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ENERGY INSTITUTE



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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 and collaborates with industry groups and government agencies to help meet this challenge.



Message from the Director

In 2012, in the third year of operation, the Melbourne Energy Institute continued its program of expanding the University's energy research portfolio. The Institute supported projects in Carbon capture and storage (CCS), energy system optimisation, direct geothermal, data fusion relevant to geothermal and energy policy, and helped generate over \$4 million of new funding for energy research and capability at the University. Of particular note was Rio Tinto's commitment of \$3 million to the creation of the Peter Cook Centre for Carbon Capture and Storage Research. The University's capacity for CCS research was further enhanced by the appointment of Professor Ralf Haese to the position of Professor of Geological Carbon Storage, supported by the Victorian Government's Department of Primary Industries and the CO2CRC.

In 2012, the Institute was proud to be associated with the successful launch of a new interdisciplinary Master of Energy Systems course, with a first year enrolment of 50, testifying to the inspired leadership of Associate Professor Michael Brear and his team. Through a co-investment with the Faculty of Business & Economics, the Institute co-supported the appointment of Doctor Leslie Martin as a lecturer in energy markets within the newly established Centre for Market Design under the leadership of Professor Peter Bardsley, along with the Federal Government's Treasury and the Victorian Government Department of Treasury and Finance.

Looking forward, 2013 will see a number of exciting developments. Our focus will remain on the challenges and opportunities of large-scale, low-emissions technologies and their integration into our domestic electrical power sector. The Australian Renewable Energy Agency (ARENA) funded project "Achieving cost effective abatement from Australian electricity generation" led by Dr Roger Dargaville, is central to this activity. The University will build capabilities in grid research through a new University funded initiative led by Professor Mohammed Aldeen and Professor Rob Evans. The University is a key partner in the Victorian CarbonNet EIF bid, which will further enhance the University's leadership in CCS research. The Institute will seek to develop a new nationally significant capability relevant to understanding how to best manage multi-use scenarios for sedimentary basin resources, by linking regulatory, geoscience, technology and social science expertise across the University.



The interest in the Institute's Energy Futures Seminar Series, in partnership with the Grattan Institute, continued to grow, with registrations consistently booking out at 700, with an expanded on-line audience view live web streaming and increasing media coverage.

We continue to explore how to capitalize on numerous expressions of interest to link with partner organisations both nationally and overseas, and we are committed to continue to build programs in international development in our neighbourhood, particularly across southern Asia where we have already established links in Timor-Leste, India, Myanmar, the Philippines and Indonesia.

Prof Mike Sandiford

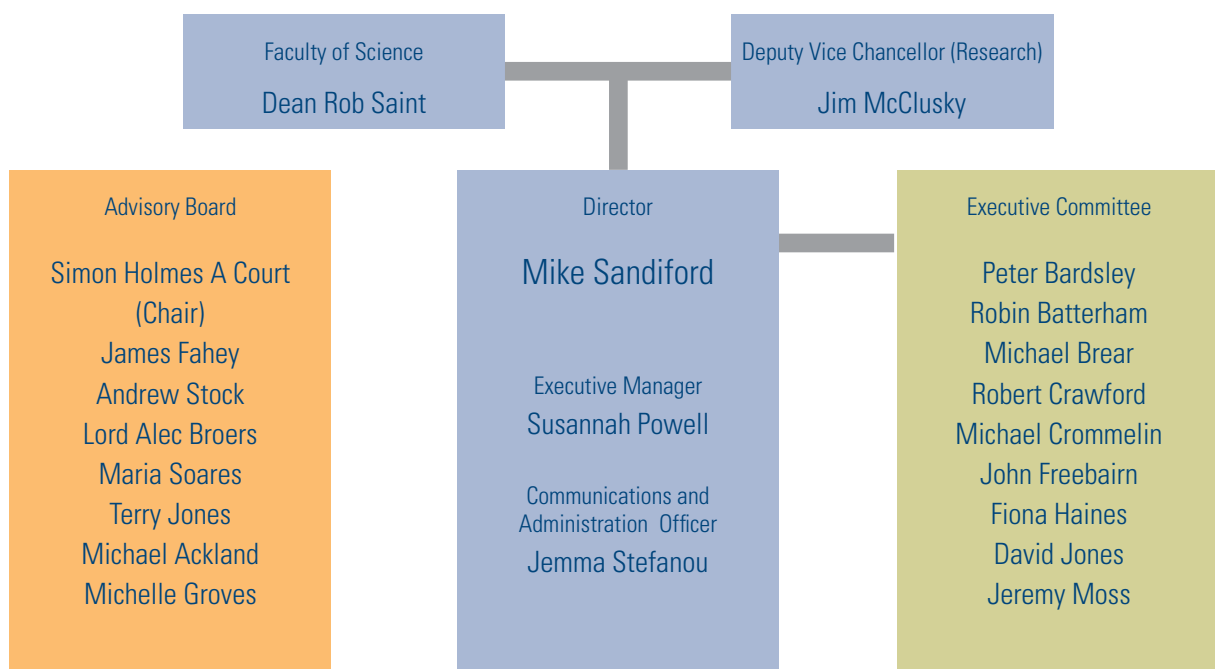
Governance

During 2012 the MEI Advisory Board meeting was held on the 7th November and Executive Committee meetings were held on 12th November and 9th October.

