Faculty of Science
School of Ecosystem and Forest Sciences

Climate Change and Carbon Policy Assessment Report

Prepared for North-Northwest Tasmania Regional Forestry Hub

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Key terms and acronyms

Term/Acronym	Definition
Abatement	The reduction in human-created emissions of greenhouse gases, either by directly reducing emissions or by using offsets.
ABBA	Australian Biomass for Bioenergy Assessment
ACCU	Australian Carbon Credit Unit, the unit of carbon sold under the Emissions Reduction Fund. Each ACCU issued represents one tonne of carbon dioxide equivalent (tCO2-e) stored or avoided by a project.
AFPA	Australian Forest Products Association
CAA	Carbon Accounting Area
CEA	Carbon estimation area
CER	Certified Emission Reduction (credits)
CFI	Carbon Farming Initiative
CSF	Climate Solutions Fund. Replaces the Emissions Reduction Fund (ERF)
DELWP	Victorian Department of Environment, Land, Water and Planning
DISER	Australian Government Department of Industry, Science, Energy and Resources
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
ERF	Emissions Reduction Fund
ETS	Emissions Trading Scheme
FMA	Field Measurement Approach
FPO	Fixed price option
FSC	Forest Stewardship Council
GDP	Gross domestic product
HWP	Harvested wood product
MPI	Ministry for Primary Industries, New Zealand
MRV	Monitoring, reporting and verification
NGGI	National Greenhouse Gas Inventory

NZU	New Zealand Unit
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
VCU	Verified Carbon Unit
VER	Verified Emission Reduction
Voluntary carbon market	Carbon market based on corporate social responsibility or non-legally binding action. For example, Climate Active or Verra

1. Executive summary

Tasmania has recently achieved net zero greenhouse gas emissions across all economic sectors. Tasmanian forest managers and rural landowners have an important role as stewards and managers of the state's natural resources, many of which are important national and global assets. The active management of forests and natural resources can have a positive impact on climate change while supporting prosperous lives and lifestyles for all Tasmanians. By taking advantage of the opportunities arising in the value chain, different parts of the forest sector can potentially monetise benefits of carbon sequestration and demonstrate sustainability and their contribution to global climate initiatives. Increasing carbon in forest and wood products can provide new income for rural landowners and forest managers and complement investment for timber production or environmental outcomes.

Climate change is likely to increase risks for production forest ecosystems but also present opportunities in short to medium term. Addressing climate change and taking advantage of the opportunities in carbon markets can create a future where the Tasmanian forest sector will be a desirable place for new investment in forests, production systems and product value chains with a reputation for innovation, sustainability and resilience in managing natural assets.

Compared with other parts of Australia, Tasmania has more intact native vegetation, with 73% of the land area under native vegetation cover and a relatively high level of connectivity across the landscape. The state is a hotspot of botanical diversity. Climate change is increasing impacts and exacerbating existing threats to biodiversity. Actions to reduce greenhouse gas emissions and adapt to climate change can consider enhancing resilience of these ecologically important natural ecosystems.

The forestry sector is diverse, including wood production in public and private native forest, hardwood and softwood plantations and farm forestry and agroforestry, and wood processing into sawn timber, woodchips and pulp plus further processing into manufactured 'secondary' products. The sector has undergone considerable change since 2009. The main source of timber supply has recently shifted from public native forest to private plantations. The proportion of wood coming from native forests declined from 65% to 22% over the 10 years to 2018 yet native forests still support 41% of direct and indirect jobs. Other important native forest products and values include honey, tree ferns, seeds and game, tourism, energy, and water and catchment services. Increasing volumes of plantation wood are mostly exported as semi-processed woodchips.

This report was commissioned by the North-North West Tasmania Regional Forestry Hub (the Hub) to provide a strategic assessment of how climate change and Australia's carbon policy impacts upon the current state of Tasmania's forestry sector, and to identify opportunities for growth and barriers to expansion of the sector.

The Hub was established in 2019 and is funded by the Commonwealth Government as part of the National Forest Industries Plan – Growing a Better Australia – A Billion Trees for Jobs and Growth. The Hub, in consultation with industry, community and government stakeholders, has identified four priority themes aimed at delivering against the Commonwealth's objectives under the Plan.

Priority themes:

1. Access to land and land use policy for plantation forest investment
2. Supply chain and infrastructure
3. Climate change and carbon policy

4. Culture, skills and training

The University of Melbourne was engaged by the Hub to deliver this report addressing the third of the four priority themes: **Climate change and carbon policy**.

The Hub advised it will consider the opportunities and recommendations identified in this report alongside any recommendations made in relation to the other priority themes. The Hub will then develop implementation plans commensurate with priority opportunities and funding.

This report first describes the current science on the potential impacts of climate change. The report then provides an assessment of opportunities and barriers in relation to climate adaptation, climate policy and carbon markets, and bioenergy and natural capital accounting. The findings are based on a review of published scientific and academic literature and recent reports and consultation with a cross-section of industry and government representatives. The report concludes with recommendations in relation to climate change and carbon policy to expand Tasmania's forestry sector.

Climate impacts and adaptation

Tasmania's climate is dominated by maritime influences and is less influenced by the continental effects that drive climate and weather in other parts of southern Australia. Due to increased atmospheric greenhouse gases, the climate has warmed and become drier this century, although these changes are not as pronounced as other regions in southern Australia. Projections are for these trends to increase, with warmer temperatures, somewhat lower average rainfall, changing seasonal rainfall patterns and more extended droughts.

Human-induced climate change has begun to impact on people and natural assets. Extensive fires recently affected important endemic plant communities. Terrestrial ecosystems in Tasmania considered highly vulnerable to climate change include alpine ecosystems, moorlands and peatlands.

Climate change will potentially impact directly on forest growth, with more heat waves potentially causing long-term loss of carbon stocks in native forests. Plantation tree growth may increase, and wood quality may improve under higher temperatures. Increased CO_2 concentrations may increase tree growth, but this effect is uncertain. On drier sites with poor soils plantation growth may decline and mortality may increase. It will increase extreme fire weather conditions and the incidence of insect pests, and possibly, plant diseases. Repeated fires may impact on regeneration of important native timber production species. Changing climate will potentially increase impacts of extreme climate events on the workforce, transport, infrastructure and processing facilities. These estimates do not consider management actions to adapt and prepare for and avoid the impacts of future climate changes. Appropriate management decisions can reduce risk and provide opportunities to capitalise on potential beneficial aspects of climate change.

A warmer, drier climate in other parts of south-eastern Australia is increasing agricultural investment in Tasmania. This is increasing land values and competition for suitable land for tree growing.

Climate policy and carbon markets

Certain forest management activities are included in national carbon markets. The main regulated market in Australia was established in 2011 as the Carbon Farming Initiative (CFI). The Federal Government is currently the main purchaser of Australian Carbon Credit Units (ACCUs) under reverse auctions by the Emissions Reduction Fund (ERF, now the Climate Solutions Fund, CSF). Some plantation growers in Tasmania are participants in the ERF and revenue from carbon is being factored into plantation investment decisions.

Methods for activities relevant to the forest sector in Tasmania include: Plantation Forestry, Farm Forestry, Human-Induced Regeneration of Even-aged Natural Forest, and Reforestation by Environmental or Mallee Plantings. No CFI methodologies are applicable for carbon sequestered in pre-existing native forests.

Developing and registering a project under the ERF to enter the auctions is costly and requires specialist knowledge. Most successful vegetation-based projects have been large-scale projects in northern or inland Australia, where property size has supported sufficient scale of emission reductions or sequestration to cover project development costs.

Opportunities

Climate change impacts and adaptation

1. In Tasmania, climate change may not impact on tree growth, or risks such as wildfire, to as great an extent as on mainland Australia. This is an opportunity to promote Tasmania as a lower risk location to invest in trees and timber production.
2. For plantations at higher altitude where growth is currently temperature limited, climate change may increase tree growth. A warmer climate may also improve softwood timber properties.
3. The near-term impacts of climate change on forest plantations can be managed through options such as thinning, wider initial spacing, fertilising, monitoring and rapid control of insect pests, and actively managing fire risks. These techniques are well-established practice in current higher risk locations in Tasmania and other parts of Australia. In the longer-term, new genotypes and species might be required for some sites.
4. Integrating trees with farm operations presents opportunities to increase the forest area for production and conservation and to enhance farm resilience. Trees on farms can diversify income from wood, carbon (see below) or other tree products, and can reduce other climate impacts on farm operations, for example reducing heat and cold stress on livestock, reducing erosion and run-off, moderating temperatures, reducing wind speed and rate of fire spread, and improving farm amenity.

Climate policy and carbon markets, bioenergy and natural capital accounting

5. Forests are an important component of the global carbon cycle. Maintaining, expanding and better managing forests, and using more forest products, have the potential to contribute to national and international objectives to reduce greenhouse gas emissions.
6. The greatest opportunity to increase carbon sequestration and reduce greenhouse gas emissions in Tasmania is by increasing the area of trees and forests on rural land, or by converting existing short rotation plantations to long rotation. There is limited potential to increase carbon sequestration by changing the management of existing native forest.
7. Tasmania is a biomass-rich economy with opportunities to replace solid fossil fuels for energy.
8. Natural capital accounting and reporting can support new types of investment in the forestry sector and build greater public understanding of the benefits of trees on rural land and of active management of native forests for multiple values.

Barriers

Climate impacts and adaptation

1. Lack of knowledge of future climate change, potential climate impacts and options for adapting to climate change is a barrier to avoiding future impacts. Current knowledge is not easily accessible, or in a useful form for making decisions, for forest managers and farm foresters.
2. Limited capacity to monitor and assess changes in forest condition and potential risks is a barrier to effectively responding to climate change impacts in a timely way. Improved forest monitoring can facilitate decisions of alternative management options to address key risks.
3. Lack of knowledge is limiting capacity to develop alternative species that are likely to be more suited to different sites in future climates.

Climate policy and carbon markets, bioenergy and natural capital accounting

4. Forest manager and farmer participation in the CFI in Tasmania has been limited due to: (i) complex methodologies and costly project development, (ii) the small scale of rural land ownership, (iii) restriction of tree planting in areas receiving more than 600 mm long-term average rainfall (this restriction has recently been made easier to meet for some regions, including northern Tasmania, but not southern Tasmania), (iv) the low carbon price and (v) inability to integrate multiple methodologies in projects such as soil carbon, plantation forestry and environmental plantings.
5. The plantation forestry methodology providing for conversion of short to long rotations is too restrictive.
6. Lack of a carbon methodology on avoided deforestation may be a factor in plantations being converted to agricultural land.
7. Lack of a native forest management methodology under the CFI is restricting opportunities for public and private native forest managers to receive credits for actions that increase sequestration or reduce emissions in native forests.
8. Lack of recognition of the carbon sequestration potential in wood products is restricting the opportunity to use wood products more widely in construction and other uses.
9. Policy settings do not facilitate the development of bioenergy as a renewable energy option.
10. Many Tasmanian landowners, and the community in general, are sceptical of planted trees as an investment. More trees in Tasmania's rural landscapes will require active communication and collaboration with landowners to overcome past legacies with plantation investment and to design approaches that meet their needs.
11. Policy makers and the public lack awareness and understanding of the natural capital, carbon sequestration potential and environmental benefits of sustainable forest management.

2. Recommendations

The recommendations outlined below reflect the findings from this report, particularly around opportunities and barriers to expansion of Tasmania's forestry sector. The recommendations are grouped around three key themes: adapting to climate change; improving climate policy and carbon markets; and exploring bioenergy opportunities and natural capital accounting and ecosystem services. The relevant barrier addressed by each recommendation is included in brackets at the end of each recommendation.

Adapting to climate change

1. Support research on potential impacts of climate change and management of increasing risks of wildfire, floods, out of season frosts, and pests and diseases. Provide tree growers with information and decision tools to manage these risks (barrier 1).
2. Continue to invest in risk mitigation for bushfires and insect pests and diseases and testing of alternative methods of fuel reduction burning such as mechanical fuel reduction (barrier 1).
3. Investigate and manage increasing risks to public infrastructure (including roads) to maintain supply chains in the forestry sector (barrier 1).
4. Develop a state-wide forest monitoring system for all tenures and forest types to provide a comprehensive picture of the structure, function and growth of the forest estate in response to changing climate and other conditions. This needs to be clearly linked to current forest assessment systems within agencies and to public datasets such as the Land Information System for Tasmania (LIST) (barrier 2).
5. Continue to explore and deploy remote sensing tools, data science and new technologies such as drones to reduce the costs of forest and carbon monitoring and to detect changes in productivity, shifts in species distribution and rapid assessment of pests and diseases (barrier 2).
6. Test and assess alternative species, or varieties within existing species, that are potentially better suited to future conditions on sites that are projected to experience reduced tree growth or increased mortality. Test suitable silvicultural options to achieve acceptable production on these sites (barrier 3).

Improving climate policy and carbon markets

7. Support recommendations of the King Review including: (i) compressed crediting in the Plantation Forestry method; (ii) new processes for ERF methods; (iii) use of forest certification schemes such as Forest Stewardship Council (FSC) and Responsible Wood to demonstrate a 'duty of utmost good faith'; (iv) developing a streamlined small-scale method; (v) method stacking in the 'landscape approach'; and (vi) streamlining audit requirements and assessing whether forest certification audits can be made dual purpose[1] (barrier 4).
8. Support proposals in the Clean Energy Regulator consultation paper on proposed changes to the audit framework. In particular noting that Plantation Forestry projects are low risk (i.e. eligible for few or no external audits) given the high level of regulatory scrutiny of plantations from other sources, such as the Forest Practices Authority and forest certification audits (barrier 4).
9. Support streamlining the regulatory approval process for prospective forest carbon projects in southern Tasmania under the '600 mm rainfall rule'. This could involve a 'deemed to satisfy' approval that can be

1 Forest sector representatives from Tasmania could meet with the Clean Energy Regulator to inform them of the current external audit processes already applied to commercial forests, in addition to carbon audits.

implemented during the property due diligence/pre-acquisition phase of project development (barrier 4).

10. Support a streamlined approval process for aggregated carbon projects allowing participants to give upfront consent for low-risk changes to the project, without the need for ongoing and costly approvals to be sought during the life of the project. This would simplify aggregation of smaller units into larger projects (barrier 4).
11. Support the viability of aggregating smaller areas of rural land into larger carbon projects by changing risk management requirements so that payment for ACCUs can be made for parts of an aggregated project, while other parts are 'paused' due to a natural disturbance, planting failure or other operational hurdles. Support a pilot project to assess the feasibility of carbon project aggregation, where an organisation provides services to bring a cluster of projects to a commercially viable size (barrier 4).
12. Consider the case for revising the Plantation Forestry methodology to enable the issue of ACCUs for avoided conversion of plantations to agricultural land (barrier 6).
13. Encourage the Clean Energy Regulator to review the Plantation Forestry methodology to incorporate the following (barrier 5):
    a. Expand the list of eligible species for conversion from short to long rotation plantations.
    b. Change the modelled baseline rotation length for these conversions from a prescribed number (currently fixed at 16 years in Tasmania), to a baseline rotation length determined by supporting management documentation (such as historical forest management plans).
    c. Expand the existing 'compressed crediting' arrangement that currently applies to conversion plantations via Equation 10, to apply to greenfield (new) plantations.
    d. Change the eligibility date in the method for conversion forests to the date the long rotation is planted, coinciding with the date that the carbon estimation area (CEA) comes into existence.
14. Seek clarity from the Federal Department of Industry, Science, Energy and Resources (DISER) on the conditions and rules for registration of a forest carbon project under the Verra or Gold Standards, for projects (such as native forests) where there is no ERF method available (barrier 7).
15. Support a new ERF method to be considered to enable the native forest sector to participate in the ERF. This could be a single broad 'native forest management' method integrating existing ERF methods, such as the Human-Induced Regeneration of a Permanent Even-Aged Native Forest (barrier 7).
16. Encourage the Australian Government to develop a procurement policy that recognises the full life cycle impacts of building products, not just those in use. This would involve encouraging the Australian Government to work with industry groups such as the Green Building Council of Australia to adopt voluntary building standards[2] to recognise the full life cycle impacts of building products (barrier 8).
17. Monitor the current review of the New Zealand Emissions Trading Scheme as it relates to forestry and consider how the design of that scheme might provide examples for reducing complexity for participation in forestry projects under the Emissions Reduction/Climate Solutions Fund and other carbon markets (barrier 4).

2 Such as the Green Star rating system: https://new.gbca.org.au/rate/green-star/.

18. Support analysis of greenhouse gas emissions and sequestration across the forest production and processing sectors to assess the overall potential of the sector to contribute to climate policy goals (barrier 11).

Bioenergy

19. Consider supporting further research on the status and cost of biofuel production in Australia and globally and assess the feasibility for construction of a liquid biofuel refinery in Tasmania (barrier 9).
20. Consult with the Tasmanian Government on a mandatory increase in the bioethanol component of fuel sold in Tasmania. This could be modelled on similar legislation to that already implemented in New South Wales under the *Biofuels Act 2007* (NSW) (barrier 9).

Natural capital and ecosystem services

21. Continue to engage with researchers and other bodies to assess and report on changes in natural capital, carbon stocks *(including carbon stocks in wood products)* and other ecosystem services *from managed forests and farm trees and demonstrate the forest sector's contributions to the UN Sustainable Development Goals* (barriers 10, 11).
22. Collaborate with state and federal governments, industry and forest land managers to encourage: (i) implementation of broader monitoring systems for natural capital accounting to enable consistent reporting and to demonstrate scale and connectivity benefits, and (ii) coordination of actions to manage risks to natural capital such as bushfires (barriers 10, 11).

3. Introduction and context

This report was commissioned by the Northern Tasmania Regional Forestry Hub (the Hub) to provide a strategic assessment of how climate change and Australia's carbon policy impacts upon the current state of Tasmania's forestry sector, opportunities for growth and barriers to expansion of the sector. The primary target audience is the Hub, with a secondary audience including Tasmania's forest industry, federal, state and local governments, and community stakeholders.

The assessment is based on a review of published scientific and academic literature and recent reports and consultation with a cross-section of industry, government, and community representatives. It provides an assessment of:

a. The current state of knowledge of climate change, impacts on the forest products and processing sector in Tasmania, and options for the sector in adapting to climate change

b. The current state of climate and carbon sequestration policy, opportunities and barriers for the forest growing and timber processing sectors in Tasmania and factors limiting growth for the future

c. Constraints related to carbon policy and climate change that affect the productivity and efficiency of the forest growing and timber processing sectors in Tasmania.

Tasmanian forest managers and rural landowners have an important role as stewards and managers of the state's natural resources, many of which are important national and global assets. They want to pass on these resources in a better state, adapting to a variable climate and in doing so contributing to significant mitigation actions. The active management of forests and natural resources can have a positive impact on climate change while supporting prosperous lives and lifestyles for all Tasmanians. By taking advantage of these opportunities arising in the value chain, different parts of the forest sector can potentially monetise benefits of carbon sequestration and demonstrate sustainability and their contribution to global climate initiatives.

Addressing climate change and taking advantage of the opportunities in carbon markets will require significant targeted investment and focused climate initiatives integrating adaptation and mitigation, enabling the sector to maintain and increase productivity and profitability in a variable and changing climate. This can create a future where the Tasmanian forest sector will be known as a desirable investment opportunity with production systems and innovation for resilience in natural assets and along product value chains.

3.1. Tasmania

Tasmania has a population of 510,000 people located in 29 local government areas, with a median age of 42.[3] On average, the population is older, with lower education attainment and a higher proportion born in Australia than the national average. Population is more regionally distributed than most mainland states. About half of the state's population lives in south-east Tasmania, in the greater Hobart area. The state's economy depends heavily on mining, tourism, fisheries and aquaculture, forestry, and primary industries.[4] Manufacturing (including secondary forest products) makes the greatest contribution to economic output in the region (16.6% of total). Tourism directly and indirectly generates $2–3 billion per annum, about 10% of the state's gross state product. Health Care and Social Assistance is the largest employer (31,714 jobs, 14.7% of total employment). Real economic growth was relatively stagnant until 2015 but increased

3 https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/6?opendocument.

4 https://app.remplan.com.au/eda-tasmania/economy/industries/value-added?state=QbYZha!Vv5whZXg6Uam7llIwxDO0IzTOfpE4hkE0EAta989GfWfOdHJfeIww3GS1Qx.

between 2015 and 2019, prior to the impacts of COVID-19. Unemployment has fluctuated between 6% and 7% of the workforce in the past few years, about 1% higher than the national average.[4]

Seventy-three per cent of Tasmania is under native vegetation cover, with high connectivity across the landscape compared with other parts of Australia. The state is a hotspot of botanical diversity and endemism with 1900 native plant species, 34 native terrestrial mammals, 159 resident terrestrial bird species, 21 land reptiles, 11 amphibians and 44 freshwater fish.[5] Many Gondwanan elements (20% of the flowering plant species), concentrated in alpine and rainforest environments in western Tasmania, are endemic to Tasmania. Invertebrate taxa and freshwater fish species also have high levels of endemism.[5] Conservation of biodiversity is provided for in a systematic reserve system on public land, a voluntary private land reserve system and management prescriptions in production forests. Over 40% of the state is formally protected in reserves, including the Tasmanian Wilderness and Macquarie Island World Heritage areas. More than 600 plant and animal species are listed under Tasmania's *Threatened Species Protection Act 1995* (Tas). Climate change is likely to exacerbate existing threats to these species. Climate mitigation and adaptation activities need to consider opportunities to reduce threats to, and enhance resilience of, these important natural assets.[5]

3.2. The Tasmanian forest sector

In June 2016, Tasmania had 3,052,000 ha of native forests, 63% of the estimated area prior to European settlement. Twenty-seven per cent of native forest is in private ownership and 58% of forests are protected in formal or informal reserves on public and private land. Fifty native forest communities have been classified and mapped of which 39 have at least 15% of their estimated pre-1750 extent protected in reserves. Seven communities, mainly dry eucalypt types on private land, have less than 7.5% of their pre-1750 extent protected in reserves.[6]

The state has 226,000 ha of hardwood plantations (89% shining gum, 8% blue gum and 3% blackwood) and 76,000 ha of softwood plantations (*Pinus radiata* i.e. radiata pine). Plantation area declined by 12,000 ha between 2011 and 2016. Plantations are now almost all privately owned, with some in joint-venture or lease arrangements with rural landowners.[7] While the state has been less cleared than other parts of Australia, significant areas of cleared land in the state are potentially suitable for expanding forests.[8]

The forest production sector is diverse, including wood and fibre production from public and private native forest, hardwood and softwood plantations, and farm trees and agroforestry. Economic activities include primary production and processing into sawn timber, woodchips, pulp and paper and further processing into 'secondary' products. These products are further manufactured into woodwork, furniture, and paper packaging.[9]

Timber production and processing have undergone considerable change since 2009. Public native forest available for harvest decreased by about 33% from 2011 to 2016, from 563,000 ha to 376,000 ha, with a significant reduction in the volume of timber harvested from native forests.[6] Across all tenures, the average native forest area approved for harvesting under forest practices plans annually during 2011–2016 (7800 ha) was less than one-third of that reported during 2006–2011 (26,300 ha).[6]

Between 2008–2009 and 2017–2018, annual total log removals from native forest declined from 3.7 million m^3 to 1.3 million m^3. Annual hardwood plantation removals increased from 1.2 million m^3 to 3.0 million m^3

5 Department of Primary Industries, Parks, Water and Environment, Resource Management and Conservation Division (2010). Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview. Unpublished report. Department of Primary Industries, Parks, Water and Environment, Hobart.

6 FPA 2017. State of the forests Tasmania 2017. Forest Practices Authority, Hobart, Tasmania.

7 Downham, R & Gavran, M 2020, Australian plantation statistics 2020 update, ABARES, Canberra, June, CC BY 4.0. DOI: https://doi.org/10.25814/5ecb5411d91fa.

8 Lyons 2011. Plantation Potential of Cleared Land in Tasmania. Report to Private Forests Tasmania, March 2011.

9 Schirmer, J. et al. 2018. Socio-economic impacts of the forest industry Tasmania. Report to Forest and Wood Products Australia. May 2018.

and softwood plantation log removals increased from 0.9 to 1.5 million m^3 during the same period. The proportion of wood for industry coming from native forests declined from 65% to 22% over the 10 years from 2008–2009 to 2017–2018.[10]

In 2015–2016, the forest industry directly and indirectly contributed around $615 million to Tasmania's gross regional product ($314 million directly) and 3076 direct jobs and a further 2651 indirect jobs. ON hundred and forty six million was generated from native forest-based businesses, with a further $244 million from softwood plantations and $225 million from hardwood plantations. Regionally, $151 million was generated in the north-west (Cradle Coast) region, $235 million in the Northern region and $171 million in the Southern region. While native forests provided 22% of wood supply, they supported 41% of direct and indirect jobs. Jobs in the forest sector declined by about 55-57%–between 2006 and 2016.[11]

Native forests are harvested and regenerated using a range of silvicultural systems. Systems for wet eucalypt forests include clear-felling followed by seed-based regeneration, seed-tree and/or habitat-tree retention, 'variable retention' retaining habitat clumps, and islands and shelterwood systems in high altitude areas. Dry native forests are managed using selection harvesting systems, including group or gap selection, thinning and potential sawlog retention.[12]

Non-timber forest products include honey, tree ferns, seeds and game. In 2016 there were seven commercial honey operations and 215 registered beekeepers, a 23% increase on 2010.[13] Other important economic forest values include tourism, energy, and water and catchment services.

4. Methods

This report is based on a compilation of relevant published scientific studies and other reports and local knowledge. This knowledge base was systematically analysed for key trends and findings. These findings were tested with 30 stakeholders in an online webinar. Further insights were generated through interviews with 15 stakeholders from relevant parts of the sector.

5. Climate change and Tasmania's forests

This section describes Tasmania's climate, observations of recent climate change, projections of future change, and observed and potential impacts on native and plantation forests. It presents options for adapting to climate change in forest management and provides recommendations for supporting adaptation actions in forest management.

5.1. Tasmania's climate

Tasmania is within the mid-latitudes of the global climate system, sitting below the subtropical ridge of high pressure (at about 30 °S) at the northern edge of the 'Roaring Forties' winds circulating the southern hemisphere between 40 and 50 °S.[14] As a small island in the Southern Ocean, Tasmania's climate is dominated by maritime influences and less influenced by the continental effects that drive climate and weather in other parts of southern Australia. The dominant rain-bearing weather systems are cold fronts and troughs from the west. Eastern Tasmania is affected by other systems such as cut-off lows in the Tasman Sea that can bring high rainfall and flood conditions. Occasional strong, hot northerly winds from

10 ABARES 2019. Australian Forest and Wood Products Statistics. https://www.agriculture.gov.au/abares/forestsaustralia/australian-forest-and-wood-products-statistics.

11 Ibid. Schirmer et al 2018 (see footnote 9).

12 MPIGA 2018. "Australia's State of the Forests Report 2018." Canberra: Montreal Process Implementation Group for Australia, Department of Agriculture and Water.

