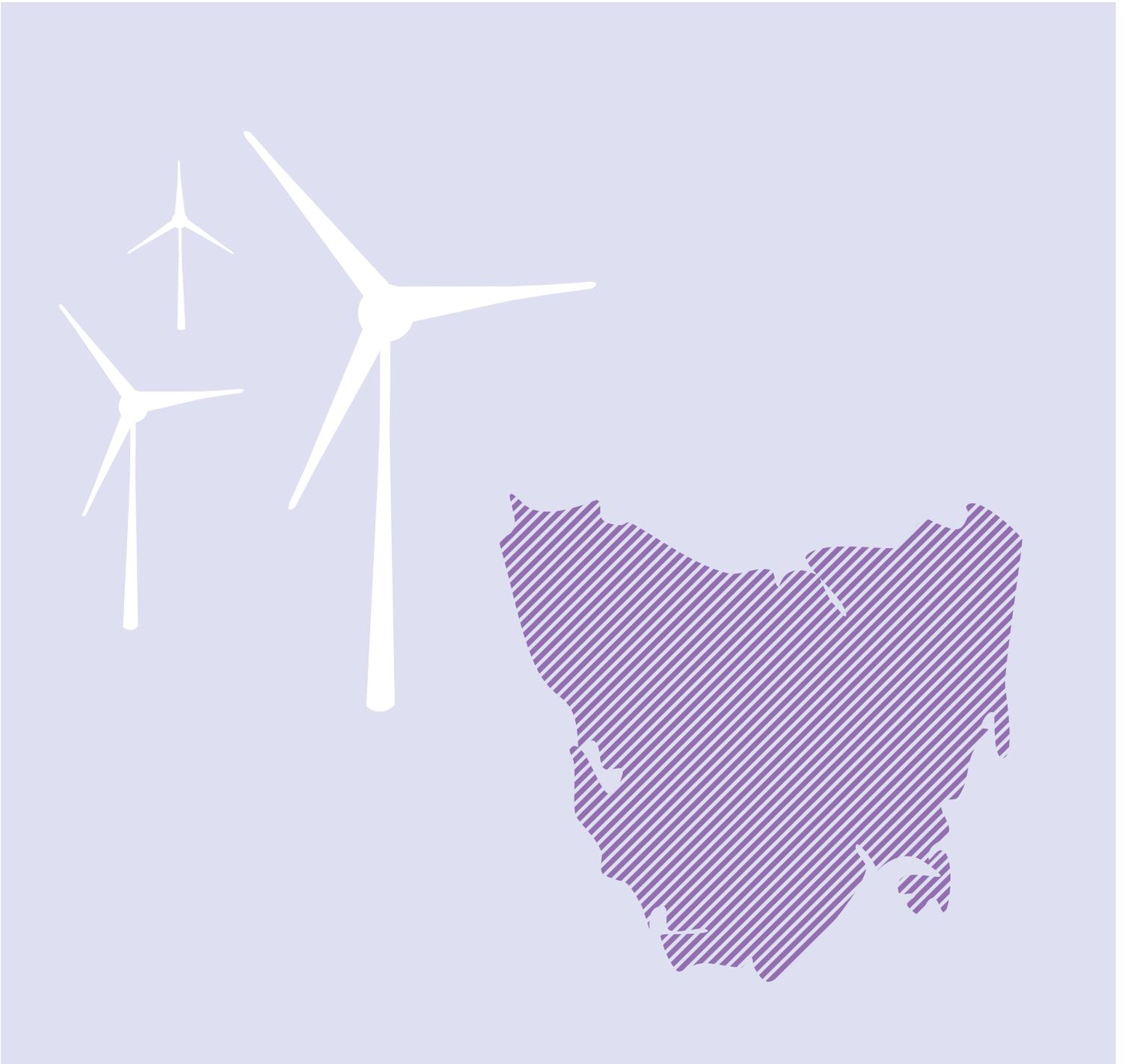




THE CRITICAL DECADE

Tasmanian impacts and opportunities



Over many decades thousands of scientists have painted an unambiguous picture: the global climate is changing and humanity is almost surely the primary cause. The risks have never been clearer and the case for action has never been more urgent.

Our Earth's surface is warming rapidly and we can already see social, economic and environmental impacts in Australia.

Failing to take sufficient action today poses substantial risks to our economy, society and way of life into the future. This is the critical decade for action.

This document highlights the key impacts and opportunities for Tasmania and accompanies *The Critical Decade* report and other work at www.climatecommission.gov.au. It draws on recent research into climate change impacts in Tasmania.

