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Carbon credits from Western Australia's multiple use public native forests: a first pass assessment

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TAI

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In order to inform its response to the draft FMP, the Conservation Council of Western Australia commissioned Andrew Macintosh from the ANU Centre for Climate Law & Policy to write an earlier version of this paper.

Contents

Summary

The object of this report was to analyse the carbon credits that could be generated by stopping all harvesting in the public native forests covered by the Conservation Commission of Western Australia's *Draft Forest Management Plan 2014-2023* (FMP forests). These forests cover an area of ~850,000 ha and have produced 300,000-500,000 m^3 yr^{-1} of logs since the reforms in the native forest sector in the early 2000s.

The proposal to stop all harvesting (the project) could generate a number of different types of carbon credits. Here it was assumed that it led to two specific types: forest management (FM) credits and Kyoto-Australian carbon credit units (Kyoto ACCUs).

FM credits (and debits) are the credits (debits) that will be recorded in Australia's international greenhouse compliance accounts if it accounts for FM in the post-2012 era. Two methods were used to project the FM credits that could result from the project: FM methods 1 and 2. The results suggest that, on average, the project would lead to the generation of between 2.2 and 2.4 million FM credits yr^{-1} over the period 2013-2032.

ACCUs are offset credits issued under the *Carbon Credits (Carbon Farming Initiative) Act 2011* (Cth) (CFI Act). Kyoto ACCUs are ACCUs issued in relation to avoided emissions and removals that can be used to meet Australia's emission targets. Because they affect emissions and removals that are recorded in Australia's national greenhouse accounts, Kyoto ACCUs can also be used to meet carbon liabilities under the *Clean Energy Act 2011* (Cth) (CE Act). Three methods were used to project the Kyoto ACCUs from the project: CFI methods 1, 2 and 3. The results suggest that, on average, the cessation of harvesting in the FMP forests would lead to the generation of between 1.8 and 2.9 million Kyoto ACCUs yr^{-1} over the period 2013-2032.

The FM credits and Kyoto ACCUs issued in relation to the project would not be cumulative. The Kyoto ACCUs would effectively be 'carved out' of the corresponding FM credit or debit entry in Australia's greenhouse accounts. Due to this, if Kyoto ACCUs are issued in relation to the project, the 'carbon benefit' from the project would accrue primarily to the project proponent under the CFI (i.e. the holder of the carbon sequestration right — presumably the Western Australian Government or another state government agency).

Three carbon price scenarios were used to estimate the potential value of the Kyoto ACCUs generated by the project: a low, medium (Clean Energy Future) and high price path. On the basis of these price paths, and assuming a 5% deduction is made to account for leakage, the annual value was assessed at between $16 million and $438 million per annum (2013 A$), with the net present value estimated at between $376 million and $3,348 million (2013 A$) using a social time preference rate of 2.7%.

The estimated total Kyoto ACCUs under CFI methods 1, 2 and 3 (with a 5% leakage deduction), and the associated net present values (2013 A$) under the three price scenarios, are shown in Table ES1.

Table ES1: Estimated total Kyoto ACCUs (with 5% leakage deduction) (millions) and the associated net present value (2013 A$), 2013-2032

	Total credits, 2013-2023 (mill)	Price scenario		
		Low	CEF	High
CFI method 1	48.1	$486	$1,450	$2,879
CFI method 2	58.2	$580	$1,767	$3,524
CFI method 3	38.4	$396	$1,146	$2,260

There are a number of uncertainties surrounding the FM credits and Kyoto ACCUs that could be generated by the project. These relate to legal, policy and accounting issues and are discussed at length in the body of the report. The carbon credit and value estimates contained here should be read in the context of these uncertainties.

1 Introduction

In August 2012, the Conservation Commission of Western Australia released its *Draft Forest Management Plan 2014-2023* (FMP) for public comment (CCWA, 2012). The draft FMP sets out intended management arrangements for approximately 2.5 million hectares (ha) of public forests in southwest Western Australia for the plan period (2014-2023). The focus of the plan is on the State forests and timber reserves within the plan area that are available for harvesting. These forests cover a total area of approximately 850,000 ha and are made up of mainly native jarrah/wandoo (~790,000 ha) and karri (~59,500 ha) forests (FMP forests).

In order to inform its response to the draft FMP, the Conservation Council of Western Australia commissioned the Australia Institute to undertake an analysis of the carbon credits that could be generated by stopping all harvesting in these native forests (the project). This report contains the results of the analysis.

The report is broken into 6 sections. Section 2 provides an explanation of the types of carbon credits that could be generated by the project and a qualitative analysis of the implications of the issuance of these credits. Section 3 details the methods used to estimate the carbon credits from the project. Section 4 provides the carbon credit results. Section 5 analyses the value of the carbon credits and section 6 concludes.

Readers should note that this report is a first pass assessment of the carbon credits that could be generated from a project involving the cessation of harvesting in the FMP forests. Additional analysis should be undertaken before any carbon credit project involving the FMP forests is undertaken. There are also several important uncertainties that could impede the generation of carbon credits from the proposed project. These issues are discussed in greater length in sections 2 and 3.

2 Types of carbon credits and impacts on Australia's net greenhouse gas emissions

Types of carbon credits

The cessation of harvesting in the FMP forests could lead to the generation of three broad types of carbon credits:

- forest management (FM) credits under the Kyoto Protocol (or a successor agreement);
- Australian carbon credit units (ACCUs) under the *Carbon Credits (Carbon Farming Initiative) Act 2011* (Cth) (CFI Act); and/or
- credits issued in accordance with an alternative voluntary standard (e.g. National Carbon Offset Standard or the Verified Carbon Standard).

It is assumed for the purposes of this report that the only credits generated by the project are FM credits and/or ACCUs.

Forest management (FM) credits

FM credits (and FM debits) are the credits (debits) that will be recorded in Australia's international greenhouse compliance accounts if it accounts for FM. Under the Kyoto Protocol, FM is defined as 'a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner' (UNFCCC Secretariat, 2006: 5). This definition allows for two approaches to be used when identifying FM lands (Penman et al., 2003). Under the first (the narrow approach), the party can define a set of specific practices (e.g. harvesting, thinning, fertilization and fire suppression) and the FM lands are those subject to these practices since 1990. The second approach (the broad approach) requires the party to define a system of FM practices and identify the area subject to these practices in the commitment period. Parties can use a mix of these approaches, which is what Australia has signalled it will do if it accounts for FM in the post-2012 period (Australian Government, 2011). Under the Australian approach, FM lands will include all multiple use public native forests that were available for harvest at December 2009, private native forests subject to harvesting since 1990 and pre-1990 plantations.[1] The adoption of this definition will mean that the FMP forests will fall within Australia's FM lands.

During the first commitment period of the Kyoto Protocol (2008-12), Australia did not account for FM. Its coverage of land use, land-use change and forestry (LULUCF) emissions and removals was confined to Article 3.3 activities: afforestation, reforestation and deforestation. Australia chose not to account for any Article 3.4 activities, including FM, because of concerns about inter-annual variability and major natural disturbances (e.g. wildfires and droughts) (Australian Government, 2008a; 2008b).

The Australian Government has announced that, if certain conditions are satisfied, it will participate in the second commitment period of the Kyoto Protocol (KP2), which will run from 1 January 2013 to either 31 December 2017 or 31 December 2020. If Australia does participate, it will be required to account for LULUCF in accordance with the rules agreed at the Durban Climate Conference in 2011 (the 17th Conference of the Parties to the UNFCCC and 7th Conference of the Parties serving as the Meeting of the Parties to the Kyoto

[1] Other forests potentially fall with the scope of Australia's FM lands. However, they are not relevant to the analysis in this report.

Protocol).[2] There are five notable aspects of these new accounting rules that are relevant to the current analysis.

- FM accounting is compulsory in KP2 (it was optional in the first commitment period).
- FM accounting will be based on a reference level (or baseline-and-credit) system. Under this approach, FM reference levels are supposed to be set for each participating country, representing an estimate of net FM emissions over the commitment period in the absence of policy changes from 31 December 2009.[3] The credits and debits recorded during the commitment period will be calculated by subtracting the reference level from the actual reported net emissions. Parties whose emissions are higher than the reference level will incur debits and those whose emissions are below the reference level will receive credits. Australia's proposed FM reference level is an average of 4.7 Mt CO_2-e yr^{-1} over the period 2013-2020 (Australian Government, 2011).[4]
- There is an optional natural disturbance rule that allows for the exclusion of net emissions from natural disturbances on FM lands above a pre-set disturbance 'baseline'. The effect of this option is to allow parties to protect themselves from debits (or credit reductions) that are attributable to major non-anthropogenic events.
- Harvested wood products from FM lands are required to be accounted for using one of four methods:
  - instantaneous oxidation;
  - the IPCC first-order decay function with default half-lives of 2 years for paper, 25 years for wood panels and 35 years for sawn wood;
  - country-specific data as a substitute for the default half-lives; or
  - definitions and estimation methodologies in the most recently adopted IPCC guidelines and any subsequent clarifications agreed by the Conference of the Parties
- FM credits, and credits associated with FM project activities undertaken through the joint implementation (JI) mechanism, are subject to a combined cap of 3.5% of total base year emissions excluding LULUCF. For Australia, the 3.5% cap currently equates to a limit of 14.6 Mt CO_2-e yr^{-1} over the commitment period.[5] When new accounting rules for methane take effect in 2015, the cap is likely to increase to 15.3 Mt CO_2-e yr^{-1}.

For the purposes of the current analysis, it is assumed that Australia participates in KP2 and that it accounts for FM using the reference level and methods described in its submission to the Durban Climate Conference.

ACCUs

ACCUs are offset credits issued under the CFI Act. There are two types of ACCUs: Kyoto ACCUs and non-Kyoto ACCUs. Broadly, Kyoto ACCUs are credits issued in relation to avoided emissions and removals that can be used to meet Australia's emission targets. Non-Kyoto ACCUs are those issued in relation to avoided emissions and removals that cannot be used to meet Australia's targets. As a general rule, Kyoto ACCUs can be used to meet carbon liabilities under the *Clean Energy Act 2011* (Cth) (CE Act), while non-Kyoto ACCUs

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[2] CMP.7, *Land use, land-use change and forestry*, http://unfccc.int/files/meetings/durban_nov_2011/decisions/application/pdf/awgkp_lulucf.pdf (24 February 2012).

[3] Ibid. A number of countries have submitted reference levels that do not accord with this principle. See Macintosh (2011).

[4] Ibid. For an analysis of the reference level system and Australia's reference level, see Macintosh (2011).

[5] Australia's 1990 base year estimate (excluding LULUCF) under the Kyoto Protocol is 416.2 Mt CO_2-e (UNFCCC Secretariat, 2009).

can only be used in voluntary markets.[6] The primary benefit associated with generating Kyoto ACCUs is that they can be sold into the larger compliance market where carbon prices are likely to be higher than those in the voluntary market.