13 Ibid. FPA 2017 (see footnote 6).

14 Climate Change in Australia https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/super-clusters/.

desert regions bring severe weather conditions. Mountain ranges along the west coast central regions and north-west and generally variable terrain results in high variability across the island in rainfall and temperatures, with a steep rainfall gradient from west to east and temperature decreases with elevation.[15]

Across Australia, including Tasmania, mean surface air temperature has warmed by around 1 °C since 1910 (Figure 1) and the duration, frequency and intensity of extreme heat events have increased.[15] Since the 1970s there has been an increase in extreme fire weather and a longer fire season.[15]

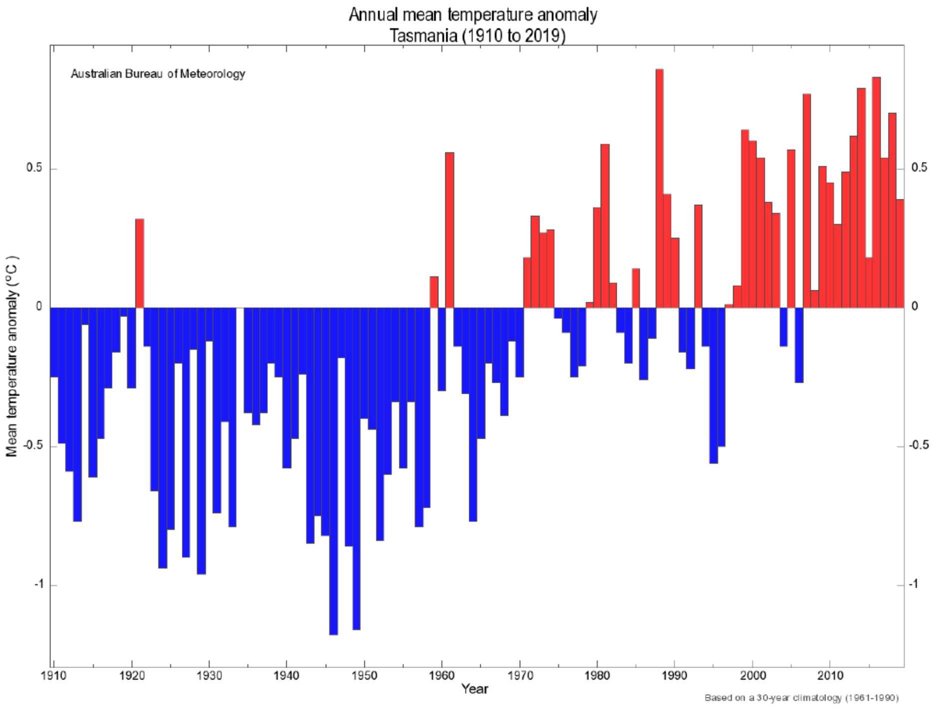

Figure 1 Annual mean temperature anomaly (°C) for 1910 to 2019 compared with the baseline of 1961 to 1990[16].

Rainfall has reduced in Tasmania since 1970 but not as much as other parts of Australia.[17] This is making Tasmania more attractive for agricultural investment, particularly for those sectors that depend on reliable rainfall and water availability, such as viticulture and horticulture. Tasmania experienced an extremely dry spring in 2015 followed by a wet autumn in 2016. Dry conditions led to significant bushfires in 2015–2016. Emergency service responses to the bushfires cost $55 million. The wet autumn of 2016 resulted in extensive, devastating flooding that cost three lives and $180 million in damages. Together these three events (i.e. bushfire, drought and flood) cost the state about $300 million, or 1% of gross state product.[18, 19]

15 Ibid. See footnote 14.

16 From Australian Government Bureau of Meteorology. Reprinted under Creative Commons licence http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=timeseries&tQ=graph%3Dtmean%26area%3Dtas%26season%3D0112%26ave_yr%3D0

17 Ibid. see footnote 14.

19 Bindoff NL, Love PT, Grose MR, Harris RMB, Remenyi TA, White CJ (2018), Review of climate impact change work undertaken, research gaps and opportunities in the Tasmanian context: Technical report, Antarctic Climate & Ecosystems Cooperative Research Centre, Hobart, Australia

19 Ibid. see footnote 19.

These changes are at least partly attributable to increased atmospheric greenhouse gas concentrations.[20] Projections indicate a strengthening of these trends,[21] including continued declines in late autumn and winter rainfall,[22] and shifts in rainfall pattern with increased summer rainfall events of short duration but greater intensity and increased localised flooding. Increased temperature and extended droughts are likely to increase the number of days with high fire danger and increase the frequency and/or intensity of wildfires, although this will depend on fuel loads, future wind patterns and topography.[23]

Current and near-term future warming and other climate shifts resulting from past increases in greenhouse gas concentrations are locked in the climate system. The extent of longer-term changes will depend on collective international efforts to reduce greenhouse gas emissions. Under the 2015 Paris Agreement, almost all signatories to the United Nations Framework Convention on Climate Change agreed to adopt aggregate emission pathways consistent with holding the increase in the global average temperature to well below 2 °C above pre-industrial levels as well as pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels.[24]

5.2. Climate projections

Projections of future climate change are developed using global circulation models with results downscaled to provide regional projections. These depend on the projected emissions of greenhouse gases, with different scenarios based on the success of policies to reduce emissions and technological change.

Projections are similar for eastern and western Tasmania (Table 1) with some differences in the magnitude of temperature increases and changes in rainfall.

20 Ibid. see footnote 19.

21 Ibid. see footnote 14.

22 Ibid. see footnote 16.

23 Fox–Hughes P, Harris RMB, Lee G, Jabour J, Grose MR, Remenyi TA & Bindoff NL (2015) Climate Futures for Tasmania future fire danger: the summary and the technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.

24 UN Framework Convention on Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

Climate component	Tasmania East	Tasmania West
Rainfall to 2030	Natural variability projected to dominate over trends due to greenhouse gas emissions. Little change in rainfall.	Rainfall decrease for spring (*high confidence*). Little change or increase for winter (*medium confidence*).
Rainfall to 2050	Increases in winter (*medium confidence*) under high emissions scenario. Winter and spring changes evident against natural variability. Summer and autumn rainfall changes possible but not clear.	Less rainfall in spring (*high confidence*). More rainfall in winter (*medium confidence*). Changes to autumn rainfall are possible but less clear. Tendency for summer decrease.
Temperature to 2030	Warming across all emission scenarios 0.4 to 1.1 °C above 1986–2005.	Warming across all emission scenarios 0.2 to 1.1 °C above 1986–2005.
Temperature to 2090	High emission scenario – warming of 2.3 to 4.0 °C. Intermediate scenario – warming of 0.9 to 1.9 °C.	High emission scenario – warming of 2.1 to 3.6 °C. Intermediate scenario – warming of 0.9 to 1.8 °C.
Extreme temperatures	Similar increase in extreme temperatures to mean temperatures. Higher temperatures on hot days. Increased frequency of hot days and duration of warm spells (*very high confidence*). Fewer frost-risk days (minimum temperatures under 2 °C) (*high confidence*).	As for eastern Tasmania.
Extreme rainfall and drought	increased intensity of extreme rainfall events is projected, with high confidence. Increase in the intensity of extreme rainfall events (*high confidence*) but magnitude of increases not clear. Longer drought (*medium confidence*) over the course of the century.	As for eastern Tasmania.
Fire weather	Increased periods of high fire risk *(high confidence*). Magnitude of the change to fire weather depends on rainfall projections and seasonal variation.	As for eastern Tasmania.
Evaporation	Increased potential evapotranspiration in all seasons (*high confidence*).	As for eastern Tasmania.
Humidity and solar radiation	Increase in solar radiation (less rain and cloud) and decrease in relative humidity in the cool season (*high confidence*). Changes in summer and autumn are less clear.	As for eastern Tasmania.

Table 1. Climate change projections for the Tasmania East and Tasmania West sub-regions. Based on Bureau of Meteorology and CSIRO[25] (This covers the whole state)

25 https://www.climatechangeinaustralia.gov.au/en/.

5.3. Climate impacts on Tasmania's forests

Vulnerability of forest ecosystems to climate change is a function of their exposure, sensitivity and adaptive capacity.[26] The exposure of forests will depend on future levels of greenhouse gas emissions, the effects of greenhouse gases on the global climate system and extent of change at a local level. Sensitivity to climate change will vary between individual organisms, between species, and between plant and animal communities and forest ecosystems. Changes in climate will also result in indirect effects that impact on forests, such as exposure to fire, introduced species and diseases.[27]

Direct effects of climate change on trees and forest species include increased atmospheric CO_2, rising temperatures, changes in rainfall and changes in fire regimes. Increased atmospheric CO_2 may increase plant productivity through increased water-use efficiency and could increase drought tolerance. However, water and nutrient availability will limit productivity increases, particularly under higher temperatures.[28] The evidence on this is mixed, with manipulative studies indicating increases in water-use efficiency provide little benefit under water limitation and globally the rate of forest mortality appears to be increasing despite rising CO_2.[29]

5.3.1. Impacts on functioning of native forests

Many Australian forest ecosystems are potentially vulnerable to increased temperatures and reduced rainfall. A quarter of Australia's eucalypt species occur over a range of annual mean temperature of less than 1 °C, and half of all native species occur over temperature ranges that vary by less than 3 °C.[30] With temperature changes to the end of the century potentially exceeding these ranges (depending on the outcomes of global greenhouse gas emissions objectives), the most suitable growing conditions for half of Australia's eucalypt species could potentially be outside the geographic range that they occupy today. However, there is considerable evidence that many species can tolerate conditions somewhat different from those experienced within their natural distributions.[31] Understanding is relatively limited of the interactions between the different aspects of climate change and their effects on forests, forest ecosystem processes and forest dependent industries and communities.

Changes in climate will alter tree flowering, fruiting[32,33] and seed set, germination and early growth of many native plant species and changes to habitats (fire regimes, soil water, flooding) and geographic distributions. Climate change is likely to affect the structure and functioning of natural ecosystems, including nutrient cycling and hydrology.[34]

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26 Keenan, R.J., 2015. Climate change impacts and adaptation in forest management: a review. Annals of Forest Science 72, 145–167.

27 Boulter, S., 2012. A Preliminary Assessment of the Vulnerability of Australian Forests to the Impacts of Climate Change – Synthesis. National Climate Change Adaptation Research Facility, Gold Coast, p. 245.

28 Franks, P.J., Adams, M.A., Amthor, J.S., Barbour, M.M., Berry, J.A., Ellsworth, D.S., Farquhar, G.D., Ghannoum, O., Lloyd, J., McDowell, N., Norby, R.J., Tissue, D.T., von Caemmerer, S., 2013. Sensitivity of plants to changing atmospheric CO_2 concentration: from the geological past to the next century. The New Phytologist 197, 1077–1094.

29 Brodribb, T.J., 2020. Learning from a century of droughts. Nature Ecology and Evolution 4, 1007–1008.

30 Hughes, L., Cawsey, E.M., Westoby, M., 1996. Climatic range sizes of Eucalyptus species in relation to future climate change. Global Ecology and Biogeography Letters 5, 23–29.

31 Booth, T.H., Broadhurst, L.M., Pinkard, E., Prober, S.M., Dillon, S.K., Bush, D., Pinyopusarerk, K., Doran, J.C., Ivkovich, M., Young, A.G., 2015. Native forests and climate change: Lessons from eucalypts. Forest Ecology and Management 347, 18–29.

32 Beaumont, L., Hartenthaler, T., Keatley, M., Chambers, L., 2015. Shifting time: recent changes to the phenology of Australian species. Climate Research 63, 203–214.

33 Rawal, D.S., Kasel, S., Keatley, M.R., C.R., N., 2015a. Herbarium records identify sensitivity of flowering phenology of eucalypts to climate: Implications for species response to climate change. Austral Ecology 40 117–125.

Rawal, D.S., Kasel, S., Keatley, M.R., Nitschke, C.R., 2015b. Climatic and photoperiodic effects on flowering phenology of select eucalypts from south-eastern Australia. Agricultural and Forest Meteorology 214–215, 231–242.

Rawal, D.S., Kasel, S., Keatley, M.R., Nitschke, C.R., 2015c. Environmental effects on germination phenology of co-occurring eucalypts: implications for regeneration under climate change. International Journal of Biometeorology in press.

34 Gilfedder L, MacGregor N, Bridle K, Carter O & Sprod D (2012) Implementing Adaptation to Climate Change in Terrestrial and Freshwater Natural Environments in Tasmania, Report on an expert workshop held in Hobart on 28–29 November 2011 (DPIPWE: Hobart, Tasmania).

Tasmanian native forests have been exposed to a high degree of historical climate variability with extreme episodic events such as droughts, floods and periodic high temperatures. Hot, dry northerly winds and associated wildfires have important impacts on forest resources. However, recent climate extremes with drought and high temperatures indicate key challenges for native forests.[35]

The effect of rising temperature will depend on whether the current range of species is above or below its optimal temperature, and its capacity to acclimatise. Reduced frosts may impact on capacity to regenerate in those species requiring cold temperature-induced dormancy for germination[36] but as the number of frost days diminishes this may allow other less cold-tolerant species to occupy sites that were previously not suitable. The impact of changing rainfall patterns will depend on the duration of longer periods of below average rainfall and the drought tolerance of individual species and capacity of species and ecosystems to respond and take up increased available water where rainfall increases.

Analysis of data from widespread, long-term permanent plots indicates that the growth rate of native eucalypt forests in Australia is sensitive to temperature with highest growth on sites with mean annual temperatures around 11 °C and where maximum average temperature is 25–27 °C. A warming climate could cause average biomass growth in temperate Australian eucalypt to decrease by 22%.[37] Recent evidence from the Warra Flux tower site in southern Tasmania supports this analysis. Tall *Eucalyptus obliqua* (stringybark) forest suffered a sharp decline in productivity during the record-breaking heatwave of November 2017, with the forest switching from being a strong carbon sink to a carbon source. The decline in productivity was associated with a sharp reduction in gross primary productivity, a small increase in respiration and a sharp increase in latent heat flux.[38] This has implications for the long-term permanence of carbon stored in native forests in Tasmania.

Repeated fires over short time intervals can potentially lead to natural regeneration failure of important obligate-seeding tree species such as *Eucalyptus regnans* (swamp gum) and *Eucalyptus delegatensis* (white-top stringybark). Increasing air temperatures, prolonged droughts and frequency of dry lightning storms is leading to multiple wildfires in short succession and more extensive immature forests, which do not produce seeds. Natural seedling establishment does not occur, leading to a loss of forest resources, less carbon stored and impacts on water, tourist and amenity values. Interventions through artificial seeding are required to ensure regeneration of these species.[39,40]

Extensive fires in Gondwanan refugia in the Tasmanian World Heritage Area due to extended drought, warming, extreme fire weather and unprecedented lightning storms has impacted on important endemic communities in destruction of organic soils. This has created debate over the need for more active management of fire and vegetation to protect these communities.[41]

Species range shifts are most likely to be in southerly directions or to higher elevations. For some species this may represent an expansion of range, for others a reduction.[42] Native forest communities are likely to

35 Harris, R.M.B., Remenyi, T., Fox-Hughes, P., Love, P., Bindoff, N.L., 2018. Exploring the Future of Fuel Loads in Tasmania, Australia: Shifts in Vegetation in Response to Changing Fire Weather, Productivity, and Fire Frequency. Forests 9, 210.

36 Mok, H.-F., Arndt, S.K., Nitschke, C.R., 2012. Modelling the potential impact of climate variability and change on species regeneration potential in the temperate forests of South-Eastern Australia. Global Change Biology 18, 1053–1072.

37 Bowman, D.M.J.S., Williamson, G.J., Keenan, R.J., Prior, L.D., 2014. A warmer world will reduce tree growth in evergreen broadleaf forests: evidence from Australian temperate and subtropical eucalypt forests. Global Ecology and Biogeography 23, 925–934.

38 Wardlaw, T. 2018. When the forest stopped growing: estimating the impact of the November 2017 heatwave on productivity of Tasmania's tall eucalypt forests. Unpublished report. Forest Knowledge.

39 Ibid. see footnote 34.

40 Bassett, O.D., Prior, L.D., Slijkerman, C.M., Jamieson, D., Bowman, D.M.J.S., 2015. Aerial sowing stopped the loss of alpine ash (Eucalyptus delegatensis) forests burnt by three short-interval fires in the Alpine National Park, Victoria, Australia. Forest Ecology and Management 342, 39–48.

41 Ibid. See footnote 34.

42 Ibid. see footnote 26.

experience local extinctions and the introduction of new species and higher potential for introduced species (including diseases, weeds and pests with expanded ranges) that are likely to result in changes to forest structure and disruption of biotic processes.

Species with restricted ranges such as mountain tops or low-lying islands and coasts, or those with life strategies or specialised habitats and ecological requirements are also considered highly vulnerable. Without intervention, climate change may result in the loss of some tree species, such as the Miena cider gum (*Eucalyptus gunnii* subsp. *divaricata*) on the Central Plateau[43]. Coastal 'swamp forests' may potentially be affected by climate change and associated sea level rise.[44]

Other terrestrial ecosystems in Tasmania considered highly vulnerable to climate change include alpine ecosystems, moorlands and peatlands. Shrub and tree invasion could transform these ecosystems, increasing fuel loads and changing fire regimes.[45] Increased fire frequency could influence flammability and availability of vegetation to burn and result in more fire in future. This could result in regional shifts in vegetation in response to frequent fire with loss of fire-sensitive vegetation due to long recovery times[46]. This has greater implications for conservation and tourism than production forestry.

5.3.2. Impacts on forest plantations

Plantations currently supply nearly 80% of wood to the Tasmanian timber industry.[47] While increased temperatures and drying climates are likely to negatively impact on tree growth and mortality in other parts of Australia, in Tasmania rainfall reductions are projected to be relatively modest and in areas with consistent rainfall timber production may increase, particularly if plantation species can increase photosynthetic rates under elevated CO_2.[48] There has been significant improvement in understanding of how increased atmospheric CO_2 might impact on forest growth.[49,50] Nutrients (particularly phosphorus) may limit the capacity of eucalypts to increase growth with higher levels of CO_2. In general, any growth increases under climate change are likely to be modest without the CO_2 effect, and mainly restricted to eucalypts on deep soils at higher altitudes (Figure 2).[51,52] Eucalypt plantation productivity may decline in areas of lower rainfall close to the coast, particularly on shallow soils. Growth rates of radiata pine may decline by 10% with projected climate change to 2030 and 2050 compared with the current baseline climate[53] (see also Figure 3). Projected increases in eucalypt production are considered unlikely to offset projected declines in softwood log supply.

The implications of these projected productivity changes on forest management are not clear. In areas where productivity is projected to increase, they are unlikely to result in increased harvest rates until realised and outcomes included in growth models and planning systems. They may result in improved profitability, depending on input costs and market conditions. Reduced yields in some regions may reduce profitability in the plantation sector, leading to reduced expenditure on protection (eg for fire trail and fire

43 Ibid. see footnote 5.

44 McDonald, J, Harkin, J, Harwood, A, Hobday, A, Lyth, A & Meinke, H 2013, Supporting evidence-based adaptation decision-making in Tasmania: A synthesis of climate change adaptation research, National Climate Change Adaptation Research Facility, Gold Coast, 169 pp.

45 Ibid. see footnote 33.

46 Ibid. see footnote 36.

47 Ibid. see footnote 10.

48 Battaglia, M., Bruce, J., Brack, C., Baker, T., 2009. Climate Change and Australia's plantation estate: Analysis of vulnerability and preliminary investigation of adaptation options. In, p. 125.

49 Ellsworth, D.S., Anderson, I.C., Crous, K.Y., Cooke, J., Drake, J.E., Gherlenda, A.N., Gimeno, T.E., Macdonald, C.A., Medlyn, B.E., Powell, J.R., 2017. Elevated CO_2 does not increase eucalypt forest productivity on a low-phosphorus soil. Nature Climate Change.

50 Quentin, A.G., Crous, K.Y., Barton, C.V., Ellsworth, D.S., 2015. Photosynthetic enhancement by elevated CO_2 depends on seasonal temperatures for warmed and non-warmed Eucalyptus globulus trees. Tree physiology 35, 1249–1263.

51 Pinkard, E., Paul, K., Battaglia, M., Bruce, J., 2014. Vulnerability of Plantation Carbon Stocks to Defoliation under Current and Future Climates. Forests 5, 1224–1242.

52 Battaglia, M., Bruce, J., 2017. Direct climate change impacts on growth and drought risk in blue gum (Eucalyptus globulus) plantations in Australia. Australian Forestry 80, 216–227.

53 ABARES, 2011. Potential effects of climate change on forests and forestry in Australia. In. Australian Bureau of Agricultural and Resource Economics and Sciences.

break maintenance, hazard reduction works, silvicultural works, and firefighting workforce and equipment) and therefore declining fire suppression capacity.[54]

These estimates do not consider management actions to adapt and prepare for and avoid the impacts of future climate changes. Appropriate management decisions can reduce risk and provide opportunities to capitalise on potential beneficial aspects of climate change (see Section 5.4).

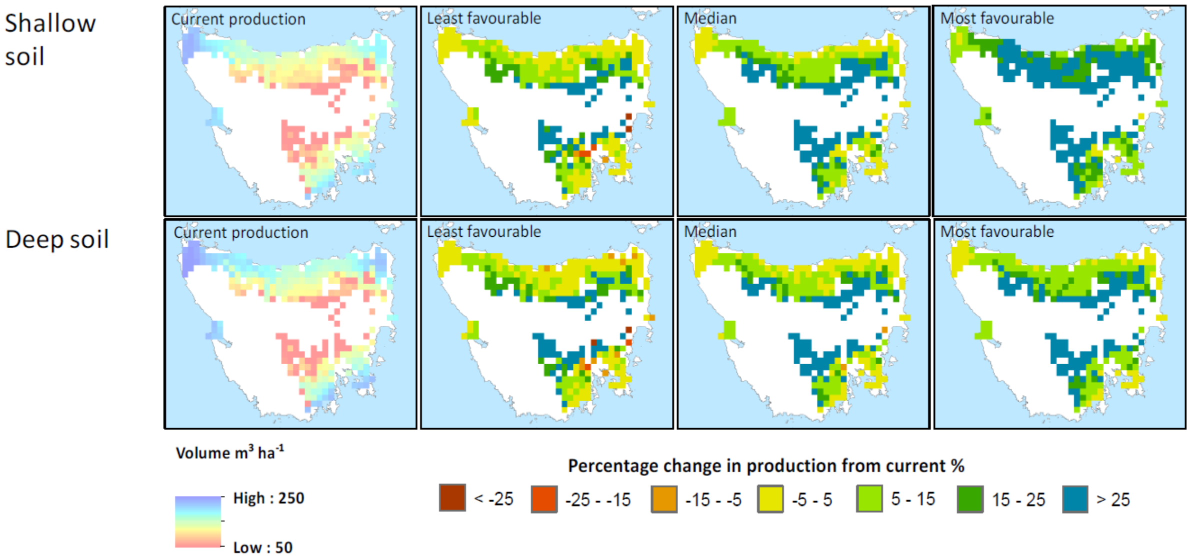

Figure 2. Potential changes in eucalypt plantation productivity in Tasmania under different climate change scenarios (least favourable to most favourable) with no effect of elevated CO_2 on tree physiology[55]

54 GHD, 2011. Report for Climate Change Amplified Plantation Fire Risk Study Final Report. In. Report for Department of Agriculture, Fisheries and Forestry, Canberra.

55 Reprinted with author permission from Pinkard E, Bruce J, Battaglia M, Matthews S, Drew D, Downes, G (2014). Climate Change and Australia's Plantations. Regional report 8. Tasmania eucalypt plantations. CSIRO.

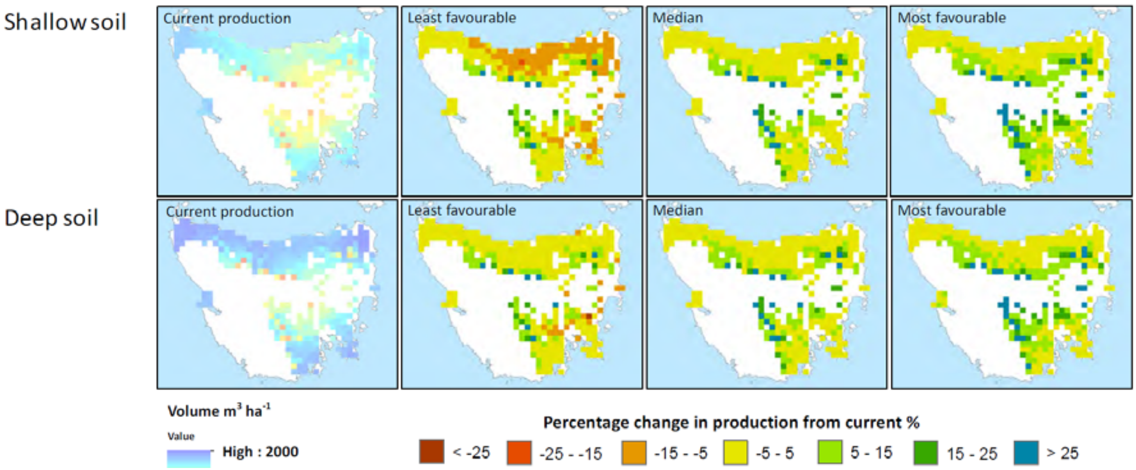

Figure 3 Potential changes in radiata pine plantation productivity in Tasmania under different climate change scenarios (least favourable to most favourable) with no effect of elevated CO_2 on tree physiology[56]

Comprehensive forest monitoring is a key factor in preparing for climate change. Industry stakeholders indicated they had not observed any obvious impacts of recent climate change on plantations. Government and researcher stakeholders interviewed indicated that Tasmania does not have a monitoring system that allows early detection of shifts in productivity, functioning or mortality in native or plantation forests that would provide the evidence to justify management responses.

5.3.3. Pests and diseases

Pests and diseases may increase under climate change with increasing temperature leading to shifts in range and more active reproduction cycles in warmer conditions.[57] Pest impacts may amplify negative effects of climate change on stand productivity in drier areas or shallow soils as trees come under more stress with warmer temperatures. Limited knowledge of pest and host responses in eucalypts restricts the reliability of assessment of future impact of insects and diseases on native eucalypt forests.[58]

Defoliators are the main pest types in the region. Defoliating insects and stem borers are likely to be favoured by warmer mean temperatures but generally not by heatwaves. Stem borers are attracted to stressed trees and may interact with drought stress. Early or later age defoliation could cause a reduction in final volume of about 10% (~15–60 $m^3\ ha^{-1}$). Fertility or rainfall may not have a large effect on defoliation responses and multiple defoliations will have a proportionally greater impact than single events, particularly at higher rainfall sites.

Foliar diseases will be favoured by warmer mean temperatures but increasing droughts and lower humidity will likely reduce the abundance and distribution of these pests. Root diseases will be favoured by warmer temperatures and more frequent storm events. Management strategies can ameliorate these impacts (see Section 5.4).

