THE UNIVERSITY OF MELBOURNE

ENERGY Research Institute

Melbourne Energy Institute
Annual Report
2010

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Background

Growing 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 leading 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 that link the many different ways of thinking that inform how modern societies work and prosper. The Melbourne Energy Institute brings together the work of more than 200 researchers engaged across seven faculties at the University of Melbourne to help meet this challenge.

Message from the Director

The Melbourne Energy Institute was launched at the beginning of 2010 to provide an interdisciplinary strand to the University's energy program. With outstanding existing strengths in areas such as photovoltaic materials, carbon capture, automotive engineering and energy resources, the MEI's brief is to create new research opportunities and enhance the University's profile. I am delighted to report MEI activities have already achieved considerable progress towards these goals.

In its first year of operation the MEI has established a profile through the launch of the award winning Australian Sustainable Energy book series, and through the Energy Futures seminar which have attracted audiences of up 1000 on topics ranging from carbon trading to nuclear energy.

In 2010 the MEI seeded several new projects ranging from the demonstration of direct geothermal energy on the University campus through to energy policy in the developing world in the context of climate change and social justice. In doing so the MEI has helped support initiatives that secured new research funding in excess of $10 million dollars, including the award of a new ARC Future fellowship to AProf Chris Manzie to research low emission road transportation and a $7.4 million award to contribute to the building of the Australian Geophysical Observing System. This funding for new initiatives is in addition to more than $10 million of funding obtained in 2010 for ongoing programs in energy research across the University.

With some $20 million dollars of funding applications already pending, we are looking forward to an even busier year in 2011.

Mike Sandiford
Director

Engagement and Profile

During 2010 the MEI ran a series of public events and workshops with The University of Melbourne researchers and relevant industry and government representatives. Our public events and publications have received wide interest and media coverage – positioning the Melbourne Energy Institute as a leader in the energy future debate.

The MEI's invitation only workshops have complimented our public engagement program, enabling targeted areas of government and industry to gain specialized 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 engagement activity is summarized in the following points:

- The MEI's Energy Futures Seminar Series featured leaders in the energy debate from academia, industry, government and key figures involved in communicating science. The series covered issues including The Future of Carbon Trading in Australia, The Future of the Grid, The Future of Renewable Energy in Australia, The Future of Cities, and The Future of Nuclear Energy in Australia. Event speakers and Master of Ceremonies included Prof. Ross Garnaut (AO), Mr. Don Henry, Mr. Robyn Williams (AM), Mr. Peter Mares, Dr. Ziggy Switkowski, Mr. Adam Morton and others.
- In 2010 the MEI launched the Australian Sustainable Energy publication series and produced two publications, including Australian Sustainable Energy – by the numbers and the Zero Carbon Australia Stationary Energy Plan. Our first publication was launched in February and the second in July. The Zero Carbon Australia Stationary Energy Plan was also launched interstate in both Sydney and Brisbane and generated significant public interest. Leaders in the energy debate spoke at the launch events, including, Mr. Malcolm Turnbull MP, Former NSW Premier Bob Carr, Greens Senator Scott Ludlam, Professor Robin Batterham, Dr. Roger Dargaville, Premier for Queensland Anna Bligh, Professor Ian Lowe, Professor Mike Sandiford and others. Notably the audiences for the three launches exceeded 1000 people and received national media coverage in major Australian newspapers and current affairs radio and television programs including, SBS 6pm New, SBS Insight and ABC Lateline.
- Notably the Zero Carbon Australia Stationary Energy Plan received the the Mercedes-Benz Australian Environmental Research Award offered by the Banksia Environmental Foundation who sponsor environmental awards considered to be the most prestigious in Australia.
- During 2010 the MEI facilitated workshops between University of Melbourne researchers and relevant industry and government groups, including national and international organisations.
- In 2010 the MEI participated in national and international energy conferences including: the First Science Outlook Conference, Canberra; All Energy Australia Conference, Melbourne; 10th International Conference on Greenhouse Gas Control Technologies; and the CRC for Greenhouse Gas Control Technologies Annual Symposium; and presented seminars at the International Energy Agency in Paris France and NIWA in Lauder New Zealand. The MEI also contributed to the Scientists in Schools Program.
- 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. In 2010 our online subscriber base grew by 500% (totaling 600 people) and our energy researcher database received an average of 227 hits per month.

2010 Highlights

In 2010, in its first year of full operation, the MEI made significant progress in establishing the University profile as an important new voice in energy research. The MEI did this through:

- A high profile public Energy Futures Seminar Series.
- A series of workshops that engaged new government and industry partners.
- Establishment of a new book series titled the "Australian Sustainable Energy" which included two publications.
- Attracting confirmed funding of $10 million with, a further $20 million pending.
- Creation of new partnerships with industry, government and not-for-profit organizations.
- Establishment of a significant new philanthropic fund.

MEI's Energy Futures Seminar Series

The Energy Futures public seminar series provides a forum for industry leaders, decision makers and the general public to learn about current research in energy related issues.

The seminars proceed with panel presentations, followed by mediated discussion. This format gives audiences a broad insight into the impact that current research may have on Australia's energy future, as well as an opportunity to have their own questions and input considered.

The seminars have brought together experts from diverse research areas to explore the topics of carbon trading,integrating the grid, renewable energy, cities in a low carbon future, and nuclear power in Australia.

At the Future of Carbon Trading seminar the University of Melbourne's Vice-Chancellor's Fellow and Professor of Economics, Ross Garnaut, presented his latest research on carbon trading, including an outlook for a carbon trading scheme and what it would mean for Australian business, individuals and contributions to greenhouse gas emissions.