The CFI Act provides for the issuance of ACCUs in relation to two types of projects: sequestration projects and emissions avoidance projects. Sequestration projects involve the sequestration of CO_2 in biomass or soils and avoidance of CO_2, CH_4 and N_2O emissions from the destruction or disturbance of biomass or soils. Emissions avoidance projects involve the avoidance of CH_4 and N_2O emissions from agricultural activities, feral animals and legacy waste in landfill facilities.

A project involving the cessation of harvesting in the FMP forests (i.e. an 'avoided native forest harvesting project') would constitute a sequestration project for the purposes of the CFI Act. This type of project is explicitly provided for under the CFI Act as a 'native forest protection project', which is defined as a project 'to remove carbon dioxide from the atmosphere by sequestering carbon in trees in one or more native forests … and to avoid emissions of greenhouse gases attributable to the clearing or clear-felling of one or more native forests'.[7]

Notwithstanding the fact that the legislation provides for avoided native forest harvesting projects, these projects are currently not eligible to participate in the CFI. This is due to the fact that they are currently not on the CFI 'positive list'. Under the CFI Act, a project can only be declared to be an eligible offsets project if the project passes the 'additionality test'. The additionality test is contained in s.41 of the CFI Act and has two limbs:

- the project must be of a kind specified in the regulations; and
- the project must not be required to be carried out by or under a law of the Commonwealth, a State or a Territory.

The 'positive list' is the list of projects specified under the regulations made for the purpose of the first limb of the additionality test (s.41(1)(a)).

While avoided native forest harvesting projects are not on the positive list:

- they cannot be declared to be eligible offset projects; and
- a methodology for these projects cannot be made and declared under the Act.

The Government has not given an explanation for why avoided native forest harvesting projects have been excluded from the positive list.

It is assumed for the purposes of this report that the positive list is amended and a methodology determination is made so as to enable avoided native forest harvesting projects to be eligible offset projects under the CFI Act.

What is the relationship between FM credits and ACCUs?

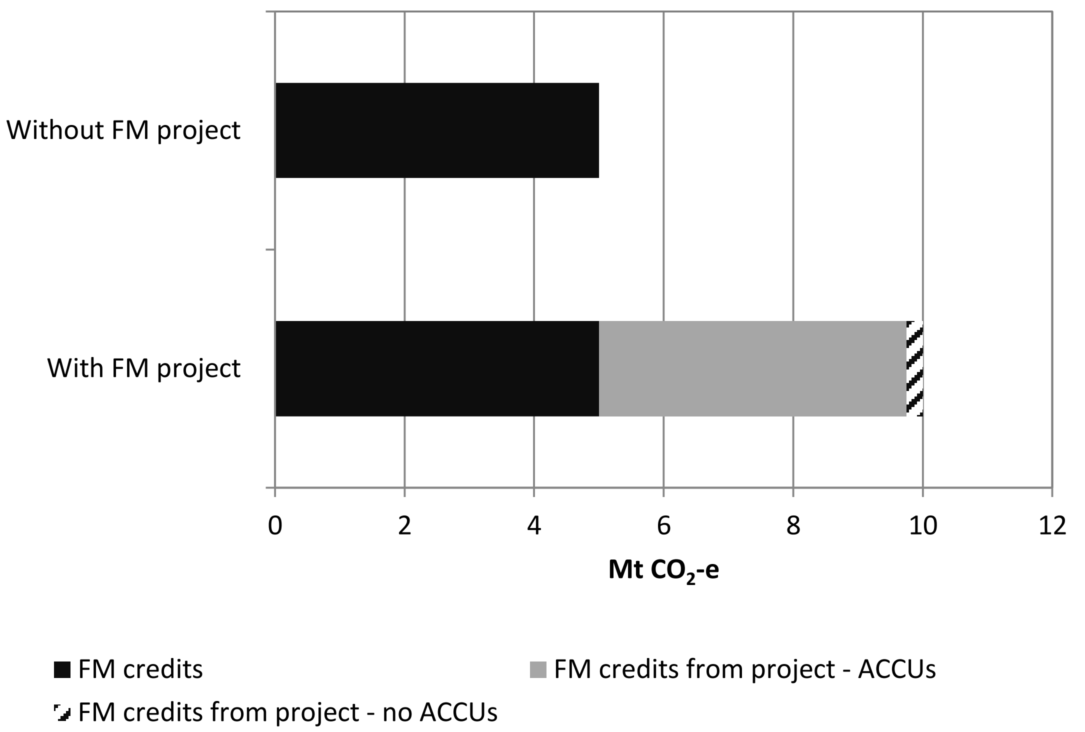
The links between FM credits (and debits) and ACCUs depend on how Australia accounts for FM in the post-2012 era. If FM is not accounted for, no FM credits (or debits) will be recorded against Australia's mitigation targets and any ACCUs issued in relation to FM projects in Australia will be non-Kyoto ACCUs. On the other hand, if FM is accounted for, FM projects in Australia will contribute to the FM credits/debits recorded against Australia's mitigation targets and, provided they are eligible offsets projects, they will also lead to the generation of Kyoto ACCUs.

[6] There are exceptions to this general rule. See *Clean Energy Act 2011* (Cth), s 5.

[7] CFI Act, s 5.

Conceptually, where Kyoto ACCUs are issued in relation to a FM project, they can be thought of as being 'carved out' of the corresponding FM entry in the national greenhouse accounts (Macintosh and Waugh, 2012). This is illustrated in Figure 1, which shows two hypothetical FM credit outcomes for a single year. In the first ('Without FM project'), there are no eligible offsets FM projects but Australia still generates 5 Mt CO_2-e of FM credits in the relevant year because total net FM emissions are 5 Mt CO_2-e below the reference level. In the second case ('With FM project'), Australia receives 10 Mt CO_2-e of FM credits comprising the initial 5 Mt CO_2-e plus a further 5 Mt CO_2-e that are attributable to an eligible offsets FM project. Most, but not all, of the FM credits generated by the eligible offsets FM project lead to the issuance of corresponding Kyoto ACCUs. The difference is a product of the CFI rules, particularly the risk of reversal buffer and required conservatism in methods. Ordinarily, these rules should ensure that the Kyoto ACCUs issued in relation to an eligible offsets FM project are less than the related FM credit entry.

Figure 1: Hypothetical representation of the relationship between FM credits and Kyoto ACCUs issued in relation to eligible offsets FM projects*



* All numbers included in Figure 1 are hypothetical and are not intended to reflect the actual impact of any project.

While the Kyoto ACCUs that are issued in relation to eligible offsets FM projects are drawn from the corresponding FM entry in Australia's greenhouse accounts, it is important to recognise that Australia's FM accounting framework is based on different principles to those that apply under the CFI. The FM accounting system agreed at the Durban Climate Conference is supposed to be based on reference levels that represent total net FM emissions assuming no change in policies from 31 December 2009. In applying this construct, the Australian Government projected carbon stock changes in the live biomass and debris pools in multiple use public native forests using the mean national harvest rate from the period 2002-2009, and carbon stock changes in the harvested wood products (HWP) pool using the 2008 wood production levels (Australian Government, 2011). Any deviation from these levels will lead to corresponding changes in FM credits and debits.

Under the CFI Act, in theory, FM projects should only qualify as eligible offsets projects if they are 'additional', or would not have been undertaken in the absence of the scheme.[8] Similarly, the abatement associated with FM projects should only lead to the generation of ACCUs if it is additional (this is embodied in the requirement that the baseline for a project should reflect the net emissions from the project area in the absence of the project activity).[9] These additionality requirements are intended to ensure that ACCUs are not issued for emission reductions and removals that would have occurred anyway. Australia's FM accounting framework is not based on the same additionality principles; if the harvest rate falls below the 2002-2009 average, Australia will receive FM credits irrespective of the cause of the decline. The additionality provisions under the CFI should ensure that, in most cases, any Kyoto ACCUs issued in relation to eligible offsets FM projects are a sub-component of the FM credits recorded against Australia's mitigation targets.

An example of the circumstances where this may not apply is if harvesting within one state's multiple use public native forests was scheduled to increase above the 2002-2009 mean under existing policy settings. If the harvesting occurred, it would lead to FM debits (or debits that reduce the total number of FM credits recorded in Australia's accounts). In principle, the baseline for a CFI project involving the avoidance of this harvesting should be set at the scheduled levels, even though they are above the 2002-2009 mean. The net outcome could be that, rather than being a sub-component of a FM credit entry, the project would result in the issuance of Kyoto ACCUs that are carved out of what would have been corresponding FM debits. As is discussed in sections 3 and 4, this may apply in Western Australia, where the allowable cut could increase under the draft FMP.

The climate and economic impacts of avoided native forest harvesting projects

If Australia accounts for FM in the post-2012 period, any avoided native forest harvesting project should reduce net emissions from FM but it should not result in a reduction in national or global emissions. This is because Australia's mitigation commitments involve the setting of a cap on net national emissions for the period 2013-2020, and ultimately through to 2050. Due to the existence of this net emissions limit, abatement actions in sectors that count towards the national total will not usually result in overall national emissions reductions; a reduction in emissions in one sector merely allows for greater emissions in another. Reductions in absolute emissions should only occur if the abatement actions lead directly to the lowering of the national target (e.g. cancellation of assigned amount units or other equivalent units) or, in the event that national emissions end up being below the target in one accounting period, the Australian Government decides not to carry-over the surplus into the next period.[10]

While an avoided native forest harvesting project involving the FMP forests should not affect the net national emissions outcome, it will have important economic impacts related to the operation of the carbon pricing scheme and the CFI, and the capital flows associated with international emissions units. In particular:

- to the extent that the project leads to the creation of FM credits (or avoidance of FM debits) for which no corresponding ACCUs are issued, it should lead to a relative

[8] CFI Act, s 41(1) and *Explanatory Memorandum, Carbon Credits (Carbon Farming Initiative) Bill 2011 (Cth)*, at para. 5.43-5.51. See also Macintosh and Waugh (2012).

[9] CFI Act, ss 106-107. See also *Explanatory Memorandum, Carbon Credits (Carbon Farming Initiative) Bill 2011 (Cth)*, at para. 5.38.

[10] The Australian Government is currently deciding whether to carry-over a surplus of ~100 $MtCO_2$-e from the Kyoto Protocol's first commitment period into the post-2012 regime.

increase in the carbon pollution cap under the CE Act and thereby increase the revenues received by the Australian Government from the sale of carbon units; and

- the increase in supply of ACCUs (and any increase supply of carbon units under the CE Act) should reduce the net economic impact of meeting Australia's mitigation commitments by decreasing reliance on imported carbon units.

It is stressed that there are significant uncertainties associated with the potential financial and economic benefits of avoided native forest harvesting projects. These include:

- Australia may not account for FM;
- the 3.5% FM cap could exclude the impact of the project, meaning the benefits related to the carbon pricing scheme would be lost and any associated units issued under the CFI would be non-Kyoto ACCUs that could only be sold in voluntary markets (or purchased by the Australian Government through the CFI Non-Kyoto Carbon Fund);
- the Australian Government may cancel surplus national units created by the project or be unable to transfer or carry them over to future commitment periods, which could limit the realisation of the financial and economic benefits;
- the carbon pollution cap may be set in a way that does not account for the impact of the project;
- avoided native forest harvesting projects may not be included on the CFI positive list; and
- carbon prices may remain low, reducing the magnitude of the financial and economic benefits.

