# Evaluation of the Australian ETS approach for reforestation

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### Abstract

The draft Australian ETS proposes that carbon units can be received from reforestation - but only up to the average long term carbon stock. Carbon units do not have to be surrendered following harvest or a catastrophic event provided the crop is re-established. This approach is a variation of that first proposed by Maclaren in 1995.

We evaluate this approach and compare it with the approach currently enacted in the New Zealand ETS. Although the approach reduces forest profitability the reduction is modest. It removes important components of risk that growers face under the current ETS - both the carbon price risk associated with post-harvest buy back of carbon units and also the risk associated with premature surrender of carbon units following a catastrophic event.


## Introduction

In 2008 the New Zealand Government enacted an emissions trading scheme (ETS). Owners of Kyoto-compliant plantations (afforestation since 1 January 1990) are able to opt into the ETS and receive units for carbon sequestered. Conversely, they will be required to surrender units when carbon stocks decrease. Carbon trading, through the provision of early cashflows, has the potential to change the economics of plantation forestry in New Zealand.

Maclaren *et al*. (2008) found that the ETS could have a major impact on forest management. The ETS favours higher stockings, less intensive silviculture and longer rotations. With increasing carbon price, the ETS leads to much greater forest profitability as measured by LEV (Land Expectation Value). However along with increasing profitability comes increasing risk. This risk takes two major forms:

(i) Carbon prices may be so high at the time of harvest that owners will not be able to afford to harvest; ie, there is financial risk.

(ii) An unexpected catastrophic event will require early surrender of units and create cashflow problems for the owner; ie, there is physical risk that creates further financial risk.

The basis of the ETS is that any change in carbon stocks from year to year creates revenue (carbon stocks increase) or cost (carbon stocks decrease) for the forest grower. It is this feature that creates the risk. An alternative approach was that originally proposed by Maclaren *et al*. (1995) and detailed by Maclaren (1996): *"The establishment, and replanting upon harvest, of one hectare of radiata pine on New Zealand pastureland, using a regime typical of present-day practices will sequester approximately 112 t of carbon in perpetuity. This can be viewed as a one-off movement of carbon from the air to the land surface"*. It was suggested that this one-off gain in carbon should be compensated by a one-off payment or, for example, three payments (subsequent to the carbon gain) at 5 years, 10 years, and 15 years, plus possibly one "wash-up" payment to reconcile any discrepancies.

A variation of this approach has been incorporated into the exposure draft of legislation for an Australian ETS. Under this scheme *"Units will be issued to reflect 'average' long-term net greenhouse gas removals in a forest stand"* and *"the project proponent will generally not have to relinquish units after the forest is harvested or in the event that the forest is destroyed by fire or pests, provided that the forest is re-established."* Given the current review of New Zealand's ETS legislation and the stated intention of the New Zealand Government to align carbon policy with Australian policy, this approach warrants further attention.

The purpose of this paper is to compare the proposed Australian approach with the existing New Zealand ETS approach. A key feature of the Australian approach, determination of the long term average carbon stock, is initially discussed. Then the profitability and associated risk of the proposed Australian and current New Zealand approaches are compared. As part of this the results of a study on the risk associated with catastrophic events (Manley & Watt, 2009) are used. Finally the advantages and disadvantages of the approaches are reviewed.

## Approach

The same general approach is followed as Maclaren *et al*. (2008). For radiata pine, an average New Zealand ex-farm site of site index[1] 32.6 m and 300 Index[2] of 32.6 $m^3$/ha/year is assumed. Three different silvicultural regimes are evaluated:

- **Clearwood** (Plant 800 stems/ha, prune to 5.5 m in 2 lifts, thin to 250 stems/ha at age 8 years).
- **Framing** (Plant 800 stems/ha, thin to 375 stems/ha at age 8 years).

[1] *Mean top height of 100 largest stems/ha at age 20 years.*

[2] *300 Index is an index of volume productivity. It is the stem volume mean annual increment at age 30 years for a defined silvicultural regime of 300 stems/ha (Kimberley et al. 2005).*

- **No thin** (Plant 800 stems/ha, no thinning).

For Douglas-fir site an average New Zealand site (site index at age 40 of 31.3 m, 500 Index[3] of 18.4 $m^3$/ha/year) while the Eucalyptus nitens site is a good Southland site (site index at age 15 of 25.6 m). Regimes adopted for other species:

- **Douglas fir** (Plant 1650 stems/ha, thin to 500 stems/ha at age 15).
- ***Eucalyptus nitens*** (Plant 900 stems/ha, no thinning). All *Eucalyptus nitens* volume was priced as pulplogs.

