2012

Australian Frontiers of Science

SCIENCE FOR A GREEN ECONOMY

Menzies Hotel, Sydney

2–4 December 2012

Foreword

The Academy has hosted the Australian Frontiers of Science symposium since 2003, bringing together the very best young Australian scientists to discuss emerging technologies, new opportunities and exciting cutting-edge advances in their fields. In these symposia, gifted young scientists from universities, government and industry discuss what they do and why, and during this process allow ideas to bridge disciplines.

This year, 70 outstanding early and mid-career scientists from around Australia, with expertise in a broad range of disciplines, will meet to discuss how science can support a successful transition to a green economy. A green economy is one that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities.

Innovative solutions need to be developed to address the climate, food and energy crises that face Australia and the world today. The 2012 Australian Frontiers of Science — Science for a green economy symposium is a unique opportunity for leading early and mid-career scientists to share ideas and envisage solutions to drive the necessary shift towards a truly sustainable future.

The 2012 Australian Frontiers of Science symposium is generously supported by the Theo Murphy (Australia) Fund, courtesy of the Royal Society of London. The Academy is delighted to have this funding available to enable some of Australia's brightest young scientists to engage in fresh thinking about a fundamental issue for our future, and to develop networks that will enrich their careers.

Professor Suzanne Cory AC PresAA FRS
President, Australian Academy of Science

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Program

Day 1 Sunday 2 December 2012

6.30 pm **Opening and welcome**

Professor Bob Williamson AO FAA FRS
Secretary for Science Policy,
Australian Academy of Science

Cocktail reception and poster session

Day 2 Monday 3 December 2012

9.00 am Session 1: Atmosphere and climate — uncertainties in the climate system

Chair

Dr Lisa Alexander
University of New South Wales

Uncertainty in Australia's new daily temperature dataset

Dr Karl Braganza
Bureau of Meteorology

Understanding uncertainty in climate modelling

Dr Gab Abramowitz
University of New South Wales

Uncertainties in climate projections

Ms Julie Arblaster
Bureau of Meteorology

10.30 am **Morning tea**

11.00 am Session 2: Economics — economics for a green economy

Chair

Dr Paul Burke
Australian National University

The contribution of 'green growth' to understanding and achieving global sustainability

Dr Steve Hatfield-Dodds
CSIRO and Australian National University

Greening China's economy

Dr Chunbo Ma
University of Western Australia

Market-based instruments and ecosystem services: perilous or panacea?

Dr Stuart Whitten
CSIRO Ecosystem Sciences

12.30 pm Lunch

1.30 pm Session 3: Mathematics — linking the economy to the environment with computer models

Chair

Dr Richard Little
CSIRO

Hedging financial risk from weather conditions

Professor Adam Clements
Queensland University of Technology

A probabilistic approach to exploring low-dimensional global dynamics

Dr Nicky Grigg
CSIRO Land and Water

Adapting primary industries for climate change — seasonal forecasting as a stepping stone for fisheries and aquaculture

Dr Alistair Hobday
CSIRO Marine and Atmospheric Research

3.00 pm Afternoon tea

3.30 pm Session 4: Physics — sustainable energy systems

Chair

Professor Barry Brook
University of Adelaide

Fossil fuel future production: world and Australian focus

Dr Steve Mohr
University of Technology Sydney

Least cost options for 100% renewable energy

Mr Ben Elliston
University of New South Wales

Decarbonising Australia's electricity supply

Mr Ben Heard
Decarbonise SA and ThinkClimate Consulting

5.00 pm Sessions close

6.00 pm Coach departs the Menzies Hotel for dinner

6.30 pm Dinner at the Sergeants Mess, Chowder Bay

Speaker

Professor Suzanne Benn
Professor of Sustainable Enterprise, University of Technology Sydney Business School

9.30 pm Dinner close and return to hotel

Day 3 Tuesday 4 December 2012

8.00 am Session 5: Ecology — biodiversity benefits and trade-offs

Chair

Dr Karel Mokany
CSIRO

Planning for biodiverse carbon forestry

Dr Josie Carwardine
CSIRO Ecosystem Sciences

Ecological modelling and the sustainability of coral reef biodiversity

Professor Sean Connolly
James Cook University

Balancing livestock production and biodiversity in a green economy

Dr Josh Dorrough
CSIRO Ecosystem Sciences

9.30 am Short break (coffee/tea)

9.40 am Session 6: Biology — bioenergy

Chair

Dr Adriana Downie
Pacific Pyrolysis

Managing forests for production and environmental gains — the greenhouse gas balance of native forests in New South Wales

Mr Brendan George
University of New England

Bioenergy technology from laboratory to commercial production

Dr Jessica O'Brien
Pacific Pyrolysis

Alternative aviation fuels

Dr Lucas Rye
Shell Company of Australia

11.10 am Morning tea

11.40 am Session 7: Agriculture and aquaculture — nutrients and nutrition

Chair

Dr Lynne Macdonald
CSIRO

Effective nitrogen use in agriculture: plant breeding to meet food demand

Dr Trevor Garnett
Australian Centre for Plant Functional Genomics

Harnessing native plants to manage phosphorus in Australian pastures

Associate Professor Megan Ryan
University of Western Australia

The role of nutrition in sustainable aquaculture development

Dr Cedric Simon
University of Tasmania

1.10 pm Lunch

2.00 pm Session 8: Social sciences — behavioural changes at individual, organisational and governmental scales

Chair

Associate Professor Tim Stephens
University of Sydney

Corporate adaptation to climate change

Dr Martina Linnenluecke
University of Queensland

Legal responses to emerging energy technologies

Miss Penelope Crossley
University of Sydney

Considering a green future: what motivates people to act in support of pro-environmental policies?

Dr Paul Bain
University of Queensland

3.30 pm Closing remarks

4.00 pm Coach departs the Menzies Hotel for Sydney Airport

Format of the presentation sessions (1.5 hours each)	
Introduction by session chair	7 min
Presentation 1	15 min
Presentation 2	15 min
Presentation 3	15 min
Discussion and questions facilitated by chair (panel forum)	30 min
Wrap-up by chair	7 min

Welcome

Professor Bob Williamson AO FAA FRS
Secretary for Science Policy, Australian Academy of Science
Honorary Senior Principal Fellow of the Murdoch Institute, University of Melbourne, and Monash University

Bob Williamson became Professor of Molecular Genetics and Biochemistry at St Mary's Hospital Medical School, University of London, in 1976, where he remained until 1995 when he moved to Melbourne as Director of the Murdoch Childrens Research Institute and Professor of Medical Genetics. He retired in 2004, and now is an Honorary Senior Principal Fellow of the Murdoch Childrens Research Institute, the University of Melbourne, and Monash University. Bob has more than 400 refereed publications, including about 40 in *Nature*, *Nature Genetics*, *Cell* and *Lancet*. He was involved in the identification and cloning of genes for thalassaemia, cystic fibrosis, craniofacial abnormalities, heart disease, Friedreich's ataxia and Alzheimer's disease.

More recently, he has taken a major interest in national science policy, and medical and scientific ethics, and has published widely on stem cell science and the ethics of embryo research. He has advised several premiers, health ministers and ministers for innovation. Although he has retired, until recently he still worked with a small research group trying to coax cord blood stem cells to help treat cystic fibrosis in children. Since retirement, he has increased his activity for a number of medical charities, including cystic fibrosis, Friedreich's ataxia and eye diseases.

Dinner speaker

Professor Suzanne Benn
Professor of Sustainable Enterprise
University of Technology Sydney (UTS) Business School

Suzanne Benn provides leadership within the Business School and across UTS, working with other disciplinary areas and external stakeholders to promote sustainability. She was previously Professor of Education for Sustainability, Director of ARIES (Australian Research Institute for Environment and Sustainability) and Head of the Graduate School of the Environment at Macquarie University, Sydney.

Suzanne has a background in the sciences and the social sciences. She has had wide experience working across the range of educational sectors, and as a research and industrial scientist. Her current research interests range across corporate sustainability and corporate social responsibility, business education for sustainability, and organisational change and development for sustainability. Her interdisciplinary academic publications include three books and more than 100 refereed journal articles, book chapters and refereed conference papers.

She has led consultancy and research projects on the topics of corporate social responsibility, organisational change and sustainability for a number of Australian organisations. She has also held major Australian Research Council grants to research topics such as the communication of corporate social responsibility through social networks, collaboration and governance for sustainability.

Suzanne has modified and taught curriculum on sustainable business at the University of Shanghai, and led the introduction of these programs into the undergraduate and postgraduate curriculum at UTS and Macquarie University. She has a strong interest in interdisciplinary curriculum development and holistic approaches to learning for sustainability. Suzanne also has a number of PhD students in the area of corporate social responsibility, sustainability and education, and learning and change for sustainability.

Presentation abstracts

Session 1 Atmosphere and climate — uncertainties in the climate system

Uncertainty in Australia's new daily temperature dataset

Dr Karl Braganza
Bureau of Meteorology

The Bureau of Meteorology released a new-generation daily temperature dataset in 2012, known as the Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT).

ACORN-SAT is a so-called 'homogenised' climate dataset, which contains corrections for a range of non–climate-related artefacts that arise during measuring. These include inconsistencies or spurious temporal changes due to the relocation of thermometers, changes in observing practices and technology over time, and changes in the local environment around the observing sites.

In this paper, we describe a range of instrumental, structural and statistical uncertainties that apply to the ACORN-SAT temperature dataset, and discuss their significance to analysed trends and variability in Australian temperatures.

Although the impact of measurement uncertainty is likely to be small given the traceability of the measurement processes, it is difficult to quantitatively estimate the impact of true structural uncertainty on area-averaged temperature estimates. However, statistical analysis indicates that such uncertainty is likely to be inversely proportional to the spatial density of the observing network. In that context, the largest uncertainties are likely to be due to sparseness of the network in the early recording period (1910–40).

Analysed trends and decadal variability in ACORN-SAT data are likely to be physically robust at large spatial scales, but less certain over small spatial domains, particularly in regions where data are sparse.

Understanding uncertainty in climate modelling

Dr Gab Abramowitz
University of New South Wales

Climate models embody our conceptual understanding of how the climate system functions. Limitations in observational data, computing power and process understanding inevitably mean that the predictions they make will always contain uncertainties. This talk outlines sources of these uncertainties and the approaches that are used to try to quantify them. Issues such as model resolution, parametrisation, initialisation, inherent climate system uncertainty and model ensemble interpretation will be discussed.

Further reading

Knutti, R, Abramowitz, G, Collins, M, Eyring, V, Gleckler, PJ, Hewitson, B and Mearns, L 2010, 'Good practice guidance paper on assessing and combining multi model climate projections', in TF Stocker, D Qin, G-K Plattner, M Tignor and PM Midgley (eds), *IPCC Expert Meeting on Assessing and Combining Multi Model Climate Projections*, meeting report, Boulder, Colorado, 25–27 January, pp. 1–13.

Abramowitz, G 2010, 'Model independence in multi-model ensemble prediction', *Australian Meteorological and Oceanographic Journal* 59: 3–6, www.bom.gov.au/amm/docs/2010/abramowitz_hres.pdf.

Uncertainties in climate projections

Ms Julie Arblaster
Bureau of Meteorology

Understanding, quantifying and communicating uncertainty in future projections of climate change is one of the most important challenges of climate scientists and a hotbed of current research. Projections are based primarily on climate models because extrapolations from past trends or comparison with previous climates are unlikely to be a good representation of the future. Uncertainty in projections stems from both the variety of socio-economic pathways that could be followed in the future and the range of modelled climate responses to the resulting emissions. Uncertainty due to natural or internal processes in the climate system is also a factor, particularly at small spatial scales and short time frames. The Intergovernmental Panel on Climate Change has developed formal treatments of uncertainty for use in its assessment reports, with a distinction made between confidence in scientific understanding and the likelihood of specific results. We have high confidence in certain things — for example, that continued increases in greenhouse gases at or above current rates would cause warming that would very likely be larger than that observed in the 20th century. In others, such as the projections of tropical cyclone numbers, confidence can be low. There are also robust patterns of future change (e.g. larger warming over land than oceans, strongest warming over the Arctic Ocean and drying in subtropical land regions that tends to scale with the strength of emissions). Recent research in presenting and communicating future projections will be highlighted.

Further reading

Hawkins, E and Sutton, R 2009, 'The potential to narrow uncertainty in regional climate predictions', *Bulletin of the American Meteorological Society* 90: 1095–1107, doi: http://dx.doi.org/10.1175/2009BAMS2607.1.

IPCC website, www.ipcc.ch.

Moss, RH, Edmonds, JA, Hibbard, KA, Manning, MR, Rose, SK, van Vuuren, DP, Carter, TR, Emori, S, Kainuma, M, Kram, T, Meehl, GA, Mitchell, JFB, Nakicenovic, N, Riahi, K, Smith, SJ, Stouffer, RJ, Thomson, AM, Weyant, JP and Wilbanks, TJ 2010, 'The next generation of scenarios for climate change research and assessment', *Nature* 463: 747–56.

Session 2 Economics — economics for a green economy

The contribution of 'green growth' to understanding and achieving global sustainability

Dr Steve Hatfield-Dodds
CSIRO and Australian National University

It is clear that current patterns of human activity are resulting in rising global environmental pressures, failing to provide for the basic needs of a substantial share of the world's population, and threatening ecological and social systems that are crucial to human wellbeing. Despite four decades of attention to environment and development issues, national and global governance arrangements continue to fall short of what is required to achieve sustainability and widespread prosperity. Recent years have seen the emergence of a 'green growth' narrative in response to these shortcomings: challenging traditional framings of the sustainability challenge and suggesting a different geopolitical strategy.

This presentation begins with the proposition that achieving sustainability is primarily an issue of governance and social organisation. It then draws on insights from economics and political economy to outline four lines of argument and evidence that the green growth narrative offers substantive insights that are relevant to achieving global sustainability. These four arguments are that the green growth approach:

- provides a better explanation of recent global environmental politics — particularly for key emerging economies — than traditional explanations by economists and others
- provides a more accurate picture of the economic impacts of ambitious climate action, addressing important misconceptions that block support for emissions reductions
- draws attention to a wider range of potential national benefits that might motivate the adoption of policies and technologies that reduce emissions and other environmental pressures
- assumes and affirms a more competitive, evolutionary and constructive approach to global action on key environmental issues.

The talk will conclude with some reflections on options available to the science community in addressing global sustainability challenges, as a self-aware component of the global earth system.

Greening China's economy

Dr Chunbo Ma
University of Western Australia

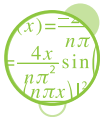
China is making a green refurbishment of its economy. Keystones in China's greening process include a structural shift to high-end manufacturing, services, and research and development; a transition to renewable energy technologies, especially wind and solar; and a large-scale retrofitting of its conventional energy sector. Perhaps nowhere is the green effort greater than in the electricity sector. In addition to a renewable energy portfolio standard, China has introduced a number of other command and control policies to clean up its conventional energy supply. This presentation will review and analyse the effectiveness of these policies, with particular attention given to the Small-Unit Shutdown Mandate, Promoting the Big and Quashing the Small Policy and the Flue Gas Desulfurization Mandate, all of which have been introduced in recent years. Results from macro and microanalyses will be presented and discussed.

Market-based instruments and ecosystem services: perilous or panacea?

Dr Stuart Whitten
CSIRO Ecosystem Sciences

Market-based instruments (MBIs) are policy mechanisms designed to convey the rewards or costs for certain actions in much the same way as commodity or service markets do. MBIs offer the potential to deliver environmental outcomes at lower cost to government and market participants (cost-effectiveness), allow flexibility in individual response (are efficient) and encourage positive environmental outcomes (positive rather than negative incentives). Together, these advantages can drive innovation and continued improvements in delivering desired ecosystem service outcomes. MBIs are most useful when there is wide variation among market participants in their costs of providing ecosystem services. It is also important that the costs of establishing, administering and participating in the MBI are moderate relative to the potential benefits.

