Cooperative Research Centre for Remote Economic Participation (CRC-REP)

Climate Change Adaptation, Energy Futures and Carbon Economies Projects

Discussion Paper for Stakeholder Consultation Workshop

CRC for Remote Economic Participation
Ninti One Limited ABN 28 106 610 833
PO Box 3971
Alice Springs NT 0871
P (08) 8959 6000
F (08) 8959 6048
W www.crc-rep.com.au

Introduction

The future social and economic viability of communities and businesses in remote regions of Australia will depend upon local and regional responsiveness to the impacts of global environmental change. Climate change, an important component of global environmental change, and in large part driven by increasing concentrations of greenhouse gases in the atmosphere, drives all three components of this CRC-REP research project: climate change adaptation, future energy options, and carbon-based economies (Fig. 1).

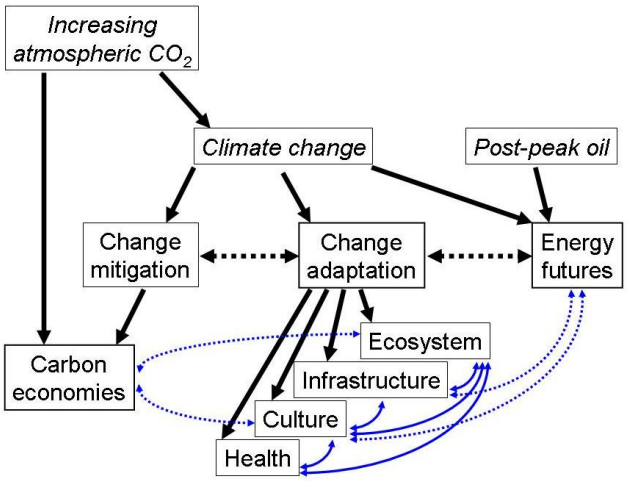


Fig. 1. The interrelated dimensions of climate change adaptation, energy futures and carbon economies as they affect remote Australia. Blue arrows indicate some of the potential interactions between anticipated components of this project and other CRC-REP projects.

Climate change adaptation describes the ways in which remote Australians can plan for, recognise and respond to risks to ecosystems, health, culture and infrastructure posed by increasing average temperatures, decreasing or increasing average rainfall, and increasing frequency of extreme weather events.

Energy futures describes the ways in which remote Australian individuals and communities can respond to

the pressures for low-carbon energy sources, particularly in the period after peak oil production and the anticipated future spiralling costs of oil, through adoption of renewable energy technologies and increasing energy-use efficiency.

Carbon economies describes the ways in which remote Australian land owners and managers can help to mitigate the globally increasing atmospheric greenhouse gas concentrations through land management approaches that reduce net greenhouse gas emissions and sequester carbon, and thus enable new economic options through engagement with carbon offset markets.

Climate change adaptation, energy futures, and carbon economies will interact in diverse and complex ways. Land management changes to reduce greenhouse gas emissions could affect biodiversity and cultural connection to country for Aboriginal and Torres Strait Islander and non-Aboriginal and Torres Strait Islander Australians alike at the very time that environmental and cultural values of country will be evolving in response to climate change.

Changes to energy sources and pressures to increase energy efficiency will affect infrastructure and social behaviours, as these are responding to climate change. The real economic opportunities across these three challenges may very well come from the points of synergy. For example, a new industry may arise from the challenge of building housing that is robust to hotter conditions and more frequent extreme storm events, more efficient to cool and heat than existing standards require, and able to be constructed in a cost-effective manner and with a low carbon footprint from more local materials in remote locations.

This paper is intended as a background briefing for a project stakeholder workshop to be hosted by the CRC-REP in Alice Springs on 23–24 August 2011. The paper describes cores issues under each of the three headings (climate change adaptation, energy futures, and carbon economies) and some potential research questions that could be pursued by the project. The paper also addresses the benefits of identifying conceptual frameworks to underpin project research and some of the practical challenges around specifying and implementing the project during the life of the CRC.

Climate Change Adaptation

Climate change predictions

The latest global circulation models predict that in 2030 remote Australia will most likely experience average temperature increases between 0.5°C and 1.5°C compared with 1990 values. The greatest increases are consistently predicted for the Great Victoria Desert and the Pilbara regions of inland Western Australia and the smallest increases for Cape York Peninsula (Fig. 2). The models predict that over the same time period, average annual rainfall is likely to increase in northern Cape York Peninsula, the Darwin region and the Kimberley, and decrease in the southern and south-western arid zone (Fig. 3). There is still an extremely high degree of uncertainty in predictions of future rainfall in all inland regions of Australia (Whetton 2011), partly because of the inherent current variability of Australia's climate (which is expected to increase even further and be experienced as more frequent 'extreme events') and partly because of the low level of understanding of how changes in global atmospheric and ocean currents will affect regions far from coasts.