3 FM credits and ACCUs associated with the cessation of harvesting in the FMP forests

Legal and policy assumptions

In order to evaluate the FM credit and ACCU implications of the proposal to stop all harvesting in the FMP forests, a number of legal and policy assumptions were adopted. These are detailed in Table 1.

Table 1: Key legal and policy assumptions

1.	Australia accounts for FM in the post-2012 era using the FM reference level and methods described in its submissions to the UNFCCC.
2.	The carbon pollution cap under the CE Act is set by subtracting an estimate of net emissions that are not subject to the Act from the national trajectory (i.e. national cap).
3.	The Australian Government is able to sell surplus national units on international carbon markets and/or carry them over to subsequent commitment (or accounting) periods.
4.	Avoided native forest harvesting projects are included on the positive list under the CFI Act.
5.	A methodology is approved for avoided native forest harvesting projects under the CFI that is consistent with the FM methods detailed in Australia's FM reference level submissions to the UNFCCC.
6.	The proposed project (cessation of all harvesting in the FMP forests) is approved by the Clean Energy Regulator as an eligible Kyoto offsets project under the CFI Act.

Again, it is emphasised that there are significant uncertainties associated with these issues. The Australian Government has indicated it will participate in KP2 if certain conditions are satisfied. This suggests Australia will account for FM in the post-2012 period; however, the situation may change after the Doha Climate Conference in late 2012. Similarly, there is considerable confusion about why avoided native forest harvesting projects have not been included on the CFI Act's positive list, and uncertainty surrounding the methods that may be used if or when it is listed.

FM credit method

Rationale behind the method

To estimate the number of FM credits that could be generated by the project, two scenarios were devised for the period 2013-2032 (the 'projection period'):

- a reference scenario, based on the assumption that harvesting continues in accordance with the existing and proposed management plans; and
- a no harvest scenario, based on the assumption that all harvesting in the FMP forests ceases in 2013.

There are three broad approaches that could be used to devise the reference and no harvest scenarios.

Approach A: *Government methods and datasets for reference and no harvest scenarios*. This approach involves applying the Australian Government's FM reference level methodology and datasets to generate the reference and no harvest scenarios.

Approach B: *Government methods and datasets for reference scenario/alternative methods and datasets for no harvest scenario*. Under this approach, the Australian Government's FM reference level methodology and datasets are used to generate the reference scenario but an alternative method and/or datasets are used for the no harvest scenario.

Approach C: *Alternative methods and datasets for reference and no harvest scenarios*. Under this approach, the Australian Government's FM reference level methodology and datasets are rejected and an alternative method and datasets are used to derive both the reference and no harvest scenarios.

There is significant uncertainty associated with the models and data used to devise Australia's FM reference level. This is a product of a number of factors, including a lack of data on carbon stocks and fluxes in native forests, data gaps concerning the age-class distribution of native forests and the silviculture practices used in them, and the counter-factual nature of reference levels (MPIG, 2008; Australian Government, 2011; 2012; Macintosh, 2011). With improved data and models, it may be possible to devise a more accurate method that better reflects 'what the atmosphere sees', a fact acknowledged by the Australian Government (Australian Government, 2011; 2012).

While improvements in the Australian Government's method are possible, and the Government has flagged its intent to make changes in the future, the use of either Approach B or C increases the risk of invalid results. Approach C would involve the use of methods and datasets unrelated to the Australian Government's accounting framework. The results may better reflect 'what the atmosphere sees' but are unlikely to better reflect the entries made in Australia's greenhouse accounts.

Approach B could ultimately be used by the Australian Government — the reference level could be treated as a fixed number, while the annual actual FM emissions are accounted for using evolving methods and datasets. Although this is a possibility, the Australian Government has stated that it has no intention of adopting this approach due to the potential for 'false' debits and credits (debits and credits that arise from method or data changes rather than changes in management practices) (Australian Government, 2011).

Due to these issues, Approach A was used for the purposes of the FM analysis because it provides the best approximation of what will be recorded against Australia's mitigation commitments over the projection period. Accordingly, in devising the FM reference and no harvest scenarios, the objective was to mirror, to the greatest extent possible, the methods and data sets used to generate the Australian Government's FM reference level. To do this, two methods were used: FM method 1 and FM method 2.

FM method 1

Reference scenario

The Australian Government's FM reference level is a projection of net FM emissions over the period 2013-2020 assuming no change in policies from December 2009. Here, the reference scenario was confined to a projection of net emissions from the FMP forests. The projection period was also extended to 2032 to provide a more complete picture of the FM credit implications of the project. The 20 year period was adopted because it is the default crediting period for native forest protection projects under the CFI Act.[11]

In the Australian Government's FM reference level, the carbon pools are confined to live above- and below-ground biomass, debris and harvested wood products (HWP). The soil carbon pool is assumed to be stable, providing no net emissions or removals (i.e. it is excluded). The same approach was adopted here. Consistent with the Australian Government's method, the calculation of the reference level was split into two parts on the basis of the accounted carbon pools:

- carbon stock changes in the live biomass and debris pools; and
- carbon stock changes in the HWP pool.

Soil carbon was excluded.

Carbon stock changes in the live biomass and debris pools

In the Australian Government's FM reference level, the projected carbon stock changes in the live biomass and debris pools were modelled using the non-spatially explicit Tier 2 capabilities of *FullCAM* (Richards and Evans, 2004; Richards and Brack, 2004; Brack et al., 2006; Australian Government, 2011; 2012). Within the model, the forest area (Australia's multiple use public forests and Tasmanian private native forests) was divided into six broad forest types (rainforest, tall dense eucalypt forest, medium dense eucalypt forest, medium sparse eucalypt forest, cypress pine forest and other forest), ten silvicultural systems and eight age classes, producing 73 forest type/silviculture/age class combinations. The carbon stock changes were modelled on the basis of the estimated area in each forest type/silviculture/age class combination using assumed forest type growth, turnover and decomposition rates. Harvest slash emissions over the period 2013-2020 were calculated using the forest type/silviculture/age class combinations and an assumption that the national harvest rate would equal the mean from the period 2002-2009.

To devise the reference scenario under FM method 1, a modified version of the approach adopted by the Australian Government was used.

- The scenario was generated using the Tier 2 capabilities of *FullCAM* (version 3.30.1).
- The *FullCAM* representative plot file data used to devise Australia's reference level were obtained from the Australian Government (Australian Government, 2011).
- Of the 73 representative plot files within the Australian Government's model, harvesting occurred in 55 of them over the period 2002-2009. For the purposes of devising the FM reference scenario, one of the harvest plot files was excluded on the basis that it was inapplicable to the FMP forests (a cypress pine harvest plot — no cypress harvesting occurs in Western Australia). The remaining 54 harvest files represent tall dense eucalypt forest (TDEF), medium dense eucalypt forest (MDEF) and medium sparse eucalypt forest (MSEF) across different age classes (juvenile, immature, mature, senescent, multi-aged, unknown age).
- To construct the reference scenario, the national mean harvest rate for the period 2002-2009 in these 54 representative plot files was used (96,958 ha yr^{-1}). That is, it was assumed that, over the projection period, harvesting occurs on the same plot types, employing the same harvest techniques as occurred between 2002 and 2009. To assign a harvest area to the FMP forests, the national area was reduced on a pro

[11] CFI Act, s 69. It may be necessary for changes to be made to the CFI Act to allow the renewal of crediting periods for avoided native forest harvesting projects. In the absence of this change, these and other similar projects could be significantly disadvantaged.

rata basis using broadleaved native roundwood removals (i.e. broadleaved roundwood removals from Western Australian multiple use public native forests as a proportion of total national roundwood removals from all multiple use public native forests and Tasmanian private native forests over the period 2002-2009).[12] This method resulted in a total assumed harvest area of 5709 ha yr^{-1}, which is significantly below the actual reported mean harvest area for Western Australia's multiple use public native forests over the period 2002-2009 (9874 ha yr^{-1}) (WAFPC, 2011). Details of the representative plot files and harvest area allocated to each are provided below in Table 2.

- The plots were assumed to form part of a single estate and the carbon stock changes on the estate were modelled using an estate simulation start date of 1960 and an end date of 2032.
- Carbon stock changes on the parts of FMP forests that are not subject to harvest over the projection period were not modelled. This is due to the fact that carbon stock changes in these areas are the same in all scenarios, thereby cancelling each other out under the FM reference level accounting system. For the same reason, the impacts of wildfires were excluded from all scenarios.[13] Similarly, non-harvest related fuelwood removals were assumed to be the same in the reference and no harvest scenarios, and were therefore not modelled.

[12] To ensure consistency with the Australian Government's methods, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES, 2012a; 2012b) data on roundwood removals were used for these purposes.

[13] It is currently unclear how the Australian Government will account for wildfires. Since 2007, the Australian Government has repeatedly stated that it wants to exclude the impacts of wildfires on the basis that the effects are non-anthropogenic. It is assumed for the purposes of this report that Australia's LULUCF accounting rules reflect this intent.

Table 2: FM method 1 – representative harvest plot files and assumed harvest area (ha yr^{-1}) in the FM reference scenario

Plot name	Area	Plot name	Area
MDEF 31-100 CF NPW.plo	3	MDEF unknown age PH NPW.plo	205
MDEF 31-100 CF PW.plo	27	MDEF unknown age PH PW TAS.plo	621
MDEF 31-100 PH NPW.plo	17	MDEF unknown age PH PW WA NSW.plo	936
MDEF 31-100 PH PW TAS.plo	52	MDEF unknown age PH PW WA.plo	86
MDEF 31-100 PH PW WA NSW.plo	78	MSEF PH NPW.plo	515
MDEF 31-100 PH PW WA.plo	7	MSEF senescent PH NPW.plo	129
MDEF 31-100_non_com_thin.plo	285	TDEF 31-100 CF NPW.plo	5
MDEF mature CF NPW .plo	6	TDEF 31-100 CF PW.plo	48
MDEF mature CF PW .plo	55	TDEF 31-100 PH NPW NSW.plo	15
MDEF mature PH NPW.plo	34	TDEF 31-100 PH PW NSW.plo	36
MDEF mature PH PW TAS.plo	104	TDEF 31-100 PH PW VIC.plo	14
MDEF mature PH PW WA NSW .plo	156	TDEF 31-100 PH PW WA.plo	3
MDEF mature PH PW WA.plo	14	TDEF mature CF NPW.plo	3
MDEF senescent CF NPW.plo	3	TDEF mature CF PW.plo	24
MDEF senescent CF PW.plo	27	TDEF mature PH NPW NSW.plo	7
MDEF senescent PH NPW.plo	17	TDEF mature PH PW NSW.plo	18
MDEF senescent PH PW TAS.plo	52	TDEF mature PH PW WA.plo	2
MDEF senescent PH PW WA NSW.plo	78	TDEF senescent CF NPW.plo	3
MDEF senescent PH PW WA.plo	7	TDEF senescent CF PW.plo	24
MDEF three aged CF NPW.plo	12	TDEF senescent PH NPW NSW.plo	7
MDEF three aged CF PW.plo	109	TDEF senescent PH PW NSW.plo	18
MDEF three aged PH NPW.plo	68	TDEF senescent PH PW WA.plo	2
MDEF three aged PH PW TAS.plo	207	TDEF unknown age CF NPW.plo	43
MDEF three aged PH PW WA NSW.plo	312	TDEF unknown age CF PW.plo	387
MDEF three aged PH PW WA.plo	29	TDEF unknown age PH NPW NSW.plo	120
MDEF unknown age CF NPW.plo	36	TDEF unknown age PH PW NSW.plo	289
MDEF unknown age CF PW.plo	327	TDEF unknown age PH PW WA.plo	25
Total area (ha yr^{-1})			**5709**

