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Impact of carbon trading on wood products

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Impact of carbon trading on wood products

Prepared for

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Preface

About the author

Monash Sustainability Enterprises (MSE) is a multi-disciplinary research centre which specialises in the development of robust methodologies to analyse linkages between corporate social and environmental management issues and financial drivers. MSE has pioneered the practical application of environmental and social rating and analysis in Australian financial markets.

Lead author, Alison George, is a Chartered Accountant and holds bachelor degrees in Arts (Jurisprudence) and Accounting as well as a Master of Environment from Melbourne University. Previously, as a Manager with Ernst & Young's Environment & Sustainability Services, she provided advisory and verification services with a focus on greenhouse (risk, reporting, and trading schemes) and sustainability (triple bottom line) reporting.

Alison is currently engaged in research developing methodologies for financial valuation of environment and social risk exposures, including research into the potential impact of climate change on company earnings and value.

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Executive summary

Carbon trading has emerged as the leading policy option to reduce greenhouse gas emissions. There is now bipartisan support for the introduction of a national carbon trading scheme, possibly as soon as 2010. This report explores the potential impact of carbon trading on wood products and key competitors.

Choices about the rules of the carbon trading scheme (the scheme 'design') can significantly alter the financial impact of carbon pricing.

Under a scheme design where all emitters are required to pay the full cost of their greenhouse gas emissions (100% auctioning with broad emissions coverage) wood products would benefit significantly from carbon trading – experiencing far lower cost impacts than all key competitor materials – due to its low emissions status.

At a carbon price of $30 per tonne, the impact (as a percentage of the price per tonne of material) is less than 1% for rough sawn hardwood and softwood, compared to blast-furnace steel (10%), cement (16%), and aluminium (18%). However, a full pricing scenario is unlikely except in the long term.

In the short to medium term, it is likely that carbon prices will be kept low and that special concessions will be provided to wood's key competitors. Two key recent proposals for a national carbon trading scheme include compensation for emissions-intensive trade-exposed industries, such as aluminium, steel, and cement. While it is not clear yet exactly how compensation mechanisms will work or which sectors will be eligible, it is probable that they will shield, at least partially, wood's key competitors from the cost impacts of carbon pricing. If so, any positive competitive impact for wood will be reduced and wood, as an uncompensated industry, may actually be left worse off from carbon pricing.

Harvested wood products store carbon - up to the equivalent of 1.28 tonnes carbon dioxide (tCO_2-e) per tonne of wood. Recent research has shown that this storage is very long term, continuing long after disposal of wood in landfill. The carbon stored in harvested wood products far exceeds any emissions associated with their production. Thus, recognition of this carbon storage has the potential to eliminate the cost impacts of carbon trading on wood products and even restore some of the competitive advantage that would flow to wood under a full pricing scenario.

However, there are a number of barriers to the recognition of harvested wood product credits and, even if these can be overcome, it is likely that credits would be restricted to less than the full carbon store. For example, credits may be limited to wood products from 'Kyoto-compliant forests' – effectively reforestation on areas that were not under forest on 31 December 1989.

While around 40% of the Australian plantation estate meets this definition, only a small proportion of these newer plantations are involved in the production of long-lived wood products. Thus, the overall benefit to the industry would be significantly reduced by using the restrictive Kyoto requirements in a domestic trading scheme.[1]

Use of wood products also results in emissions savings where wood processing residues or discarded wood products are burned for energy displacing fossil fuels. Recognition of the carbon benefit of such displacement is highly likely, but it is not clear who would benefit. If the carbon benefit accrues to the user of the wood as fuel, the benefit to the forestry industry would be limited to its own use.

Proposals for a national carbon trading scheme for Australia are still under development. Thus, there remains an opportunity for the industry to engage with policy makers and pursue an approach that recognises the greenhouse benefits that flow from increased use of wood products. Key issues for policy engagement are:

- The implications of concessions to energy-intensive trade-exposed industries for lower emissions competitors and the environment; and
- Developing a workable, approach to harvested wood product credits.