(a) (b)

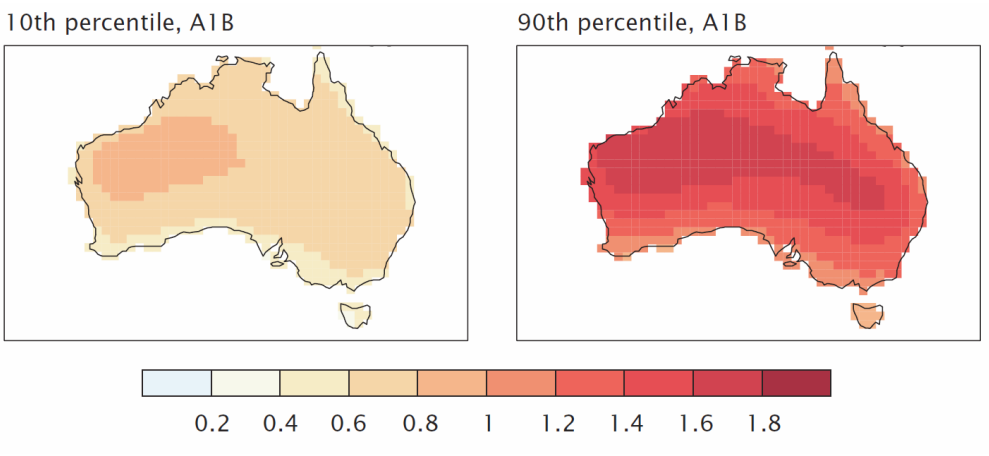


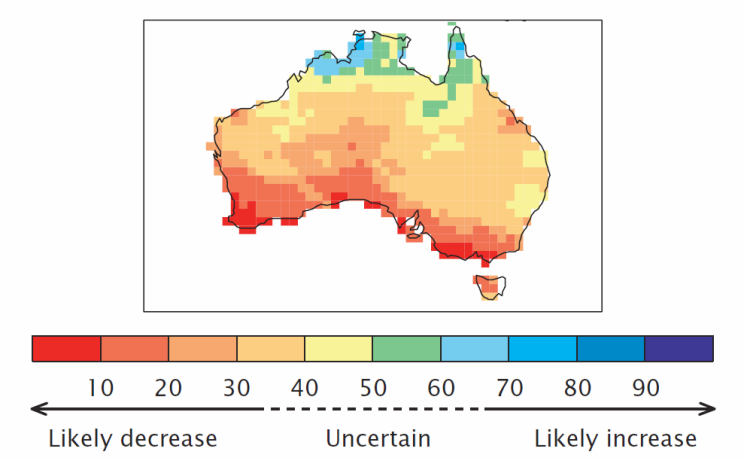
Fig. 2. Projected changes in annual average temperatures across Australia in 2030, based on global circulation models: (a) Low degree of warming predicted by 1 in every 10 model results; (b) High degree of warming predicted by 1 in every 10 model results. Average predicted warming is between these two scenarios. From Whetton (2011).

Fig. 3. Likely direction of changes in annual average rainfall across Australia in 2030, based on global circulation models. From Whetton (2011).

Climate change impacts

By 2030, climate change is expected to have wide-ranging impacts (after Hennessy 2011):

- Water supply reliability will decline in southern remote regions where rainfall is predicted to decline and in inland regions where rainfall is predicted to become more variable. This decline is likely to apply to refilling of both surface (e.g. dams) and artesian water supplies.
- There will be risks from rising sea level and severity and frequency of coastal flooding, risks already of concern across northern Australia (e.g. in Kakadu, Brook 2009; in remote Aboriginal and Torres Strait



Islander communities, as reported by Hunter & Leonard 2010, Sinnamon & Mango 2010).

- Losses and migrations of biodiversity will be driven by the changes in temperature and annual water availability, and affected by the viability of conservation areas and corridors.
- Infrastructure risks will include failure of drainage and sewerage systems during floods, transport and electricity disruption during extreme floods and heatwaves, and greater building damage and maintenance demands due to greater average and extreme temperature conditions. Holper et al. (2007) provide a matrix analysis of infrastructure risks under climate change in Victoria, but no equivalent exists for any part of remote Australia.
- Human health will be affected in several ways. Heatwaves may increase heat-related deaths, and higher average temperatures may increase the physiological stress of those suffering other illnesses. Infectious diseases are likely to have greater distributions across Australia and the probability of new diseases arriving from Southeast Asia will increase. Tropical insect-borne microbial diseases are of particular concern.