Key messages

- Tasmania has become drier, posing challenges for agriculture and Tasmania's hydro-electric power supply.
- Changes in Tasmania's climate will have far-reaching implications for agriculture, tourism, electricity generation, fisheries, biodiversity and human health.
- A hotter climate is a climate of more extremes. Tasmanians can expect to feel the impacts of more intense rain events and associated flooding, as well as increased fire danger days.
- Tasmania is particularly vulnerable to sea-level rise because most Tasmanians live close to the coast. For instance, in some places a 50 cm sea-level rise could result in a present 1-in-100 year event becoming an annual or more frequent event by the end of the century.
- Tasmania's internationally renowned biodiversity is at risk from a changing climate. For instance, it is likely that hotter temperatures will reduce available habitat for unique Tasmanian plants and animals. The Tasmanian fisheries industry, worth \$522 million per year, will also be at risk from rapidly increasing water temperatures and new invasive species.
- This is the critical decade for action. The choices we make between now and 2020 will shape our future. To minimise climate change risks we must begin to decarbonise our economy and move to cleaner energy sources this decade. The longer we wait the more difficult and costly it will be. Tasmania is leading Australia in renewable energy generation and is well-placed to capitalise on the global trend towards clean energy.

1. Changes in rainfall patterns and rising temperatures pose challenges for agriculture and power supply.

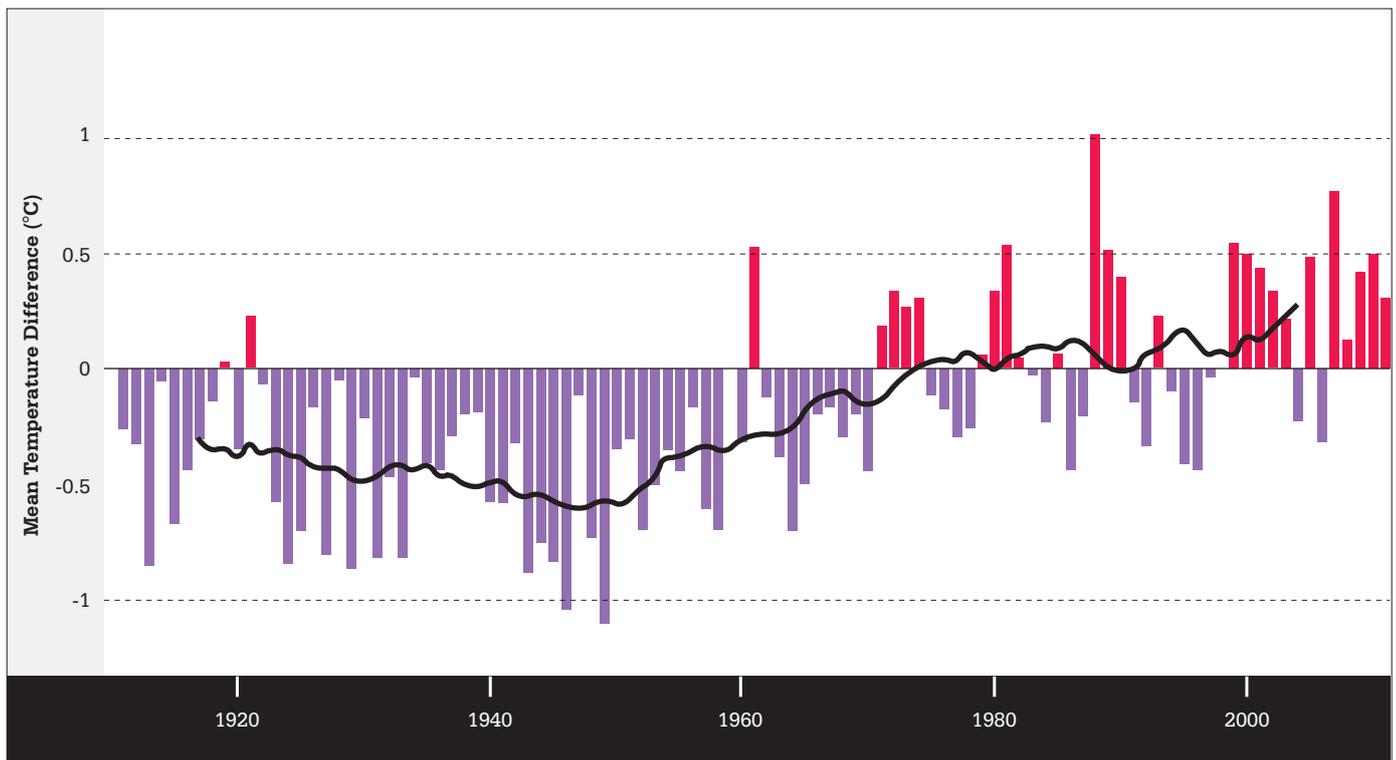
Average annual temperature in Tasmania has risen by 0.8°C over the past century (Figure 1), slightly less than the increase for mainland Australia. Tasmania's total annual rainfall has reduced, most noticeably in autumn, and there has been greater variability in rainfall year-to-year since 1975 (Grose *et al.*, 2010; BOM/ACSC, 2011).

These changes – warmer temperatures and changing rainfall – are expected to continue. The number of days warmer than 25°C is projected to double or triple in most regions of Tasmania. Some areas – such as around Bridport and Launceston – could see 40 additional days above 25°C per year by the end of the century, a significant change to the climate (White *et al.*, 2010). Overall the amount of rain falling may not change significantly. However, the location and intensity is likely to change. It is likely there will be more extreme wet days, more intense rainfall and more dry days – that is, less 'average' conditions.