MBIs are not the panacea for all environmental problems; neither are they a perilous policy experiment. Rather, performance depends on the difficulty of the implementation environment and careful design, some recent examples of which will be provided in this presentation. Effective market design identifies clear performance objectives, the impediments preventing a market, and the natural and human environment in which the policy will operate. Markets for markets' sake are simply an efficient way of wasting money. While we now know much more about how to design and implement MBIs, some surprises have also emerged that are providing ongoing research frontiers. For example, the availability and distribution of information in markets is much more critical than originally thought. Secondly, our ability to design complex markets has now moved beyond our biophysical knowledge in many areas, requiring caution and emphasis on integrating economic and biophysical knowledge in design.



Session 3 Mathematics — linking the economy to the environment with computer models

Hedging financial risk from weather conditions

Professor Adam Clements
Queensland University of Technology

Financial derivative contracts derive their value from movements in the price of an underlying financial asset. The pricing of such contracts is well understood, and hence the markets in which these contracts are traded are well established. Derivatives are often used to manage the financial risk associated with investments or general business operations. In recent times, derivatives relating to climatic conditions such as temperature, rainfall or snowfall have been developed, with the volume of trading growing in recent years. Companies with costs or revenues linked to climatic conditions, such as agricultural producers and electricity or gas suppliers, can use these contracts to manage the financial risk stemming from climatic fluctuations. For a very general introduction to weather derivatives, see http://theconversation.edu.au/why-hedging-a-bet-on-mother-nature-is-a-hot-commodity-5495. In this presentation, a general background to derivatives (mainly option contracts) will be provided, followed by a discussion of weather contracts. The market for these contracts and a number of issues surrounding pricing will be discussed. Various applications of the contracts and future research questions will also be outlined.

A probabilistic approach to exploring low-dimensional global dynamics

Dr Nicky Grigg
CSIRO Land and Water

To navigate the consequences of global change safely, we need to understand how our social and economic systems interact with the biophysical world. Mathematical models play a growing role in aiding that understanding. In particular, models are increasingly representing the dynamic coupling between biophysical, social and economic systems in mathematical models. This talk will explore two kinds of challenges associated with such integrated modelling efforts: (1) representing key (non-linear) dynamics and (2) issues of implementation. These issues will be illustrated using a simple dynamic model of interactions between world population, carbon dioxide emissions and gross domestic product. The model

allows feedback between population growth, climate change and economic impacts to be characterised, and is grounded in empirical relationships derived from global datasets. A probabilistic approach was used to capture the variability inherent in the data and to deal with uncertain climate impacts. The approach yields distributions that evolve over time. Distributions are more informative than single trajectories and acknowledge the reality that there is no single model 'answer' but rather a set of possibilities. Such approaches provide a means to address questions of trade-offs and risks.

Adapting primary industries for climate change — seasonal forecasting as a stepping stone for fisheries and aquaculture

Dr Alistair Hobday
CSIRO Marine and Atmospheric Research

Primary industries have been historically exposed to climate variation, leading to attitudes that coping is 'business as usual'. Both climate change–related trends and recent extreme events have shown that coping is becoming more difficult, and that directed adaptation to climate change is required. While awareness around the need for adaptation to climate-related changes is growing, the timescales for different actions vary considerably between industries, and near-term planning is considered a priority by many. Developing skills for long-term decision-making is also important. We have found that seasonal timescales represent an intermediate step between reactive responses to climatic events and proactive planning for long-term climate change. To support such medium-term decision-making, we have developed and implemented seasonal forecasts for a range of Australian fisheries and aquaculture industries using POAMA. POAMA is the Australian Bureau of Meteorology's seasonal forecast system, which forecasts sea and air temperature and rainfall for Australia at lead times of 9 months. We illustrate a range of targeted forecast products being delivered to marine industries. Advance warning of suboptimal conditions allows for proactive management responses, and helps maintain industry profitability in an uncertain environment. As for agriculture, seasonal forecasts are increasingly recognised as important inputs to support aquaculture and fisheries management in Australia, with forecast accuracy, scope of applications and adoption by industry expected to increase in the next 5–10 years.

Session 4 Physics — sustainable energy systems

Fossil fuel future production: world and Australian focus

Dr Steve Mohr
University of Technology Sydney

Natural gas, oil and coal are fossil fuels that are vitally important in the transport and electricity-generation sectors. In recent years, the supply of these energy resources has been researched, particularly oil supplies. This has led debate around the issue of peak oil supplies by the wider community. This presentation will examine the future supply of these resources by estimating the remaining recoverable resources of these fossil fuels for all countries. These resource estimates will be inserted into GeRS-DeMo (Geologic Resource Supply–Demand Model) to project the future supply and demand of fossil fuels. The focus of the presentation will first be on the overall situation for the world, highlighting the role unconventional oil and gas can play to offset future conventional oil and gas declines. The second focus will be on the production and demand situation in Australia.

Least cost options for 100% renewable energy

Mr Ben Elliston
University of New South Wales

Least cost options are presented for supplying the Australian National Electricity Market (NEM) with 100% renewable electricity using wind, photovoltaics, concentrating solar thermal (CST) with storage, hydroelectricity and biofuelled gas turbines. We use a genetic algorithm and an existing simulation tool to identify the lowest cost scenarios of renewable technologies and locations for an actual year of NEM regional hourly demand and observed weather, using projected technology costs for 2030. These scenarios maintain the NEM reliability standard, limit hydroelectricity generation to available rainfall and limit bioenergy consumption.

The lowest cost scenarios — dominated by wind power — will be presented, with smaller contributions from photovoltaics and dispatchable generation: CST, hydro and gas turbines. Annual costs are compared with a scenario where fossil-fuelled power stations in the NEM today are replaced with modern fossil substitutes at projected 2030 costs, and a carbon price is paid on all emissions.

Decarbonising Australia's electricity supply

Mr Ben Heard
Decarbonise SA and ThinkClimate Consulting

Despite proactive policies for renewable energy and the recent introduction of carbon pricing, Australia's per capita greenhouse emissions remain among the highest in the world. A meaningful response to climate change demands a rapid and full decarbonisation of our electricity supply. Although recent indications suggest that policies may finally be putting downward pressure on emissions from our electricity sector, a credible pathway to a fully decarbonised electricity supply remains unarticulated by government and relevant planning bodies. Australia's refusal to actively engage with the potential role of nuclear power is a major impediment to the development of such a pathway. This presentation will outline the decarbonisation challenge and provide critical context relating to Australia's engagement with the nuclear sector. It will then provide additional focus on the critical role that may be played by small, modular reactors and other advanced reactor technology in the Australian setting.

Session 5 Ecology — biodiversity benefits and trade-offs

Planning for biodiverse carbon forestry

Dr Josie Carwardine
CSIRO Ecosystem Sciences

Economic incentives to plant trees have the potential to change landscapes while mitigating the effects of climate change and adapting to it — for example, the carbon farming initiative in Australia (www.climatechange.gov.au/cfi). The extent to which these landscape changes will benefit biodiversity depends upon where and how carbon forestry is carried out. I will discuss the biodiversity benefits and trade-offs associated with carbon forestry and biodiversity. Using a case study across the Australian continent, I will demonstrate an approach for assessing the cost-effectiveness of areas for environmental plantings to sequester carbon and meeting a set of biodiversity targets for restoring heavily cleared ecosystems. Our research demonstrates both synergies and trade-offs between carbon and biodiversity values, highlighting that many restoration targets will be unmet in a landscape designed for carbon sequestration alone. Profitable areas for carbon forestry under a scenario reflecting the current price on carbon in Australia, $20/tonne, have the potential to sequester up to 29.4 $MtCO_2$ /year, but meet less than half of our restoration targets. A 'biodiversity bank' of approximately $138 million could shift this landscape to achieve the same level of carbon sequestration and all restoration targets. Our approach enables a significant cost saving of 25% compared with a scenario where biodiversity and carbon goals are planned for in isolation. Our systematic and integrated planning approach can assist in making cost-effective decisions when designing landscapes for biodiverse carbon.

Ecological modelling and the sustainability of coral reef biodiversity

Professor Sean Connolly
James Cook University

Increases in human population size and per capita resource use have led to increasing demands for the goods and services provided by ecosystems. In particular, coastal tropical ecosystems, such as coral reefs, have experienced rapid degradation associated with these overall trends, as well as the increased intensity and globalisation of tourism, coastal development and fishing. In this talk, I give an overview of some applications of ecological modelling in support of sustainable human interactions with coral reef ecosystems, using examples from work in my research group that address both single-species and whole-assemblage effects of human activity. I also develop in some detail an example of how an accounting of within and between-model uncertainty can be used to inform management decisions, focusing on an apparent controversy about the viability of reef shark populations on the Great Barrier Reef.

Balancing livestock production and biodiversity in a green economy

Dr Josh Dorrough
CSIRO Ecosystem Sciences

Livestock grazing and agriculture have massively transformed natural vegetation, soils and landscape processes throughout Australia. The effects of livestock on soils, vegetation and landscapes are easily recognised, with negative impacts, particularly during drought. These images of the potential impacts of livestock strongly shape our perception about the role of livestock in a future green economy. So it is perhaps surprising that much recent research and application has focused on how livestock grazing can be used to increase or maintain biodiversity and other natural values in grassy ecosystems throughout Australia. In southern Australia, it is increasingly apparent that nutrient enrichment, not grazing, plays the largest role in transforming ground layer vegetation and hence ecosystem processes. Livestock removal from conservation areas is also no longer a fait accompli, and in some cases retaining livestock could result in equal or better outcomes. There has also been widespread adoption by graziers of planned grazing management, in which biodiversity is seen as underpinning ecosystem processes, production, profit and society. These approaches offer some promise for biodiversity management, not because the grazing management strategies they advocate are necessarily better for native fauna and flora, but because the emphasis is on management towards a holistic goal that incorporates biodiversity and profitability rather than increasing production through greater use of external inputs (fertilisers). However, long-term maintenance of biodiversity across agricultural landscapes is still likely to require massive restorative actions that will probably be impeded by nutrient-enriched soils, a lack of knowledge of appropriate grazing management strategies, perennial exotic grass weeds and significant financial costs. Current restoration approaches are intensive and costly, and the search for low-cost strategies to improve biodiversity at broad spatial scales will be one of the next major environmental challenges for rural Australia.

Session 6 Biology — bioenergy

Managing forests for production and environmental gains — the greenhouse gas balance of native forests in New South Wales

Mr Brendan George
University of New England

Fundamental to how humans respond to climate change is an understanding of the role of natural resource management in providing for our needs within environmental constraints. Forests have the capacity to provide not only wood products but also energy by using wood residues. Considered, holistic management of the forest resource can yield wood as an energy source, as well as help reduce overall carbon emissions. To quantify the climate change impacts of forestry and forest management options, we must consider the entire forestry system and how products are used: the carbon dynamics of the forest, the life cycle of harvested wood products, and the substitution benefit of using biomass and wood products compared with more greenhouse gas–intensive options.

This presentation is based on a recently published paper that presents modelled estimates of the greenhouse gas balance of two key native forest areas managed for production in New South Wales for a period of 200 years, and compares them with the option of managing for conservation only (Ximenes et al. 2012). The case studies show that forests managed for production provide the greatest ongoing greenhouse gas (with long-term carbon storage in products) and product substitution benefits that are critical to the outcome. Thus, native forests could play a significant part in climate change mitigation, particularly when sustainably managed for production of wood and non-wood products, including biomass for bioenergy.

The potential role of production forestry in mitigating climate change, though substantial, has been largely overlooked in recent Australian climate change policy.

Reference

Ximenes, F, George, B, Cowie, A, Williams, J and Kelly, G, 2012, Greenhouse gas balance of native forests in New South Wales, Australia, *Forests* 3: 653–83.

Bioenergy technology from laboratory to commercial production

Dr Jessica O'Brien
Pacific Pyrolysis

The gap between industry and research in the biomass to energy space is closing rapidly. Currently, the race to commercialise is attracting significant investment internationally.

Research gaps specific to bioenergy that must be addressed in a successful commercial project include effective and consistent conversion of sometimes highly variable materials, and safe use of new products derived from waste materials. Possible changes in reaction chemistry on scale-up must also be considered because biomass reactions are highly complex and often not well understood. Investigation of and allowance for these sensitivities can be key to successful transitions in scale.

Commercialisation involves achieving the balance between marketing hype required for investment and academic caution in overselling the technical capabilities of new technologies. For example, pyrolysis technology yields both energy and biochar products, and addresses the need for organic waste-management solutions. Developing a scientifically rigorous support for the co-benefits of the technology, such as novel applications for new products and the greenhouse gas mitigation potential, are often just as critical to the technology's commercial success as the successful operation of the technology itself. Focusing on the success of one parameter alone does not give the full commercial story of a particular technology.

This presentation will discuss the research challenges presented by scaling up and commercialising technology in the biomass to energy field. Experiences with technology from both Pacific Pyrolysis and Ignite Energy Resources will be used to highlight achievements that bridge the research gap and lead the way to commercialisation of renewable energy in Australia.

Further reading

Pacific Pyrolysis, http://pacificpyrolysis.com.

Alternative aviation fuels

Dr Lucas Rye
Shell Company of Australia

Increased interest in alternative aviation fuels — driven by supply security and environmental concerns — and consequent advances in non-conventional refining techniques are providing increased hydrocarbon diversification (e.g. Shell's Pearl GTL). Recent activity has demonstrated incident-free operation of alternative jet fuel refined from both gas and biomass feedstock. These test programs, which required no airframe or engine modification, supported the recent inclusion of synthetic kerosene in the jet fuel specification (ASTM D7566), thus allowing the sector to operate commercial flights.

Alternative fuel programs, however, have focused on assessing technology pathways and/or sourcing test fuels (e.g. through demonstration flights) based on fuel specification compliance and sustainability criteria. It has not been realised that certain pathways may provide a more or less desirable fuel composition. Limited data, however, exist on the complexity of hydrocarbon combustion.

A background on alternative aviation fuels will be presented, followed by a brief introduction to hydrocarbon combustion.

Further reading

Rye, L, Blakey, S and Wilson, CW 2010, 'Sustainability of supply or the planet: a review of potential drop-in alternative aviation fuels', *Energy and Environmental Science* 3: 17–27.

Session 7 Agriculture and aquaculture — nutrients and nutrition

Effective nitrogen use in agriculture: plant breeding to meet food demand

Dr Trevor Garnett
Australian Centre for Plant Functional Genomics

A vast amount (>100 million tonnes) of nitrogen fertilisers is applied to crops each year to maximise yield (FAO 2006). Human population is intimately tied to fertiliser use, with the wide application of nitrogen fertilisers during the green revolution enabling increased food production, which has been credited with saving billions from starvation (Fischer et al. 2009). This massive input of industrially fixed nitrogen to the biosphere, which was only possible following the development of the Haber–Bosch process in the early 1900s, is a cause for concern for a range of reasons that are only now beginning to be recognised (Rockstrom et al. 2009). Food production will require another boost over the next few decades if we are to feed the human population estimated for 2050 (Tester & Langridge 2010). Given the known and hypothesised impacts associated with nitrogen fertiliser use, this increased food production will need to come with improved efficiency in nitrogen fertiliser use. There is plenty of scope to improve nitrogen-use efficiency — for example, cereal production accounts for 60% of nitrogen fertiliser use, but only 40–50% of the applied nitrogen is actually taken up by the intended crop (Peoples et al. 1995; Sylvester-Bradley & Kindred 2009). One avenue for improving the effeciency of nitrogen fertiliser use is through improved fertilisation practices, but another, the focus of this presentation, is improvement in the ways crop plants access and use nitrogen fertiliser.