Contents

1 Introduction

Carbon trading has emerged as the leading policy option to reduce greenhouse gas emissions. There is now bipartisan support for the introduction of a national carbon trading scheme, possibly as soon as 2010. Two separate designs for a national carbon trading scheme have been proposed recently.

Carbon trading has the potential to affect the cost of both wood products and of non-wood substitutes, such as cement, steel, and aluminium. The different greenhouse profiles of competing products are expected to result in considerably different cost burdens from carbon trading and this has the potential to shift demand to less greenhouse-intensive substitute products. The 'internalisation' of carbon pollution costs is one of the key objectives of placing a price on carbon emissions (through carbon trading or other means) as it:

- Provides a signal to consumers to consume less of emissions-intensive products; and
- Ensures that the polluter pays for the negative impacts of greenhouse emissions.

On this basis, the impact of carbon trading should be favourable for wood products, as they are typically less emissions intensive than non-wood substitutes. However, actual impacts of carbon trading can vary significantly depending on the details of the design of the scheme. This report examines how carbon trading is likely to impact on wood products and key competitors.

1.1 Project objectives

The primary objectives for the project are to:

- Describe the relative emission profiles of wood and its key competitors.
- Identify those scheme design issues that have the potential to cause significant impacts for wood products.
- Quantify the size of the potential impact for wood products under different approaches to these issues.

1.2 Methodology

The project has involved the following stages:

- Literature review covering greenhouse emissions profile of wood and non-wood substitutes, carbon storage in wood products, carbon accounting methodologies for wood products, and current carbon trading proposals for Australia.
- Identify and review of greenhouse emission data for wood and non-wood substitute products.
- Use of TimberCAM model to generate carbon storage values for use in modelling. TimberCAM is a carbon accounting model for wood and wood products developed within the CRC for Greenhouse Accounting. TimberCAM is available for download from http://www.greenhouse.crc.org.au/tools/models/timbercam/.
- Establish a spreadsheet model and generate scenario results.
- Summarise modelling results and other findings into research report.
- Stakeholder consultation on draft report.

An advisory group has provided guidance throughout all stages of the project.

2 Climate change and wood products

2.1 Emissions profile – wood and key competitors

Wood competes with different materials in different product applications. 'Steel, concrete, and brick are important alternatives in construction. Aluminium and plastics are widely used in manufacturing of windows and doors. Along with plastics, aluminium is also an important competitor in the packaging sector.'[3]

Table 1: Materials competing with wood[4]

Material	Products
Aluminium	▪ Windows and doors ▪ Internal decoration ▪ Structural members for concrete form work ▪ Roof and ceiling coverings ▪ External building decoration (e.g., fences) ▪ Bridge components ▪ Packaging
Plastics	▪ Packaging ▪ Windows and doors ▪ Wall cladding ▪ Decking ▪ Outdoor furniture
Steel	▪ Structural members for long-span structures ▪ Framing products
Concrete	▪ Construction of buildings and bridges and other infrastructure
Brick	▪ Wall cladding and other building applications
Gypsum	▪ Wallboards

The greenhouse gas emissions 'profile' of wood differs significantly from competitor materials. The emissions profile of wood and key competitors is summarised in the Table 2.

Table 2: Greenhouse gas emissions - profile of wood and key competitors

Materials	Greenhouse gas emissions per tonne material (tCO_2-e / tonne)	Percentage of emissions from electricity
Aluminium[5]	22.4	83%
Steel (blast furnace production)[6]	2.55	5.9%
Steel (scrap-based electric arc furnace production)[7]	1.1	81.8%
Cement[8]	0.77	13%
Hardwood (rough sawn kiln dried)[9]	0.230	50%
Softwood (rough sawn kiln dried)	0.234	64%
MDF (Medium Density Fibreboard)	0.726	47%
Particle board	0.982	9.9%

Production of wood results in few greenhouse gas emissions,[10] with the main emissions source being energy used in processing. A significant proportion of the energy requirements of the industry are met from use of wood residue, which results in emissions savings compared to use of fossil fuel based energy.