Intense rain events and associated flooding cause significant damage to homes, communities and infrastructure, and place stresses on emergency and medical services. These incidents are projected to increase over the next century. The largest increases in rainfall intensity will be in areas where the most variable and intense rain is already observed. The number of extreme wet days could increase by up to 25% per year in both the southwest and northeast of the state (White *et al.*, 2010). For example, it is expected that by late this century what is now a 1-in-200 year rainfall event in St Helens could become a 1-in-20 year event (White *et al.*, 2010).

Climate affects almost every aspect of agricultural production, including the plants used, agricultural yield and quality, and which areas are farmed. Therefore projected changes in rainfall and temperature will have significant impacts on agriculture. Agriculture plays an important role in the Tasmanian economy, with a total value in 2009/10 of about \$1.08 billion (ABS, 2011).

Figure 1. The long-term trend in Tasmania's average temperature. The purple bars show the yearly temperature difference from the 1961 to 1990 average and the red line shows the average long-term temperature. This graph shows that from around 1950 there has been a steady temperature rise – approximately 0.8°C – in Tasmania. Most human-caused carbon dioxide emissions have occurred since 1950.



Source: Modified from BOM, 2011

Some changes in climate will have a negative impact on agriculture. For example, the projected increases in rainfall during summer and autumn in the eastern regions of Tasmania could cause more fungal disease during the period when crops are developing and particularly vulnerable. As the temperature rises new weeds and pests, such as the Queensland fruit fly, may establish in Tasmania (Holz *et al.*, 2010).

As Tasmania's climate becomes more like that of mainland Australia, Tasmania may be able to sustain a broader range of crops. Warmer temperatures mean that in some regions the number of 'growing degree days' (days when plants grow) will increase, with potential benefits for crop yields. Wheat crops, for example, have potential to increase yield by 10–15% (Holz *et al.*, 2010). Increases in growing degree days also means more grape varieties can be grown in Tasmania and by 2070 conditions in northern Tasmania could be similar to the current conditions in the Coonawarra region of South Australia (Holz *et al.*, 2010). Mainland wineries are already seeing opportunities in Tasmania, with two major Australian wineries, Brown Brothers and Shaw and Smith, recently acquiring cool-climate vineyards in Tasmania.

Changes to rainfall patterns and evaporation rates will also affect runoff and water availability, posing significant challenges for farmers. There is a risk not only for water supplies and irrigation but also for Tasmania's large hydroelectric system. An ongoing decline has been observed in the inflows to hydroelectric system catchments over the past century and this decline is projected to continue. Decreased inflows could lead to an overall reduction in power generation capacity by 2100 and could have an impact on power generation if not addressed (Bennet *et al.*, 2010).

2. Rising sea levels will threaten coastal towns and homes.

Global average sea level has risen by about 20 cm since the late 1800s, and at an increasing rate since the early 1990s. Sea levels have also risen around Tasmania, although at a slightly slower rate than the global average. Over the next century, global sea levels are projected to increase by at least 0.5 m and perhaps by as much as 1.1 m.

Tasmanian communities are vulnerable to the impacts of sea-level rise because 75% of the population lives in coastal areas (DCC, 2009). An estimated 8,700–11,600 houses, with a value of up to \$3.3 billion, may be at risk of flooding towards the end of this century (**Figure 2**), assuming a sea level rise of 1.1 m which is at the higher end of projections (DCC, 2009).

The impacts of sea-level rise are felt most acutely during severe storm events. Even small rises in sea-level lead to very large increases in the frequency of coastal flooding when combined with a storm surge and high tide. In some locations in Tasmania, a half metre sea-level rise would result in a present 1-in-100 year event becoming an annual or more frequent event by the end of the century (Church, 2008; Hunter 2011).

Figure 3. Sea-level rise will contribute to sandy beach erosion, such as at Five Mile Beach in Pittwater near Hobart.



Photo: C. Sharples

Figure 2. Up to 11,600 houses may be at risk of flooding by the end of the century. Images of Kingston (Kingborough LGA) in 2009 and with simulated inundation from a sea-level rise of 1.1 metres and a 1-in-100 year storm tide using medium resolution elevation data (not suitable for decision-making).



Photo: © DNES 2009/ imagery supplied courtesy of SPOT Imaging Services and Geospatial Intelligence Pty Ltd

Local government areas in Tasmania most susceptible to flooding from high sea level events include Clarence (**Box 1**), Central Coast and Break O'Day (DCC, 2009). In the Clarence City Council area, for example, up to 10% of existing houses could be flooded by the end of the century, and up to 16 and 23% of houses could be flooded in Central Coast and Break O'Day councils respectively (DCC, 2009).

Rising sea levels can also cause significant erosion of soft, sandy beaches which are used for swimming, fishing and surfing. Around half of Tasmania's open coasts are sandy shores that are vulnerable to significant erosion, such as those on Tasmania's southwest coast and at Snug, Margate and Coningham in the south (DCC, 2009). Sandy beach erosion also threatens coastal properties; an estimated 6,100 houses in Tasmania are located within 110 metres of soft, sandy shorelines (**Figure 3**) Tasmania's World Heritage coastal environment, the most extensive untouched coastal environment in temperate Australia, is also seriously threatened by sea-level rise (DPIPWE, 2010).