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

We are pleased to announce that MEI's former Deputy Director Professor Sandra Kentish has taken on a new role as Head of Department of Chemical and Biomolecular Engineering. The Deputy Director role has since evolved to constitute two research program leaders representing the technical and social aspects of energy research. These program leaders will be announced in 2013.

Organisational Structure



New Capability

The Institute's activities have contributed to new interdisciplinary research and enhanced research capacity, to new partnerships and an enhanced external profile. Since conception, it has directly supported the creation of two new professorial positions, one lectureship, and the appointment of 5 Honorary Professorial fellows.

During 2012, the MEI helped facilitate a number of senior appointments that have significantly strengthened the University's energy research leadership which include:

Dr Malte Meinshausen (Senior Honorary Research Fellow, Science – in partnership with MSSI) is an expert in greenhouse gas emissions scenarios and their impact. He has been a scientific advisor to the German delegation at the United Nations Framework Convention on Climate Change negotiations since 2000 and was helped in the design of various accounting rules for the international emissions trading. Dr Meinshausen, is leading the development of an Australian Graduate School of energy climate between University of Melbourne and the Potsdam Institute for Climate Impact on climate and energy.

Prof Sau-Wai Wong (Honorary Professorial Fellow, Science), is manager of Shell's Unconventional Resource Group, and an expert in geomechanics. He will help develop and mentor young researchers in the PeterCook CCS Centre in developing reservoir engineering capability and geomechanical properties assessment of reservoir integrity.

Prof Ralf Haese (Professor of Geological Carbon Storage, Peter Cook Centre for Carbon Capture and Storage Research) comes to the position from Geoscience Australia, where his work included the assessment of sedimentary basins for CO₂ storage. He is particularly interested in the biogeochemical processes and chemical reactions at play in the deep subsurface during CO₂ storage. Following these interests, Dr Haese has led the CO₂CRC research program on reactive reservoir rocks for the past two and a half years.

Dr Leslie Martin (Economics, Centre for Market Design) specialises in environmental economics, energy economics, and industrial organization. Her research currently focuses on consumer preferences for environmentally-friendly products, environmental and welfare impacts of access to used durable goods in developing countries, energy efficiency gains from trade liberalization, and how power cuts affect investment decisions in industrializing countries.

Engagement and Profile

The Institute has achieved a high profile through its event program, publications, and media engagement. It is increasingly recognised for its contributions to the national energy debate. The Institute's profile has grown through active engagement with industry and government via our events program, media engagement and publications and communications, as detailed below.

The Institute's events program creates an environment to discuss and develop ideas relating to energy through a program of public seminars, lectures, workshops, and symposia.

The Institute's Energy Futures Seminar Series brings industry, government and academia around critical energy future issues, and has attracted a number of high profile speakers to the University. The program has significantly increased the profile of the Institute with seminars consistently booking out at 700 registrations and a growing national audience watching online. Since 2011 the Energy Futures Seminar Series has been held in collaboration with the Grattan Institute.

The Institute engages and responds to the media on energy issues and has established a reputation as an independent, reliable source of advice. On average MEI will generate 133 media mentions over a 6-month period.



2012 Highlights

In 2012 the MEI made significant progress in broadening the University profile as an important new voice in energy research. The MEI did this through:

- A co-investment with Faculty of Business & Economics to support the appointment of a lecturer in energy markets within a newly established Centre for Market Design.
- Projects in energy system optimization, direct geothermal, geothermal and data fusion and energy policy, originally seeded by the Institute, generated over \$4 million of new research funding for the University.
- A \$3 million dollar commitment by RioTinto for the creation of the Peter Cook Centre for CCS Research.
- A successful launch of the interdisciplinary Masters of Energy Systems course.
- Energy Futures Seminar Series in conjunction with Grattan Institute continues to grow, with an expanded on-line audience viewing live web streaming and increasing media coverage.

Energy Futures Seminar Series 2012

Multiple Climate Change Policies: Killing No Birds with Two Stones? – 1 March 2012

Mr Tony Wood	Energy Program Director, Grattan Institute
Dr Cameron Hepburn	Economist specializing in environmental and public policy, LSE/ Oxford University
Mr Andrew Stock	Director, Executive Projects, Origin Energy Australia
Dr Malte Meinshausen	School of Earth Sciences, University of Melbourne

The Future of Coal and Gas in Australia – 27 June 2012

Mr Tony Wood	Energy Program Director, Grattan Institute
A/ Prof Michael Brear	Director, Thermodynamics, Department of Mechanical Engineering, University of Melbourne
Dr Nikki Williams	Chief Executive Officer, Australian Coal Association
Mr David Byers	Chief Executive Officer, Australian Petroleum Production and Exploration Association (APPEA)

The Future of Electricity Demand in Australia – 22 July 2012

Mr Greg Borschmann	Environment Editor, Radio National Breakfast
Mr Mark Collette	Group Executive Energy Markets, TRUenergy
Mr Matt Zema	CEO, Australian Electricity Market Operator
Mr Andrew Reeves	Chair, Australian Energy Regulator
Mr Terry Jones	Business Development Smart Networks, SPAusnet
Mr Tristan Edis	Editor, Climate Spectator
Prof Mike Sandiford	Director, Melbourne Energy Institute

The Future of Carbon Pricing and the Australian Electricity Market – 15 October 2012

Prof Ross Garnaut	Vice-Chancellors Fellow and Professorial Fellow in Economics, University of Melbourne
Mr Tony Wood	Energy Program Director, Grattan Institute
Prof Mike Sandiford	Director, Melbourne Energy Institute

Renewables 2012: Positioning Australia in a Global Context

In conjunction with the Clean Energy Council and Grattan Institute, MEI co-hosted the Global Perspectives Public Seminar **Renewables 2012: Positioning Australia in a Global Context**.