Carbon sequestration was estimated for radiata pine and Douglas-fir using Calculators (NZTG 2003), and for *Eucalyptus nitens* from a carbon allocation model.

Financial criteria used are Land Expectation Value (LEV) and Net present Value (NPV) at an 8% real discount rate. Published MAF[4] 12-quarter average prices (as at January 2008) are used. Industry average costs are used. A base carbon price of \$30/t $CO_2$ is used and a fixed cost (\$60/ha/year) was assumed for the costs of measurement, auditing, registration associated with carbon trading.

For the Australian approach, carbon trading ceases once the long term average is reached.

## Long term average

The exposure draft of the Australian legislation states that the carbon unit limit will be calculated "based on an average of cumulative net greenhouse gas removals over the time period specified in regulations." The question is how the long term average should be calculated; ie, over how many years should it be calculated? Figure 1 shows the average carbon for the clearwood regime on a 30 year rotation. The average carbon after 30 years (for the first rotation) is 447 t $CO_2$.

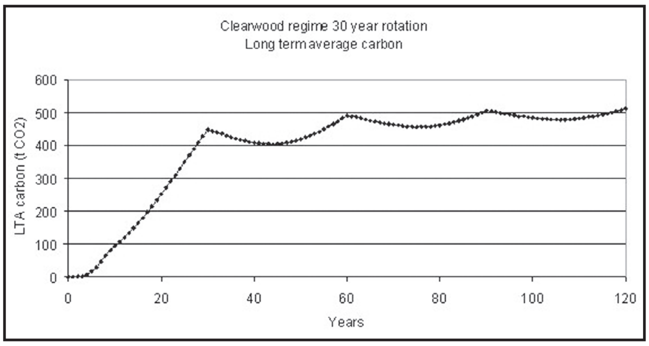


*Figure 1: Long term average carbon (t $CO_2$) for the clearwood regime on a 30 year rotation.*

[3] *500 Index is an index of volume productivity. It is the stem volume mean annual increment at age 40 years for a defined silvicultural regime of 500 stems/ha (Knowles 2005).*

[4] *http://www.maf.govt.nz/forestry/statistics/logprices/*

The ultimate long term average is 533 t $CO_2$. This is the average carbon for the second and subsequent rotations. This is indicated in Figure 2.

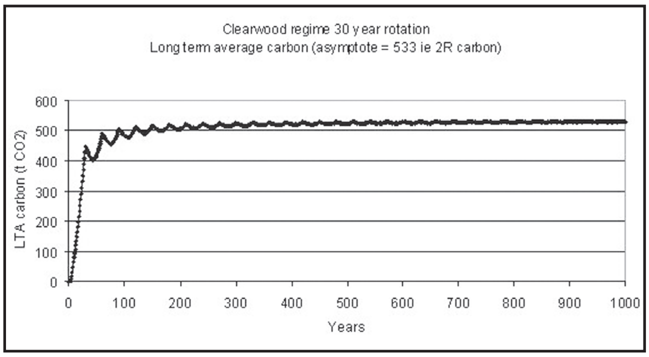


*Figure 2: Long term average carbon for the clearwood regime on a 30 year rotation extended for 1000 years.*

Figure 3 compares the average carbon for the first rotation, the second rotation and the first 120 years. The non-smooth trend of the 120 year curve reflects the varying number of rotations that occur in the initial 120 years with different rotation lengths - ie, there are 4 complete 30 year rotations in 120 years but only 3 and 27/31 31 year rotations. Consequently the average for the 31 year rotations is calculated from a non-integral number of rotations.

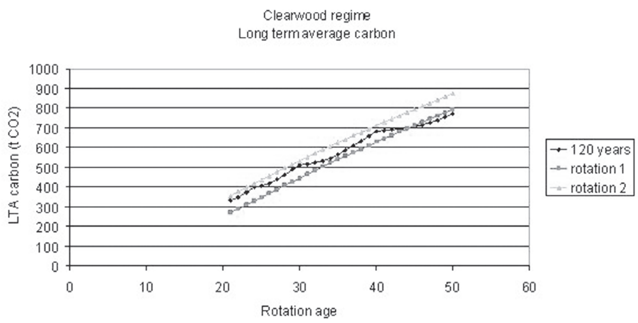


*Figure 3: Long term average carbon for the clearwood regime for rotations between 21 and 50 years. Long-term average carbon is shown for (a) the first 120 years; (b) the first rotation; and (c) the second rotation (which is the long-term asymptote).*

The analysis undertaken here initially uses the asymptotic long term average calculated as the average of the carbon stocks for the second rotation. The 120 year average was not used because the non-smooth trend will potentially influence the optimum rotation age in an arbitrary way.