The public response to the seminar series has been excellent, with large numbers attending each event. The Future of Renewable Energy in Australia seminar demonstrated the extraordinary interest in this field, with The Spot (Economics) filled to capacity, as industry experts and researchers provided valuable insights into the potential of renewable technologies in Australia. The seminar went some way to breaking down commonly held myths about renewable energy, showing how solar power with storage can meet the nation's power demand, both day and night. At this seminar, John Daley, CEO of the Grattan Institute, proposed that the single greatest challenge facing renewable energy scale-up is the human barrier: "To ask people to spend a lot of money up front to get a return in the future is psychologically one of the hardest decisions you can ask anyone to make."

The seminars were chaired by prominent members of Australia's media community. ABC Radio's Robin Williams and Peter Mares, Lateline's Quentin Dempster, and The Age's environment writer, Adam Morton, have each provided stimulating leadership at these events.

MEI Energy Futures Seminar Series Participants

The Future of Carbon Trading in Australia - 17 February 2010

Mr. Don Henry	Executive Director, Australian Conservation Foundation
Prof. Ross Garnaut (AO)	Vice Chancellor's Fellow and Professor of Economics, University of Melbourne
Prof. Robyn Eckersley	Professor and Head of School of Social and Political Sciences, University of Melbourne
Mr. Kane Thornton	Senior Policy Advisor, Hydro Tasmania
Dr. Jeremy Moss	Director of the Social Justice Initiative, University of Melbourne

The Future of the Grid - 21 April 2010

Mr. Robyn Williams (AM)	Science Journalist, The Science Show, ABC
Mr. Terry Jones	Director, Centre for Distributed Energy and Power, CSIRO
Mr. John Howarth	Executive General Manager, Transmission Services, AEMO
Mr. Simon Holmes à Court	Founding Chairman, Hepburn Wind
Dr. Roger Dargaville	Senior Energy Systems Analyst, Melbourne Energy Institute, The University of Melbourne
Mr. Matthew Wright	Director, Beyond Zero Emissions

The Future of Renewable Energy in Australia - 14 July 2010

Prof. John Daley	CEO, Grattan Institute, The University of Melbourne
Dr. Keith Lovegrove	Solar Thermal Group Leader, Australian National University
Mr. Lane Crocket	General Manager, Pacific Hydro
Mr. Matthew Wright	Director, Beyond Zero Emissions
Mr. Andrew Dyer	Director, BrightSource Energy
Assoc. Prof. Peter Seligman	The University of Melbourne

The Future of Cities in the Low Carbon Economy - 18 August 2010

Mr. Peter Mares	ABC Radio National and Swinburne University of Technology
Prof. Rob Adams AM	Director, City Design, City of Melbourne
Prof. Chris Ryan	Director, Victorian Eco-Innovation Lab, University of Melbourne
Mr. Michael Ambrose	Group Leader, Urban Dynamics and Transition Group, CSIRO
Prof. Rod Tucker	Director, Institute for a Broadband-Enabled Society, University of Melbourne

The Future of Nuclear Energy in Australia - 17 November 2010

Mr. Adam Morton	Environment Reporter, The Age
Dr. Ziggy Switkowski	Chairman, Australia Nuclear Science and Technology Organisation
Dr. Selena Ng	Regional Director, South East Asia and Oceania, AREVA
Prof. John Daley	CEO, Grattan Institute, The University of Melbourne
Prof. Lee Godden	Melbourne Law School, University of Melbourne
Prof. Mike Sandiford	Professor of Geology, Director, Melbourne Energy Institute, The University of Melbourne

Audio recordings of all seminars are available at the Energy Institute website http://energy.unimelb.edu.au.

Workshops and Conferences

During 2010 the MEI facilitated workshops between University of Melbourne researchers and relevant industry and government groups. These included the IBM Smarter Planet Energy Initiative, Victorian Smart Grid Planning Workshop, Decarbonising Australia's Electricity Supply, The Climate, Energy and Water Nexus Forum, and The Garnaut Review Update Round Table all hosted at the University of Melbourne. Finally our Grand Energy Challenges Symposium was held in New Delhi.

In 2010 the MEI participated in national and international energy conferences including: the First Science Outlook Conference, Canberra; All Energy Australia Conference, Melbourne; 10th International Conference on Greenhouse Gas Control Technologies; and, the CRC for Greenhouse Gas Control Technologies Annual Symposium; and presented seminars at the International Energy Agency in Paris France and NIWA in Lauder New Zealand. The MEI also contributed to the Scientists in Schools Program.

The Grand Energy Challenge Symposium

The Grand Energy Challenge Symposium was held at the Habitat Centre in New Delhi on 28 April 2010 as a joint initiative between the Melbourne Energy Institute, the Australian India Institute, The Energy and Resources Institute (TERI) and IBM India. The symposium explored research synergies and opportunities for strategic partnerships in energy research between the participating groups. Discussion focused on a number of research areas that might underpin the development of a joint submission for the AISRF 2011 Grand Energy Challenge Scheme, a joint initiative between the Australian and Indian Governments which has the objective of increasing science and technology research in collaboration with Indian Researchers, and other funding opportunities.

The high-level symposium was opened by the University of Melbourne Vice Chancellor Professor Glyn Davis (AO), with remarks from the director of TERI Akanksha Chaurey, the Head of International Cooperation at the Department of Science and Technology Dr A. K. Sood, the Deputy Australian High Commissioner Dr Lachlan Strahan and the Director of the University of Melbourne Energy Institute Professor Mike Sandiford. Three themed sessions were held on the subjects of Renewable Energy Systems (co-chaired by Roger Dargaville (MEI) and V.V.N. Kishore (TERI), Offline Grid Deployment (Deva Seetharam (IBM) and Parimita Mohanty (TERI)) and Social Inclusion and Energy Service (Jeremy Moss (MEI), Akanksha Chaurey (TERI) and Rajesh Kunnath (National Council of Applied Economic Research)). Short presentations were followed by discussions amongst the participants, and priority areas for collaboration were identified.