In July 2011 severe storms with high tides and destructive ocean swells caused significant damage to dunes in Lauderdale, on the outskirts of Hobart. A number of waterfront properties and many public areas were flooded, requiring emergency repair works (WRL, 2011). The effect of such wild weather is exacerbated by sea-level rise.

Sea-level rise also threatens roads, railways and commercial buildings in Tasmania. A 1.1 m sea level rise would threaten up to 2,000 km of roads, up to 160 km of railways and up to 300 commercial buildings, with a combined estimated value of up to \$6.2 billion (DCCEE, 2011). Many major industries and infrastructure, such as emergency services, sewerage and waste water systems, are also located in coastal regions.

Box 1. Preparing for climate change in Clarence City Council, Hobart

The community of Clarence east of Hobart has a long history of coastal erosion and flooding events, caused by severe weather and storm surges (**Figure 4**). Storms in July 2011 resulted in dune erosion of up to five metres and many flooded Lauderdale residences. With 191 km of coastline and a large number of residents living near the beach, coastal erosion and flooding are of increasing concern to the community.

Clarence City Council has worked with the community to assess the vulnerability of its coastal areas to the impacts of climate change, including sea-level rise, over the next 100 years. The council has also identified ways to prepare and respond to future impacts. A detailed assessment report, published in 2009, has been recognised as best practice across Australia.

The council is now working with three other local councils, the Tasmanian Government and consultants on ways to develop realistic responses to climate change. They have developed a number of planning options (or pathways) for local councils and communities. Possible responses include adding sand to beaches, revegetating dunes, raising reinforcement of some roads, and developing new planning standards and controls. The Council will consult the community as it develops the preferred pathway.

Other local councils and communities around Australia could use Clarence City Council's work as a model to understand vulnerability to sea-level rise and to prepare for the impacts of climate change in coastal areas.

Figure 4. Severe storms caused significant damage to beaches at Lauderdale, Clarence City Council, in July 2011.



Photo: Dr Tom Shand, UNSW Water Research Laboratory

3. Tasmania's world heritage biodiversity will be at risk.

Tasmania is known worldwide for its biodiversity – its unique range of plants and animals – and for its extensive temperate wilderness areas. The state hosts two World Heritage areas, with the Tasmanian Wilderness World Heritage area covering 20% of the main island. These natural areas support Tasmania's growing tourism industry which contributes around \$1.4 billion per year to the state economy (Tourism Tasmania, 2008). Research suggests that the Tasmanian wilderness and coastal environments are the strongest attraction for new visitors (Tourism Tasmania, 2011). The combination of higher temperature and changes in rainfall patterns, especially the seasonality and intensity of rainfall, bring risks not only to individual species but also to southwest Tasmania's vast temperate forest ecosystems as a whole.

Figure 5. Burnt King Billy pines, Western Arthurs, southwest Tasmania.



Photo: Peter Matthews and the Department of Sustainability, Environment, Water, Population and Communities

Many ecosystems are already stressed as a result of clearing of native vegetation and conversion of land to other uses (DPIPWE, 2010). Other stressors include changes to the water cycle, introduction of invasive species, soil and stream-bank erosion and changes to fire regimes (Steffen *et al*, 2009).

Many plants and animals in the state, especially those in cool, high altitude habitats, have very limited ability to adapt to rapid climate change. As temperatures increase and snow cover declines, alpine and sub-alpine habitats are likely to decline in area, increasing risks for species such as the King Billy pine (**Figure 5**) (ANU 2009).

Moorlands and peatlands are particularly vulnerable to increasing temperatures and changed rainfall patterns. Tasmanian moorlands and peatlands currently depend on the cool, coastal climate and rainfall to store large amounts of carbon in the soil. With higher temperatures and potentially drier conditions, moorlands and peatlands could start releasing carbon into the atmosphere (DPIPWE, 2010; Nieveen and Schipper, 2005). Moorland fauna such as the broad-toothed mouse (**Figure 6**) and burrowing crayfish (**Figure 7**) are sensitive to changes in habitats and may be threatened by changes in the climate. It is projected that the distribution of the broad-toothed mouse will contract into the mountains near Cradle Mountain-Lake St Clair (DPIPWE, 2010).

As a consequence of increased temperature and longer dry periods, there is likely to be an increase in fire danger days (DPIPWE, 2010). Many Tasmanian ecosystems are highly flammable, occur in limited areas and contain species that are not well-adapted to surviving fire. Iconic trees, such as the Huon pine, King Billy pine and the deciduous beech, may face significant population decline with climate change (ANU, 2009). There has already been a widespread lack of regeneration in the endemic pencil pine following fires in the Central Plateau woodlands (Parks and Wildlife Services, 2004).

Figure 6. The moorland habitat of the broad-toothed mouse (*Mastacomys fuscus fuscus*) is threatened by the changing climate.



Photo: Michael Driessen

Figure 7. The burrowing crayfish is sensitive to changes in habitat and may be threatened by climate change.