Ms Christine Lins, Executive Secretary of REN21 of the United Nations Environment Programme presented REN21's Renewables Global Status Report (GSR). Christine referenced the most recent GSR findings and reflected on its significance to the world globally and in relations to Australia's clean energy industry with the introduction of the carbon price, the commencement of the Clean Energy Finance Corporation and the review of the Renewable Energy Target.

Panel members included Mr Kane Thornton, Deputy Chief Executive of Clean Energy Council, Dr Malte Meinshausen, Senior Fellow in the School of Earth Sciences at the University of Melbourne, Mr Tony Wood, Grattan Institute's Energy Program Director and Chair Mr Tristan Edis, Editor of the Climate Spectator.

Student Engagement

The Australian-German College of Climate & Energy Transitions

The Australian-German College of Climate & Energy Transitions is a new International Graduate College jointly instituted by the University of Melbourne and a partnership of German universities in the Berlin-Potsdam area. The College offers PhD candidates the opportunity to pursue research in climate change and energy transitions at a world-class level, complemented by a six month exchange program to broaden their horizons and expertise at the overseas partner institution.

The college will provide all PhD candidates with a strong disciplinary training in economics, physics, energy system theory, political science, and network theory - complemented by a broad, transdisciplinary perspective. Ensuring originality of research at the frontline of science will lead students into overlapping areas of study across the four research clusters:

1. energy systems and the requirements for a national transition towards a dominant contribution of renewable energies
2. emission pathways and mitigation strategies including trading systems, intergenerational equity, carbon budgets and mitigation costs all aspects of the climate system itself
3. climatic impacts on the global supply network of goods and services with a special focus on energy infrastructure

Further information is available via the College website www.climate-energy-college.net



THE UNIVERSITY OF
MELBOURNE

THE POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH



UNIVERSITY OF POTSDAM



HUMBOLDT-UNIVERSITÄT
ZU BERLIN



TECHNISCHE UNIVERSITÄT
BERLIN



Master of Energy Systems

The University of Melbourne's Master of Energy Systems is a graduate program designed to train specialists who understand the 'technology and business of energy'. This program was successfully launched in Semester 1, 2012.

The Master of Energy Systems has been developed in close consultation with industry in response to rapid changes in today's global energy sector.

This program integrates the study of the technology, business and science of energy, focusing on the key areas of: evaluating energy systems; energy-related investment decisions; policy development and implementation; and greenhouse gas management issues.

Given this strong initial enrolment, the University now plans to grow the cohort whilst refining the degree design.

Since its launch, applications have increased significantly, making entry into the Master program much more competitive for local and international students.

The course has been developed by Associate Professor Michael Brear. The Melbourne School of Engineering leads the Masters in collaboration with the Faculty of Science, Business and Economics and the Melbourne School of Land and Environment.



Research Centres

The University of Melbourne hosts three research centres that address future energy challenges. Launched in 2012 these include Peter Cook Centre for Carbon Capture and Storage, the Australian Geophysical Observing System and the Centre for Market Design.

Peter Cook Centre for Carbon Capture and Storage Research

Opened in 2012, the Centre hosts over 30 world-leading scientists working on carbon dioxide capture technologies, as well as a growing field of researchers focusing on geological storage including a recently funded Professor of Carbon Storage supported by Rio Tinto, the Victorian Government and CO2CRC.

The Centre has been sponsored by Rio Tinto with \$3 million in funding over 3 years. A further \$3 million in Rio Tinto funding over 3 years supports the CO2CRC Otway Project, Australia's first demonstration of geological carbon dioxide storage and a subsurface field laboratory for carbon storage research.

The Centre has been named after the eminent geologist and founder of the CO2CRC Professor Peter Cook.

The Centre brings together professors and researchers from a wide variety of disciplines, including the chemical and process engineering associated with capturing CO2 from power plants, and the geology and geomechanics required for storage of carbon dioxide in deep rock formations. The Centre builds the kind of critical mass vital to the national development and deployment of large-scale CCS, which will be a major part of Australia and the world's drive to manage climate change. It is an important collaboration between research, industry and government that demonstrates the widespread support in Australia for CCS technology development.

The Centre has a special relationship with the Victorian CCS industry based in the Latrobe Valley and the Gippsland Basin. It provides postgraduate education and applied research in carbon capture and storage, contributing to the next generation of carbon capture and storage operations by developing CCS technologies and associated engineering skills. It is a centre of knowledge, analysis and services for students, industry, governments and the public.

Prof Ralf Haese



**PETER COOK CENTRE
FOR CCS RESEARCH**

Centre for Market Design

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 MEI works 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.

The Institute contributes to the energy program in the Centre by providing support for a Lecturer in Energy Market Design. That position is held by Dr Leslie Martin. In 2012, Dr Martin began research in the project 'Real-time pricing and competition in the retail electricity market'.