New Capability

During 2010, the MEI has helped facilitate a number of senior appointments that have significantly strengthened the University's energy research leadership. These include:

Prof Robin Batterham AO (Kernot professor of Engineering) is President of the Australian Academy of Technological Sciences and Engineering (ATSE) and Chair of the International Energy Agency Expert Group on Science for Energy, has previously held positions as the Chief Scientist of Australia, Chief of the Division of Mineral and Process Engineering at CSIRO, President of the International Council of Chemical Engineering and Chief Technologist, Rio Tinto Ltd.

Prof Peter Seligman (Honorary Professorial Fellow in Engineering) was a key member of the team that developed the cochlear implant, leading the design of the first portable speech processor. In 2009 he was awarded a Doctor of Engineering by the University of Melbourne. Since retirement from Cochlear Ltd in 2009, he has focused on sustainable energy leading to the recent publication of his book Australian Sustainable Energy: by the Numbers – the first in the MEI's Australian Sustainable Energy book series.

Prof Peter Cook (Honorary Professorial Fellow in Earth Sciences) is the CEO of the CO2CRC, having formerly held positions as Director of the Australian Petroleum CRC, Director of the British Geological Survey and before that Division Chief/Associate Director at the Bureau of Mineral Resources. His published work comprising more than 150 papers includes seminal work on the climate change record of young geological sequences in south eastern Australian that pre-empted much of the current concern about drivers of long-term climate change.

MEI Sustainable Energy Publication Series

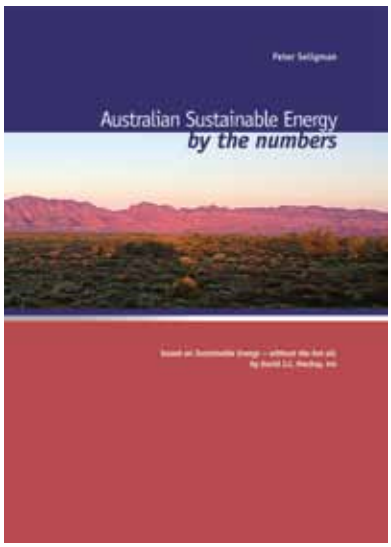
In 2010 MEI launched the Australian Sustainable Energy publication series and released two 'energy roadmaps'. Australian Sustainable Energy – by the numbers and the Zero Carbon Australia Stationary Energy Plan. Zero Carbon Australia Stationary Energy Plan launched in Sydney and Brisbane generated significant public interest. Leaders in the energy debate spoke at the launch events, including, Mr. Malcolm Turnbull MP, Former NSW Premier Bob Carr, Greens Senator Scott Ludlam, Professor Robin Batterham, Dr. Roger Dargaville, Premier for Queensland Anna Bligh, Professor Ian Lowe, and Professor Mike Sandiford.

Australian Sustainable Energy - By the Numbers

The Institute's first publication, Australian Sustainable Energy– By the Numbers, by Melbourne Energy Institute Honorary Professor Peter Seligman was inspired by David MacKay's Sustainable Energy – Without the Hot Air. It provides a clear account of Australia's renewable energy potential as well as a blueprint for a nationwide renewable energy system based on the most efficient mix of technological, societal and habitual changes.

Australia Sustainable Energy – By the Numbers shows that, unlike many countries, Australia could comfortably supply all of its energy requirements from renewable resources including solar, wind and geothermal energy, backed by pumped hydrostorage systems.

Dr Seligman also identifies situations in which energy efficiency measures represent a cheaper option in terms of immediate cost of abatement, and quantifies these strategies accordingly.

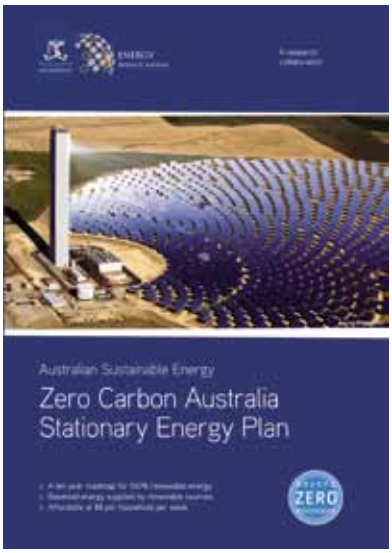


The Stationary Energy Plan

The second Melbourne Energy Institute publication was the Zero Carbon Australia Stationary Energy Plan – the first report in a bold collaborative project that maps a national-scale transformation to 100 per cent renewable energy. The Stationary Energy Plan confirms not only the technical feasibility of achieving 100 per cent renewable energy in Australia, but presents a strategy for achieving it without sacrificing any of the benefits of our present energy system.

The Plan shows that provision of baseload power through renewable sources can be achieved through solar thermal technologies that include molten-salt storage. Industrial-scale solar power plants, like those currently operating overseas in Spain and the US, would replace baseload power currently sourced from fossil fuels, with a significant contribution also from wind power.

The Plan has prompted considerable public engagement, and was awarded a Banksia Prize (Mercedes-Benz Australian Environmental Research Award). The Zero Carbon Australia Project is an ongoing research collaboration between the climate change think tank Beyond Zero Emissions and the Melbourne Energy Institute.



> “The Zero Carbon Australian Stationary Energy Plan represents the kind of visionary work that should be eagerly embraced. It is the first time that I’ve seen a plan that makes the possibility of zero emissions feasible and affordable. In particular, solar energy offers much promise in this dry and sunny continent. Politicians have been postponing decisions in this area for far too long. They, and decision-makers generally, should study Zero Carbon Australia intensely and urgently. The work is so comprehensive that it makes me eager to see the further studies that will be emerging in the near future.”
>
> Sir Gustav Nossal

New MEI Initiatives

Climate Change, Energy and Justice in East Timor

The Melbourne Energy Institute East Timor research project will analyse the energy needs of people living in East Timor's rural region Ainaro for utilising sustainable generation and transmission infrastructure, including the use of distributed systems.

