photovoltaic and some small wind turbines.

Stationary Energy Plan Update

The Stationary Energy Plan, launched in June 2010, demonstrates that 100% renewable energy is achievable. The plan outlined a fully costed and detailed system of commercially available and proven renewable energy technologies, including concentrated solar thermal plants and large scale wind farms.

Later this year, development of an updated Stationary Energy Plan will commence. This will reflect recent trends and developments in renewable energy technologies.

Research Hubs Energy Market Design

In 2011 the MEI collaborated with University of Melbourne Business and Economics in shaping the energy market component of the Centre for Market Design that is currently in development. The Centre for Market design is a partnership between the University of Melbourne, the Commonwealth Treasury, and the Victorian Department of Treasury and Finance. The Centre will provide an institutional framework to build capacity and to support ongoing policy collaboration between participating jurisdictions and academic institutions.

The MEI will work with the Centre in regard to the market challenges around next generation electricity – including applied research in the area of market failure, market design, information and incentive problems underlying areas of public policy.

This work will support Government in the design of policy mechanisms, including auctions, markets and regulatory frameworks to address specific problems identified by participating jurisdictions.

The expected launch date of the Centre is April 2012.

Prof Peter Bardsley
Faculty of Business and Economics



CO2CRC, Centre for Geological Carbon Storage

In 2011, there has been significant expansion of capacity in carbon capture and storage research at the University of Melbourne in 2011.

With the appointment of Prof Paul Webley to the Capture Research Program the majority of the CRC for Greenhouse Gas Technologies (CO2CRC) research is now based at the University. Prof Webley will take up his position within the Department of Chemical and Biomolecular Engineering in the role of Discipline Leader for Adsorbents within the CO2CRC. With Melbourne University Professor Geoff Stevens will continue to lead the Solvent Technology program and MEI Deputy Director Prof Sandra Kentish will lead the Membrane program.

The capture research program has also been further enhanced by the involvement of Prof Kentish, A/Prof Brendan Abrahams and Prof Richard Robson in the Science and Industry Endowment Fund (SIEF) project 'Solving the Energy Waste Roadblock'. This five-year program, led by the University of Sydney will investigate novel inorganic materials for both carbon dioxide capture and carbon dioxide utilisation.

Within the capture research program, work is proceeding on the construction of a pilot scale solvent contactor within Chemical and Biomolecular Engineering. Construction has been sponsored by Australian National Low Emissions Coal Research and Development (ANLEC R&D) and will allow further development of a novel precipitating solvent process. The Membrane Technology program continues to develop and characterise novel membrane materials and has recently identified a commercial water treatment membrane that may be utilised in a facilitated transport mode for carbon capture.

In 2011 the University has also significantly grown its research program in the CO2 subsurface storage field with the establishment of the Centre for Geological Carbon Storage. Based in Earth Sciences the Centre houses an international team of experts including the CO2CRC Storage Program Manager, Dr Matthias Raab and the Otway Operations Manager, Rajindar Singh. Most importantly, funding was secured during 2011 from both the Victorian Government and the CO2CRC to support a new position of Professor of Geological Sequestration at the University. In addition, the CO2CRC has recently appointed Dr Richard Aldous as its new Chief Executive Officer. Richard will be partly based in Canberra, and has also taken up an office within the School of Earth Sciences as his Melbourne base.

In early 2012, \$100M funding towards the Victorian CarbonNet project was announced. The investment includes \$70 million as part of the Federal Government's carbon capture and storage (CCS) Flagship program and \$30 million from the Victorian State Government. CarbonNet incorporates the staged development of a multi-user foundation CCS network over the next ten years. It will link high carbon dioxide emission sources such as coal-fired power stations in the Latrobe Valley to proven and safe geological carbon storage sites. Education Investment Fund (EIF) is likely to be awarded on the basis of this announcement and will facilitate infrastructure developments in both the School of Earth Sciences and the Department of Chemical and Biomolecular Engineering. The EIF proposal also includes funds for the development of a Simulator for the full CCS value chain.

Prof Sandra Kentish
Department of Chemical and Biomolecular Engineering



Bioenergy at the University of Melbourne

The MEI coordinates bioenergy research at the University of Melbourne through interaction with the University's three key bioenergy research groups; the Plant Cell Biology Research Centre (School of Botany); the Algal Biofuel research group (School of Chemical and Biomolecular Engineering); and Artificial Photosynthesis (Bio21 Institute).

The Plant Cell Biology Research Centre within the School of Botany includes research programs such as Metabolomics Australia and the Australian Centre for Plant Functional Genomics. The PCBRC also includes the ARC Centre of Excellence in Plant Cell Walls, conducting world-class research characterising plant cell wall composition. Plant cell wall composition varies substantially between different bioenergy feedstocks and its accurate characterisation is crucial for efficient and effective conversion to energy products.