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Harnessing native plants to manage phosphorus in Australian pastures

Associate Professor Megan Ryan
University of Western Australia

As reserves of rock phosphate decline and fertiliser prices rise, it is imperative that Australian agricultural systems become more phosphorus efficient. Australian soils are naturally some of the lowest in phosphorus in the world. Can our native plants suggest novel ways in which plants can use phosphorus efficiently? Could we even domesticate native species with favourable phosphorus-use characteristics? Although Australia has a wealth of native legumes and herbs, until recently, very little was known of their potential to be developed as pasture or crop species. It now appears that some natives, including species of *Cullen*, *Kennedia* and *Ptilotus*, have pasture potential. As well as an ability to grow on low-phosphorus soils, some species have a superior ability to (a) access phosphorus stores in soil that have low solubility, (b) store very high amounts of phosphorus in their tissues without suffering toxicity, and (c) remain highly productive under summer drought conditions. Further research is required to determine how best to incorporate such species into Australian agricultural systems.

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The role of nutrition in sustainable aquaculture development

Dr Cedric Simon
University of Tasmania

Aquaculture is the fastest growing primary industry in Australia and the fastest growing food-production sector in the world. Aquaculture in Australia, like other industrialised countries, is dominated by the farming of high-value species in intensive systems, while most aquaculture production worldwide is in developing countries from extensive systems. Globally, production from capture fisheries has levelled off, and most of the main fishing areas have reached their maximum potential. With an ever-increasing world population, aquaculture is set to overtake capture fisheries as a source of seafood to meet world demand. It is estimated that feeding a world population of 9.1 billion in 2050 would require raising food production by some 70%. Aquaculture has the potential to make a significant contribution to addressing the big issue of food security; however, to achieve this, the sector faces great challenges. This presentation focuses on a number of specific issues in the field of aquatic animal nutrition that are critical for a sustainable aquaculture future in both industrialised and developing countries. These include the development of aquafeed for new species, broodstock and larval nutrition, the availability and supply of feed resources for aquafeeds, understanding nutrient requirements of cultured species and optimising nutrient use under practical farming conditions, and minimising the environmental pollution of aquaculture systems.

Session 8 Social sciences — behavioural changes at individual, organisational and governmental scales

Corporate adaptation to climate change

Dr Martina Linnenluecke
University of Queensland

This presentation deals with a pressing topic — how should business organisations strategically engage with the physical impacts of global warming and more frequent or intense weather extremes? Impacts from climate change already pose major challenges for organisations and industrial systems, and vulnerabilities are expected to increase in the future, particularly in vulnerable sectors and locations. Findings by the Intergovernmental Panel on Climate Change suggest that climate change–related vulnerabilities of organisations and industries, but also of settlement and society as a whole, can be expected, not only because of gradual changes in the environment due to global warming but, in particular, due to changes in the intensity and/or frequency of extreme weather. Organisation researchers and managers have not yet systematically considered the organisational implications of changes in the environment and trends of weather extremes, such as changes in the intensity or frequency of storms, floods and droughts. Although some exposed companies, such as those in the reinsurance industry (e.g. Munich Re, Swiss Re), have begun to research the risks associated with a changing climate and impacts on their organisations, most current debates on climate change and corporate response are mainly focused on mitigation (i.e. adjustments that organisations can make to reduce their greenhouse gas emissions, mostly in response to policy and legislative changes). As the question of how organisations can cope with the physical impacts of global warming and more frequent or intense weather extremes has largely remained outside these debates, this presentation will look into possible future corporate strategies under a changing climate.

Legal responses to emerging energy technologies

Miss Penelope Crossley
University of Sydney

While science marches ahead in making new discoveries and commercialising technologies, the law has often been accused of 'marching in the rear and limping a little'. This is because the law often fails to anticipate the development of new technologies and, when it does do so, has a tendency to be either over or under inclusive in the definitions it adopts. This phenomenon is particularly visible in laws designed to encourage the acceleration of the deployment of 'renewable energy'. This paper argues that many jurisdictions include overly inclusive or inappropriate definitions of 'renewable energy', which incorporate established technologies that do not require assistance in their development or commercialisation, leading to serious distortions in the market. This means that well-established projects using renewable-generation technologies that are already commercially viable without government assistance and, in some cases, that have been fully operational for decades are benefiting from subsidies and other commercial support, leading to super-profits for those renewable energy generators. This paper will argue that the reason for this problem is that the act of legislating in the energy sector is an inherently political process, often undertaken in a manner that fails to reflect current scientific and environmental knowledge. This balance needs to be redressed if the legislation in this sector is not going to further distort the market.

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Considering a green future: what motivates people to act in support of pro-environmental policies?

Dr Paul Bain
University of Queensland

Public support for green policies and initiatives underpins the move towards a green economy. Building on research showing that people are most concerned about the social consequences of environmental issues (compared with consequences for themselves or the biosphere), I focus on people's beliefs about how society will change as a result of addressing environmental issues, and show how these are related to support for pro-environmental policies. I describe a general model for understanding people's beliefs about the future of society, called 'collective futures', encompassing projected changes in society as a whole (e.g. levels of crime, poverty, economic prosperity) and changes in the people who constitute society (their character and values). Focusing on climate change, I show that people are more willing to actively support climate change policies when they believe these policies would result in changing people's character, specifically in making people more caring and concerned for others (interpersonal warmth). This is even the case for climate change sceptics, who were more willing to actively support climate change policies when they thought it would contribute to a more moral and caring society (and were also persuaded by potential economic benefits). Incorporating these community-oriented goals into green policies is likely to increase active support in both 'green' and 'less green' sectors of the community, facilitating the transition to a green economy.

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Poster abstracts

The CLIMDEX project: creation of long-term global, gridded products for the analysis of temperature and precipitation extremes

Dr Lisa Alexander
University of New South Wales

The CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices has developed a suite of indices derived from daily temperature and precipitation data, with a primary focus on extreme events. These indices have been calculated at station locations using quality-controlled data from international daily datasets (i.e. the daily Global Historical Climatology Network and the European Climate Assessment), with data-sparse regions supplemented with data from targeted regional workshops. To account for the uneven global distribution of stations and easily compare with the output from climate models, these indices were gridded onto a 3.75 longitude × 2.5 latitude grid to create the HadEX dataset. HadEX made significant advances in our understanding of global changes in temperature and precipitation extremes, and allowed modelled extremes to be evaluated for the first time using state-of-the-art global climate models. However, HadEX still suffers from a lack of coverage over large areas (particularly for precipitation extremes), only covers the period 1951–2003, and does not contain the measures of uncertainty required to fully assess the trends and variability in extremes.

This poster introduces the 'next generation' of global, gridded extremes products (the CLIMDEX project) that aim to improve our understanding of the variability of extremes, improve detection and attribution studies, and provide the highest quality observations for model evaluation. Advances over previous datasets include longer term data availability, delivery via a web interface, including near real-time updates, and an assessment of the uncertainty in the gridded products.

The Antarctic ozone hole and climate change

Ms Julie Arblaster
Bureau of Meteorology

Future anthropogenic climate change in the Southern Hemisphere is likely to be driven by two opposing effects: the recovery of the Antarctic ozone hole and increasing greenhouse gases. Poleward shifts in atmospheric circulation are projected in all climate models under increasing CO_2, while ozone recovery leads to a circulation shift towards the equator, primarily in austral summer. These circulation changes have widespread impacts on Southern Hemisphere surface climate, including on Australian temperature and rainfall. However, the relative importance of greenhouse gases and ozone on the circulation response varies across both climate models and emission scenarios, thus contributing to uncertainty in the projections. This poster summarises the changes projected in the Southern Hemisphere extratropical circulation by the Coupled Model Intercomparison Project phase 5 (CMIP5), which presents an unprecedented opportunity to explore the magnitude of ozone-induced change under multiple greenhouse gas scenarios. Models with prescribed stratospheric ozone concentrations are contrasted with those with interactive or semi-offline chemistry. It is found that stratospheric ozone forcing plays an important role in future changes in the atmospheric circulation, even leading to a weak jet shift towards the equator under a low-emission scenario. As greenhouse gas forcing strengthens, the role of ozone is diminished, with a significant poleward shift in the circulation seen in all models under the highest emission scenario.

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Selective hearing? Why scientific evidence resonates in some policy arenas and not others

Dr Betsi Beem
University of Sydney

'Evidence-based policy' is increasingly referred to in all government decision-making contexts. This should empower the scientific community to marshal evidence and arguments derived through robust standards of enquiry and validation. However, behind this rhetorical support for evidence are two substantial sets of questions: (a) What makes something 'evidence' and how does the context in which the knowledge is being used affect what counts as evidence? and (b) What practices are initiated or validated by reference to the need for 'evidence' in support of policy? Does it serve as the vehicle for the entry of new players, or for a realignment among existing participants? How does it relate to the mobilisation of other rationales for action? What do these practices of evidence-based policy reveal about the location of power and its flow between policy actors?

'Evidence-based policymaking' is grounded in the portrayal of policymaking as rational decision-making that assumes that principles for selection of questions, data and methods of evaluation are shared among policy actors. This research challenges that notion, following the 'interpretive turn' in policy analysis as a process involving continuing attempts by a range of actors to stabilise shared understandings and practices about issues of collective concern: policy, and the evidence 'used', are being generated by the interaction of the various participants as they engage in 'making sense together'. Context, interests, values and issues interact to create a range of 'evidences' that vary in the degree to which they reflect those produced through scientific enquiry.

Reimagining the suburb: planning for biodiversity in the urban fringe

Dr Sarah Bekessy
RMIT University

Temperate native grasslands on Melbourne's urban fringe represent some of the last remaining examples of this critically endangered ecosystem. Yet their future is in peril; very few patches exist on public land, and housing development threatens many remaining areas.

Two major problems are driving the loss of grasslands on the urban fringe. Firstly, once development occurs, grasslands inevitably deteriorate. Community perception of grasslands is very poor, and appropriate management is difficult to maintain. Over time, the fragmentation of the landscape, introduction of pests and weeds, increased roads and traffic, and disturbance from intensive recreation result in the disappearance of sensitive flora and fauna species.

The second major problem is that Melbourne's key growth corridors are aligned with key grassland biodiversity hotspots. This inevitably leads to conflict in land use, with biodiversity values typically coming off second best, and the continued expansion of the urban growth boundary pushing further and further into biodiversity-rich areas.

This project seeks to find solutions to these two problems, and aims to improve the scientific rigour of planning for grassland conservation at both the strategic and development design phases.

Constraining regional climate projections with observations of recent change

Dr Jonas Bhend
CSIRO Marine and Atmospheric Research

Regional climate change projections are often highly uncertain. A key factor contributing to this uncertainty is related to the difficulties in validating climate models on timescales relevant for climate change. Here we explore how we can use observed recent change to learn about future climate.

We use observations of near-surface temperature and rainfall change, and climate model simulations from the latest set of internationally coordinated experiments: the Coupled Model Intercomparison Project phase 5 (CMIP5). In our three-tiered analysis, we first compute the maximum potential improvement in projections by incorporating observations of recent change. We find moderate correlation between variability in simulated recent and future change across models, with correlation coefficients of up to 0.7 but generally below 0.4, depending on season, region and variable combinations. We proceed by assessing the consistency of observed and simulated recent change, as strongest improvements in projections are expected in cases for which simulated and observed change differ. We find large coherent areas where simulated and observed warming are significantly different, and where there is a strong indication of biases shared across models. Finally, we constrain projections with recent observed change, taking into account biases shared across simulations. In general, we find small changes in regional projections after incorporating recent observed change as an additional constraint.

We conclude that, even though past changes do not yet provide sufficient constraints, integrating the recent past and the projected future is crucial to address user needs, and make sense of climate projections.

Looking into the past to learn for the future: climate extremes informing climate change adaptation

Dr Sarah Boulter
Griffith University

Climate change may mean more extreme events, or more severe events, in the future. Studies of preparedness and responses to past events can usefully inform understanding of how societies and the environment will adapt to these future changes, and in turn contribute to improved climate change adaptation planning.

We examined past extreme events (caused by tropical cyclone, flooding, heatwave, drought, east-coast low and storm tide) in Australia, Europe, America and developing countries to determine how communities, emergency managers, policymakers and research scientists responded. We have used this case-study approach to consider the attributes that determined the success or failure of the response and recovery phases (i.e. the prior conditions, decision-making around the event and subsequent policy changes), and to

explore the lessons to be learned about what determines the success or failure of climate change adaptation strategies in the future.

Our results point to several broad lessons. First, actions need to be realistic and pragmatic as well as forward thinking; some responses or adaptations may be appropriate in the short term, but prove to be maladaptations in the longer term. Second, while building a 'resilient' community is an important response, it must be acknowledged that this may mean change. Third, there is extensive knowledge around extreme events and how to manage their impacts, but for a variety of reasons this knowledge doesn't necessarily translate into action.

Modelling climate variability and change in the tropical Pacific

Dr Jo Brown
Bureau of Meteorology

Global climate models are an important tool for understanding natural climate variability and making projections of future climate change. In regions such as the tropical Pacific, models are improving in their ability to represent the observed climate, but major issues remain. It is therefore important to evaluate the strengths and weaknesses of climate models, and to communicate uncertainty in future projections.

The latest global climate models (Coupled Model Intercomparison Project phase 5) are able to reproduce many large-scale features of climate in the tropical Pacific, including the monsoon system, the Intertropical Convergence Zone (ITCZ) and the South Pacific Convergence Zone (SPCZ). Most models also reproduce the interannual variability associated with El Niño – Southern Oscillation (ENSO). However, many models have errors in the spatial distribution of rainfall and surface temperature, including an overly flat or 'zonal' SPCZ, and overly cold sea surface temperatures near the equator, which must be considered when making regional climate projections.

Under a high emission scenario for 21st century climate, climate models project an increase in tropical Pacific rainfall, particularly during the wet season and in regions that are wet in the present-day climate, such as tropical convergence zones. As warming of sea surface temperatures is greatest near the equator, rainfall increases are largest in this region. The ITCZ and SPCZ do not move average position significantly, but become wetter in a warmer climate. Changes in ENSO are uncertain, but there is some evidence that impacts of ENSO, including heavy rainfall, may increase in future.

Further reading

Pacific Climate Change Science Program, www.pacificclimatechangescience.org.

How can organisations be structured so as to contribute to a sustainable society and environment?

Dr Paul Brown
University of Technology Sydney

This cross-disciplinary and team-based research program investigates the broad question, How can organisations be structured so as to contribute to a sustainable society and environment? Critical to each research project is the combination of economics and other branches of science. In the carbon trading project (http://ssrn.com/abstract=1633028), the science-based view of a carbon-constrained global economy and market-based economics are linked to the principles of 'equity', leading to a novel design for

an emissions trading scheme addressing both climate change and global poverty. The energy efficiency project links engineering principles with the disciplines of accounting and management to identify how organisations can become more energy efficient (www.business.uts.edu.au/energyefficiency). The project contains a large education component, including the development and delivery of a two-day course, interactive seminars for accountants, managers and higher education participants, and the integration of energy efficiency management principles into University of Technology Sydney Business School courses. We are also conducting four case studies, focusing on the evaluation of energy efficiency projects, strategies to enable the Australian steel supply chain to become more sustainable via energy efficiency, studying the energy efficiency program of a large university campus, and energy efficiency accounting for farmers, using cotton farming as the context. The cotton value chain project links agronomy with mainstream management accounting theories, where we identify not only how on-farm sustainability practices can be supported through improved information systems, but also how on-farm information can be communicated to key stakeholders to support a more sustainable Australian cotton industry.

Risk, ambiguity and the adoption of new technologies: experimental evidence from a developing economy

Dr Tim Capon
CSIRO Ecosystem Sciences, Climate Adaptation Flagship

The slow adoption of innovations in less developed countries has long been a puzzle, given their higher expected returns. This paper investigates the role of ambiguity aversion as a fundamental behavioural determinant of technology adoption, using primary data collected from farmers to explain their decision not to adopt innovations in technology. The results suggest that it is aversion to ambiguity (rather than risk) that limits technology adoption. Policy interventions that reduce this type of uncertainty, through the provision of information about innovations, may have the potential to speed adoption.