Responding to climate change while providing for growing energy needs is a core policy challenge for countries in the Asia-Pacific region. In the rugged mountainous areas of East Timor where the majority of the population lives, only five per cent of households are connected to the electricity grid. Those that are connected face inordinate prices. Retail electricity prices in East Timor are broadly similar to Australian prices despite per capita GDP being 100 times lower.

There is a clear need for the construction of reliable and affordable energy infrastructure in regional East Timor. But with energy infrastructure contributing substantially to greenhouse gas emissions, the potential impact on climate change must be carefully considered. This is especially so given that many developing countries in the Asia-Pacific region are particularly vulnerable to the impacts of climate change. On the other hand, demanding that the energy needs are met through the construction of sustainable infrastructure may increase the cost of providing for the energy needs of people in developing countries, potentially pricing energy beyond their means. This raises the question of how these additional costs are to be distributed in and between developed and developing countries and what the role of intellectual and technology transfers ought to be.

In response to these challenges, the Melbourne Energy Institute East Timor research project will analyse the energy needs of people living in East Timor's rural region Ainaro, including a survey of the opportunities available in the region for utilising sustainable generation and transmission infrastructure, including the use of distributed systems.

The project will also study the environmental impacts and costs of alternative models of electricity generation and transmission infrastructure suited to rural areas of East Timor, and study the existing regulatory framework governing access to energy in East Timor and the equity challenges facing this framework.

In the context of a global response to climate change the project will also explore how the costs of providing sustainable energy infrastructure and securing universal access to energy ought to be distributed equitably in and between developed and developing countries. While the project focuses on East Timor, it has wider significance because the technological and policy challenges facing the provision of energy infrastructure in regional East Timor are similar to those faced by many other developing countries in the Asia-Pacific. The analysis of the role of developed countries in contributing to mitigation efforts in East Timor also has wide applicability to the global debate concerning socially just responses to climate change.

Melbourne University Renewable Energy Integration Laboratory (MUREIL)

As the amount of renewable energy on the grid increases, a strategy to build the most efficient energy system will be required. The various technologies (wind, solar, wave, hydro, geothermal etc) all have different characteristics in terms of cost and impact of weather variability. The weather strongly affects the electricity demand, and so understanding which combination and locations for the various technologies will deliver electricity in the most efficient manner is vital. Australia needs a system that takes into account the variability in the weather when the wind power stations are not producing power, the solar or wave or hydro stations are able to generate power.

The Melbourne University Renewable Energy Integration Lab is a system of numerical models with the goal of finding the optimal mix of wind, solar, hydro and other renewables, as well as current and new fossil fuel technologies, to best meet Australia's energy demands at least cost with the lowest carbon emissions. The model system includes a weather model that provides wind, solar radiation and temperature information across the entire county at high spatial and temporal resolution, allowing all locations to be considered - not just those where data is currently collected. A technology model converts the weather information to potential electricity production for each technology. A transmission model connects the different sites to the grid and an electricity system model estimates demand and the back-up required if and when the renewables cannot meet that demand. A spot market economics model predicts the price of electricity

The overall system is optimized with a Genetic Algorithm. The result is a network of renewable power stations with fossil fuel backup (if required) that provide enough power at the least cost. Depending on assumptions about cost and the required fossil emission reduction, the model predicts different amounts of installed capacity of the various technologies. By including demand side factors such as electric vehicle fleets or load shedding, the model can further adapt the energy system. By providing a strategy for the optimal energy system, billions of dollars can be saved by avoiding building infrastructure that fails to satisfy the energy demands of the future.

New MEI Initiatives

Victorian Geothermal Assessment Report (VGAR)

Over the past decade, the case has been made for humanity to take serious action to minimise the effects of climatic change. The challenge now is to develop sources of energy that will meet global requirements whilst being environmentally sustainable.

Important contributions are already being made by wind and solar systems, but base load power options providing continuous energy generation will be needed. Clean coal technologies will provide some respite from the damaging effects of the coal emissions, but remain undemonstrated at the scale required to provide a significant contribution. Nuclear power has significant societal barriers to overcome.

Geothermal energy is a potential alternative that could provide significant base load power with almost zero carbon footprint. While the potential is huge, the technology for extracting geothermal energy in geological settings such as Australia still needs to be explored. The Victorian Geothermal Assessment Report (VGAR) will provide a rigorous evaluation of geothermal energy in Victoria, paving the way for substantial investment should this new energy option prove viable.

The University of Melbourne has initiated this project to provide a full geophysical, technical, legal and economic assessment of the potential for geothermal energy in Victoria. The project will provide an independent, detailed evaluation of the prospects for geothermal energy production in Victoria and the most promising technologies required to develop a commercially viable industry. It will address the necessary R&D hurdles that need to be addressed to realise any potential, and highlight existing investments and synergies.

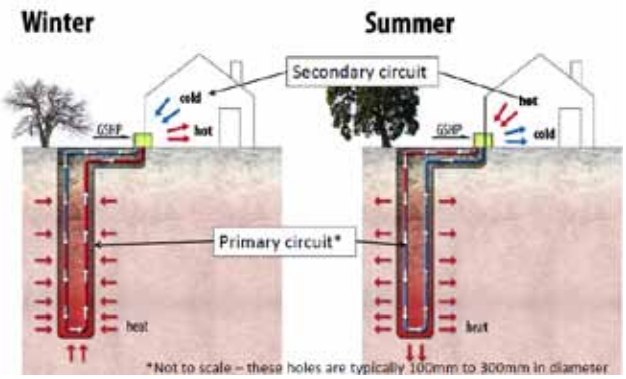
This project will bring the intellectual strength of the University of Melbourne to bear on a global issue, with the possibility of a major impact locally.