5.3.4. Fire

Climate change affects the risks of natural disasters such as bushfire, drought and energy security. Tasmania has experienced a level of climate change and this has had economic impacts. In general, climate

56 Reprinted with author permission from Pinkard E, Bruce J, Battaglia M, Matthews S, Drew D, Downes, G (2014). Climate change and Australia's Plantations. Regional report 9. Tasmania Radiata pine plantations. CSIRO.

57 Pinkard, E., Paul, K., Battaglia, M., Bruce, J., 2014. Vulnerability of Plantation Carbon Stocks to Defoliation under Current and Future Climates. Forests 5, 1224–1242.

58 Ibid. See footnote 30.

change impacts in Tasmania are likely to be milder relative to other parts of Australia or other parts of the world. Potential impacts must still be managed, but this may present opportunities for the state. Some stakeholders felt that recent wildfires were no greater in extent or intensity than those observed in Tasmania in the past.

A warmer and potentially drier climate will increase risk of uncontrolled bushfires. In a study of future fuel load and fire weather using projections from a range of climate models and emission scenarios, mean annual fine litter amounts would increase under future climate change by 1.2 to 1.7 t ha^{-1} in temperate areas, with the largest increases in fuel load and fire weather risk projected to occur in spring. Changes in annual cumulative Forest Fire Danger Index ratings varied from 57 to 550 in temperate areas.[59]

Tasmania is often projected to experience only minor changes in fire risk.[60] However, recent research indicates an overall increase in fire danger, especially in spring, with more days per year likely of total fire bans. Weather systems bringing the worst fire weather days to south-east Tasmania are projected to become more frequent. The number of 'Very High Fire Danger' days is projected to increase about 10% per decade, to more than 120% by the end of this century. The area under 'Total Fire Ban' conditions during summer will increase by 75% and the area of 'Very High Fire Danger' in spring could increase by more than 250%. These projections vary between regions; those with greatest fire risks are projected to worsen most rapidly.[61]

Under the current climate, average number of fire damage days is higher than fire danger days, because of the effect of litter quantity on fire intensity. Forest Fire Danger Index ratings tend to be relatively uniform across Tasmania, but higher altitude inland areas of Tasmania and central northern regions have less fire damage days (0–10 days) while the north-west and south-east areas have more (50–90 days). By year 2030, the annual number of fire damage days are projected to increase in the north-west (15–30 days), and north-east coast (10–25 days).[62]

5.3.5. Frost

Frost causes significant damage to broadacre and horticultural crops, with certain periods during crop development being particularly sensitive. Out of season frosts can also cause damage newly planted seedlings. Climate projections indicate that the number of frost days will decrease. However, clear, still conditions are resulting in increased out of season frosts in some southern parts of Australia. Frost at a critical time, such as during fruit tree flowering and early fruit development from October to November, may have significant impacts on bud set and fruit yield. Frosts are also important in agricultural and natural systems, by breaking life cycle development of pests or seed dormancy. While minimum and maximum temperatures in Tasmania have been increasing over the past 50 years, the number of frost days have not declined because frost incidence is determined by a range of factors including rainfall, wind and cloud cover.[63]

5.3.6. Wind

While climate projections indicate potentially increased intensity, size and more southerly extent of tropical storms and cyclones, they say little about increased wind speeds or storm damage in Tasmania. Wind can

59 Clarke, H., Lucas, C., Smith, P., 2013. Changes in Australian fire weather between 1973 and 2010. International Journal of Climatology 33, 931–944.

60 Ibid. see footnote 51.

61 Ibid. see footnote 34.

62 Ibid. see footnote 34.

63 Holz GK, Grose MR, Bennett JC, Corney SP, White CJ, Phelan D, Potter K, Kriticos D, Rawnsley R, Parsons D, Lisson S, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: impacts on agriculture technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.

cause significant damage to forest plantations but forest management organisations have well-developed guidelines and tools available for identifying windthrow risk and selecting sites and establishment practices.[64]

5.3.7. Impacts on forest industries and dependent communities

People and communities dependent on forests and forest resources are also vulnerable to climate change. While there is a high degree of exposure to changing climate, there is generally considerable capacity to adapt in Australian society.[65] Australia generally has a diverse and well-developed economy, extensive scientific knowledge, disaster mitigation and management arrangements, capacity to practice sustainable forest management and tight biosecurity procedures.

The Tasmanian economy is also relatively narrowly based and natural resource dependent. With a small population and limited tax base, the state has fewer resources and less human capacity to respond to climate-related events and less capacity to connect to mainland sources of raw material supply than other forest production regions.

Climate change is also just one form of rapid change affecting these communities and industries. Market changes, import competition, demographic and political change have all placed considerable demands on forest dependent communities in the last 20–30 years. Other forms of rapid change in Tasmania during the past decade are changes in timber production, level of supply and industry structure. Climate change may exacerbate these impacts on forest sector dependent communities.[66]

Projected future declines in plantation productivity in some regions (see Section 5.3.2) may impact on log supply and may result in reduced investment in harvesting, haulage and log-processing capacity and lead to reductions in the value of production and levels of employment[67]. Communities with a greater dependence on forest employment, eg Dorset (9.3%), Circular Head (6.6%), Derwent Valley (6.5%), George Town (6.0%), the Central Highlands (5.4%), Huon Valley (2.7%) and Waratah/Wynyard (2.2%) may be more vulnerable to changes in the sector.[68]

The interactions between people, economic change and climate impacts on natural resources are also important. Rural population decline may present problems for recruitment of industry staff and volunteer bushfire brigades that could be exacerbated if climate change reduces family farm viability. 'Tree-change' and absentee landowners in some rural areas may increase risks from unmanaged woody and grassy vegetation cover and likely fire ignition.[69]

Across Australia, understanding of adaptive capacity in the forest sector is limited[70] (Barlow et al 2013). While there has been considerable research on the vulnerability and impacts on other industry sectors and environments in Tasmania, for example agriculture, marine and coastal environments, the forest sector has received relatively little investigation.

64 Pinkard, E., Battaglia, M., Bruce, J., Matthews, S., Callister, A.N., Hetherington, S., Last, I., Mathieson, S., Mitchell, C., Mohammed, C., Musk, R., Ravenwood, I., Rombouts, J., Stone, C., Wardlaw, T., 2015. A history of forestry management responses to climatic variability and their current relevance for developing climate change adaptation strategies. Forestry 88, 155–171.

65 Garnaut, R., 2008. The Garnaut Climate Change Review Cambridge University Press, Melbourne.

66 Keenan, R.J., 2017. Climate change and Australian production forests: impacts and adaptation. Australian Forestry, 1–11.

67 Ibid. See footnote 56.

68 Ibid. See footnote 9.

69 Ibid. see footnote 51.

70 Barlow, S, Eckard, R, Grace, P, Howden, M, Keenan, R, Kingwell, R, McKellar, R, Meinke, H, Miller, C, Nelson, Lee, Russell, J, George, D, 2013 National Climate Change Adaptation Research Plan Primary Industries: Update Report 2013, National Climate Change Adaptation Research Facility, Gold Coast, Australia. ISBN: 978-1-921609-80-0

5.3.8. Climate change impacts on related sectors

Climate change in other parts of south-eastern Australia is driving change in production systems and in suitable locations for certain activities such as viticulture. This is increasing demand for land in regions with more reliable rainfall and favourable temperature regimes such as Tasmania. Climate change may allow for shifts in agricultural production in Tasmania. For example, currently most of the intensive cropping along the north-west coast is at elevations of less than 300 m due mainly to the shorter growing season and lower temperatures at higher elevations. The zone between 300 m to 500 m is used for crops for animals, seed potatoes, grazing and plantation forestry. With little agricultural production on suitable soils above 500 m, there are extensive areas of plantations, predominantly shining gum (*Eucalyptus nitens*) [71].

Under future climate projections, lands suitable for cropping may extend to higher elevations (450 m by 2030 and greater than 500 m by 2050). Projections for these areas of land indicate that rainfall is likely to remain adequate for cropping and pasture, and that arable land that is currently temperature limited may become suitable for more intensive land uses by 2085. For example, intensive horticulture and other forms of cropping may become suitable for production under a warmer climate and increases in carbon dioxide concentrations, with plant growth in the period 2070−2100 projected to increase by 11% at Burnie, 34% at Tewkesbury, and 54% at Waratah[72].

Tourism is impacted by natural hazards such as bushfires and floods. Change to fire risk has been assessed but more information is needed on the impact of other hazards (heat waves, storms, floods) on tourism in the long term. For example, tourists were concerned about visiting Tasmanian Wilderness World Heritage Area after fires in 2016 and visitor numbers dropped.[73]

5.4. Adapting to climate change

The most recent study on climate change adaptation for Tasmania[74] recommended investing in the following adaptation measures:

1. Research to provide a firm foundation for action by measuring and predicting climate change and identifying options
2. Providing individuals, communities and businesses appropriate information, resources, skills and incentives to plan and adapt to climate change and manage risks
3. Preparing for adequate and appropriate emergency responses to more frequent and intense events, such as bushfires, floods and storms, and assisting communities to recover from such events
4. Managing risks to public infrastructure, assets and values (including roads, biodiversity, national parks and reserves), and protecting industry and the community against health and biosecurity risks.

5.4.1. Options for adapting to climate change in production forests and plantations

In the primary industries across Australia there has been considerable research on incremental adjustments to current systems but less about longer-term transformation to new crops or production systems, or how decision makers might consider the relative costs and benefits of these transformation options. Analysis of

71 Holz GK, Grose MR, Bennett JC, Corney SP, White CJ, Phelan D, Potter K, Kriticos D, Rawnsley R, Parsons D, Lisson S, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: impacts on agriculture technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

72 Ibid. see footnote 74.

73 Press, A.J. 2016. Tasmanian Wilderness World Heritage Area Bushfire and Climate Change Research Project. Tasmanian Government, Hobart.

74 See footnote 42.

the potential benefits, costs and risks of incremental versus systemic or transformational changes need to be integrated into management processes.[75]

Forest managers can adapt to climate change by anticipating and preparing for potential changes or reacting in response to change in planned or unplanned ways. They can aim to build resistance to change (for example, to protect rare, high value species in a specific location or a plantation forest that is close to rotation age), or to promote resilience to enable forests to respond to future change while maintaining or providing for the recovery of important ecological processes [76]. Industry stakeholders reported that preparing for wildfires is taking resources away from production and processing and they need to invest in tankers and equipment and prepare for ember attacks on processing facilities.

Adapting forest management to climate change involves monitoring and anticipating change and undertaking actions to avoid the negative consequences or take advantage of potential benefits of those changes. Adopting the principles and practices of sustainable forest management (SFM) can provide a sound basis for addressing the challenges of climate change. Forest managers will need to plan at multiple spatial and temporal scales and adopt more adaptive and collaborative management approaches to meet future challenges.

While forest managers are accustomed to thinking in long time scales – considering the long-term implications of their decisions and factoring in uncertainty and unknowns into management – many are now responding to much shorter term social or economic imperatives. Local forestry practices are often based on an implicit assumption that local climate conditions will remain constant. As we have seen recently in Tasmania, other social and economic changes will also continue to drive changes in forest management.

For the next 10 years or so, when extreme climate events remain within the bounds of those experienced historically, past practice can be used as a basis for future management. Once climatic conditions move outside that range, new practices are likely to be required. Past strategies used by the forest industry involve locally based, autonomous decisions. Preparing for, and adapting to, more extreme climatic changes will require policy and infrastructure support and greater planning at regional and national levels.[77]

Adaptation strategies will differ between industrial forest managers, individual private tree growers, organisations growing trees for non-production purposes, wood product processors and others in the forest products value chain and communities who depend on forest resources for their livelihoods and wellbeing.[78]

Adaptation actions can be grouped into broader forest management, site-specific silvicultural practices, increasing community capacity and policy and planning options. Forest managers in Australia have developed and adopted techniques to reduce the effects of climate stresses on plantation establishment and growth,[79] for example:

- Hardening radiata pine nursery seedlings by increasing root:shoot ratios and planting containerised rather than open-rooted seedlings
- Controlling weeds for up to three years after establishment in drier environments and fallowing sites to reduce water stress and to increase stored soil water

75 Ibid. See footnote 61.

76 Millar, C.I., Stephenson, N.L., Stephens, S.L., 2007. Climate change and forests of the future: managing in the face of uncertainty. Ecological Applications 17, 2145-2151.

77 Ibid. See footnote 61.

78 Ibid. see footnote 63.

79 Ibid. see footnote 61.

- Planting on mounds to reduce impacts of waterlogging on sites receiving heavy inundations
- Pre-commercial thinning to avoid stand productivity and mortality in radiata pine and maritime pine (*Pinus pinaster*)
- Using lower initial stocking and managing soil fertility to adjust leaf area and reduce water stress in blue gum (*Eucalyptus globulus*)
- Selecting species and genotypes for drought resilience in maritime pine
- Monitoring programs and biological control for pests such as: *Sirex noctilio, Ips grandicollis, Phoracantha mastersi* and *Essigella californica*.

Silvicultural management has the potential to mitigate the negative impacts of climate change. Measures to reduce potential future climate impacts include[80] :

- Monitor insect populations and rapid control when populations are high
- Fertilise to promote crown recovery after insect defoliation
- Thinning plantations to manage drought stress
- Reducing initial stocking of *E. globulus* in water limited environments can reduce risk of mortality without impacting on productivity. Fertilising can increase productivity but may increase mortality
- For radiata pine, varying stocking or thinning and shortening the rotation to reduce exposure to extreme events
- On sites likely to become drier in future, replacing *E. globulus* with radiata pine

5.4.2. Adaptation options for native vegetation and biodiversity

Partnerships between state and university researchers is guiding research efforts with adaptation focused on reducing existing threats from fire, pests, weeds, disease and inappropriate land use change and land management. [81]

Adaptation goals include maintaining and enhancing connectivity and facilitating species movement, identifying and protecting future refugia, restoring degraded habitats and protecting keystone species. Ex situ conservation and seed banks of rare or endangered species are also important.[82]

While there has been considerable discussion of possibilities of translocation of species to assist adaptation, in Australia and elsewhere,[83,84] the appropriate situations to implement assisted migration of species to new habitats that may become suitable under changed climatic conditions are still poorly understood[85].

80 Ibid. see footnote 67.

82 Keenan, R.J., Nitschke, C., 2016. Forest management options for adaptation to climate change: a case study of tall, wet eucalypt forests in Victoria's Central Highlands region. Australian Forestry, 1–12.

82 Keenan, R.J., Nitschke, C., 2016. Forest management options for adaptation to climate change: a case study of tall, wet eucalypt forests in Victoria's Central Highlands region. Australian Forestry, 1–12.

83 Corlett, R.T., Westcott, D.A., 2013. Will plant movements keep up with climate change? Trends in Ecology and Evolution 28, 482–488.

84 Spittlehouse, D.L., 2005. Integrating climate change adaptation into forest management. Forestry Chronicle 81, 691–695.

85 Harris, R.M.B., et al 2018. Biological responses to the press and pulse of climate trends and extreme events. Nature Climate Change 8, 579–587

5.5. Climate-related challenges for Tasmania's forests

- Marginal sites with lower rainfall and shallow soils and low fertility are likely to become more marginal in terms of future growth potential, more susceptible to insect pests and experience higher mortality. Deployment of alternative species (see recommendations in Bush et al 2019)[86] or varieties of existing species (*E. globulus*) better suited to future conditions, combined with suitable silvicultural management may be necessary to achieve acceptable production on such sites. While the alternative species may have less capacity to produce wood, they may be less likely to completely fail or suffer from high mortality, presenting the grower with greater certainty. Research on alternative timber production species for Tasmania is relatively limited.[87]
- While potential forest productivity on some sites may increase under future climate scenarios, this is unlikely to be enough to offset lost production potential on others. Expansion of plantations in higher altitude, higher rainfall regions may face increased competition from agriculture – warmer temperatures will make cropping in these areas more viable and increase land values.
- Repeated fires in production native forests may drive a shift in species composition from current high value species like *E. obliqua*, *E. regnans* and *E. delegatensis* to more fire tolerant, lower value species.[88]
- Increased days with high fire danger and reduced periods during the year to safely undertake prescribed burning will increase risks of losses due to bushfires in native forests and plantations. More effort will be needed for fire surveillance and rapid bushfire suppression. Alternative fuel reduction approaches, such as thinning, mechanical fuel reduction or the use of animals, will be required, particularly in areas near human settlements.[89]
- While capacity to monitor and assess forest condition has improved in some parts of Australia,[90] there are gaps in monitoring of potential risks, such as mapping of the spread of myrtle rust (*Puccinia psidii*). Improved monitoring can facilitate the implementation of alternative management options to address key risks. This will require national investment and coordination across states and research organisations to detect emergence of key risks such as declining tree health, insect pests or disease outbreaks, reduced water availability and changing fire regimes.[91] Remote sensing tools, data science and new technologies such as drones can significantly reduce the costs of forest monitoring. Combining ground plot information and remote sensing will be needed to detect shifts in species distribution.[92]

5.6. Climate-related opportunities for Tasmania's forests

- Integrating trees with farm operations can enhance farm resilience by diversifying income from wood, carbon (see Section 6) or other tree products. Trees can reduce other climate impacts on farm operations, for example reducing heat and cold stress on livestock, reducing erosion and run-off, moderating temperatures, reducing wind speed and rate of fire spread and improving farm amenity. More trees will increase carbon stocks on farms, providing marketing opportunities for carbon neutral products.[93]

86 Bush, D., Harwood, C., Pinkard, E., 2018. Species for changing climates – Australian dryland forestry opportunities. Australian Forestry 81, 102–115.

87 Ibid. see footnote 76.

88. Ibid. see footnote 88.

89 Ximenes, F., Stephens, M., Brown, M., Law, B., Mylek, M., Schirmer, J., Sullivan, A., McGuffog, T., 2017. Mechanical fuel load reduction in Australia: a potential tool for bushfire mitigation. Australian Forestry 80, 88–98.

90 Haywood, A., Mellor, A., Stone, C., 2016. A strategic forest inventory for public land in Victoria, Australia. Forest Ecology and Management 367, 86–96.

91 TERN, 2017. TERN Science Enabling Plan 2013 – 2025: Transforming Australian Ecosystem Science In. Terrestrial Ecosystem Research Network, Canberra.

92 Fei, S., Desprez, J.M., Potter, K.M., Jo, I., Knott, J.A., Oswalt, C.M., 2017. Divergence of species responses to climate change. Science Advances 3.

93 O'Grady AP,Mitchell PJ (2017) Agroforestry: realising the triple bottom benefits of trees in the landscape. CSIRO, Australia.

- Using lower tree densities, alley planting, and very wide spacing in agroforestry increases resources for individual trees, allowing them to reach target size on a shorter rotation, despite lower per hectare yield. However, control of apical dominance and branching may be more difficult to achieve at wide spacing.
- The potential for alternative species can be improved by selecting the best performing genotypes of these species and selecting for better branching habit and apical dominance and by creating new hybrid eucalypts with combinations of good growth and better form and wood properties.[94]

94 Ibid. See footnote 76.

6. Carbon policy and Tasmania's forests

This section explores issues related to markets for forest carbon in Tasmania, identifies barriers to participation in the carbon market, and provides recommendations for reform to unlock further carbon market opportunities. In this section, 'abatement' describes carbon sequestered in trees (for example by forest growth), as well as avoided emissions (for example by avoided forest clearing).

Tasmania has recently become almost carbon neutral, with land sector sequestration now offsetting almost all emissions from energy, agriculture, industrial processes and waste. This has largely been achieved through a substantial reduction in the land use, land use change and forestry sector since 1990, included reduced land clearing and reduced rates of harvest in native forests.[95]

However, carbon market activity has been low. Eleven forest carbon projects in Tasmania were registered under the Emissions Reduction Fund (ERF) up to August 2020. Industry consultation suggests that revenue from carbon is beginning to be factored into plantation investment decisions. However, administrative and market barriers restrict participation by the plantation and farm forestry sectors. Native forest owners have not engaged in the carbon market due to a lack of suitable methods and uncertainties about appropriate baselines, measurement of carbon stock changes, and other requirements of trading.

6.1. Introduction to the carbon market

Australia's carbon market can be categorised as either compliance-based, or voluntary, as described below.

6.1.1. Regulated carbon markets

The main Australia carbon market is a government endorsed and regulated carbon market. The legislative framework for Australia's carbon market was established in 2011, initially known as the Carbon Farming Initiative (CFI) and designed to provide offset options for entities with emissions reduction obligations and linked to Emissions Reduction Fund (ERF). The Safeguard Mechanisms under the legislation create a compliance obligation for some emitters.

The ERF has three main mechanisms, which broadly relate to the supply and demand for Australian Carbon Credit Units (ACCUs):

1. Supply or creation of ACCUs occurs via the registration and running of eligible 'carbon farming' projects. This includes projects that sequester or reduce emissions from vegetation (including forests), agriculture, waste, and industry (including energy and transport)
2. Demand for purchase of ACCUs predominantly occurs via a reverse auction system in which the Federal Government is the sole buyer
3. Additional demand for ACCUs comes from the 'safeguard mechanism', whereby large emitters may need to report on and constrain their emissions.

There are many steps in registering and running a carbon project under the ERF. While a detailed discussion of this process is beyond the scope of this document, a good summary of how to participate in the ERF has been prepared by the Clean Energy Regulator (the Australian Government body that administers the ERF).[96]

The ERF had an initial funding commitment of $2.55 billion. The ERF auctions are held roughly every six months, and 11 have been held so far (since 2015). At the time of writing, the volume of ACCUs already

95 Tasmanian Climate Change Office 2019. Tasmanian Greenhouse Gas Emissions Report. The State of Tasmania, Hobart.

96 A good summary of the different phases in the ERF process is available on the Clean Energy Regulator website: http://www.cleanenergyregulator.gov.au/ERF/About-the-Emissions-Reduction-Fund/emissions-reduction-fund-schematic.

delivered to the government under the ERF auction mechanism is 58.9 Mt since 2015, with a further 140.9 Mt contracted for delivery between now and 2030.[97] The total value of ACCUs already contracted for purchase by the government to 2030 is $2.4 billion. A further funding injection of up to $2 billion for a package of climate measures known as the Climate Solutions Fund was announced in February 2019, and this includes ERF funding should ensure that the ERF has ongoing capacity to continue running auctions and purchasing ACCUs for the foreseeable future. To put the size of the ERF carbon market into context, the total value of all carbon market transactions under the ERF since 2015 ($2.4 billion), is just under the total value of Australia's log harvest in 2017–2018 ($2.6 billion).[98]

The volume purchased and average price reported in each of the 11 ERF auctions is shown in Figure 4

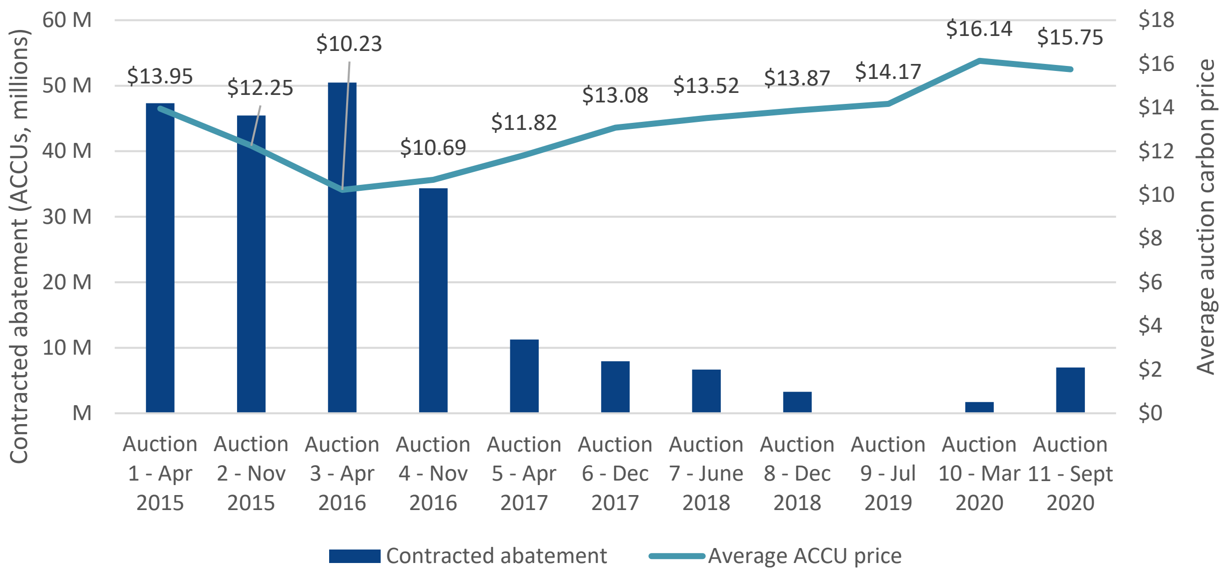

Figure 4 ERF auction results – carbon price and volume contracted

Source: Adapted from the Clean Energy Regulator, Quarterly Carbon Market Report, June 2020 and September Auction Results.

Since the third ERF auction in April 2016, the carbon price has risen with each auction held, with a 58% rise in the average ACCU price paid between April 2016 ($10.23) and the March 2020 ($16.14) (Figure 4), followed by a slight decline in the September 2020 auction to an average of $15.74 per ACCU. At the same time, the volume of abatement purchased at auction has declined significantly since the third auction. From a peak of 50 million ACCUs contracted at the April 2016 auction, the volume of ACCUs contracted dropped 99% to a low of just 60,000 ACCUs in the July 2019 auction. There may be a number of reasons for the steady increase in price since the third auction, but a significant factor is a decline in new ERF project registrations (i.e. constrained supply).

More recently in the tenth and eleventh ERF auction in March and September 2020 respectively, the volume contracted at auction started to increase again. There may be several reasons for this, but it is likely the higher carbon price is attracting increased project registration activity. In addition, the Clean Energy Regulator offered a new 'optional delivery' contract type in the tenth and eleventh auctions which has been very attractive, as it provides sellers with the option of selling to the government at a fixed price, or selling to other buyers (effectively providing a 'price floor').

97 Data current to September 2020. Source: Clean Energy Regulator September Auction Results:http://www.cleanenergyregulator.gov.au/ERF/Pages/Auctions%20results/September%202020/Auction-September-2020.aspx.

98 Source: ABARES, Australian Forest and Wood Products Statistics: https://www.agriculture.gov.au/abares/forestsaustralia/australian-forest-and-wood-products-statistics.

Via the ERF auction mechanism, the Federal Government is the major buyer of ACCUs and their subsequent 'retirement' (i.e. cancellation of the ACCU to meet an emissions reduction target), makes up 94% of the total ACCUs retired since 2018 (Table 2 ACCUs 'retired' under the ERF, safeguard mechanism, and voluntary carbon market. However, as mentioned above, compliance-based demand for ACCUs also comes from liable entities (i.e. large emitters) that are required to reduce their emissions under the safeguard mechanism, comprising 2% of the total number of ACCUs retired since 2018. The remaining 4% of ACCUs were retired by voluntary buyers, and state or territory governments. Note that this data does not reflect any forward purchases of ACCUs made, only ACCUs retired.