## Results

At a carbon price of \$30/t $CO_2$ LEVs for the Australian approach are reduced by \$380/ha to \$813/ha compared to the current ETS. Optimum rotation ages stay the same in most cases (Table 1).

*Table 1: LEV and optimum rotation age[5] for (a) Forestry only; (b) Forestry + Carbon under the existing ETS; and (c) Forestry + Carbon under the Australian approach. Carbon price of $30/t CO2.*

| | Forestry only | | ETS | | Australian | |
|---|---|---|---|---|---|---|
| | LEV | age | LEV | age | LEV | Age |
| Clearwood | 1215 | 25 | 6647 | 30 | 6125 | 30 |
| Framing | 863 | 25 | 8201 | 36 | 7557 | 36 |
| No thin | 421 | 27 | 11105 | 48 | 10292 | 50 |
| Eucalyptus | -1193 | 19 | 6427 | 25 | 5981 | 25 |
| Douglas fir | -1970 | 40 | 1359 | 44 | 979 | 44 |

As might be expected, the reduction in LEV for the Australian approach increases as carbon prices increase (Figure 4). Optimum rotation age is similar, but sometimes lower or higher for the Australian approach compared to the current ETS (Figure 5). Patterns for other regimes and species are similar to those shown for the clearwood regime, although ages were consistently the same or higher under the Australian approach for the radiata pine no thin regime.

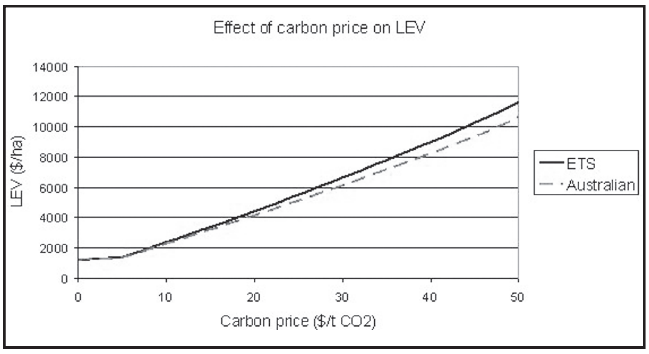


*Figure 4: Comparison of the LEV of the clearwood regime for different carbon prices (a) of the existing ETS and (b) the Australian approach.*

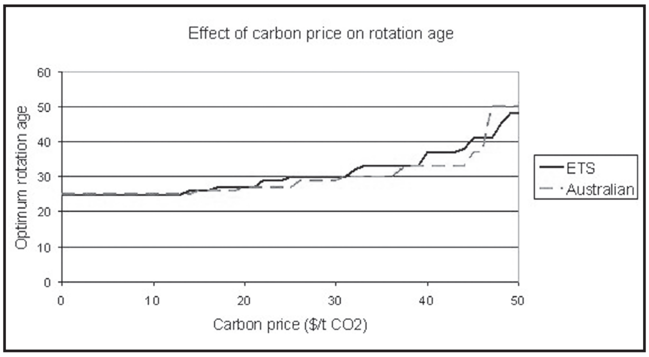


*Figure 5: Comparison of the optimum rotation age of the clearwood regime for different carbon prices (a) of the existing ETS and (b) the Australian approach.*

[5] *Results vary from the Maclaren et al. (2008) study in some cases - the maximum age analysed for radiata pine was increased from 40 to 50 years.*

### *Carbon overhead costs*

As a variation we assumed that the carbon overhead costs reduce from $60/ha/year to $30/ha/year when the long term average is reached (at age 19 for the clearwood regime). LEV of the clearwood regime for the Australian approach increases by $87/ha from $6125/ha to $6212/ha.

### *Alternative long term averages*

We looked at the sensitivity of LEV to the method by which the long term average carbon stock is derived. Table 2 shows the results for the clearwood regime.

*Table 2: LEV and optimum rotation age of the Australian approach when the long term average carbon is calculated from (a) the second rotation (long-term asymptote); (b) the first rotation and (c) the first 120 years.*

| | LTA | LEV | age |
|---|---|---|---|
| ETS | | 6647 | 30 |
| Australian | 2R | 6125 | 30 |
| Australian | 1R | 5533 | 30 |
| Australian | 120 year | 5986 | 30 |

### *Comparison of risk/return tradeoffs*

Maclaren *et al*. (2008) considered three different carbon trading strategies:

- Trade every year.
- Trade only until the minimum long term carbon stock is reached.
- Trade up to the average long term carbon stock.