Carbon stock changes in the HWP pool

In the Australian Government's FM reference level, projected carbon stock changes in the HWP pool were estimated using the harvested wood products model that is used for the purposes of Australia's *National Inventory Reports* (Richards et al., 2007; Australian Government, 2011; 2012). When used for the purpose of *National Inventory Reports*, the model estimates carbon stocks and flows from all wood products in Australia, regardless of their origin. The model was adjusted for the purposes of the FM reference level to exclude imports and include exports to ensure consistency with the proposed accounting framework. Adjustments were also made to the decay rate assumptions. For all domestically produced and consumed wood products, the standard decay rates in the model were used. With exports, the model was used to classify exported products into decay class pools but losses from the pools were determined in accordance with the default decay rates set out in the 'Revised proposal by the Chair, Draft decision -/CMP.6 (Land use, land-use change and forestry)'.[14]

In estimating HWP emissions in its FM reference level (and the *National Inventory Reports*), the Australian Government did not use the log removal estimates generated by *FullCAM*. Separate ABARES wood production data were used for this purpose. For the FM reference level, the Government assumed that annual wood production and the proportion of production allocated to end-use categories remain stable at 2008 levels throughout the period through to 2020 (Australian Government, 2011).

For current purposes, carbon stock changes in the HWP pool were estimated using a simplified wood flow model and the IPCC first-order decay function,[15] assuming half-lives of 2 years for paper, 25 years for wood panels and 35 years for sawn wood. The simplified wood flow model was derived from the wood flow assumptions in the Australian Government's HWP model (Jaakko Pöyry, 1999; Australian Government, 2012), and from ABARES (2012a; 2012b), Tucker et al., (2009) and Burns et al., (2009). The log data used in the model were obtained from the Forest Products Commission (WAFPC, 2011) and ABARES (ABARES, 2012a; 2012b). As in the Australian Government's FM reference level, it was assumed for the purposes of the reference scenario that wood production from the FMP forests remains constant at 2008 levels over the projection period.

No harvest scenario

The method used to generate the no harvest scenario was the same as that applied for the reference scenario, only with adjusted harvest and wood production projections. To estimate the carbon stock changes in the live biomass and debris pools, the 54 representative harvest plots used in the reference scenario were replicated and the harvest events removed. The areas allocated to each representative no harvest plot were the same as those allocated to the corresponding harvest plot (i.e. the modelled estate covered the same area in the reference and no harvest scenarios).

To project carbon stock changes in the HWP pool, the simplified wood flow model and IPCC first-order decay function were used with modified wood supply estimates. For the period up to 2011, data on actual log production were obtained from the annual reports of the Forest Products Commission (WAFPC, 2011). Log production in 2012 was assumed to be the same as in 2011 and, for the period 2013-2032, it was assumed that log production was zero.

There is the potential for the cessation of harvesting in the FMP forests to result in 'leakage', or the transfer of wood production to other areas, both in Australia and overseas. Any

[14] FCCC/KP/AWG/2010/18/Add.1.

[15] Eggleston et al. (2006), Vol 4, Chpt 12, Equation 12.1 (p 12.11).

leakage to forests in other countries is irrelevant for current purposes because it will have no impact on the FM credits that are recorded in Australia's greenhouse accounts. In contrast, leakage within Australia will reduce the FM credits that are recorded in Australia's accounts and thereby reduce the benefits associated with the project. Another possibility is that the exclusion of harvesting from the FMP forests could prompt increased reforestation as the forestry sector looks for alternative sources of long-term wood supply. This form of leakage would increase recorded LULUCF credits.

Projecting the likely rate of leakage within Australia is difficult. The capacity to increase log removals in multiple use public native forests and private native forests differs between jurisdictions because of resource constraints, state regulations and commitments under the Regional Forest Agreements. There may also be community resistance to any plans to increase the intensity of harvesting in native forests in response to the cessation of harvesting in Western Australia's multiple use public native forests. How these resource, regulatory and political factors might interact to facilitate or constrain leakage is unclear. Due to this, the no harvest scenario was split into two sub-scenarios on the basis of two assumptions. In the first, it was assumed that the creation of the reserves does not result in any leakage within Australia ('no harvest (no leakage)'). In the second, it was assumed that the net effect of leakage within Australia is to reduce the FM credits associated with the reserves by 5% ('no harvest (leakage)'). The choice of 5% was influenced by the fact that the project would cover WA's entire public native forest estate and the capacity to increase production in WA's private native forests is limited.

FM method 2

FM method 1 has several limitations. Most notably, a number of the representative harvest plots included in the model are intended to reflect the forests and silvicultural practices in other jurisdictions. The method also uses an 'artificial' harvest area based on log production. In effect, rather than modelling the forests and practices in Western Australia, FM method 1 provides an averaged national estimate of the FM credits that would be generated by reducing broadleaved roundwood removals by 492,000 m^3 (i.e. the mean roundwood removals from Western Australian multiple use public native forests over the period 2002-2009). To remedy this, FM method 2 was devised using the representative harvest plots from the Australian Government's model that reflect the forest types and silvicultural practices in Western Australia.

FM method 2 applied the same approach as described for FM method 1 using a subgroup of 20 of the original 54 representative plot files to estimate carbon stock changes in the live biomass and debris pools. These 20 files, and the areas allocated to them, are shown in Table 3. Broadly, the medium dense eucalypt forest (MDEF) and medium sparse eucalypt forest (MSEF) plots were assumed to reflect jarrah/wandoo forests, while the tall dense eucalypt forest (TDEF) plots were assume to represent karri forests. The areas allocated to the 20 selected representative plot files were derived using the mean area assigned to them in the Australian Government's model over the period 2002-2009. For plots that were not specific to Western Australia, the area was assigned on a pro rata basis using adjusted actual mean harvest areas (Australian Government, 2012; Forests NSW, 2011).[16]

[16] Harvest areas were adjusted to account for the fact that New South Wales and Victoria report harvest areas on a net basis, while all other jurisdictions, including Western Australia, report on a gross basis.

Table 3: FM method 2 – representative harvest plot files and assumed harvest area (ha yr^{-1}) in the FM reference scenario

Plot name	Area
MDEF 31-100 PH PW WA NSW.plo	134
MDEF 31-100 PH PW WA.plo	122
MDEF mature PH PW WA NSW .plo	268
MDEF mature PH PW WA.plo	245
MDEF senescent PH PW WA NSW.plo	134
MDEF senescent PH PW WA.plo	122
MDEF three aged PH PW WA NSW.plo	536
MDEF three aged PH PW WA.plo	489
MDEF unknown age PH PW WA NSW.plo	1608
MDEF unknown age PH PW WA.plo	1467
MSEF PH NPW.plo	3131
MSEF senescent PH NPW.plo	783
TDEF 31-100 CF PW.plo	30
TDEF 31-100 PH PW WA.plo	54
TDEF mature CF PW.plo	15
TDEF mature PH PW WA.plo	27
TDEF senescent CF PW.plo	15
TDEF senescent PH PW WA.plo	27
TDEF unknown age CF PW.plo	238
TDEF unknown age PH PW WA.plo	430
Total area (ha yr^{-1})	**9874**

ACCUs method

To estimate the Kyoto ACCUs that could be generated from the proposed avoided native forest harvesting project, two additional scenarios were developed:

- CFI baseline scenario, which is an approximation of the baseline that would apply under the CFI Act; and
- CFI no harvest scenario, which provides the basis on which to estimate the project's net sequestration number under the CFI Act.

There are a number of challenges associated with deriving these scenarios. Most significantly, there is currently no methodology for avoided native forest harvesting projects and no guidance on the approach that the Government might follow for these purposes. To account for this, three different methods were used to derive the CFI baseline and no harvest scenarios: CFI methods 1, 2 and 3. The purpose of using the three methods was to provide a crude sensitivity analysis, which would provide some insight into the extent of uncertainty surrounding the ACCU results.

CFI method 1

CFI baseline scenario

The method used to estimate carbon stock changes in the live biomass and debris pools in the CFI baseline scenario under CFI method 1 was a replica of that employed in the FM reference scenario in section 3.2.2 (FM method 1). The only difference was that an alternative harvest area was used for both scenarios. Under the CFI, the baseline should represent the net emissions from the project area in the absence of the project. This was derived on the basis of the percentage change in the mean allowable cut under the FMP. Under scenario 1 in the draft 2014-2023 FMP, there is a 17% increase in the total allowable cut compared to the 2004-2013 FMP. On this basis, it was assumed there would be a 17% increase in the harvest area over the projection period compared to the assumed mean over the period 2004-2009 (5468 ha yr^{-1}).[17] This provided a total harvest area under the CFI baseline of 6403 ha yr^{-1}. The area was then allocated to the 54 representative no harvest plots in proportion to the areas used by the Australian Government to project carbon stock changes in the live biomass and debris pools over the period 2004-2009.

To project carbon stock changes in the HWP pool, the simplified wood flow model and IPCC first-order decay function were used. The log data for the period 1990-2011 were obtained from the Forest Products Commission (WAFPC, 2011) and ABARES (ABARES, 2012a; 2012b). For 2012 and 2013, log production was assumed to be the mean over the period 2009-2011. For the period 2014-2032, log production was derived by multiplying the mean from 2004 to 2011 by the percentage change in the allowable cut under scenario 1 in the 2014-2023 FMP (i.e. a 2% reduction in 1st and 2nd grade karri and jarrah logs and a 21% increase in other bole volume production).

CFI no harvest scenario

The CFI no harvest scenario was developed using the same method as that described for the FM no harvest scenario in section 3.2.2. Again, two sub-scenarios were used to account for leakage, one with zero leakage (‘CFI no harvest (no leakage)’) and another than assumes 5% leakage (‘CFI no harvest (leakage)’). It should be emphasised that these are arbitrary leakage assumptions and that the leakage deduction applied under the CFI could be more or less than 5%.

To estimate the Kyoto ACCUs from the project, net emissions under the CFI no harvest scenario were deducted from the net emissions in the CFI baseline scenario. A 5% risk of reversal buffer was then applied to the results. In the CFI no harvest (leakage) scenario, the 5% leakage deduction was also applied.

CFI method 2

CFI method 2 was a mirror of FM method 2, only different harvest areas and log volumes were used to estimate carbon stock changes in the live biomass, debris and HWP pools under the baseline and no harvest scenarios.