Quarter	ERF	Safeguard mechanism	Voluntary carbon market
Q1 2018	1,821,935	379,792	2,281
Q2 2018	3,249,831	0	292,766
Q3 2018	3,119,120	0	68,105
Q4 2018	2,302,684	10,101	164,568
Q1 2019	1,833,288	141,206	38,787
Q2 2019	2,918,490	0	111,278
Q3 2019	4,275,345	0	132,669
Q4 2019	2,566,313	2,637	194,144
Q1 2020	3,249,125	56,994	114,843
Q2 2020	3,352,122		206,019
Total since 2018	28.7 M	0.59 M	1.3 M
ACCU market share	94%	2%	4%

Table 2. ACCUs 'retired' under the ERF, safeguard mechanism, and voluntary carbon market

Source: Adapted from data provided by the Clean Energy Regulator, Quarterly Carbon Market Report, June 2020.

Key points:

- The ERF is the dominant carbon market in Australia at the present time, and the government is the main buyer of credits (i.e. ACCUs).
- Since the third auction in April 2016, the carbon price has risen by 58%, from $10.23 to $16.14 in the March 2020 auction, and then down to an average of $15.75 in the September auction.
- The volume of abatement purchased by the government in the ERF auction declined by 99% between the April 2016 auction, and the July 2019 auction. At the March and September 2020 auctions, market activity has picked up again, likely spurred on by the higher price and other factors.

6.1.2. Voluntary carbon markets

In addition to the ERF and safeguard mechanism, there is an active voluntary carbon market, albeit much smaller in size than that operated by the ERF, dominated by corporate buyers seeking to purchase ACCUs or other carbon credits via bilateral trades. The three main drivers for voluntary purchases of credits are:

1. Consumer demand or expectations for carbon neutral products and services
2. Internal company decisions to reduce emissions, including responses to shareholder pressure or demand for investments with low climate risk
3. Corporate buyers seeking to purchase ACCUs in anticipation of emission reduction targets at a future time. State and territory governments are also buyers of ACCUs in order to fulfil their respective policy commitments.

Demand for credits in the voluntary carbon market is non-legally binding and is therefore driven by a range of soft law instruments. The two main standards relevant to consumer and shareholder demand in Australia are (respectively) Climate Active,[99] and the Taskforce on Climate Related Financial Disclosure.[100]

Climate Active is a government-endorsed, nationally applicable carbon neutrality certification scheme. At the time of writing, Climate Active has certified over 120 companies or products as carbon neutral, offsetting over 15 Mt CO_2e over the life of the scheme. The following types of carbon units are eligible to offset emissions in order to claim carbon neutrality: ACCUs issued under the ERF; CERs issued under the Clean Development Mechanism; Removal Units (RMUs) issued by another Kyoto Protocol country; VERs issued by the Gold Standard,[101] and VCUs issued by the Verified Carbon Standard (now Verra).[102] Figure 5 shows the total number of ACCUs used to achieve Climate Active certification since 2018, which is just under 0.5 million. This compares with a total delivered ACCUs of 25.3 million under the ERF over the same time period.

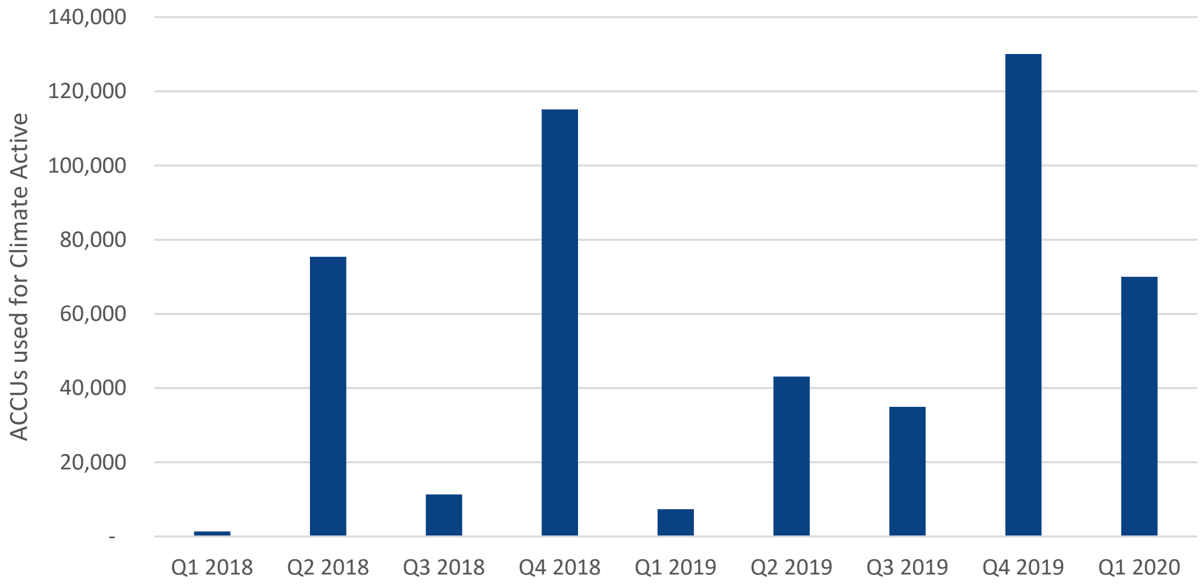

Figure 5. ACCUs used to achieve Climate Active certification by quarter since 2018

Source: Adapted from data provided by the Clean Energy Regulator, Quarterly Carbon Market Report, March 2019.

It is technically possible to register and run a carbon project under a voluntary carbon market standard and generate carbon units other than ACCUs. This may particularly be of interest, given the lack of an existing ERF method for Tasmania's native forest sector. One reforestation company in Western Australia has

99 https://www.climateactive.org.au/.
100 https://www.fsb-tcfd.org/.
101 https://www.goldstandard.org/.
102 https://verra.org/.

chosen to register and sell its credits under the Gold Standard, instead of the ERF.[103] However, any forest carbon project implemented under a voluntary carbon market standard would need to ensure it is compliant with rules to avoid double counting of emissions (in cases where the management activities are already accounted for in our National Greenhouse Gas Inventory).[104,105] The current process under the Government's Climate Active program to avoid double accounting the Gold Standard and the Verra for a voluntary carbon project in Australia, requires each credit (either VCU or VER) to be backed by another credit type (typically an international credit), which is purchased and then cancelled to ensure that each Australian credit is additional.[106] However this process of matching each Australian voluntary credit with an international credit is subject to review at the time of writing, given that most other countries will soon be required to report their emissions under the Paris Accord.

In addition, the newness requirement under the ERF[107] acts as a disincentive for implementation of pilot project activities prior to completion of a legislated method. This is because implementation of pilot activities as a voluntary carbon project would later render the project ineligible under the ERF.

The price of credits sold on the voluntary carbon market is highly variable and is often linked to the extent to which the project generates co-benefits beyond just carbon. However, the price is typically lower than credits in the compliance market. According to the World Bank, in 2018 the global price of voluntary credits under the Verra and Gold Standard ranged between US$0.1 and US$70/t CO_2e, but around half of the voluntary credits sold for less than US$1/t CO_2e.[108]

Given that most of Australia's carbon market transactions are related to the ERF, and the lack of clarity around whether Tasmanian forests are eligible to register under voluntary carbon market standards, the remainder of this document will focus on carbon projects under the ERF.

Key points:

- A voluntary carbon market exists in Australia, but the quantity of demand for ACCUs and other credits is much smaller than under the ERF.
- The price of voluntary credits is highly variable, however there is a significant supply of cheap voluntary credits internationally. In the absence of a price premium for co-benefits, the price of voluntary credits would generally be lower than the price of an ACCU.
- The pathway to register and implement a voluntary carbon project in Australia is unclear.

103 Source: 'First Australian project earns Gold Standard certification' Media Release by the Gold Standard. Available at: https://www.goldstandard.org/blog-item/first-australian-project-earns-gold-standard-certification.

104 The Gold Standard Guideline on Double Counting is available at: https://www.goldstandard.org/sites/default/files/documents/2015_12_double_counting_guideline_published_v1.pdf and the Verra/VCS policy on double accounting is available here: https://verra.org/wp-content/uploads/2018/03/VCS-Policy-Brief-Double-Counting_0.pdf.

105 MacIntosh et al. (2019) provide an explanation of how avoided timber harvesting projects implemented in Tasmania under the VCS Standard were no longer eligible to receive credits under the standard from 1 January 2013 (ie once Australia started accounting for 'forest management' in its Kyoto reporting). See Box 1 in 'Improving Carbon Markets to Increase Farmer Participation' Agrifutures Report, available at: https://www.agrifutures.com.au/wp-content/uploads/2019/07/19-026-Digital-1.pdf.

106 Personal communication, Ben Jobson, Assistant Manager, Climate Active. 15 September 2020.

107 Newness requirements under the ERF mean that a carbon project is not eligible if the project activities commence before the project is registered with the Clean Energy Regulator.

108 World Bank Group (2019). "State and Trends of Carbon Pricing 2019" World Bank, Washington, DC.Doi: 10.1596/978-1-4648-1435-8. Available at: https://openknowledge.worldbank.org/handle/10986/31755.

6.2. Regulatory framework of the Emissions Reduction Fund

The regulatory framework governing the ERF is summarised in this section.

6.2.1. Key legislation

Key legislation governing Australia's carbon market includes the Carbon Credits (Carbon Farming Initiative) Act 2011 and associated rules and methodologies (Table 3).

Carbon market legislation	Summary of legislation and implications for forests
Carbon Credits (Carbon Farming Initiative) Act 2011 (Cwlth)	Founding legislation that enables the registration, monitoring and auditing of carbon farming projects (i.e. supply of ACCUs), the ERF auction mechanism, and the safeguard mechanism (i.e. demand for ACCUs). Section 54 of the Act specifies that sequestering carbon or avoidance of emissions from living biomass, dead organic matter, and/or soil, are eligible carbon projects. Part 9 of the Act relates to Methodology Determinations, which are documents approved by the relevant Federal minister, that set out the requirements for a carbon project to be eligible under the ERF, and how the amount of abatement (i.e. ACCUs) will be calculated.
Carbon Credits (Carbon Farming Initiative) Regulations 2011 (Cwlth)	Sets out a list of excluded carbon farming projects, including: • Forests established under a managed investment scheme • Planting on land that was illegally cleared • Planting on land that was cleared of native forest in the last seven years • Protection of native forest in cases where the clearing would lead to an environmental improvement • Restrictions on planting of trees in areas with annual rainfall above 600 mm, unless it meets one of the eligible exemptions. More detail on this rule is provided below
Carbon Credits (Carbon Farming Initiative) Rule 2015 (Cwlth)	Provides further detail on administration of carbon farming projects and the ERF auction mechanism. Section 20B requires the Minister for Agriculture to assess whether a new plantation carbon project will have an adverse impact on agricultural production in the region. Note that this approval process applies to new plantations only, not conversion from short to long rotation.
Forest carbon methodologies	To generate ACCUs under the ERF, a proposed forest carbon project must meet the certain eligibility requirements as specified in a Methodology Determination. Those relevant to the Tasmanian forest sector are described below.

Table 3. Regulatory framework for the Emissions Reduction Fund

It should be noted that all the legislation identified above is applied nationally. There are no locally specific approvals requirements for carbon plantings in Tasmania, beyond those required for normal forest establishment or management. However, in southern parts of the state that are not covered by a specified exemption under Section 3.37(4A) of the CFI Regulations (i.e. the '600 mm+ rainfall rule'), there is a requirement within the Federal legislation to seek approval from the relevant State-based water authority,[109] prior to registering a tree planting carbon project. More information on the 600 mm+ rainfall rule is provided below.

6.2.2. The 600 mm+ rainfall/water interception rule

Section 3.37 of the CFI Regulations states that 'specified tree planting' (i.e. planting of trees in an area that receives more than 600 mm long-term average rainfall), is not permitted as an eligible carbon offset project unless it meets one of a number of exemptions. The exemptions are generally related to water uptake and availability within the catchment or region. On 2 April 2020, the CFI Regulations were amended to enable presentation of a plantation forestry project in some areas with greater than 600 mm rainfall, subject to meeting other conditions, if it was within an area deemed unlikely to have a material adverse impact on the availability of water.[110] The location of exempted areas is shown in Figure 6, in Tasmania this overlaps with the North-North West Tasmania Regional Forestry Hub.[111] More information about the implications of this rule is provided in Section 6.5.

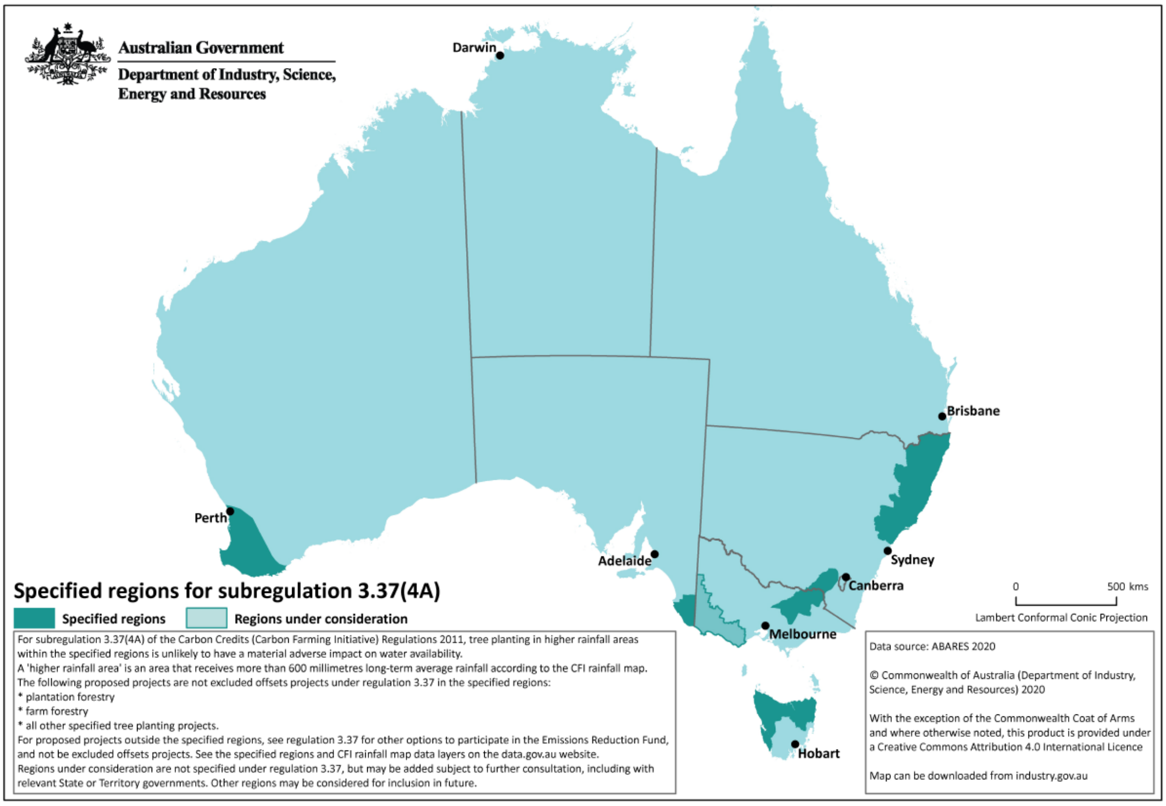

Figure 6. Areas declared as exempt from the 600 mm+ rainfall/interception rule

Source: https://consult.industry.gov.au/climate-change/plantation-forestry/supporting_documents/plantationforestryspecifiedregionsforsubregulation3374A.pdf

109 In Tasmania the relevant water authority is the Department of Primary Industries, Parks, Water and Environment (DPIPWE).

110 The CFI Regulations were amended via the *Carbon Credits (Carbon Farming Initiative) Amendment (Excluded Offsets Projects) Regulations 2020* (Cwlth), available at: https://www.legislation.gov.au/Details/F2020L00396.

111 Spatial data showing the boundaries of exempted regions and the official CFI rainfall map is available from the Australian Government data website: https://data.gov.au/dataset/ds-dga-b46c29a4-cc80-4bde-b538-51013dea4dcb/details?q=emission reduction fund.

Key points:

- Prospective farm forestry or industrial forestry plantation projects located within the North North West Tasmania Regional Forestry Hub region seeking registration under the ERF will not require a separate water interception approval from DPIPWE prior to project registration.
- Currently, plantations established in the south-east region are not covered by the exemption, although they may still be deemed not to have a material impact on water availability (i.e. given approval to proceed), as determined by DPIPWE.

6.2.3. Regulatory reviews

Under the *Climate Change Authority Act 2011* (Cwlth), the legislation underpinning the ERF is subject to an independent review by the Climate Change Authority every three years. The list of recommendations from the 2014 review of the CFI (i.e. the predecessor to the ERF), and the 2017 ERF review are available on the Climate Change Authority's website.[112] At the time of writing, the Climate Change Authority is in the process of performing another review of the ERF. Among the list of those that provided submissions to the 2014 and 2017 Climate Change Authority reviews was the Australian Forest Products Association, which articulated specific carbon market reforms sought by Australia's peak forest industry body.[113]

In addition to the reviews by the Climate Change Authority, in October 2019 the Federal Minister for Energy and Emissions Reduction, Angus Taylor, commissioned an Expert Panel to identify new opportunities to unlock low-cost abatement across the economy. Known as the 'King Review', the findings of the expert panel were published in May 2020.[114] Among the 26 recommendations was one to: "undertake consultation on amending the water requirements that apply to farm forestry and plantation projects under the ERF". As described above, this recommendation has already been acted upon, and uncertainty associated with the 600 mm+ rainfall/water interception rule has been reduced for prospective plantation projects located within eligible Hub regions, including the North North West Tasmania Regional Forestry Hub region.

In August 2019, the Federal Minister for Energy and Emissions Reduction, Angus Taylor, commissioned an Expert Panel on technology investment, led by Dr Alan Finkel. The outcomes of the review were intended to "guide the Government's technology investment portfolio to reduce emissions and be the cornerstone of the Long-Term Emissions Reduction Strategy". The Technology Investment Roadmap Discussion Paper was released for consultation on 21 May 2020[115] and the resulting 'Low Emissions Technology Statement' was released on 22 September 2020.[116] The Technology Statement prioritised five technologies for investment, including: hydrogen, energy storage, low carbon materials, carbon capture and storage, and soil carbon. Given the strong emphasis on soil carbon in this recent policy announcement, more research is needed to quantify the response of forest soils to different management activities.

112 The Final Reports and submissions from the Climate Change Authority's reviews are available at: https://www.climatechangeauthority.gov.au/publications/legislative-reviews.

113 AFPA provided submissions to both the 2014 and 2017 CFI/ERF reviews. Respectively, these submissions can be accessed here: https://www.climatechangeauthority.gov.au/sites/default/files/2020-06/CFI 2017 August/Submissions/AFPA_Climate Change Authority ERF Review 2017 final.pdf; and here: https://www.climatechangeauthority.gov.au/sites/default/files/2020-06/submissions/2014/cfi-review/submission-09-v2.pdf.

114 The Report of the King Review is available at: https://www.industry.gov.au/data-and-publications/examining-additional-sources-of-low-cost-abatement-expert-panel-report.

115 The Technology Roadmap Discussion paper is available at: https://www.industry.gov.au/news-media/australias-technology-investment-roadmap-have-your-say.

116 The first Low Emissions Technology Statement is available at: https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-first-low-emissions-technology-statement-2020. The document is intended to be updated annually.

More information on the opportunities arising from these reviews is provided in the Section 6.6 below.

6.2.4. Forest carbon methodologies

In order to generate ACCUs under the ERF, the proposed forest and management activities must meet the certain eligibility requirements as specified in a Methodology Determination. These are developed by the Commonwealth Government in consultation with stakeholders and are approved by the Federal Minister for Energy and Emissions Reduction prior to public release. The methodologies that are generally applicable to Tasmanian forests are described in Table 4 below.[117] The Clean Energy Regulator has produced a 'Sequestration Decision Tree' which is useful to assess which methodology (if any) might be applicable for different types of forests and associated management activities.[118]

Table 4 Summary of ERF methodologies that are currently applicable to the Tasmanian forest sector

Methodology[119]	Applicable forest type / management activities	Commercial timber harvesting allowed?	Applicable species
Plantation forestry	• Establishment of a new plantation on non-forested land, with the intention of producing wood products. • Conversion of a short rotation plantation to a long rotation plantation (either mid-rotation, or after the short rotation has been completed), with the intention of producing wood products.	Yes, timber harvesting is required under this method. The method also recognises carbon storage in harvested wood products. The allocation to different wood product categories is based on fixed, default values specific to Tasmania that cannot be altered.	• New plantation: any species permitted • Conversion plantation (i.e. long rotation): *Pinus radiata* is the only eligible species for planting in Tasmania
Measurement based methods for new farm forestry plantations	• Establishment of a new farm forestry plantation on land previously used for grazing or cropping. • For areas with 400 mm+ annual rainfall, planting must be no more than 300 ha or 30% of the farm, whichever is smaller.	Yes	Any, as long as it has potential to form forest cover (i.e. >2 m height; >20% canopy cover; >0.2 ha)
Human-induced regeneration of a permanent even-aged native forest	Natural regeneration of trees via the removal of one or more of the following suppression agents: • Clearing • Grazing by domestic livestock • Grazing by feral animals	No, although ecological thinning and collection of small amounts of firewood are permitted.	Native species that occur naturally in that area

117 There are a number of vegetation methods that are not included in this table, as they are not considered suitable for or eligible in Tasmania. For example, methods focused on cessation of clearing of native forest are unlikely applicable in Tasmania, as this activity is not widespread in Tasmania.

118 The Sequestration Decision Tree is available at: http://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Sequestration decision tree.pdf.

119 The full suite of vegetation carbon farming methods are available at: http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Vegetation-methods.

Methodology[119]	Applicable forest type / management activities	Commercial timber harvesting allowed?	Applicable species
	• Weeds.		
Reforestation by environmental or mallee plantings	• Establishment of permanent environmental or biodiversity plantings; or • Establishment of permanent mallee plantings.	No, although ecological thinning and collection of small amounts of firewood are permitted.	• Mixed species environmental plantings; or • Mallee species.

It is notable from the list above that there are currently no methodologies that are applicable for carbon sequestered in native forests that are sustainably managed for wood production. To this end, Tasmania's native forest industry has no clear way to participate in the ERF at the present time.

It should be noted that on 2 April 2020, the CFI Regulations were repealed to remove 'the cessation or avoidance of the harvest of a plantation' as an ineligible offsets project. According to the Explanatory Statement to the amendment regulation, the revised text: "…would allow projects that cease or avoid harvesting of plantation forests to proceed, subject to development of a new ERF Methodology Determination for this activity in future".[120]

This suggests that the Federal Government may have an intention of developing or revising a method to allow issuance of ACCUs to avoid plantation conversion or to a permanent planting. Such a method may be of interest to many landholders in Tasmania that have been left with stranded ex-managed investment scheme (MIS) plantations after the global financial crisis. There are many examples of farmers who have inherited standing plantations that are not commercially viable for harvest. The most likely scenario for these plantations is conversion to agriculture. An avoided conversion component could allow continued maintenance carbon sequestration and storage, potentially in combination with thinning and grazing. The project proponent would potentially need to demonstrate that this activity is additional - that is, retaining the plantation would not have occurred under normal practice. It should be noted that the Plantation Forestry method as currently drafted provides the option to convert (unviable) short rotation plantations to long rotation plantations, however the assumed 'baseline' scenario is the ongoing harvest and replanting of the short rotation plantation (not conversion agricultural land). Therefore, the current method does provide carbon project options for the stranded ex-MIS assets, albeit with reduced carbon abatement estimates than if the baseline were correctly assumed to be conversion to agriculture.

120 The Explanatory Statement to the *Carbon Credits (Carbon Farming Initiative) Amendment (Excluded Offsets Projects) Regulations 2020* (Cwlth) is available at: https://www.legislation.gov.au/Details/F2020L00396/Explanatory Statement/Text.

Key points:

- To be eligible for credits purchased by the ERF, the proposed project must meet the certain eligibility requirements as specified in a Methodology Determination.
- Tasmania's native forest managers have no clear way to participate in the ERF at the present time, due to a lack of a suitable methodology.
- A legislative barrier has been removed that might allow the creation/revision of a method to allow crediting of avoided harvest of a plantation.

6.3. Carbon market trends

The Clean Energy Regulator regularly updates an ERF Project Register, containing valuable data on the number of projects registered under the ERF, their method type, location and number of issued ACCUs.[121] This section provides market trends related to forest carbon projects located in Tasmania, as listed on the ERF Project Register. The analysis is current to 5 August 2020. For a detailed sectoral wide analysis of carbon market trends (i.e. without a specific focus on Tasmania and forests), the Quarterly Carbon Market Reports prepared by the Clean Energy Regulator provide an excellent resource.[122]

Figure 7 puts the size of the Australian forest carbon market in context with other method types under the ERF. It shows that vegetation-based projects dominate the ERF, making up 56% of ACCUs issued so far, followed by waste (31%), and savanna burning (10%). In terms of the total number of issued ACCUs, just over 81 Mt of ACCUs have been issued thus far, of which 44.7 Mt is from vegetation projects.

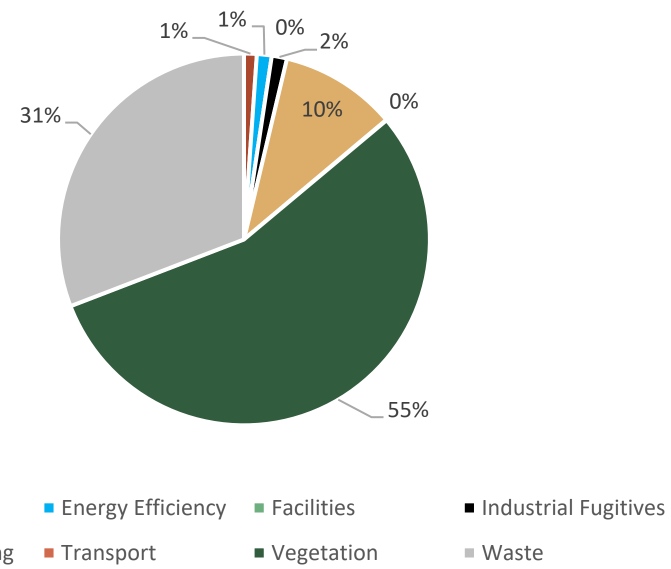

Figure 7. Total issuance of ACCUs under the ERF – by method type

Five hundred and thirty-six vegetation carbon projects have been registered under the ERF (Figure 8), only 3% (i.e. 18 projects) are in Tasmania. New South Wales has the largest number of registered projects (42%), followed by Queensland (30%) and Western Australia (15%).

