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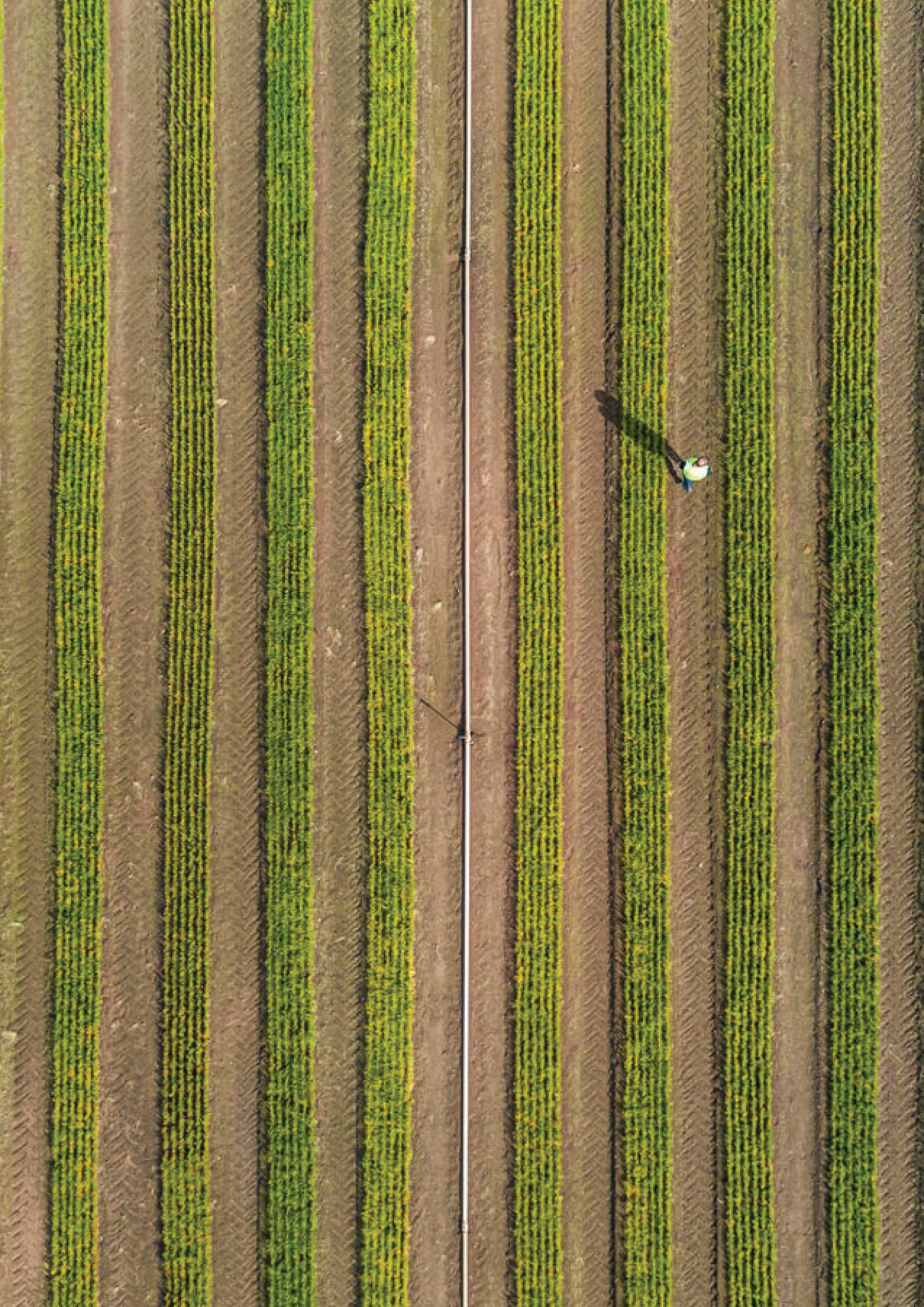
The role of the Emissions Reduction Fund



Unlocking opportunities for plantation forestry expansion in the Green Triangle.

The role of the Emissions Reduction Fund

Research report prepared for

The Green Triangle Forest Industries Hub
PO Box 9511
Mount Gambier West
SA 5291

Research report prepared by

Courtney M. Regan & Jeffery D. Connor
The University of South Australia
UniSA Business
City West Campus
Adelaide, SA 5000, Australia

Green Triangle Forest Industries Hub

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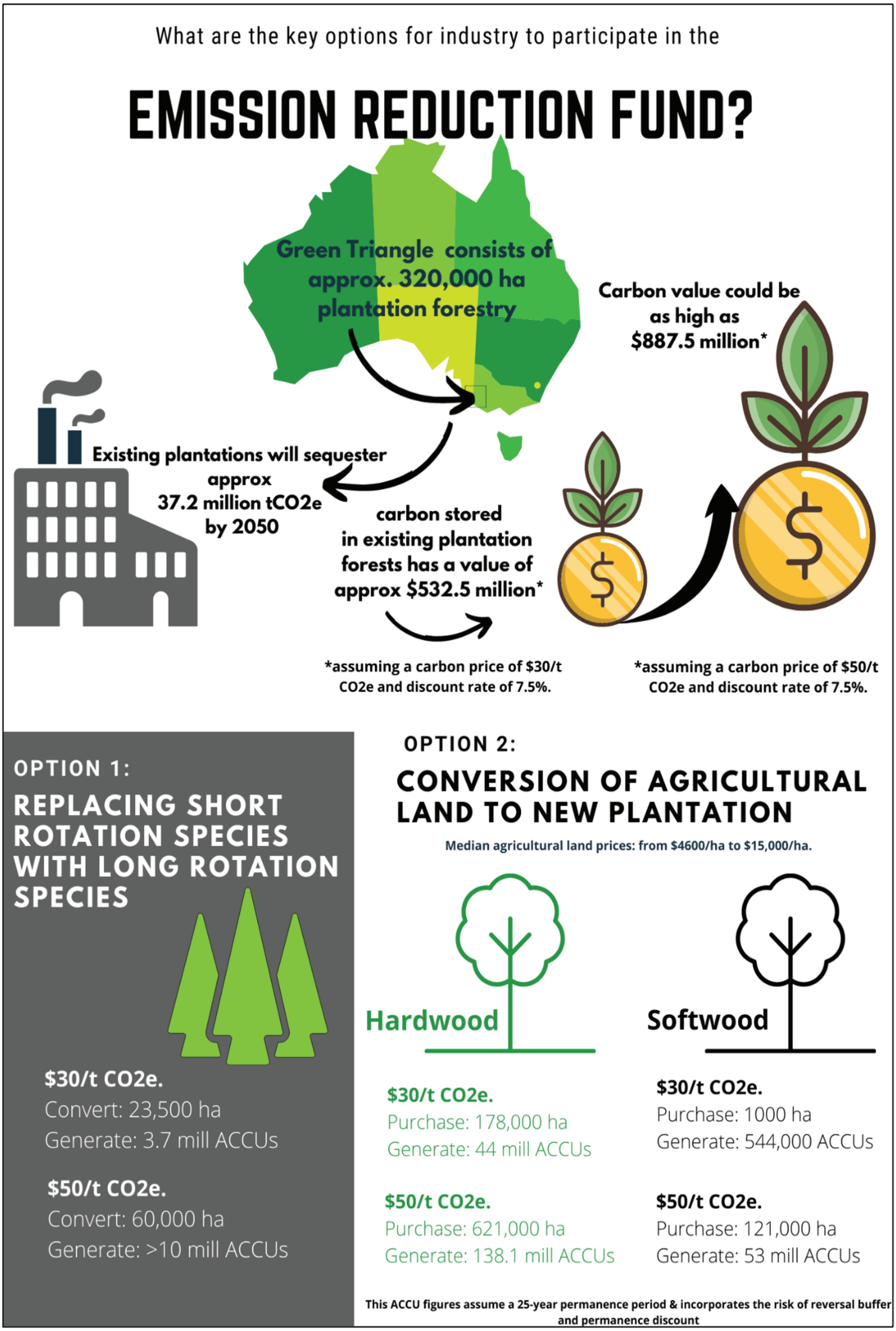

What are the key options for industry to participate in the
EMISSION REDUCTION FUND?
Green Triangle consists of approx. 320,000 ha plantation forestry
Carbon value could be as high as $887.5 million*
Existing plantations will sequester approx 37.2 million tCO2e by 2050
carbon stored in existing plantation forests has a value of approx $532.5 million*
*assuming a carbon price of $30/t CO2e and discount rate of 7.5%.
*assuming a carbon price of $50/t CO2e and discount rate of 7.5%.
OPTION 1:
REPLACING SHORT ROTATION SPECIES WITH LONG ROTATION SPECIES
$30/t CO2e.
Convert: 23,500 ha
Generate: 3.7 mill ACCUs
$50/t CO2e.
Convert: 60,000 ha
Generate: >10 mill ACCUs
OPTION 2:
CONVERSION OF AGRICULTURAL LAND TO NEW PLANTATION
Median agricultural land prices: from $4600/ha to $15,000/ha.
Hardwood
Softwood
$30/t CO2e.
Purchase: 178,000 ha
Generate: 44 mill ACCUs
$30/t CO2e.
Purchase: 1000 ha
Generate: 544,000 ACCUs
$50/t CO2e.
Purchase: 621,000 ha
Generate: 138.1 mill ACCUs
$50/t CO2e.
Purchase: 121,000 ha
Generate: 53 mill ACCUs
This ACCU figures assume a 25-year permanence period & incorporates the risk of reversal buffer and permanence discount

Executive Summary

Background

The Green Triangle is one of Australia's most important forestry regions and is the largest supplier of wood products into domestic markets.

However, despite growing demand for wood products, the Green Triangle estate is shrinking (IndustryEdge, 2021). A host of regulatory and economic factors are driving declines in plantation area and acting as a barrier to plantation expansion. Foremost being the growing pressure from the agriculture sector driving property prices to record levels in the region. In addition to high land values, long investment time frames, high upfront establishment costs and the availability of land within proximity of processing/port facilities have been cited as major barriers to plantation expansion in Australia (Whittle et al., 2019).

Evidence suggests investors in forestry projects require returns of approximately 7-7.5 percent for investments in new plantations to be financially viable (Ferguson, 2018). However, under current market conditions, expected returns to new forestry investments are reportedly closer to 3 percent (EY, 2020). It has long been anticipated that payments for carbon sequestration associated with the development of commercial plantations may lower the gap between expected versus required investment return rates. Although until relatively recently (2017) there was no mechanism for plantation forestry to participate in the Emission Reduction Fund while important forestry areas such as western Victoria were excluded from participation until 2022.

To date several companies have developed Emissions Reduction Fund projects, however to the authors knowledge this has been across limited spatial areas. This work presents a quantitative assessment of the carbon abatement potential across the greater Green Triangle (GT) region and the opportunities for the forestry sector to leverage Australian carbon policy to increase investment in forestry assets in the region.

Scope and Aims

This research was conducted to support the Green Triangle Forest Industries Hub's (GTFIH) strategic planning for unlocking opportunities for plantation forestry expansion in the Green Triangle (GT). The focus of this work is to provide a rigorous evidence base of the potential role emerging carbon markets could play in future forestry expansion. The emphasis of the research is on the Australian Government's carbon policy, the Emissions Reduction Fund (ERF).

The work included:

1. Spatially explicit quantification of the current carbon volume in existing plantations using the Full Carbon Accounting Model (FullCAM) and estimates of economic value.
2. Spatially explicit quantification of carbon sequestration potential in 'greenfield' land across the greater GT region using FullCAM and current ERF plantation forestry methods.
3. Understand the economic potential for ERF projects to influence plantation expansion viability.
4. A brief review of barriers to plantation expansion and policy settings globally aimed at increasing plantation forestry extent.
5. Production of GIS layers of carbon abatement potential for hardwood (*E. globulus*) and softwood (*P. radiata*) across the greater GT region that can be used in industry strategic planning.

Methodology

The modelling of carbon sequestration potential across the region was done with the Full Carbon Accounting Model (FullCAM) 2020 public release version at a 500-metre spatial resolution.

FullCAM is used in Australia's National Greenhouse Gas Accounts for the land sector and provides fully integrated estimates of carbon pools in forestry and agricultural systems in Australia. Two plantation forestry methods were modelled, Schedule 1 "Establishing a new plantation" and Schedule 2 "Converting an existing plantation from a short rotation to a long rotation".

While Schedule 3 "Avoided conversion of a plantation to non-forest land by continuing plantation activity" has potential applicability in the Green Triangle, data on land that meets this method's eligibility criteria were unavailable.

Economic returns to forestry were modelled as land expectation values (LEV). The LEV is the present value of the costs and revenues resulting from a perpetual sequence of forestry rotations, starting initially from bare land. Return from participation in an ERF method were modelled as present value according to the accumulation ACCUs set out in the methodology determination.

Executive Summary

For Schedule 1 projects ACCUs are issued for increases in carbon during the project up to the long-term average carbon sequestration for the new plantation.

For Schedule 2, the ACCUs generated by the project is the difference between long-term carbon stock of continued short rotation operations and long-term carbon stock of the long rotation regime. ACCUs generated by the project are split into equal apportionments and credited over the first 15 years of the crediting period. The threshold carbon prices that created returns that a) covered land purchase and establishment costs for new plantations or b) returned a higher LEV than the continuing hardwood production was calculated.

Key findings

- Continuous business as usual forestry on the current existing plantation extent will sequester approximately 133 million tonnes CO_2e over the next 100 years and approximately 37.2 million tonnes CO_2e by 2050.
- Current ACCU spot price is approximately $30/t CO_2e but have trades as high as $55/t CO_2e.
- The value of the carbon stored in existing plantation forests has a present value of approximately $532.5 million assuming a carbon price of $30/t CO_2e and discount rate of 7.5 percent.

Schedule 1 - Establishing a new plantation

Softwood

- Median agricultural land prices in the region are strong ranging from $4600/ha to over $15,000/ha.
- Lowest carbon price required to economically purchase land and convert to softwood was $21/t CO_2e. At that price approximate 700 ha was available in the region for purchase and development.
- This scale of development would generate up to 390,000 ACCUs with a present value of up to $5.5 million.
- At carbon prices in line with current voluntary market prices of $30/t CO_2e approximately 1000 ha would be available for purchase and development of softwood plantations.
- This would generate approximately 544,000 ACCUs with a present value of up to $7.6 million.
- Potential for the development of softwood plantations increase substantially at carbon prices of $50/t CO_2e. At that price approximately 121,000 ha would available, generating approximately 53 million ACCUs with a present value of up to $1 billion.

Hardwood

- The results showed that without a carbon price approximately 5500 ha, if on the market, would currently be viable to purchase and establish hardwood plantations.
- At carbon prices in line with current voluntary market prices of $30/t CO_2e approximately 178,000 ha may be economically viable for purchase and development if available on the market[1]. Comparatively more area is potentially available for hardwood than softwood due to the shorter rotation length of hardwood.
- Development of hardwood plantations at this scale would generate approximately 44 million ACCUs over a 25-year project, with a present value of up to $442 million.