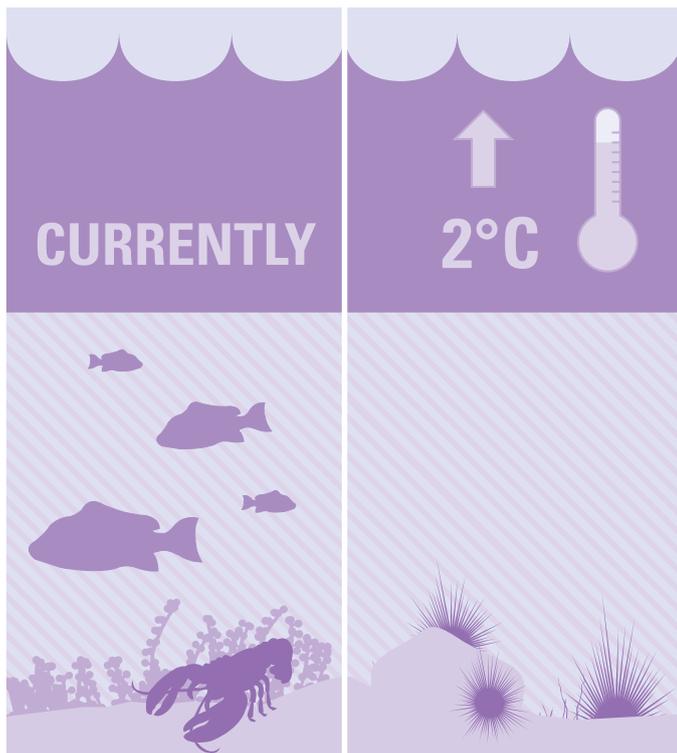
Photo: Michael Driessen

4. Marine diversity and fisheries are already threatened.

The oceans are warming; the surface waters off the east coast of Tasmania have warmed by approximately 2°C over the past 60 years, which is two to three times the average global rate (Wu *et al.*, 2012). Ocean temperatures will continue to increase, and the warm East Australian Current (EAC) is likely to move further south along the Tasmanian coast (Ridgway, 2007). The observed strengthening of the EAC is consistent with projections that Tasmanian waters would warm by as much as 2–3°C by 2070 (Figure 8) (CSIRO, 2007).

Invasive species favoured by climate change may threaten marine ecosystems (DPIPWE, 2010). For example, the warm EAC moving south has allowed new species, such as the long-spined sea urchin *Centrostephanus rodgersii* (Figure 9), to enter and thrive in Tasmanian waters. This sea urchin, formerly restricted to the coast of NSW, has invaded many kelp beds, significantly reducing their biodiversity and damaging Tasmanian rock lobster habitat (DPIPWE, 2010; Pecl *et al.*, 2009). Continued ocean warming will favour expanding sea urchin populations (Ling *et al.*, 2009).

Figure 8. Tasmanian waters could warm by 2–3°C by 2070.



The Tasmanian fisheries industry, worth \$522 million per year, will also be at risk from increasing water temperatures and new invasive species (ABARES, 2010). The Tasmanian salmon industry is one of Australia's largest and most valuable aquaculture industries. Increasing water temperatures may exceed salmon's optimal growing temperature with a temperature rise of 3°C potentially resulting in severe stress. Warmer temperatures are also likely to increase outbreaks of disease in aquaculture farms, and changes in rainfall, salinity, nutrients and sediments may also have a negative impact (Battaglene *et al.*, 2008).

Figure 9. Ocean warming favours the invasive long-spined sea urchin which has overtaken many kelp beds and is threatening marine biodiversity.



Photo: Scott Ling

5. Health will be affected.

The effects of climate change – increasing temperatures, changes to rainfall and rising sea levels – have serious consequences for our health. There are significant health risks for Tasmania.

All major health bodies in Australia have raised concerns regarding the impact of a changing climate on Australians' health, including risks due to increasing frequency and severity of extreme weather events, rising temperatures and the southern spread of disease. The Climate Commission recently published a comprehensive report on Climate Change and Health which provides more detail on national health consequences. It can be downloaded at www.climatecommission.gov.au.

The more vulnerable members of the community – the elderly, the very young, those with existing medical problems, those in rural communities and those in lower socio-economic groups – are especially at risk (**Figure 10**). Tourists, an important part of the Tasmanian economy, are also at risk due to their lack of familiarity with the climate, public health warnings, and local resources such as emergency evacuation routes and bushfire safety.

Climate change is likely to lead to increases in certain types of air pollutants and air-borne allergens like pollen and mould spores (IPCC, 2007, ch.8; Wolf *et al.*, 2010). These have serious impacts on people who suffer from respiratory illnesses, such as asthma, hay fever and lung cancer, and from heart disease. There is good evidence that climate change is affecting the timing of allergenic pollen production (IPCC, 2007). An earlier start to the pollen season will bring forward the start of allergic respiratory diseases, like hay fever. The amount of pollen may also increase with higher temperatures, contributing to an increase in the severity and occurrence of asthma and allergies.

Mental health is already a significant concern in Australia, and could be under further strain with changes in our environmental, social and economic systems. For example, changes in climate are likely to alter or disrupt current agricultural practices, including the types of crops and the regions in which they are grown. Farming, forestry and fishery communities may see their livelihoods adversely affected, could be exposed to natural hazards and in some cases, may be faced with relocation. These environmental, economic and social changes can lead to mental and emotional pressures and illness.