Beaurepaire Geothermal Experiment: Heating and Cooling Buildings using Ground-Source Heat Pumps

Energy use in buildings accounts for 26% of Australia's greenhouse emissions (CSIRO, 2010). Over half of this energy is for heating and cooling. Ground-source heat pumps (GSHP) use the Earth as a heat source or sink to heat and cool buildings using considerably less electricity than conventional systems. By reducing electricity demand (GSHPs do not generate electricity), GSHPs have the potential to significantly cut Australia's electricity use and carbon footprint. This research aims to demonstrate the potential for GSHP systems in Melbourne and to improve design techniques. Energy generated during the experiment will be used to heat and cool the adjacent heavy weights room of the Beaurepaire Sports Centre

GSHP systems comprise a primary circuit linked to a secondary circuit through a heat pump. The primary circuit consists of piping embedded in the ground, through which water or refrigerant is circulated. This fluid is then warmed or cooled by the surrounding ground, as required. The secondary circuit is in the building to be heated or cooled. The heat pump moves heat between the primary circuit and the secondary circuit. Heat pumps operate on the same principle as fridges, using refrigerant to efficiently transfer and upgrade heat with the input of some electricity. In heating mode, the pump will extract heat from the circulating fluid in the primary circuit (the cooled fluid will then be heated by the ground) and the extracted heat will warm the building. In cooling mode the process is reversed, with heat extracted from the building and rejected into the ground. The Beaurepaire Geothermal Experiment comprises a number of different types of primary circuit, including energy piles (building foundations fitted with HDPE piping), borehole installations and direct exchange systems (where copper piping extends into the ground). Piles and boreholes drilled at the Beaurepaire Centre are all about 30m deep.

The "constant" ground temperature at depth allows GSHP systems to be more efficient than conventional air-conditioners, which rely on the air as a heat source or sink.



Imagine trying to dump heat from your house into air at 40°C, when you could be using 18°C ground. Unlike many other sources of renewable energy, GSHP systems can potentially be used in almost any geographic location and the energy is available 24/7 – rain, hail, sun, storm or calm. This gives GSHP systems a significant advantage over alternative forms of renewable energy.

Most forms of geothermal energy require ground temperatures in excess of 100°C. However, GSHP systems operate at "normal" temperatures as the ground needs only to warm or cool the circulating fluid. At about 10m depth, the temperature of the ground is relatively constant and is typically warmer than the air in winter and cooler than the air in summer. The temperature at this depth at this site is about 18°C.

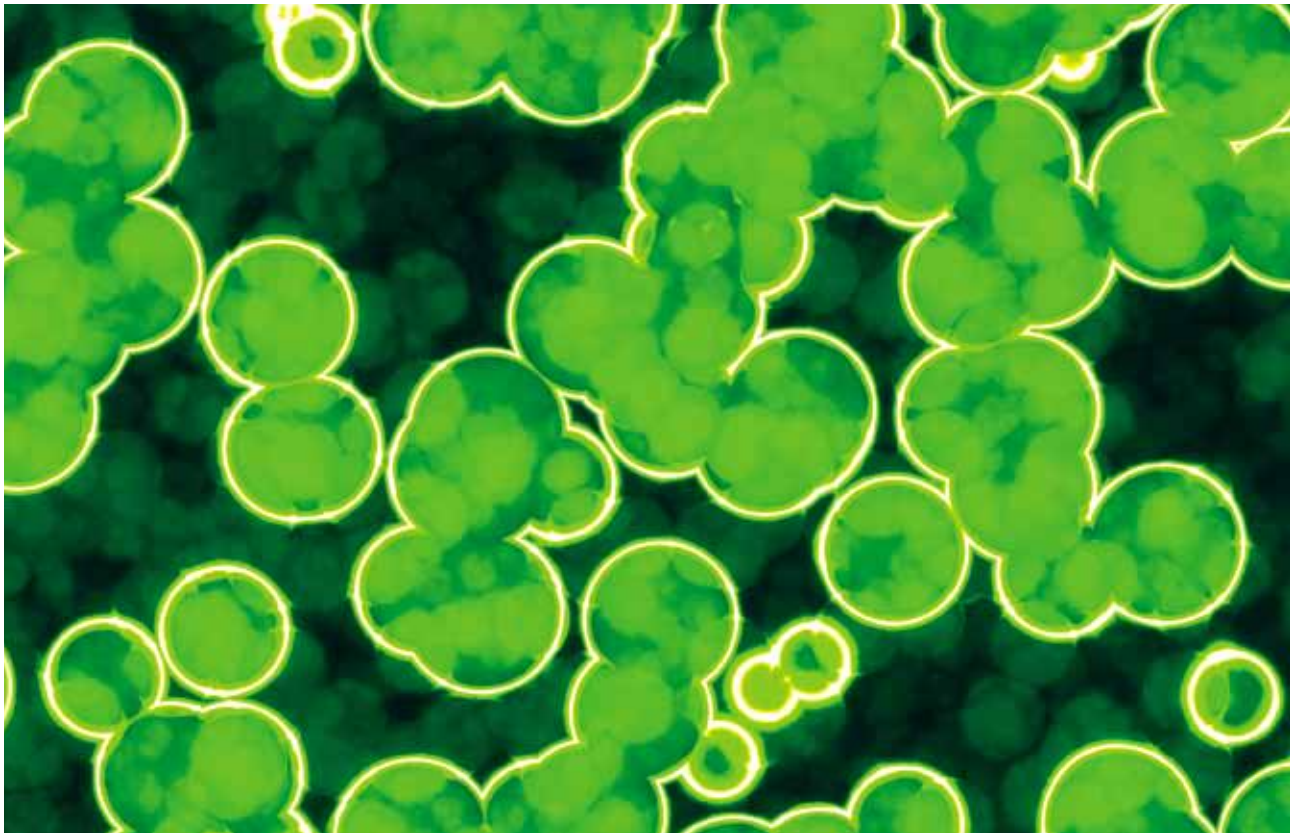
The Beaurepaire Geothermal Experiment is expected to run for most of 2011.