- At carbon prices of up to $50/t CO_2e approximately 621,000 ha may be economically viable for purchase and development, generating up to 138.1 million ACCUS with a present value of up to $2.35 billion.

Schedule 2 - Converting an existing plantation from a short rotation to a long rotation

- At $30/t CO_2e approximately 23,500 hectares of hardwood plantation could economically be converted to softwood. This would take place primarily in South Australia.
- This scale of conversion would generate up to 3,683,500 ACCUs[2] with a present value of up to $75 million[3].
- At $50/t CO_2e approximately 60,000 hectares could be economically viable to be converted from hardwood to softwood
- This would produce 10,032,477 ACCUs and if sold into the voluntary market at that price would have a present value of up to $350 million.

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[1] Comparatively more area is potentially available for hardwood than softwood due to the shorter rotation length of hardwood and the resultant effects on the time value of money.

[2] This ACCU figures assume a 25-year permanence period & incorporates the risk of reversal buffer and permanence discount.

[3] This value of ACCUS assumes 7.5% discount rate and immediate conversion and should be viewed as a maximum upper bound.

Contents

Figures

Tables

Introduction

The Green Triangle is one of Australia's most important forestry regions and is the largest supplier of wood products into domestic markets (IndustryEdge, 2021).

The region supplies approximately :

- 35 percent of Australia's locally produced house framing and interior sawn wood
- 30 percent of the particleboard used in Australia
- 48 percent of the packaging and industrial grade timber used domestically, and
- 60 percent of the fencing poles and posts used in the agriculture, horticulture, and landscaping industries (IndustryEdge, 2021).

Despite growing demand for wood products, the Green Triangle estate is shrinking. Annually the region loses up to 5,000 hectares of plantation (IndustryEdge, 2021). Several regulatory and economic factors are driving the decline in plantation area and acting as a barrier to plantation expansion. Foremost being growing pressure from the agriculture sector which has driven property prices to record levels. Demand for farmland is the product of a combination of factors including agricultural commodity prices, farmer terms of trade, seasonal conditions, and interest rates (Rural Bank, 2021). These factors have been mostly favorable for agriculture for some time. Coupled with the long-term trend of consolidation of farms into larger holdings, the market has seen fewer listings over time and has promoted a general environment where demand for land out paces supply. Other factors, such as tightening forest water use policy under the Limestone Coast Water Allocation Plan in South Australia has precipitated a decline in replanting of harvested plantations (primarily in the hundreds of Coles and Short in the Wattle Range Local Government area) have contributed to the general poor investment environment for plantation forestry in the Green Triangle region.

The region has an extensive infrastructure base suited to the further development of commercial forest assets. The region is well serviced by extensive transport networks, existing power and gas networks capable of supplying wood processing operations, large processing plants and the deep-water port of Portland, Victoria (RDA, 2012). Over the past two decades a number of industry funded studies (De Fegely et al., 2011; EY, 2020; IndustryEdge, 2021; Matysek and Fisher, 2016; RDA, 2012; Schirmer et al., 2008; Schirmer et al., 2018b) have quantified the socio-economic value of the forestry industry to the GT, highlighted barriers to expansion of forest area and proposed policies that may improve forestry's competitiveness at the margins. They commonly cite high land values, long investment time frames and distance from processing/port facilities among the main barriers to expansion. More recently, the prospects of the industry's participation in developing markets for carbon offsets has provided renewed hope of reversing the decline in plantation area.

Evidence from previous studies suggest investors in forestry projects require returns of approximately 7–7.5 percent for investments in new plantations to be financially viable (De Fegely et al., 2011; EY, 2020; Ferguson, 2018). However, under current market conditions, expected returns to new forestry investments are approximately 3 percent (EY, 2020). It has long been anticipated that the receipt of carbon sequestration payments associated with the development of commercial plantations may lower the gap between expected versus required investment return rates.

The extent to which plantation forestry will benefit from carbon markets will depend on a range of biological, economic and institutional factors (Paul et al., 2013). Several estimates of the biological and economic potential for expansion of industrial plantations incorporating carbon markets in Australia have been published over time (Lawson et al., 2008; Paul et al., 2013; Polglase et al., 2008; Polglase et al., 2013). Many of these studies relied on generalised scenarios of growth and management and as such the results could be seen as best approximations of the opportunities carbon payments may present the plantation forestry sector in the region. In addition, these studies were often not specific to the Emissions Reduction Fund (ERF) which has strict criteria for participation.

The Emission Reduction Fund is Australia's mechanism for securing lowest cost carbon abatement and offsets. Vegetation projects have been a key generator of carbon offsets. The policy operates as both a carbon credit certification scheme and as an auction. The ERF solicits applications for emissions reductions or offset projects from several sectors including energy efficiency, landfill emissions reductions, transport, and land-based vegetation methods. Approved projects create certified Australian Carbon Credit Units (ACCUs) which are tradeable in several markets for carbon credits. A large portion of these credits (about 88 percent) to date have been sold into the ERF auctions. The auctions involve ranking bids received in each auction round (14 have been held to date) and funding projects that offer emissions reductions or offsets at least cost per ACCU (1 ACCU = 1 tonne of CO_2 equivalent emissions reduction). In 2017, plantation forestry was included in Emissions Reduction Fund via the plantation forestry method. To date, vegetation projects have been responsible for approximately 55 percent of Australian Carbon Credit Units (ACCUs) issued Australia wide (CER, 2020). Vegetation projects generate abatement by removing carbon dioxide from the atmosphere and storing it as carbon in plants.

Examples of vegetation activities include:

- reforestation
- revegetation, or
- protecting native forest or vegetation that is at imminent risk of clearing (CER, 2021b).

Vegetation methods can encompass a wide variety of activities including Human Induced Revegetation, Avoided Deforestation, Native Forest from Managed Regrowth, Reforestation and Afforestation by Environmental or Mallee Plantings, Farm Forestry and Plantation Forestry.

Plantation forestry in the Green Triangle is already a significant carbon sink. However, the industry has potential for further land-based sequestration through participation in the ERF, further assisting Australia achieve its emissions reductions goals while continuing to deliver significant public-goods. Several previous reports (EY, 2020; Matysek and Fisher, 2016; Polglase et al., 2013) have provided initial appraisals of the role carbon markets could play in increasing plantation extent in the region. This report builds on those assessments by providing a spatially explicit quantitative assessment of bio-physical sequestration potential in the region and economic appraisal of the opportunities under the ERF plantation forestry methods[4].

The report is structured as follows:

- A brief review of policies in Australia and overseas that have encouraged plantation expansion
- Outline of the study area
- An explanation of the Emissions Reduction Fund, the plantation forestry methods and how ACCUs are earned
- An outline of carbon supply from plantation forestry methods including the results from FullCAM modelling across the study area
- A brief explanation of the economic modelling including a description of some of the main economic variables and calculation of land expectation values across the study area
- Presentation of results for Schedule 1 Establishing a new plantation
- Presentation of results for Schedule 2 Converting an existing plantation from a short rotation to a long rotation, and
- Summary.

[4] The results should be viewed as areas of opportunity for participation in the ERF under any given scenario, and not predictions of the extent of land use change, which is affected by a multitude of market and social factors.

Policies to encourage plantation expansion

Australia has not established any significant areas of new long rotation sawlog plantations since the early 1990s (De Fegely et al., 2011).

This being despite strong demand for sawn timber products, generally favourable outlook in main markets and the quantification of the importance of the industry to regional economies (Schirmer et al., 2018a; Schirmer et al., 2008; Schirmer et al., 2018b). Many studies have been conducted over the past decade (De Fegely et al., 2011; Greenwood Strategy, 2020; Kah et al., 2010; Kelly et al., 2005) assessing the reasons for low investment rates and proposing strategies and policies to rectify the problem. Common themes cited for the observed investment inertia are the long-term nature of forestry investments compared to other investment classes, high capital cost of establishment and long waiting periods for a return (i.e., time value of money) particularly for longer rotation species. These factors largely explain the low rate of return on investment, particularly for longer rotation species. More recently factors including inflation in agricultural land values and natural resource constraints (water in South Australia) have contributed to the general poor investment environment for plantation forestry in the GT region.

Historically government intervention has been required to promote plantation development in Australia. Policies have included the Softwood Forestry Agreement, state government farm forestry loans, concessions to develop crown land, and managed investment schemes. De Fegely et al. (2011) provide a comprehensive review of Australian policy and programs aimed at increasing plantation extent. The authors argue that the two most successful schemes in terms of expanding the Australian plantation estate were the Commonwealth Government funded Softwood Forestry Agreement Loans (SFAL) and the implementation of personal taxation deductions, most notably the managed investment schemes (MIS). While successful, the authors also acknowledge both mechanisms have attracted criticism. For example, the SFAL has been criticised for promoting native vegetation clearance and the MIS for inflating rural land prices, changing rural demographics, and encouraging investment on land with poor suitability for forestry.

Internationally, a combination of direct and tax-based incentives have been adopted to promote plantation expansion (De Fegely et al., 2011; Stephens and Grist, 2014).

- In Brazil, over 6M ha were established between 1967 and 1987 through a program of taxation incentives of up to 75% of the value of the project. Since 1999, there has been increased plantation development; however, this has largely been done without major fiscal incentives from the government.
- From 1974 to 1994, the Chilean government provided subsidies of up to 75% of the establishment cost, as well as exemptions on property and inheritance taxes, which supported the establishment of over 1.5M ha of plantations. In 1998, the program was reformed with an emphasis on small forest landowners, and afforestation projects on degraded land, with a cap of 15 ha per landowner implemented (España et al., 2022).
- In Uruguay, incentives provided through the National Forest Plan included subsidies of up to 50 percent of planting costs, no taxes on the planted forest or land, and low interest loans. This scheme supported the development of around 2.5M ha of plantations.
- In New Zealand between the 1960s and early 1980s the plantation forest estate was expanded by almost 700,000 hectares through a range of programs including forestry encouragement grants, low interest loans and taxation deductions of up to 100 percent of the planting costs. In 2018 the Afforestation Grant Scheme was replaced by the One Billion Trees Fund which sought to encourage both permanent and plantation forests made up of exotic and native tree species. The fund (now closed) was largely focused on private landholders and provided $118 million for accessible grants to landowners and organisations looking to plant trees.
- In Scandinavian countries, strong forest owners' associations enable small forest owners to cost effectively participate in markets. However, some incentives do remain and are primarily designed to ensure environmental policy integration. For example, in Sweden, incentives include economic compensation encouraging specific environmental or cultural targets to be reached. For example, ensuring that the proportion of broadleaved species are maintained or increased, and to safeguard and develop cultural environments and natural values (Lindahl et al., 2017)

- In the United Kingdom tax incentives from the basis of forestry incentives. These include freedom from income tax liability, corporation tax or capital gains tax arising from growing and producing timber. As such, the majority of the income arising from forestry investment is likely to be free of tax (HM Revenue & Customs, 2018).

The Republic of Ireland continues to have some of most generous supports available for the establishment of new forests. Plantation forestry in Ireland has largely focused on increasing the estate via private landholders (Vidyaratne et al., 2020). Incentives and tax concessions are managed under the Afforestation Scheme 2014-2022. The scheme provides financial support to landowners to plant trees on land not previously forested. The benefits include:

  - 100 percent of the costs of establishing new forests are covered by the Department through grants
  - Farmers and landowners are paid up to 680 euros per hectare for each of the first 15 years of their forest.
  - All profits from the management of Irish forests, including grants and premiums, thinning, and felling are exempt from income tax (DAFM, 2015).

Tax incentives are often considered a blunt instrument by policy makers (De Fegely et al., 2011). While research suggests that taxation concessions have been more attractive to investors when compared to grant or loan based incentives (Boutland and Byron, 1987; Byron and Boutland, 1987), evidence from countries with generous taxation exemptions, such as Ireland, show that after initial success, rates of plantation expansion have stagnated (Vidyaratne et al., 2020). It is thought unlikely that the Australian Government will take action towards reimplementing MIS taxation incentives (Nery et al., 2019). In any case, the previous MIS was largely unpopular with rural communities and their reimplementation may cause additional social license issues for the industry (Greenwood Strategy, 2020).

Economic analysis has consistently shown that without government intervention large scale forestry expansion is unlikely to occur in the near future. There has also been considerable concerns from agricultural industries regarding the use of prime agricultural land being used to grow trees. These concerns have not been without political support adding to the to the generally unfavourable investment environment. However, it has been suggested that given the already apparent increasing competition for land it has been suggested that plantations would be best established in locations where they contribute to improving ecosystem and landscape functioning and increasing the provisioning of ecosystem services (Bauhus et al., 2010). Developing ecosystem services markets, particularly for carbon, present one of the best opportunities to fundamentally change the economic case for plantation establishment in Australia, by providing additional, early rotation cashflow (Greenwood Strategy, 2020).

Study Area

The Green Triangle plantation region is defined by the National Plantation Inventory (NPI) and is the region straddling the south east South Australian and South Western Victorian border region and covers an area of 3.4 million hectares (ABARES, 2018).

For this study, and as requested by industry partners, we have extended the modelling extent of what is defined as the Green Triangle NPI to encompass parts of the Central Victoria NPI region. The Greater Green Triangle region (denoted in grey in Figure 1) indicates the area included in the economic analysis encompasses approximately 4.6 million hectares.

The expanded study area includes 17 local government areas (Figure 2).