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Major industries in remote Australia, including pastoralism, mining and tourism, will be affected by the combination of the impacts above (e.g. Turton et al. 2009).

Vulnerability

The impacts are not likely to be experienced to the same degree by all people in remote Australia due to their varying vulnerability (IFRCRC 1999, Turner et al. 2003). Vulnerability formally incorporates the exposure, sensitivity and resilience to climate change impacts by individuals or groups of people. Remoteness of itself may increase sensitivity and decrease resilience. Aboriginal and Torres Strait Islander communities are of concern because of their relatively high exposure, higher sensitivity in some cases, and lower resilience (e.g. Green et al. 2008). Green et al. concluded that:

- There is an urgent need to engage with Aboriginal and Torres Strait Islander communities on matters associated with climate change
- There is a need to develop a climate change clearinghouse in partnership with Aboriginal and Torres Strait Islander institutions
- Little attention has been given to the topic of Aboriginal and Torres Strait Islander vulnerability to climate change in northern Australia by the research sector
- Each community has specific concerns, and therefore there is no 'one size fits all' approach to reducing vulnerability
- Climate change is expected to elevate the health risks for Aboriginal and Torres Strait Islander people
- Dispossession and loss of access to traditional lands, waters and natural resources have made Aboriginal and Torres Strait Islander people more vulnerable to the effects of climate change
- Transport and communication infrastructure is already extremely limited in many parts of the study region; climate change is expected to place further strain on these services
- Overcrowding and inappropriate building stock in many Aboriginal and Torres Strait Islander communities may increase vulnerability to climate change
- Awareness about the potential impacts of climate change is likely to be an even greater problem for Aboriginal and Torres Strait Islander people owing to the recognised challenges of current forms of formal educational systems, remoteness and lack of appropriate educational materials
- Climate change will affect the 'natural' environment, with major flow-on implications for remote communities dependent on natural resources.

Adaptation

Adaptation is about coping with changes that are already happening or appear unavoidable in the future. In the climate change arena, adaptation remains weakly conceptualised (see 'adaptation pathways' in the Conceptual Frameworks section below). Uncertainty about the rate and impacts of future climate change is a strong barrier to adoption of adaptive behaviour and planning, despite societies' experiences with large uncertainty in economic arenas such as banking and the stock market. Consequently, adaptation is most often perceived as a net cost rather than a potential opportunity. Opportunities can include 'no regrets'

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measures – actions that make good sense even in the absence of climate change – and 'win-win' activities – actions that generate new industries, wealth, jobs or other desirable outcomes.

Potential research topics and questions

- What is the current understanding of climate change impacts, vulnerability and adaptation options among the people, communities and industries of remote Australia?
- What options exist for providing information on climate change impacts, vulnerability and adaptation to the people, communities and industries of remote Australia? Would a climate change clearinghouse be appropriate?
- What information gaps exist that could be filled by CRC-REP research?
- What are the social, economic and environmental barriers to developing adaptation pathways in remote Australia?
- What are the species, ecosystem functions or ecosystem types most sensitive to climate change in remote Australia? Could these be used to develop indicators for monitoring the progress of climate change impact in general?
- What will be the likely climate change impacts on communities that rely on natural resources, including Aboriginal and Torres Strait Islanders and pastoralists?
- What are the opportunities for minimising potential health impacts of climate change on a 'no regrets' or 'win-win' basis in remote Australia?
- What are the economic opportunities in preparing for predicted climate change impacts on housing, transport and telecommunications infrastructure? Can these opportunities build on those for increasing efficiency, as identified in the Energy Futures section below?

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Energy Futures

Remote Australia has historically had most of its energy needs met by a combination of diesel, petrol and wood. The combination of increasing global pressure for low-carbon energy sources for reducing greenhouse gas emissions, likely future declining reserves of oil and thus increasing prices for liquid petroleum products presents both a threat and an opportunity to remote Australia.