Cold-thermal storage with air-conditioning systems can provide a new wave of energy savings and grid flexibility

Dr Francis Clark
Charles Darwin University

The integration of cold-thermal storage into commercial and residential air-conditioning systems, and other refrigeration systems, can be expected to boom in the coming decade. The three reasons underpinning this view are presented in this poster, with the overarching dynamic being the capacity to shift load. First, significant energy savings are possible by shifting compressor cycles into earlier parts of the day when ambient temperature is lower; second, with air-conditioning representing a key component of peak demand, the capacity to peak-shave has significant economic implications for networks; and third, the task of integrating non-dispatchable renewables (e.g. wind and solar) is greatly aided by new sources of flexibility on the demand side.

By presenting some thinking and analysis on cold-thermal storage, this poster can stimulate discussions and connections that will assist my colleagues and me to move forward with facilitating deployment of cold-storage load-shifting applications in the Northern Territory and elsewhere. This new focus follows from modelling work on 50% renewable penetration into the National Electricity Market using wind and solar (www.oz-energy-analysis.org/TTS.html), which gave some quantification of the level of storage and buffering required to accommodate these renewables. The Northern Territory, without hydro resources and

with only solar power expected to make significant inroads into the medium term, presents an ideal market for cold-thermal storage products and research.

Optimising large-scale, low-carbon electricity systems

Dr Roger Dargaville
University of Melbourne

Managing the variability and lack of control in dispatching renewable energy technologies such as wind, solar photovoltaic and wave power is a major challenge, especially as the penetration of renewables increases beyond 20%. By considering the way the synoptic and seasonal weather variability acts on different technologies, we can reduce the amount of generating capacity that will be required to meet carbon emission reduction goals, such as the target of 80% by 2050 put forward by the current government. Given the cost of the energy system, small percentage savings can amount to billions of dollars.

We present the results for a prototype energy system model for eastern Australia that optimises the amount and location of different technologies to find a least cost combination. Results show that wind power is the dominant technology — up to around 30% penetration— and that solar technologies become favourable due to their improved ability to follow demand. The model tends to spread wind farms out as much as possible to smooth out variability, but puts the solar power in concentrated areas where the solar resource is optimal. Initial results need to be used with caution as transmission costs are only very crudely estimated. Future work to simulate spot-market prices will also affect results, with some niche technologies, such as wave power, becoming more viable.

Centre for Policy Development: Sustainable Economy Program

Miss Laura Eadie
Centre for Policy Development

Australia needs to build a diverse economy that can thrive in a resource-constrained and carbon-constrained future.

We have tremendous opportunity to leverage our abundant natural resources and skills in innovation to build a fair, sustainable and prosperous economy — one that provides a secure future for all Australians. Yet, to do so, we need to get the policy settings right.

The Centre for Policy Development's Sustainable Economy Program is identifying practical policies for different sectors of Australia's economy to preserve the environment and resources that sustain them.

Stocking up: securing our marine economy was released in 2011. This report found that the world's oceans are at risk of ecological collapse, with potentially catastrophic social and economic impacts. However, Australia can secure a competitive advantage if we preserve our marine assets through marine protected areas and rebuild fish stocks (http://cpd.org.au/2011/09/stocking-up).

Farming smarter, not harder: securing our agricultural economy will be released at the end of October. This report finds that booming global food demand presents a big opportunity for Australian agriculture. To grasp this opportunity, Australian farming needs to use resources more efficiently than the rest of the world, because we have fragile and vulnerable soils (http://cpd.org.au/2012/09/sustainable-economy-farming-smarter-not-harder).

Sustainable manufacture and recycling of lightweight structures

Dr Stefanie Feih
RMIT University

My research aims to achieve lightweight structural design with minimal environmental impact, and focuses on two areas: (a) optimum design of metallic structures through advanced manufacturing methods, with minimal material waste, and (b) optimisation of the processes for recycling glass and carbon fibre composites.

Conventional production of metallic components removes up to 95% of solid material during the manufacturing process. Advanced manufacturing technology has major benefits, such as (1) new designs can be developed, which are not possible using conventional subtractive technology, (2) dramatic savings can be made in time, materials, wastage, energy and other costs in producing new components, and (3) environmental impacts can be significantly reduced. Selective laser melting builds finished components from metal powders layer by layer by melting powder particles. The technology allows computationally optimised, high-performance structures to be used. My research focuses on the validation of design strategies tailored to this new manufacturing technology.

Composite materials are used extensively in new aeroplane designs (over 50% by weight for the new Boeing 787), highlighting the problem of disposal of obsolete aircraft and recycling for aeroplane design. European guidelines for 2050 state that new aircraft should be designed and manufactured to be recyclable. Composites are generally recycled through burn-off of the resin system at high temperatures, thereby allowing the fibre reinforcement to be potentially reused. However, the heat treatment weakens the fibres. My research focuses on optimising the recycling process in terms of temperature and duration, while also investigating the cause of the strength loss to allow for efficient reuse of the expensive fibre product.

The response of the maize nitrate transport system to nitrogen demand and supply across the life cycle

Dr Trevor Garnett
Australian Centre for Plant Functional Genomics

An understanding of nitrate (NO_3^-) uptake throughout the life cycle of plants and how this process responds to nitrogen availability is an important step towards the development of plants with improved nitrogen-use efficiency. NO_3^- uptake capacity and transcript levels of putative high-affinity and low-affinity NO_3^- transporters were profiled across the life cycle of dwarf maize (*Zea mays*) plants grown at reduced and adequate NO_3^- levels. Plants showed major changes in high-affinity NO_3^- uptake capacity across the life cycle, which varied with changing relative growth rates of roots and shoots. Transcript abundance of putative high-affinity NO_3^- transporters (predominantly ZmNRT2.1 and ZmNRT2.2) were correlated with two distinct peaks in high-affinity root NO_3^- uptake capacity and also nitrogen availability. Reducing NO_3^- supply during the life cycle led to a dramatic increase in NO_3^- uptake capacity, which preceded changes in transcript levels of NRTs, suggesting a model with short-term post-translational regulation and longer term transcriptional regulation of NO_3^- uptake capacity. These observations offer new insight into the control of NO_3^- uptake by both plant developmental processes and nitrogen availability, and identify key control points that future plant improvement programs may target to increase nitrogen uptake relative to availability or demand.

Is Asian countries' nuclear-free pathway an environmentally friendly choice?

Mr Sanghuyn Hong
University of Adelaide

The Fukushima nuclear accident in March 2011 has arguably increased social (and political) reluctance to embrace nuclear power in Japan, despite the government's commitment to mitigate that nation's greenhouse gas emissions. The Japanese Government has thus been considering four possible future energy mixes: a nuclear-free pathway, and three others with a 10–35% nuclear component coupled with renewable energy and fossil fuels. This research quantifies and contrasts the potential negative effects of the four proposed pathways on the economy (levelised cost of electricity and energy security), environment (greenhouse gas emissions, land transformation, water consumption, heated water discharge, air pollution, radioactive waste generation and solid waste) and society (safety issues), to determine which one minimises adverse future outcomes. The nuclear-free pathway has the highest overall potential for adverse outcomes relative to the status quo, with the 35% nuclear power supply option yielding the lowest negative impact score. Despite some sensitivity to the choice of criterion weights, the analyses demonstrate clearly that, from a tangible perspective, a nuclear-free pathway for Japan is the worst environmental and economic option to pursue.

Production of iron-enriched rice to improve global health

Dr Alex Johnson
University of Melbourne

Iron deficiency affects more than 2 billion people and is the most widespread micronutrient deficiency in the world. Fortifying manufactured rice products with iron is common practice in developed countries, and helps people to achieve their recommended daily intake of this vital micronutrient. Often provided as water-soluble compounds, such as ferrous sulfate, during food processing, iron fortificants have contributed to major reductions in iron-deficiency anaemia in developed countries since the 1940s. In developing regions of the world where rice is a major food staple, such as South and South-East Asia, rice is frequently consumed as a non-fortified food, and iron deficiency abounds in these regions because of the low concentration of iron that is found in polished rice grain, commonly referred to as 'white rice'. The production of iron-enriched rice varieties could radically improve the health of billions of people living in developing countries, yet decades of conventional breeding for this trait have not been successful. My research group has developed genetically modified rice varieties that have four-fold more iron and two-fold more zinc in the polished grain (Johnson et al. 2011; Johnson 2012). These 'biofortified' rice varieties could extend the health benefits of iron fortification to billions of people in developing countries in a natural, inexpensive and sustainable manner.

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Estimating Australia's blue carbon stocks and fluxes by combining marine models and observations

Dr Emlyn Jones
CSIRO Marine and Atmospheric Research

As Australia moves towards a 'green economy', there is a growing interest in the storage and cycling of carbon in the marine environment, referred to as 'blue carbon'. Much of this blue carbon cannot be explicitly observed at regional, shelf or continental space scales, and we require specific marine environmental models to predict the mass and flux of carbon between various marine carbon pools. Given that there are numerous sources of model error and uncertainty, and observations are sparse in time and space, the application of model-data fusion algorithms is an attractive way to reconcile these problems and yield quantitative estimates of model confidence. Several pilot algorithms have been investigated using a highly simplified marine model and synthetic data. We present the general approach being used to combine marine carbon models with observations, and give some early results on how uncertainty in model predictions can be quantitatively estimated for use in further socio-economic studies.

Plants in the black: tackling the food, energy and climate change crises, one plant at a time

Dr Jitka Kochanek
University of Queensland

The food, energy and climate change crises are among the main issues facing human society (Grierson et al. 2011). Our research is testing novel ways to reuse organic waste from cities and farms to create products that store carbon long term in the soil — to offset carbon emissions — for improved plant growth and ecosystem health.

- *University of Queensland, Horticulture Australia Ltd and Brisbane City Council*: This study aims to understand whether novel biochar products (and/or their combination with compost) made from recycled organic waste improve the performance of horticultural crops. Biochar is a carbon-rich residue manufactured by pyrolysis, during which organic material is thermally decomposed under oxygen-limited conditions. Biochar generation allows co-production of fossil fuel–replacing bio-oils and syngas (Laird 2008; Sohi et al. 2010; Ahmed et al. 2012). The residue biochar is purported to increase on-farm productivity by improving the physical, biological and chemical properties of soil. Our research combines field, pot and laboratory-based experiments to understand *how* these new products affect plant growth and *why* they promote or harm plants. Uniquely, our biochars were manufactured by three pyrolysis technologies, allowing their chemical and physical properties to be compared, and economic and environmental aspects to be examined.

- *University of Queensland and University of Western Australia*: Scientists have begun to elucidate the chemical mechanisms through which biochar may positively and adversely affect plant growth. In a world first, the presence of karrikinolide, a plant growth regulator, at biologically active concentrations has been confirmed from two of the four biochars sampled (Flematti et al. 2004).

- *University of Queensland*: We have developed and are testing a novel laboratory protocol to rapidly assess products from recycled organic waste for plant-harming attributes. Such a test is needed to overcome batch-to-batch product inconsistency issues (Gell et al. 2011; Solaiman et al. 2012).

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Total absorption gamma-ray spectroscopy for the understanding of nuclear decay heat

Dr Greg Lane
Australian National University

The quantity of decay heat produced in the fuel of a nuclear fission reactor, and its time behaviour immediately after the fission reaction ceases, are critical design factors that affect fuel removal and reloading processes, safety after accidents, and the storage, transport and reprocessing requirements for spent fuel. The importance of understanding decay heat was made especially apparent following the nuclear accident at Fukushima in March 2011.

A full understanding of the decay heat requires knowledge of the fission yields and beta-decay lifetimes, and of the beta and gamma-ray decay schemes for all of the fission products and their subsequent daughter decays. The International Atomic Energy Agency (IAEA) has noted that there are a number of nuclei for which a lack of experimental information on the beta-decay branching ratios has important implications for the design of generation IV reactors, and has requested that priority be given to studies of these nuclei (see report of the assessment of fission product decay data for decay heat calculations at www.nea.fr/science/wpec). Total absorption gamma-ray spectroscopy is the experimental tool of choice to accurately measure the weak beta-decay branches that are prevalent in neutron-rich fission products. This poster will report on preparations for such measurements on some of the IAEA priority nuclei that will be available as radioactive beams from the CARIBU facility (see CARIBU page on the ATLAS website, www.phy.anl.gov/atlas) at the Argonne National Laboratory.

A 'green' economy requires the eventual transition to a steady-state (non-growing) economy

Associate Professor Philip Lawn
Flinders University

Any serious consideration of a 'green' economy requires serious consideration of the limits to economic growth and of the best way to operate should such limits exist. There are both 'economic' and 'ecological' limits to growth. What's more, the economic limit is arrived at well before the biophysical limit. The aim of a nation should not be to increase the scale of economic activity until it reaches its biophysical limit, but to maximise the wellbeing of its citizens. This requires a nation to operate a steady-state (non-growing) economy at or around its optimal scale, which is much smaller than its maximum sustainable scale. Once there, a nation should focus on qualitative improvements that, by increasing economic benefits and lowering economic costs, can increase a nation's economic welfare. Failure to do this poses the greatest threat to democracy, freedom in the liberal-democratic tradition, capitalism and international peace.

Sharing or sparing? How should we grow the world's cities?

Dr Brenda Lin
CSIRO

There has long been a debate among conservation biologists about how agricultural land use should be distributed spatially. Advocates of land sparing argue that high-intensity food production on small units of land will conserve more natural habitat than low-intensity farming spread across larger areas. Others argue that less intensive production over a greater area of land will reduce the overall load of human stressors upon ecosystems. Increasing research into urban landscapes has shown similar patterns of land use degradation, with large-scale urban growth systematically reducing the amount of 'biodiversity supporting vegetation', thus affecting both wildlife conservation and ecosystem services in urban settings. Like agricultural systems, there is a question of how best to grow cities with the minimum impact on the environment. Continued and rapid urban population growth, with associated losses in vegetation, suggests that a similar land-sparing debate needs to emerge around the ecological impacts of urbanisation to promote a more spatially explicit debate regarding urban development. Intensification of urban systems to increase housing density leads to extensive coverage by buildings, interspersed with small tracts of semi-natural habitat patches. Urban extensification is characterised by sprawling suburbanisation with less concentrated, more distributed greenspace, predominantly in the form of backyard and streetscape vegetation. Such different patterns of urban development will affect biodiversity across the urban frontier. We chart the early progress of empirical work on the land-sparing debate in an urban context, to learn how developing urbanisation patterns can minimise overall ecological impact.

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Challenges to Australian agriculture under a green economy: the role of soil carbon

Dr Lynne Macdonald
CSIRO Land and Water

Australian agriculture faces many challenges under a green economy. A growing population requires more food and fibre on less land. A changing climate puts focus on the need to reduce greenhouse gas emissions and to sequester carbon. Increasingly, society is demanding adaptation, improved resource efficiency and green credentials that protect our soils, waterways and natural landscapes. There is the expectation that the agricultural sector will meet these demands while remaining economically viable and providing greater consumer choice. These expectations create a complex landscape of tension between sustainable resource management and the dollar.

Extending far beyond sequestration and a carbon dollar value alone, soil organic carbon (SOC) has a key role in a sustainable future. SOC contributes to key physical (water retention, structural stability), chemical (nutrient retention, pH buffering) and biological (nutrient provision, resilience) functions that support productivity, nutrient and water-use efficiency, and the fate of nutrients in waterways and the atmosphere. The long-term management of SOC requires integration of research disciplines to understand how farming decisions affect the input and loss of SOC and, ultimately, long-term productivity. When aiming to build SOC stocks, we must consider different types of organic carbon, how they contribute to key functions and over what timescales different fractions are likely to decompose. Examples of current research include (a) the need to improve estimates of below-ground inputs (root structures and labile carbon) and how these are impacted by emerging practices and new biotechnologies (e.g. plant varieties, inoculants), and (b) the potential role of pyrolysed carbon (biochar) in long-term carbon sequestration, greenhouse gas mitigation and wider soil functions.