In contrast, production of most competitor materials results in high greenhouse gas emissions.

Materials also differ significantly in the sources of emissions. Electricity is classified an 'indirect' emissions source as, unlike other energy sources, the actual release of greenhouse gases occurs offsite (at the power station where the electricity is generated), rather than where the electricity is used. Thus, the consumer of the electricity is only indirectly responsible for the emission. Indirect electricity emissions represent 83% of the total emissions for aluminium compared to only 5.9% for blast-furnace steel. Electricity is an important emission source for basic wood products, representing more than half of total emissions for both rough sawn hardwood and softwood.

The emission values in Table 2 are presented per tonne of material. However, in order to be comparable, values must take into account the different quantities of each material required for a particular application. For example, the weight of clay bricks required to clad a wall would be far greater than the weight of wood for the same application. In this way, comparisons of the emissions intensity of different materials should consider both the emissions per tonne and the tonnage required of each material for the application being considered.

Because of wood's low emissions intensity, use of wood can result in emissions savings in many applications. Additional savings may arise due to differences in disposal options at end of the product's life. The ability to use wood products for energy, displacing fossil fuels, is likely to result in higher emissions savings than the disposal options for many other products.[11] Thus, increased use of wood can help to reduce greenhouse gas emissions.

2.2 Wood product carbon storage

Wood products, unlike their competitors, are part of the carbon cycle. As they grow, trees absorb carbon dioxide and store it as carbon, acting as an important carbon 'sink'. This is referred to as carbon sequestration or biosequestration, with specific reference to plant-based carbon storage. Much of this carbon remains stored after harvesting and conversion to wood products.

About half the dry weight of a wood product is carbon and one tonne of carbon represents 3.67 tonnes of carbon dioxide.[12]

The approximate amount of carbon dioxide stored per tonne dry wood is:

- Hardwood 1.28 tonnes CO_2
- Softwood 1.24 tonnes CO_2[13]

In wood processing wood residues are created. Typically, 40-60% of log biomass is lost to residues during processing to green rough sawn boards.[14] Wood residues also contain stored carbon. How these wood residues are disposed of determines whether this carbon remains stored and for how long.

Wood residues typically go to one of the following destinations:

- Other wood products (paper and panel-board)
- Burned for energy
- Burned to waste
- Landfill

Of these, only burning to waste results in no carbon saving. The release of carbon when wood is burnt to waste is treated as carbon neutral under carbon accounting rules, which recognise that the carbon that is released was taken up from the atmosphere initially as a normal part of the carbon cycle. So, the burning simply releases previously stored carbon, rather that adding to the total amount of carbon in the carbon cycle.

The majority of residues are used in production of other products. This results in the carbon in the wood residues being stored for the life of that product.

Wood residues that are burned to energy save greenhouse gas emissions where this meets energy needs that would otherwise have been met with fossil fuels. Use of wood residues for energy can result in significant emissions savings - equivalent to the greenhouse intensity of the displaced fuel (see Table 3).

Table 3: Greenhouse emissions intensity of common fossil fuels[15]

(Kg CO_2-e per Gigajoule, 2004)

	Vic	Qld	WA	SA	NSW	Tas
Indirect - Electricity	407	321	276	280	274	8.7
Combustion - Natural gas	63.4	64.2	60.0	71.2	68.0	n/a
Combustion - Coal (unwashed)	94.6	94.9	n/a	n/a	97.0	n/a

In addition, such savings are permanent. 'When fossil fuels are burned, the transfer of carbon from geological storage in the biosphere is permanent. As a result, when biomass is used instead of fossil fuel, the avoided … emissions are considered permanent.'[16]