New MEI Initiatives

Toward the Development of a Biofuels Roadmap for Victoria

The overall aim of this project is to identify novel non-food feedstocks from local plant resources in Victoria (eg. blue gum plantation industry) and explore their suitability for bio-ethanol production. Carbohydrate microarray technology and other analytical techniques that have been established at the School of Botany, University of Melbourne will be employed to assess complex carbohydrate composition and advise on the best possible feedstock resources. Engineering conversion technologies will be used to explore how the sugars released from the biomass can be efficiently converted to a usable fuel, that is affordable and produced in an environmentally responsible manner.

The project will include the collection of a comprehensive variety of non-food plant material, with an emphasis on Australian native trees and grasses, and agricultural waste for analysis (e.g. by-products from blue gum plantations used in pulp and paper industry). A recently established carbohydrate microarray technology will be used to characterize the complex polysaccharide composition of selected feedstocks before and after chemical pretreatment. The results obtained from these investigations will assist in evaluating the relative potential of different feedstocks for biofuel production in Victoria.



Zero Carbon Australia Project

The Zero Carbon Australia Project is a research collaboration between Beyond Zero Emissions and the University of Melbourne. The Zero Carbon Australia Stationary Energy Plan is the first of six, ten-year plans for a fully decarbonised future.

1. Zero Carbon Australia Stationary Energy Plan
2. Zero Carbon Australia Transport Plan
3. Zero Carbon Australia Land Use & Agriculture
4. Zero Carbon Australia Buildings
5. Zero Carbon Australia Industrial Processes
6. Zero Carbon Australia Renewable Energy Super Power

The Project's guiding principles are:

- Australia's energy is provided entirely from renewable sources at the end of the transition period.
- All technological solutions employed are from proven and scaleable technology which is commercially available.
- The security and reliability of Australia's energy supply is maintained or enhanced by the transition.
- Food and water security are maintained or enhanced by the transition.
- The high standard of living currently enjoyed by Australians is maintained or enhanced by the transition.
- Social equity is maintained or enhanced by the transition.
- Other environmental indices are maintained or enhanced by the transition.

The Project draws on the enormous wealth of knowledge, experience and expertise from volunteers working in industry and researchers from the University of Melbourne and other Universities across Australia.

> "This is a fantastic piece of work. Our response to climate change must be guided by science; the science tells us that we have already exceeded the safe upper limit for atmospheric carbon dioxide. We are, as humans, conducting a massive science experiment with this planet, it is the only planet we have got."
>
> Malcolm Turnbull MP

> "The Zero Carbon Australia Plan is based on up-to-date and sound information and provides quality insights on how a country well-endowed in renewable resources can transition to a solar and wind economy."
>
> Cédric Philibert
> International Energy Agency

University of Melbourne Flagship Energy Research Programs

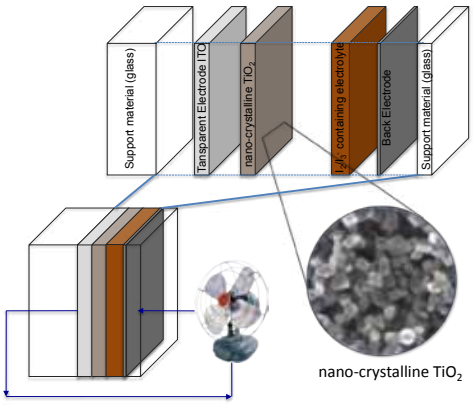
The Victorian Organic Solar Cells Consortium: developing low cost printed Solar Cells

More solar energy hits the earth in one hour than is used by the whole of the earth's population in a year. This equates to an average energy use of around 13.5 Terawatts (TW) while this is expected to grow to 25 to 30 TW by 2050. Of the 13.5 TW around 86% is derived from fossil fuels. Solar remains one of the few viable alternatives for a carbon free replacement of fossil fuels and needs to be part of the power mix to help reduce carbon emissions associated with power supply.

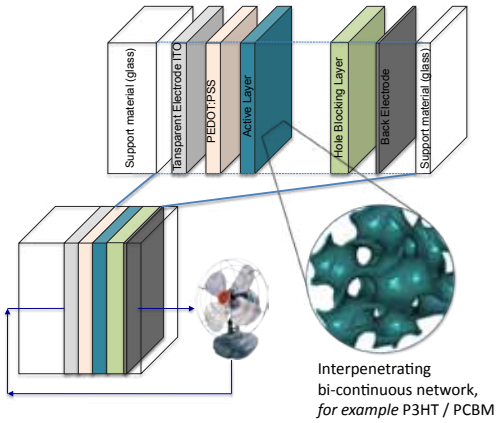
However, to be a viable alternative to fossil fuels the average power costs for solar need to be reduced. Currently solar power costs an average of $1-2 per kWh and this is being reduced down to $0.50 per kWh. To be rapidly taken up the cost of solar needs to be driven down to parity with traditional power sources of less than $0.10 per kWh.

There is an intense international effort to develop flexible electronics, which is driven by the potential advantages of low cost, printed displays, flexible electronics, lighting and solar cells.