The Artificial Photosynthesis Research Program will utilise new facilities within the \$120 million Bio21 Institute for the further development of three key aspects of artificial photosynthesis; membrane technology, oxygen and CO₂ catalysts and photon receptors.

The Algal Biofuel Research Group was established with grant funding from the Second Generation Biofuels R&D Grant Program in 2010 to investigate the efficient separation, processing and utilisation of algal biomass. Research group staff have many years of experience in international biofuel programs including both algae and cellulosic ethanol production.

Toward the Development of a Biofuels Roadmap for Victoria

To date there has been limited emphasis on bioethanol production from second generation feedstocks derived from local natural and agricultural resources in Australia. Also, there is limited technical information that can be used to compare the relative merits of the various potential feedstocks.

The objective of this project was to take a first step towards a comprehensive technical evaluation of possible local non-food feedstocks for bioethanol production. The project has brought together expertise from the School of Botany, the Department of Forest and Ecosystem Science, and the Department of Chemical & Biomolecular Engineering to develop a multidisciplinary approach for determining key feedstock attributes relevant to bioethanol production processes. This approach can then be applied more broadly to develop a technical roadmap for guiding the future development of a biofuels industry in Victoria.

Of particular importance to the ethanol production process are the changes to the carbohydrate component of the biomass that occur during the initial acid pretreatment reaction. To assess these effects, novel high-throughput methods were combined with conventional biochemical characterisation techniques to perform a detailed analysis of the carbohydrate component of the biomass as a function of the pretreatment process. Eucalyptus was selected as the model feedstock on which to develop and demonstrate these techniques.

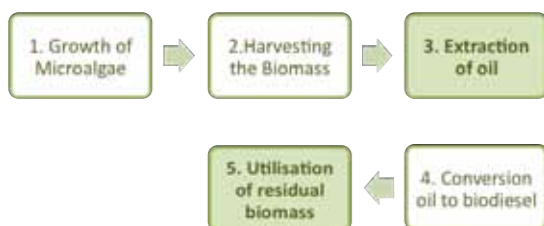
The approach developed through this work has been able to reveal new insights into the behaviour of various eucalyptus components during pretreatment. This information will be useful in evaluating its potential use as a feedstock for bioethanol production. The results of the current study will soon be submitted for publication in a leading bioengineering journal. It is hoped that this work will form the basis for a more extensive evaluation of other potential feedstocks.

Microalgae-derived Biofuel

Microalgae-derived biofuel has the potential to become a future method of sustainable fuel production. The Algae Biofuel team at The University of Melbourne is working on making this process a near-term reality.

Microalgae are small aquatic organisms that use sunlight to convert atmospheric CO₂ into biomass, which in turn can be converted into biodiesel. When this biodiesel is combusted the CO₂ initially absorbed is released back into the atmosphere. Hence in comparison to fossil fuels biofuels from microalgae are essentially carbon neutral. Microalgae's advantages over traditional renewable fuel crops such as wheat and canola are numerous - a key driver being their ability to grow on non-arable land. They are fast growing and only require sunlight, water and nutrients to survive. Microalgae can be grown on arid land and use saline or waste water as a growth medium, making Australia an ideal location for microalgae cultivation.

Our team is focusing on developing commercial production methods for converting microalgae into biofuels and other valuable products. The process can be split into five steps:



Funded by the Commonwealth Department of Resources, Energy and Tourism Generation 2 Biofuels R&D Program, this project has focussed on developing robust processes for converting microalgal biomass to fuels and feed products.

This work has been done in partnership with Victorian-based algae biofuels company, Bio Fuels Pty Ltd. Utilising the laboratories and expertise of the Department of Chemical & Biomolecular Engineering, the infrastructure of the School of Chemistry, and the analytical capabilities of Metabolomics Australia, the team has developed an advanced understanding of the key scientific and technical challenges to be addressed.



Algae bio-reactors on the roof top of University of Melbourne's Chemistry building.

This project is currently working towards minimising the processing costs associated with extracting the oil as well as maximising the value obtained from the residual biomass, which will help accelerate commercialisation of microalgal biofuels technology.

Dr Greg Martin
Department of Chemical and Biomolecular Engineering

Energy Production Beaurepaire Geothermal Trials

Direct geothermal energy is a sustainable energy source which can be used to heat and cool buildings and to provide heating and cooling for industrial processes. By replacing conventional fossil fuel systems with direct geothermal systems, major reductions in greenhouse gas emissions can be obtained. Also, because the overall efficiency of these systems is high, running costs can be significantly cheaper than conventional systems allowing significant long term savings. This means that the capital costs of installation can be recovered in a few years. With the costs of conventional power set to rise considerably, the 24/7 availability of direct geothermal is likely to become an important and continuous energy source for the future.