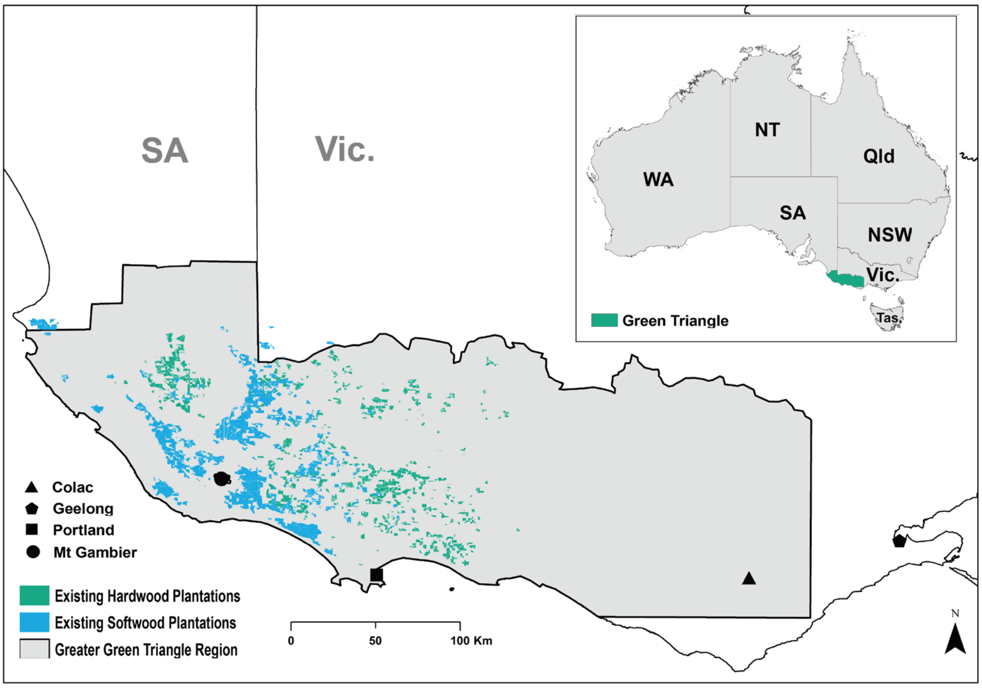


Figure 1: The greater Green Triangle study area

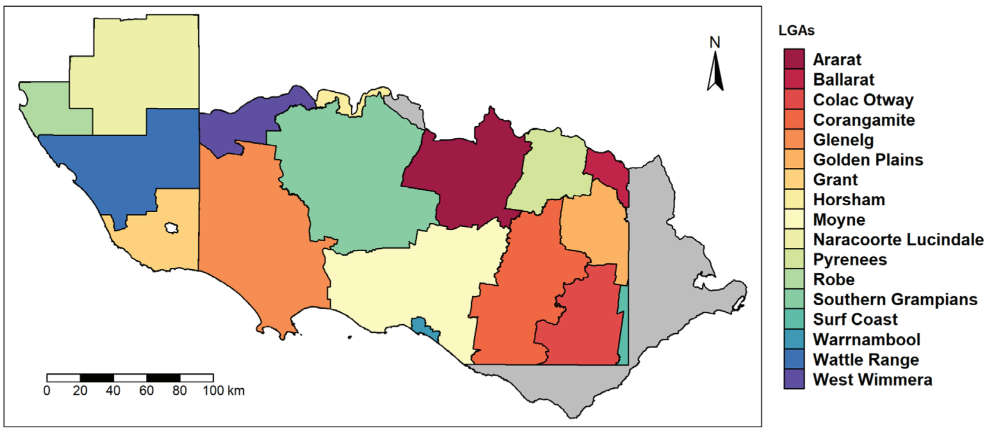


Figure 2: Local Government Areas included in the analysis

The Emissions Reduction Fund

The Emissions Reduction Fund (ERF) is key part of Australia's emissions reductions efforts. The ERF is a voluntary scheme that aims to provide economic incentives for a range of industries and individuals to adopt new practices and technologies to reduce their greenhouse gas emissions (CER, 2021b).

The ERF is one of the largest carbon payment schemes in the world with funded projects representing 79 percent of all financial investment in forest-based emissions reduction across the globe in 2015 and 2016 (Hamrick and Gallant, 2017).

The policy operates as both a carbon credit certification scheme and as an auction. The ERF solicits applications for emissions reductions or offset projects from several sectors including energy efficiency, landfill emissions reductions, transport, changed fire regimes in the northern Australia and land-based vegetation methods (Figure 3). Land-based vegetation methods play a central role in the ERF and are the largest source of carbon credits in ERF auctions to date with approximately 150 million tonnes contracted (CER, 2022c) and 47.5 million tonnes delivered to the Commonwealth (CER, 2022b).

Approved projects create certified and highly valued Australian Carbon Credit Units (ACCUs) which are tradeable in several markets. A large portion of these credits (around 88 percent) are sold into the ERF auctions. The auctions involve ranking bids received in each auction round (14 have been held to date) and funding projects that offer emissions reductions or offsets at least cost per ACCU (1 ACCU = 1 tonne of CO_2 equivalent emissions reduction). Across the first 14 ERF auctions, a total of AUD 2.7 billion has been committed to achieve 217 Mt CO_2e abatement at an average price of AUD $12.06/t CO_2e (CER, 2020).

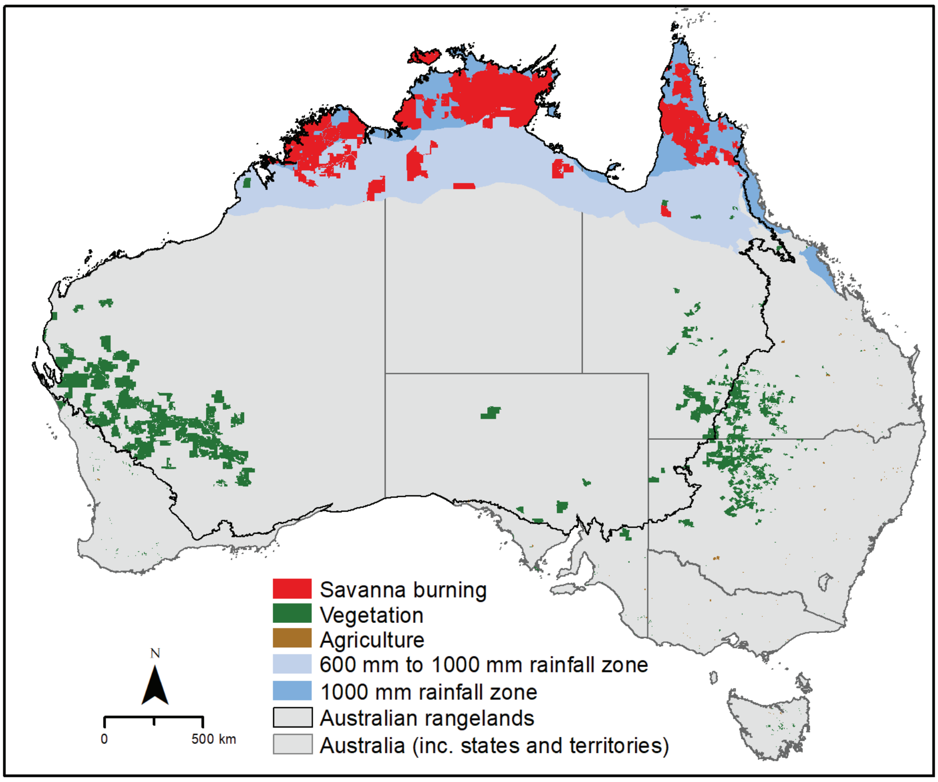


Figure 3: Locations of land sector-based Emissions Reduction Funds Project by method.

The Emissions Reduction Fund

The Clean Energy Regulator (CER) administers the creation and transfer of ACCUs and to date has been the major purchaser. However, there is increasing demand for ACCUs from businesses and other levels of government (state and local).

Figure 4 shows the growth in demand from the private sector and State and Territory Governments.

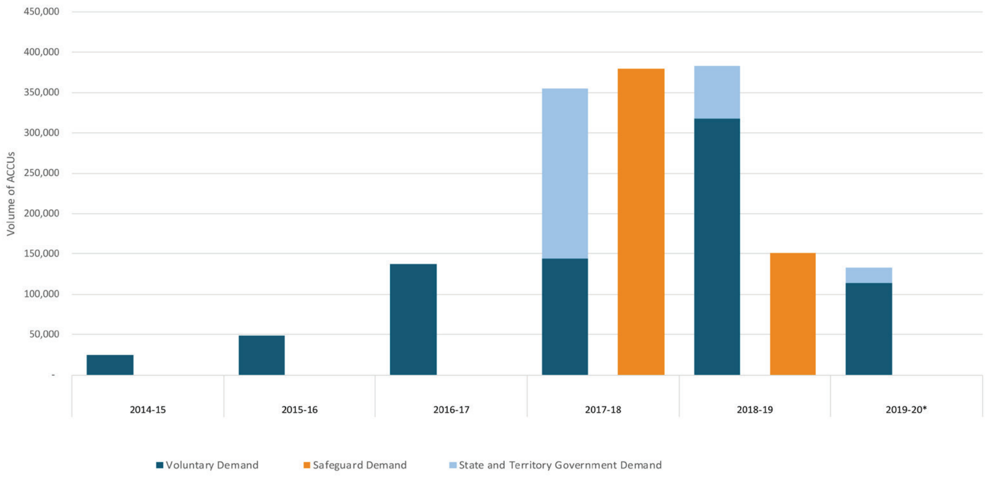


Figure 4: Demand for ACCUs 2014-2020. Source: CER (2021a)

The result is that an active secondary (spot) market for ACCUs has emerged and prices for ACCUs on the spot market can far exceed those paid through the ERF auction process (Figure 5). Each quarter the CER publishes the carbon market report.

The March Quarter 2022 report indicates the spot market price of $30.50/ACCU compared to $17.35/ACCU in the April 2022 ERF auction (CER, 2022e).

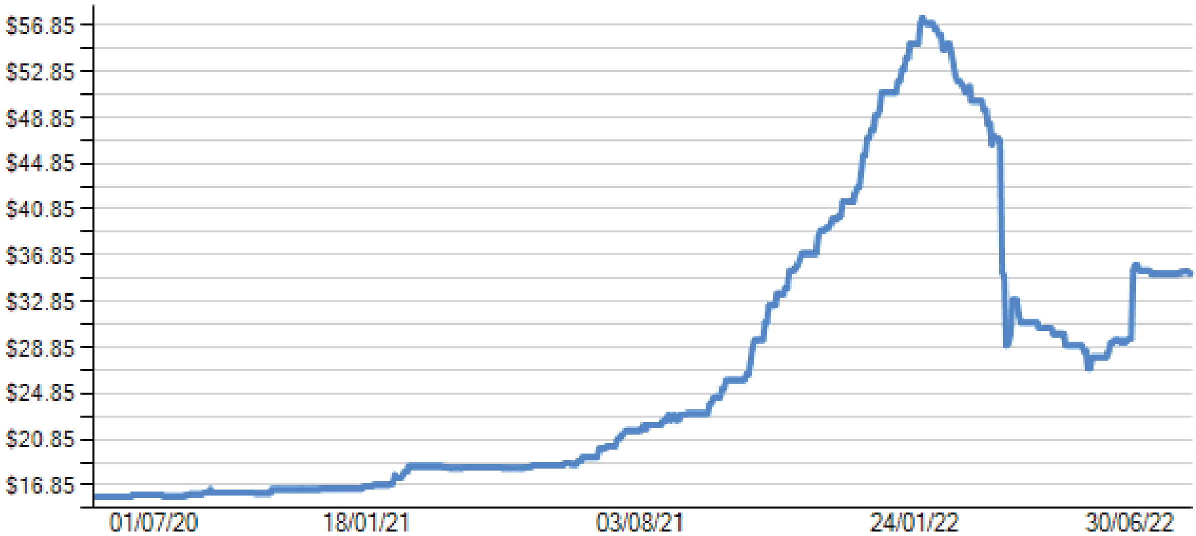


Figure 5: Voluntary market ACCU prices 2020-2022. Source: Jarden Australia (2022).

The trade in ACCUs is currently a rather administrative process often involving high transactions costs associated with finding parties with surplus ACCUs. Currently there exists no central point where buyers and sellers can interact. This is currently being addressed with the development of the Australian Carbon Exchange by the Australian Government. The Australian Carbon Exchange is proposed to be an online carbon exchange that will operate in a similar way to a stock exchanges (CER, 2022a). It is envisaged that the exchange will make trading ACCUs simpler, will increase market transparency and will lower transaction costs and reduce red tape.

ERF plantation forestry methods

The plantation forestry methods provide a way for industry and landholders to increase carbon sequestration through either the establishment of a new plantation forest, conversion of a short-rotation plantation to a long-rotation plantation, or the maintenance of a pre-existing plantation forest (CER, 2022d).

Specifically, four ERF methods are applicable to the plantation forestry industry in the Green Triangle.

1. Establishing a new plantation - Schedule 1

Under this method, ACCUs are issued for projects that establish new plantations on land previously not used for forestry (native or plantation)

2. Converting an existing plantation from a short rotation to a long rotation - Schedule 2

Under this method ACCUs can be issued for projects that convert an existing short rotation plantation to a long rotation plantation. The change of rotation length extends the growing time of the trees and subsequently sequesters additional carbon. The conversion can occur either part-way through the short-rotation cycle or following the scheduled harvest of the current short-rotation plantation.

3. Avoided conversion of a plantation to non-forest land by continuing plantation activity -Schedule 3

This method involves the continuation of plantation forestry activity on land where it would otherwise be converted to non-forest land use in the absence of the ERF. This includes replanting on land that has previously been used for commercial forestry and harvested within the last 7 years.

4. Transition to a permanent forest - Schedule 4

This method involves the transition of an existing commercial plantation forest to a permanent, not-for-harvest forest.

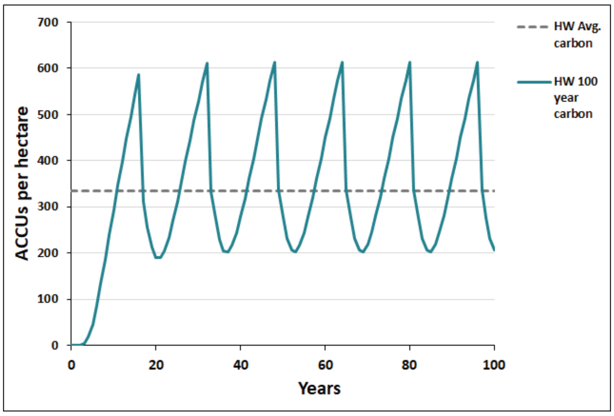
All four plantation forestry methods may have application in the Green Triangle, however schedules 1-3 are likely to be most relevant to industry. While areas invariable exist in the region that have been harvested with the past 7 years and not replanted (Schedule 3) data on these areas was not available and therefore not modelled in this work. The modelling presented in this report was conducted for Schedule 1 and 2 methods.

Earning ACCUs

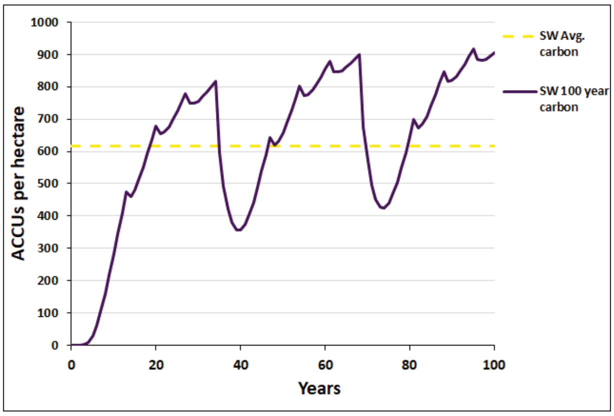
New plantations – Schedule 1

This method involves the establishment of a new plantations on land not currently used for forestry. Plantations established can be short rotation or a long rotation. Unlike other vegetation methods in the ERF carbon sequestration activities that rely on commercial plantation forestry will have fluctuations in carbon stocks as trees are grown, thinned, and harvested. To ensure that the crediting of ACCUs is not overestimated, carbon stocks attainable by a plantation are calculated as the average carbon stock over a 100-year period net of all carbon inflows and outflows (i.e., tree growth and harvesting).