121 The ERF Project Register can be accessed at: http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register.

122 The Quarterly Carbon Market Reports can be viewed at: http://www.cleanenergyregulator.gov.au/csf/market-information/Pages/quarterly-Market-report.aspx.

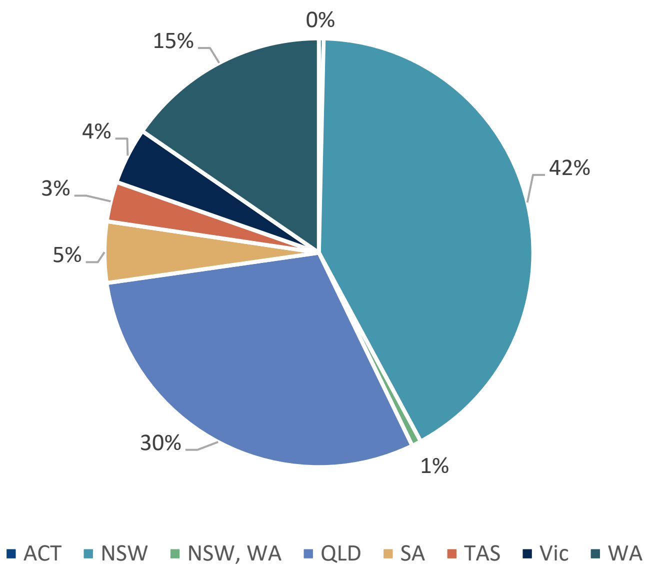

Figure 8. Number of vegetation carbon projects registered[123] under ERF, by location

Carbon market activity in Tasmania is also small in terms of total issued ACCUs (as opposed to the number of projects), making up 1.4% of Australia's total issuance to vegetation projects (Figure 9. Although, to put this into perspective, Tasmania has just 0.36% of Australian agricultural land (the land used for most reforestation projects), and 15% of Australia's total land used for forestry.[124]

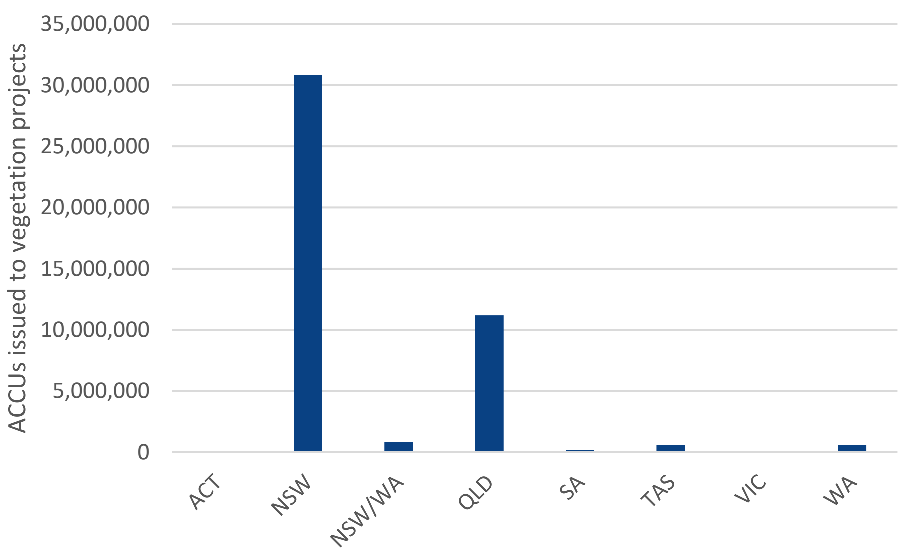

Figure 9. Total issued ACCUs from vegetation projects, by state/territory

Taking a closer look at the vegetation projects registered in Tasmania (Figure 10), there are three types: plantation forestry (eight projects); environmental plantings (three projects); and avoided harvesting of native forests (three projects).

123 The figure also includes projects that were registered but have since been revoked (ie withdrawn). Data on revoked projects has been included as it is useful to gauge where there is interest in carbon abatement projects, but for whatever reason the project did not go ahead.

124 Adapted from: Australian Bureau of Statistics (2020). 7121.0 – Agricultural Commodities, Australia, 2018–19. Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7121.02018-19?OpenDocument.

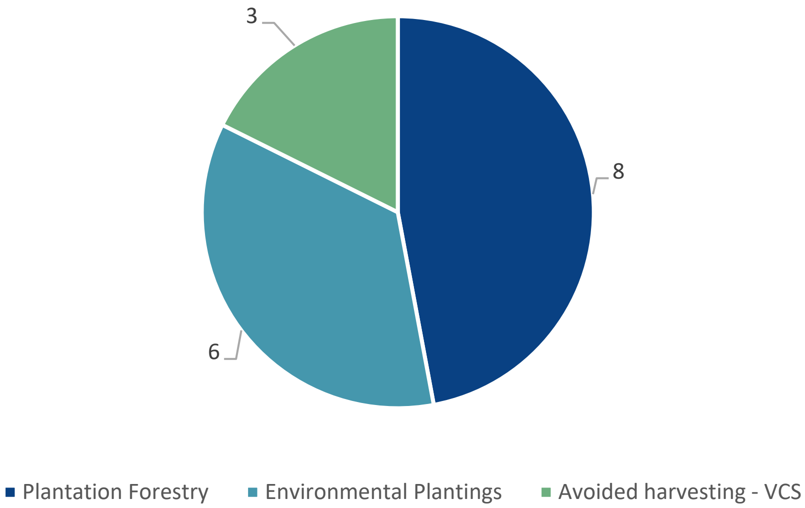

Figure 10. Breakdown of vegetation projects registered in Tasmania

In terms of issued ACCUs, most of Tasmania's vegetation ACCUs have been issued to 'avoided harvesting' projects. These are historical projects transitioned from the voluntary carbon market (developed using the Voluntary Carbon Standard (VCS)) in 2015 and 2017. These projects, located on private land, involved protection of native forests from being harvested. The method was written specifically to transition these three projects to the ERF, and no method is currently available for native forest management across Australia.

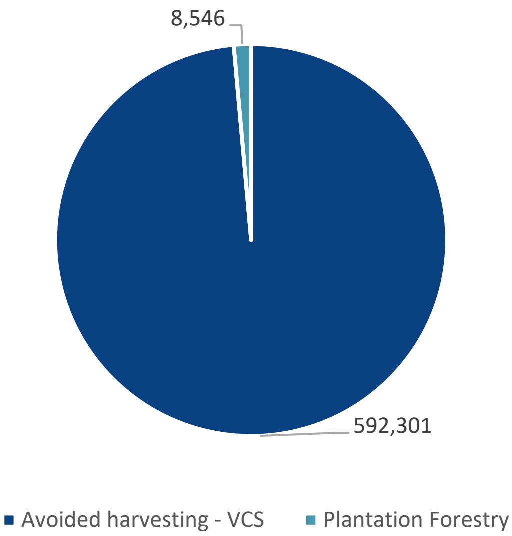

Figure 11. Issuance of ACCUs to vegetation projects in Tasmania – by method

The remainder of ACCUs issued to Tasmania's vegetation projects (1.4% of the total) have been to a project registered by Forico in December 2017 under the Plantation Forestry method (Figure 11), the first project to be registered under this method in Australia.[125] While an additional seven projects are located in

125 Source: https://forico.com.au/news/australian-first-for-forico-plantations.

Tasmania registered under the Plantation Forestry method, they have not yet been issued ACCUs likely because they have only recently been registered.

Six environmental planting projects were registered in Tasmania in 2015, but these were later revoked (i.e. withdrawn) in 2017 before generating any ACCUs.[126] This may reflect the difficulties in covering transaction costs for environmental plantings projects, under a relatively low carbon price.

However in terms of projects, Tasmania has the largest number of registered projects (eight) under the Plantation Forestry method of any Australian state (Figure 12), followed by Western Australia (six projects) and Victoria (five projects).

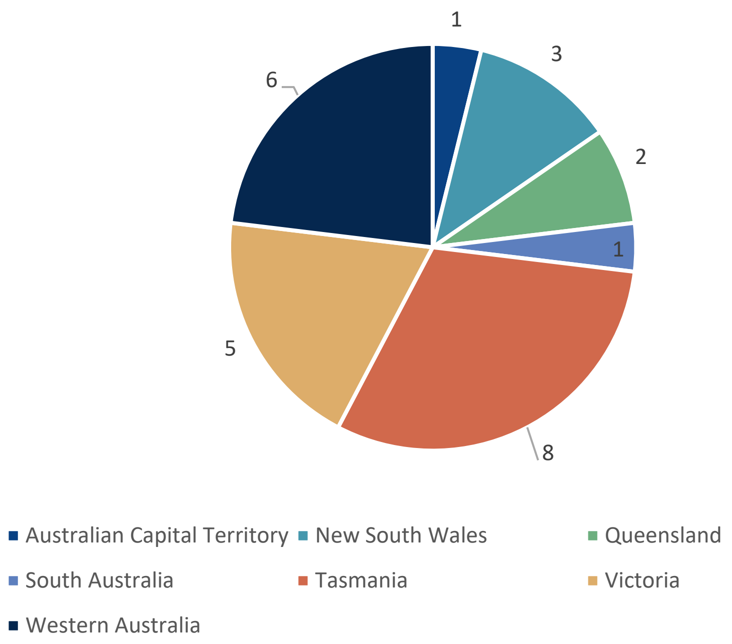

Figure 12. Location of projects registered under the Plantation Forestry method

Key points:

- On a national scale, Tasmania makes up only 1.4% of the total ACCUs issued under land sector ERF projects, although this is roughly in proportion to its national share of agricultural land (0.36%).
- Tasmania has the largest number of registered projects (eight) under the Plantation Forestry method of any Australian state.

6.4. Potential to reduce greenhouse gas emissions in Tasmania's land sector

The preceding section provided information about the status of carbon market activity in Tasmania under current policy settings. However, the abatement potential of forests in Tasmania is much higher than current markets. It should be noted that in most carbon markets (including the ERF), the eligible abatement potential of forests differs from the actual biophysical sequestration or avoided emissions. This is because most carbon markets have 'additionality' requirements, whereby only carbon that is sequestered or

126 These projects were all registered in the name of 'Australian Integrated Carbon Financial Services', and the company was deregistered in 2017. Source: ERF Project Registry and ASIC.

emissions avoided beyond 'business-as-usual' activity is eligible to generate credits. The intention of this rule is to incentivise behaviour change to further reduce emissions, not to simply reward existing good practice. Calculation of additional carbon sequestration typically requires the estimation of carbon stock change compared with either a historical baseline or a forward-looking baseline describing emissions under a 'business-as-usual' scenario. The baseline estimate is then deducted from the carbon stock changes that occur under the 'carbon project' scenario. This section provides a summary of existing studies that examined the theoretical abatement potential of native forests, plantation forestry and farm forestry in Tasmania.

6.4.1. Native forest

Reducing greenhouse gas emissions by changing management of Tasmanian, and Australian, native forests has been a matter of public debate for some time. Forest carbon stock and sequestration potential vary considerably with high variability in climate, topography and disturbance history. Native forest carbon stocks also vary through time with climate and disturbance, particularly large-scale wildfires. Policy decisions have also led to considerable changes in the extent of harvesting and the areas available for wood production. Consequently, establishing a baseline against which to assess any further change in management of native forests is challenging.

A study conducted by May et al (2012) modelled the estimated change in carbon stocks in Tasmanian native forests for different management scenarios compared with a 'business-as-usual' scenario.[127] The scenarios modelled for native forests were:

- **N1**: 570,000 ha of publicly owned native forests are protected in reserves, with the native forest harvest rate reduced from 300,000 m^3 $year^{-1}$ to 155,000 m^3 $year^{-1}$, resulting in a commensurate reduction in the pool of carbon stored in wood products by 2 Mt CO_2e
- **N2**: Phasing out old growth harvesting by 2020, while maintaining public native forest sawlog production at 300,000 m^3/year
- **N2A**: Phasing out old growth harvesting by 2020, while reducing public native forest sawlog production to 155,000 m^3/year
- **N3**: Extending the average rotation length of regrowth forests from 80 years to 120 years
- **N4**: Immediate cessation of old growth harvesting while maintaining public native forest sawlog production at 300,000 m^3/year
- **N5**: Immediate cessation of all native forest harvesting across all public and privately owned land

The modelled change in carbon stocks in Tasmanian native forests between 2013 and 2050 are shown in Figure 13 below.

127 May, B., Bulinski, J., Goodwin, A. and Macleod, S. (2012). Tasmanian Forest Carbon Study – CO2 Australia. Prepared for the Tasmanian Climate Change Office. Available at: http://www.dpac.tas.gov.au/__data/assets/pdf_file/0007/172789/ForestCarbonStudy_Report.pdf.

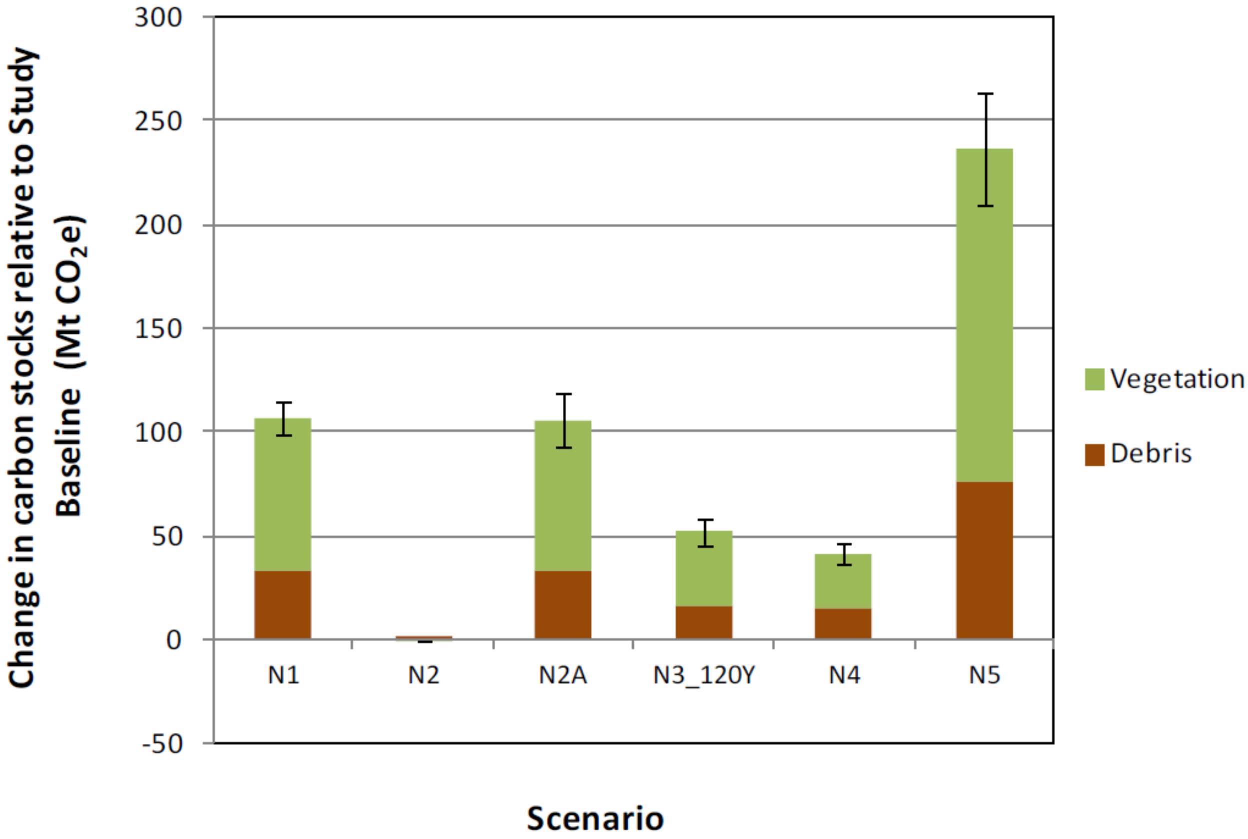

Figure 13. Modelled change in carbon stocks in Tasmanian native forests between 2013 and 2050, based on six scenarios[128]

The results show that cessation of native forest harvesting in Tasmania would result in a significant increase in forest carbon stocks compared to the business-as-usual baseline, even after accounting for reduced carbon stored in wood products. This effect is demonstrated through figures presented in the 2017 Tasmanian Greenhouse Gas Inventory indicating that Tasmanian native forests were a source emissions of about 9 Mt CO_2/year in the late 2000s to a net uptake of carbon of about –9 Mt CO_2/year since 2013 due to the decline in harvesting of public native forest in 2011 to about one-third of the annual rate in the late 2000s.

However, the potential for further emissions reductions by reducing native forest harvesting is likely to be limited. Sequestration in growing forests now exceeds emissions from harvesting of regrowth forests. In considering the potential effects of any future changes in forest management, a new baseline will need to be established based on current net emissions. The broader social and economic costs also need to be considered in relation to any financial benefits the state government might gain from further reducing native forest harvesting. Native forests now contribute about 20% of the wood removed from Tasmanian forests, but processing of this timber provides 41% of jobs in the sector.

May et al 2012[129] identified other opportunities for increasing carbon stocks, such as extending the rotation length in harvesting regrowth native forests. This could result in further net gains in carbon stocks. This opportunity needs to be reviewed considering current forest management objectives.

128 Ibid. See footnote 127. Reprinted with permission from CO2 Australia

129 Ibid. see footnote 129

Stakeholders also raised concerns that while native forests are currently sequestering carbon, without active management they become longer-term carbon sources with projected increases in wildfire extent and intensity, impacts of rising temperatures on tree growth and carbon stocks, and increased drought death and insect attack. Rates of future forest growth and sequestration capacity are therefore more uncertain.

Key points:

- A study conducted by May et al in 2012 identified a significant abatement opportunity from ceasing harvest of native forests in Tasmania. This was mainly due to ceasing harvesting of old growth and mature forests.
- Since the 2012 study, due to government policy decisions and changes in market conditions, log removals of public native forests have decreased from 3.7 million to 1.3 million m^3, mainly due to decreased harvesting in old growth and mature forests.
- Consequently, net carbon emissions from native forests have decreased. Under current rules, most of the opportunity to generate carbon revenue from reducing harvesting in public native forests has passed, as changed policies and market have already resulted emission reductions.
- Further opportunity to reduce emissions by reducing native forest harvesting are likely to be limited. The main opportunity for a new carbon method for Tasmania's native forest sector may be from changing silvicultural regimes, rather than avoided harvesting.
- Future losses of carbon stocks in native forests due to increased heatwaves, longer droughts, and increases in fire frequency and intensity will need to be considered in assessing future abatement options in native forests.

6.4.2. Plantations – industrial and farm forestry

The study conducted by May et al (2012) also examined the impact of different management scenarios on carbon stock of Tasmania's plantations (both industrial and farm forestry), and substitution between land uses.[130] The scenarios modelled for plantations and/or planting native forests were:

- **P1**: A 10% increase in rotation length for all plantations
- **P2**: Conversion of hardwood pulpwood plantations to long rotation sawlog plantations, by increasing the rotation length
- **P3**: Increased growth rate of all plantations by 25% through improved management
- **A1**: Conversion of 10,000 ha of private native forest to plantations by 2015, after which conversion ceases
- **A2**: Replanting unstocked areas of native forest with native eucalypt forest that are not harvested
- **A3**: Establishment of plantations across 10% of existing cleared farmland at average rate of expansion that occurred from 2000 to 2010
- **A4**: Establishment of plantations across 10% of existing cleared farmland at double the historical (2000–2010) expansion rate

130. Ibid. see footnote 127.

- **A5**: Conversion of 25% of existing short rotation hardwood plantations back to farmland after harvest.

The modelled change in carbon stocks in Tasmanian native forests between 2013 and 2050 are shown in Figure 14 below.

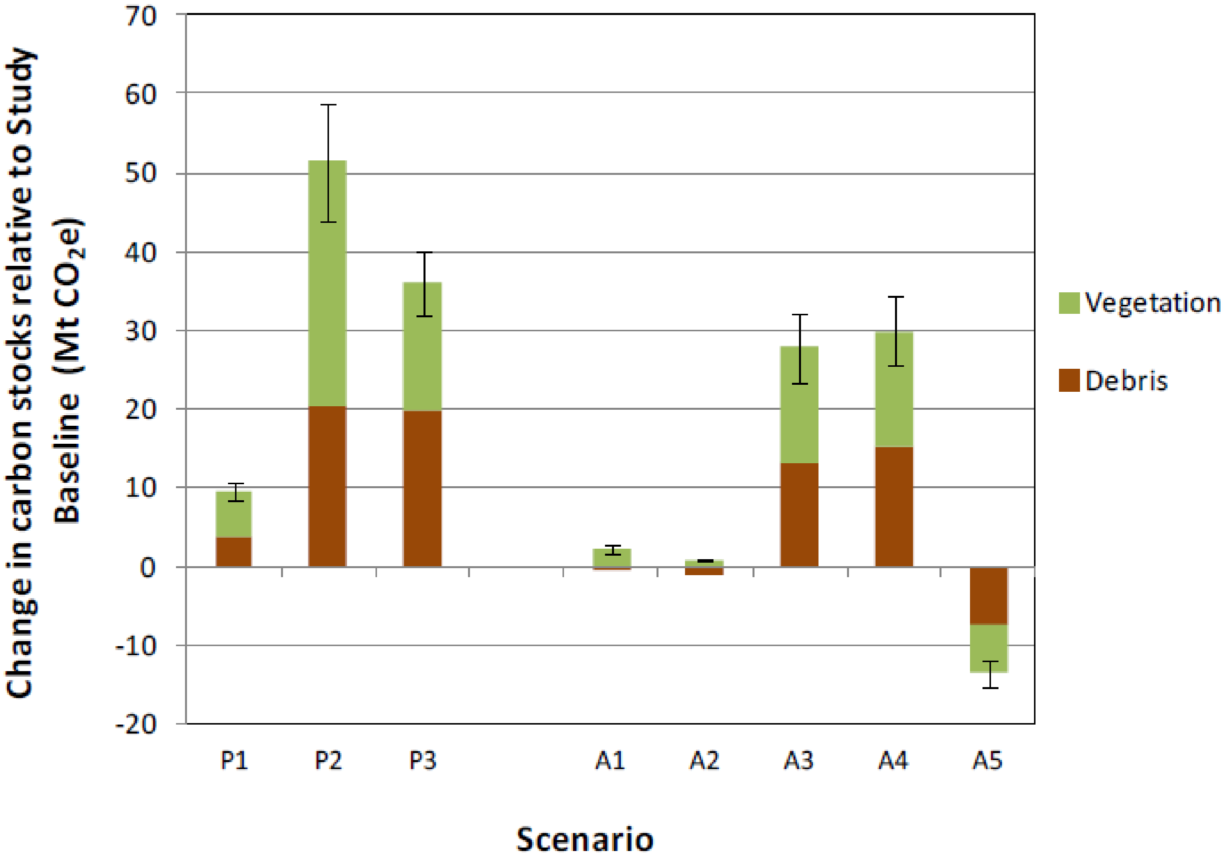

Figure 14. Modelled change in carbon stocks in Tasmanian plantations (P scenarios) and different land uses (A scenarios) between 2013 and 2015[131]

The results show that there is significant sequestration potential from increasing the rotation length of existing short rotation plantations (already eligible under the ERF Plantation Forestry method) and improving silviculture of existing plantation (not currently captured under any ERF method). There is also up to 30 Mt of abatement that could be gained by establishing plantations on farmland. The study also shows that significant carbon is lost from the landscape when existing short, or longer, rotation plantations are not replanted after harvest. This latter scenario is already occurring in Tasmania, where failed ex-MIS plantations are being returned to farmland instead of being replanted.

It should be noted that the study by May et al (2012) did not consider the commercial viability of the assumed land use changes or management scenarios. However, this has been assessed in studies by CSIRO in 2013, which modelled the extent to which a carbon price might increase financial viability of new farm forestry,[132] or industrial timber plantations.[133]

131 Ibid. See footnote 127. reprinted with permission from CO2 Australia.

132 K.I. Paul, A. Reeson, P. Polglase, N. Crossman, D. Freudenberger, C. Hawkins (2013). Economic and employment implications of a carbon market for integrated farm forestry and biodiverse environmental plantings. *Land Use Policy*, 30(1): 496–506.

133 K.I. Paul, A. Reeson, P.J. Polglase, P. Ritson, (2013). Economic and employment implications of a carbon market for industrial plantation forestry. *Land Use Policy* 30: 528–540.

The farm forestry analysis included a case study on planting of *P. radiata* in Northern Tasmania. The farm forestry scenarios modelled for northern Tasmania were: (i) High rainfall (900–1100 mm annually), average land cost \$2466 ha^{-1}; (ii) Moderate rainfall (700–900 mm annually) average land cost \$1880 ha^{-1}; and (iii) Low rainfall (600–700 mm annually), average land cost \$1013 ha^{-1}. The break-even carbon price for each of these management scenarios were all negative suggesting that all management scenarios tested were potentially profitable in the absence of carbon. Therefore, inclusion of revenue from carbon is likely to make more marginal sites economically viable for plantation establishment. It should be noted that the study was published in 2012, using land prices from 2011. Rural land prices in most parts of Australia have increased significantly since that time, so the results may differ using current land prices.

The industrial plantation forestry analysis by Paul et al.[132] included a case study of short rotation *E. globulus/E. nitens* in Northern Tasmania (800−1300 mm annual rainfall). The industrial plantation management scenarios modelled for northern Tasmania were: (i) Fertile soils, average land cost \$4553 ha^{-1}; (ii) Moderate soils, average land cost \$3437 ha^{-1}; (iii) Low productivity soils, average land cost \$1205 ha^{-1}; and (iv) Poor soils, average land cost \$647 ha^{-1}. The study also examined the impacts of a 'business-as-usual' rotation length (scenario C), and a scenario where the rotation length was extended by three years (scenario E). The break-even carbon price for each of these management scenarios show that a price on carbon is needed to make all industrial plantation management scenarios profitable. The business-as-usual (i.e. shorter) rotation length was more profitable than the longer rotation length, as the reduced revenue from carbon under the shorter rotation length was more than offset by the benefits (in a discounted cashflow model) of earlier revenue from harvest of wood products. A positive finding for the Tasmanian plantation industry is that the break-even price of carbon for all scenarios under the business-as-usual rotation length appears to be within current carbon price trends observed in recent ERF auctions (Section 6.1).

The two studies by Paul et al [132, 133] suggests that farm forestry plantations may be more commercially viable than industrial plantations, even in the absence of carbon revenues. The authors offered two explanations for this: (i) the study assumed that belt planting farm forestry scenarios had growth rates 25% higher than block plantings, due to: "decreased intra-specific competition for light, water and nutrients";[134] and (ii) the land values for the farm forestry plantings were lower, as it was assumed that these would be planted on parts of the farm that are less productive, or in areas where the plantation improved productivity on the rest of the farm (i.e. through shade and shelter). However, in the case of the industrial (block) plantings, it was assumed that a plantation company would have to pay the full value of the agricultural land.