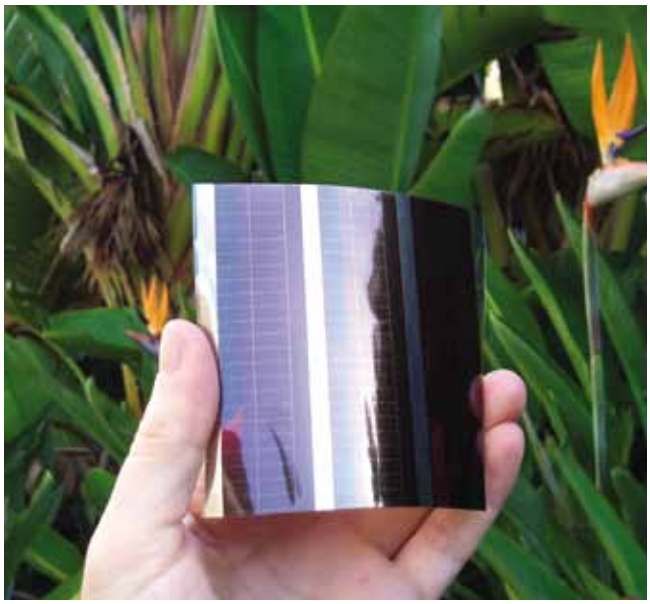
We are examining two recently developed solar technologies: dye sensitised solar cells (DSCs) and bulk heterojunction solar cells (BHJs). DSCs, often called artificial photosynthesis, absorbs a dye on a nano-structured titanium dioxide, while an electrode and an electrolyte complete the circuit. While for BHJs, a nano-structured blend of light absorbing polymers or organic molecules, formulated as an ink, is required. Both DSCs and BHJs can be printed, however the translation of each technology to large scale has its own unique development problems, which are being examined. To reduce the cost of solar cells we need improve the efficiency, improve durability and translate device assembly to high volume production processes.



Above: Dye Sensitised Solar Cell (DSC)



Above: Bulk Heterojunction Solar Cell (BHJ)



Above: Printed BHJ solar cell.

Low cost, printed building integrated photovoltaics is the target of the current research which is strongly supported by the Victorian Government, Department of Business Innovation.

The availability of low cost solar cells in high volume is the driving force for the University of Melbourne along with its research partners, Monash University and CSIRO MSE, and its industry partners BlueScope Steel, Securency International, Innovia Films and Robert Bosch SEA, to deliver new technologies to print solar cells. The Victorian based consortium (VICOSC) is examining the translation of lab based research to industry compatible printing processes.

Low cost, printed building integrated photovoltaics is the target of the current research which is strongly supported by the Victorian Government, Department of Business Innovation.

University of Melbourne Flagship Energy Research Programs
Transportation

Alternative fuels offer the potential for significantly lower tailpipe emissions in automotive and stationary power generation. To this end, researchers in the School of Engineering have been conducting significant research activity at fundamental and applied levels into the use of fuels such as hydrogen, compressed natural gas and liquefied petroleum gas. One significant research project supported by Ford Australia and the Victorian Department of Sustainability has successfully demonstrated a six-cylinder internal combustion engine running on hydrogen with close to fuel-cell efficiency.

Ongoing research into modelling combustion engine and aftertreatment systems, and using these models in low order, model based controllers promises to improve the efficiency of existing powertrains, and to lead to faster and better calibration of production engines and consequently improved emissions. A large section of this work with gaseous fuels has been conducted by Dr Rahul Sharma, who was this year recognised by the Society of Automotive Engineers Australasia as their Young Engineer of the Year.

The optimal use of alternative powertrains, and in particular hybrid powertrains, have also been a source of research activity. The use of telematics to provide information about the likely traffic situations a vehicle will shortly encounter has led to improved overall efficiency through optimal use of regenerative braking and velocity scheduling. This research has shown significant improvements in fuel consumption with increasing traffic information.

While zero emission transport may remain a goal in the future, the net cost of transition both in terms of total emissions (included embedded energy) and financial to various low emission transportation systems remains a largely unknown quantity. With this in mind an interdisciplinary project involving researchers across Engineering, Science and GAMUT (Australasian Centre for the Governance and Management of Urban Transport) has been assembled to undertake some preliminary studies to investigate the real cost of emissions reductions in kilograms of CO2 per dollar given various emission scenarios. This is expected to lead to results in 2011 that will be of significant interest to a wide range of groups.

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Carbon Capture and Storage Flagships Program

The CO2CRC is a collaboration between universities, industry and federal and state governments, conducting research into carbon capture and storage (CCS). The CO2CRC is seeking new and efficient ways to capture CO2 from fossil fuel power plants, and to transport and safely store the CO2 in geological reservoirs.

The University of Melbourne leads the CO2 capture research within the CO2CRC, with the research teams led by the Melbourne Energy Institute Deputy Director Associate Professor Sandra Kentish and Professor Geoff Stevens.

The success of recent proposals submitted to the Australian Government's CCS Flagships program and the Australian Government Education Investment Fund (EIF) will allow the University to further establish its research profile in this area, facilitated by the movement of a number of key researchers from the CO2CRC organisation onto the University site. New laboratory facilities will allow the University to cement its world-leading research in this field.

The CCS Flagships program is designed to accelerate the development and demonstration of CCS technologies. The program aims to promote the wider dissemination of CCS technologies by supporting a small number of demonstration projects that capture CO2 emissions from industrial processes and safely store CO2 underground in stable geological formations to mitigate global warming.

If the Flagship proposal is successful it will lead to the construction of CarbonNet, a multi-user capture, transport and storage infrastructure project in the Latrobe Valley. CarbonNet aims to capture between three and five megatonnes of CO2 per annum from a number of high emissions sources and transport the gas via common user infrastructure for storage in suitable geological formations. The proposal has been shortlisted by the Federal Minister for Resources, Energy and Tourism.

The University of Melbourne has provided input to an EIF bid led by the CO2CRC to access research infrastructure funding. If successful, this will provide high quality chemical engineering and geological/petrophysical laboratory space at the University to support CarbonNet research. EIF funds will also be directed to improving existing pilot-scale capture facilities within the Latrobe Valley and to drilling a new experimental well.

New Funding Initiatives

During 2010, as a result of the partnerships established through our engagement activity, the MEI generated $10 million in new research funding in addition to a further $10 million for ongoing energy programs across the University. There is a further $20 million worth of funding still pending.

The research programs established as a result of this new funding include the AGOS Subsurface Observatory, Low Emission Road Transportation Novel Storage Task Force, the Zero Carbon Australia Project, BCIA Research Scholarships, Organic-Inorganic interactions in Mineral Systems, Reactive Reservoir Rocks and the impact of CO2 Storage, Membrane processes for Amine Contaminant Removal, Solvent Precipitation Systems. These new programs initiated in 2010 will run until 2015. The project funding sources, the MEI contribution, project timeline and other details are outlined below.