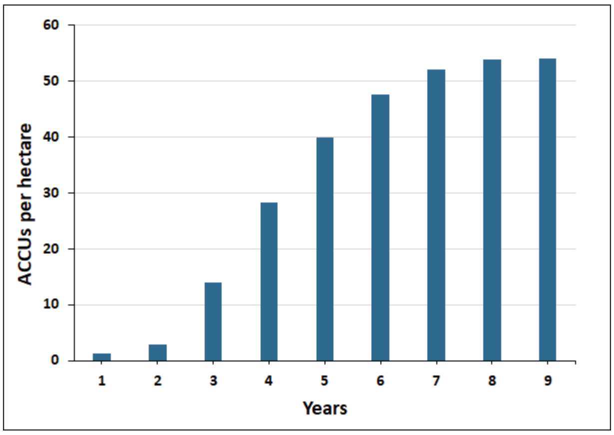
ACCUs are issued for increases in carbon during the project up to the long-term average carbon stock for the plantation. ACCUs are not issued for any growth in trees beyond the estimated long-term average carbon stock for the project. ACCUs stop being issued once the cumulative ACCUs generated reach the long-term average carbon stock (Figure 6 (A1:B1)). In a similar way to other ERF vegetation methods, ACCUs are credited to align with physical carbon stocks generated by the project (Figure 6 (A2:B2)).



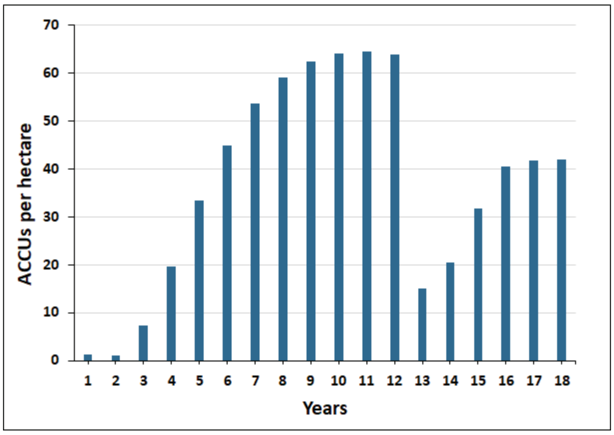
A1



B1



A2



B2

Figure 6: Project carbon and long-term average carbon stock for a new 15-year rotation plantation of *E. globulus* (A1) and 32-year CO2e plantation (B1). Annual ACCU's issued for the *E. globulus* plantation (A2) and *P. radiata* plantation (B2).

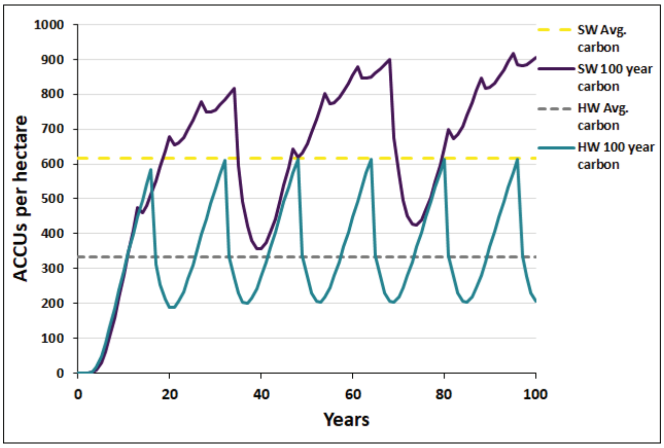
New plantations are commonly established on agricultural land. A common concern of agricultural industries is that new plantations may have an adverse impact on agricultural production.

For any new plantation forestry projects established on agricultural land the Federal Agriculture Minister must assess whether a proposed project may lead to an undesirable impact on agricultural production in that region. This applies to commercial forestry developments and new farm forestry plantations.

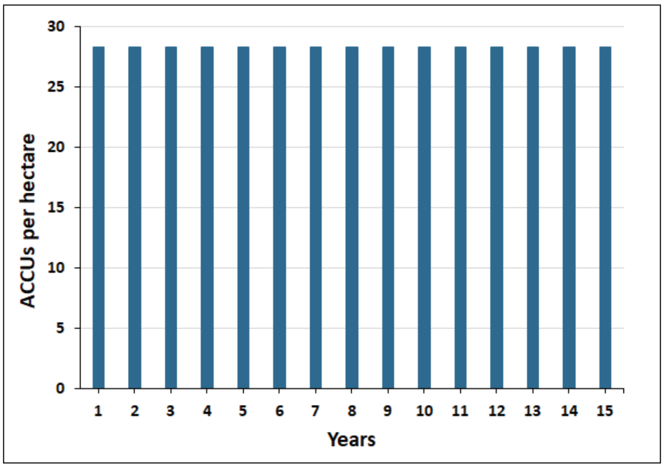
Where the Agriculture Minister determines that the project would have an undesirable impact on agricultural production in the region, the project is deemed ineligible (CER, 2022f)

Converting an existing plantation from a short rotation to a long rotation - Schedule 2

ACCUs are issued for projects that convert an existing short rotation plantation to a long rotation plantation, in Figure 7 (A) this represents replacing *E. globulus* with *P. radiata*. Unlike Schedule 1 projects the baseline carbon stock assumed is not zero, instead it is assumed to be the long-term carbon stock of the short rotation tree species. ACCUs generated by the project is the difference between long-term carbon stock of continued short rotation operations and long-term carbon stock of the long rotation regime. ACCUs generated by the project are split into equal apportionments and credited over the first 15 years of the crediting period (Figure 7 (B)).



A



B

Figure 7: Carbon stored by the project scenario (*P. radiata*) and the baseline scenario (*E. globulus*) for a Schedule 2 project (A). Pattern of ACCU issuance for Schedule 2 project (B).

Permanence periods

When registering an ERF vegetation project, the proponent can select to participate in a project with either a 25 or 100-year permanence period. The permanence period is the length of time during which the project's activities must be maintained. Due to the half-life of CO_2e, sequestered carbon must be stored for 100 years to be considered permanently removed from the atmosphere. Projects electing a 25-year permanence period are subject to a reduction in ACCUs issued for sequestration, known as the *permanence period discount*. The permanence period discount covers the risk that carbon stored in is returned to the atmosphere, reducing the environmental benefit.

Vegetation projects are also subject to the *risk of reversal buffer*. The risk of reversal buffer is a 5 percent reduction in the ACCUs to a project to protect the ERF against temporary losses of carbon and residual risks that cannot be managed by the other permanence arrangements (CER, 2022g). Table 1 outlines the discounts applied to the economic modelling and quantification of potential available ACCUs. Schedule 1 - **Establishing a new plantation** (softwood) and Schedule 2 - **Converting an existing plantation from a short rotation to a long rotation** had a 25 percent discount applied to the ACCUs generated by the project. Schedule 1 - **Establishing a new plantation** (hardwood) had a 30 percent discount applied to ACCUs generated by the project.

Table 1: Permanence period discounts and risk of reversal buffer for plantation forestry projects

Permanence period	Relevant schedule	Permanence discount	Total discount, including 5% risk of reversal buffer
25 years	All projects, unless specified below	20%	25%
25 years	Short rotation plantations under Schedule 1, or short or long rotation plantations under Schedule 3	25%	30%

Carbon Supply from plantation forestry methods

FullCAM Modelling

The modelling of carbon sequestration potential across the region was done with the Full Carbon Accounting Model (FullCAM) 2020 public release version. FullCAM is used in Australia's National Greenhouse Gas Accounts for the land sector and provides fully integrated estimates of carbon pools in forest and agricultural systems for Australia's land sector reporting (Roxburgh et al., 2019). FullCAM integrates data on land cover change, land use and management, climate, plant productivity, and soil carbon over time to estimate carbon stock change and greenhouse gas emissions at fine spatial and temporal scales (Roxburgh et al., 2019).

For this study, the 2020 version of FullCAM of was used in preference to the 2016 version as is stipulated in the FullCAM guidelines for plantation forestry methods for several reasons. Firstly, the 2020 version provides the ability for simulations to be automated enabling the model to be run over large spatial domains (i.e., at a regional scale at fine spatial resolution). Secondly, the 2016 FullCAM calibrations for plantation species were largely informed by Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) estimates of wood volumes harvested from different plantation species and management regimes (Roxburgh et al., 2019; Waterworth and Richards, 2008). Since then, a recalibration of forest growth parameters has occurred and incorporated in to the 2020 version of FullCAM (Roxburgh et al., 2019).

Representative softwood and hardwood rotations were developed with the aid of industry. The results presented below assume a 32-year softwood rotation and a 15-year hardwood rotation. The modelling was done at a spatial resolution of 500 metres and consisted of over 317,000 individual points across the study area. A resolution of 500 metres was selected to reduce computation time while minimising any loss of spatial resolution.

A full account of the FullCAM settings used are presented in Appendix 1. The FullCAM modelling undertaken was done consistently with the 2022 Methodology Determination for the plantation forestry methods (CER, 2022d).

Softwood

The FullCAM modelling for softwood plantation was conducted for a 32-year rotation consisting of three thinning events at year 13, 20 and 27 and final harvest operations in year 32. The rotations were modelled as consecutive rotations over a 100-year time frame (Figure 6 (B1)) assuming a 1-year hiatus between final harvest and replanting of the next rotation.

The carbon sequestration estimates produced by FullCAM across the study area are presented in Figure 8.

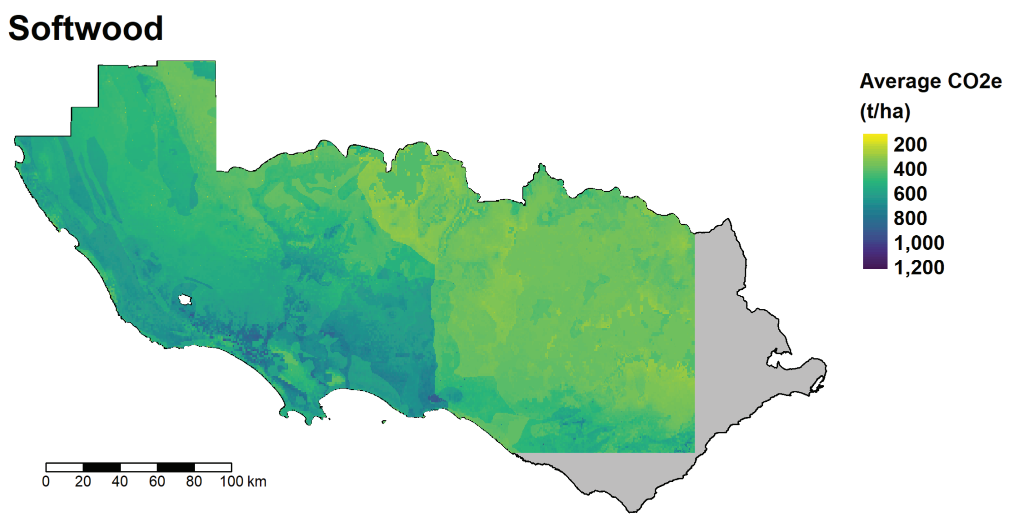


Figure 8: Average long term sequestration potential for 32-year *P. radiata* plantations across the study area.

Carbon Supply from plantation forestry methods

Significant variation in carbon sequestration potential could be seen across the study area. The mean long term carbon sequestration potential from continuous softwood plantation was 470 t CO_2e/ha (std = 109 t CO_2e/ha). The minimum estimated long term carbon sequestration potential was 104 t CO_2e/ha and maximum estimated long term carbon sequestration potential was 1210 t CO_2e/ha. Figure 9 shows carbon sequestration potential across the local government areas in the study area.

The local government areas (LGAs) with the highest potential long-term sequestration were Grant (mean= 600 t CO_2e/ha), Glenelg (mean = 584 t CO_2e/ha), Robe (mean = 567 t CO_2e/ha) and Wattle Range (mean = 542 t CO_2e/ha). However, significant intra-LGA variation could be seen (Figure 9), particularly in Glenelg, Moyne, and Corangamite.

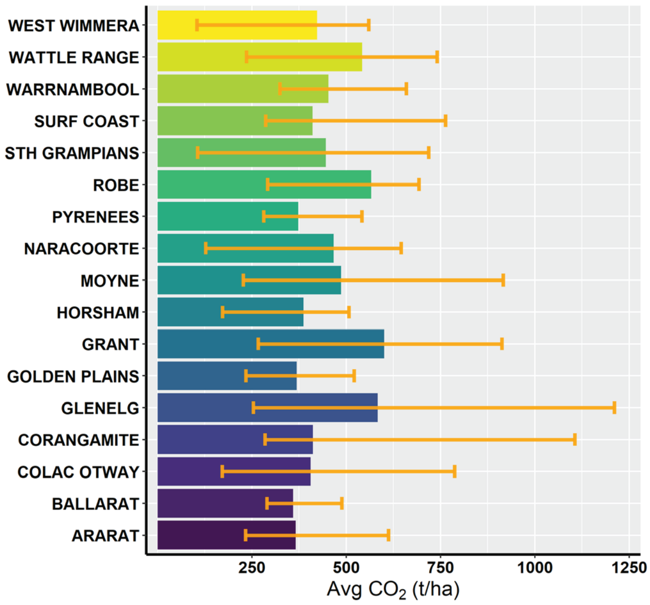


Figure 9: Average long term sequestration potential for 32-year *P. radiata* plantations by local government area (LGA). The orange bars highlight the range of observed values in each LGA.

Hardwood

The hardwood species (*E. globulus*) was modelled as a 15-year rotation. As with softwood, the rotations were assumed to be consecutive over a 100-year period with a 1-year hiatus between rotations. Due to the shorter rotation length, mean long term carbon sequestration potential from hardwood rotations was generally far lower than for softwoods (Figure 10).

The mean long-term sequestration across the region was 292 t CO_2e/ha (std = 49 t CO_2e/ha). As with softwoods, there was significant variation in long term sequestration for hardwoods, with the minimum being 64 t CO_2e/ha while the maximum seen in the study area was 850 t CO_2e/ha.

The variability in hardwood long term sequestration across LGAs can be seen in figure 11. (Figure 11).

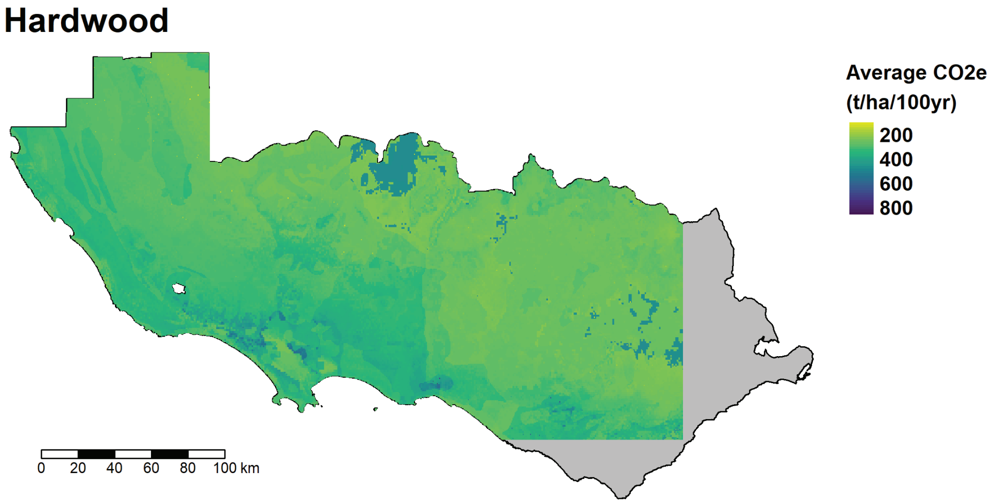


Figure 10: Average long term sequestration potential for 15-year *E. globulus* plantations across the study area.