[17] This assumed mean harvest area was derived using the same method as described in FM method 1, with the exception that the period was confined to 2004-2009 so as to better reflect the practices under the existing FMP.

CFI baseline scenario

The total harvest area in the baseline scenario was derived by multiplying the mean jarrah and karri harvest areas for the period 2004 to 2010 (i.e. the current FMP period for which data were available) by the projected percentage increase in total log volumes under scenario 1 in the 2014-2023 FMP (i.e. 17%). The resulting assumed total harvest area, by forest type, is shown in Table 4.

Table 4: Jarrah and karri actual and assumed harvest area (ha yr^{-1})

Year	Jarrah*	Karri	Total
2004	8,860	1,250	10,110
2005	6,250	1,530	7,780
2006	8,838	1,490	10,328
2007	7,264	1,546	8,810
2008	6,619	1,008	7,627
2009	9,087	1,571	10,658
2010	4,555	1,583	6,138
Total	51,473	9,978	61,451
Mean	7,353	1,425	8,779
Assumed harvest area (ha yr^{-1})	8,610	1,669	10,280

* Includes mixes jarrah/karri and jarrah/wandoo.

Source: WAFPC (2011); CCWA (2012).

Having derived the total harvest area (10,280 ha yr^{-1}), it was allocated between the 20 representative harvest plot files in proportion to the areas used in FM method 2. The resulting allocation is shown in Table 5. The carbon stock changes in HWP pool were estimated using the same approach as described in CFI method 1.

Table 5: CFI method 2 – representative harvest plot files and assumed harvest area (ha yr^{-1}) in the CFI baseline scenario

Plot name	Area	Plot name	Area
MDEF 31-100 PH PW WA NSW.plo	128	MSEF PH NPW.plo	2982
MDEF 31-100 PH PW WA.plo	116	MSEF senescent PH NPW.plo	746
MDEF mature PH PW WA NSW .plo	255	TDEF 31-100 CF PW.plo	59
MDEF mature PH PW WA.plo	233	TDEF 31-100 PH PW WA.plo	107
MDEF senescent PH PW WA NSW.plo	128	TDEF mature CF PW.plo	30
MDEF senescent PH PW WA.plo	116	TDEF mature PH PW WA.plo	54
MDEF three aged PH PW WA NSW.plo	511	TDEF senescent CF PW.plo	30
MDEF three aged PH PW WA.plo	466	TDEF senescent PH PW WA.plo	54
MDEF unknown age PH PW WA NSW.plo	1532	TDEF unknown age CF PW.plo	476
MDEF unknown age PH PW WA.plo	1397	TDEF unknown age PH PW WA.plo	859
Total area (ha yr^{-1})			**10,280**

CFI no harvest scenario

As in FM method 2, to estimate the carbon stock changes in the live biomass and debris pools under the CFI no harvest scenario, the representative harvest plots used in the baseline scenario were replicated and the harvest events removed. The areas allocated to each representative no harvest plot were the same as those allocated to the corresponding harvest plot. The same approach to leakage was also adopted: two sub-scenarios, one with zero leakage ('CFI no harvest (no leakage)'), the other with 5% leakage ('CFI no harvest (leakage)'). Similarly, the stock changes in the HWP pool were estimated using the same approach as in CFI method 1, under which log production was assumed to be zero over the period 2013-2032.

CFI method 3

As discussed, there is a reasonable prospect that the Australian Government will revise the methods it uses to account for FM. The Government has indicated that its ultimate objective is to establish a spatially-explicit Tier 3 FM accounting system (Australian Government, 2012). The move toward this system is likely to take place in stages, with refinements being made to the existing Tier 2 methods as a precursor to the shift to Tier 3. This process of evolution has already commenced, as evidenced by the improvements that have been made in the Government's Tier 2 methods since 2007. One potential near-term improvement is the incorporation of more jurisdiction-specific data on forest types and silvicultural practices. This would improve the accuracy of the FM-related emissions and removals in each state and territory.

Any notable changes in the Australian Government's FM accounting methods are likely to lead to corresponding changes in the methodologies used for FM projects under the CFI Act.

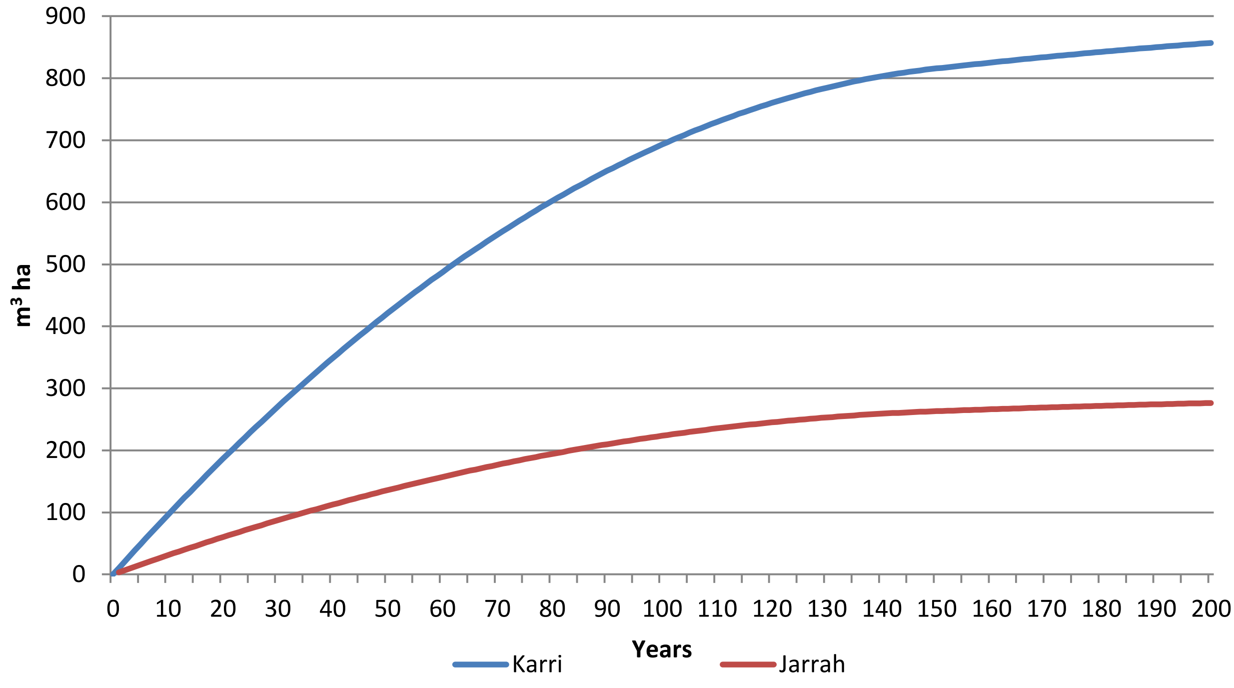
This is a product of the statutory requirement that methodologies 'not be inconsistent with the methods set out in the National Inventory Report'.[18]

CFI methods 1 and 2 are consistent with the Australian Government's current practices. However, due to the Government's intent to revise its FM accounting system, there is a risk that these methods may soon be out-dated. CFI method 3 was intended to account for this risk by providing an approach based on data that potentially better reflect the forest types and silvicultural practices in Western Australia. Consistent with the requirement in s 133(1)(g) of the CFI Act, the method is based on conservative assumptions about the carbon stores in the FMP forests and the impacts of harvest events.

CFI method 3 uses a similar modelling framework to methods 1 and 2. A CFI baseline and CFI no harvest scenario were devised for the purpose of estimating the potential credits. Similarly, carbon stock changes in the live biomass and debris pools were again modelled using the Tier 2 capabilities of *FullCAM*, and carbon stock changes in the HWP pool were modelled using the simplified wood flow model and IPCC first-order decay function.[19] The primary difference between the methods relate to the representative harvest and no-harvest plot files that were used to estimate carbon stock changes in the live biomass and debris pools.

Two new representative base plot files were constructed for the baseline and no harvest scenarios: one for karri forests, one for jarrah. Using data published by the WA Department of Environment & Conservation (WADEC, 2012) and Conservation Commission of Western Australia (CCWA, 2012), and information from Eamus et al., (2000) and Hingston et al. (1979; 1980), average bole volume yield curves were devised for these forest types. This was initially undertaken assuming no stem mortality. The resulting (no mortality) cumulative yield curves are provided in Figure 2.

Figure 2: Bole volume yield curves (no mortality) for karri and jarrah forests, cubic metres per hectare

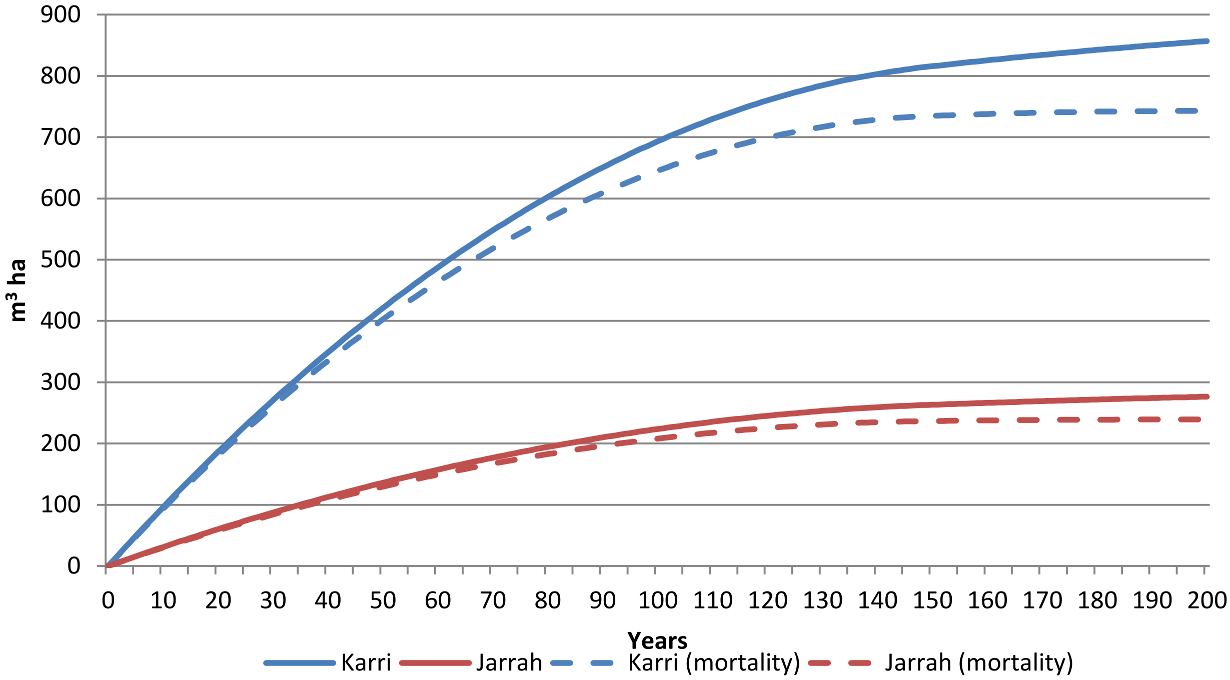


[18] CFI Act, s 133(1)(c).