Natural variability in CO_2 accelerates the onset of ocean acidification for the Great Barrier Reef

Dr Ben McNeil
University of New South Wales

The ocean's carbon cycle has undergone immense change since the industrial revolution; its capacity to absorb anthropogenic CO_2 is changing, along with its chemical composition (pH and carbonate), leading to ocean acidification. Our understanding of how natural processes and variability can either amplify or suppress ocean acidification is still uncertain. We examined the diurnal and seasonal variability of carbonate chemistry on a reef flat in the Great Barrier Reef, and found extremely high natural variability in carbonate chemistry. This variability, when coupled with continued increases in atmospheric CO_2, will lead to corrosive conditions for these coral reefs by mid-century (i.e. 2040). Characterising natural variability is critically important to accurately diagnose the onset of ocean acidification for coral reefs.

Comparing reserve design strategies for retaining biodiversity under climate change

Dr Karel Mokany
CSIRO Ecosystem Sciences

Establishing new conservation reserves is a key management response to promote the persistence of biodiversity under climate change. Although there are many approaches to designing reserves, quantitatively assessing the performance of alternative habitat configuration strategies in retaining biodiversity has been limited by the lack of suitable modelling frameworks. We applied a dynamic macroecological modelling approach to compare the outcomes under climate change for plant biodiversity in Tasmania (all 2051 native species) when new conservation reserves are established according to four contrasting reserve design strategies: connectivity, aggregation, representativeness and a balanced approach. The most effective reserve design strategy under climate change depended on the specific conservation goal. To maximise the total number of species retained in a region, the best strategy was to allocate new reserves in habitats that are poorly represented in the current reserve estate. However, if the conservation goal was to benefit all species, the reserve design strategies based on increasing reserve aggregation performed best. Our results demonstrate that the best reserve design strategy under climate change may vary between regions, due to unique combinations of attributes, and between taxonomic groups, due to contrasting dispersal abilities. Adherence to a single habitat configuration strategy, such as connectivity, is unlikely to result in the best outcomes for biodiversity — quantitative assessments are needed to identify the configurations that will best retain the biodiversity of each region under climate change.

Transitioning to an economy that's cleaner, smarter and more productive

Mr Simon O'Connor
Australian Conservation Foundation

This poster focuses on two elements of my work on transitioning to a green economy: a tool called The Whole Economy and the Clean Energy Finance Corporation. The Whole Economy is a graphic tool that highlights a broader way of understanding what it is that we value, and how this is reflected in our national accounting system and therefore our national priorities. It looks at the economy in its entirety: both market and non-market activity, including environmental production, market production, community production and losses from production.

The Clean Energy Finance Corporation is an investment vehicle designed to hasten and scale up both private and public investment in clean energy on a scale to meet the greenhouse gas reductions required to avoid climate change. As proposed initially in our report *Funding the transition to a clean energy economy*, the Clean Energy Finance Corporation is the most efficient and effective vehicle for delivering government funding to clean renewable energy, which gained support from the peak super fund industry bodies in Australia, and eventually became law in 2012, with seed funding of $10 billion.

Through this dedicated, independent and well-financed authority, public money can be invested in emerging renewable energy projects, along with money from large investors, such as super funds, to give a serious kickstart to Australia's clean energy industry. The poster outlines the mechanisms that can be used by the Clean Energy Finance Corporation, and where it will invest along the clean energy innovation chain.

How customers might like to participate in a distributed energy market

Dr Rob Passey
University of New South Wales

In Australia, electricity demand has decreased every year since 2008–09. The factors most responsible for these decreases include increased electricity rates, energy efficiency, solar water heaters and photovoltaics. All are projected to continue increasing, resulting in additional reductions in electricity demand that will likely put significant pressure on the traditional revenue and business models of electricity providers.

If utilities increase electricity rates to increase revenue, this could further reduce electricity use, leading to more rate increases, resulting in what has been termed an 'energy market death spiral'. Thus, the current utility response to maintain revenue is to increase daily fixed charges for electricity services. This decreases the relative financial effectiveness of energy efficiency measures, especially when offered with lower electricity use charges.

A more efficient and equitable alternative is to engage utilities in a new market of distributed energy services (energy efficiency and distributed generation), rather than just electricity supply and sales. Such innovation would mean a significant change for customers from passive participation to active management of some combination of distributed energy options.

The CSIRO and the Australian PV Association are using focus groups and surveys to understand the range of ways in which customers might like to participate in such a market — which could range from being a passive consumer to being an active participant using a combination of energy efficiency and distributed generation. This will lead to the development of new business models and regulatory arrangements appropriate for such a distributed energy market.

Decarbonising cities and regions: certifying urban development for its carbon reduction potential

Miss Vanessa Rauland
Curtin University

Cities and urban areas — their infrastructure, their management of resources and the activities undertaken within them — are responsible for a considerable proportion of global greenhouse gas emissions. Although their contribution to climate change is significant, they are also likely to be severely impacted by its effects. Cities therefore face the dual challenges of mitigation and adaptation. As a result, we have seen cities and communities throughout the world take action to reduce emissions and prepare themselves for a carbon-constrained and resource-constrained future.

Although outstanding examples of carbon-neutral, climate-neutral, zero-carbon, carbon-negative and various other forms of low-carbon cities, districts and developments are emerging, these are not yet mainstream. Indeed, how each city or district calculates its emissions (i.e. what sources they include) and achieves its claimed status (e.g. the role that offsets play in reducing net emissions) appears to vary considerably. This makes comparisons difficult, claims less meaningful and replication challenging.

This research is reviewing existing ways of measuring precinct-level emissions, which is where most innovation is currently occurring, and seeks to propose a standardised framework for calculating the emissions associated with urban development. Adoption of this standardised framework can provide the basis for a benchmarking system, which will make comparisons between developments much more

meaningful, and could lead to a mechanism by which progressive low-carbon developments can be acknowledged and rewarded. Developments that reach certain standards or achieve a carbon status could be rewarded with incentives such as a fast-track approval process, carbon and land tax exemptions or green financing, thereby encouraging and fostering greater take-up.

Widespread adoption can also allow for greater transfer of knowledge around carbon abatement technologies, and encourage better resource management within cities.

Frameworks for capacity building in renewable energy technology delivery and acculturation

Dr Maria Retnanestri
University of New South Wales

Capacity building in renewable energy technology (RET) delivery and acculturation is necessary to facilitate a transition to a green economy. Design of a capacity-building scheme should be based on a holistic view of technology as hardware (equipment), software (information, skill, knowledge) and orgware (institutions, governance). The I3A Framework refers to an implementation of the hardware, software and orgware dimensions of RET that maintains energy service accessibility (financing, skill, network, resources), availability (reliability and security of supply) and acceptability (social and ecological) for the host community during and beyond the initial installation project. The I3A Framework can be used as a diagnostic tool to assess existing energy service delivery or as a design tool for proposed energy service delivery, and can be applied at local or national levels, and for single or multiple technologies. RET acculturation refers to the process by which RET diffuses into, and is assimilated by, a community. The KPDAC (knowledge, persuasion, decision, adoption and confirmation) acculturation model can be used to understand the extent to which potential RET adopters are progressing through stages of gaining knowledge of RET, forming an attitude towards or against it, making decisions to adopt or reject it and, if to adopt it, then to confirm or repudiate the adoption decision. The KPDAC model can explain the roles of stakeholders at each stage of the acculturation process, and can shed light on the importance of maintaining effective hardware, software and orgware operation for users to confirm RET service benefits and absorb it into local culture.

Improved water quality dampens the effects of future CO_2 in kelp forests

Dr Bayden Russell
University of Adelaide

There is widespread agreement that human activities alter environmental conditions, causing stress and driving changes in important habitats. More recently, there is increasing recognition that multiple stressors can combine to have synergistic effects; however, little has been done to assess if alleviating one or more contributing stressors may disrupt these interactions, such that change is slowed or recovery hastened. In particular, it would be useful to identify whether habitat phase shifts, such as the loss of kelp forests, driven by a combination of stressors could be either ameliorated or reversed by reducing a subset of stressors. We used field-based mesocosms to manipulate CO_2 (i.e. forecast global concentrations) and nutrients (i.e. local pollution) to test the hypothesis that, where synergies exist, reducing one contributing stressor would limit the effect of the other. Initial manipulations of CO_2 and nutrient enrichment produced an anticipated synergistic effect (Russel et al. 2009) on the biomass of turfing algae, which can out-compete kelps for space under altered environmental conditions. However, the reduction of nutrients slowed any further increase in turf growth such that growth was less than when enriched nutrients and CO_2 were maintained

in combination. Although the rate of increase was reduced, biomass of turfs was still greater than under control conditions (i.e. ambient CO_2 and nutrients). Together, these results indicate the value of identifying, and managing against, synergies among multiple stressors that may underpin disproportionately large effects on natural ecosystems. Consequently, management that alleviates local pollution (e.g. nutrients) may ameliorate some of the effects of global change.

Reference

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Investigations into ash transformations during pulverised combustion of biomass

Dr Kalpit Shah
University of Newcastle

The physical and chemical transformations during thermal conversion of biomass solid fuels can be termed as complex time-dependent processes. To predict the overall ash formation process, it is essential to understand the integration of the simultaneously occurring and critically important first-line physical and chemical transformations, such as char burnout, volatilisation and fragmentation. In the present study, six different biomasses and two different coals were tested in the Lab-scale Combustion Simulator (LCS) at the Energy Research Centre of the Netherlands under typical pulverised-fuel firing conditions. Ash release, conversion, size reduction and size distribution, along with changes in inorganic chemical compositions, were derived at different char burnout levels at residence times of 20, 90, 210 and 1300 milliseconds. Char burnout, devolatilisation and fragmentations were quantified for all burnout levels. Results indicate that char oxidation and devolatilisation depend to a large extent on the fuel mineral matter and its association inside the char matrix under these conditions. However, fragmentation of the fuel particles depends on char devolatilisation and oxidation. During the initial heating and devolatilisation, smaller particles of biomass and coals were converted faster than larger particles. After a certain conversion, larger particles fragment more than smaller particles, likely due to the high temperature gradient. Attrition, breakage and percolative fragmentation were observed under the kinetic diffusion-controlled regime during combustion. On the basis of the results, a qualitative predictive tool is suggested to gauge the extent of first-line physical transformations for biomass pulverised-fuel combustion.

Further reading

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Returning forest to degraded tropical land on a budget

Mr Luke Shoo
University of Queensland

Financial cost is a major factor impeding restoration of high-diversity forest over large areas of degraded land in the tropics. Tree planting is probably the most commonly used technique to reinstate forest for biodiversity conservation and carbon sequestration. However, in many instances, costs can be prohibitively high. Consequently, there is a need for alternative restoration techniques that require lower input of labour and resources. We are investigating the outcomes and time frames required for lower cost natural regeneration (including potential for minimum intervention management) relative to higher cost active reforestation (replanting). This new knowledge will enable planners to assess the costs, risks and benefits of different approaches to reforestation, and choose the most appropriate method for any particular ecological or economic context and time frame. Our findings will also be useful to private enterprises interested in capitalising on emerging carbon markets.

Knomics: understanding genomes as functional islands in a vast k*-mer universe*

Dr Jen Taylor
CSIRO

Conceptually, genomes can be considered as a set of overlapping words of fixed length (*k*) derived from an alphabet of nucleotides. Understanding the properties of the set of *k*-mers that make up a genome can help us characterise and compare efficiently within and across genomes to look for sequences (*k*-mers or words) that have interesting attributes. These attributes include functional signatures, high rates of conservation or evolution of new or rare *k*-mers, and biases or reuse of certain *k*-mers in particular genomes. As expected, as length *k* increases, the space of possible *k*-mers grows exponentially while the actual set of *k*-mers in a given genome or transcriptome stays fixed, becoming lonelier and lonelier in the increasingly empty space of higher dimension.

The loneliness of the long-sequence *k*-mer has implications for whole-genome studies that rely on robust sequence alignment and identification. We will present empirical and theoretical observations about *k*-mer differences within and between genomes, and within-sample *k*-mer strategies for error correction, and the impact these have on genome assembly. We contend that *k*-mers afford a useful (but perhaps underused) means to characterise and compare highly dimensional genome data.

Intelligent mining and mineral processing

Dr James Tickner
CSIRO

Mining, extracting and refining metals and mineral resources use a substantial portion of Australia's total energy. These processes also consume substantial amounts of water, and can lead to considerable volumes of waste material. Optimising the efficiency of mineral extraction and processing is an essential part of a future green economy.

There is a growing shift towards so-called intelligent mining and processing methods. These rely on improved characterisation of mineral resources, allowing better selectivity for the material that is to be mined, crushed, ground and processed.

CSIRO's Online Analysis for Control group is one of the world's leading developers of the sensor systems that form the heart of the intelligent mining and processing revolution. Some of the developments that will be described include:

- laser-based, down-hole elemental measurements that allow on-the-fly decisions to be made before blasting and extracting iron ore deposits
- radiowave techniques for sorting thousands of tonnes of rocks per hour according to the grade of the valuable metals that they contain
- X-ray techniques for detecting ultra-low levels of metals such as gold and platinum, for better control and improved recovery during processing.

The poster explores some of the impacts of these developments, which encompass both improved productivity and profitability for industry, as well as step-change reductions in water use, waste production and embedded energy in some of Australia's major exports.

Instrumentally observed data and their role in Australian climate change analyses

Dr Blair Trewin
Bureau of Meteorology

High-quality, long-term observed datasets are critical in assessing observed climate change and determining the extent to which observed changes can be attributed to human activity. To develop such high-quality sets, extensive work is normally necessary to ensure that the datasets are homogeneous (i.e. that changes in the meteorological data reflect changes in the climate and not changes in the way in which the observations have been made — for example, through site relocations, changes in instruments or local site conditions, or changes in observation methods). Careful quality control is also necessary to identify erroneous data, because quality control methods used in the past were often much less rigorous than those applied to present-day data.

This poster will present long-term Australian datasets for a range of variables (e.g. temperature, rainfall, evaporation, cloud, tropical cyclones), the methods used in their development and issues involved, which may differ between variables. For some variables (e.g. rainfall), the number of good-quality sites with 100 years or more of data is large enough to make dataset development straightforward, at least for the more settled regions of Australia. In other cases (e.g. evaporation), data availability and the sensitivity

of observations to local site conditions mean that only much shorter and spatially sparser datasets are feasible. As an extreme case, developing high-quality, long-term datasets for wind speed has thus far not been possible because of instrument changes and the influence of changes in local site exposure, causing spurious changes.

Selected data analyses using long-term datasets are also presented, demonstrating an Australian climate showing substantial trends in a number of variables.

Further reading

Observing Australian climate change, www.bom.gov.au/climate/change/observe_climate_change.shtml.

Assessing the potential value of renewable generation in future carbon-constrained electricity industries

Dr Peerapat Vithayasrichareon
University of New South Wales

Growing concerns over energy security, volatile fossil fuel prices and climate change have all contributed to the rapid growth of large-scale renewable generation technologies over recent decades. These drivers also increase the challenges for electricity industries around the world to determine appropriate future generation mixes. Renewable energy generation, such as wind and solar, has high capital costs but very low operating costs, and zero emissions. Coal-fired generation has high capital costs but low operating costs, and high emissions. Gas-fired generation has moderate capital costs and emissions, but operating costs significantly depend on highly volatile gas prices. Currently, a growing number of countries, including Australia, are establishing mechanisms to 'price' carbon emissions from the electricity sector, which may markedly change coal and gas operating costs. To further complicate matters, future electricity demand is likely to change depending on future supply costs. A key question for policymakers, then, is how to estimate the expected costs and risks associated with different future generation portfolios, given possible future fossil fuel, carbon price and demand uncertainties.