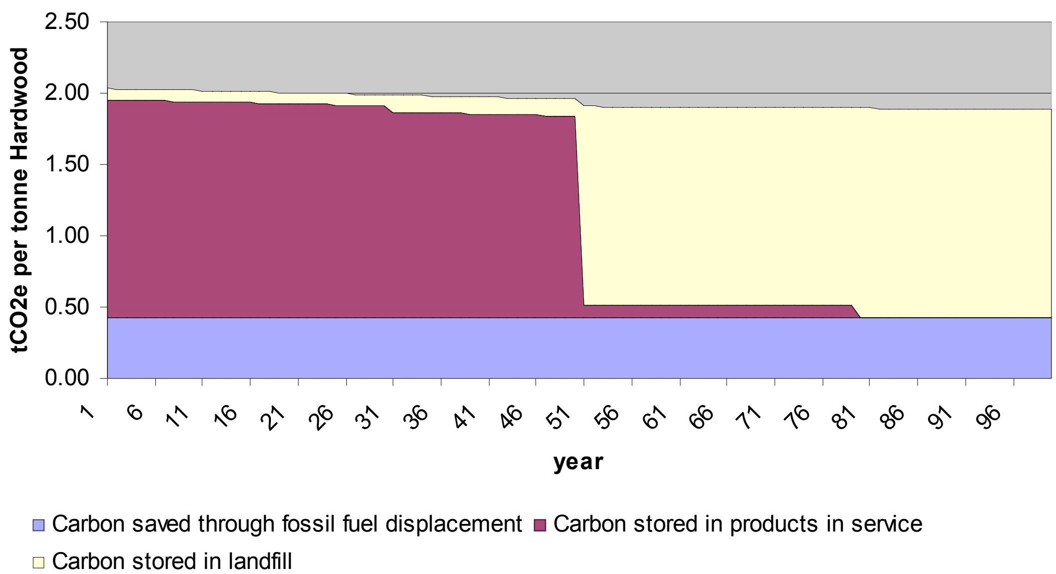
There may be scope to increase the use of wood residues from Australian wood industries for energy, representing potential carbon savings.

For wood residues that are sent to landfill, previously, it was assumed that the wood decomposed and released its stored carbon rapidly. Recent research is challenging this assumption by showing that wood recovered from landfill (some after up to 46 years) had experienced minimal decomposition (less than 4%).[17] At the decomposition rates indicated by these findings, wood in landfill represents a very long-term carbon store.

For greenhouse purposes, 100 years is sometimes taken as the threshold for permanency. The use of 100 years is, in part, related to the calculation of 'global warming potentials'. These values represent the contribution of a greenhouse gas to global warming over 100-years and are used extensively in greenhouse accounting. Thus, a carbon store that remains in place for 100 years may be treated as a permanent store, as it has fully offset the global warming impact that would have been accounted for if the stored gas had instead been released.

For wood products that are sent to landfill on disposal, considering the combination of service life and landfill storage, the carbon in these products can be considered permanently stored for greenhouse accounting purposes. Figure 1 shows an example of the storage of carbon associated with a hardwood product over a 100-year period.[18]

Figure 1: Carbon Stored in Hardwood Product
(Service Life: 50 years)



As shown in Figure 1, initially, the majority of the carbon is stored in the product in use. The small amount of carbon stored in landfill relates to wood residues created during production of the wood product. The remainder of the stored carbon is from use of wood residues for energy, displacing fossil fuel consumption.

A small amount of the carbon stored in use is released over the product's life. But the majority remains stored until the end of the product's useful life.

At the end of the product's life, a proportion of the wood is reused, but the majority of the carbon store is transferred to landfill,[19] where it remains stored to the end of the 100-year period, with only minimal losses.

In this example, the total carbon that remains stored at the end of the 100-year period is equivalent to 1.57 tonnes CO_2 per tonne of hardwood input at the start of the period.

Wood product pools offer significant potential to further reduce emissions. This emissions abatement is not constrained by issues such as land and water availability that apply to forest sequestration.

2.2.1 Carbon accounting

The 'default' approach under carbon accounting rules is to treat all carbon stored in a growing tree as released at the time the tree is harvested.[20] This is the approach that has been adopted for accounting for commitments under the Kyoto Protocol.[21]

However, the Intergovernmental Panel on Climate Change (IPCC) has approved accounting approaches that recognise that carbon remains stored in wood products after harvest. These can be applied where the wood product pool is increasing in size, and, thus, the store of carbon in wood products is increasing.[22] National reporting under the United Nations Framework Convention on Climate Change (UNFCCC)[23] allows voluntary reporting of carbon stored in wood product pools in accordance with IPCC methods.