[19] The soil carbon pool was excluded.

The 'no mortality' yield curves shown in Figure 2 were adjusted to account for mortality. Due to time and resources constraints, and limitations of *FullCAM*,[20] mortality was modelled using a single annual mortality rate (0.087% yr^{-1}). This rate was selected to ensure consistency with mortality data concerning karri forests published by the Department of Environment & Conservation (WADEC, 2012). The resulting 'mortality' yield curves are shown in Figure 3. Future research is required to incorporate a more appropriate variable annual mortality rate that better reflects actual forest dynamics.

Figure 3: Bole volume yield curves (no mortality and mortality) for karri and jarrah forests, cubic metres per hectare



The mortality bole volume yield curves shown in Figure 3 provided the above-ground mass increment data used in *FullCAM*. Basic density was assumed to be 695 kg m^3 for karri and 658 kg m^3 for jarrah, consistent with WADEC (2012). The yield allocations, carbon content, turnover rates, resistant/decomposable percentages and debris pool breakdown percentages for karri and jarrah forests were assumed to be the same as those in the Australian Government's TDEF and MDEF plot files respectively.

Mortality was modelled within *FullCAM* using the model's thin event function. For each plot, it was assumed that, at the end of every year, a thin event occurred that affected 0.087% of the forest. In each representative thin event, all of the affected stem, branch, bark, leave, and root biomass was allocated to the corresponding onsite debris pool.

Having constructed the base karri and jarrah plots, silviculture event and age class data were incorporated. To model silviculture events, gross harvest area and harvest type data were obtained from the draft FMP (CCWA, 2012) and Western Australian Forest Products Commission for the period 2001-2010 (WAFPC, 2011). Using these data, the reported gross harvest areas for each forest type were allocated to silviculture event types using the averages from the 2001-2010 period. The results are shown in Table 6.

[20] *FullCAM* includes a mortality function. However, it does not transfer the biomass lost in mortality events to the debris pools.

Table 6: Assumed mean gross harvest areas, by forest type and silvicultural practice, 2004-2010

	Jarrah		Karri	
Silviculture practice	**Thin, single tree and selective cut**	**Gap creation and shelterwood**	**Clearfell and partial clear**	**Commercial thin**
Mean	3677	3677	438	987

Source: WAFPC (2011); CCWA (2012).

Having obtained the mean gross harvest areas, these data were converted to net harvest areas. For jarrah forests, the thin, single tree selection and selective cut events were assumed to affect between 10-30% of the forest area, while gap creation and shelterwood harvest events were assumed to affect between 40-60% of the forest area. For karri, the reported clearfell and partial clear events were assumed to affect 70% of the forest area. Commercial thin events in karri forests were assumed to affect 20% of the forest area. The resulting assumed net harvest area equivalents are provided in Table 7.

Table 7: Assumed mean net harvest areas, by forest type and silvicultural practice, 2004-2010

	Jarrah						Karri	
Silviculture practice	**Thin, single tree and selective cut**			**Gap creation and shelterwood**			**Clearfell and partial clear**	**Commercial thin**
Affected area (%)	10%	20%	30%	40%	50%	60%	70%	20%
Mean	92	368	276	368	919	551	307	197

Source: WAFPC (2011); CCWA (2012); Australian Government (2012).

By converting the gross harvest areas to net equivalents, it allowed all harvest events to be modelled in *FullCAM* on a net basis, where 100% of the modelled plot area was assumed to be affected by each harvest event. To obtain the assumed total net harvest area over the projection period, the percentage increase in the total allowable cut under scenario 1 from the 2004-2013 FMP was used (17%). The mean net harvest area from Table 7 (3078 ha yr^{-1}) was multiplied by 1.17, providing an assumed net harvest area for the projection period of 3604 ha yr^{-1}. The resulting assumed harvest areas under the CFI baseline scenario, by forest type and silviculture practice, are shown in Table 8. In all modelled harvest events, it was assumed that 30% of stem biomass is allocated to deadwood, with the remaining 70% taken off site as saw, pulp and other logs. All branch, bark, leaf and root biomass is assumed to remain on site.

Table 8: CFI baseline scenario, assumed net harvest areas, by forest type and silvicultural practice, 2013-2032

	Jarrah		Karri	
Silviculture practice	**Thin, single tree and selective cut**	**Gap creation and shelterwood**	**Clearfell and partial clear**	**Commercial thin**
Mean	861	2153	359	231

No reliable data were available on the age class of the FMP forests that are likely to be harvested under the draft FMP. To account for this, the following assumptions on age class were adopted on the basis of information in the draft FMP (CCWA, 2012):

- thin, single tree selection and selective cut events occur in jarrah forests aged between 20 and 80 years;
- gap creation and shelterwood harvest events occur in jarrah forests aged between 30 and 200 years;
- thin events occur in karri forests aged between 20 and 80 years; and
- clearfell and partial cut events occur in karri forests aged between 80 and 150 years.

The assumed net harvest areas shown in Table 8 for each forest type were allocated over the assumed harvest age periods using the Gaussian function:

$$f(x;\mu,\sigma^2) = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

Where x is the forest age, μ is the mean age, and σ is the standard deviation. For each forest type/silvicultural combination, the mean (μ) was assumed to be the same as the median of the age range. The standard deviation (σ) was assumed to be 16 for the 20-80 years forests and 80-150 year forests, and 30 for the 30-200 year forests. The resulting age distributions of the forests subject to harvest in the CFI baseline scenario are shown in Figures 4 and 5.

Figure 4: Age class distribution of jarrah forests subject to harvest in the CFI baseline scenario

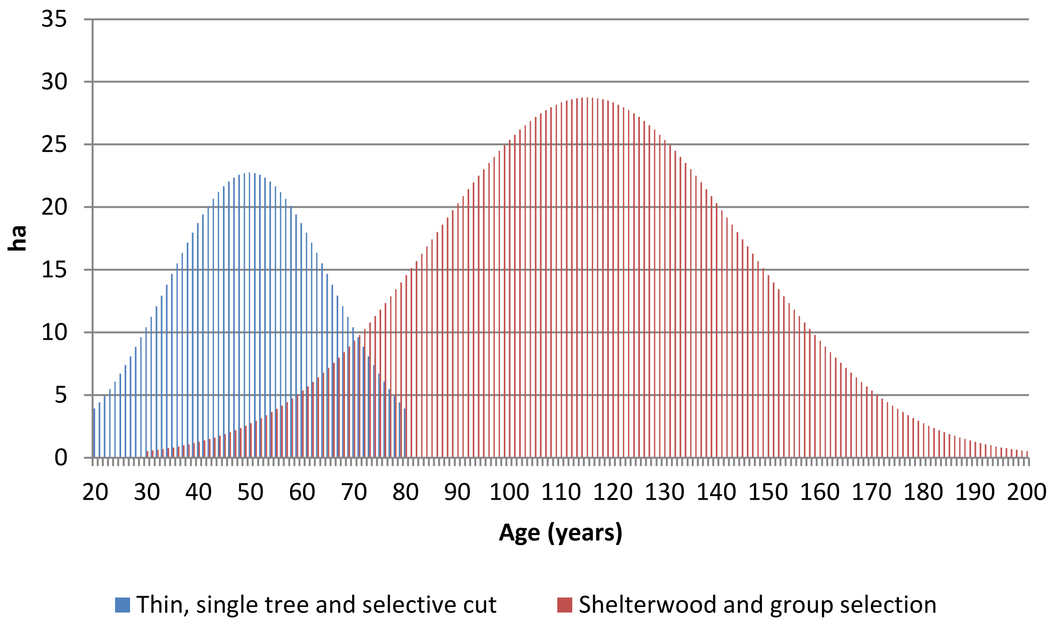
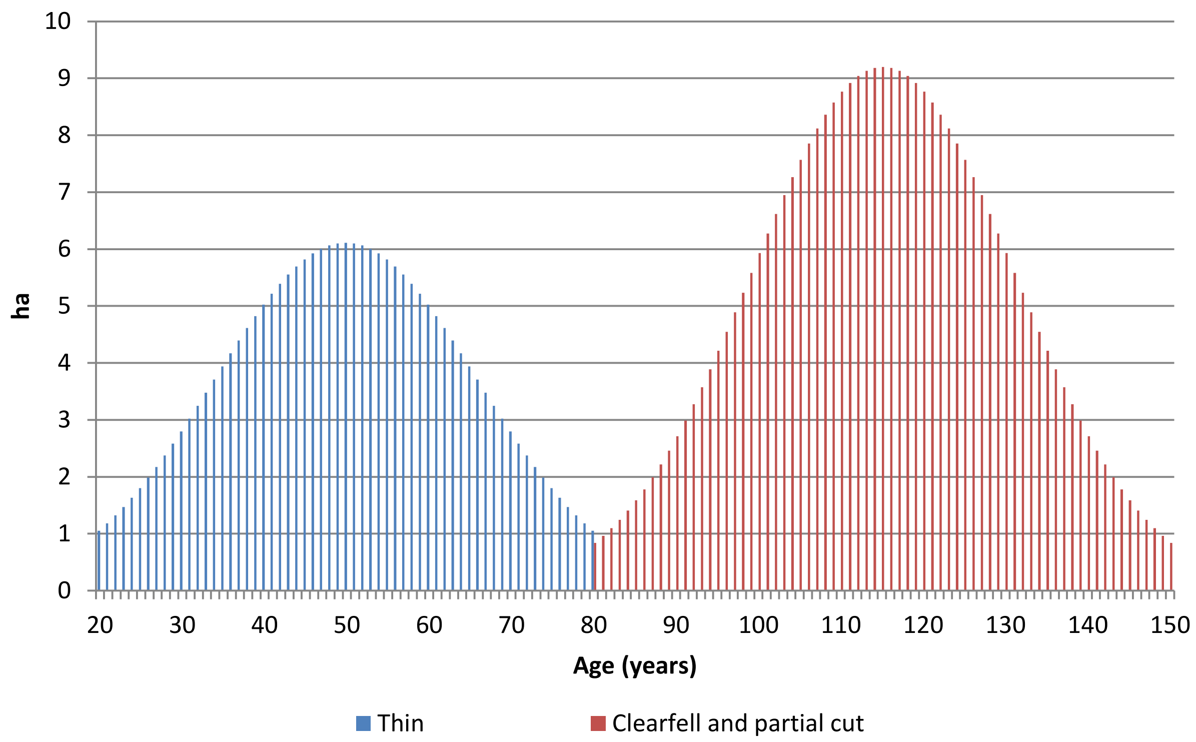


Figure 5: Age class distribution of karri forests subject to harvest in the CFI baseline scenario



The combination of age class and forest type assumptions provided a total of 312 representative plot files: 181 jarrah plots and 131 karri plots. The plots were assumed to form part of a single estate and the carbon stock changes on the estate were modelled over the period 2013-2032 using the individual plot timing. The use of plot timing ensured the age distribution of the forests remained static throughout the projection period.