Using a generation planning tool developed at the University of New South Wales, this study explores the potential impacts of increasing large-scale renewable energy penetration on the expected cost, risks and carbon emissions of different future generating plant portfolios under fuel and carbon price, demand and plant capital cost uncertainties. The findings suggest that the economic value of wind and solar generation, and the extent to which their penetration levels affect the overall industry generation cost and cost risks, will be influenced primarily by the level of carbon price and the mix of conventional generation technologies in the portfolio. The results also show that renewable generation technologies are valuable in reducing emissions from the Australian electricity industry.

An analysis of the effect of diet and genotype on protein and energy utilisation by the black tiger shrimp, Penaeus monodon *— why do genetically selected shrimp grow faster?*

Dr Nick Wade
CSIRO Food Futures Flagship

Selected (G8 or generation 8) and wild-type (W) genotypes of black tiger shrimp (*Penaeus monodon*) juveniles were fed either of two diet types in a clear-water tank trial to examine the effects of diet type and genetics on growth and feed use. Animals were fed twice daily at one of five ration levels, from starvation to apparent satiety. Diet type varied by protein content, raw material choice and the presence (high-specification diet [HSD]) or absence (low-specification diet [LSD]) of bioactive substances. At the end of the study, faecal samples were collected to determine the digestible protein and energy content of each diet by each genotype. Whole-animal protein and energy content were also assessed from samples from the initial populations and those from each tank. After 6 weeks, those animals fed to satiety showed that the G8 animals fed the HSD diet had grown at a rate of 2.56 g/week, significantly faster than any other treatment. G8 animals fed the LSD diet (1.81 g/week) had grown significantly faster than the W animals fed the HSD diet (1.25 g/week), while those W animals fed the LSD diet grew the slowest (0.61 g/week). Using the data from the varying ration levels, we were able to define that the growth gains of the G8 animals were achieved not only by a greater appetite, but also through lower maintenance energy costs (29 versus 57 kJ $kg^{-0.8}$ day^{-1}) and a more efficient energy conversion (19.5% versus 11.6% when fed the HSD diet). A low-specification diet for the G8 and W shrimp limited their growth and impaired their potential, as demonstrated by a curvilinear response of growth to intake. By comparison, shrimp fed the HSD diet had a relatively linear growth response to intake. Combined, these results clearly demonstrate that the growth benefits of selectively bred shrimp can be further improved by the dietary inclusion of bioactive substances, and provide massive improvements in growth and feed use in farmed shrimp.

Participants

Dr Gab Abramowitz
Speaker
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Gab is a researcher and lecturer with a primary research interest in model evaluation in climate science, ecology and hydrology. Gab's research focuses on two main areas: model dependence in multi-model climate prediction and the standardisation of model evaluation in land surface research. Broad questions of interest include: What is the relationship between model predictions and the natural system, and under which conditions are model results meaningful? To what extent do different climate models constitute independent estimates? What is the most appropriate statistical framework with which to define model independence? Gab is also leading the development of the Protocol for the Analysis of Land Surface Models (PALS), an online land surface model benchmarking tool. Gab is involved with the International Land Model Benchmarking Project and is a member of the GEWEX Global Land–Atmosphere System Study panel.

Dr Lisa Alexander
Steering Committee
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Lisa's early-career research has concentrated on understanding the variability and driving mechanisms of climate extremes, with particular emphasis on improving understanding of observed changes in these events using multiple research tools, ranging from station observations to climate model output. Of particular significance is Lisa's ongoing work assessing global changes in temperature and rainfall extremes, which has contributed significantly to the Intergovernmental Panel on Climate Change assessments. Lisa was awarded the 2011 Priestley Medal by the Australian Meteorological and Oceanographic Society for contributing to this field of research. Lisa also chairs the World Meteorological Organization's Commission for Climatology Expert Team on Climate Risk and Sector-specific Indices.

Ms Julie Arblaster
Speaker
Senior Research Scientist, Centre for Australian Weather and Climate Research, Bureau of Meteorology

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Julie Arblaster is a member of the climate change science team of the Centre for Australian Weather and Climate Research. Julie is based at the Bureau of Meteorology and maintains a strong collaboration with the climate change prediction group at the National Center for Atmospheric Research in Boulder, United States. Julie's research interests lie in using climate models to investigate mechanisms of recent and future climate change, with a particular focus on shifts in the Southern Hemisphere atmospheric circulation, tropical variability and climate extremes. Julie is a lead author on the long-term projections chapter of the upcoming fifth assessment report of the Intergovernmental Panel on Climate Change.

Dr Paul Bain
Speaker
Research Fellow in the Humanities and Social Sciences, University of Queensland

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Paul Bain is a social psychologist who is fascinated by how people think about the future of their society — their utopias and dystopias, and how these projections to the future can impact present-day behaviour. Paul investigates how political and demographic changes in society (e.g. climate change, decline of religion) are seen to affect citizens (their values and character), societal dysfunction (e.g. crime and poverty) and societal development (economic and technological). Paul's research identifies the specific dimensions of these projected societal changes that motivate people to act today. Paul also researches human values and dehumanisation.

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Betsi's interests include the intersection of international and domestic policy and politics in governing the environment. Betsi examines the ways in which science or other forms of expert knowledge gain authority in political decision-making, while also attending to agenda-setting and institutional dynamics. The interaction of issue frames, decision venues and advocacy groups that transcends national borders in environmental policymaking is of particular interest. Betsi's research focuses on marine policy and protected areas. Betsi has done extensive work on the roles of science and policy learning in the development of fisheries policies for the management of blue crabs in Chesapeake Bay. Current research projects include evaluating the dynamics of change that led to the rezoning of the Great Barrier Reef Marine Park; examining implementation of the World Heritage Convention in the United States, Canada and Australia; and studying how policy instruments create new domestic political institutions that may provide opportunities or constraints to national and international advocacy groups.

Dr Sarah Bekessy
Senior Lecturer, RMIT University

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Sarah Bekessy is a senior lecturer in environmental studies, and specialises in the emerging field of sustainability science, which seeks to understand the fundamental character of interactions between society and our environment. Sarah is involved in an interdisciplinary range of research projects, including two ARC projects: biodiversity planning in urban fringe landscapes, and building capacity for a sustainable future —embedding education for sustainability into universities. Sarah is also involved in the Centre of Excellence for Environmental Decisions research hub that seeks to develop and test tools to support transparent decision-making for environmental management (www.ceed.edu.au). Sarah teaches a course in sustainability to over 400 students, and several other courses in environmental studies.

Dr Jonas Bhend
Postdoctoral researcher, CSIRO Marine and Atmospheric Research

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Jonas Bhend was born in Bern, Switzerland, studied geography at the University of Bern and holds a PhD in meteorology from the University of Hamburg. During his PhD, he investigated the detectability and attribution of regional climate change in northern Europe. As a postdoc at CSIRO Marine and Atmospheric Research in Melbourne, Jonas has been working on constraining regional climate projections with observed recent change. Jonas's research interests are in understanding past and recent climate change as a pathway to improve climate projections. More than anything, however, Jonas is fascinated by the vexing statistical problem of how to make sense of simulations of a complex system.

Dr Sarah Boulter
Research Fellow, National Climate Change Adaptation Facility, Griffith University

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Sarah Boulter has been involved in the research, development and synthesis of knowledge to support adaptation planning and management across all sectors. Currently, Sarah's work focuses on extreme events, and the lessons for adaptation and assessment of forest vulnerability. Previous roles at Griffith University involved research into the impacts of climate change on plant reproduction and biodiversity in forests, and understanding the drivers of phonological patterns in tropical forests.

Dr Karl Braganza
Speaker
Manager of Climate Monitoring, National Climate Centre, Bureau of Meteorology

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The National Climate Centre in Melbourne is responsible for collecting and analysing climate data for Australia and the region, and provides sector-relevant climate information related to drought, bushfires, extreme events and climate change. Karl received a PhD from the School of Mathematics at Monash University and has a major research interest in climate change science using climate modelling, instrumental observations and paleoclimate evidence.

Professor Barry Brook
Chair, Steering Committee
Director of Climate Science, The Environment Institute, University of Adelaide

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Barry Brook is a leading environmental scientist and modeller at the University of Adelaide's Environment Institute. Barry has published three books (one on nuclear energy) and over 200 refereed scientific papers, is a highly cited researcher, and regularly writes popular articles for the media. Barry has received many awards for research and outreach, including the 2006 Australian Academy of Science Fenner Medal and the 2010 Community Science Educator of the Year. Barry's research interests include global change, extinction, simulation modelling, energy systems analysis (modelling future nuclear and renewable energy scenarios) and synergistic human impacts on the biosphere.

Dr Jo Brown
Research Scientist, Bureau of Meteorology

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Josephine Brown is a climate scientist in the Centre for Australian Weather and Climate Research at the Bureau of Meteorology. After completing a PhD at the University of Melbourne in 2004 and postdoctoral fellowships at the University of Reading (United Kingdom) and Monash University, Jo joined the Bureau of Meteorology in 2009. Jo's research focuses on tropical climate variability and climate change, including El Niño – Southern Oscillation and monsoons. Jo currently works in the Pacific Australia Climate Change Science and Adaptation Planning Program (PACCSAP), providing climate change information to 15 partner countries in the Pacific and East Timor.

Dr Paul Brown
Lecturer, University of Technology Sydney Business School

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Paul Brown completed a PhD in corporate governance and contracting theory in 2009. Since then, Paul has embarked on a cross-disciplinary research program investigating the broad question, How can organisations be structured so as to contribute to a sustainable society and environment? As part of a team, Paul has been funded for two large projects: leadership and change for energy efficiency in accounting and management, funded by the NSW Office of Environment and Heritage; and accounting for value chain sustainability and competitive advantage, funded by the Cotton Research and Development Corporation. For further information, see Paul's staff page: http://datasearch.uts.edu.au/business/staff/details.cfm?StaffId=1296.

Dr Paul Burke
Steering Committee
Research Fellow, Arndt-Corden Department of Economics, Australian National University

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Paul Burke works on the economics of energy systems, climate change, sustainability and developing countries. Paul's research includes examining energy transitions and their implications for carbon dioxide emissions, the measurement of sustainability, green growth in Indonesia, and factors affecting the adoption of fuel-efficient cars and the use of gasoline in the road sector. Paul joined the Australian National University in 2010 and teaches microeconomics and executive short courses in environmental economics. Paul holds a PhD in Economics from the ANU and a Bachelor in Agricultural Economics from the University of Sydney, and was formerly an economist with Mekong Economics Ltd, conducting research for the World Bank and other aid donors.

Dr Tim Capon
Postdoctoral Research Fellow — Economist, CSIRO Ecosystem Sciences, Climate Adaptation Flagship

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Tim Capon's PhD thesis, *An experimental study of risk, ambiguity and market behaviour*, used experimental economics methods to examine the predictions of alternative models of decision-making under risk and uncertainty. This research examined alternative theories for decision-making when objective information about probabilities is unavailable. Other research projects have included a study of resilience thinking and floodplain ecosystem goods and services in Australia. This approach uses complex systems thinking to help manage the risks associated with environmental decision-making in an uncertain world. Tim's recent work has included experiments on the design of markets for soil carbon sequestration and a comparison of decision-making frameworks for managing uncertainty in climate adaptation.

Dr Josie Carwardine
Speaker
Postdoctoral Research Fellow, CSIRO Ecosystem Sciences

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Josie Carwardine is a joint postdoctoral fellow with the Conservation Decisions Lab at CSIRO and the Environmental Decisions Group, University of Queensland. Josie is also a researcher in the ARC Centre of Excellence for Environmental Decisions (CEED) and the National Environmental Research Program (NERP). Josie's research focuses on conservation planning and decision-making for biodiversity conservation under a changing climate and a carbon economy. Josie is an expert in spatial prioritisation and cost-effectiveness analysis for achieving multiple conservation objectives. Josie endeavours to draw together the best ecological and socio-economic information to support better decision outcomes for biodiversity and people.

Dr Francis Clark

Research Fellow, Centre for Renewable Energy, Charles Darwin University

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Francis Clark studied physics and maths, and subsequently worked in genomics, computational biology and ecological modelling. Francis has particular experience in computation and modelling, including working with large and sometimes messy datasets. Currently working in renewable energy, Francis is focusing on scenarios and analysis for 20% photovoltaic integration into Northern Territory electricity grids. Since the Northen Territory has no hydro power, no National Electricity Market–style spatial smoothing and substantial air-conditioner use, this work brings demand management and distributed storage issues into sharp focus. Previously, at Adelaide University, Francis studied the dynamics of 50% renewable integration into the National Electricity Market, and developed the associated OzEA Open Science website (www.oz-energy-analysis.org).

Professor Adam Clements

Speaker

Professor in Finance, School of Economics and Finance, QUT Business School, Queensland University of Technology

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Adam's main research interests include financial econometrics, nonparametric estimation, time-series modelling of asset return volatility and correlation, forecast evaluation, model selection and modelling price spikes in electricity markets. Recently, Adam has become involved with a number of projects dealing with point processes, in both financial market microstructure and electricity market contexts.

Professor Sean Connolly

Speaker

ARC Australian Professorial Fellow, School of Marine and Tropical Biology, James Cook University

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Sean Connolly uses a combination of mathematical modelling and empirical work to address fundamental questions about the origin and maintenance of biodiversity, and to understand the ecological impacts of human activities, such as overfishing and climate change. Sean received a PhD from Stanford University in 1999, and completed a postdoctoral fellowship at the University of Arizona before moving to James Cook University in late 2000. Sean currently holds an ARC Australian Professorial Fellowship, and is Program Leader for Understanding and Managing Coral Reef Biodiversity in the ARC Centre of Excellence for Coral Reef Studies. Sean is a recipient of the 2009 Fenner Medal from the Australian Academy of Science.

Miss Penelope Crossley
Speaker
Lecturer, Sydney Law School, University of Sydney

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Penelope Crossley specialises in energy and resources law. Penelope holds a Bachelor of Economics (Social Sciences)(Hons) and an LLB(Hons) from the University of Sydney, and was awarded the University Medal in 2003. Before entering academia, Penelope practised as a solicitor in London and Beijing, specialising in global energy and infrastructure law. Penelope has also worked inhouse for a supermajor energy company, advising their alternative energy division on issues related to emissions trading, renewable energy, emerging consumer markets and technologies. Penelope is an active researcher in this area, currently undertaking a PhD focusing on comparative renewable energy law in Australia, China and the United Kingdom. Penelope is also developing an international profile in the field, recently being invited to be a member of an international expert panel for the Korean Presidential Committee on Green Growth.

Dr Roger Dargaville
Research Fellow, School of Earth Sciences, University of Melbourne

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Roger Dargaville is an atmospheric dynamics expert who, for many years, has researched the atmospheric transport of carbon dioxide and the inversion method to deduce surface sources and sinks in the ocean and terrestrial biosphere. More recently, Roger has been modelling the impact of variability in wind and solar fields on the output of renewable energy technologies. Funded by ARENA, Roger is leading a project to build an energy system model for the National Energy Market to find least cost pathways to low-carbon electricity networks.

Dr Josh Dorrough
Speaker
Principal Research Scientist, Natural Regeneration Australia, and Visiting Research Scientist, CSIRO Ecosystem Sciences

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Josh Dorrough's research has focused on understanding the relationships between agricultural land use practices and the persistence of native biodiversity. Josh has a passion for sustainable and regenerative agriculture, and a love of both natural and agricultural landscapes. This has led to interdisciplinary research investigating approaches to integrating biodiversity conservation and agricultural production. Josh is currently a visiting research scientist with CSIRO Ecosystem Sciences, a private ecological research consultant and a small-scale farmer producing native seeds and cattle. Josh has recently completed a systematic review of plant responses to grazing and fertilisation, and is developing research projects on broadscale native plant restoration in commercial grazing systems.