Confirmed New Funding from MEI-Lead and MEI-Supported Activities in 2010
The multiplier of 2010 central funding of $900k is 11.2

Confirmed Date	Funding Source	Name	CI/proponent		Funding Period	Total ($k)	MEI Commitment
29/06/2010	AuScope/ EIF round 3	AGOS - subsurface observatory	Prof Mike Sandiford	EarthSci/ SCI	2011-2014	7432	160
26/10/2010	BCIA	BCIA Research Scholarships	AProf Sandra Kentish Dr A Stickland	ChemEng/ MSE	2010-2013	300	
1/07/2010	ARC Future Fellowship	Low Emission Road Transportation	Dr Chris Manzie	MechEng/ MSE	2011-2014	700.59	50
1/12/ 2010	ANLEC R&D	Novel Storage Task Force	Ms Susannah Powell	EarthSci/ SCI	2011	151	
14/12/2010	Graeme Wood Foundation	ZCA	Ms Susannah Powell	EarthSci/ SCI	2011-2012	300	50
12/12/2010	CSIRO flagship	Organic-inorganic interactions in mineral systems	Dr John Moreau	EarthSci/ SCI	2011-2013	535.5	60
1/10/ 2010	CO2CRC	Reactive reservoir rocks and their impact on CO2 storage	Dr John Moreau	EarthSci/ SCI	2011	135.5	
9/12/ 2010	ANLEC R&D	Membrane processes for amine contaminant removal	AProf Sandra Kentish	ChemEng/ MSE	2011-2013	497	
					Subtotal	10051.59	320
					MEI central allocation	900	
					Multiplier	11.2	

Other Significant University Energy Research Funding

Date	Funding Source	Name	CI/proponent	Department/ Faculty	Funding Period	Total ($k)
	VSA SPF	VICOSC	Dr David Jones	SCI/ChemEng/ Bio21	2010-2013	5000
	SERD2	VICOSC	Dr David Jones	SCI/ChemEng/ Bio21	2011-2014	1763
	Aust Solar Institute 2	VICOSC	Dr David Jones	SCI/ChemEng/ Bio21	2011-2014	1763
9/12/ 2010	ANLEC R&D	Solvent Precipitation Systems	Prof Geoff Stevens	ChemEng	2011-2013	771
16/12/2010	BCIA	Carbonate Based Solvent Systems	Prof Geoff Stevens	ChemEng	2011-2013	1200
					Subtotal	10497

New Funding from MEI-Lead and MEI-Supported Activities in 2010 with outcomes still pending

Date	Funding Source	Name	CI/proponent	Department/ Faculty	Funding Period	Total ($k)	MEI Commitment ($k)
14/12/2010	SIERD	Solving the Energy Waste Roadblock	AProf Sandra Kentish	ChemEng/MSE		1000	
1/07/2010	Calera	Groundwater assessment for Calera Process	Prof Mike Sandiford	EarthSci/SCI		250	
12/06/2010	CCS EIF	CarbonNet - Capture	AProf Sandra Kentish	ChemEng/MSE	2011-2014	5000	
12/06/2010	CCS EIF	CarbonNet - Storage	Prof Mike Sandiford	EarthSci/SCI	2011-2014	10000	
	Rod Carnegie	Brown coal dewatering	Prof Robin Batterham	ChemEng/MSE		900	
	DPI/ CO2CRC	State Chair in Geologic storage	Prof Mike Sandiford	EarthSci/SCI	2011-2015	750	250
	PICIR, Germany	Carbon cycling	Prof David Karoly	EarthSci/SCI	2011-2015	600	100
30/10/2010	SEPD2	Direct geothermal	Prof Ian Johnston	InfEng/MSE	2011-2012	1950	
					Subtotal	20450	350

Expenditure

MELBOURNE ENERGY INSTITUTE 2010 BUDGET		Paid excl. GST + Commitment
OPERATIONS		
Director		$210,330.77
Deputy Director		$30,000.00
Executive Officer		$70,145.17
Administration		$62,000.00
Marketing and Web Development		$8,359.44
Travel & Entertainment		$24,317.63
Operations		$38,974.19
Equipment		$5,872.80
	TOTAL	$450,000.00
RESEARCH		
New Capability		$77,500.00
Biofuels & Forestry		$35,000.00
Energy & Development		$23,959.20
Direct Geothermal		$40,000.00
Victorian Geothermal Assessment Report (VGAR)		$73,759.25
Zero Carbon Australia		$18,538.90
Energy Futures		$36,139.00
Knowledge Transfer		$48,432.09
Director's Discretionary		$81,671.56
Sustainable Campus		$5,000.00
Communition		$10,000.00
	TOTAL	$450,000.00

Knowledge Transfer

During 2010 the MEI, engaged with a range of research, government and industry organisations. These included collaborative events, and research partnerships with the following organisations:

- Grattan Institute
- Clean Energy Council
- Australian National Low Emissions Coal Research & Development (ANLEC R&D)
- CSIRO
- Australian National University
- The United States Studies Centre
- Australian Electricity Market Operators (AEMO)
- IBM
- Suzlon Energy Australia PTY LTD
- Pacific Hydro Australia
- Suntech Power Holdings Co. Ltd.
- BrightSource Energy
- Jemena
- Energy Australia
- The Energy Research Institute (TERI)
- Power Grid Corporation of India Limited
- 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
- Australia India Institute
- Melbourne Social Justice Initiative
- Victorian Eco Innovation Lab
- Melbourne Sustainable Society Institute
- Institute for a Broadband-Enabled Society
- AREVA
- Brown Coal Innovation Australia (BCIA)

Melbourne Energy Institute

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