The Geotechnical Group of the Department of Infrastructure Engineering completed a detailed field trial facility in late 2010 on the University of Melbourne's Parkville campus adjacent to the Beaurepaire Sports Centre with funding provided by MEI. It consists of a number of different types of instrumented vertical ground loop systems, including energy piles (building foundations fitted with HDPE piping) and borehole installations to depths of 30m. A range of thermal response tests were conducted during 2011. One of the principal findings is that these systems under

Melbourne and Victorian conditions are even more efficient than in many other parts of the world because of the optimal ground temperatures.

The facility and the data which it has been generating has provided impetus for a significant expansion of the research group with a rapidly growing number of research personnel, projects and individual sites providing data to permit the development of the technology.

Prof Ian Johnston
Department of Infrastructure Engineering



An energy pile being installed at the Beaurepaire Centre.



A large horizontal "slinky" system being backfilled as part of the extended research project.

Tech Focus: Panax back to school on geothermal plans

Panax Geothermal has formed a strategic partnership with the University of Melbourne to try to understand where it went wrong on its Penola geothermal prospect in the south-east of South Australia; and what it needs to do to get the project on track.

The Penola project has been more or less on hold since last year, when testing from its Salamander 1 well revealed higher than expected temperatures, but poor flow tests – meaning that the heat trapped in hot sedimentary aquifers (HSA) some 4000m below the surface would be more difficult, and more expensive, to extract.

To best understand what mistakes it made, and how it might address the issues in future, Panax is teaming up with the University for a two-year collaboration to draw on its expertise and access some of the \$23 million in funds attached to the Australian Geophysical Observing System, a research infrastructure platform funded by AuScope.

The outcome will be crucial not just for Panax, but many other geothermal aspirants as well. HSA was regarded as less “cutting edge” than the hot dry rocks technologies being pursued elsewhere, because the depths were shallower and the drilling not as daunting, and therefore more easily commercialised.

Origin Energy encountered similar “permeability” problems when it drilled in its “shallows” resource in the Cooper Basin last year, and put on hold – at least temporarily – plans to develop up to 300MW of HSA capacity as a prelude to the deeper, and more lucrative, resources in its “deeps” joint venture with Geodynamics.

Panax CEO Kerry Parker says the company is still confident that up to 1500MW of geothermal resources in the Otway Basin can be exploited. But he won’t be drawn on a timeline for when that might happen, suggesting the geothermal industry has, in the past, done itself a disservice for providing over-optimistic predictions, and then failing to deliver.

“In a lot of ways, we regard Salamander as a great success – no one had drilled to that depth onshore in this country before. We did it quite quickly, we got a greater temperature than we were after, but we didn’t get the flow rate,” he told RenewEconomy in an interview.

“We have got our own view on that – and the work from Melbourne Uni will be aimed at verifying what we believe. We still think that there is an exploitable resource there – it has proven temperature, it can be easily drilled and it sits directly under the grid.”

Panax anticipates the research will deliver insight into downhole logging with temperature and seismic logging tools, and in-situ stress analysis. Laboratory-based research is also set to be carried out.

Once completed, Panax hopes to then use the information to apply for further funding under the Emerging Renewables fund, so that it can remediate the Salamander-1 well and drill others.

Parker says he expects the region will be a major contributor towards Australia’s clean energy targets, given the size of the project and its strategic location. “But we won’t be tied on time frame,” he was quick to add. “As an industry we’ve gone wrong on given those sort of forecasts.”

Giles Parkinson
20 February 2012
www.reneweconomy.com.au

New Funding Initiatives

During 2011, as a result of partnerships established through our engagement activity, the MEI generated \$5 million in new research funding. There is a further \$3 million of funding still pending.

The research programs developed as a result of this new funding include the establishment of a Centre for Geological Carbon Storage, a direct geothermal energy pilot project for Victoria, establishment of the energy market component

of the Business and Economics Centre for Market Design, a collaborative agreement with the Postdam Institute for Climate Impact Research (PIK) jointly with MSSI and a research partnership with the Social Justice Initiative focusing on energy and equity.

These new programs initiated in 2011 will run up until 2015.