Dr Adriana Downie
Steering Committee
Chief Technology Officer, Pacific Pyrolysis

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Adriana Downie is a founder of Pacific Pyrolysis, a technology development company commercialising organic waste to energy and biochar solutions. Adriana has bachelor degrees in both chemical engineering and science, and a PhD from the School of Materials Science and Engineering at the University of New South Wales in biochar production and use. Adriana has twice been a finalist for a Eureka Science prize for work in this area, and was selected by *The Australian* newspaper as one of the 'next 100 emerging leaders'.

Miss Laura Eadie
Research Director, Sustainable Economy Program, Centre for Policy Development

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Laura Eadie has qualifications in environmental management, finance and investment, and industrial chemistry, and experience spanning corporate strategy consulting, management in green finance and natural resources policy advice. Laura's core skill is providing rigorous thinking to support evidence-based decision-making, with a focus on the intersection of policy, economics and sustainability. Laura is a member of the Green Capital Advisory Committee for the Total Environment Centre.

Mr Ben Elliston
Speaker
PhD student, University of New South Wales

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Ben Elliston worked in industry as a computer engineer for a decade. With a growing interest in sustainability, Ben completed a Master of Engineering at the Australian National University in 2009, and then began a PhD in electrical engineering at the University of New South Wales to pursue an interest in renewable energy futures. Ben is investigating the technical performance and economics of 100% renewable electricity in a future National Electricity Market under the supervision of Associate Professor Mark Diesendorf and Associate Professor Iain MacGill. Ben's interests in sustainability are diverse and include renewable energy, sustainable housing, transport planning and public policy.

Dr Stefanie Feih
Senior Lecturer, School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University

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Before working at RMIT University, Stefanie completed an engineering degree at Darmstadt University (Germany) and a PhD at Cambridge University (United Kingdom), and then worked as a postdoctoral researcher at Riso National Laboratory (Denmark). Stefanie has extensive international research experience and manages research projects with strong collaborative aspects with industry and international research partners. Stefanie is interested in all aspects of composite and advanced materials research, with special focus on sustainability and biomimetic design of light-weight structures, and has published over 90 journal and conference publications in the field.

Dr Trevor Garnett
Speaker
Senior Research Fellow, Australian Centre for Plant Functional Genomics, University of Adelaide

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Trevor Garnett is a plant physiologist whose research is focused on improving the way plants use nitrogen fertiliser, and uses a multidisciplinary approach to understand how plants take up and use nitrogen. Trevor's PhD from the University of Tasmania investigated nitrogen uptake by forest trees. Trevor has also researched various aspects of plant nutrition, including micronutrient transport into cereal grains and developing pasture plants with tolerance to abiotic stress.

Mr Brendan George
Speaker
PhD student, Rural Climate Solutions, University of New England

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Brendan George is currently studying the energy and greenhouse balance of forest bioenergy systems. Brendan has an agricultural science background, having completed a bachelor degree with honours (majoring in soil science) and a research masters degree (studying soil water measurement) from the University of Sydney. In 2004, Brendan completed a business degree from Southern Cross University, and is currently on leave from the position of Industry Leader for Bioenergy and Private Forestry with the NSW Department of Primary Industries. Brendan is a board member of Bioenergy Australia and an executive committee member and Task 43 National Team Leader for the International Energy Agency Bioenergy.

Mr Scott Grierson

Chief Technology Manager — Research and Development, MBD Energy

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Scott has a sustainability consulting, scientific research, engineering, strategy and mixed-media background, and a breadth of international experience. Scott's research is broadly focused on assisting corporate and public sector organisations in terms of their response to social, environmental and financial sustainability challenges — 'achieving business success, without systemic harm'. Specific areas of interest include renewable energy and biomass technology (with a focus on marine and freshwater algae), and life cycle assessment. Scott has previously worked in the broad field of sustainable development, especially in relation to sustainable product development, product stewardship and innovation.

Dr Nicky Grigg

Speaker

Research Scientist, CSIRO Land and Water

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Nicky Grigg's PhD research included modelling aquatic sediment nitrogen dynamics. Postdoctoral work at CSIRO investigated the implications of nonlinear dynamics on mathematical modelling of ecological systems. Subsequent applied research projects have included analyses of biogeochemical responses in the Coorong, and drought conditions and ecological response modelling for a triple-bottom-line assessment of stormwater harvesting in the Australian Capital Territory. Currently, Nicky is part of a team of complex systems scientists working on interdisciplinary approaches to understanding impacts of, and responses to, global change.

Professor Steve Hatfield-Dodds

Speaker

Research Director, National Outlook project, CSIRO, and Australian National University

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Steve Hatfield-Dodds is recognised as one of Australia's leading experts in environmental economics, climate policy, integration science and the science–policy nexus.

Steve's research focuses on identifying and addressing the distinctive challenges associated with responding to climate change, and promoting sustainable development within real-world democratic institutions and social processes. Specific research interests include the design, evaluation and communication of incentive-based climate and sustainability policies; integrated approaches to complex human values, motivation and wellbeing; and promoting adaptive governance of interdependent social and biophysical systems. Steve is the Research Director of the National Outlook project and the Integrated Carbon Pathways collaboration within CSIRO, which seeks to develop integrated knowledge platforms, data and analysis to support national climate, sustainability and natural resource policy.

Mr Ben Heard
Speaker
Founder and Director, Decarbonise SA, and ThinkClimate Consulting

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Ben Heard is Director of ThinkClimate Consulting, a strategic advisory firm specialising in climate change and sustainability. Ben holds a Masters in Corporate Environmental and Sustainability Management from Monash University. Ben's growing understanding of the climate crisis forced a rethink about his opposition to nuclear power. Ben has publicly presented this work to audiences around Australia, including the landmark televised nuclear debate victory for Intelligence Squared in 2012. Ben has written on nuclear power extensively in print and online media. Decarbonise SA, an advocacy website, has attracted over 50 000 hits in its first 18 months, and has over 130 original postings, six radio interviews, a podcast to the United States and an original animated video. Ben's climate change work has been published in the refereed proceedings of the 2011 Australian and New Zealand Regional Sciences Association International Conference. Ben was a participant at the 2012 Breakthrough Dialogue in the United States, and, in December 2012, will launch the report *Zero carbon options*, which will illustrate the role nuclear power may play in decarbonising Australia.

Dr Alistair Hobday
Speaker
Principal Research Scientist, CSIRO Marine and Atmospheric Research

Alistair.hobday@csiro.au

Alistair Hobday works on a range of marine research topics, including spatial management and migration of large pelagic species, and determining the impact of both climate variability and climate change on marine species. A focus is investigating the impacts of climate change on marine resources and developing adaptation options to underpin sustainable use into the future. Alistair leads the Marine Climate Impacts and Adaptation area within the CSIRO Climate Adaptation Flagship, co-leads the Biodiversity and Resources theme in the National Climate Change Adaptation Research Facility Marine Network and is co-chair of the international Climate Impacts on Top Ocean Predators (CLIOTOP) program.

Mr Sanghuyn Hong
PhD student, University of Adelaide

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Sanghyun Hong has an interest in sustainable energy scenario planning in a range of countries. Currently, Sanghyun analyses the possible negative impact of the nuclear-free scenario in Japan using multicriteria decision analysis and external costs analysis. In the future, the energy production and consumption scenarios of Australia and New Zealand will be analysed. Ultimately, Sanghyun desires to suggest a global sustainable energy scenario.

Dr Alex Johnson
Lecturer, School of Botany, University of Melbourne

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Alex Johnson is a researcher and lecturer who heads a plant nutrition laboratory focused on producing iron-rich rice. Using a process called biofortification, the lab aims to help an estimated 2 billion people suffering from iron deficiency by increasing the concentration of iron in polished rice grain, a major food staple that is the primary source of energy for many people in developing countries. Alex has a Master of Science and PhD from Virginia Tech in Blacksburg (Virginia, United States), and has held postdoctoral positions at the University of Cambridge (Cambridge, United Kingdom) and the Australian Centre for Plant Functional Genomics (Adelaide).

Dr Emlyn Jones
Research Scientist, CSIRO Marine and Atmospheric Research

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Emlyn Jones has expertise in combining modelling results with observations (data assimilation) to yield information on marine environmental processes and dynamics. These techniques are needed to reconcile the fact that we cannot completely observe marine systems (or any system, for that matter) and that we know our models are imperfect. Data assimilation gives us a method to combine models and observations to make better forecasts and hindcasts of complex marine environments.

Dr Jitka Kochanek
Research Fellow, University of Queensland

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Jitka Kochanek is an expert in plant ecophysiology, researching the responses of plants to environmental variation and stress. Jitka's PhD (in collaboration with Kew Gardens, United Kingdom) and postdoctoral research covered plant stress physiology, biochemistry, nutrition, ecology, seed biology and conservation biology, using horticultural and native plants. Currently, Jitka is the chief investigator of a three-year research project funded by the Brisbane City Council and Horticulture Australia Ltd to examine plant growth response to novel soil amendments manufactured from recycled organic waste. As part of this project, Jitka is developing a screening tool to rapidly assess the phytotoxicity of soil amendments.

Dr Greg Lane

Senior Fellow (ARC Future Fellow), Department of Nuclear Physics, Australian National University

Gregory.Lane@anu.edu.au

Greg Lane received a PhD from the Australian National University and then completed postdoctoral appointments at SUNY Stony Brook and Lawrence Berkeley National Laboratory, both in the United States. Greg's research, which is partly done at international laboratories, focuses on time-correlated gamma-ray and electron spectroscopic studies of exotic nuclei, and uses the 14UD electrostatic tandem accelerator at the ANU. Although Greg's primary focus is on understanding the structure of nuclei in terms of nuclear models, the results of this research can be applied to other areas — for example, problems in nuclear astrophysics and the modelling of decay heat in nuclear fuels.

Associate Professor Philip Lawn

Associate Professor, Flinders Business School, Flinders University

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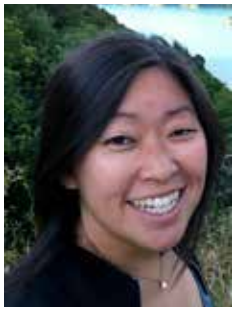
Over the past decade, Philip has written and edited a number of books and articles on the principles, indicators and policy aspects of sustainable development. Some of his books are: *Sustainable development indicators in ecological economics* (2006), *Frontier issues in ecological economics* (2007), *Sustainable welfare in the Asia–Pacific* (2008; co-edited with Matthew Clarke) and *Environment and employment: a reconciliation* (2009). Philip is currently working on a climate change book and an edited volume on how nations can best make the transition to a sustainable, just and efficient economy.



Dr Brenda Lin

Research Scientist, CSIRO

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Brenda B Lin has sought to understand how the increasing intensification of the landscape, through both agriculture and urban development, has affected the delivery of ecosystem services to society. Natural systems are increasingly lost or being pushed to the outskirts of the landscape, creating a large gap between ecosystems and the communities that could potentially benefit from their services. One specific focus has been on the development of integrated agricultural landscapes that provide ecosystem services that mitigate climate change impacts (e.g. increasing temperature variability, decreasing precipitation, extreme storm events) on agricultural food production. More recently, Brenda's research has moved into the context of the built environment in an attempt to understand how ecosystem services may be helpful in protecting urban environments from projected climate change impacts.

Dr Martina Linnenluecke

Speaker
Lecturer in Sustainability, Business School, University of Queensland

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Martina Linnenluecke's research pioneers the areas of organisational strategic adaptation and resilience to global climate change, specifically to the expected increase in the number and severity of extreme weather events. Martina is a recipient of the Carolyn Dexter Best International Paper Award (Academy of Management, 2008), a University of Queensland International Research Award and a Smart State PhD Research Grant from the Queensland Government, Department of the Premier and Cabinet.

Dr Rich Little

Steering Committee
Senior Research Scientist, CSIRO Marine and Atmospheric Research

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Rich Little specialises in modelling population dynamics, economics and management decision-making in natural resource and marine environmental science. Much of this work has focused on the Coral Reef Fin Fish Fishery of the Great Barrier Reef, where Rich has worked on the development of a computer-based decision support tool called ELFSim. Rich has published widely on modelling tradeable permit markets for fisheries quotas, artificial intelligence mechanisms (Bayesian belief networks) for simulating fishing behaviour and the economics of marine protected areas. Rich's current research interest is in exploring the use of computer-based biophysical process models for financial risk management.

Dr Chunbo Ma

Speaker
Assistant Professor, School of Agricultural and Resource Economics, University of Western Australia

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Chunbo Ma completed a PhD in ecological economics in 2007 at the Rensselaer Polytechnic Institute in the United States, and then took a postdoctoral research position at the University of Michigan at Ann Arbor (United States) to study China's electricity market reforms and environmental justice. Since joining the School of Agricultural and Resource Economics in 2009, Chunbo's primary research interests have been in energy economics and policy, environmental valuation and policy, and the Chinese economy. Recent work has focused on residential adoption of green electricity and rooftop solar photovoltaics, and the economic efficiency of power plants.

Dr Lynne Macdonald
Steering Committee
Research Scientist, CSIRO Land and Water

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Lynne Macdonald works in the Carbon and Nutrient Cycling research group at CSIRO Land and Water in Adelaide, and is currently researching how to reduce the carbon footprint of Australia's land-use sector while meeting productivity gains to ensure global food security. Lynne is currently involved in a wide range of projects, including those focusing on organic carbon in Australian soils and knock-on effects on nitrogen cycling, soil organic matter stoichiometry (elemental ratios, e.g. C:N) and greenhouse gas emissions. Lynne's other research includes assessing the potential role of biochar in plant productivity and greenhouse gas emissions, and the potential to manage native soil organic carbon. As a soil biologist, Lynne has a common overarching interest in the impact of agricultural management and plant carbon allocation (i.e. root production, rhizodeposition) on microbial community structure and function. Originally from Scotland, Lynne has previously worked at the Macaulay Land-Use Research Institute (Aberdeen), and Agriculture and Agri-Food Canada (Lethbridge).

Dr Ben McNeil
Senior Research Fellow, Climate Change Research Centre, University of New South Wales

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Ben McNeil leads a research team that combines fieldwork and modelling to advance our understanding of oceanic biogeochemical cycles in a high-CO_2 world. From 2001 to 2004, Ben worked as a postdoctoral research fellow at Princeton University as part of group that developed a new method for detecting decadal anthropogenic CO_2 storage in the ocean using chlorofluorocarbon measurements, which started the era of more advanced diagnostic estimates of oceanic anthropogenic carbon uptake using only transient tracers. Ben won an Australian Research Council Queen Elizabeth II research fellowship in 2008 in recognition of his outstanding mid-career research achievements. During 2009, Ben co-led the coordination and writing of an important book, *The Copenhagen diagnosis: updating the world on the latest climate science*, which brought together 21 of the world's top climate scientists to update the community on the latest climate research since the publication of the Intergovernmental Panel on Climate Change fourth assessment report (IPCC AR4) in 2007. Ben and colleagues were awarded a Future Justice Prize 2010 at the prestigious Eureka Awards for this work. Also in 2009, Ben published his first highly acclaimed popular science book — *The clean industrial revolution* — which presents both the science and economic opportunities emerging from climate change. Ben is a core member of the Scientific Commission for Antarctic Research on Ocean Acidification, has been an expert reviewer for the United Nations IPCC AR4 (Working Groups I and II) since 2007, and has presented his ocean acidification research to Australia's Prime Minister and Cabinet.

See www.benmcneil.net for more details.