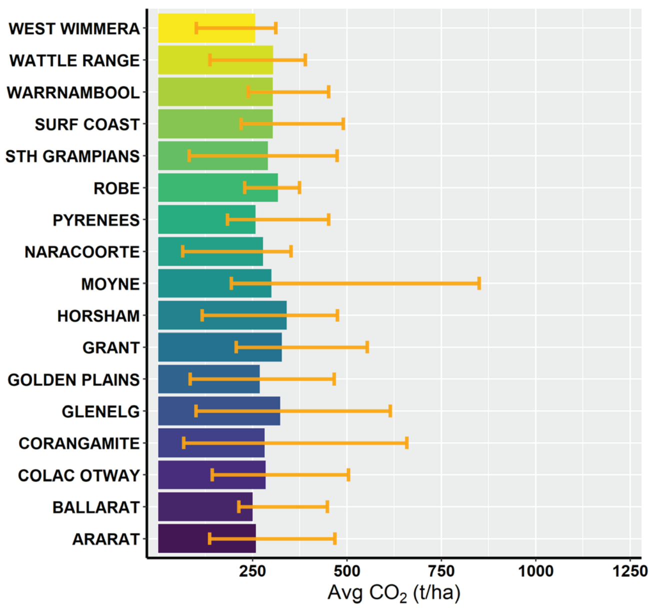


Figure 11: Average long term sequestration potential for 15-year *E. globulus* plantations by local government area (LGA). The orange bars highlight the range of observed values in each LGA.

Harvest volumes

Softwood

Harvest volumes associated with both hardwood and softwood were modelled using FullCAM. Extensive calibration of FullCAM has been undertaken to ensure FullCAM growth estimates are within the range of reported mean annual increment (MAI) data from across 15 NPI regions for a combination of 57 separate species and management combinations (Roxburgh et al., 2019).

Figure 12 displays the spatial distribution of harvest volumes for *P. radiata* as modelled by FullCAM for the study area.

P. radiata first thinning volumes ranged from 19 m^3/ha to 242 m^3/ha (mean = 74 m^3/ha). Second thinning volumes ranged from 17 m^3/ha to 208 m^3/ha (mean = 76 m^3/ha). Third thinning volumes ranged from 15 m^3/ha to 191 m^3/ha (mean = 74 m^3/ha). Clearfell volumes ranged from a minimum of 75 m^3/ha to a maximum of 914 m^3/ha (mean = 376 m^3/ha).

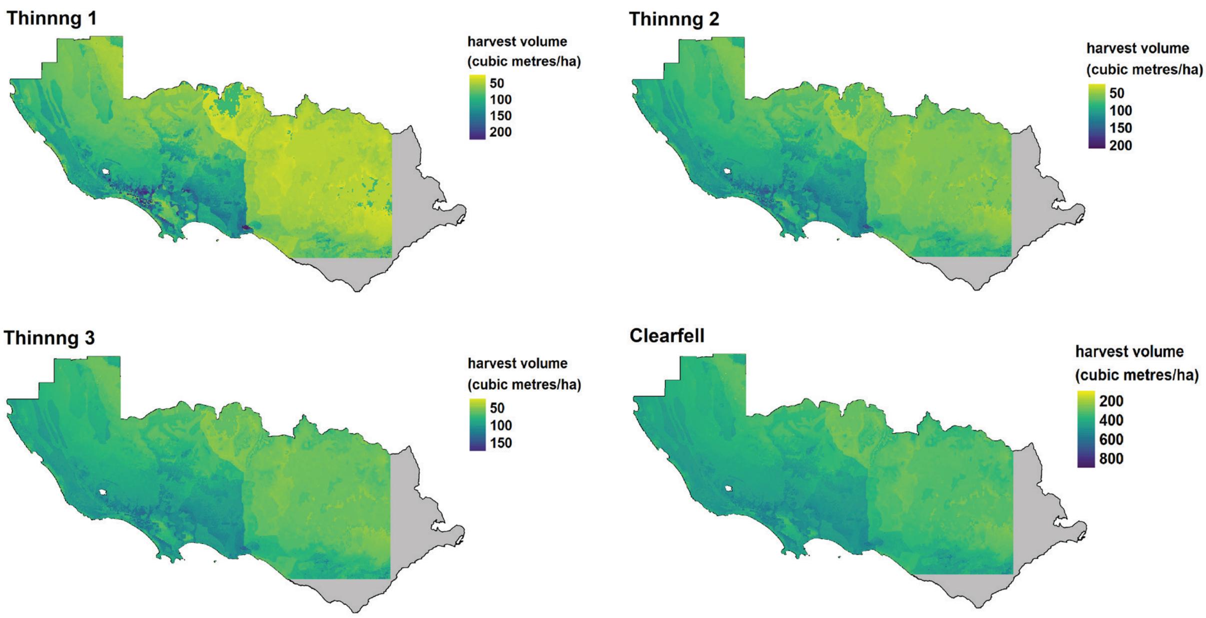


Figure 12: Harvest volumes for 32-year *P. radiata* plantations across the study area.

Hardwood

Figure 13 displays the spatial distribution of harvest volumes for *E. globulus* and *P. radiata* as modelled by FullCAM for the study area. The minimum harvest value for *E. globulus* was 48 m^3/ha and the maximum 690 m^3/ha (mean = 235 m^3/ha).

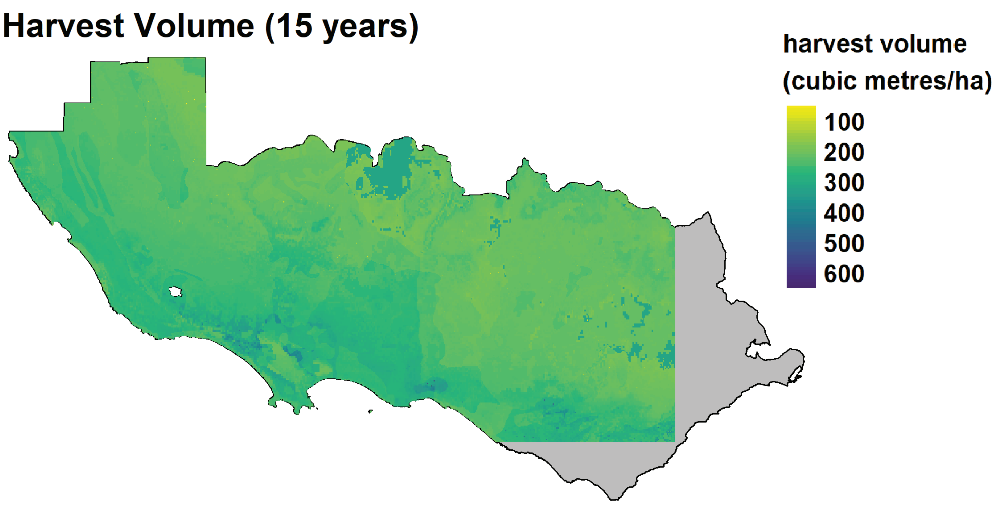


Figure 13: Harvest volumes for 15-year *E. globulus* plantations across the study area.

Economic analysis

Details of the economic methods are described in detail in Appendix 1. Data on the cost of establishment of new plantations or re-establishment of existing plantation was given as commercial in confidence by an industry partner and cannot be disclosed, however are described in summary in Appendix 1.

Discount rate

The specific discount rates used in corporate forestry investments in the study area were not disclosed by the companies consulted in this research. In the literature, Ferguson (2018) and Manley (2016) showed that real discount rates use in forest valuation in Australia and New Zealand can vary considerably from between 5 percent to 14 percent. Ferguson (2018) found a discount rate of 7.4 percent was likely appropriate for deterministic economic analyses. We chose to use a real discount of 7.5 percent. Sensitivity analysis was conducted using discount rates of 5 and 10 percent (Appendix 1). The results presented in this report assume the 7.5 percent discount rate.

Agricultural land values

Data on the value of agricultural land was sourced from the Rural Bank (2021) Australian Farm Land Values report. The report is based on farm sales data collected by government agencies in each state and territory. Data is compiled by local government area and provides an assessment of the median price per hectare, median price growth and the number of sales transactions over the past 12 months (Table 2).

Table 2: Median rural property prices and transaction frequency across the study by LGA (Rural Bank, 2021).

LGA	State	Median land Price ($/ha)	Number of transactions
Grant	SA	$15,109	20
Naracoorte	SA	$8,036	36
Robe	SA	$10,472	10
Wattle Range	SA	$11,105	24
Kingston	SA	$7,666	8
Ararat	VIC	$7,808	25
Ballarat	VIC	$9,752	5
Colac-Otway	VIC	$10,629	54
Corangamite	VIC	$12,205	93
Glenelg	VIC	$9,879	38
Golden Plains	VIC	$11,134	21
Moorabool	VIC	$13,351	6
Moyne	VIC	$12,354	89
Pyrenees	VIC	$4,658	19
South Grampians	VIC	$8,709	46
Surf Coast	VIC	$13,216	7
West Wimmera	VIC	$7,096	25

Transport costs

Cost associated with transport can be a significant determinant of the economic viability of new plantation development. To model transport cost across the study area as accurately as possible, a graph network model was developed using South Australian and Victorian Government spatial data of regional road networks (DPTI, 2022; VicMAP, 2022). The model used the road network spatial data to find the shortest route to the designated port location for all 317,000+ points modelled (Figure 14).

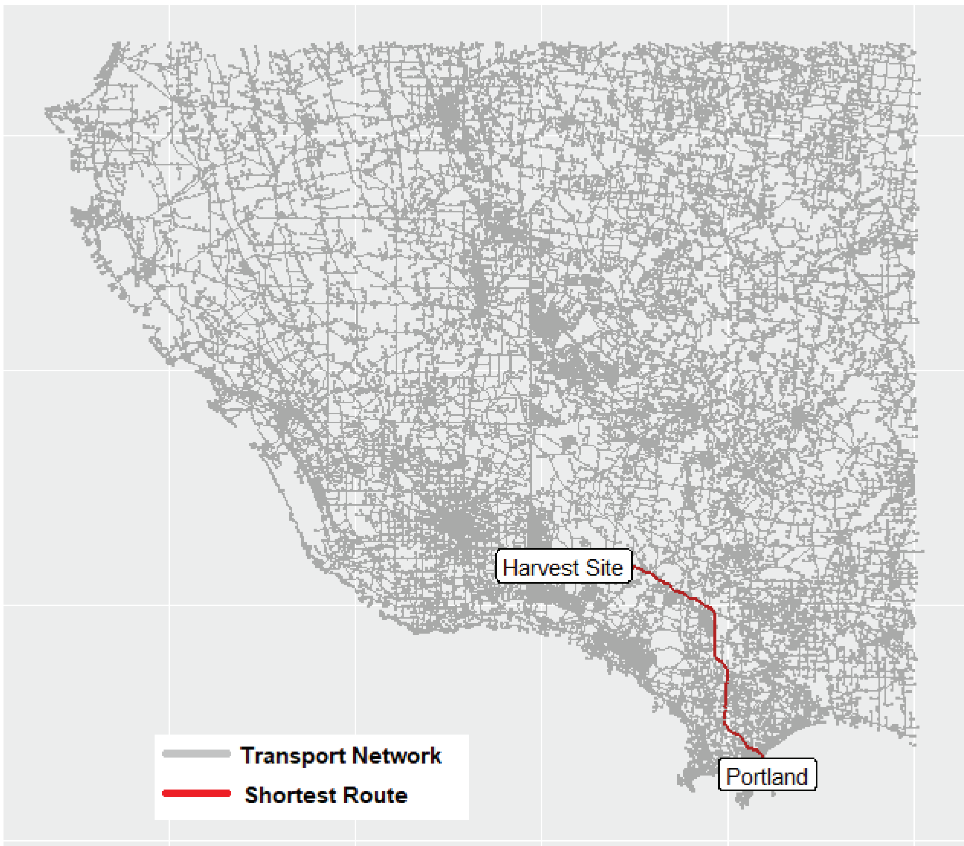


Figure 14: Example of the results from the graph network model employed to calculate transport distances across the study region.

In the case of Schedule 1- **Establishing a new plantation,** Portland was the assumed destination for all hardwood products. However, for new softwood plantations, transport distances to Colac and Geelong were also modelled. Transport costs were then allocated by selecting the destination that was closest to the point being modelled. As such, the results represent the lowest cost transport option for new softwood plantations.

In the case of Schedule 2- **Converting an existing plantation from a short rotation to a long rotation**, Portland was the assumed destination for hardwood products and Mt Gambier was the assumed destination for softwood products.

The calculation of hardwood transport costs was straight forward. Harvest volumes were converted to green metric tonnes (gmt) using a factor of 1.05 and a cartage cost of $0.16/gmt/km was applied to the harvest volumes. The calculation of softwood transport cost requires harvest volume for each of the harvest operations (thinning 1 to clearfell) to be calculated. A cartage cost of $0.12/m^3/km was applied to softwood harvest volumes.

Returns from forestry

Land expectation values

Economic returns to forestry were modelled as land expectation values (LEV). The LEV is the present value of the costs and revenues resulting from a perpetual sequence of forestry rotations, starting initially from bare land. The LEV is standard forest industry practice for valuing bare land in timber production, evaluating the value of various forest management alternatives and determining the optimal rotation age (Faustmann, 1995).

Softwood

The LEV of softwood across the area (Figure 15) ranged from -$3,154/ha to $5,015/ha. The mean LEV for the region was -$306/ha, due primarily to large area of study region being unprofitable for softwood production. Areas modelled to have higher LEVs were largely confined to the regions existing softwood production areas namely the LGAs of Grant, Wattle Range and Glenelg.

Hardwood

The LEV of hardwood across the area (Figure 16) ranged from -$3,432/ha to $15,594/ha (mean= $3,598, std = $1,996). Hardwood production had the highest LEV in the LGAs of Glenelg and Moyne.

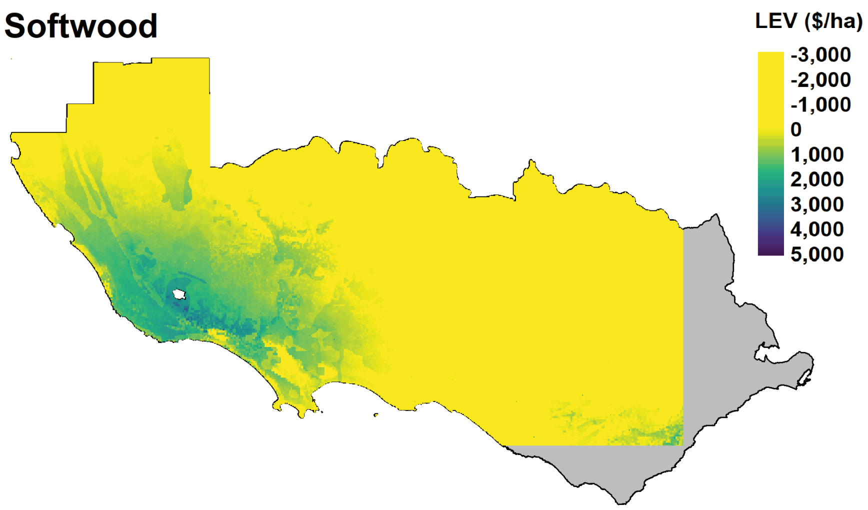


Figure 15: Distribution of *P. radiata* LEVs across the study area assuming the lowest cost destination for harvested products.