Australia has adopted voluntary reporting of carbon stored in wood products for UNFCCC reporting. Under this accounting regime, the increase in carbon stored in harvested wood products reduced Australia's greenhouse gas emissions by 5 million tonnes in 2005.[24] It is estimated that the pool of wood products in service in Australia in 2005 is storing a total of 96.5 million tonnes of carbon,[25] which is equivalent to 354 million tonnes CO_2.

For national carbon accounting purposes, wood products are assigned to pools according to estimated service life (see Table 4). It is assumed that the carbon stored within each pool is released at an increasing rate over the product life.

Table 4: Wood product pools used in Australia's National Carbon Accounting[26]

Pool	Life (Yrs)	Products
Very short-term products	3	▪ Paper and paper products ▪ Softwood – pallets and cases ▪ Plywood – formboard
Short-term products	10	▪ Hardwood – pallets and palings ▪ Particleboard and MDF – shop fitting, DIY, miscellaneous ▪ Hardboard – packaging
Medium-term products	30	▪ Plywood – other (noise barriers) ▪ Particleboard and MDF - kitchen and bathroom cabinets, furniture ▪ Preservative treated pine – decking and palings ▪ Hardwood – sleepers and miscellaneous
Long-term products	50	▪ Preservative treated pine – poles and roundwood ▪ Softwood – furniture ▪ Hardwood – poles, piles, and girders
Very long-term products	90	▪ Softwood – framing, dressed products (flooring, lining, mouldings) ▪ Cypress – green framing, dressed products (flooring, lining) ▪ Hardwood – green & dried framing, flooring and boards, furniture timber ▪ Plywood – structural, LVL, flooring, bracing, lining ▪ Particleboard and MDF – flooring and lining ▪ Hardboard – weathertex, lining, bracing, underlay ▪ Preservative treated pine – sawn structural timber

3 Impact of carbon trading on wood products

3.1 Carbon trading overview

Concern about climate change has led governments around the world to introduce regulation to reduce greenhouse gas emissions. Numerous measures have been introduced, such as:

- Support for research and development of low emissions technologies;
- Rebates or subsidies to encourage the adoption of low emissions technologies; and
- Education and behaviour change programs.

Increasingly, approaches that put a price on carbon (greenhouse gas emissions) are being pursued. Carbon pricing is generally considered necessary in order to achieve the deep cuts in emissions being advocated by many experts and stakeholders.

Carbon pricing can be in the form of a carbon tax or carbon trading, or some combination of the two.

Carbon taxes are administratively simple and provide certainty in terms of cost. However, they are environmentally uncertain – it can be difficult to estimate what level of tax is required to achieve a particular emission reduction – and result in higher economic costs for the same level of emissions reduction compared to carbon trading.

Carbon trading results in a lower overall cost, as it allows flexibility about where the reductions are achieved. Firms that are able to reduce emissions more cheaply are able to reduce more and sell the emission reductions that they do not need to other firms with a higher cost of abatement. Where emissions reductions from sectors outside the scheme are allowed to be traded, costs may be reduced further.

The lower overall costs associated with carbon trading have resulted in it becoming the preferred policy response where compulsory reductions in emissions are considered.

Carbon trading schemes fall into two broad categories:

- Cap and trade; and
- Baseline and credit.

Cap and trade schemes involve:

- Setting an emissions 'cap' - the maximum amount of greenhouse emissions allowable in a given period. The difference between the cap and 'business as usual' emissions is the targeted reduction in emissions. It is common for carbon trading proposals to involve modest reduction targets initially, with progressively more stringent targets over time.
- Creating tradeable permits ('carbon credits') for the allowable emissions, i.e., a right to emit. Typically a permit will be for one tonne of greenhouse gas emissions (1 tCO2-e).
- Allocating tradeable permits to affected parties (those emitting greenhouse gases).