While heat-related deaths are expected to increase in Australia from around mid-century (Bambrick *et al.*, 2008), initial studies indicate that in parts of southern Australia, including Tasmania, warmer winters could see a reduction this century in cold-related deaths. This reduction in deaths could outweigh an expected increase in heat-related deaths in southern Australia.

Figure 10. Some groups in society are particularly vulnerable to the effects of climate change.



6. There are low-carbon opportunities in Tasmania.

In the coming decades, Tasmania will progressively see many opportunities that a low-carbon future will provide.

Renewable energy

Renewable energy will play a vital role in decarbonising our economy through reducing reliance on fossil fuels. Tasmania already produces around 70% of its electricity from renewable sources, mainly hydro (water) and wind (DEDTA, 2011). A growing number of Tasmanians are using renewable energy, including energy generated from wind, solar photovoltaic cells and methane from waste. Research and development is under way on other commercial-scale electricity generation options such as wave, geothermal and bioenergy technologies.

Tasmanian businesses taking advantage of renewable energy opportunities include engineering and manufacturing firms who have, for example, constructed steel towers for wind farms in Tasmania and other states.

Tasmania has the capacity to produce around half of Australia's renewable electricity (DEDTA, 2011). The Basslink electricity transmission cable between Tasmania and the mainland has enough capacity to allow Tasmania to send electricity that is beyond its own needs to Victoria.

Figure 11. Woolnorth Bluff Point Wind Farm.



Photo: Hydro Tasmania

Box 2. Renewable Energy on King Island

King Island, which is in Bass Strait about half way between mainland Australia and the Tasmanian mainland, has historically used diesel generators to meet its electricity needs. In 1998 Hydro Tasmania established Australia's second commercial wind farm on King Island. Following installation of more wind turbines as well as solar photovoltaic systems, diesel fuel use has been reduced by 45% (Hydro Tasmania, 2011).

Hydro Tasmania is working on innovations to increase renewable energy generation on King Island to over 65% of the island's needs, with capability to produce 100% of electricity from renewable sources some of the time. New developments will include expanding the wind farm, improving batteries and other energy storage, installing new diesel engine technology and trialling use of biodiesel.

The new storage systems and diesel engine, combined with advanced control systems, will allow excess wind energy to be absorbed for later use, and rapid switching between diesel and wind generation. This integrated system is designed to allow for times when wind generation exceeds demand and when it falls short of demand. In addition to these new electricity generation systems, a smart grid is being installed to provide better matching of supply and demand.

Box 3. Nichols Poultry Farm Sustainability Program

Nichols Poultry Farm, a free range poultry farm in the north of Tasmania, has found a way to save money while helping to reduce the farm's carbon emissions.

Owner, Rob Nichols, installed a 225 kilowatt wind turbine in 2008 to produce renewable power on the farm (**Figure 12**). The turbines produce about 300 megawatts of electricity per year, providing almost 50% of the needs of the poultry processing plant. When not needed on site, power is fed back into Tasmania's electricity grid. It is expected that the original investment will be paid back through reduced electricity costs within five years of installation.

Rob also started a separate business, *Blowing in the Wind*, to assist other small businesses to set up and maintain similar wind projects. The business is currently assisting with three other local wind turbine projects which are all expected to be operational by mid-2012.

Figure 12. Rob Nichols uses renewable energy on his poultry farm.



Photo: Nichols Poultry Farm

Wind

Tasmania has excellent access to reliable wind power because it lies within the path of the 'Roaring 40s' – a belt of strong westerly winds that circle the earth's mid-southern latitudes.

Some organisations are already utilising this potential. There are two operating wind farms in the state: Woolnorth Wind Farm in the northwest (**Figure 11**), the largest wind farm in the southern hemisphere, and the Huxley Hill Wind Farm on King Island (**Box 2**). There are also a number of privately owned wind turbines in the state, including a 225 kilowatt wind turbine located on the Nichols Poultry Farm (**Box 3**) and two wind turbines on Flinders Island with a combined generation capacity of 80 kilowatts. Additionally, new wind turbines are being installed on Flinders Island and expansion of the wind farm on King Island is planned.

Forests

Forests cover around half of Tasmania and about one fifth, or 150 million hectares, of Australia (**Figure 13**) (MIG, 2008). Australia has a much larger area of forest per person than many other countries (DAFF, 2011), and therefore the effect that carbon storage in forests has on our overall greenhouse gas emissions is more significant than in many other countries.

Figure 13. Forests are important stores of carbon.