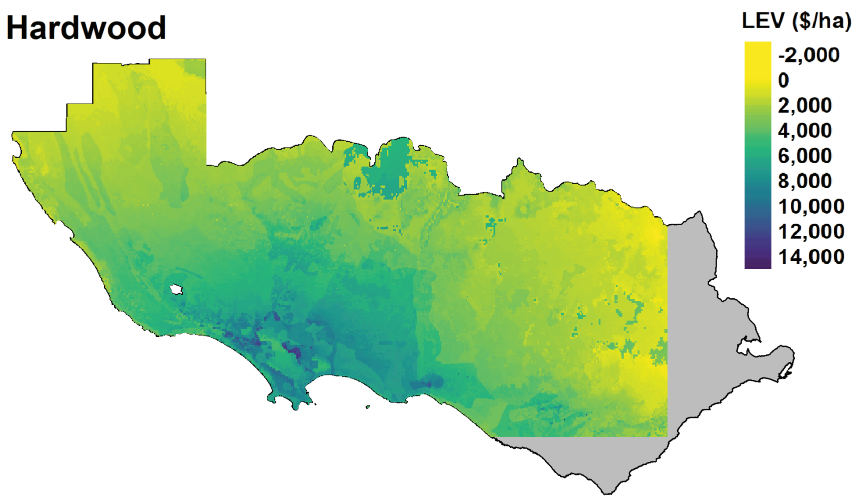


Figure 16: Distribution of *E. globulus* LEVs across the study area assuming Portland as transport destination.

For Schedule 1- **Establishing a new plantation**, the LEV of both hardwood and softwood was calculated with the discounted returns from carbon included in the LEV calculation as demonstrated in Figure 6 (A2:B2). The purchase price of the land was assumed to be an upfront cost and added to other upfront costs incurred when establishing a forestry project such as establishment costs (Appendix 1).

For Schedule 2- **Converting an existing plantation from a short rotation to a long rotation,** the decision to convert to softwoods was assumed to occur at the end of the current hardwood rotation. The LEV of both hardwood and softwood were calculated, with the discounted returns to carbon included in the LEV calculations for softwood as demonstrated in Figure 7 (B).

The returns to carbon sequestration were calculated by iterating over carbon prices ($0 to $250/ t CO_2e) for each point in the study area. In the case of Schedule 1, the first carbon price that returned a positive LEV was taken as the carbon price required to create economic value from purchasing agricultural land and developing it for plantation forestry. In the case of Schedule 2, the same iterative process was followed. The first carbon price that returned a softwood LEV greater than the hardwood LEV was taken as the carbon price required to make the conversion economically viable.

In line with the plantation forestry method determination (CER, 2022d, g), ACCUs earned though both project types are subject to a risk of reversal buffer and permanence discounts. The analysis assumes a 25-year permanence period, in line with industry advice. ACCUs earned for a hardwood Schedule 1 project are discounted by 30 percent (25 percent permanence discount, 5 percent risk of reversal buffer). ACCUs earned for a Schedule 1 softwood project or a Schedule 2 project are discounted 25 percent (20 percent permanence discount, 5 percent risk of reversal buffer).

Running and administering an ERF project incurs a number of costs including for brokerage, reporting and auditing. These costs can vary depending on the size of the project and the frequency of reporting making the quantification of specific project costs difficult, especially over such a large spatial scale. Most participants in ERF vegetation methods use brokers to handle complex contracting, compliance, monitoring functions (Cockfield et al., 2019). To ensure the number of ACCUs were not overestimated, a 20 percent ‘brokerage fee’ consistent with Cockfield et al. (2019) was applied to the value of the ACCUs to cover the costs of running and administering the project.

Carbon supply from Schedule 1: Establishing a new plantation

The establishment of new plantations in this study is assumed to take place on land currently used for agricultural production.

Agricultural production in the study area is diverse and includes production of broad acre cereal and pulse crops, livestock products including wool, meat and dairy, potatoes and wine grapes (ABS, 2020).

The region also has a significant livestock processing industry and wine production industry. For the analysis in this study, cadaster based land use data was sourced from South Australian and Victorian Government databases (Agriculture Victoria, 2016; DIT, 2022). These data sets were then used to filter by land use and property size to determine the extent of land included in the analysis (Figure 17). Properties needed to meet the following criteria to be included in the analysis:

1. Be classified as being used for broadacre cropping or livestock grazing (dairy was excluded).
2. Be equal to or greater than 20 hectares.

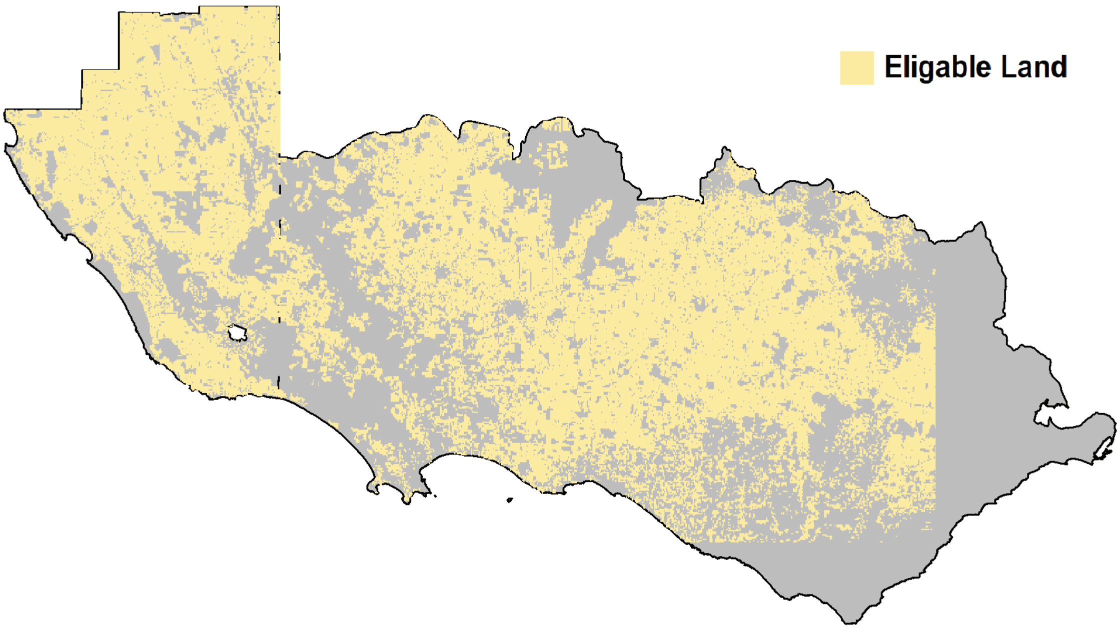


Figure 17: Current agricultural land included in the analysis of Schedule 1 projects.

It should be noted that some of the areas in Figure 17 are likely to contain remnant native vegetation despite being classified as broadacre cropping or livestock grazing. Areas of remnant native vegetation cannot be developed for plantation forestry ERF projects. Such areas were not accounted for in the analysis. As such area estimates presented should be viewed as maximum upper quantities.

Softwood

The results showed no opportunity for further softwood plantation development in the study area without the additional value created by selling carbon credits. Figure 18 shows the carbon price at which the LEV of developing new softwood plantation forestry, including land purchase price was greater than zero.

The results showed that at carbon price of $30/t CO_2e, approximately 987 hectares of land in the Glenelg LGA would be viable for softwood plantation development, assuming the median property price for the LGA. This level of development would create up to 544,000 ACCUs over a 25-year ERF project with a present value of up to $7.6 million.

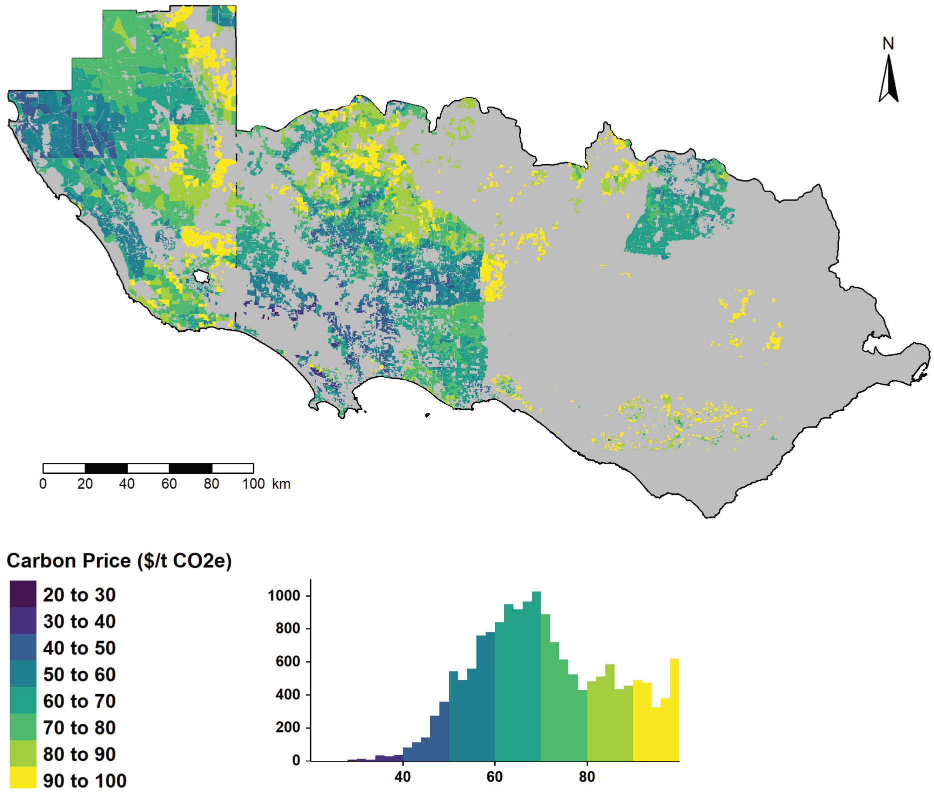


Figure 18: The spatial distribution of threshold carbon prices that return a positive LEV for developing new *P. radiata* plantations, accounting for land purchase price and upfront establishment costs. The histogram shows the frequency of each threshold price across the study area.

Significant opportunity exists at prices of $50/t CO_2e with approximately 121,000 ha being economically viable for purchase for softwood development. Figure 19 shows potential ACCU generation for each LGA in the study area. At $50/t CO_2e approximately 53 million ACCUs with a present value of up to $1 billion could be generated from 121,000 ha if developed for softwood plantations. It should be noted that these results assume the harvested products are transported to the nearest destination (Mt Gambier, Colac, or Geelong). If Mt Gambier, the main processing centre in the region, is assumed to be the transport destination, approximately 300 ha less would be viable for purchase and development generating approximate 100,000 less ACCUs.

Carbon supply from Schedule 1: Establishing a new plantation

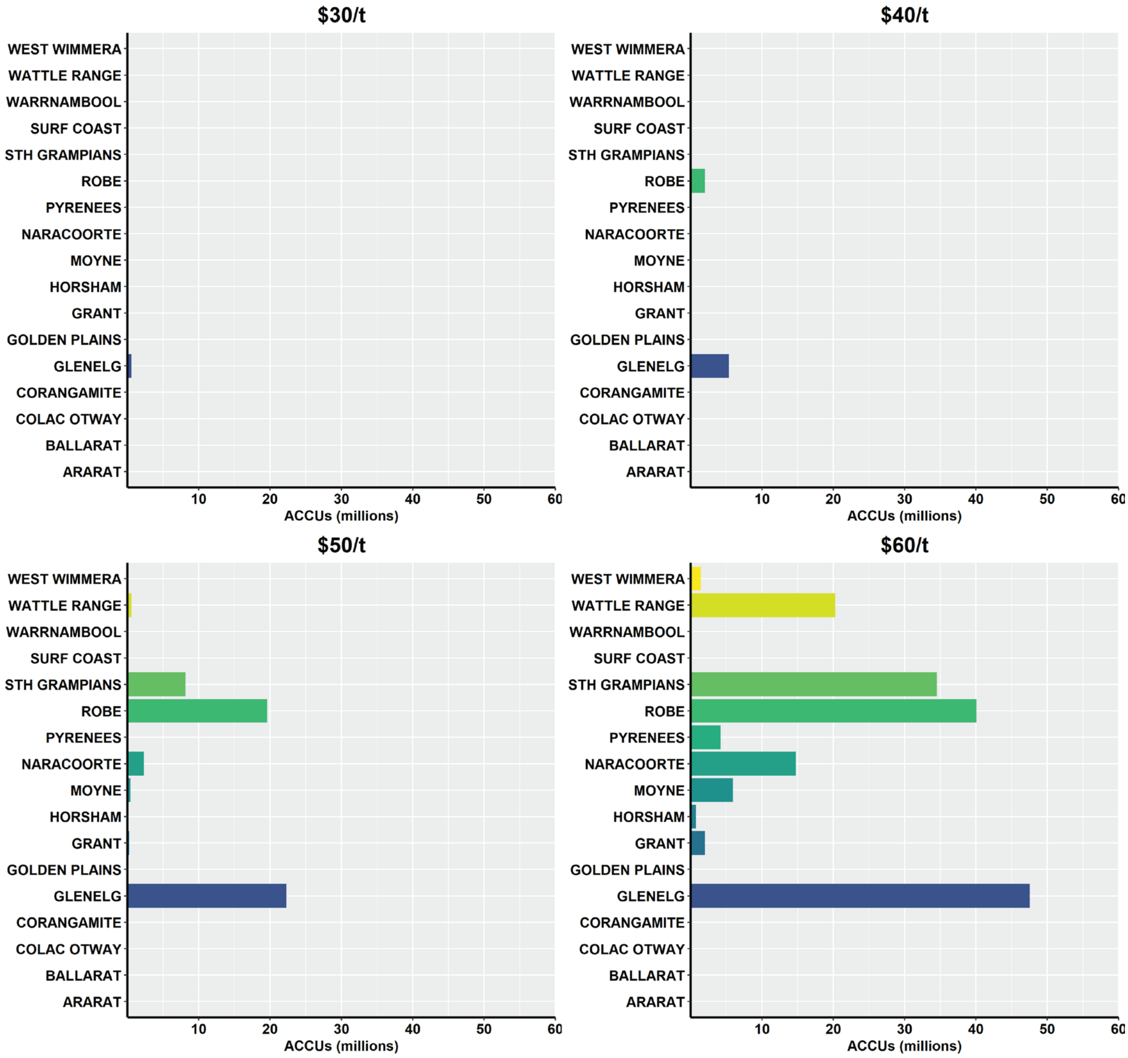


Figure 19: Potential ACCU generation for new *P. radiata* plantations for each LGA in the study area at $30, $40, $50 and $60/t CO_2e.