Dr Steve Mohr
Speaker
Senior Research Consultant, Institute for Sustainable Futures, University of Technology Sydney

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Steve has chemical engineering and mathematics degrees and a PhD from the University of Newcastle. As part of his PhD, Steve developed GeRS-DeMo (Geologic Resource Supply–Demand Model), which is capable of replicating production of resources extracted from mining methods, and oil and gas from fields. Steve applied this model to all countries and fossil fuel types in the world to make projections of fossil fuel production for the world. Steve is passionate about resource futures and data modelling more generally.

Dr Karel Mokany
Steering Committee
Research Scientist, CSIRO Ecosystem Sciences

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Karel Mokany has been developing and applying new modelling approaches to better understand likely outcomes for biodiversity under climate change. The focus of this research has been overcoming substantial shortfalls in our knowledge of biodiversity, while incorporating important ecological processes in projecting changes in biodiversity over time. A major goal of this work is to identify configurations of habitat that best retain biodiversity over long time periods. Karel has been a research scientist with CSIRO for four years. Before this, Karel completed a PhD in ecology at the Australian National University and held a number of research positions, including with the Tasmanian Institute of Agricultural Research and the CRC for Greenhouse Accounting.

Dr Ana Norman
Researcher, CSIRO Marine and Atmospheric Research

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Ana has a Masters in Fisheries Economics and a PhD in economics from the University of Portsmouth, which investigated the development of markets for the cichlid tilapia in Egypt and internationally, and the interaction between different tilapia markets. Since completing her PhD in September 2008, Ana has worked with CSIRO as an economist within the Climate Adaptation Flagship, concentrating on estimating the potential economic impacts of climate change on Australian fisheries and the flow-on effects to other sectors in the economy.

Dr Jessica O'Brien

Speaker
Research Engineer, Pacific Pyrolysis

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Jessica has a mixed engineering and chemistry background, including an undergraduate chemical engineering degree and doctorate in chemistry from the University of Newcastle, Australia. Jessica's PhD thesis (undertaken with the CSIRO Energy Centre, Newcastle) relates to large-scale solar hydrogen production from thermochemical water-splitting cycles, with a focus on electrocatalytic reactions. Jessica began work with Pacific Pyrolysis in 2011, working on commercialisation of pyrolysis technology, including operation and analysis of pilot plants, model verification and project-specific application of pyrolysis technology. Jessica has also recently completed some work with Ignite Energy Resources, helping in the commissioning and operation of a wood to crude oil hydrothermal commercial demonstration plant.

Mr Simon O'Connor

Economic Adviser, Australian Conservation Foundation

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Simon O'Connor has a long interest in the convergence of economics and finance with the environment. In particular, Simon's recent work within the Australian Conservation Foundation has focused on finance for a transition to a low-carbon economy. Working with academics, researchers, the finance sector, non-government organisations and government, both in Australia and overseas, Simon has undertaken research that has resulted in substantial government investment in renewable energy through the Clean Energy Finance Corporation. Additionally, Simon's research interests and experience within non-government organisations and the private sector include environmental and resource economics, public financing, climate change economics, green economic development, public interest economics and improved measurement of wellbeing.

Dr Rob Passey

Senior Research Associate, Centre for Energy and Environmental Markets, University of New South Wales, and Project Manager, IT Power (Australia)

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Rob Passey is responsible for research and analysis in the areas of renewable energy, distributed generation, electric vehicles, energy efficiency and carbon markets. Specific interests include policy mechanisms to reduce greenhouse emissions, increase uptake of low-emission technologies and drive energy efficiency; distributed generation and its integration into electricity networks; electric vehicles and their impact on distribution networks; technical assessments of low emissions technologies; and the characteristics of end-user decision-making relevant to uptake of distributed energy.

Miss Vanessa Rauland
Project Coordinator and PhD student, Sustainability Policy Institute, Curtin University

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Vanessa Rauland coordinates an ARC-funded Linkage Project: Decarbonising cities and regions, for the Sustainability Policy Institute. Vanessa is also studying carbon-neutral land development, with a focus on certification, for a PhD. After recently assisting a local high school to become the first officially certified Carbon Neutral School in Australia, Vanessa co-founded SimplyCarbon, a small organisation assisting schools, not-for-profits, and small and medium-sized enterprises to manage and reduce their carbon footprint. Areas of interest for future research include exploring how schools can better prepare themselves for a low-carbon future, and developing quantifiable metrics to better understand resource production and management opportunities at the city scale.

Dr Maria Retnanestri
Visiting Fellow, University of New South Wales

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Maria Retnanestri's interdisciplinary research has focused on overcoming barriers to the design and use of renewable energy technology (RET). Maria's PhD project included the development of the I3A (Implementation, Accessibility, Availability and Acceptability) Framework to investigate the sustainability of RET projects, taking into account institutional, economic, technological, social and ecological aspects. From 2008 to 2011, as a Postdoctoral Research Associate at the University of New South Wales supported by an Australian Development Research Award, Maria further developed and applied the I3A Framework to identify ways to overcome barriers to successful deployment of RET in off-grid communities in Indonesia. Maria is now further developing the I3A Framework for application to a broader range of services, including food and water.

Dr Bayden Russell
Lecturer, University of Adelaide

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Bayden Russell is interested in attempting to predict how local environmental conditions will interact with climate change in marine ecosystems, from kelp forests to coral reefs. Bayden has identified that the combined effects of nutrient pollution and increasing CO_2 concentrations will accelerate the degradation of near-shore systems and the associated species diversity and ecosystem services. Bayden's current research has two parts. The first is to identify if management of local conditions (such as recycling wastewater to reduce nutrient pollution) can increase the resistance of ecosystems to some of the anticipated negative effects of climate change. The second is to assess how the balance between primary productivity and consumption may change with different environmental conditions, and to examine the resulting restructuring of kelp and seagrass-dominated ecosystems.

Associate Professor Megan Ryan
Speaker
Associate Professor, University of Western Australia

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Megan Ryan completed a PhD comparing mycorrhizal fungi and crop phosphorus nutrition on organic and conventional farms at the Australian National University in 1998. Megan then investigated the effect of non-mycorrhizal canola crops on the nutrition and growth of following wheat crops at CSIRO Plant Industry in Canberra. Since joining the University of Western Australia in 2003, Megan has researched the development of new perennial pastures, including Australian natives. The phosphorus nutrition of these species has been a particular focus. Current projects examine the root and shoot adaptations that allow specialised native species to flourish in environments that experience high seasonal variation in phosphorus availability.

Dr Lucas Rye
Speaker
Business Development Adviser, Shell Company of Australia

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Lucas Rye, PhD, BEng(Hons), BComm, recently joined the Shell Company of Australia as a business development adviser. Before joining Shell, Lucas worked on the assessment of algae biofuels as part of CSIRO's Energy Transformation Flagship. Lucas has also worked on the development of next-generation aviation fuels in collaboration with Shell Aviation through a sponsored PhD at the University of Sheffield, United Kingdom. This work involved investigating fuel composition effects on gas turbine performance and emissions through fundamental and large-scale tests, including work at NASA and British Airways. Lucas's background in aviation stems from work at Qantas and his earlier bachelor's degree in Aeronautical (Space) Engineering at the University of Sydney.

Dr Kalpit Shah
Research Associate, Priority Centre for Energy, University of Newcastle

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Kalpit Shah's current research interests and research projects are in the area of oxy-fuel combustion, chemical looping and biomass co-firing. Before joining the University of Newcastle in 2011, Kalpit completed a PhD at Curtin University in 2010 and worked there as a Research Associate, studying coal and biomass co-firing. Kalpit also worked at the Biomass and Energy Efficiency group in the Energy Research Centre (the Netherlands) between 2008 and 2010. Kalpit has been a certified energy auditor for the Central Government of India's Bureau of Energy Efficiency since 2005, and has more than six years of industrial experience as an energy manager in India and overseas.

Mr Luke Shoo

Postdoctoral Research Fellow, University of Queensland

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Luke's primary interests are in conservation ecology. Luke has studied a wide range of systems, from mountaintop birds in tropical cloud forests to pebble-mimic dragons in Australian deserts. Luke's current research is concerned with prioritising investment in tropical forest restoration to maximise persistence of biodiversity and carbon sequestration.

Dr Cedric Simon

Speaker

Postdoctoral Research Fellow — Aquaculture Nutrition, Institute for Marine and Antarctic Studies, University of Tasmania

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Cedric's current research is in the field of digestive physiology and nutrition, which is contributing to solving production bottlenecks of rock lobster in aquaculture. In 2012, Cedric was awarded the Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry for a research project aimed at developing innovative methods for the assessment of nutritional condition of rock lobsters. Cedric's research interests include the aquaculture of new species, nutrition and aquafeed development, aquatic animal physiology, and the use of novel technology and innovative approaches to assess and improve animal welfare.

Associate Professor Tim Stephens

Steering Committee

Co-Director, Sydney Centre for International Law, Faculty of Law, University of Sydney

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Tim Stephens is an international lawyer and human geographer with a PhD in law from the University of Sydney, and an MPhil in geography from the University of Cambridge. Tim's research interests span a range of areas of public international law, with a particular focus on international environmental law and the law of the sea. Recent books by Tim include *The international law of the sea* (2010) with Donald R Rothwell, and *Climate change and Australia: warming to the global challenge* (2012) with Ben Saul, Jane McAdam, Steven Sherwood and James Slezak. In 2010, Tim was the recipient of the International Union for the Conservation of Nature Academy of Environmental Law Junior Scholarship Prize for his contribution to environmental law research.

Dr Jen Taylor
Bioinformatics Leader, CSIRO Plant Industry

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Jen Taylor leads the CSIRO's Plant Industry Computational Biology Team. The team researches computational and analytical methods to increase the impact of modern, high-throughput genome profiling technologies to improve agricultural production and the use of plants in energy production and environmental outcomes. The team works in close collaboration with experimental scientists on a wide range of projects aimed at understanding the molecular basis of important plant traits. In particular, Jen is interested in the analysis of data that capture how, when and in which tissues genomes are expressed into functional RNA and protein molecules. Functional genomics provides a bridge between the genetic potential of a living system and the realisation of biological phenotypes.

After studying for a PhD at the Queensland Institute of Medical Research, Jen took up a three-year postdoctoral post at the Department of Statistics, University of Oxford, United Kingdom, in Professor Jotun Hein's Bioinformatics Group. Jen was then appointed Head of Functional Analysis at the Wellcome Trust Centre for Human Genetics, also at the University of Oxford, for three years before joining CSIRO Plant Industry in late 2008.

Dr Olivier Thébaud
Research Scientist, CSIRO Marine and Atmospheric Research

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Olivier Thébaud holds a PhD from the School of Higher Studies in the Social Sciences, Paris, and a Habilitation for Research Direction from the University of Western Brittany (Brest, France). Before joining CSIRO in November 2009 as a senior economist for the Marine and Atmospheric Research division, Olivier was Head of the Economics Department of the French marine research institute Ifremer, Deputy Director of the AMURE research group, one of the largest European research groups in marine resource economics and law, and Associate Professor at the University of Western Brittany. Olivier's research focuses on the development of decision-support approaches and tools for the management of coastal and marine resources, including ecological–economic modelling and the economics of ecosystem-based approaches to natural resources management. Key areas of application include the regulation of commercial and recreational fisheries, aquaculture, multiple ecosystem uses, chronic and accidental pollution of coastal waters, and biodiversity conservation policies including marine protected areas. Selected publications authored and co-authored by Olivier Thébaud are listed at www.researcherid.com/rid/D-9792-2011.

Dr James Tickner
OCE Science Leader, CSIRO

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James Tickner read physics at Oxford University and completed his DPhil at the same institution in 1997. James now specialises in the development of new methods to solve challenging measurement and imaging problems in the minerals and security industries, and is currently a CSIRO OCE Science Leader and head of CSIRO's nucleonics research team. One of James's key projects was the invention, development and commercialisation of a novel air-cargo scanning technology to find concealed explosives and other contraband. James's team is currently developing new sensors to detect and monitor ultra-low levels of valuable metals, such as gold and platinum, to improve the efficiency of developing these mineral resources. James has received numerous awards for his work, including two CSIRO medals, the Australian Academy of Science Frederick White prize and a Eureka Prize. James has authored more than 100 publications and patents in the fields of particle physics and nuclear instrumentation.

Dr Blair Trewin
Climatologist, Bureau of Meteorology

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Blair Trewin is a climate scientist whose major areas of research are the analysis of observed climate change and variability, particularly climate extremes, the development of long-term historical datasets to support climate analyses, and the sensitivity of climate observations to local topography and site exposure. Blair is a member of the Steering Committee of the International Surface Temperatures Initiative, the World Meteorological Organization's Expert Team on Climate Change Detection and Indices, and the Task Team on Definition of Extreme Weather and Climate Events, and was the scientific coordinator of the World Meteorological Organization's annual Global Climate Statement in 2010 and 2011. Blair is editor of the *Australian Meteorological and Oceanographic Journal*, and is currently President of the Australian Meteorological and Oceanographic Society.

Dr Peerapat Vithayasrichareon
Postdoctoral researcher, Centre for Energy and Environmental Markets, University of New South Wales

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Peerapat has a PhD in electrical engineering from the University of New South Wales, an MEng in energy economics from the Asian Institute of Technology and a BEng in electrical engineering from the University of Melbourne. Peerapat worked as an engineer in the National Load Dispatch Centre in Thailand before completing a PhD, and has several years of industry experience in power system planning and operation. Peerapat's research interests include electricity industry modelling and simulations, with a particular focus on long-term generation planning and investment under uncertainty, integration of renewable energy technologies in the electricity grid, energy sustainability and power system economics.

Dr Nick Wade
Research Projects Officer, CSIRO Marine and Atmospheric Research, CSIRO Food Futures Flagship

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Nick Wade is a functional molecular biologist and biochemist in the aquaculture research team at CSIRO. The goals of the flagship's aquaculture research are to deliver novel genetic, nutrition and production technologies to achieve a quantum increase in sustainable production. Nick leads research into the genetic regulators of key metabolic pathways in fish, and how they are modified in response to changes in dietary nutrient sources, also known as nutrigenomics. Other research projects focus on the mechanisms that regulate pigment deposition in prawns and how they can be optimised in aquaculture. As part of the larger team, Nick works with national and international feed companies, as well as local farm producers, to optimise nutrient use and animal performance in aquaculture.

Dr Tim Wark
Principal Research Scientist, CSIRO

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Tim joined CSIRO in 2004 and during the past eight years has undertaken a range of research around sensing and sensor networks, and held various leadership roles, including Group Leader for Pervasive Computing and Theme Leader for National Security Technology Partnerships. Tim held a Visiting Scientist appointment at the University of California Berkeley in 2009, and recently was lead within the Digital Productivity and Services Flagship for the technology transfer of CSIRO's 3D mapping research. Currently, Tim leads the Sensors and Sensor Networks Transformational Capability Platform — a large, multidisciplinary program aimed at transforming data-driven science. Tim is an Adjunct Professor at the Queensland University of Technology and is a Senior Member of the Institute of Electrical and Electronics Engineers.

Dr Stuart Whitten
Speaker
Team Leader, Stream Leader and Institutional Economist, CSIRO Ecosystem Sciences

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Stuart Whitten is an environmental and institutional economist who has worked on the design and delivery of a wide range of markets for ecosystem services. Recent projects include an evaluation and redesign of the metric of the Australian Government's Environmental Stewardship Program, pilot implementation of a conservation tender paying for on-ground results, and two major reports helping shape a national wildlife corridor plan for Australia. Stuart's current research focus is on understanding institutions and policy needs to support landscape-scale biodiversity, and on land management and Great Barrier Reef water quality. Stuart has coordinated two major symposia (New Horizons in Market-based Instruments and Market-based Tools for Environmental Management) and published widely in a variety of forums.

THE ROYAL SOCIETY

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The 2012 Australian Frontiers of Science is supported by the Royal Society — the national academy of science of the United Kingdom and the Commonwealth — through the Theo Murphy (Australia) Fund.

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