Liable parties are required to surrender sufficient tradeable permits at the end of each period to cover all of their actual emissions. Liable parties who are able to reduce their emissions below the level of emissions for which they have permits are able to sell excess permits on market. The European Union's Emissions Trading Scheme (EU ETS) is an example of a cap and trade scheme.

Under a baseline and credit scheme, liable parties are assigned an emissions path or 'baseline' which sets out allowable emissions over time. The difference between the baseline and business as usual emissions is the targeted reduction in emissions. Tradeable permits are allocated with reference to the baseline. Liable parties who are able to reduce their emissions below their baseline are able to sell excess permits on market. The NSW Greenhouse Gas Abatement Scheme (NGGAS) is an example of a baseline and credit scheme.

In practice, there are many similarities between the two categories of scheme. For simplicity, the following analysis focuses on cap and trade schemes.

3.2 Carbon trading proposals for Australia

There have been two recent proposals for national carbon trading schemes in Australia. Both are cap and trade schemes.

All state governments have been involved in the development of a scheme proposal through the National Emissions Trading Taskforce ('NETS' proposals). In August 2006, the taskforce released a Discussion Paper setting out a possible design for a national carbon trading scheme.[27]

The former Federal Government announced on 3 June 2007 it would introduce an emissions trading scheme to commence no later than 2012. In doing so, the recommendations of the Task Group on Emissions Trading with respect to the scheme's design ('TGET' proposals) were endorsed.[28]

The new Federal Government has also committed to implementing carbon trading no later than 2010, but has not yet put forward any detailed proposals, but it is likely that they will draw upon both previous proposals and the surrounding stakeholder consultation.[29]

There are many similarities between the NETS and TGET proposals. The differences that are significant for wood products are discussed further in section 3.3 below.

Both sets of proposals require significantly more work before they could be implemented through legislation. The new Federal Government has indicated that a detailed design will be released by the end of 2008.[30]

3.3 Scheme design issues relevant to wood products

Choices about the rules of the scheme (the scheme 'design') can significantly alter the financial impact of carbon pricing.

Key design issues relevant to the impact on wood products and their competitors are:

- Emission targets / carbon prices
- Emission coverage
- Permit allocation method and concessions
- Treatment of carbon stored in wood products.

Each of these design issues is discussed below.

3.3.1 Emission targets / carbon prices

Carbon prices are determined by the interaction of supply and demand for permits, where:

- Demand is determined by the emission reduction target set – the larger the absolute reduction in emissions required, the higher the carbon price; and
- Supply is determined by the cost of abatement in liable sectors and other sectors able to generate tradeable offsets – the lower the average abatement cost, the lower the carbon price.

The TGET proposals do not contain any specific guidance on targets or likely carbon prices.

NETS has consulted on a long term target of reducing greenhouse gas emissions by around 60% compared with 2000 levels by 2050.[31] This is consistent with the new Federal Government's long-term reduction targets.[32] Short-term targets would need to be consistent with achieving the long-term reduction target. Modelling prepared for the NETS proposals predicted carbon prices associated with the indicative short-term targets presented for discussion would initially be in the around \$6-12 per tCO_2-e rising to around \$28-34 per tCO_2-e by 2030.[33]

A common feature of carbon trading schemes is to set a penalty for non-compliance, which can act as a cap on carbon prices. Where the carbon price (including transaction costs) is equal to the penalty in after tax terms, liable parties should be indifferent to paying the penalty or buying credits.

Both the NETS and the TGET proposals include such a relief valve mechanism. NETS specifically refers to a penalty. As penalties are generally not tax deductible, the effective price cap would be the after tax cost of the penalty (being the penalty divided by 1 minus the tax rate). For example, if the penalty were set at \$10, with a corporate tax rate of 30%, permits prices would need to exceed \$14.29 before liable parties would choose to pay the penalty rather than buy permits.

The TGET proposals refer to an emissions fee as the mechanism to cap prices. Because it is described as a fee rather than a penalty, it may be tax deductible. If so, the price cap would be equal to the fee amount.