This project explores how regulatory policies that make detailed residential meter data available to retailers may affect customer screening in the retail electricity market. The research will focus on identifying which customers will chose to switch to time-of-use pricing and how that selection will affect contracts offered to customers that want to remain on flat rates.

This project uses a cross-disciplinary approach that combines economic models of competitive screening and market unraveling with an understanding of Victoria's residential electricity markets. Research questions relating to energy have previously been studied exclusively by disciplines within engineering. This project however examines the economic aspects of this problem, and uses structural econometric techniques.

This project is an example of the potential to make use of the synergies between MEI and the Department of Economics that arise from economists' methodologies for dealing with strategic interaction between firms, such as large power generators, which are a key characteristic of energy markets. Further, the technical skills of engineering faculty and graduate students complement the computational aspects of both estimating demand and supply elasticities and modelling strategic interaction amongst large power generators in the Australian energy market. This co-operation will potentially result in research that is of high value for policymakers and academics alike.

Prof Peter Bardsley



cmd CENTRE FOR
MARKET DESIGN

A CONSORTIUM OF



Australian Government
The Treasury



Department of
Treasury and Finance



Research Centres Australian Geophysical Observing System

In partnership with AuScope the University of Melbourne's Australian Geophysical Observing System (AGOS) is funded through the Education Investment Fund (EIF3) designed to augment existing NCRIS AuScope infrastructure with new capability that focuses particularly on emerging geophysical energy issues.

It will build the integrated infrastructure that facilitates maximum scientific return from the massive geo-engineering projects that are now being considered – such as deep geothermal drilling – in effect building the platform for treating these as mega geophysical science experiments.
AuScope

AGOS infrastructure will enable collection of new baseline data including surface geospatial and subsurface imaging and monitoring data, thereby providing for better long-term management of crustal services, particularly in Australia's energy-rich sedimentary basins.

The Melbourne Energy Institute manages the \$7.4 million Subsurface and Geohistory components of AGOS through the School of Earth Sciences at the University of Melbourne.

A/Prof Tim Rawling



Research Projects

Optimising emission abatement in the Electricity network

Meeting the requirements for large cuts in CO₂ emissions in the stationary energy sector is a major challenge. The costs will be high, but can be minimized through careful planning. This model development project will produce the tools to test different pathways and to find the least cost options to a clean energy future.

Avoiding dangerous climate change will require at least an 80% reduction in CO₂ emissions in the electricity sector. This can be achieved through reducing demand and replacing fossil fuel generation with wind, solar PV, concentrating solar, wave, biomass and hydro power, or capturing CO₂ from fossil fuel power stations. The new system will require a mix of many technologies (there is no one silver bullet) and each comes with its own benefits and disadvantages.

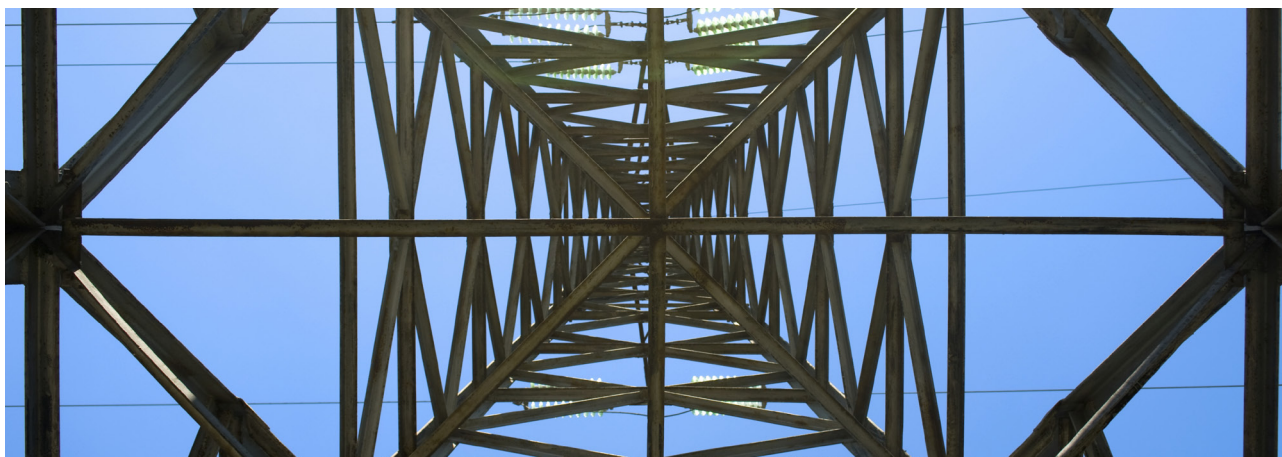
Deciding how much of each technology should be deployed to achieve the least cost carbon abatement is difficult. The decision requires consideration of the cost of capital and operations, reliability, dispatchability, and cost of transmission. It requires that the covariance of the different technologies and demand are understood over timescales ranging from seconds to decades. This model will link together the weather variability, renewable and fossil technologies, transmission and economics market models within an optimization scheme to facilitate the search for the least cost solution.

The inter-disciplinary nature of this problem is clear – it requires the expertise of mechanical, civil and electrical engineers, climatologists, computer scientists, economists and energy system regulators. The audience for this work is equally broad involving the electricity system planners and regulators, market operators, the generators and retailers, managers of the transmission and distribution systems, politicians and the general public who pay the electricity bills.