Responding to this threat and opportunity will by no means be from a blank slate. Technologies for alternative, renewable energy sources abound. Over the last 20 years, research on improving the range and efficiency of these sources has gained momentum (and enormous government funding) around the world. All parts of remote Australia are recognised to have significant potential for at least one type of renewable energy for which technologies already exist: wind, solar (photovoltaic and thermal systems), geothermal (e.g. the southern Lake Eyre Basin), bioenergy and tidal (see www.ga.gov.au/energy).

The issues for alternative energy systems servicing remote Australia fall under three broad headings:

- Local stationary energy supply e.g. energy supply to houses and communities
- Transport e.g. cars, trucks and trains using alternative energy sources
- Energy export e.g. generation of electricity for sale to urban/non-remote Australia.

Local stationary energy supply and demand

Research on options for local stationary energy supply is significantly more advanced than research on the other issues. Wind and solar electricity generation systems have been successfully trialled or installed commercially in individual houses or communities in many parts of remote Australia (e.g. www.horizonpower.com.au; www.energy.wa.gov.au; www.alicesolarcity.com.au). Backup and storage systems are available. Wood-fire heating and cooking has been historically important and remains a viable renewable energy option in much of remote Australia, although sustainability of wood supply could become a problem near growing population centres.

The flip side of local supply is local demand, which will be driven by the balance between increasing local population (at least in parts of remote Australia); additional energy required to counteract negative impacts of climate change (e.g. use of airconditioners); and efficiency gains through better design of buildings, telecommunications equipment and appliances. Research is required in this domain, although Tangentyere Design in Alice Springs (www.tangentyere.org.au/enterprises/ design/) has been pursuing appropriate materials and design principles for climatically responsive buildings, and the Centre for Appropriate Technology (www.icat.org.au) has pursued efficient appliances and other low-energy household technologies.

Potential research topics and questions

- What are the future energy needs of people, communities and industries of remote Australia under various climate change and demographic scenarios?
- What will be the social impacts of rising electricity prices and/or reduced supply to Aboriginal and Torres Strait Islander communities?
- What are the social, economic and institutional requirements for more widespread adoption of renewable

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generation systems, including systems to support larger tourism centres and mining operations (but see www.dlgp.qld.gov.au for discussion of renewable energy options for mines)?

- What are the social, economic and institutional requirements for more widespread adoption of more efficient building designs, appliances and telecommunication systems?

Transport

Efficient land and air transport will be essential to the maintenance of vibrant communities and businesses in remote Australia, and transport cost could become the factor that most limits social and economic sustainability and development in the future. However, there has been little research on the options for future transport to service these regions. The Centre for Appropriate Technology has tested a small-scale, local biodiesel plant in central Australia (www.icat.org.au), and non-native oil-crop plant species such as *Pongamia* and *Agave* have been proposed as the basis of local biodiesel production systems. There has been no assessment of the potential for electric (or hydrogen-fuelled) vehicles, especially the social and institutional requirements in sparsely populated areas. The viability of future electrification of railways servicing mines, cities and larger towns is likely to depend on infrastructure needs identified under the 'Energy export' section (below).

Potential research topics and questions

- What will be the impact of much higher transport costs on Aboriginal and Torres Strait Islander culture, health and education?
- How will higher fuel costs affect remote industries such as tourism, pastoralism and mining?
- Development of a model of environmentally, socially and economically sustainable biofuel production in remote Australia.

Energy export

The bulk of Australia's energy demand is in its large coastal cities and their fringes. Thus remote Australia's high potential for renewable energy generation could be turned into a major industrial sector to service the urban energy 'sink'. Such a possibility requires both construction of large-scale renewable energy power stations and high-voltage electricity transmission lines over long distances.

Until now, remote electricity generation for export has been dismissed on economic grounds, but the changing institutional/government and technical environment is driving a reconsideration of *what* renewable energy can be generated *where*. Melbourne Energy Institute (2010) proposed expansion of the Australian electricity grid by 2020 to include solar and wind power stations on the periphery of what we define as remote Australia and a set of transmission lines to connect these power stations to cities and major mining areas. Increasing urban population growth and energy demand, and a need for greater redundancy in renewable generation, may lead to extension of the grid into more remote areas becoming feasible in subsequent decades.

Such a development could result in a large increase in the size of the economy of remote Australia, with local employment opportunities associated with construction and maintenance of all aspects of the grid. However,

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there may be negative impacts, and thus tradeoffs, that might threaten the sustainability of an energy-export economy or require significant institutional investment to counterbalance. Local employment opportunity might be displaced by a fly-in/fly-out workforce such as is currently dominating much of the mining sector in rural Australia, and the infrastructure requirements could have negative impacts on biodiversity and cultural values, including Aboriginal and Torres Strait Islander law in its broadest sense. Environmental impacts of large-scale renewable energy infrastructure in low-population areas have already been subject to scrutiny in other countries (e.g. the USA; CEIWEP 2007).