An analysis study conducted by Climate Friendly in 2020 examined the commercial viability of carbon projects across Australia, assuming adoption of a 'landscape' approach (i.e. stacking of multiple methods on one property).[135] The analysis assessed carbon sequestration associated with planting of trees on agricultural (non-forested) land. Commercial viability of carbon projects was based on minimum viable project size, in accordance with Climate Friendly's internal costings. The analysis assumed that a landscape approach would unlock an additional 30 carbon projects in Tasmania, across 450,000 ha, resulting in sequestration of 45 million ACCUs. This represents approximately 0.5% of Australia's new projects that might become commercially viable under a landscape approach, meaning that Tasmania would continue to be a relatively small player in Australia's carbon market, unless reforms to favour small-scale projects are

134 Ibid. See note 132..

135 Presentation by Skye Glenday, CEO, Climate Friendly, 2 September 2020, conducted as part of this report.

implemented. More information about the constraints to development of carbon markets in Tasmania are described below (Section 6.5).

Key Points:

- The most readily accessible and largest carbon market opportunity for the Tasmanian forestry sector under current policy is likely to be either conversion of non-commercial short rotation plantations to long rotation, and farm forestry integrated with traditional agricultural production. This could include timber plantations in belt configurations and, on the right sites, environmental plantings. These planting could also have significant co-benefits for farmers.
- Farm-scale methodologies that integrate farm forestry with other activities to increase soil carbon or reduce livestock methane emissions would reduce transaction costs and increase potential returns.
- Reforms that increase the viability of small-scale carbon projects are vital to unlock this opportunity for Tasmania.

6.4.3. Carbon stored in wood products

As mentioned above, twin studies conducted by CSIRO Paul et al (2013) modelled the impact that carbon price might have on the financial viability of new farm forestry[136] or industrial timber plantations.[137] This included a breakdown of the contribution of different carbon pools to sequestration over a long-term average (i.e. 100 year) time period. It was found that: "only modest amounts of carbon were stored in wood products, averaging 11% of the total in the longer rotation sawlog scenarios". However, the inclusion of carbon storage in wood products resulted in an average 20% increase in the net present value of carbon projects for industrial plantings.[138]

6.5. Barriers

This section summarises some of the barriers that constrain uptake of forest carbon projects in Tasmania, based on information presented in the reviews described above, published studies, and the consultant's carbon market experience. The barriers described in this section are related to the carbon market only. Non-carbon related barriers faced by Tasmania's forest industry such as high land prices, water usage and social licence are beyond the scope of this report.

6.5.1. High transaction costs relative to project size

The main constraint to carbon market participation, particularly from the farm forestry sector, is the high, fixed transaction costs of participating in the ERF. The transaction costs involved with running a carbon project under the ERF are generally quite high, and many are fixed, irrespective of project size. This makes it harder for projects with smaller volumes of abatement to compete with larger projects because the ERF auction mechanism purchases abatement based on carbon price alone (i.e. not accounting for method type or co-benefits). As such, the problem of high, fixed transaction costs has constrained carbon project development in Tasmania because the volumes delivered under the Plantation Forestry method are generally quite small relative to other project types. For farm forestry plantings, this is also an issue as farms in Tasmania are typically small relative to farms in other states or territories (Figure 17). In addition,

136 K.I. Paul, A. Reeson, P. Polglase, N. Crossman, D. Freudenberger, C. Hawkins (2013). Economic and employment implications of a carbon market for integrated farm forestry and biodiverse environmental plantings. *Land Use Policy*, 30(1): 496–506.

137 K.I. Paul, A. Reeson, P.J. Polglase, P. Ritson, (2013). Economic and employment implications of a carbon market for industrial plantation forestry. *Land Use Policy* 30: 528–540.

138 K.I. Paul, A. Reeson, P.J. Polglase, P. Ritson, (2013). Economic and employment implications of a carbon market for industrial plantation forestry. *Land Use Policy* 30: 528–540.

in intensively managed farmland such as in Tasmania, farmers typically only want to contribute a portion of their farm to trees.

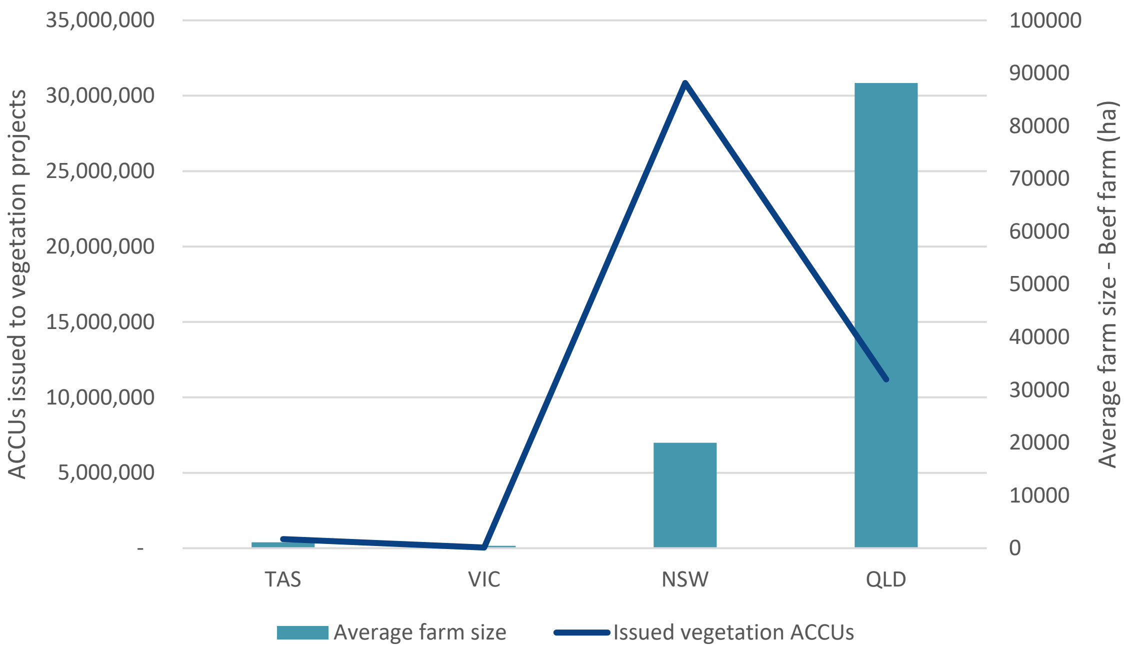

Figure 15. Average beef farm size in selected regions vs issued vegetation ACCUs[139]

Sources: Farm size: 2019 data from ABARES/MLA Farm Survey Data; ACCUs issued: ERF project registry. Data current to 5 August 2020.

Figure 17 compares the average size of a beef farm in Tasmania and Victoria with the average size of a beef farm in the rangeland regions of New South Wales and Queensland (i.e. the regions where most the ERF projects in those states are located) together with the number of ACCUs issued to vegetation projects in the four states. The data shows that there is a reasonable correlation between the average farm size and the number of issued ACCUs.

6.5.2. Lack of suitable mechanisms to aggregate landholders

To overcome the problem of high transaction costs associated with participating in the ERF, it is theoretically possible that a viable project size could be achieved if multiple projects were aggregated together. However, there are few examples where aggregated projects have successfully achieved economies of scale. This is because the initial sales process, mapping, due diligence assessment, and process of obtaining legal rights and eligible consents[140] are all incurred for each landholder participating in a project, regardless of whether they are part of a standalone or aggregated project. These processes are generally tailored to the specific requirements of an individual landholder, and there are limitations to the extent to which the processes can be ‘batched’ to achieve economies of scale. Furthermore, under the current rules of the ERF, any time that land is added or removed from a project area (as would be expected

139 Source: ABARES/MLA Farm Survey, http://apps.agriculture.gov.au/mla/mla.asp; and ERF Project Registry; http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register. Data current to 5 August 2020. Average farm size based on 2019 data for beef farms. Size of beef farms were chosen to enable comparison between states (since Tasmania has very little broadacre farming). Farm size for Tasmania and Victoria is the weighted average for the entire state. Farm size for New South Wales is based on the ABARES far west region, and Queensland is based on West and Far West region, both of these regions being where most of the ERF projects on those states are located.

140 Section 43 of the CFI Act describes the circumstances under which the legal right to the carbon benefits of a project can be obtained. Section 44 of the CFI Act defines the conditions under which eligible consents (ie permission to implement the project) must be obtained. Note that eligible consents must be obtained from all parties with an interest in the land, including mortgagees. A summary of the eligible consent processes is described at: http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/eligible-interest-holder-consent#:~:text=The%20Clean%20Energy%20Regulator%20requires,with%20the%20Emissions%20Reduction%20Fund.&text=This%20applies%20to%20all%20eligible,land%20being%20added%20or%20removed.

to occur in an aggregated project), all landowners within an aggregated project must give 'consent' to such changes. If the land is mortgaged to a bank, then each land manager's bank would be required to give consent each time the project area is changed. Subject to a few exceptions (discussed in Section 6.4), the time and cost associated with administering such changes can render a carbon project aggregation unviable.

Another barrier to carbon project aggregations is that the methodologies create adverse co-dependencies between participants within the aggregation. This occurs due to the nature of the summation equations in the methods, which issue ACCUs based on the net stock change of all carbon estimation areas (CEAs) in the project over the reporting period. Thus, the methods have no ability to 'quarantine' potential abatement loss on one property (such as might occur due to a fire) and report it separately to sequestration in the remainder of the CEAs or properties. Therefore, there is a risk that some participants in a project aggregation may not be issued with ACCUs, due to a natural disturbance, or poor management, occurring on land owned by another participant in the project aggregation.

The CFI legislation and associated methods create an adverse co-dependency between participants in a project aggregation because carbon 'losses' in part of the project cannot be quarantined from other parts of the project that are meeting expected sequestration.

6.5.3. Lack of suitable methods

Native forests and woodlands store significant volumes of carbon and management can result in increased carbon stocks though restoring degraded areas or arresting ongoing decline. Currently low or declining carbon stocks in native forests may be due to altered fire regimes, grazing or past harvesting practices resulting in highly stocked dense stands of small trees or forest canopies that may be susceptible to dieback and decline due to pests and diseases. Activities to increase carbon stocks include ecological thinning in suitable forest types, thinning of invasive native scrub, extending harvest cycles or rotation lengths, enrichment planting, improving natural regeneration by excluding or modifying grazing and removing feral animals, or halting other agents of decline or dieback.

Carbon methodologies provide the basis for monetising reduced forest emissions and carbon sequestration under the ERF. However, native forest owners and managers are currently unable to participate in the ERF, as there are no obvious methods applicable for native forest harvesting and management. Necessary research and development of an ERF method can take up to seven years. The process of developing a new method is now the responsibility of the Clean Energy Regulator and additional resources have been committed for method development[141].

A recent study assessed potential for new methods for forest-related activities[142] . They used the following criteria:

1. Broad business support indicating a high level of potential uptake
2. Significant volume of potential abatement
3. Cost and certainty of emissions reductions estimation
4. Technology is proven and commercially ready

141 https://www.industry.gov.au/sites/default/files/September%202020/document/first-low-emissions-technology-statement-2020.pdf

142 Smith, HF and Ximenes, F. 2019. Production Forest Methodologies for the Emissions Reduction Fund. Report to Forest and Wood Products Australia

5. The activity does not have adverse social, environmental or economic impacts and may have benefits
6. No better alternative policy options.

Other integrity requirements for new methods were also considered: additionality, measurement and verification capacity, eligibility under the Kyoto Protocol and the Paris Agreement, clear evidence of abatement, capacity to project future emissions and reductions, material amounts of sequestration and that estimates, and projections or assumptions included in the methodology are conservative.

The outcome of this assessment did not support further development of a method under the ERF for this activity. The baseline against which emission reduction or sequestration would be assessed is uncertain and estimating the cause and magnitude of abatement will be difficult and the likely level of abatement in specific projects would be relatively low.

However, investment in actions to address forest degradation (for example, ecological thinning and fire management, particularly cultural fire) could result in significant abatement at landscape scales and provide important co-benefits. A landscape approach to native forest and native vegetation management could provide resources and incentives for better forest management. A review of existing forest and vegetation methods – avoided deforestation, avoided forest clearing and restoration of native forests and savanna burning – could identify more integrated models to provide multiple benefits, including carbon abatement.

Such a method would need to be approved by the relevant Federal minister, who would consider:

- The potential uptake of the activity and the likely scale of reduced emissions
- Whether the volume of emissions reduced can be estimated at an acceptable cost and to a reasonable degree of certainty
- Potential adverse impacts on society, the environment or the economy
- Whether it could be better supported by other government measures.

6.5.4. Restrictive methodology requirements

There are numerous restrictions in the existing Plantation Forestry method that constrain carbon market participation by Tasmania's plantation sector. For example, the eligibility criteria are highly specific, meaning a minor deviation from the criteria renders a project ineligible. In addition, the only species that can be planted if replacing a short rotation plantation, is *P. radiata*. In addition, the method requires a modelled rotation of 16 years for a short rotation plantation in the baseline scenario, the average of which must be deducted from carbon sequestered in the project scenario. The 16-year rotation is longer than most commercial short rotation plantations in Tasmania. This has the effect of raising the 'baseline' carbon stock, meaning that the per hectare abatement returns for a conversion plantation in Tasmania are much lower than in other parts of Australia.

6.5.5. Low carbon price

Comparing the ERF carbon prices in with carbon prices in the rest of the world,[143] the average ERF ACCU price is relatively low, although this depends on the jurisdiction and the nature of the market, such as

143 To benchmark Australia's carbon price to other carbon markets globally, click on 'price' in the World Bank Carbon Pricing Dashboard. https://carbonpricingdashboard.worldbank.org/map_data.

whether offsets are allowed. Reasons for the relatively low price include the 'value for money' criterion in ERF auctions, which effectively enables the government to set a ceiling price; and the availability of credits from projects using relatively low-cost methods such as avoided deforestation and human-induced regeneration. Stakeholders interviewed indicated that the current price limited interest in participating in the carbon market from the plantation sector. Other disincentives include high project development and monitoring costs, accounting models not reflecting actual growth rates, additional approval requirements in higher rainfall areas and risks associated with preparing projects and not being successful. However, the carbon price under the ERF has been rising steadily since the third ERF auction (Figure 4), averaging $16.14 per t CO_2e in the March 2020 auction, with a slight drop to $15.75 in the September 2020 auction. As the price rises, there is anecdotal evidence that revenue from carbon is being factored into investment decisions, and that it is helping to overcome investment hurdle rates.

6.5.6. Water interception rule

Whilst the revision of the water interception rule has reduced the administrative burden and increased certainty for growers inside the exempted areas, uncertainty remains for growers outside these regions, including in southern Tasmania. This is problematic, as southern Tasmania is an area of interest for plantation expansion. Whilst DPIPWE's efforts to clarify the water interception approval process via a template/questionnaire should be applauded, the assessment process is very confusing, and the outcome of the assessment is determined by DPIPWE/the Regulator in a 'closed door' process, and is not communicated to the applicant until the final stages of carbon project registration.

In addition, the fact that the water approval is required to be provided at the time of carbon project registration is also problematic, as it is generally not possible to mitigate this risk if a new property is being acquired for plantation development (i.e. during the due diligence phase). Finally, the process of seeking approval under the water interception rule with DPIPWE has been time consuming and relatively unclear.

6.5.7. Impacts of COVID-19

The Clean Energy Regulator's Quarterly Carbon Market Report[144] makes the following observations about the impact of COVID-19 on the carbon market:

> "*Reduction in aviation travel, postponement of major events and financial pressures on business may soften voluntary demand for ACCUs in the short to mid-term. However, this demand still represents a small component of the market. Demand from the Australian Government, the primary purchaser of ACCUs, is unaffected*." – CER Quarterly Carbon Market Report, March 2020 (p. 4).

6.6. Opportunities

6.6.1. Revised 600 mm+ rainfall/water interception rule

The removal of the 600 mm+ rainfall/water interception approval process for plantations within the NNW Tasmania Regional Forestry Hub boundaries (i.e. exempted region) will increase certainty and reduce cost associated with registration of plantation forestry and farm forestry projects in these regions.

6.6.2. Recommendations from the King Review

The Federal Minister for Energy and Emissions Reduction, Angus Taylor, personally commissioned the King Review, the purpose of which was to identify new opportunities to unlock low-cost abatement across the

144 Available at: http://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Quarterly Carbon Market Report - March Quarter 2020.pdf.

economy. As evidenced by the government response to the King Review (which agreed to 21 out of the 26 recommendations),[145] there is a high level of political support to implement the findings. The table below summarises key recommendations from the King Review and the government response, and then provides analysis on impacts for Tasmania's commercial and farm forestry sector.

145 Australian Government response to the Final Report of the Expert Panel examining additional sources of low-cost abatement ('the King Review'). May 2020. Available at: https://www.industry.gov.au/sites/default/files/2020-05/government-response-to-the-expert-panel-report-examining-additional-sources-of-low-cost-abatement.pdf.

Recommendation	Government response	Analysis/implications for Tasmanian forests	Recommended response from Tasmanian forest sector
5.1. Allow certain ERF methods to award ACCUs on a compressed timeframe.	Agreed-in-principle. The government acknowledges that for some ERF methods the 'gap' between revenue (ACCU delivery) and high upfront capital costs can mean that projects that otherwise provide low-cost abatement do not proceed. The government will consult with stakeholders on the best mechanisms to encourage projects with high upfront costs on a method-by-method basis.	Compressed crediting basically means averaging out the ACCU issuance over time. For planting projects this would smooth out the abatement profile and provide more ACCUs earlier in the project. This significantly improves the commercial viability of the carbon project.	Support. Work with DISER to implement compressed crediting for greenfields (new) plantations in the Plantation Forestry method. Equation 10 in the Plantation Forestry method already provides an example of compressed crediting. However, this equation currently only applies to conversion forests. It should also apply to greenfield plantings.
6.1 Establish a new process to provide third parties with the opportunity to propose and prepare ERF methods.	Agreed. The government agrees that giving industry greater opportunity to support the development of new methods would encourage innovation and new method development. The government will also investigate deeper industry involvement in method development and prioritisation through the provision of in-kind support (for example, by supporting drafting of new methods or procurement of new datasets to support the scientific integrity of methods).	The ability of the private sector to be able to develop new methods is particularly significant to the native forest sector, due to the lack of any suitable methods at present. In addition, the farm forestry and plantation forestry sector might seek to work with the DISR to revise existing methods to remove roadblocks. Having greater ability to revise existing methods would also be beneficial to the plantation sector.	Support. Work with DISER and the Electrical Regulatory Authorities Council to better understand the proposed schedule of method reviews, and to influence the new method prioritisation process.
6.2 Establish a pilot method program to test new method ideas and expedite method preparation.	Agreed. The government agrees with the concept of pilot methods to expedite new method development and enable the ERF to achieve a greater range of low-cost abatement. The government also notes that pilot method programs may facilitate the faster adoption of new technologies.	The ability to test and implement methods from the voluntary carbon market may be particularly attractive to the native forest sector, given the lack of existing methods under the ERF.	Support. Work with DISER and the Electrical Regulatory Authorities Council to commence a pilot carbon project in native forests in Tasmania, using one of the existing voluntary carbon market standards.

Recommendation	Government response	Analysis/implications for Tasmanian forests	Recommended response from Tasmanian forest sector
6.3 Introduce a formal 'duty of utmost good faith' on participants in the ERF.	Agreed. The government agrees that a duty of utmost good faith could facilitate less prescriptive rules while maintaining the integrity of the ERF. The government will consult stakeholders on options to implement this recommendation.	A duty of utmost good faith would lessen the need for prescriptive project eligibility rules. This would have the dual benefit of reducing transaction costs, while broadening project eligibility. This would be particularly beneficial in making smaller projects commercially viable.	Support. Work with DISER to demonstrate how some of the existing soft policy frameworks in the forest industry (eg forest certification schemes such as FSC and Responsible Wood) may also help demonstrate a 'duty of utmost good faith'. The Tasmania Regional Forestry Hubs may have a role to play in helping to develop and enforce codes of good faith within the forest industry.
6.4 Establish a scheme to subsidise the costs of directly measuring the abatement associated with certain types of project activities, particularly the sequestration of carbon in agricultural soils.	Agreed-in-principle. The government agrees that the costs of direct measurement and the conservativeness of model-based methods are significant barriers to the uptake of some methodologies, particularly soil carbon projects.	The advance purchase arrangement as proposed for soil ACCUs has already been implemented by the Regulator and was included as a new contract mechanism in the September 2020 ERF auction.[146] This will enable landowners implementing a soil carbon project to pay for some of the soil sampling costs.	Support. Given the high upfront costs of planting, it would be useful if the advance ACCU purchase arrangements currently extended to soil carbon projects could be expanded to include the Plantation Forestry method. By providing some upfront cash to help pay for establishment costs, this would significantly improve the commercial viability of plantation forestry projects.

146 Source: http://www.cleanenergyregulator.gov.au/About/Pages/News and updates/NewsItem.aspx?ListId=19b4efbb-6f5d-4637-94c4-121c1f96fcfe&ItemId=812.

Recommendation	Government response	Analysis/implications for Tasmanian forests	Recommended response from Tasmanian forest sector
6.6. Create a fixed price purchasing desk for small projects under the ERF.	Agreed. The government agrees that smaller projects should be enabled to participate and access the benefits of the ERF.	The theory of this reform is that it would encourage uptake of small-scale projects, by reducing price risks and marketing costs. If correct, this could unlock opportunities for farm forestry and other small-scale forest projects in Tasmania.	Support. Under the current policy settings, small-scale projects struggle to compete with large-scale projects. Implementation of a separate auction or purchasing mechanism might result in a higher price and/or lower transaction costs for small-scale projects. To be implemented alongside recommendations 3 and 4 in this report to enable project aggregation of small-scale projects.

Recommendation	Government response	Analysis/implications for Tasmanian forests	Recommended response from Tasmanian forest sector
6.7 Create tailored small-scale ERF methods for particular types of agriculture projects, including shelterbelts.	Agreed. The government will consult with stakeholders on the potential for methods and other mechanisms to support uptake of abatement opportunities through small-scale projects.	The theory of this reform is that it would encourage uptake of small-scale projects, by reducing monitoring costs. If correct, this could unlock opportunities for farm forestry and other small-scale forest projects in Tasmania. Most of the existing ERF forest methods already have streamlined measurement and/or monitoring requirements, such as use of the government-approved FullCAM model, instead of requiring field-based forest measurements.	Many of the costs associated with participating in the ERF are related to the CFI legislation (such as requirements to obtain eligible consents), not the method itself. As such, it is unclear whether creation of a streamlined small-scale method would achieve its stated aim of increasing participating of small-scale projects, unless it was coupled with a streamlined approval pathway embedded within the CFI legislation. Suggest working with the Regulator to implement recommendations 3 and 4 in this report to enable project aggregations and a streamlined approval pathway, in collaboration with working with DISER on the development of a streamlined small-scale method.
6.9 Facilitate ‘method stacking’, where multiple ERF projects are taken on the same property using different methods	Agreed. The government will work with industry to identify the best ways to simplify and streamline method stacking. In response to the Panel’s recommendation, the Clean Energy Regulator has commenced work to streamline transaction costs for projects, which is likely to support method stacking.	Refer to comments in section earlier in this document titled ‘Landscape approach to carbon abatement’. Stacking of multiple methods is likely to be particularly interesting to the farm forestry sector, where they might seek to earn credits for numerous sequestration activities on one farm, such as establishment of shelterbelts, soil carbon sequestration, and beef herd management.	Support.

Recommendation	Government response	Analysis/implications for Tasmanian forests	Recommended response from Tasmanian forest sector
6.10 The Clean Energy Regulator should continue its efforts to streamline ERF audit requirements at an administrative level and to explore the potential to use 'big data' as an alternative to more traditional audit processes.	Agreed. The Clean Energy Regulator is undertaking work to review audit requirements with a view to streamlining the audit process to identify efficiencies for both auditors and project proponents. The Regulator is also exploring aspects of ERF activity where new geospatial tools, apps and improvements to online systems may complement existing audit processes or be an alternative assurance mechanism.	Small-scale projects such as farm forestry are highly sensitive to audit costs, which occur upfront, and can range between $15,000 and $30,000 for a first audit. Reduced audit costs would therefore increase the commercial viability of small-scale forestry projects.	Support. Refer to the section below titled 'Process-based audits' for a specific recommendation.

Table 5 Analysis of relevant recommendations from the King Review, government responses and recommended forest sector response.

6.6.3. Rising carbon price

Preliminary modelling by Climate Friendly for Tasmania shows that carbon price can have a significant impact on the commercial viability of plantation investments.

Stakeholders consulted as part of this report indicated that a carbon prices of $18–20/t CO_2e would provide significant additional incentive to invest in tree plantations. The current carbon price adds 1–2% to the internal rate of return (IRR) for investors in long rotation radiata pine. This helps reduce risk and increase investment attractiveness but is ‘icing on the cake’ not the fundamental value proposition. Some considered the price would need to be higher than $25/t CO_2 before an investor might consider establishing trees for carbon alone. Others felt that a carbon price provided little additional incentive with current administrative costs for project development, management and measurements costs and constraints on land use being major barriers.

6.6.4. Landscape approach to carbon abatement

There may be potential to improve the viability of environmental planting carbon projects if they are established alongside another carbon project activity (i.e. if they are established as a ‘nested’ carbon project). It is hoped that the registration of two or more carbon projects on the same property might help reduce the per-ACCU transaction costs associated with running the carbon project, relative to standalone implementation of an environmental plantings project.

An example of a co-located project activity that might be suitable for the plantation sector is the implementation of environmental plantings in the waterway buffer area adjacent to a carbon project proposed to be registered under the ERF Plantation Forestry method (i.e. within a commercial timber plantation).

These methods could also be integrated with methods for soil carbon sequestration.

6.6.5. Project aggregation

Existing forest industry actors and organisations, such as NRM North or South, could act as aggregators. Activities would include aggregating landholders into a commercially viable carbon project size (eg by pre-screening candidates and connecting with landholders in work typically done by a carbon service provider) and packaging the aggregated project for tender to external carbon service providers. To realise this opportunity, the numerous barriers to project aggregation discussed in Section 6.5 would need to be addressed.

6.6.6. Working with traditional owners

Tasmania’s commercial timber plantation companies have sought and achieved certification to either of the two main forest certification schemes (Australian Forest Standard, or the Forest Stewardship Council). Certification against these standards provides the consumer with assurances regarding the sustainability of the timber harvesting operations. The timber companies are required to undergo regular audits to maintain compliance with these schemes. Both forest certification schemes include principles or criteria pertaining to working with traditional owners including consents, mapping and appropriate management of cultural sites, and creation of business opportunities for traditional owners.[147] The framework of the forest

147 Criterion 8 of the AFS provides that “forest management shall protect and maintain, for Indigenous and non-Indigenous people, their natural, cultural, social, recreational, religious and spiritual heritage values”. This includes a requirement to consult with TOs, and to support “Indigenous people’s economic and social aspirations in sharing benefits from the management of forests”. https://www.responsiblewood.org.au/wp-content/uploads/2017/11/AS4708-2013-Publish.pdf.
Principle 9 of the FSC Standard states that “the Organisation shall identify and uphold Indigenous peoples’ legal and customary rights of ownership use and management of land territories and resources affected by management activities.” Available at: https://au.fsc.org/en-au/standards/forest-management.

certification standards therefore creates an additional incentive for plantations companies to work with traditional owners, as it would help in maintaining their forest certification status.