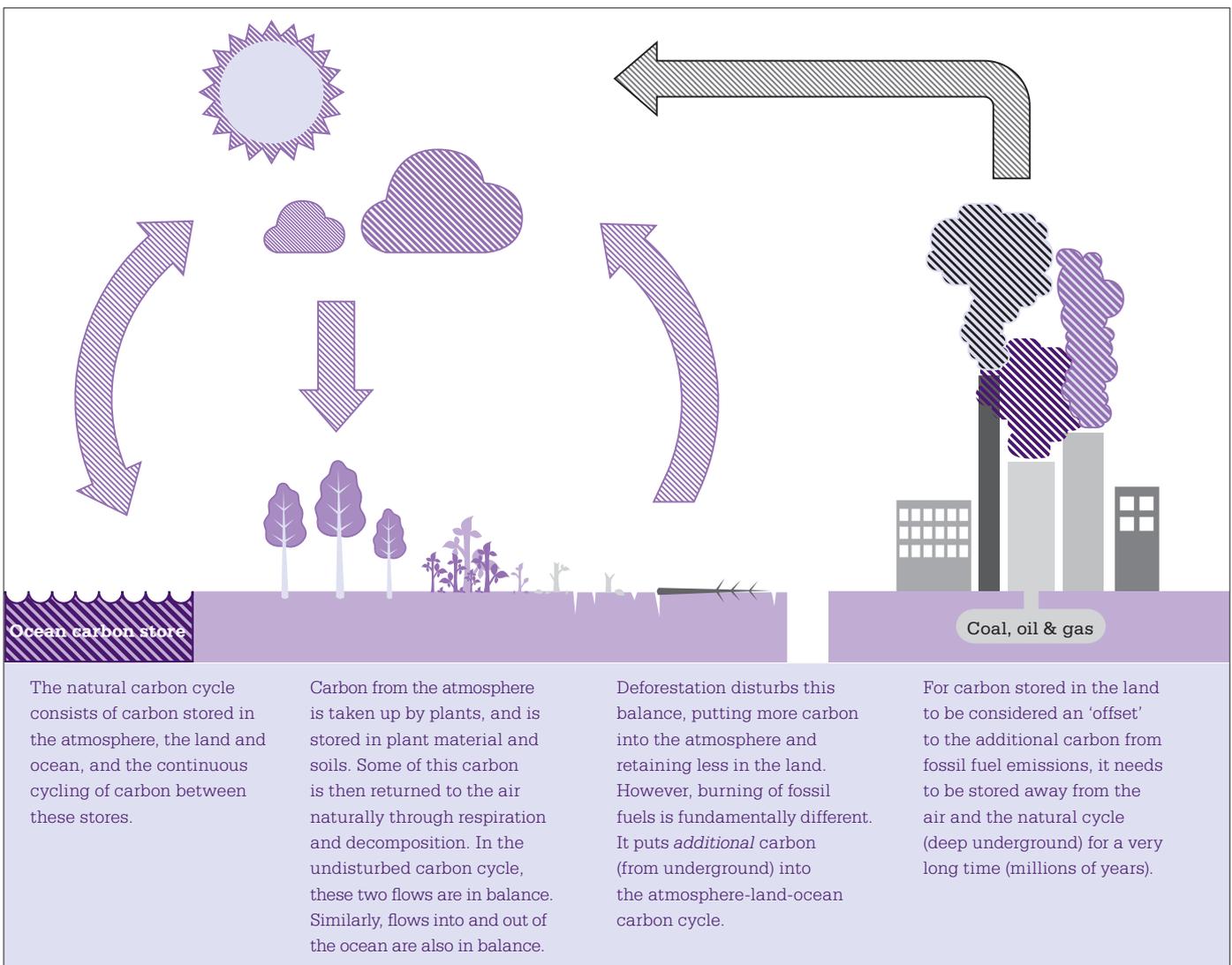
Photo: Department of Agriculture, Fisheries and Forestry

Forests and the carbon cycle

In the global carbon cycle (**Figure 14**), carbon is stored in the oceans, in the atmosphere and on land, and it also moves between these three compartments. From 12,000 years ago until the industrial revolution, the stocks of carbon in these compartments have not varied by much, and the net movements between them have been very close to zero. Carbon on the land is found in both below-ground (roots and soil organic matter) and above-ground (biomass in vegetation). Forests account for most of the above-ground carbon, and are therefore an important part of the natural carbon cycle.

Since the industrial revolution, human activities have disturbed the balance of the global carbon cycle in two ways. Deforestation, primarily to clear land for agriculture, has led to a net movement of carbon from the land to the atmosphere, resulting in a decrease in the land store of carbon and an increase in the atmospheric store. Second, burning of fossil fuels has released carbon from a geological carbon store that has been locked out of the atmosphere for millions of years, and which has played no part in the global carbon cycle during the time that humans have been on the planet. The release of this carbon is adding even more carbon to the atmosphere. Since the industrial revolution, about 80–85% of the additional carbon in the atmosphere has come from fossil fuel combustion and about 15–20% from deforestation (Raupach and Canadell, 2010). This shows that our major focus should be on reducing fossil fuel emissions.

Figure 14. The carbon cycle and human-produced emissions.