The partners on the project come from Earth Sciences, Engineering and Economics from both the University of Melbourne and University of New South Wales. Our external partners include the Australian Energy Market Operator, GE, Department of Treasury and Finance (Vic), the Bureau of Meteorology and Market Reform.

The key output of this project will be an open-source model of the Australian electrical energy system including generation, transmission, demand-side modeling, spot market model. The model will use a high powered search algorithm to find the least cost combination of supply-side and demand-side options over a transition period from the present with the current generation mix out to 2050 and beyond.

Dr Roger Dargaville



Wind Farm Syndrome

Wind Turbine Syndrome is a highly topical issue, with a recent move by the Victorian State government requiring large setbacks from habitation and exclusions of wind farms from certain areas. At a Senate Inquiry into the Social and Economic Impact of Rural Windfarms, over 1000 submissions were made. The issue is prominent in the media and a number of TV programs have been aired putting both the viewpoints that noise from windfarms is injurious to health and that it is harmless.

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 present situation is that the development of wind energy is increasingly hampered by fear. The intention of this project is to clarify the issues surrounding Wind Turbine Syndrome and to smooth the path for future development of wind energy which is informed, safe and non-divisive in the community.

Prof Peter Seligman



The role of distributed solar generation in reducing wholesale spot market electricity prices

The design of policies to facilitate the transition to low emission electric power production presents significant challenges. Any new generation necessarily incurs up-front cost, particularly in the case of renewables, such as solar photovoltaic. However the introduction of renewables into electricity grids has been shown to reduce the wholesale spot price for electricity, through the 'merit order effect'. This project will investigate the extent to which the merit order effect may offset the costs associated with solar photovoltaics.

Internationally, Feed-in Tariffs have been an effective policy mechanism to accelerate the deployment of renewable technology, particularly solar photovoltaics. In Australia, feed-in tariffs remain controversial and are criticized for the impact they have on consumer electricity prices, and are argued to constitute a form of regressive taxation.

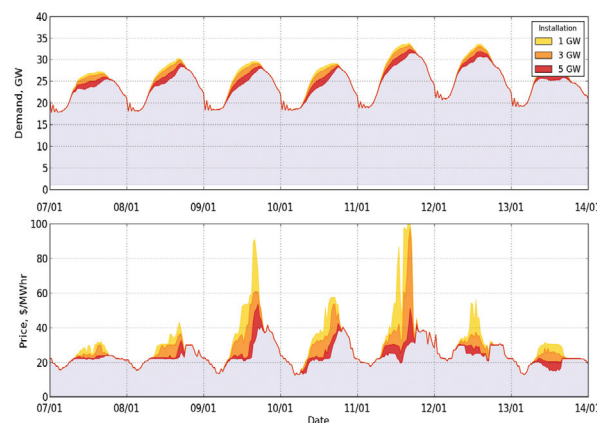
However, there are other mechanisms and interactions through which renewables can impact electricity prices which may offset the cost impost levied on consumers. One key offset is the 'merit order effect', a phenomenon whereby the addition of low marginal cost renewable capacity into the electricity market lowers wholesale spot prices. Internationally, this interaction has been shown to reduce spot prices by billions of dollars annually.

This project will integrate an advanced solar output model with a model of the national electricity market to evaluate this interaction, and the potential for the merit order effect to offset photovoltaic support costs, in the Australian context.

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.

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.

This multifaceted project requires expertise in solar generation, the operation of Australia's National Electricity



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

market, and the economic implications of the findings. The project steering committee consists of experts from the Department of Earth Sciences, the Melbourne Energy Institute and the Department of Economics to advise in the relevant project areas. Our external funding partner is the Australian Energy Market Commissions Consumer Advocacy Panel.

The project findings are relevant to consumers, industry and government stakeholders, including market participants and electricity system operators and regulators.

Mr Dylan McConnell

Climate Change, Energy and Justice in Timor Leste

Ensuring the optimal balance of energy options in developing countries partly depends on development priorities. For instance, in some rural areas of Timor Leste, energy will continue to be a limited resource, but 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? To ensure equal access to energy resources, this project focuses on who would benefit most from the provision of a particular energy resource. This project provides an overview of the energy options for Timor Leste at both a national and local level.

This report evaluates the energy options available for Timor-Leste in light of social justice and environmental concerns. The report pays particular attention to the needs of the rural population and develops a framework for integrating key issues such as climate justice and equality in national energy debates. It examines each energy option against its ability to deliver energy services critical to the enjoyment of core capabilities, its potential climate change impacts, whether it promotes equality or increases inequality and its effect on energy security.

A key outcome for the Climate Change, Energy and Justice in Timor Leste report is to identify the way in which different energy options impact on local people and communities. This project has been partly funded by the Melbourne Energy Institute and Social Justice Initiative of the University of Melbourne.

Dr Jeremy Moss



The Zero Carbon Australia Project

Meeting the full-scale challenge of avoiding dangerous climate change will require completely halting and reversing the rise in atmospheric greenhouse gases – the Zero Carbon Australia Project aims to show what is possible to achieve this challenging goal.

The prudent, risk-averse response to avoid dangerous climate change requires full economy-wide decarbonisation as soon as possible, yet it is not well understood what will be required to achieve this goal. The Zero Carbon Australia Project sets out to explore what this scenario looks like for Australia, quantitatively defining the technical solutions to be put in place to achieve zero ongoing greenhouse gas emissions, the costs and benefits, and the achievability of devoting sufficient human and material resources to complete the transformation in a decade. Since the first installation, the ZCA Stationary Energy Plan, was launched in July 2010; there has been a significant body of work completed on the next three sectors of Buildings, Land Use, and Transport. Industrial Processes and Renewable Superpower are the final sectors awaiting to commence.