6.6.7. Process-based audits

Under current policy arrangements, most ERF projects are required to have three external third-party audits: one at the time of submitting the first offsets report, and another two over the duration of the 25-year crediting period.[148] The cost of these audits is generally paid by the project proponent or the carbon service provider. In the case of the first audit, the cost occurs before any ACCUs have been issued. As such, the viability of small-scale projects is particularly sensitive to this upfront external cost, which can be in the tens of thousands of dollars (particularly when considering the time taken to prepare materials for audit).

In responding to recommendation 6.10 from the King Review related to audits (i.e. recommendation 6.10: "… to streamline ERF audit requirements at an administrative level..."), on 3 September 2020 the Clean Energy Regulator released a consultation paper titled 'Proposed changes to the audit framework'.[149] The paper includes a number of suggestions to streamline the ERF audit requirements, including proposals to:

- Delay the timing of first audit until after ACCUs have already been created (presumably so that ACCUs can then be sold to help fund audit costs)
- Provide greater flexibility in the timing of audits to enable 'batching' of audits with a portfolio of other projects of the same method type (which would presumably reduce audit costs for carbon service providers or companies with multiple projects)
- Reduce the number of audits for some method types that are deemed 'low risk' or where ancillary data (such as geographic information system data) can help confirm project compliance without needing a third-party auditor. This would reduce the number of audits to only one or zero in some (deemed low risk) cases
- Provide auditors with greater ability to use their professional judgement to adjust the scope of the audit, based on their assessment of project risk.

It is likely that these reforms, if implemented, would remove a significant barrier to uptake of smaller-scale ERF projects in Tasmania. Comments on the consultation paper are due on 2 October 2020.

6.6.8. A carbon farming methodology for harvested wood products

A certain proportion of carbon in harvested timber is stored in harvested wood products (HWPs) and is emitted over time. The proportion of storage depends on the utilisation rate during processing and the rate of emissions depends on the type of product and the disposal method after use. Some carbon is emitted directly to the atmosphere as wood products decompose. At the end of life, carbon may be emitted to the atmosphere if products are burnt. Some products can be recycled, extending the period of carbon storage. If products go to landfill, the rate of decomposition can be extremely slow.[150]

Methods for estimating carbon in HWPs are well established and approaches have been incorporated into Australia's National Greenhouse Gas Inventory (NGGI) through the FullCAM model and in voluntary market standards. The greenhouse gas reduction in HWPs while in use is included in the ERF Plantation Forestry method, as described above. Carbon in HWPs in landfill was not included, due to the perceived risk of

148 An additional audit will also be required if a project submits an offsets report where the abatement claim is greater than 100,000 t CO_2e. This would rarely be the case for a vegetation project.

149 The CER consultation paper on streamlining the audit framework is available at: http://www.cleanenergyregulator.gov.au/ERF/Want-to-participate-in-the-Emissions-Reduction-Fund/Step-3-Reporting-and-auditing/Audit-Requirements.

150. Ibid. Footnote 141.

double counting and the need to revise default percentages in the waste component of the NGGI. It was not considered appropriate to develop a standalone method for HWPs from non-plantation forests.

A recent report [151] indicated a high level of business support in the forest sector to develop a Carbon Farming method for the abatement of carbon in HWPs from all sources. This could increase uptake of the Plantation Forestry method by possible proponents and provide for new opportunities to change product streams and reduce emissions from other parts of the sector. The potential volume of abatement was considered sufficient and no negative social, environmental or economic impacts were identified of more widely incorporating carbon in HWPs into an ERF method.

It was recommended that additional carbon storage in HWPs be included in Carbon Farming methods using the average increase in carbon stored after each harvest event and recognising carbon in HWPs in landfill as permanent abatement credited over the 100-year project period.[152] Other policy measures to promote the use of HWPs (see below) can complement this method by supporting the wider use of wood in construction and other uses to replace fossil fuel-based chemicals.

Low carbon procurement policies that favour wood products

In its 2017 submission to the Climate Change Authority, the Australian Forest Products Association (AFPA) recommended that government agencies consider the full life cycle analysis of products as part of its procurement policies.[153] Generally wood products have low embodied energy when compared with substitute products in the building and construction sector, such as steel, aluminium and concrete. As such, procurement policies that account for the full life cycle impacts of the product (as opposed to simply looking at energy in use) tend to favour wood products.

Policies such as those suggested by AFPA have been successfully implemented elsewhere in the world. For example, on 16 September 2020, the New Zealand Government announced a low carbon procurement policy. [154] The policy requires government agencies to procure construction materials with the lowest carbon emissions. The policy is estimated to result in the creation of five thousand jobs in New Zealand's forestry sector, an increase log processing by 1.7 million tonnes annually, and in the sequestration of 918,000 t CO_2 annually.[155] The announcement has been widely supported by the New Zealand forest industry.[156] Similar policies have also been implemented in France, Japan, Canada, Australia, and the US.[157]

6.6.9. International experience

Stakeholders frequently raised the issue of complexity of participation as a barrier to entry in ERF forestry projects. Under the ERF, project participants voluntarily join the offset certification scheme by registering a project, under one of the approved methods, with the Clean Energy Regulator. Participants run their project according to the chosen method, report on it and ensure it is audited under an audit schedule set by the Regulator. The projects then receive ACCUs for the emissions reductions they have achieved. For

151 Ibid. Footnote 135.

152 Ibid. Footnote 135.

153 The 2017 AFPA submission to the Climate Change Authority is available here: https://www.climatechangeauthority.gov.au/sites/default/files/2020-06/CFI%202017%20August/Submissions/AFPA_Climate%20Change%20Authority%20ERF%20Review%202017%20final.pdf

154 https://www.beehive.govt.nz/release/procurement-promote-jobs-m%C4%81ori-and-pasifika-businesses-and-sustainability.

155 Friday Offcuts newsletter, 18 September 2020. Available at: https://www.fridayoffcuts.com/index.cfm?id=889#1.

156 For example, see the media release from the New Zealand Forest Owners Association: https://www.nzfoa.org.nz/news/foa-news/foa-media-releases-2020/1651-new-construction-policy-will-deliver-more-timber-use-2.

157 Friday Offcuts newsletter, 18 September 2020. Available at: https://www.fridayoffcuts.com/index.cfm?id=889#1.

most projects, a minimum of three scheduled audits by accredited auditors across the seven plus year crediting period is required.

The report of the King Review expressed a preference for the crediting approach to be as simple as possible, while ensuring abatement represents genuine reductions in emissions.

Of relevance to this issue is the New Zealand Emissions Trading Scheme (ETS) created through the *Climate Change Response Act 2002* (NZ). Forestry entered the ETS in 2008. Post-1989 forest owners that opt into the New Zealand ETS are analogous in some ways to forest owners in Australia who enter the ERF under the Plantation Forestry methodology. Under the New Zealand system, different rules for measuring forest carbon stocks apply depending on forest size and forestry look-up tables are provided to reduce administrative complexity and costs and support consistency of emissions reporting. New Zealand participants follow a 'self-assessment' model for emissions monitoring, reporting and verification. No independent third-party verification is required of emission reports, but the government has the power to conduct audits. Each year, the New Zealand Environmental Protection Authority selects a sample of New Zealand ETS participants for internal and third-party reviews of compliance.

Between 2015 and 2019, the New Zealand Government conducted a review of the ETS and a wide range of changes to the forestry provisions in the *Climate Change Response Act 2002* (NZ) are now being introduced, with most of the changes applying from 2023. The government announced in June 2020:[158]

1. Streamlined processes
2. Improved administration
3. Better guidance and tools for landowners
4. A quicker and simpler system for registering trees
5. Reduced complexity – making it easier to meet statutory requirements.

Recommendations 6.7 and 6.10 of the King Review are also relevant to this issue.

7. Bioenergy and Tasmania's forests

In Australia, bioenergy is only 4% of total energy consumption[159] and was only 1.4% of the total electricity produced in 2019.[160] This situation contrasts significantly to the EU where, on average, 10% of energy is from biomass. Some of the reasons for Australia's low uptake of bioenergy are lower heating demand as compared with Europe, and a broader range of energy supply options.[161] Historically, electricity in Tasmania has been relatively cheap (largely sourced from hydro-generated electricity), contributing to human wellbeing and supporting industry and economic growth. Over the past decade, retail electricity prices around Australia have increased and, because Tasmania is connected to the national energy market, this has impacted on electricity prices in the state. the Draft Tasmanian Renewable Energy Action Plan is not ambitious enough, focusing too heavily on electricity and missing the abundant opportunities provided in

158 https://www.mpi.govt.nz/protection-and-response/environment-and-natural-resources/emissions-trading-scheme/emissions-trading-scheme-improvements/#dec-decisions-2018.

159 KPMG (2018). Bioenergy State of the Nation Report. A report on Australia's bioenergy performance for Bioenergy Australia. November 2018. Available at: https://cdn.revolutionise.com.au/news/vabsvwo5pa8jnsgs.pdf.

160 Source: Clean Energy Council: https://www.cleanenergycouncil.org.au/resources/technologies/bioenergy.

161 KPMG (2018). Bioenergy State of the Nation Report. A report on Australia's bioenergy performance for Bioenergy Australia. November 2018. Available at: https://cdn.revolutionise.com.au/news/vabsvwo5pa8jnsgs.pdf.

the areas of heat generation and transportation fuels. In 2017−2018, renewable energy represented 42% of Tasmanian's primary energy consumption with oil comprising 34%, gas 12% and coal 10%.[162]

Wood supplies a significant proportion of residential energy as firewood.[163] Bioenergy from wood could potentially comprise up to 30% of Tasmania's energy production[164] with approximately 6–8 million tonnes of residual wood available per year for bioenergy production.[165] This section provides a summary of the policy framework related to bioenergy production from forest residues in Tasmania, identifies barriers to production of bioenergy in Tasmania, and provides recommendations for reform to unlock further carbon market opportunities.

Bioenergy Australia has argued that Tasmania can be a leader in affordable, locally generated renewable energy, by decarbonising its gas network using biomethane and developing a renewable fuels industry that converts waste and residue from forests and the agriculture sector into fuels such as biodiesel, renewable diesel and ethanol.

7.1. Current policy framework

National and state energy policy is rapidly changing. In November 2018, KPMG prepared the 'Bioenergy State of the Nation' report for Bioenergy Australia.[166] States and territories were ranked against five evaluation criteria to assess preparedness and support for bioenergy markets. Tasmania was ranked behind Queensland, Victoria and South Australia (Table 6). The table below provides a snapshot of the national bioenergy policy framework at the time of writing. Criteria used to evaluate Tasmanian policies for bioenergy development are indicated in Table 7.

162 Australian Energy Statistics 2019. https://www.energy.gov.au/sites/default/files/australian_energy_statistics_2019_energy_update_report_september.pdf.

163 Department of State Growth (2020). Energy Issues Strategy Paper. https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0005/90815/Energy_Strategy_Issues_Paper.pdf.

164 Rothe, A. (2013). Forest biomass for energy: Current and potential use in Tasmania and a comparison with European experience Report on the Sabbatical Project Prof. Dr. Andreas Rothe Hobart, July 2013. Available at: https://www.pft.tas.gov.au/__data/assets/pdf_file/0019/131950/Forest_Biomass_for_energy_-_Current_and_potential_use_in_Tasmania_and_a_comparison_with_European_experience.pdf.

165 Indufor (2016). Tasmanian Government Department of State Growth Forest Residues Solutions Study Stage 2 – Detailed Options Analysis Final Report https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0015/135321/Residues_Solutions_Study_Stage_2_Report_final.pdf.

166 KPMG (2018). Bioenergy State of the Nation Report. A report on Australia's bioenergy performance for Bioenergy Australia. November 2018. Available at: https://cdn.revolutionise.com.au/news/vabsvwo5pa8jnsgs.pdf.

Table 6 Policy framework related to bioenergy production using wood as feedstock

Policy document	Summary of legislation and implications for forests
Bioenergy Roadmap – under development,[167]	Once developed, the roadmap will: "identify the role that the bioenergy sector can play in Australia's energy transition and in helping Australia further reduce our emissions. The Bioenergy Roadmap will help to inform the next series of investment and policy decisions in the bioenergy sector in Australia". The Call for Submissions document included a number of questions related to feedstocks from agricultural, forestry and waste sectors. The Final Report is due to be submitted to the Minister for Energy and Emissions Reduction in late 2020.
Technology Investment Roadmap – Under development by an expert panel led by Dr Alan Finkel[168]	The outcomes of the review will: "guide the Government's technology investment portfolio to reduce emissions and be the cornerstone of the Long-Term Emissions Reduction Strategy". Highlights of the Discussion paper that are relevant to forests include: "A range of emerging technologies are already competitive with fossil fuel alternatives in certain circumstances. Biomass is competitive provided that a low-cost feedstock is available, such as a waste stream." (p. 55)
Technology Investment Roadmap First Low Emissions Technology Statement – 2020	Aims to accelerate the development of new and emerging technologies by making them economically competitive with established technologies, unlocking new opportunities across the country.

167 For more information about the Bioenergy Roadmap under development by the Australian Renewable Energy Association (ARENA), see: https://arena.gov.au/knowledge-innovation/bioenergy-roadmap/.

168 The Technology Investment Roadmap Discussion Paper is available at: https://consult.industry.gov.au/climate-change/technology-investment-roadmap/.

Table 7 KPMG's evaluation of Tasmania's policies in support of bioenergy

Policy criteria	Assessment
Criteria 1: **Policy development and effectiveness**	The Tasmania Energy Strategy was released in 2015 and included $200,000 funding for biofuels, $550,000 in funding for forest residues and $1.25 million in funding for wood and fibre processing. In their 2017 report,[169] the Tasmanian Energy Security Taskforce, a committee implemented under the *Energy Co-Ordination and Planning Act 1995* (Tas), deemed bioenergy (biomass) technology too costly in the short term, however, given more government support it may be viable in the long term.
Criteria 2: **Bioenergy project development**	Of the 12 bioenergy projects in Tasmania, there are four operating projects and one project proposed which generate over one megawatt of electricity. While two bioenergy projects are or would produce wood pellets, another five are considered 'other' projects (flaring, wastewater for treatment or biogas for behind the meter). Of the 12 project responses to the bioenergy questionnaire, three have received grants or support from either Federal or state jurisdictions. Several commissioned projects have employed 345 people nationally, while the $50 million Valley Central Industrial Precinct – Bioenergy Hub is expected to create 82 full-time positions during construction and 30 full-time positions during operation.
Criteria 3: **Technology and feedstock diversity**	Tasmania's application of bioenergy technology is predominately combustion technologies across the bioenergy projects either proposed, under construction or commissioned. Of those projects, the commonly used feedstocks are municipal waste and wood waste.
Criteria 4: **Sustainability guidance**	Based on this research no evidence of sustainability guidance was in place. Tasmania has endorsed the Australian Biomass for Bioenergy Assessment (ABBA) via provision of information on potential bioenergy feedstocks.[170] Information pertaining to Tasmanian Forest Agreement (TFA) and FSC certification for sustainable timber can be found on the Department of State Growth website as well as other information relating to the state's strategic plans for timber.
Criteria 5: Advocacy and education	Information pertaining to forestry/timber in Tasmania is easily accessible through the https://www.stategrowth.tas.gov.au website, which includes information on regulation, funding, industry bodies and planning. Although, through our research it is difficult to identify suitable information relating to bioenergy and other biomass sources. Community groups in the south (Huon region) and the north-east (Dorset region) have been specifically established for the commercialisation of wood residue opportunities that can benefit regional communities.

Source: KPMG, 2018.

169 Available at: https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0004/151159/Tasmanian_Energy_Security_Taskforce_-_Final_Report.PDF.

170 Information on bioenergy feedstocks is displayed in the Australian Renewable Energy map: https://nationalmap.gov.au/renewables/.

7.2. Status of bioenergy development in Australia and Tasmania

As of 2018, there were 222 operating bioenergy plants in Australia, with 55 projects under construction or in feasibility stage.[171] Of those currently operating, six are in Tasmania (Figure 18).

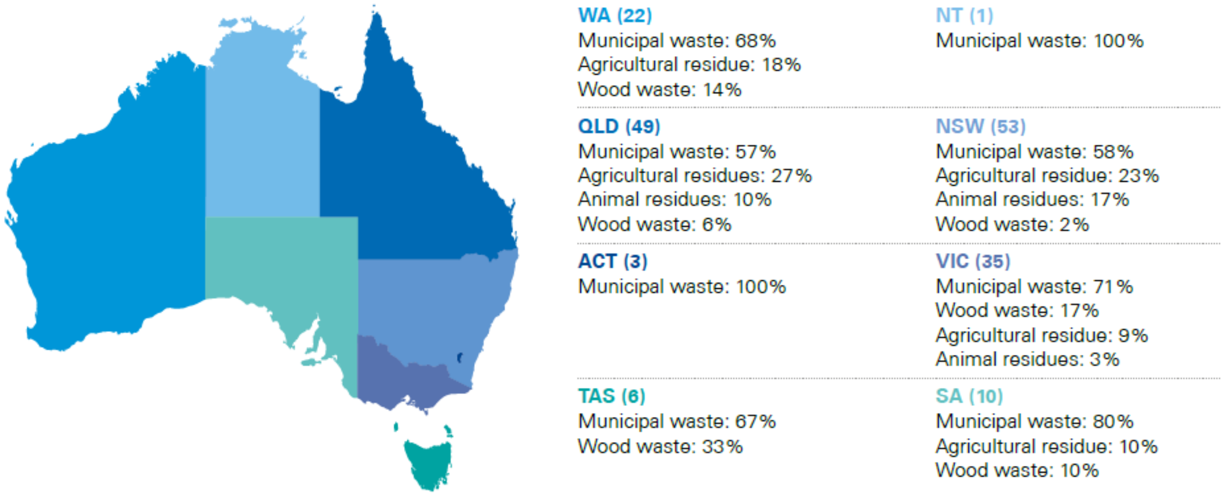

Figure 16. Operating bioenergy projects in Australia – by region and feedstock.

Source: Bioenergy Australia and KPMG, 2018 [171].

Of the operational bioenergy projects in Tasmania, 33% of the feedstock is derived from wood waste, with the remainder from municipal waste. This contrasts with the national average where wood waste comprises 9% of the total feedstock for operating bioenergy projects (with municipal and industrial waste being the predominant feedstock at 64%).

One of the projects recently registered on the ERF is titled the 'Norske Skog Boyer Mill Heat Recovery Project', registered by Norske Skog Paper Mills. The stated description of the project on the ERF project register is: "this project improves energy (fuel) efficiency by modifying, installing, removing or replacing equipment that affects the energy consumption of existing energy-consuming equipment". The project currently has a Carbon Abatement Contract with the Regulator to sell 250,000 ACCUs generated by the project over seven years.[172]

Stakeholder interviews indicated different perceptions on the potential for bioenergy. Timber processors are using waste wood for kiln drying and local energy. However, the costs of local bioenergy-based electricity generation did not stack up compared with current grid prices. Bioenergy might be of most value near energy-poor communities or energy-intensive industries.

Forest growers and processors are considering options for pellet production for local use, including heat and power, biochar, agriculture supplement and carbon for water filtration. Export of pellets for bioenergy is also a growing market.

Some considered bioenergy to be a transformational opportunity for Tasmania, with high biomass availability from agriculture and wood waste relative to size of the population and economy. This can be used to replace stationary energy systems and boilers (combined heat and power) and potentially transport

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171 KPMG (2018). Bioenergy State of the Nation Report. A report on Australia's bioenergy performance for Bioenergy Australia. November 2018. Permission pending. Available at: https://cdn.revolutionise.com.au/news/vabsvwo5pa8jnsgs.pdf.

172 Source: http://www.cleanenergyregulator.gov.au/ERF/Pages/Emissions%20Reduction%20Fund%20project%20and%20contract%20registers/Carbon%20abatement%20contract%20register/contract-details.aspx?ListId=%7BF861019E-475A-415B-86D7-E9E9CADFCAF5%7D&ItemID=431.

fuels. Bioenergy can be an important contributor to a localised circular economy and contribute to Tasmania's reputation as a 'clean, green' economy. This needs clear policy direction and budget to support investment. Community opposition to use of wood from native forests for bioenergy is a policy challenge. This will need a clear understanding of the life cycle of the system.

7.3. Challenges

7.3.1. Cost competitiveness with other energy sources – electricity production

Tasmania already derives 76% of its energy production from hydro-electric sources.[173] When modelling a mix of other energy sources (i.e. for electricity production) to supplement Tasmania's hydro-electric supply, the Tasmanian Energy Security Taskforce made the following assumptions about the cost of energy production from renewable sources:[174]

- Wind power: New wind generation developed in 2019 is assumed to cost $91.10 per MWh for 700 GWh per annum of capacity, dropping down to $74.80 per MWh for a wind farm developed in 2023
- Commercial solar PV: Assumed to have a standardised cost of $100 per MWh in 2018 falling to $85 per MWh in 2020
- Biomass energy: Assumed to have a standardised cost of $120 per MWh in 2020 with 170 GWh per annum available. However, the report noted that: "there is significant variability in biomass costs due to the cost and quality of feedstock, transportation costs, seasonality and other factors. The cost is indicative and not site specific".

Ultimately the report concluded that: "large-scale solar and biomass energy generation are likely to be more expensive to implement than wind energy in Tasmania in the short to medium term". (p. 44).

Similar conclusions were drawn by Indufor in 2016,[175] who stated that:

> "*The cost to produce electricity from biomass currently exceeds the wholesale electricity price even when: Large-scale Generation Certificates are taken into account; the scale of the biomass facility is maximised (to reduce the unit cost of production); and the cost of feedstock is effectively zero. Without increases in electricity prices or explicit government support, bioenergy generated electricity is only competitive to particular electricity consumers or circumstances*." – Indufor, 2016. Forest Residues Solutions Study for the Tasmanian Government (p. v).

It is understood that in 2016, New Forests commenced a $5 million feasibility study into the viability of establishing a $115–145 million plantation fibre-only wood pellet plant in Tasmania.[176] The status of this feasibility assessment at the time of writing is unclear.

173 Indufor (2016). Tasmanian Government Department of State Growth Forest Residues Solutions Study Stage 2 – Detailed Options Analysis Final Report https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0015/135321/Residues_Solutions_Study_Stage_2_Report_final.pdf.

174 Tasmanian Energy Security Taskforce (2018). Final Report. Available at: https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0004/151159/Tasmanian_Energy_Security_Taskforce_-_Final_Report.PDF.

175 Indufor (2016). Tasmanian Government Department of State Growth Forest Residues Solutions Study Stage 2 – Detailed Options Analysis Final Report.

176 Source: http://www.premier.tas.gov.au/releases/support_for_wood_pellet_plant_study.

7.4. Opportunities

7.4.1. Liquid biofuels

Indufor[177] identified liquid biofuels (which they called ‘drop in hydrocarbon biofuels’)[178] as being a significant opportunity for Tasmania. Strengths of producing liquid biofuels for transport using residual wood included:

- Good integration with existing liquid transport fuel infrastructure
- Proven technology
- Potential to utilise most of Tasmania’s woody residues
- The ability for Tasmania to develop its own fuel refining capacity (at present it has none).

Barriers to entry for this opportunity were cited by Indufor (2016) as:

- Technology not yet commercialised
- Social licence issues associated with using native forest residues for biofuel
- Capital costs of several billion dollars for new biofuel production facility
- Longer-term commercialisation timeframe (5–8 years).

177 Indufor (2016). Tasmanian Government Department of State Growth Forest Residues Solutions Study

Stage 2 – Detailed Options Analysis Final Report https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0015/135321/Residues_Solutions_Study_Stage_2_Report_final.pdf.

178 ‘Drop in’ hydrocarbon biofuels was defined as fuels that can blend in or replace fossil fuels, representing no discernible change for consumers at the petrol station.

8. Natural capital accounting

Natural systems provide us with clean water and air, fertile soils, a stable climate and other conditions essential to human health and wellbeing. The physical and intrinsic values of nature to humans has been understood for centuries but until relatively recently they have not been integrated into economic policy decision making. Nature's benefits to people are decreasing in many parts of the world, posing significant challenges to societal wellbeing and rural livelihoods. Biodiversity loss and ecosystem damage have been estimated to cost 3% of global gross domestic product (GDP) and could rise to 18% by 2050.[179]

In standard welfare economics, these impacts have been considered 'externalities' to mainstream economic activity that are difficult to assess and quantify in economic terms. The term **natural capital** was developed to bring the dependency of human beings on the natural environment into economic thinking. A closely related concept is **ecosystem services**. Accounting can be either retrospective or prospective. This section describes natural capital, and ecosystem services and other policy drivers including the United Nations Sustainable Development Goals. It presents an overview of activities to support natural capital accounting and its implementation and discusses some key challenges and opportunities.

Figure 17 Relationship between natural capital, ecosystem services and benefits to people[180]

8.1. Natural capital and ecosystem services

Natural capital describes the stock of renewable and non-renewable resources (eg plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. Biodiversity is a component of natural capital stocks and is an indicator of their condition and resilience.

The ecosystem services concept also developed to bridge modern economics and ecological science. In the same way that financial capital produces a flow of financial benefits, natural capital produces ecosystem services or benefits to people (Figure 17). These services can provide economic, social, environmental, cultural or spiritual benefits. The value of these benefits can be understood in economic, financial or social terms. Different types of forest provide different combinations of provisioning, regulating, habitat and cultural services (Figure 18).

179 Smith, G.S., Ascui, F., O'Grady, A., Pinkard L. (2020) Opportunities for Natural Capital Financing in the Forestry Sector, CSIRO, Hobart, Australia.

180 from Natural Capital Coalition https://naturalcapitalcoalition.org/natural-capital-2/.