Table 3 compares the results of each of these strategies with those of the Australian approach. The number of carbon units that have to be surrendered subsequent to harvesting is used as a measure of risk. The Australian approach gives the second highest return with low risk - in fact zero surrender risk.

Trading of 533 units takes place under both the Australian approach and a Trade to average long term carbon stock strategy under the current ETS. The increase of LEV from $5696/ha to $6125/ha reflects the value of not having to surrender the 283 units after harvest.

*Table 3: Measure of return (LEV) and risk (units to surrender) for the Australian approach compared to different trading strategies under the ETS. Radiata pine clearwood regime.*

| | | LEV | Units sell | Units to surrender |
|---|---|---|---|---|
| ETS | Trade every year | 6647 | 1002 | 752 |
| ETS | Trade to minimum | 3808 | 250 | 0 |
| ETS | Trade to minimum | 3808 | 250 | 0 |
| Australian | | 6125 | 533 | 0 |

*Catastrophic risk*

Under the proposed Australian ETS carbon units will not have to be surrendered in the event that the forest is destroyed by wind or fire or pests or diseases provided that the forest is re-established. This is in contrast with the current New Zealand ETS where the grower carries the liability for early surrender following a catastrophic event.

Manley and Watt (2009) calculated risk-adjusted LEVs assuming different levels of catastrophic loss for the clearwood regime with a target rotation of 30 years. Table 4 shows how allowance for risk of early surrender of carbon reduces the LEV. The analysis of Somerville (1995) indicates that many parts of New Zealand have a probability of wind loss of around 0.25% with some areas much higher.

*Table 4: Impact of the risk of catastrophic events on LEV ($/ha) of the clearwood regime with a target rotation age of 30 years. Reduction in LEV reflects the early surrender of carbon (loss to the tree crop would cause an additional reduction to LEV). Probabilities are expressed as percentages.*

| | Probability of event occurring in any year | | | | |
|---|---|---|---|---|---|
| | 0 | 0.25 | 0.5 | 1 | 2 |
| LEV ($/ha) | 6647 | 6535 | 6426 | 6193 | 5648 |

The proposed Australian approach removes the risk of having to surrender carbon units prematurely (but not the direct risk of crop loss). Allowance for catastrophic loss causes the LEV under the current ETS to reduce - however an annual loss in excess of 1% would be required for the risk-adjusted LEV to fall beneath the LEV of $6125/ha for the Australian approach.

## Discussion

A comparison of the Australian approach with the current ETS indicates certain advantages and disadvantages. Some of the advantages:

*Simplicity and predictability.*

Growers know what they will get and when.

*Reduced risk*

The Australian approach reduces risk by:

- Removing the carbon price risk at the time of harvest. There is still risk associated with the price of carbon during the period when carbon units are being received.
- Removing the risk of premature surrender of carbon units following a catastrophic event. Note that this reduction in risk is more a function of government policy than the carbon trading approach; ie, it would be possible for the New Zealand Government to cover the risk of catastrophic events under the current ETS.

*Lower measurement and compliance costs*

The Australian approach would require a similar level of measurement during the phase up to the long term average carbon level being reached. Thereafter costs would be less - at this point how much carbon is standing is not an issue. Rather the focus becomes one of ensuring that the forest is managed as intended (to ensure that the assumed average long term carbon stock is appropriate) and that land is not converted to another land use.

Some of the disadvantages:

*Reduced LEV*

The Australian approach gives a lower LEV than the current ETS provided that the rate of catastrophic loss is less than 1% per year.

*Sensitivity to long term average carbon level*

LEV for the Australian approach is sensitive to the long term average carbon stock level assumed. This in turn is sensitive to site, species, silviculture and rotation age. It will be a challenge to determine a robust way to estimate the appropriate carbon level for each project.

*Long term average is a moving target*

Genetic improvement, regime changes, and climate changes mean that the long term average will not be known in advance but would require ongoing measurement to pin point. On the other hand, this difficulty is a problem for professional foresters not for the investor - an approximate figure could be reached relatively easily to enable long-term planning.

*Difficulty in explaining the concept*

The concept of a long term average carbon stock may be more difficult to explain than the concept of the annual change in carbon stocks.

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