The Zero Carbon Australia Project covers many fields of knowledge, from almost every discipline of engineering to architecture, economics, applied mathematics, agriculture and forestry science, transportation network planning and computational modeling to name a few.

The Melbourne Energy Institute and Melbourne Sustainable Society Institute are the key University partners on the ZCA Project with independent climate solutions think-tank Beyond Zero Emissions, which works with over one hundred pro-bono contributors. The Buildings Plan in particular has received contributions from over a dozen commercial organisations involved in the buildings industry, while the German Aerospace Centre (DLR) is working on the non-urban rail component of the Transport Plan.

The approach of each sector of the ZCA Project is asking and answering questions in the form of:

- Quantification of problem: where and how large are the sources of greenhouse gas emissions, and the service demand that generates them, in this sector?
- Quantification of benefits: If alternative solutions were put in place to displace the emissions, how much would be required and what would the impact be?
- Quantification of costs: How much would it cost, in capital and operating terms, to put these alternative solutions in place and how does this compare to business-as-usual?
- Achievability: What resources, human and material, would it take to put these solutions in place over ten years and how does this compare to business-as-usual?

Mr Patrick Hearps

Facilitating the Photovoltaic Revolution in the Australian Electricity System

Australia's electricity system is predicated on centralized and cheap coal fired power, which has high carbon footprint. If Australia is to meet its political commitment to decarbonize the economy, transformational change of the electricity system will be necessary. This project explores the operation of the current system and the requirements needed to enable transformation. It takes one technology, solar PV, and explores the technical, regulatory, political and social potential of and barriers to optimal uptake of the technology.

The electricity system is currently well designed – but for one fatal flaw. It is premised on coal and currently generates 36% of Australia's greenhouse gas emissions. The transformation of our electricity supply system is essential if Australia is to realise a low carbon future. However, each element of the current design of the system – from the norms that underpin it, the finance that supports it, the regulatory regime that guides it to the technology that comprises it – supports the continuation of high carbon intensity power generation.

This project aims to explore both how the current electricity system operates and what is needed to transform it. This is achieved through a focusing on one particular technology, solar photovoltaic (PV) panels on householder rooftops, a technology that poses a challenge to the current regulatory framework and incumbent electricity industry, yet contains potential for transformative change as people both produce and consume electricity.

There are considerable challenges in integrating large amounts of solar PV into the system. The interconnections between norms, regulations, technology and finance within this system demonstrate the need for a multidisciplinary perspective. The members of this research team bring together earth sciences, environmental science, politics, criminology and law.

The potential role of solar PV in electricity systems require careful analysis of these multiple dimensions, such as essential service nature of electricity provision and its political impact, longevity of infrastructure, the nature of the resource base (that includes both sun and coal) and the move towards liberalized markets as mode of delivery.

This project addresses several critical questions emerging from the analysis of the prospective transformation. These include:

- What role will distributed generation play in the transformation of technology and law consistent with a low carbon future?
- What influence will the growing number of 'prosumers' (i.e. those who both produce and consume electricity) have on technological and legal change?
- What norms (market or other) will guide technology upgrades and law reform?
- How will transformation be funded? By whom? What role will the growing electricity futures market play in transformation?
- What role will be played by current participants in the National Electricity Market in facilitating or inhibiting transformation?

Prof Fiona Haines

Victorian Organic Solar Cell Consortium (VICOSC)

Solar is the most abundant form of renewable energy but current solar cell technologies remain expensive. We are developing printed organic solar cells using ink formulations of special organic polymers. The technology offers the potential to deliver large area, low cost solar cells printed on awnings, tents or rooftops.

Rapid introduction of renewable energy to the market has been delayed by the perceived high cost of alternative technologies. Solar remains, in most countries, a consumer discretionary purchase based not on cost but on a desire to “do the right thing”. This will only change when the cost of solar is significantly reduced allowing low-cost renewable energy to be delivered directly to end users, or used in energy storage or chemical conversion systems.