Potential research topics and questions

- What are community perceptions, in both remote and urban Australia, of the economic, social and environmental costs and benefits of large-scale renewable energy generation for export to urban Australia?

Carbon Economy

For remote regions of Australia, where many lands are in a semi-natural state under generally low-intensity management practices, the opportunities for participating in a carbon economy is almost exclusively through transformed land use and management, and the elements of this potential transformation under the umbrella of the Carbon Farming Initiative are described by Garnaut (2011). In 2008, ~20% of Australia's total greenhouse gas emissions was from the land sector; changed land management that reduces these emissions represents significant potential carbon offsets. The recent announcement of a carbon pricing policy by the Australian Federal Government means that the economic value of these offsets can be calculated. The land management opportunities applicable to remote Australia include:

- Reduction in deforestation
- Carbon forest plantations
- Reduction in rumen fermentation emissions from livestock
- Carbon pools in rangeland soils and vegetation
- Reduction in emissions from fire
- Reduction in emission from feral animal control
- Bioenergy.

Remote Australia includes major climatic and ecological gradients, including the north–south gradient from winter- and summer-rain arid shrublands and grasslands to tropical forests, all lying across a mosaic of fundamentally different soil types. This diversity of ecosystem types and range in productivity leads to location-specific sets of options for engaging with a carbon economy.

Successful implementation of changed land management practices for any of these opportunities requires understanding of both:

- The biophysical dimensions of the relevant carbon pools, greenhouse gas fluxes and their potential for manipulation in the local environment.

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- The social and economic dimensions of acceptance and adoption, including stakeholder knowledge of the environmental, employment and economic opportunities; tradeoffs against other values or income streams; and management costs.

There have been varying degrees of research on the biophysical aspects of carbon opportunities. Greenhouse gas abatement through manipulation of fire regimes in the northern savannas has been studied extensively (savanna.cdu.edu.au) and the extent to which a shift from late-season to early-season fire reduces methane emissions can now be modelled in savanna ecosystems. However, these models are only considered reliable for savannas with at least 1000 mm average annual rainfall and thus for most of the arid and semi-arid parts of remote Australia the carbon offset potential of fire regime management is not quantified. Exploratory preliminary assessments have been made (or are currently being made) of tropical forest plantations (e.g. www.tiwilandcouncil.net.au), arid-zone forest plantations (e.g. www.centrefarm.com), altered cattle-rumen microbial flora (www.csiro.au), reductions of feral camels (www.nintione.com.au) and bioenergy (e.g. www.icat.org.au), but none has reached a stage at which understanding could underpin management decision-making. Thus with the exception of savanna fire management for reduced methane emissions, there are significant biophysical knowledge gaps around all carbon-market opportunities.

The social and economic dimensions of adoption of land management practices for carbon offsetting in remote Australia are also poorly researched. Previous uncertainty over carbon-market structure and pricing, in Australia and overseas, has contributed to a lack of research focus. There is a need for extensive research to predict the opportunities on the different biophysical pathways for greenhouse gas abatement; to build a comprehensive integrated cost:benefit analysis, including biodiversity conservation, of management options; and to develop cost-effective methods to measure and monitor the magnitude of actual abatement for reporting to offset buyers. Throughout remote Australia, these challenges apply to almost all land owners and managers who are considering carbon offsets as part of their future income stream. On pastoral properties, the cost:benefit analysis of management for carbon offsets will require consideration of other market values such as any co-benefits or tradeoffs with cattle production and tourism, as well as non-market values such as outback historical perspectives or traditions. For Aboriginal and Torres Strait Islander land owners and management, the cost:benefit analysis is also likely to include non-market values such as extent of new local employment, stronger or renewed connection with country and culture, and any co-benefits or tradeoffs with traditional law. All of these issues require further research.

Potential research topics and questions

- A methodology for estimating the potential carbon offset gains that could be achieved through management of fire regimes in Australian rangelands with <1000 mm average annual rainfall.
- Field-based and/or remote-sensing-supported methods to estimate carbon stocks in rangeland vegetation and soils.
- The nature and magnitude of co-benefits from or tradeoffs between greenhouse gas abatement management and other economic, social and environmental values of remote Australia's lands, including Aboriginal and Torres Strait Islander law, bush foods, pastoral production, mining, tourism and biodiversity.
- A multiple-values decision-making tool to support land management choices based on understanding of the co-benefits and tradeoffs, plus the value systems of land owners, managers and stakeholders.