Several features of the role of forests in the carbon cycle are important to bear in mind:

- Deforestation and fossil fuel emissions are fundamentally different in how they affect the natural carbon cycle. Deforestation redistributes existing carbon in the cycle from one compartment to another; fossil fuel combustion releases additional carbon into the natural carbon cycle. Thus, from a scientific perspective, storing carbon in forests cannot 'offset' fossil fuel emissions.
- Storing carbon in forests is nevertheless a very valuable activity, but should be considered as returning carbon to the land from earlier deforestation and forest degradation (human land use that results in a depletion of carbon stocks in the forest). Forests can potentially store a large amount of carbon, and thus could be a valuable greenhouse gas emission reduction activity, particularly to provide some early gains during the transition to clean energy sources. However, storing additional carbon in forests should not delay the transition to a clean energy future.
- For a given soil type and regional climate, native forests with minimal human disturbance store more carbon than forests that have been planted or which are subject to extensive human disturbance (Diochon et al., 2009; Brown et al., 1997; Nepstad et al., 1999;

Costa and Wilson, 2000; Thornley and Cannell, 2000). Some of the most carbon-rich forests are moist temperate forests, such as those in southeast Australia (Keith et al., 2009). In the same way that avoiding emissions is the most effective approach for reducing emissions from fossil fuels, maintaining carbon stores in landscapes (including forests), through avoiding emissions from deforestation and by ensuring that where forests are managed it is done sustainably, is recognised internationally as a high priority.

- Significant amounts of forested land in Tasmania and throughout Australia are managed to deliver benefits such as clean water and shelter, and some forests are being managed for wood production. Careful and innovative management can help reduce our overall greenhouse gas emissions by maximising forest carbon storage for a given management regime, and in many cases, by using wood in place of other products (see 'Opportunities' below). Full carbon accounting for all products must be applied to determine the overall effectiveness of using wood products to reduce overall emissions. Full carbon accounting includes emissions from production, such as mining and forestry operations, through to use and disposal.

Opportunities

Re-establishing forests on cleared land can increase carbon storage in the landscape and provide many other benefits, including wildlife habitat, improved water quality, reduced soil erosion and shelter for livestock, as well as providing wood products for society (**Figure 15**). For example, Forestry Tasmania is establishing farm forestry plantations in partnership with farmers, giving priority to less productive farmland and sites where the plantings can assist with weed management and provide wildlife habitat and livestock shelter.

Where forests are harvested, the wood products continue to store carbon until they decompose or are burnt. The harvested wood can remain a store of carbon for many decades when it is used in long-lived items such as housing frames (Kapambwe et al., 2009), is recycled or disposed of in landfills (Ximenes et al., 2008a; Ximenes et al., 2008b). Obsolete wood products can also be burnt to produce energy.

Figure 15. Re-establishing forests on cleared land can increase carbon storage in the landscape.



Photo: Private Forests Tasmania

Wood can be used in construction instead of other materials, such as steel and concrete, which require comparatively more fossil fuel use (Moroni, 2011; Lippke et al., 2011; May et al., 2012). For example, in Australia, the emissions associated with using an elevated timber floor are around 13% lower than for concrete slabs, and the emissions associated with using timber frames are 21–43% lower than for steel frames (Carre, 2011). These estimates take into account the life cycle emissions associated with obtaining the raw materials, transport, manufacturing, construction, heating and cooling after construction, and waste from demolition of the building.

Wood residues can also be used to produce electricity, heat and liquid biofuels, instead of fossil fuels. Carbon is released to the atmosphere when the wood residue is used as a fuel, but these emissions can be balanced by uptake of carbon when the harvested forest is re-established, whereas emissions from the fossil fuels that have been replaced are avoided.

With a carbon price, goods that have low levels of emissions associated with their production and use will be less expensive relative to goods that have high levels of emissions. This could provide new opportunities for forest industries. For example, innovative new wood products and construction techniques may allow wood to replace a wider range of products. Any use of forests to reduce net emissions needs to avoid undesired impacts, such as competition with food production or negative impacts on biodiversity and water quality.

The new opportunities could be substantial, but more research and development is needed, in areas such as full accounting for carbon gains and losses, and wood-based energy production technologies and systems that are cost-effective and suited to Australian conditions.

The opportunities will also be influenced by climate change. While droughts and bushfires have always affected Australia's forests, climate change may increase the frequency and severity of these natural features in ways that shift the forest carbon balance towards lower storage and more transfers to the atmosphere. This risk underscores the need to take effective action to reduce greenhouse gas emissions and to reduce the risks of fire or other disturbances through appropriate management of the forests.

This is the critical decade. Decisions we make from now to 2020 will determine the severity of climate change our children and grandchildren experience.

Without strong and rapid action there is a significant risk that climate change will undermine our society's prosperity, health, stability and way of life.

To minimise this risk, we must decarbonise our economy and move to clean energy sources by 2050. That means carbon emissions must peak within the next few years and then strongly decline.

The longer we wait to start reducing carbon emissions, the more difficult and costly those reductions become.

This decade is critical. Unless effective action is taken, the global climate may be so irreversibly altered we will struggle to maintain our present way of life. The choices we make this decade will shape the long-term future for our children and grandchildren.



A handwritten signature in black ink, appearing to read 'Will Steffen'.

Professor Will Steffen
Climate Commissioner



A handwritten signature in black ink, appearing to read 'Lesley Hughes'.

Professor Lesley Hughes
Climate Commissioner

With thanks to the Science Advisory Panel, particularly Professor Brendan Mackey, and Dr Martin Moroni, representing a range of forest experts.

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