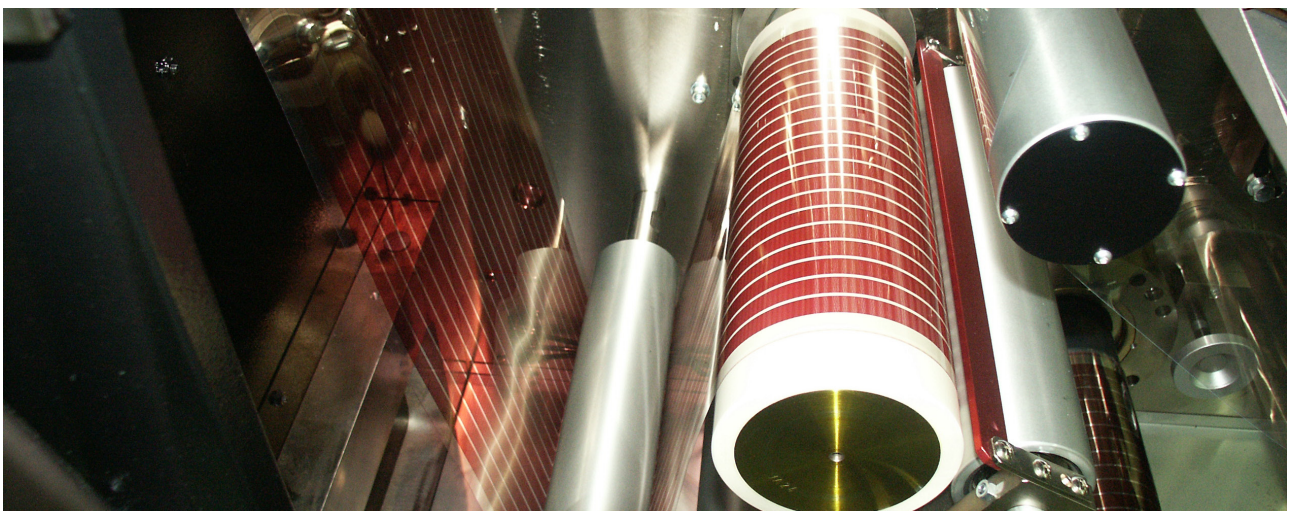
The ability to print organic solar cells (OPV) is expected to significantly reduce manufacturing cost by using inks, formulated with special polymers designed to absorb light and generate current, in commercial printing or coating machines. The VICOSC consortium is leading the world by bringing together researchers and industrialist, who are working together on new materials, materials processing, characterization, printing, encapsulation and durability programs. VICOSC remains one of the few consortia where strong feedback loops are possible because all the key researchers are located in the same city.

VICOSC brings together three key research providers in Victoria, each with complimentary skills in materials synthesis, materials processing, and device architecture and physics. The key research partners are joined by four industrial partners, together providing materials supply chain and end users to drive the project forward. The industrial partners have vast experience in coated steel products for roofing, printing on plastics (polymer banknotes), coated specialty plastics, and consumer and automotive electronics and solar cell technologies.

The collaboration will deliver,

- High performance materials and device architectures
- Printed solar cells prototypes
- Well defined printing process for transfer to a pilot plant
- A world leading team of experts in flexible electronics, materials design and synthesis, device physics and printed solar cells.
- International collaborations with leading institutes in Australia, Germany, United Kingdom, United States, Korea, Japan, China, Singapore.

A/Prof David Jones



In the news: don't spit chips over power bills

It was Intel founder Gordon E. Moore who observed in 1965 that there was a doubling in the power of computer chips every two years.

Moore predicted this trend would persist for another 10 years and his prognostications have proven eerily correct.

Even extrapolating Moore's Law, as it became known, beyond the realms of semiconductors into digital technology and elsewhere, technology tends to double in power every couple of years.

And as the performance increases, the price drops in sync.

Advertisement

It is to this phenomenon that electricity consumers can pin their hopes in coming years as they grapple with rising power bills. The technology to deliver cheaper energy is here.

The question is: can industry and government deliver?

Already, solar power has hit a "tipping point", where it is economic without government subsidies.

This was one of the findings of a recent draft report by engineer Robert Rollinson on the electricity industry on the New South Wales mid-north coast.

The Melbourne Energy Institute's Professor Mike Sandiford says solar PV (photovoltaic) is close to "grid parity". "PV [pricing] has been trending down with a 20-25 per cent cost reduction for every doubling of capacity globally."

This, however, is no guarantee of relief from surging prices.

The electricity industry needs to get a return on its massive spending over recent years - spending which has been the impetus behind nosebleed power bills.

Thanks to the high fixed costs of the network, even if consumers were to flee the grid in droves for wind and solar power, many would still use it for a portion of their power needs.

Less savvy consumers - read the most needy - will still be stuck on the grid.

For industry, the unpleasant consequence of falling demand and the incursion of solar power is the prospect of large write-downs at a time when the Queensland and NSW governments are keen to privatise their transmission and distribution assets.

There is a little ray of sunshine, though.

Electric cars may take up surplus capacity on the grid in the off-peak hours. You charge them at night.

Like TV sets, digital cameras and DVD players, electric cars have rapidly improved in performance and dropped in price.

A paper from the Australian Energy Markets Commission estimates that electric cars will make up 20 per cent of all new vehicle sales in Australia by the end of this decade and 45 per cent by 2030.

If consumers charge their cars overnight the AEMC says that electricity demand will rise only 4 per cent by 2030.

The cost of charging an electric car during the night is about 1¢ per kilometre versus 10¢ a kilometre to fuel a petrol car.

Ergo, lower costs for consumers and higher demand for the networks at times of when they have most un-utilised capacity and therefore no need to make capital expenditures (or operating expenditures, for that matter).

A win-win.

The incremental off-peak revenue flows to industry (the five-year regulatory periods allow for significant capture; then it's, fingers-crossed that the regulators don't roll the same opportunities for "gold-plating", or unnecessary expenditure, into the next period). Off-peak prices are lower, but this is incremental revenue nonetheless, and revenue gained without offsetting capital or operating costs.

Are electric cars at a tipping point, too?

Over the New Year, Nissan unveiled the pricing for its entry level LEAF electric vehicle at \$US28,800 (\$A27,900) - that's 18 per cent cheaper than the most basic 2012 model and presents a robust challenge to GM's dominant offering, the Volt.

Applying the US federal incentive, the price of the new LEAF is an aggressive \$US21,300, or as low as \$US18,800 in California once the state rebate has been discounted.