The areas available for development in each LGA for a range of carbon prices are shown in Table 3.

Considerable opportunity may exist in several LGAs, particularly in Glenelg and Robe and Naracoorte at prices at or above $50/t CO_2e.

Table 3: Potential areas available for *P. radiata* development by LGA at at $30, $40, $50 and $60/t CO_2e.

LGA	Carbon Price ($/t CO_2e)			
	$30	$40	$50	$60
Ararat	0	0	138	266
Ballarat	0	0	0	0
Colac Otway	0	0	38	38
Corangamite	0	87	87	179
Glenelg	987	10,546	46,548	106,575
Golden Plains	0	0	0	0
Grant	0	131	429	4,083
Horsham	0	0	0	2,193
Moyne	0	0	717	11,878
Naracoorte	0	0	5,981	39,189
Pyrenees	0	28	152	15,090
Robe	0	4,470	47,186	100,114
Sth Grampians	0	120	18,671	82,971
Surf Coast	0	0	0	0
Warrnambool	0	0	0	54
Wattle Range	0	0	1,227	46,849
West Wimmera	0	0	103	4,032

Carbon supply from Schedule 1: Establishing a new plantation

Hardwood

The profitability of purchasing agricultural land and converting it to hardwood was assessed for carbon prices ranging from $1 to $250/t CO_2e. Under the LEV assumptions developed in this study the results showed that opportunity already exists to develop hardwood plantations without the need for an ERF project. Approximately 5,585 ha of agricultural land in the Glenelg LGA would be economically viable for purchase at current land prices and assumptions regarding hardwood returns.

Figure 20 shows the carbon price at which the LEV of developing new hardwood plantation forestry, including land purchase price was greater than zero. At $30/t CO_2e, a price consistent with current secondary market prices for ACCUs, 178,028 hectares of land would be viable (i.e., an LEV > 0) for purchase and developed into hardwood plantations. The large majority located in the LGAs of Glenelg (69,308 ha), Southern Grampians (88,000 ha) and Horsham (8,824 ha). Smaller areas are available in the LGAs of Ararat (3,332 ha) and the Pyrenees (3,207 ha). There was no economically feasible land in South Australia at that carbon price.

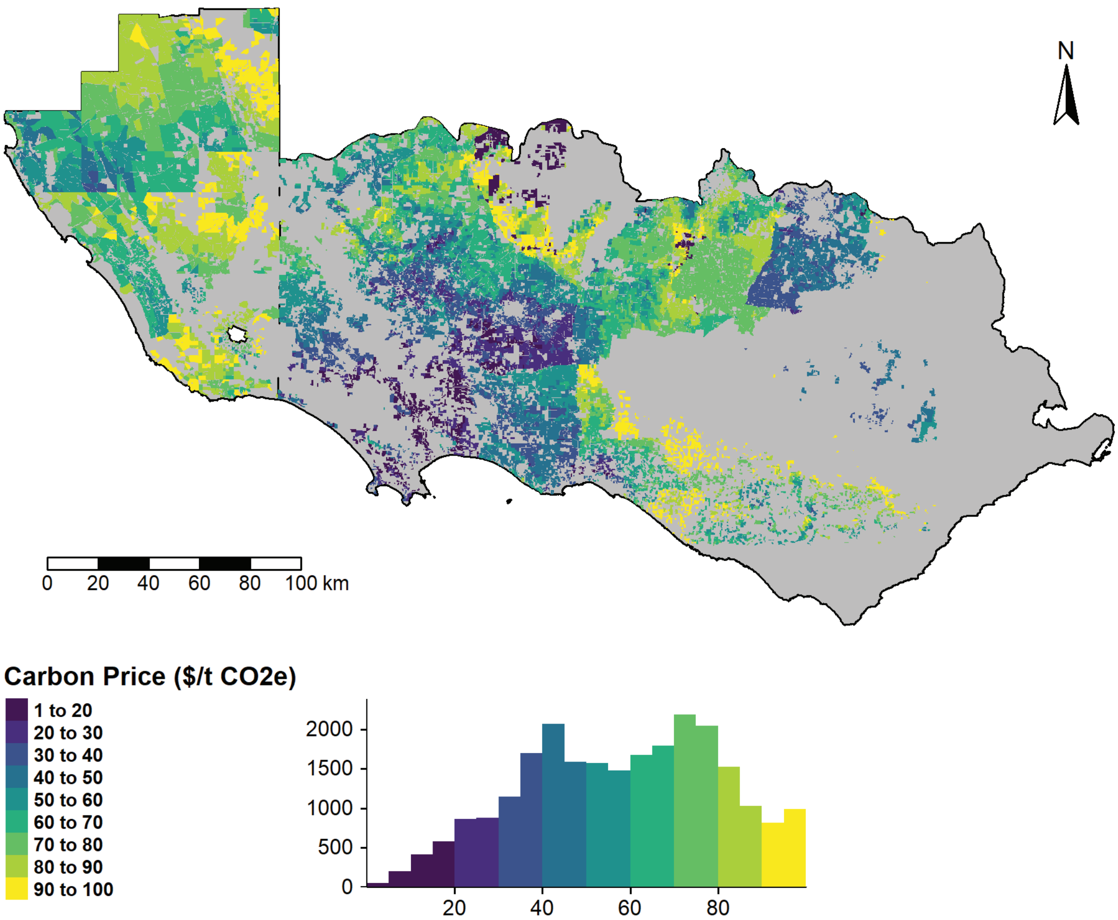


Figure 20: The spatial distribution of threshold carbon prices that return a positive LEV for developing new *E. globulus* plantations, accounting for land purchase price and upfront establishment costs. The histogram shows the frequency of each threshold price across the study area.

Prices for ACCUs have been as high as $57/t CO_2e in January of 2022 (Figure 5). When a carbon price of $50/t CO_2e was considered up to 621,000 ha would be economically viable for purchase for the establishment of hardwood plantations. The majority located in the LGAs of Southern Grampians (184,086 ha), Glenelg (147,272 ha), the Pyrenees (99,361 ha) and Moyne (93,307 ha).

Even at this historically high ACCU price comparatively little land resource is economically viable for purchase in South Australia Grant (366 ha), Naracoorte (4,996 ha) and Wattle Range (1,167 ha) apart from the LGA of Robe (34,671 ha). Table 4 shows areas economically viable for hardwood expansion in each LGA.

Table 4: Potential areas available for *E. globulus* development by LGA at at $30, $40, $50 and $60/t CO_2e.

LGA	Carbon Price ($/t CO_2e)			
	$30	$40	$50	$60
Ararat	3,332	4,015	11,013	25,703
Ballarat	0	0	106	106
Colac Otway	0	4,272	5,259	8,286
Corangamite	115	1,210	3,480	11,684
Glenelg	69,308	107,976	147,272	176,580
Golden Plains	0	4,347	8,811	8,865
Grant	0	131	366	3,132
Horsham	8,824	8,824	8,824	8,824
Moyne	4,668	37,105	93,307	133,596
Naracoorte	0	0	4,996	35,085
Pyrenees	3,270	52,549	99,361	106,874
Robe	0	7,007	34,671	70,355
Sth Grampians	88,005	126,750	184,086	247,214
Surf Coast	0	0	76	3,197
Warrnambool	507	1,668	2,528	2,528
Wattle Range	0	0	1,167	20,905
West Wimmera	0	1,549	15,825	36,009

Carbon supply from Schedule 1: Establishing a new plantation

The potential ACCUs generated by Schedule 1 hardwood projects at a range carbon prices are shown in Figure 21. At $30/t CO_2e there is potential to generate approximately up to 44 million ACCUs over a 25-year project period. The present value of these ACCUs is up to $442 million[5]. At $50/t CO_2e there is potential to generate approximately up to 138 million ACCUs over a 25-year project period. The present value of these ACCUs is up to $2.35 billion.

At The ability to generate this value should be viewed in the context of land availability in the region, with land being a significant limiting factor to expansion. In 2020, a total of approximately 61,191 hectares changed hands in the south west Victoria (Rural Bank, 2021) with a further 80,504 hectares in 2021 (Rural Bank, 2022).

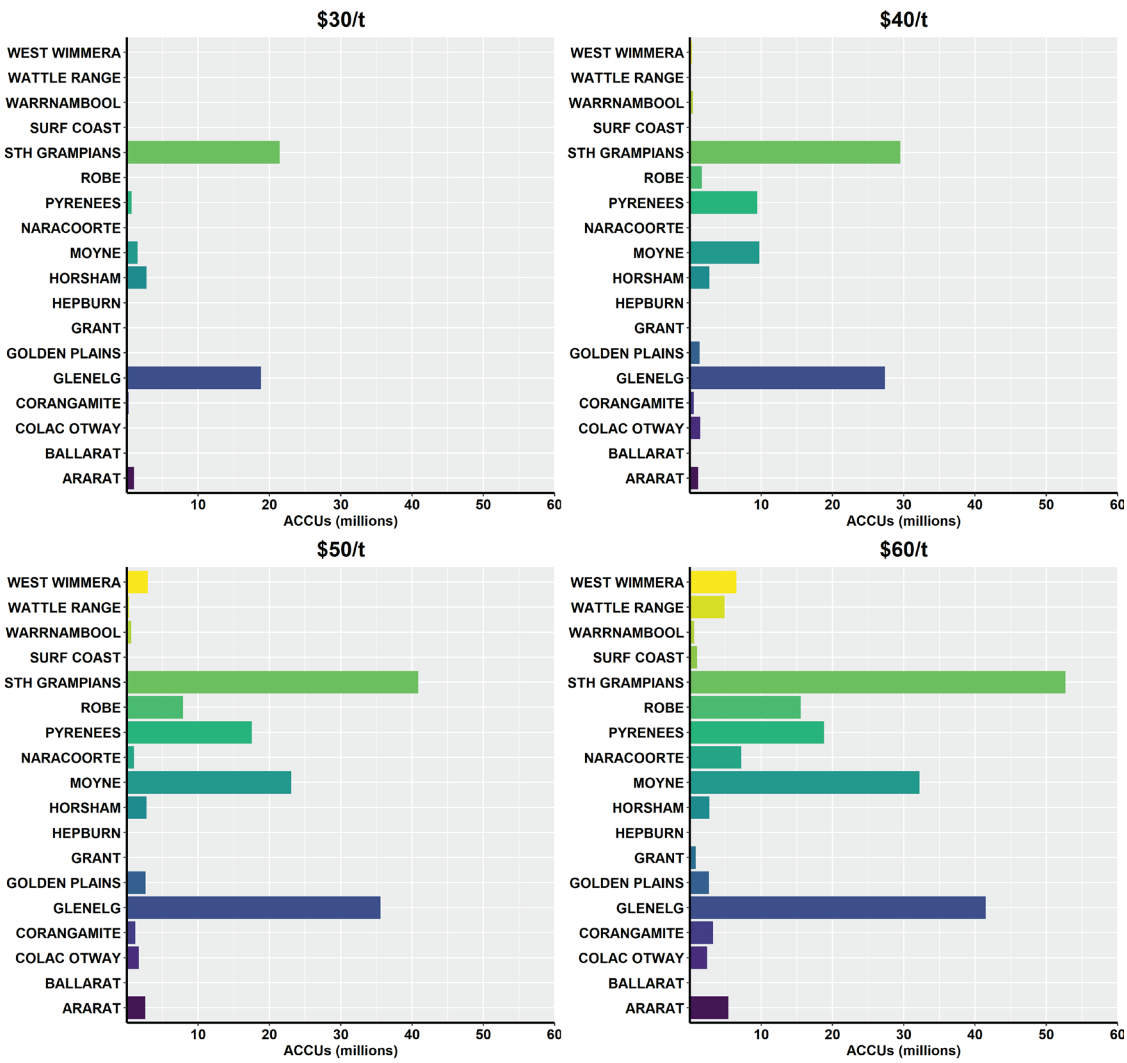


Figure 21: Potential ACCU generation for new *E. globulus* plantations for each LGA in the study area at $30, $40, $50 and $60/t CO_2e.

[5] This value of ACCUS assumes 7.5% discount rate, ability to purchase all viable land at median land values and conversion of land occurs immediately. As such these values should be viewed as absolute maximum upper bound.

Carbon supply from Schedule 2: Short rotation to long rotation plantation forestry

The most immediate available opportunity for the commercial forestry industry to participate in the ERF is through the conversion of short rotation, *E. globulus* plantations to long rotation, *P. radiata* plantations.

The results (Figure 22) clearly indicate much of the low-cost opportunity for this schedule exists in South Australia. However, at current ERF auction prices ($17/ t CO_2e) a very small opportunity exists in the Southern Grampians LGA to convert 30 ha to long rotations.

The opportunity increases considerably at $25/ t CO_2e, well below current spot market prices. At that price approximately 1,647 ha is economically viable to convert to long rotation forestry primarily in the LGAs of Naracoorte (1,098 ha), Wattle Range (472 ha) and Robe (50 ha). At $30/ t CO_2e a significant level of land use change would be potentially viable with 23,522 ha more economically valuable in softwood rotations than hardwood, again primarily in South Australia. Large areas of conversion could be seen in the LGAs of Naracoorte (14,409 ha), Wattle Range (8,946 ha), with smaller areas in Grant (88 ha).