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Conceptual Frameworks

Identification of efficient pathways for implementing effective responses to the adaptation, energy and carbon economy challenges and opportunities facing remote Australia will be facilitated if the project is underpinned by one or more conceptual frameworks. Such frameworks are valuable in ensuring:

- thorough and systematic analysis of the many interacting biophysical, social, economic effects that flow from climate change
- clear prediction of outcomes from actions and innovations.

There is also value in models being scalable to match the level of complexity of interactions and the level of detail required to capture key drivers or constraints facilitating and limiting responsiveness.

At a broad scale, the consequences of climate change can be characterised as a cascade, via impacts and identification of potential responses and technologies, to realisation of adaptation and implementation of innovations (Fig. 4). Biophysical, social and economic processes and filters (including those related to government and institutions) describe the effects of drivers and constraints at each step of the cascade. Adaptations and implementation of innovations can also act as further filters that affect the magnitude of future climate change, its impacts, and the range of potential responses, and thus there are feedback loops back to all stages of the simple cascade.

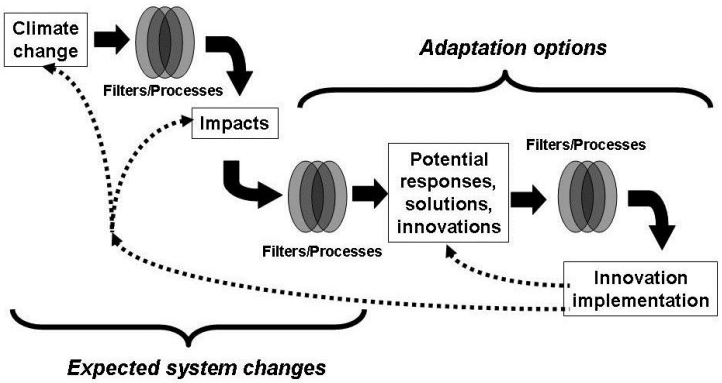

Fig. 4. Simple model of the cascade of effects from climate change, to response, to change through the implementation of relevant innovations. Adoption of innovations is likely to be the result of the magnitude and experience of the climate change filtered through many biophysical, social and economic filters.

This simple cascade model permits a simple, but instructive analysis of the level of previous research across the three components of this research project:

Research relevant for remote Australia	**Potential responses, solutions, innovations**	**Pathways to adoption and implementation**
Climate change adaptation	Medium-low	Medium-low
Energy futures	Medium-high	Medium
Carbon economies	Low	Low

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Potential research topics and questions

- Can we identify, develop or create one or more conceptual frameworks that will allow us to maximise our understanding of the interrelationships between responses to climate change, energy futures and carbon economies?

Challenges

Vision for effective outcomes over five years

Climate change, adaptation, alternative energy sources and carbon economies are all highly topical, even volatile, issues in the current Australian social and political environment. The 14 July 2011 announcement of a carbon pricing policy by the Australian Federal Government, and the subsequent parliamentary and public debate, is a case in point. While the overall aim of this project is to achieve significant benefits for the people, economy and environment of the remote regions of Australia, topical volatility presents the danger of this research project being expected to be so responsive to every fluctuation of social and political focus that significant longer-term research questions and outcomes are compromised. Consequently, one challenge for this project is the balance between:

- Clearly identifying and pursuing the core questions and critical research required to achieve outcomes against longer-term aims and objectives. Undertaking research activities within shared conceptual frameworks is likely to help achieve this longer-term perspective.
- Being responsive to opportunities and expectations as they arise, especially where they can enhance pursuit of the wider picture of long-term outcomes.

Coherence

In order to achieve project outcomes, the project scope will need to encompass a broad range of ecological, social and economic research fields in which a large number of previous projects have been undertaken in remote Australia, elsewhere in Australia and/or overseas. A gap analysis is revealing a large number and diversity of knowledge gaps (‘vacant niches’ to an ecologist) which could be addressed over the next five years. However, in practice, successful achievement of outcomes often requires more than filling all the knowledge gaps; that is, ‘the whole is greater than the sum of the parts’. Thus a second project challenge is to address the interactions between current knowledge and knowledge gaps and thereby select research activities, from among all those activities that might be undertaken, on the basis of their potential for synergies. The result of this analysis of the knowledge gaps should be a more coherent and effective research project.

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