The tumbling Japanese yen will make imported electric cars far cheaper in Australia, too, or at least for as long as the \$A remains high.

In Australia though, if high power prices persist, particularly in off-peak, they may act as an impediment to take-up of electric cars.

As an interesting aside, one corollary of the carbon tax is that it will also act as an impediment to take-up as it is a very large share of off-peak costs but not so much for on-peak - and the tax is not levied on its competitor: petrol.

While electric cars may prove a happy if unintended consequence of technology for the electricity networks, industry remains in denial when it comes to solar PV.

Research by Mike Sandiford last year estimated that, thanks to the spectacular take-up of solar panels, there would be

in excess of 2 gigawatts of solar PV capacity installed by now, enough to produce about 8 per cent of the average daytime electricity demand.

Rather than being hard to measure, Sandiford says the solar PV signature is "blindingly obvious", putting big dents in electricity consumption figures in the places where PV penetration is highest.

"In South Australia, midday to early afternoon demand was down over the financial year 2011-12 by about 8 per cent on the average for the period spanning mid- 2007 through mid-2009. That contrasted with a negligible change in demand outside daylight hours," said Sandiford.

If his estimates are even roughly correct, the electricity industry is in for a shock.

Revenues were down 35 per cent, or \$3.3 billion, across the National Electricity Market in 2011-12, compared with the \$9.6 billion in turnover for the two years prior to mid-2009.

If solar PV deployment proceeds at its present pace, it will take only 18 months to reduce midday demand to current midnight levels.

Michael West
Business Columnist
The Age
21 December 2012

New Funding Initiatives

Confirmed External Funding from MEI-Supported Activities in 2012

Funding Source	Name	CI/proponent	Faculty	Funding Period	Total (\$k)	UoM Component (\$k)
ACRE MEASURE	Renewable energy integration	Dr Roger Dargaville/ A/Prof Michael Brear	SCI/MSE/FBE	2012-2013	1,231	623
CAP	The role of distributed solar generation in reducing wholesale spot market prices	Ms Susannah Powell/ Mr Patrick Hearps	ARTS/SCI	2012	76	76
ACRE MEASURE	Data fusion and machine learning in geothermal research	Prof Mike Sandiford/ Prof Hugh Durrant-Whyte	SCI	2012-2013	1,902	200
GE Energy	Development of interactive model for Australia stationary energy sector - futrEnergy	Ms Susannah Powell/ Dr Roger Dargaville	SCI/MSE/FBE	2012	77	77
ARUP	Large scale pumped energy storage	Dr Roger Dargaville	SCI/MSE	2012	73	66
RioTinto	Centre for GCS/Peter Cook Centre for CCS Research	Prof Mike Sandiford/ Prof Geoff Stevens	SCI/MSE	2012-2014	3,000	3,000
Total (\$k)					6,359	4,042
MEI Allocation (\$k)						992
Multiplier						4.1

External Funding from MEI-Supported Activities in 2012 with outcomes still pending

Funding Source	Name	CI/proponent	Department/ Faculty	Funding Period	Total (\$k)
Education Investment Fund (Fed Gov)	CarbonNet	Prof Mike Sandiford A/Prof Sandra Kenitsh	EarthSci/SCI Chem&BioMol Eng/ MSE	2013	14,900
Total (\$k)					14,900

Expenditure

MELBOURNE ENERGY INSTITUTE 2012 BUDGET

OPERATIONS

Salaries	\$435,211
Administration and general expenses	\$31,895
Events and communications	\$23,997

Subtotal \$491,103

RESEARCH

Salaries (Research Enabling Staff)	\$103,079
Research project seed funding	\$122,500
Partnership development seed funding	\$280,000
Other	\$25,000

Subtotal \$530,579

Total	\$1,021,682
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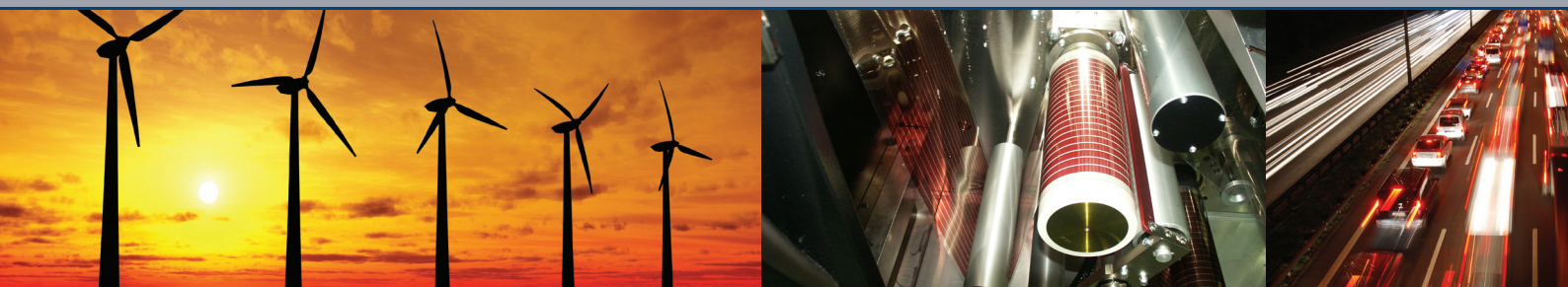
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