As with the other methods, the impacts of wildfires were not modelled (i.e. they were assumed to be the same in the baseline and no harvest scenarios). Again, the method used to devise the CFI no harvest scenario was the same as that for the baseline scenario, only with the harvest events removed.

4 Carbon credit results

FM results

The FM credits generated by the project using FM method 1 are shown in Table 9. The results for FM method 2 are shown in Table 10.

The results suggest that, on average, the cessation of harvesting in the FMP forests would lead to the generation of between 2.2 and 2.4 million FM credits per year over the period 2013-2032.

A notable aspect of the results is that FM method 2, which involves the use of plots that reflect WA forest types, produces higher credit numbers over the projection period (45.8-48.2 million compared to 44.6-47 million) and a greater range of annual credits (1.26-2.93 million yr^{-1} compared to 1.48-2.64 million yr^{-1}) than FM method 1.

Table 9: *FM method 1*: annual FM credits under the no harvest (no leakage) and no harvest (leakage) scenarios, millions, 2013-2032

	No harvest (no leakage)	No harvest (leakage)
2013	1.56	1.48
2014	1.81	1.72
2015	1.98	1.88
2016	2.10	1.99
2017	2.19	2.08
2018	2.27	2.16
2019	2.33	2.22
2020	2.36	2.25
2021	2.39	2.27
2022	2.42	2.30
2023	2.45	2.33
2024	2.48	2.35
2025	2.51	2.38
2026	2.53	2.41
2027	2.56	2.43
2028	2.58	2.45
2029	2.60	2.47
2030	2.61	2.48
2031	2.62	2.49
2032	2.64	2.50
Total	**47.0**	**44.6**
Mean	**2.3**	**2.2**

Table 10: *FM method 2*: annual FM credits under the no harvest (no leakage) and no harvest (leakage) scenarios, millions, 2013-2032

	No harvest (no leakage)	No harvest (leakage)
2013	1.33	1.26
2014	1.63	1.55
2015	1.83	1.74
2016	1.98	1.88
2017	2.11	2.00
2018	2.21	2.10
2019	2.30	2.18
2020	2.36	2.25
2021	2.43	2.31
2022	2.49	2.37
2023	2.55	2.42
2024	2.60	2.47
2025	2.65	2.52
2026	2.70	2.57
2027	2.74	2.61
2028	2.79	2.65
2029	2.83	2.68
2030	2.86	2.72
2031	2.89	2.75
2032	2.93	2.78
Total	**48.2**	**45.8**
Mean	**2.4**	**2.3**

Kyoto ACCU results

The estimated Kyoto ACCUs from the project under CFI methods 1, 2 and 3 are provided in Tables 11, 12 and 13. The results suggest that, on average, the cessation of harvesting in the FMP forests would lead to the generation of between 1.8 and 2.9 million ACCUs per year over the period 2013-2032.

Table 11: *CFI method 1*: Kyoto ACCUs under the CFI no harvest (no leakage) and CFI no harvest (leakage) scenarios, millions, 2013-2032

	No harvest (no leakage)	No harvest (leakage)
2013	1.73	1.64
2014	1.95	1.86
2015	2.13	2.03
2016	2.26	2.15
2017	2.36	2.25
2018	2.45	2.32
2019	2.51	2.39
2020	2.55	2.42
2021	2.57	2.45
2022	2.61	2.48
2023	2.63	2.50
2024	2.66	2.53
2025	2.69	2.56
2026	2.72	2.59
2027	2.75	2.61
2028	2.77	2.63
2029	2.79	2.65
2030	2.80	2.66
2031	2.81	2.67
2032	2.83	2.68
Total	**50.6**	**48.1**
Mean	**2.5**	**2.4**

Table 12: *CFI method 2*: Kyoto ACCUs under the CFI no harvest (no leakage) and CFI no harvest (leakage) scenarios, millions, 2013-2032

	No harvest (no leakage)	No harvest (leakage)
2013	1.79	1.70
2014	2.07	1.97
2015	2.30	2.19
2016	2.47	2.35
2017	2.60	2.47
2018	2.71	2.58
2019	2.81	2.67
2020	2.87	2.73
2021	2.94	2.79
2022	3.00	2.85
2023	3.06	2.90
2024	3.11	2.96
2025	3.16	3.00
2026	3.21	3.05
2027	3.26	3.09
2028	3.30	3.13
2029	3.34	3.17
2030	3.37	3.20
2031	3.40	3.23
2032	3.43	3.26
Total	**58.2**	**55.3**
Mean	**2.9**	**2.8**

Table 13: *CFI method 3*: Kyoto ACCUs under the CFI no harvest (no leakage) and CFI no harvest (leakage) scenarios, millions, 2013-2032

	No harvest (no leakage)	No harvest (leakage)
2013	1.56	1.48
2014	1.66	1.58
2015	1.77	1.68
2016	1.84	1.75
2017	1.89	1.79
2018	1.92	1.83
2019	1.95	1.85
2020	1.97	1.87
2021	1.98	1.88
2022	1.99	1.89
2023	1.99	1.89
2024	2.00	1.90
2025	2.00	1.90
2026	2.00	1.90
2027	1.99	1.89
2028	1.99	1.89
2029	1.98	1.88
2030	1.98	1.88
2031	1.97	1.87
2032	1.96	1.86
Total	**38.4**	**36.5**
Mean	**1.9**	**1.8**

The ACCUs generated under CFI methods 1 and 2 are higher than the corresponding FM results. This is due to the fact that the CFI baseline scenario assumes a higher rate of log removals and greater harvest area than the FM reference scenario. The FM reference scenario is based on the mean harvest area over the period 2002-2009. In contrast, the CFI baseline scenario is based on the planned maximum allowable cut under scenario 1 in the draft FMP, which is 17% higher than that allowed under the existing FMP. At present, it is unclear how the Australian Government will deal with avoided native forest harvesting projects involving baseline harvesting scenarios that are above the 2002-2009 mean (this is particularly problematic for projects involving multiple use public native forests). There is the potential for the Government to dictate that baselines must be based on the mean harvest rate over the period 2002-2009 (i.e. to ensure consistency with the methods in the National Inventory Report). This would reduce the ACCUs available for a project involving the FMP forests. An alternative solution would be for the Australian Government to modify its FM reference level to account for harvesting operations in native forests under existing policy settings. An issue facing the Australian Government is that state forest agencies may be tempted to artificially inflate their harvesting projections to increase the capacity to generate ACCUs.

The other notable feature of the results is the extent of the differences under the three methods: the average annual number of ACCUs projected under CFI method 2 over the period 2013-2032 is 2.8-2.9 million yr^{-1}, compared to 1.8-1.9 million yr^{-1} under CFI method 3. CFI method 1 produces results that are roughly in the middle of those from methods 2 and 3 (2.4-2.5 million yr^{-1}). There are multiple reasons for the differences, including that the jarrah plots in CFI method 3 have significantly lower growth rates than the MDEF plots from the Australian Government's model, CFI methods 1 and 2 have a higher mean forest age at the date of harvest than in method 3, and the Australian Government's model assumes that harvesting occurs in old growth (200 year old senescent) forests whereas method 3 does not.[21]

Despite the limitations of the Australian Government's model, and corresponding issues with CFI methods 1 and 2, CFI method 3 should not be viewed as providing the most reliable credit projections. In constructing the baseline and no harvest scenarios in CFI method 3, a number of assumptions were required to be made that may not reflect the carbon dynamics or forest practices in the FMP forests. It is also unclear when and how the Australian Government will modify its FM accounting methods. Until there is a change in the Australian Government's methods, CFI methods 1 and 2 arguably provide the best estimate of the carbon credits that could be generated by stopping harvesting in public native forests.

Although the FM methods contained in the *National Inventory Report* set the boundaries for those used under the CFI Act, if there is a desire to progress the proposed project, it would be worthwhile refining CFI method 3 (or constructing an alternative). Additional information required for these purposes includes:

- better data on bole volume yields in the FMP forests;
- data on the age distribution of FMP forests subject to harvest (by forest type and silviculture practice);
- data on net harvest areas (by forest type and silviculture practice);
- data on the proportion of stems effected by harvest events that are left on the forest floor (or burnt);
- better data on tree mortality in FMP forests (and more resources to better calibrate *FullCAM* to account for tree mortality);
- better data on the debris pool in Western Australian forests (coarse woody debris, litter and snags by forest type, age and disturbance history); and
- better data on the impacts of climate change and disease on growth rates, mortality and harvest rates in the FMP forests.

Readers should also note that none of the methods used here account for the impacts of wildfire. This is due to the natural disturbance rule agreed at the Durban Climate Conference in December 2011. How the Durban rule might be incorporated into the CFI is unclear. There is also considerable uncertainty surrounding the project boundaries, crediting periods and methods that might be used for avoided native forest harvesting projects. If (or when) the Australian Government provides additional information on these issues, it will be necessary to update the ACCU projections.

[21] The harvesting of old growth forests in Western Australia was phased out by the Gallop Labor Government in the early 2000s.

5 The potential financial value of the Kyoto ACCUs

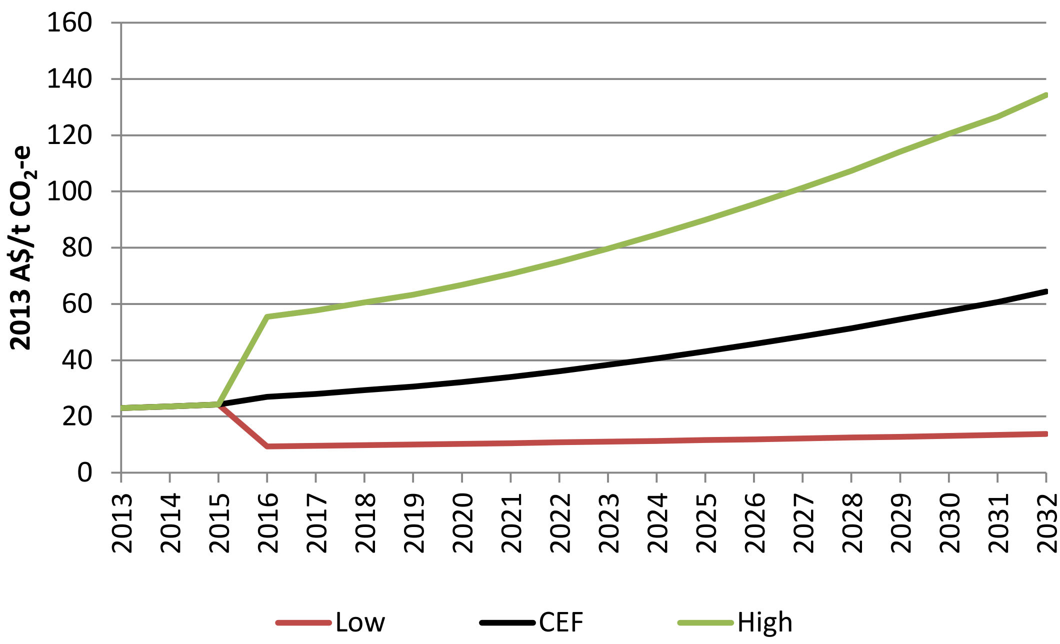
Method

In estimating the financial value of the ACCUs, the following key assumptions were adopted:

- All Kyoto ACCUs associated with the project are sold into domestic or international compliance markets in the year of generation (i.e. they are not banked, nor are they affected by the 5% cap on ACCUs under the CE Act).
- The Kyoto/non-Kyoto status of the ACCUs issued in relation to the project is not affected by the 3.5% cap on forest management credits under KP2.
- The Kyoto ACCU price follows one of three paths:
  - the Clean Energy Future price path from the Australian Treasury's *Strong Growth, Low Pollution* report (Australian Treasury, 2011);
  - a low price path, where the carbon price follows the Clean Energy Future (CEF) path until the end of 2014-15, falls to $10 (nominal) in 2015-16 and then grows at 2.5% real through to 2031-32; or
  - a high price path, where the carbon price follows the Clean Energy Future path until the end of 2014-15 and then follows the *Strong Growth, Low Pollution* report's high price path through to 2031-32.