Neither set of proposals have yet set out specific penalty / fee amounts.

It is likely that carbon prices will be kept modest in early phases of a carbon trading scheme, ramping up over time, to encourage continued adjustment to a lower carbon economy. Ultimately, it is anticipated that high carbon prices will be required to reduce emissions to 'safe' levels.[34]

3.3.2 Emission coverage

Carbon trading proposals typically apply only to selected sectors of the economy or sources of emissions.

Electricity generation is typically a focus of carbon pricing proposals, due to:

- The size of emissions from this sector (35% of Australia's greenhouse gas emissions in 2004);
- The comparative administrative simplicity of applying emission controls; and
- The low risk of import substitution.

Emissions from electricity generation may be the only sector covered by a carbon pricing scheme. Alternately, proposals may also cover emissions from other stationary energy sources as well as emissions from industrial processes, fugitive emissions, and emissions from transport fuels.

While, in theory, it would be possible to have a carbon pricing scheme that covered all sources of greenhouse gas emissions, this presents significant practical difficulties. No economy-wide carbon pricing schemes have been implemented anywhere in the world to date.

Carbon pricing may be ‘phased in’ – applying to a small number of sectors initially, with additional sectors included at a later stage. For example, the EU ETS initially imposes controls only on:

- Large electricity generating units (over 20MW);
- Oil refineries; and
- Manufacturers of iron and steel, cement, brick, tile, glass, pulp and paper.

Consideration is being given to expanding the EU ETS to other sectors, such as aviation, from the beginning of the second or third phase (2008 and 2013 respectively).

The two key Australian carbon trading proposals involve different initial coverage.

TGET proposes a broad initial coverage including all energy, industrial and fugitive emissions. Agricultural and land use emissions are to be excluded due to ’measurement uncertainties and compliance costs’[35] resulting from the large number of small sources involved. Whether other emissions sources, in particular, waste, should be covered is to be determined after further investigation.

The NETS proposals were to introduce carbon trading for the electricity generation sector only initially, due to ’considerations of practicability and workability’.[36] Additional sectors/sources are to be progressively phased in over time. The National Emissions Trading Taskforce (NETT) is now examining a broader initial coverage.[37]

Emission / sector coverage determines who has direct liability under a carbon pricing scheme and for what emissions. Where covered sectors provide inputs to other parts of the economy, this creates indirect exposure to the scheme for those downstream of covered sectors. This indirect exposure can be highly significant. Carbon pricing of electricity generation emissions has the potential to impact across the economy, as electricity is an input to production for every industry, to a greater or lesser extent.

As noted in section 2.1 above, the proportion of total emissions from electricity varies significantly across materials. Aluminium and electric arc furnace steel have very high proportions of their emissions from electricity (greater than 80%) making these materials particularly exposed to carbon trading schemes that are limited to electricity generation emissions. For many wood products electricity contributes a significant proportion of emissions.

3.3.3 Permit allocation method and concessions

A variety of permit allocation methods can be used. Typically this will involve some combination of:

- Auctioning - where liable parties are required to pay a market price for tradeable permits through an auctioning process.
- ’Free’ allowances – where permits are allocated to affected parties at no cost.

The basis of free allocations to liable parties may be historical emission levels, or a benchmark emissions intensity and actual production levels. The benchmark may be the average emissions intensity for the sector or a ‘best practice’ intensity level.

Free allocation on the basis of historical emissions is also referred to as ‘grandfathering’, as some emissions are allowed to continue without attracting a penalty (or carbon price). The main reason given for free allocations is to protect international competitiveness, in the absence of an international carbon pricing regime.

Free allocations may also be given as a form of compensation to those detrimentally affected by the introduction of a carbon price scheme, whether they have a liability under the scheme or not, such as large users of electricity.