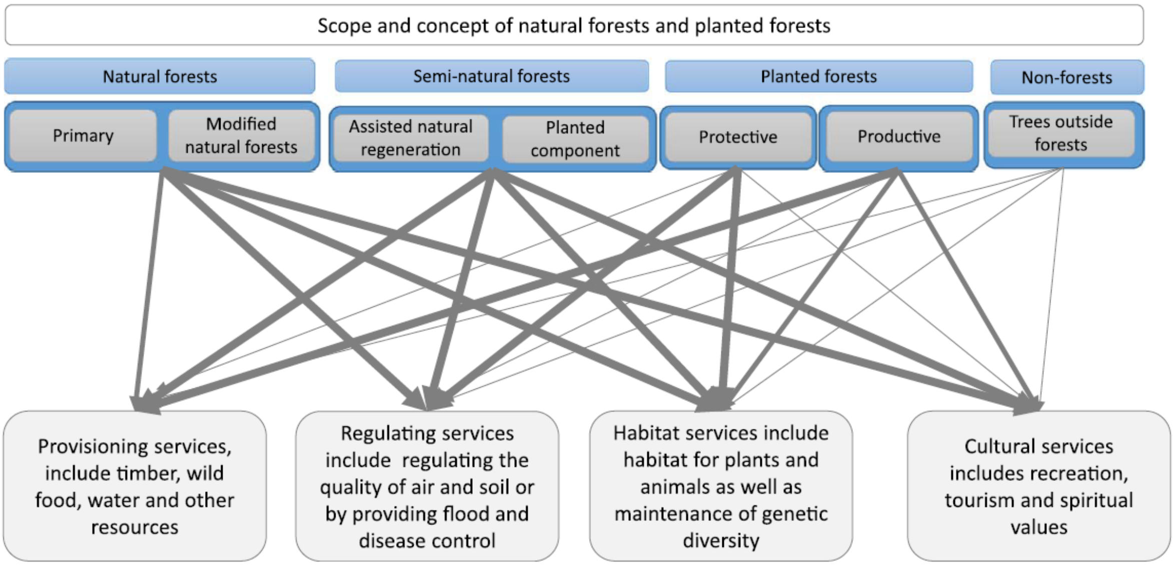


Figure 18 . Relationship between different forest types and different ecosystem services[181]

Quantifying and valuing ecosystem services were intended to improve decision making through the generation of knowledge about ecosystem functions and their contribution to society and translating this information into measures that can be communicated to decision makers and the community.

8.2. Sustainable Development Goals and responsible investment

In 2017, United Nations member states agreed to achieving 17 Sustainable Development Goals by 2030 [182] These goals include targets for sustainable use and conservation of ecosystems, climate action, poverty alleviation, improving health and education, and reducing inequality. Achieving these goals will require substantial redirection of financial investment public, private, domestic and international sources of finance.

Many governments, private investors and organisations investing on behalf of individual members, such as superannuation funds, are now targeting their investment towards achieving these goals. This is generating a new class of investment called responsible investment. Most large investors, and their sources of capital, are considering the social and environmental impact of investment alongside financial returns. This represents a new opportunity for attracting an impact-informed pool of capital into trees for timber production. This includes equity investment, bonds, loans, public sector finance and philanthropy. Environmental markets, such as for carbon, also provide potential new sources of income for owners of assets that deliver different types of ecosystem services.

Bonds are essentially loan contracts between the investor and the issuer specifying the issuer's obligation to repay the bond principal at a certain date (maturity), plus an additional fixed or variable amount of interest. They are issued by large, established companies or governments when they want to borrow more money than a bank is willing to lend. Green bonds have the same structure and pricing to traditional bonds but the capital raised is directed towards financing environmental activities or projects. Climate bonds are a

181 Figure from Dr Himlal Baral.

182 https://sdgs.un.org/goals.

sub-set of green bonds aimed specifically at raising capital for climate change mitigation and adaptation projects. Large amounts of money are becoming available through this type of investment.[183]

8.3. Measuring and accounting for natural capital and ecosystem services

Systems and accounting standards for business-level financial reporting and national and global economic accounts enable businesses, investors and policy makers to make informed decisions about financial investments and economic management. While mainstream economics has developed systems for measuring and valuing financial and human capital, until recently little attention has been given to assessing the value of natural ecosystems. For example, the Australian Treasury's Intergenerational Reports provide detailed information on trends in GDP, employment, population change, health, education and other economic and social statistics, yet have few comparable measures of the condition of environmental assets.[184]

Providing consistent information about natural capital at all scales indicates how the environment contributes to economic and human activity and how economic activity affects the environment. Reports can be retrospective or forward looking, to evaluate future natural capital related risks.[185] This can support better decisions for land management and forest management, and for policy and investment.

Accounting for natural capital can better inform decision makers about the impacts of investment decisions on the environment. With the development of agreed systems and measurement approaches, accounts of governments and businesses can routinely report on the status of the environment. Like other measures such as GDP, accounts can be aggregated to generate consistent farm regional, landscape, and state and national accounts of greenhouse gas emissions/carbon sequestration; nutrient cycling; water quality; air quality; biodiversity; and timber production.

Neither approach is currently widely applied in the forestry sector, although it is being tested by some industry players. Forest management can have positive or negative effect on natural capital stocks and the flow of ecosystem services. Only some of these stocks and flows, such as the stock of merchantable timber or flows of harvested wood products, have traditionally been included in forest management and investment decisions.

8.3.1. System of Environmental-Economic Accounting (SEEA)

"The System of Environmental-Economic Accounting (SEEA) is a framework that integrates economic and environmental data to provide a more comprehensive and multipurpose view of the interrelationships between the economy and the environment and the stocks and changes in stocks of environmental assets, as they bring benefits to humanity."[186]

The system is an internationally agreed set of concepts, definitions, classifications, accounting rules and tables for producing comparable statistics and accounts. It follows a similar accounting structure to the System of National Accounts (SNA) to facilitate integration of environmental and economic statistics. It is flexible and can be adapted to different priorities and policy needs while providing a common framework, concepts, terms and definitions. The Victorian Department of Environment, Land, Water and Planning (DELWP) released a five-year strategic plan in 2015 focusing on the adoption of SEEA at a state level.[187]

183 Ibid. See footnote 164.

184 Wentworth Group of Concerned Scientists 2016. Accounting for Nature. A scientific method for constructing environmental asset condition accounts.

185 Ibid. see footnote 164.

186 https://seea.un.org/.

187 DELWP. 2015. Valuing and accounting for Victoria's environment: Strategic Plan 2015–2020. Department of Environment, Land, Water and Planning, Melbourne.

The Natural Capital Protocol is a similar set of tools for measurement, reporting and verification for use in private entities for supporting delivery of ecosystem services.[188]

Forico, Tasmania's largest private forest owner, piloted the use of the SEEA to develop natural capital accounts for a Tasmanian forest plantation and developed a method to integrate this information with standard financial accounting frameworks. It involved accounting for the natural capital stock on their properties and the flow of ecosystem services supplied by these stocks. The exercise enabled Forico to improve operational decision making, improve communication to stakeholders through the recognition of a wider range of environmental values, and improve its strategic allocation of financial resources to maximise flows of ecosystem services.[189]

8.3.2. Natural capital roadmap

While momentum on assessing and using natural capital and ecosystem services concept is positive, tools and systems for measurement are generally inadequate and inconsistent. Climateworks were supported to develop a roadmap to guide and encourage implementation.[190] This report outlines nine action areas for improving the measurement and valuation of natural capital in Australia.

The assessment indicated that approaches to measuring natural capital vary in robustness and coverage and are not easily comparable, and incentives for land managers to measure natural capital are lacking. Indigenous knowledge is rarely considered in the design of natural capital measurement systems, farmers are reluctant to share data on their property and natural capital information is often not seen as useful to inform or enable land management decisions or key financial decisions (especially lending, property valuation, insurance). Consequently, natural capital is not fully integrated into property level or corporate decision making in the food, fibre or timber value chains and use of natural capital information to inform policy is not prioritised at a whole-of-government level.

Actions in the roadmap included:

- Establishing a natural capital forum to agree on common language and core set of metrics, and to investigate approaches to achieve greater standardisation, assurance and inter-operability of measurement
- Using public and private incentives to enable land managers to participate in natural capital projects
- Piloting of data management and aggregation systems and technology enablers to protect confidential data (eg blockchain)
- Bringing together traditional knowledge into natural capital measurement (such as savanna burning carbon methodologies)
- Undertaking market analysis to clarify end-user needs for natural capital information
- Designing and piloting flexible, accessible, affordable approaches at all scales, and supporting enabling technologies for lower-cost data collection, processing and analytics (remote sensing, drones, Internet of Things, global information system mapping)
- Accelerating piloting and implementation of new business and financing models for sustainable land management and sharing lessons learned
- Researching links between natural capital and financial performance and on integrating natural capital into mainstream financial decision making and corporate reporting

188 Ibid. see note 165.

189 https://forico.com.au/natural-capital.

190 Climateworks Australia 2019. https://www.climateworksaustralia.org/resource/land-use-futures-natural-capital-roadmap/.

- Increasing investment and reporting through wider participation in Natural Capital Coalition and sharing of natural capital valuation case studies
- Accelerating implementation of National Strategy for Environmental-Economic Accounting, for example by establishing an independent institution to monitor and report on natural capital (eg the UK Natural Capital Committee)
- Value natural capital within carbon markets and investigate new or expanded natural capital market mechanisms (eg biodiversity offsets, Reef Credits, etc).

8.3.3. Accounting for Nature Framework

In 2008, the Wentworth Group of Concerned Scientists and other experts in science, economics and statistics, applied a conceptual framework similar to that used for national economic accounts to produce a practical and robust method to measure changes in the biophysical condition of environmental assets.[191] The Accounting for Nature® Framework uses reference condition benchmarking to create a common unit of measure for building biophysical accounts to describing condition of environmental assets such as native vegetation, soil, rivers, fauna, or estuaries at any scale. The common measure, an Econd, is an index between 0 and 100, where 100 describes an environmental asset in an undegraded state.

This framework was tested by Australia's regional Natural Resource Management authorities. Benefits of applying the framework were improved capacity to measure success or otherwise of public investments in natural resource management; increased efficiency of expenditures through better targeted investments; and a better-informed community, leading to less conflict and enhanced community effort and a cost-effective pathway for industry, farmers and other land managers to demonstrate the sustainability of their business practices. The framework also provided monitoring information needed to adapt to climate change.

The Accounting for Nature Framework[192] has been developed as a formal reporting standard like those used for carbon offset projects, impact investment opportunities (eg green bond criteria) or forest stewardship. It offers a system of rules and processes designed to ensure the integrity and transparency of environmental accounts. This framework is being adopted by a range of carbon project developers and conservation managers to report on the environmental outcomes of investment.

8.4. Issues and challenges

The approach to valuation of natural capital and ecosystem services is a matter of some debate. Neo-classical economists and environmental economists generally favour market-based approaches, but these often depend on complex scientific models to quantify the service and provide a basis for trading. Others have suggested that local knowledge and well-facilitated group learning processes might be a more suitable approach to assess the 'true' value of natural capital, than traditional positivist approaches aimed at comprehensive quantification and valuation of ecosystem services. Decision makers and stakeholders may prefer to use a variety of value metrics, not just monetary values. Linking changes in ecosystem services to metrics of human wellbeing is an important science gap.

Analysis of data from 20 interview participants in Victoria[193] indicated that impediments to implementing ecosystem services included structural and governance deficiencies, lack of public and private leadership, complexity of language, and the lack of sustained, long-term investment. Proposed solutions include standardised measurement and reporting such as the SEEA, improved communication tools, and potential

191 Ibid see footnote 169.

192 https://www.accountingfornature.org/.

193 Keenan, R.J., Pozza, G., Fitzsimons, J.A., 2019. Ecosystem services in environmental policy: Barriers and opportunities for increased adoption. Ecosystem Services 38, 100943.

commercial investment in ecosystem services through government regulated markets. The study revealed that ecosystem services concepts have arrived at a moment of change in Victoria. They can potentially provide a basis for better environmental management decisions; however, many respondents felt implementation has stalled. Implementing complex policy change requires sustained effort. Active political leadership, a supporting advocacy coalition, and explicit theory on mechanisms to implement ecosystem services are required if the concept is to be widely adopted by decision makers in public or private spheres.

Currently, planted tree investments in Australia are not generally regarded by the finance and investment sector as meeting the requirements of this investment class.[194] However, a survey of finance actors indicated low levels of trust towards the sector's ambitions for tree planting, and this negatively impacts on risk–return assessments made by investors. There is a need to overcome negative past experiences and negative perceptions, through strengthening of ties between the forestry industry, landowners, local communities and investors. This can be done by positioning the industry as a key partner in building local communities' resilience.

8.5. Opportunities

- Analysis of the recent literature and discussions with stakeholders identified several opportunities in the application of natural capital accounting in the Tasmanian forest sector.
- Developing and applying approaches to natural capital accounting in different types of forests can be a valuable communication tool to support investment in the sector and build public support. Implementing sustainability 'impact' measurement and reporting has potential to unlock new finance opportunities. This information and tools can be used to build new relationships with responsible and ethical investors who expect solid evidence of the way in which their money makes a difference.
- Impact measurement is also required by financial institutions that seek to introduce new valuation methods and can therefore open possibilities for lower-cost capital.
- Natural capital measurement and reporting is an excellent tool for managing performance and risk, and can help improve the image of the industry and position it strategically in the new investment landscape. It is also a useful tool for current investors in forestry who are increasingly expected to demonstrate the socio-environmental impact of their investments.
- Natural capital reporting can be used to increase awareness of forestry as an investment class, especially among financial intermediaries such as financial advisors and the managers of responsible, ethical and impact funds. Awareness of forestry among these groups is low and sometimes based on unfounded assumptions.
- Investment vehicles aimed at small-scale private native forest owners or plantation growers could also have environmental benefits through improved collective management of these forests combined with new revenue streams from environmental markets. These may need some degree of government or philanthropic support to underwrite investment returns. Other examples include working forest conservation covenants to increase public funding for forest natural capital management; collaborative funding approaches to achieve landscape-level outcomes; blended finance; and new environmental markets.

194 Dembek, K and York, J. 2019. Next Generation Forest Plantation Investment Financial Sector Report. https://cpb-ap-se2.wpmucdn.com/blogs.unimelb.edu.au/dist/d/279/files/2020/03/Report-7-NGPI-Financial-Sector-Report.pdf.

- This will require actors across the sector engaging with researchers and government-provided tools and data and developing new investible projects, activities and assets with the potential to improve natural capital benefits and demonstrated contribution to the United Nations Sustainable Development Goals.
- Governments can play an important role in coordinating actions to manage risks to natural capital such as bushfires and implementing natural capital monitoring and accounting frameworks to enable consistent reporting and demonstrating scale and connectivity benefits.

Appendix 1. New Zealand Emissions Trading Scheme

Background

The New Zealand Emissions Trading Scheme (ETS) was created through the *Climate Change Response Act 2002* (NZ) (the Act). The Act was passed in recognition of New Zealand's obligations under the Kyoto Protocol.

The ETS puts a price on emissions, by charging certain sectors of the economy for the greenhouse gases they emit. On an annual basis these sectors must calculate their emissions by submitting an emissions return to the Environmental Protection Authority, the scheme administrator.

They must then acquire and surrender New Zealand Units (NZUs) or other eligible emission units to account for their direct greenhouse gas emissions or the emissions associated with their products.

The Act specifies the activities that are included in the ETS for each of the following industry sectors: forestry, liquid fossil fuels, stationary energy, industrial processes, synthetic greenhouse gases, agriculture and waste. Forestry entered the ETS in 2008. Forestry matters in the ETS are managed by the Ministry for Primary Industries (MPI).

Forest land in the ETS

Owners of forest land may be able to earn units through the ETS but must also meet specific obligations. Forest land has a specific meaning under the ETS and is classed into two types: pre-1990 or post-1989 forest land.

Pre-1990 forest land

Pre-1990 forest land is land that was forested in any forest species on 31 December 1989 and remained in predominantly exotic forest on 31 December 2007.

The government provided pre-1990 forest landowners with an option to apply for a one-off allocation of NZUs, between 2010 and 2013, in recognition of the impact of the ETS deforestation rules.

Pre-1990 forest landowners can harvest and replant their forest without any liability. But if the land is deforested, the landowner must notify MPI of deforestation, submit an emission return and pay for any emissions created through deforesting the land.

Post-1989 forest land

Post-1989 forest land is land that was established in forest species after 31 December 1989. Post-1989 forest landowners, or holders of registered forestry rights or leases, can apply to register as voluntary ETS participants at any time to earn NZUs for carbon sequestered by the forest. However, they must surrender NZUs when the trees are harvested or if the land is deregistered from the New Zealand ETS.

Registering and managing post-1989 forest land in the ETS

A Carbon Accounting Area (CAA) is an area of post-1989 forest land registered in the ETS. It must be at least 1 ha in size.

Steps to registration include:

- Assess spatial imagery as at 31 December 1989 and other records to confirm the eligibility of the land (i.e. the forest was first established after 31 December 1989)
- Obtain written consent from those with a registered interest in the land

- Create an electronic map of the forest to the requirements set out in the Geospatial Mapping Information Standard
- Submit the application to MPI online or by post.

The obligations under the ETS include:

- Filing an emissions return (a calculation of the changes in a forest's carbon stock during a defined period) over five-year mandatory emission return reporting periods (ending 2012, 2017 and 2022). They can also choose to report their emissions annually
- Paying back NZUs if the forest's carbon stock decreases, the land is deforested, or forest land is removed from the ETS registration
- Notifying MPI when the ownership of registered forest land changes.

MPI keeps a Carbon Accounting Record (CAR) as a permanent record for each CAA. It records the change in carbon stocks over time through information contained in emissions returns. It records the number of NZUs issued or paid for that CAA (i.e., the 'unit balance').

While post-1989 forest land is registered in the ETS, the unit balance stays with the land if there is a change in land ownership.

Forest landowners are charged at prescribed hourly rates for services provided by MPI relating to registering and managing post-1989 forest land in the ETS.

Calculating changes in forest carbon stocks

For areas less than 100 hectares

Owners of forest land registered in the ETS can use look-up tables (taken from the *Climate Change (Forestry Sector) Regulations 2008* (NZ)) that give pre-calculated values for a forest's carbon stock based on its age, region (if the forest is *Radiata pine*), and forest type.

For areas 100 hectares or more (post-1989 forest)

Owners of forest land registered in the ETS must use the Field Measurement Approach (FMA). This involves measuring trees at specific sample plots and submitting this information to MPI, which then uses the data to create participant-specific carbon look-up tables that provide the carbon stock in the forest.

Information for the FMA must be collected, recorded, and submitted to MPI in accordance with prescribed rules and procedures set out in three standards related to field measurements, formats of field information, and geospatial mapping procedures.

Emissions returns

Once the look-up carbon tables have been prepared by MPI, the forest owner can use them to prepare and submit an emissions return and can also use them for future emissions returns. A forest landowner can choose to submit a voluntary emissions return for post-1989 forest each year to claim carbon credits (NZUs).

Recent changes (June 2020)

The *Climate Change Response (Emissions Trading Reform) Amendment Act 2020* (NZ) (the Act) was passed into law in June 2020. It makes a number of changes to the New Zealand ETS.

Several decisions have been taken on forestry in the New Zealand ETS. The key forestry changes include:

- Introducing average accounting for some post-1989 forests
- Creating a new permanent forestry activity in the New Zealand ETS
- Exempting post-1989 forests from the requirement to surrender NZUs to cover emissions from temporary adverse events (such as fire or wind throw)
- Allowing some types of post-1989 forestry participants to offset their deforestation liability by planting a forest elsewhere.

The government announced:

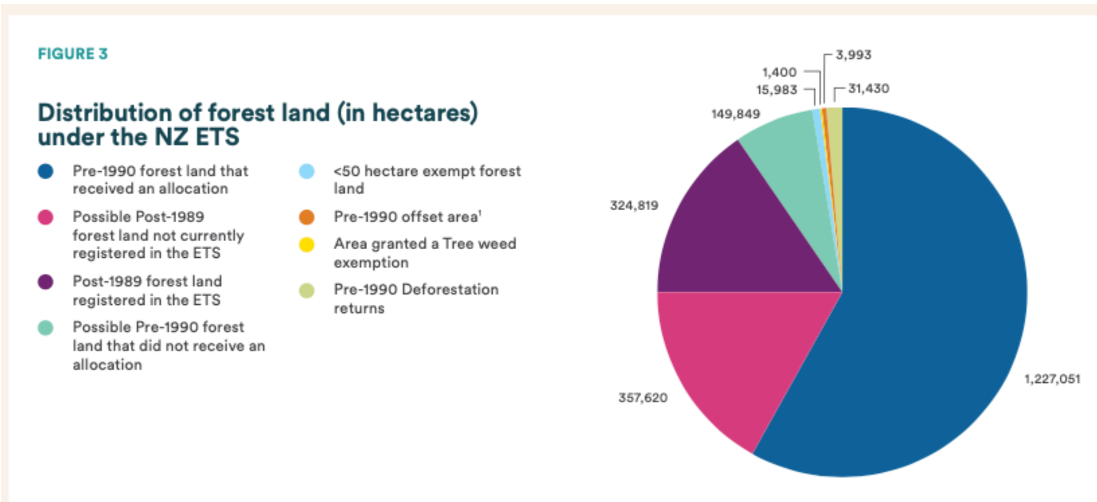
"Over the next 2 years we're looking at ways to streamline our ETS administration and upgrade our technology to make it easier for people to take part.

We're replacing the existing Climate Change Information System (CCIS) with a new system. The first version of this will be live by mid-2022. Along with this you'll also see:

- Streamlined processes
- Improved administration
- Better guidance and tools for landowners
- A quicker and simpler system for registering trees
- Reduced complexity – making it easier for you to meet statutory requirements."

There are also changes to the fixed price option (FPO) that may interest forestry participants:

- The FPO has changed from $25 to $35 for emissions from the start of 2020
- For emissions that occurred up to 31 December 2019, participants will continue to have access to the FPO at $25 for those emissions.



Appendix Figure 1. Distribution of forest land under New Zealand ETS, 2018 data (permission pending)

Pricing as at 2018

The government gives eligible forest owners units for carbon dioxide that is absorbed by their trees. The foresters can sell these units on the New Zealand ETS market. Businesses with surrender obligations (legal obligations to hand over units) must purchase enough units to cover their emissions. These units are then surrendered to the government.

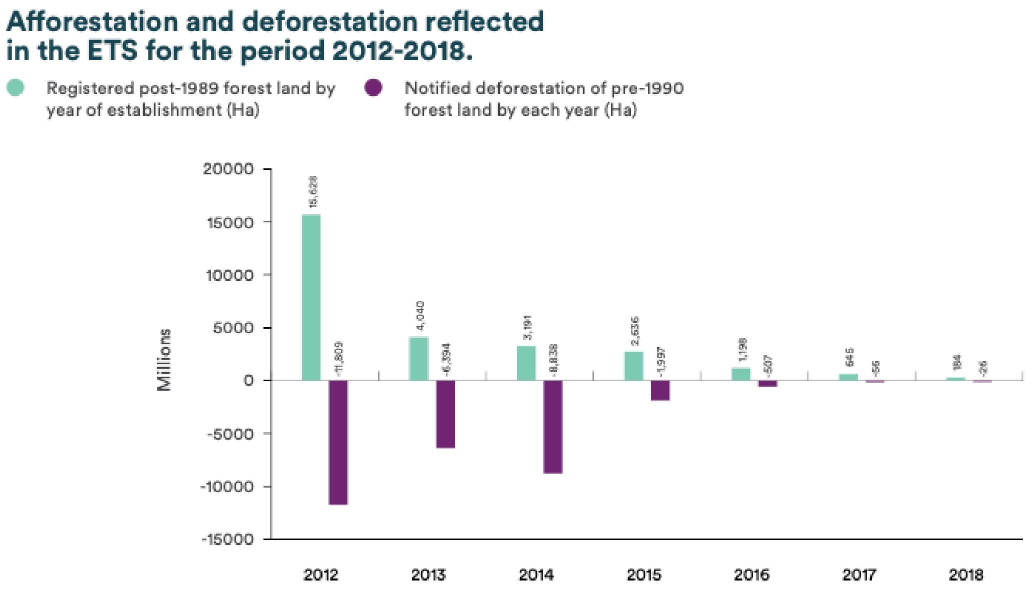
The New Zealand ETS operates with a price ceiling mechanism. Participants can purchase unlimited NZUs from the government for immediate surrender (not banking or trading) at a fixed price of NZ$25 per NZU.

The New Zealand ETS permits unlimited banking of units by participants. Over time, participants have accumulated a substantial bank of units which can be used for compliance.

2020 review

The government has announced new price controls designed to prevent unacceptably high or low auction prices. These prices could be passed on to businesses and households.

1. The cost containment reserve will replace the FPO. The FPO will increase from $25 to $35 and be available for participants to use from the start of 2020 and overlap with the start of auctioning to cover emissions in 2020.
2. The government has announced that the cost containment reserve will be triggered if the unit price were to reach $50 in 2021. This would release more NZUs into an auction to ease demand. The trigger price will increase by 2% for each subsequent year, based on forecast annual inflation.
3. The Act will enable a price floor to be implemented through an auction reserve price. The government has announced that the minimum accepted price to bid at auction will be $20 in 2021 and rise by 2% for each subsequent year.



Appendix Figure 2. Afforestation and deforestation from 2012 to 2018, ETS data (permission pending)

2018 review: Post-1989 forest owners that opt into the New Zealand ETS have a mandatory emissions reporting period of five years. However, they are able to voluntarily report annually to receive units and must report when making changes to their registration in the system.

When measuring changes in forest carbon stocks in post-1989 forests, participants with less than 100 ha must use government look-up tables, whereas those with areas of 100 ha or more must use a FMA involving sample plots. For measuring deforestation emissions, pre-1990 forest participants must use government look-up tables.

Participants follow a 'self-assessment' model for emissions monitoring, reporting and verification (MRV). No independent third-party verification is required of emission reports, but the government has the power to conduct audits. Each year, the Environmental Protection Authority selects a sample of New Zealand ETS participants and free allocation recipients for internal and third-party reviews of compliance.

Failure to comply with data collection, record keeping, reporting, registration or notification requirements carries a fine. Knowingly providing false information carries a larger fine and/or a prison term.

The provision of default emission factors and forestry look-up tables is intended to reduce administrative complexity and costs and support consistency of emissions reporting. Enabling unique emission factors offers a fair approach – and a further emission reduction incentive – for those whose emissions may fall below the industry average. The FMA is intended to improve the precision of emissions reporting for those with large areas of post-1989 forest.

The 'self-assessment' model for MRV is modelled on the New Zealand tax system. The combined possibility of an audit and substantial fines and civil/criminal penalties acts as a deterrent for non-compliance.

Administration of the New Zealand ETS is complex and relevant to the domain of multiple government departments. Delegating New Zealand ETS operations for forestry and agriculture to the Ministry for Primary Industries has helped to ensure that subject specialists can meet the unique needs of New Zealand ETS participants in those sectors.

The Environmental Protection Authority and the MPI (referred to as the administering agencies) administer the New Zealand ETS.

Sources:

New Zealand Emissions Trading Scheme Facts and Figures 2018: https://www.epa.govt.nz/assets/Uploads/Documents/Emissions-Trading-Scheme/Reports/Annual-Reports/2018-ETS-Facts-and-Figures.pdf.

Environmental Protection Authority – Emissions Trading Scheme: https://www.epa.govt.nz/industry-areas/emissions-trading-scheme/about-the-nzets/.

Government announcement of changes to the ETS: https://www.mpi.govt.nz/protection-and-response/environment-and-natural-resources/emissions-trading-scheme/emissions-trading-scheme-improvements/ - dec-decisions-2018.

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