These three price paths are shown in Figure 6 below.

Figure 6: Clean Energy Future, Low and High carbon price scenarios, real 2013 $A/t CO_2-e



Source: Australian Treasury (2011) and author estimates.

To calculate the net present value (NPV) of the revenues from the credits, a social time preference rate of 2.7% was used, based on a pure time preference rate of 1.5% (including catastrophic risk), an elasticity of marginal utility of consumption of 1 and a per capita consumption growth rate of 1.2% for the projection period.[22] The choice of social time preference rate is a controversial issue and one that has been subject to extensive debate within the economic and environmental literature.[23] The rate chosen here is the author's preference but there are valid reasons for using higher or lower alternatives. The use of a higher (lower) social time preference rate would decrease (increase) the net present value estimates.

Results

The estimated annual value and NPV (2013 A$) of the Kyoto ACCUs generated from the project under CFI methods 1, 2 and 3, using the low, CEF and high price paths, are shown in Tables 14, 15 and 16.

Under the leakage scenarios, the NPV (2013 A$) of the projected ACCUs over the period 2013-2032 is between $376 million and $3,348 million ($396 million to $3,524 million without leakage). The annual value of the ACCUs in the leakage scenarios ranges between $16 million and $438 million (2013 A$) ($17 million to $461 million in the no leakage scenarios).

[22] The pure time preference rate and elasticity of marginal utility of consumption were taken from the HM Treasury *Green Book* (HM Treasury, 2003). The per capita consumption growth rate was taken from the *Strong Growth, Low Pollution* report's Clean Energy Future scenario (Chart 5.38) (Australian Treasury, 2011).

[23] Feldstein (1964); Olson and Bailey (1981); Lind (1982); Cline (1992; 1993); Birdsall and Steer (1993); Weitzman (1994); Portney and Weyant (1999); Nordhaus and Boyer (2000); Pearce (2003); Tol and Yohe (2006); Stern (2007); Weitzman (2007); Nordhaus (2007); Dietz and Stern (2008).

Table 14: *CFI method 1*: Annual value and net present value of ACCUs (2013 A$ million)

	No harvest (no leakage)				No harvest (leakage)			
	Credits	Price scenario			Credits	Price scenario		
		Low	CEF	High		Low	CEF	High
2013	1.73	$40	$40	$40	1.64	$38	$38	$38
2014	1.95	$46	$46	$46	1.86	$44	$44	$44
2015	2.13	$52	$52	$52	2.03	$49	$49	$49
2016	2.26	$21	$61	$126	2.15	$20	$58	$119
2017	2.36	$23	$66	$136	2.25	$21	$63	$130
2018	2.45	$24	$72	$148	2.32	$23	$68	$141
2019	2.51	$25	$77	$159	2.39	$24	$73	$151
2020	2.55	$26	$82	$170	2.42	$25	$78	$162
2021	2.57	$27	$88	$182	2.45	$26	$83	$173
2022	2.61	$28	$94	$196	2.48	$27	$90	$186
2023	2.63	$29	$101	$210	2.50	$28	$96	$199
2024	2.66	$30	$108	$225	2.53	$29	$103	$214
2025	2.69	$31	$116	$242	2.56	$30	$110	$230
2026	2.72	$32	$125	$260	2.59	$31	$118	$247
2027	2.75	$33	$133	$278	2.61	$32	$127	$264
2028	2.77	$35	$142	$297	2.63	$33	$135	$282
2029	2.79	$36	$152	$318	2.65	$34	$145	$302
2030	2.80	$37	$161	$337	2.66	$35	$153	$320
2031	2.81	$38	$171	$356	2.67	$36	$162	$338
2032	2.83	$39	$182	$379	2.68	$37	$173	$360
Total	**50.6**	**$651**	**$2,069**	**$4,158**	**48.1**	**$619**	**$1,966**	**$3,950**
NPV		**$511**	**$1,526**	**$3,030**		**$486**	**$1,450**	**$2,879**

Table 14: *CFI method 2*: Annual value and net present value of ACCUs (2013 A$ million)

	No harvest (no leakage)				No harvest (leakage)			
	Credits	Price scenario			Credits	Price scenario		
		Low	CEF	High		Low	CEF	High
2013	1.79	$41	$41	$41	1.70	$39	$39	$39
2014	2.07	$49	$49	$49	1.97	$46	$46	$46
2015	2.30	$56	$56	$56	2.19	$53	$53	$53
2016	2.47	$23	$67	$137	2.35	$22	$63	$130
2017	2.60	$25	$73	$150	2.47	$24	$69	$143
2018	2.71	$26	$80	$164	2.58	$25	$76	$156
2019	2.81	$28	$86	$178	2.67	$27	$82	$169
2020	2.87	$29	$92	$192	2.73	$28	$88	$182
2021	2.94	$31	$100	$208	2.79	$29	$95	$197
2022	3.00	$32	$109	$225	2.85	$31	$103	$214
2023	3.06	$34	$117	$244	2.90	$32	$111	$231
2024	3.11	$35	$126	$263	2.96	$33	$120	$250
2025	3.16	$37	$136	$284	3.00	$35	$130	$270
2026	3.21	$38	$147	$307	3.05	$36	$140	$291
2027	3.26	$40	$158	$330	3.09	$38	$150	$313
2028	3.30	$41	$169	$354	3.13	$39	$161	$336
2029	3.34	$43	$182	$381	3.17	$41	$173	$362
2030	3.37	$44	$194	$406	3.20	$42	$184	$385
2031	3.40	$46	$206	$430	3.23	$43	$196	$409
2032	3.43	$47	$221	$461	3.26	$45	$210	$438
Total	**58.2**	**$745**	**$2,410**	**$4,859**	**55.3**	**$708**	**$2,289**	**$4,616**
NPV		**$580**	**$1,767**	**$3,524**		**$551**	**$1,679**	**$3,348**

Table 14: *CFI method 3*: Annual value and net present value of ACCUs (2013 A$ million)

	No harvest (no leakage)				No harvest (leakage)			
	Credits	Price scenario			Credits	Price scenario		
		Low	CEF	High		Low	CEF	High
2013	1.56	$36	$36	$36	1.48	$34	$34	$34
2014	1.66	$39	$39	$39	1.58	$37	$37	$37
2015	1.77	$43	$43	$43	1.68	$41	$41	$41
2016	1.84	$17	$50	$102	1.75	$16	$47	$97
2017	1.89	$18	$53	$109	1.79	$17	$50	$103
2018	1.92	$19	$56	$116	1.83	$18	$54	$110
2019	1.95	$19	$60	$123	1.85	$18	$57	$117
2020	1.97	$20	$63	$131	1.87	$19	$60	$125
2021	1.98	$21	$67	$140	1.88	$20	$64	$133
2022	1.99	$21	$72	$149	1.89	$20	$68	$142
2023	1.99	$22	$76	$159	1.89	$21	$73	$151
2024	2.00	$23	$81	$169	1.90	$21	$77	$161
2025	2.00	$23	$86	$180	1.90	$22	$82	$171
2026	2.00	$24	$91	$191	1.90	$23	$87	$181
2027	1.99	$24	$97	$202	1.89	$23	$92	$192
2028	1.99	$25	$102	$214	1.89	$24	$97	$203
2029	1.98	$25	$108	$226	1.88	$24	$103	$215
2030	1.98	$26	$114	$238	1.88	$25	$108	$226
2031	1.97	$26	$119	$249	1.87	$25	$113	$237
2032	1.96	$27	$126	$263	1.86	$26	$120	$250
Total	**38.4**	**$499**	**$1,541**	**$3,079**	**36.5**	**$474**	**$1,464**	**$2,925**
NPV		**$396**	**$1,146**	**$2,260**	**1.8**	**$376**	**$1,089**	**$2,147**

6 Conclusion

The object of this report was to analyse the carbon credits that could be generated by stopping all harvesting in the Western Australia's FMP forests. These forests cover an area of ~850,000 ha and have produced 300,000-500,000 m^3 yr^{-1} of logs since the reforms in the sector in the early 2000s (WAFPC, 2011; ABARES, 2012a; 2012b).

The proposed project could generate a number of different types of carbon credits, the most notable of which are FM credits and Kyoto ACCUs. FM credits (and debits) are the credits (debits) that will be recorded in Australia's international greenhouse compliance accounts if it accounts for FM in the post-2012 era. Two methods were used to project the FM credits that could result from the cessation of all harvesting in the FMP forests: FM methods 1 and 2. The results suggest that, on average, the project would lead to the generation of between 2.2 and 2.4 million FM credits yr^{-1} over the period 2013-2032.

ACCUs are offset credits issued under the CFI Act. Kyoto ACCUs are credits issued in relation to avoided emissions and removals that can be used to meet Australia's emission targets. Because they affect emissions and removals that are recorded in Australia's national greenhouse accounts, Kyoto ACCUs can also be used to meet carbon liabilities under the CE Act. Three methods were used to project the Kyoto ACCUs from the project: CFI methods 1, 2 and 3. The results suggest that, on average, the cessation of harvesting in the FMP forests would lead to the generation of between 1.8 and 2.9 million Kyoto ACCUs yr^{-1} over the period 2013-2032.

The FM credits and Kyoto ACCUs issued in relation to the project would not be cumulative. The Kyoto ACCUs would effectively be carved out of the corresponding FM entry in Australia's greenhouse accounts. Due to this, if Kyoto ACCUs are issued in relation to the project, the 'carbon benefit' of the project would accrue primarily to the project proponent under the CFI (i.e. the holder of the carbon sequestration right – presumably the Western Australian Government or another state government agency).

Three carbon price scenarios were used to estimate the potential value of the Kyoto ACCUs generated by the project: a low, medium (Clean Energy Future) and high price path. On the basis of these assumed price paths, and assuming a 5% deduction is made to account for leakage, the annual value was assessed at between $16 million and $438 million per annum (2013 A$), with the net present value estimated at between $376 million and $3,348 million (2013 A$) using a social time preference rate of 2.7%.

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