Confirmed New Funding from MEI-Lead and MEI-Supported Activities in 2011

Confirmed Date	Funding Source	Name	CI/proponent	Department/Faculty	Funding Period	Total (\$k)	MEI Commitment (\$k)
01/09/2011	DPI/CO2CRC	Centre for Geological Carbon Storage	Prof Mike Sandiford	EarthSci/SCI	2011-2014	750	
01/02/2011	AuScope	Director of AGOS infrastructure	Prof Mike Sandiford	EarthSci/SCI	2011-2014	360	25
01/10/2011	Graeme Wood Foundation	Zero Carbon Australia	Ms Susannah Powell	EarthSci/SCI	2011-2014	200	
	DPI	Direct geothermal energy pilot demonstration project	Prof Ian Johnston	EarthSci/SCI	2012-2013	1,614	40
01/04/2011	PIK	PIK (Potsdam Institute for Climate Impact Research) UoM collaborative agreement	Prof David Karoly	EarthSci/SCI	2011-2015	800*	60
21/11/2011	Treasury (State & Federal)	Centre for Market Design	Prof Peter Bardsley	Ec/BUSEC	2011	400	200
01/02/2011	Garnuat Update	Renewable Energy Technology Cost Review	Mr Patrick Hearps	EarthSci/SCI	2011	5	
19/09/2011	TRUEnergy	Solar PV in Australia	Ms Susannah Powell/ Mr Dylan McConnell	EarthSci/SCI	2011	30	
01/12/2011	CSIRO SEIF	Solving the Energy Waste Roadblock	Prof Sandra Kentish/ A/Prof Brendan Abrahams	Chem/ChemEng/ MSE	2011-2015	930	
Total (\$k)						5,089	325
MEI central allocation						945	
Multiplier						5.4	

* In-kind value provided by PIK for joint MEI/MSSI project

New Funding from MEI-Lead and MEI-Supported Activities in 2011 with outcomes still pending

Funding Source	Name	CI/proponent	Department/ Faculty	Funding Period	Total (\$k)
ACRE MEASURE	Renewable energy integration	Dr Roger Dargaville/ A/Prof Michael Brear	EarthSci/SCI MechEng/MSE	2012-2013	900
CAP	The role of distributed solar generation in reducing wholesale spot market prices	Ms Susannah Powell/ Mr Patrick Hearps	EarthSci/SCI	2012	62
ACRE MEASURE	Data fusion and machine learning in geothermal research	Prof Mike Sandiford/ Prof Hugh Durrant-Whyte	EarthSci/SCI	2012-2013	1,902
UNDP	Comprehensive hazard assessment mapping East Timor	Prof Mike Sandiford	EarthSci/SCI	2012	236
Total (\$k)					3100

New Funding Initiatives (cont.)

Confirmed New Funding from MEI-Supported ARC Funding Round Outcomes in 2011

Funding Source	Name	CI/proponent	Department/ Faculty	Funding Period	Total (\$k)
ARC Discovery	Towards an event based model of combustion generated sound	A/Prof Michael Brear	MechEng/ MSE	2012-2014	320
ARC Discovery	Optimising Flex Fuel Engine Performance	A/Prof Chris Manzie	MechEng/ MSE	2012-2014	330
ARC Discovery	A complex systems approach to granular rheology: interconnecting topology, stability, dynamics and function	A/Prof Antoinette Tordesillas	Maths/ SCI	2012-2014	330
ARC DECRA	Comparison of early Mesozoic sedimentary provenances of both sides of the YarlungTsangpo zone	Dr Guangwei Li	EarthSci/ SCI	2012-2014	375
ARC LEIF	Testing facilities for clean energy transformation technologies	A/Prof Sankar Bhattacharya/ Prof Sandra Kentish	ChemEng/MSE	2012	300
ARC LEIF	An advanced, macro-scale, hydro-thermo-mechanical testing chamber for sustainable deep geological applications	A/Prof Ranjith Pathegama Gamage/ Saman Halgamuge	CivEng/MSE	2012	940
ARC LEIF	A new seismic facility for investigating tectonic collision zones, earthquake hazards and passive imaging techniques	Dr Nick Rawlinson/ Prof Mike Sandiford	EarthSci/ SCI	2012	285
ARC LEIF	A fluid inclusion facility for studying past Earth Temperatures	Dr Russell Drysdale	Geog/ MSLE	2012	150
Total (\$k)					3,030

Expenditure

MELBOURNE ENERGY INSTITUTE 2011 BUDGET

OPERATIONS

Salaries	\$419,246.94
Administration and general expenses	\$15,666.80
Events and communications	\$27,915.70

Subtotal \$462,829.44

RESEARCH

Research project seed funding	\$302,175.10
Partnership development seed funding	\$171,051.65
Visiting fellow scheme	\$9,000.05

Subtotal \$482,226.80

Total	\$945,056.24
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Melbourne Energy Institute

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