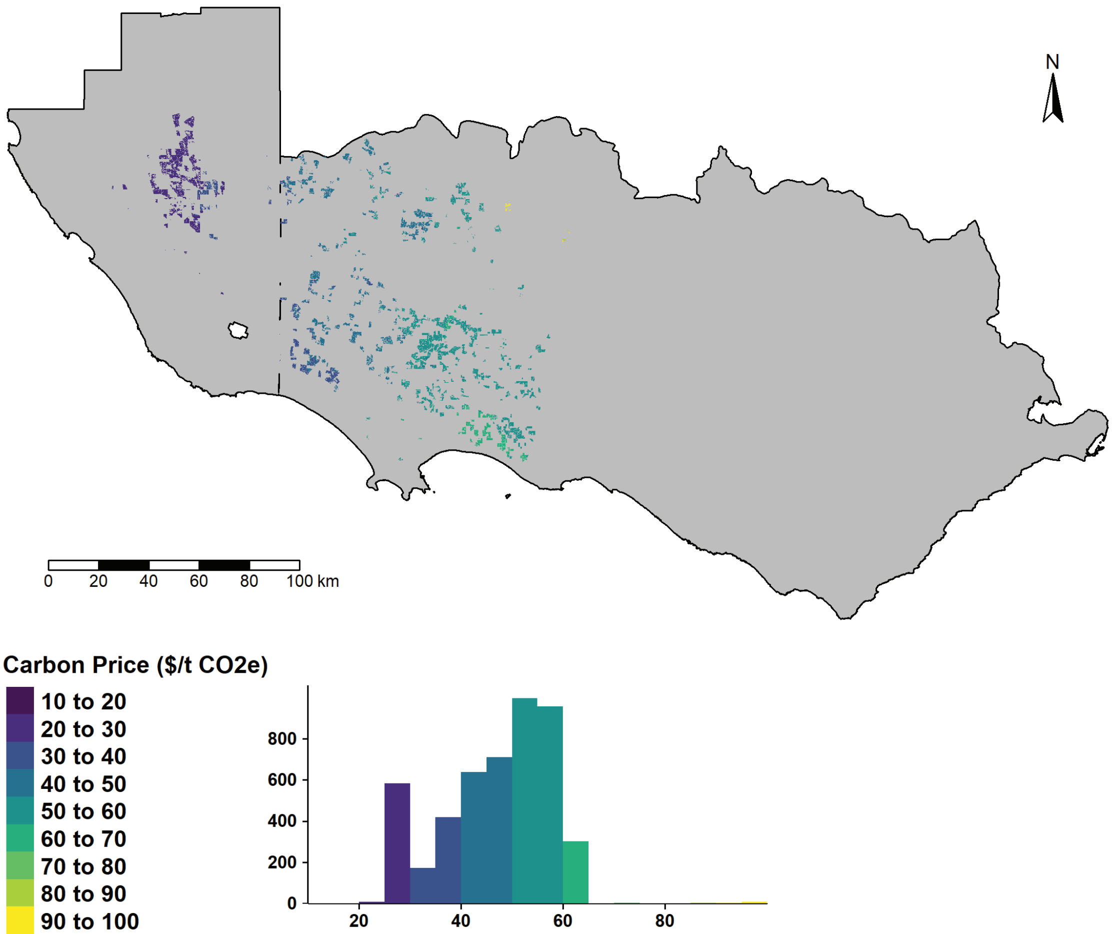


Figure 22: The spatial distribution of threshold carbon prices that return a *P. radiata* LEV greater than the LEV of continuing *E. globulus* plantations for existing hardwood plantations in the Green Triangle NPI. The histogram shows the frequency of each threshold price across the study area.

Carbon supply from Schedule 2: Short rotation to long rotation plantation forestry

At \$30/t CO_2e the scale of land use conversion outline above would generate up to 3,683,500 ACCUs. If sold into voluntary market these ACCUs would have a present value of up to \$75 million. The majority produced in the LGAs of Naracoorte and Wattle Range (Figure 23).

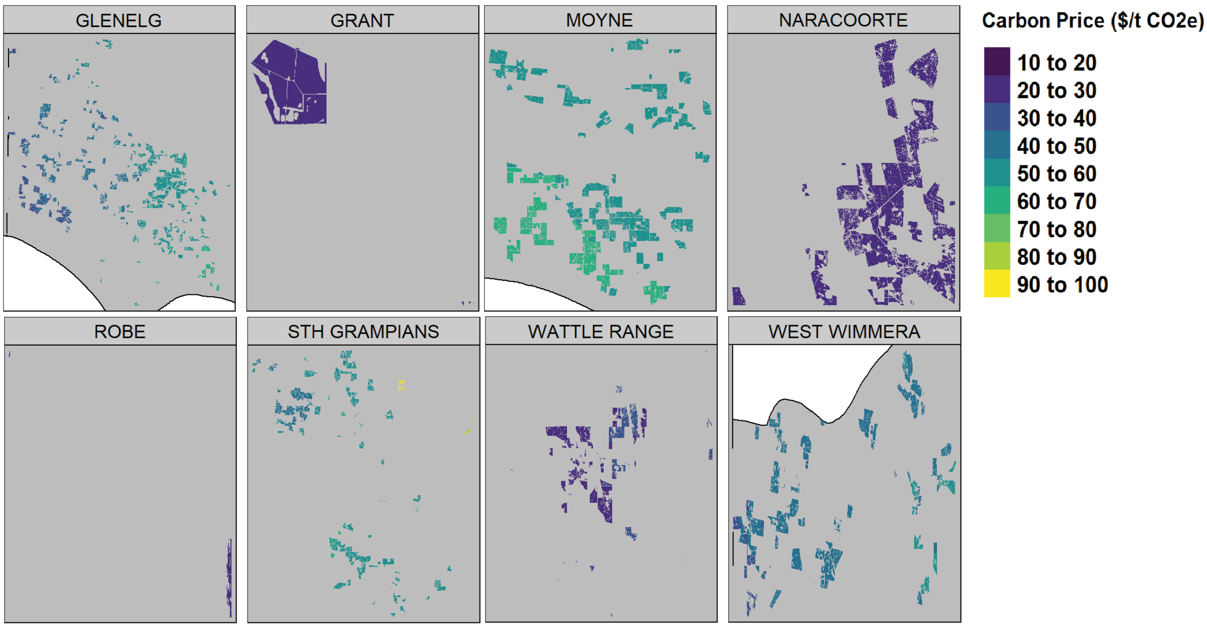


Figure 23: The spatial distribution of threshold carbon prices that return a *P. radiata* LEV greater than the LEV of continuing *E. globulus* plantations for existing hardwood plantations in the Green Triangle NPI by LGA.

At \$50/t CO_2e approximately 60,000 ha could be economically viable to be converted from hardwood to softwood. This would generate up to 10 million ACCUs with a present value of up to \$350 million. At prices above \$50/t CO_2e hardwood plantations in Victoria become viable for conversion (Figure 23) with the LGA of Glenelg potentially having 42,065 ha of hardwood plantation economically viable for conversion to softwood. This land use conversion could generate more than 8 million ACCUs.

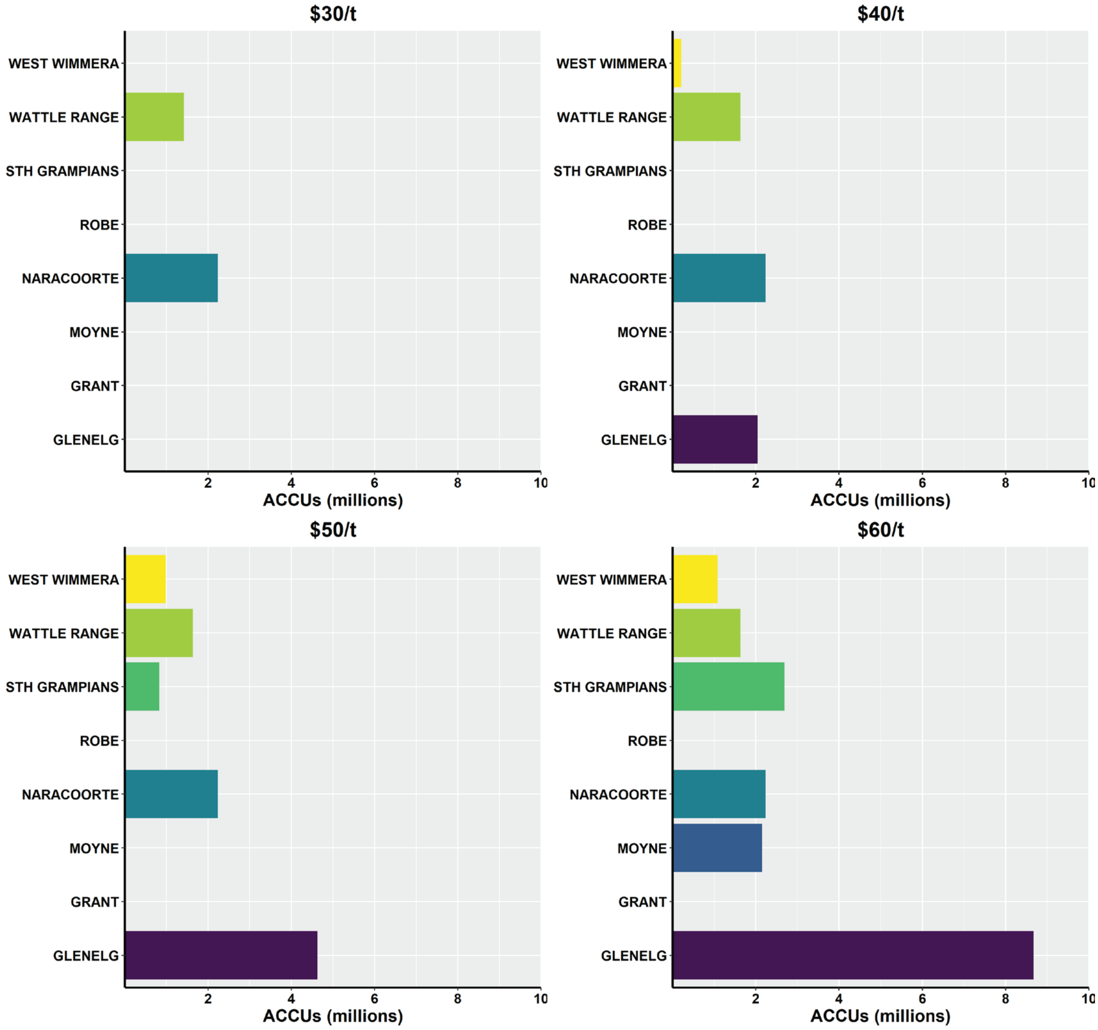


Figure 24: Potential ACCU generation from conversion of *E. globulus* plantations to *P. radiata* for each LGA in the study area at $30, $40, $50 and $60/t CO2e.

Summary

This research was conducted to support the Green Triangle Forest industry Hub's strategic planning for unlocking opportunities for plantation forestry expansion in the Green Triangle region of southern Australia.

The focus of this work was to provide a rigorous assessment of the potential role emerging carbon markets may play in contributing to plantation forestry expansion in the region. The emphasis of the research was on the Australian Government's carbon abatement policy, the Emissions Reduction Fund (ERF).

The plantation forestry method provides several mechanisms for industry to participate ERF. These include establishing a new plantation, converting an existing plantation from a short rotation to a long rotation, avoided conversion of a plantation to non-forest land use by continuing plantation activity, and transition to a permanent forest. Of those four methods, establishing a new plantation and converting an existing plantation from a short rotation to a long rotation were seen likely to have the most applicability to the forestry sector in the region and have data to support the analysis.

The carbon modelling undertaken in this research was completed using the Full Carbon Accounting Model (FullCAM) at a spatial resolution of 500 metres. FullCAM is used in Australia's National Greenhouse Gas Accounts for the land sector and is the mandated modelling framework for projects registered with the ERF. The hardwood species (*E. globulus*) was modelled as a 15-year rotation. The mean average long-term sequestration across the region was 292 t CO_2e/ha (std = 49 t CO_2e/ha). Significant variation in long term sequestration was seen across the region, with the minimum long term sequestration potential from perpetual hardwood rotations being 64 t CO_2e/ha while the maximum seen in the study area was 850 t CO_2e/ha. While the mean long term carbon sequestration potential from continuous softwood plantations (*P. radiata*) was 470 t CO_2e/ha (std = 109 t CO_2e/ha). The minimum estimated average long term carbon sequestration potential was 104 t CO_2e/ha and maximum carbon sequestration potential in the region was 1,210 t CO_2e/ha.

The existing plantation forestry estate in the region consists of approximately 320,000 ha of hardwood and softwood plantations. The FullCAM modelling showed that continuous business-as-usual forestry on the current existing plantation extent could sequester over 133.1 million tonnes of CO_2e over the next 100 years and approximately 37.2 million tonnes of CO_2e by 2050.The value of the carbon stored in existing plantations has a present value of approximately $532.5 million assuming a carbon price of $30/t CO_2e and assuming a discount rate of 7.5 percent.

The economic analysis was conducted by estimating land expectation values (LEV) of existing a potential new plantation developments. The results indicate that the LEV of hardwoods (without carbon payments) across the area ranged from -$3,432/ha to $15,594/ha (mean= $3,598, std= $1,996). While the LEV of softwood plantations across the area ranged from -$3,154/ha to $5,015/ha. LEVs including carbon payments were calculated and the carbon prices that compensated for land purchase price and plantation establishment (Schedule 1) and produced an LEV higher than those of continuing hardwood rotations (Schedule 2) were generated.

Considering hardwoods, the results for Schedule 1 - establishing a new plantation showed that 5,585 ha of agricultural land in the Glenelg LGA would be economically viable for purchase at current land prices without a carbon price. At $30/t CO_2e, consistent with current voluntary market prices, 178,028 hectares of land could be viable for purchase and developed for hardwood plantations. The large majority located in the local government areas of Glenelg (69,308 ha), Southern Grampians (88,000 ha) and Horsham (8,824 ha). This would have the potential to generate 44 million ACCUs over a 25-year project timeframe with a present value of up to $442 million.

Summary

The results showed far less opportunity for softwood development at lower carbon prices. The lowest carbon price required to buy land and convert to softwood was \$21/t CO_2e. At that price approximately 700 hectares may be available with the potential to generate up to 390,000 ACCUs with a value of up to \$5.5 million. At current voluntary market prices, the results indicated that only 1,000 hectares would be potentially viable for purchase and development. Voluntary market carbon prices have been more than \$50/t CO_2e in 2021. At those price levels, approximately 121,000 ha could be available for purchase and development, generating approximately 53 million ACCUs with a present value of up to \$1billion.

The results assumed a property could be purchased at median property prices in each of the local government areas. The data used was aggregated and did not differentiate between property sizes. This may be a somewhat unrealistic assumption as larger parcel sizes (> 150 ha) in the region are reported to have lower median values than smaller (30-50 ha) properties (Rural Bank, 2021). This assumption was unavoidable however, as property price data used was not differentiated by parcel size at the LGA level. It is also important to point out that the results are by no means suggesting this level of land use change is possible. The results present only the carbon threshold prices that would increase forestry profitability enough to compensate for land purchase and establishment costs. In reality, land is held tightly in the region and there has been considerable competition for land by family farms looking to consolidate holdings, especially grazing properties (Rural Bank, 2021).

Likely the largest strategic opportunity for the Green Triangle industry to participate in the ERF is through the Schedule 2 - converting an existing plantation from a short rotation to a long rotation method. Population growth and continued demand for new dwellings remain powerful long-term drivers of future Australian timber product consumption (IndustryEdge, 2021). There continues to be a significant gap between demand and supply of sawn timber, particularly framing timber. This gap is estimated to continue to grow and be as high as 179 percent of supply by 2050 (Woods and Houghton, 2022) .

Imports of sawn softwood are seen to be unlikely to fill this gap as imported volumes in 2050 would need to approximately triple the 2021 level (Woods and Houghton, 2022). While the industry is placing greater emphasis on engineered wood products that can incorporate hardwood resource, there is some evidence to suggest these are not commercially viable at this time (IndustryEdge, 2021).

The Schedule 2 method presents a viable opportunity for the industry to increase the softwood plantation extent albeit at the expense of the hardwood estate. The results of the modelling showed that at \$30/t CO_2e approximately 23,500 hectares of hardwood plantation could economically be converted to softwood primarily in the South Australian areas of the region. This scale of conversion would generate up to 3.7 million ACCUs with a present value of up to \$75 million. While at \$50/t CO_2e approximately 60,000 hectares of current hardwood plantations could be viably converted to softwood generating approximately 10 million ACCUs with a present value of up to \$350 million.

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