Full auctioning combined with a broad emissions coverage represents the maximum potential carbon cost. This approach is consistent with the ’polluter pays’ principle. It is also consistent with environmental economic theory, as it fully internalises cost of carbon. Fully internalising carbon costs enables rational decisions to be made about trade-offs between economic benefits and environmental damage. It also enables wood to realise fully the benefits of its low emissions nature. However, full auctioning entails significant economic adjustment – it would result in many high carbon activities becoming unviable. Thus, full auctioning is only likely in the very long term.

In the first phase of the EU ETS there was limited use of auctioning, with the majority of allowances allocated for free.[38] Experience with the EU ETS to date has revealed one of the problems with free allocations. Each liable party was granted free allowances for the bulk of expected emissions. Thus, each had only a small net liability and was facing only a small increase in costs to meet the liability under the scheme. However, each of the free allowances has value - it can be sold at the prevailing carbon price. Liable parties took the value associated with the free allowances into account when setting prices for sales after the scheme was introduced. Where they could raise prices to compensate for the lost opportunity to sell the free allowances, they did so, leading to larger price increases than were necessary to cover real cost increases. This is referred to as opportunity cost pricing.

In the case of electricity, generators have been highly successful in achieving price increases, due to the relative inelasticity of electricity demand (that is, price rises typically result in only small decreases in consumption). This has resulted in a windfall profit for many generators, estimated to total £800 million p.a. in phase one of the EU ETS for the UK power generation sector alone.[39]

Other forms of permit allocation, such as auctioning or free allocations on the basis of sector average emissions intensity and actual production levels, have the potential to reduce or eliminate such windfall profits. However, these methods do not reduce downstream price rises. Rather, prices rise by a similar amount regardless of the permit allocation method.

This effect is particularly important for those materials with a high proportion of electricity emissions, such as aluminium and electric arc furnace steel, as it means that that electricity costs will rise significantly regardless of the permit allocation method. Wood products are also exposed, as a significant proportion of emissions for many products comes from purchased electricity.

NETS and TGET both acknowledge the potential for windfall profits to arise to some sectors from carbon trading and propose similar approaches to permit allocation to address this, with:

- Some permits allocated free to compensate liable parties significantly adversely affected by the introduction of carbon pricing;
- Some permits allocated free to emissions-intensive, trade-exposed industries likely to be adversely affected by carbon pricing, with allocations continuing until their overseas competitors are subject to similar carbon price constraints; and
- The balance of permits auctioned.

The two types of free allocation proposed are referred to as 'compensatory allocations', as the intention is merely to compensate for detrimental impacts without introducing the possibility of windfall profits. This is complex to achieve and will likely rely on detailed economic calculations, necessarily involving assumptions and uncertainties. Thus, there is a high potential for over or under-compensation, although less so than under a regime that provides the same proportion of free allocations to all liable parties.

As noted above, the permit allocation method has little impact on the extent of price pass through. Thus, providing some free permits to electricity generators is unlikely to change significantly the relative impact of carbon pricing on wood and competitor materials.

By contrast, compensatory allocations to emissions-intensive, trade-exposed industries could have a significant impact on the relative impact of carbon pricing on wood and competitors. A number of wood's key competitor materials, including, aluminium, steel, and cement may be treated as emissions-intensive and trade-exposed industries eligible for compensation.

To the extent that compensation is provided, producers of these materials will be sheltered from the impacts of carbon pricing. This prevents wood from realising the benefits of its low emissions status and may, in fact, leave wood products worse off. Wood is likely to face some cost increases under carbon pricing. If its competitors are fully compensated for the cost impact of carbon pricing, wood will face a higher cost impact than its emissions-intensive competitors.

For both NETS and TGET, the detail about how the compensatory allocations will be made is yet to be developed.

Based on the available information, one potential difference is that TGET proposes to compensate for loss of **profit in after-tax terms**, whereas NETS proposes to compensate for increases in **costs** due to carbon pricing and is silent on tax implications.

It appears that both sets of proposals will provide compensation on all output, not just exports. Further, it is not clear whether there will be any recognition that even trade-exposed industries do have some ability to pass through cost increases to customers. The profit-focussed approach of TGET is perhaps more likely to recognise pass through than the NETS focus on cost.

Both NETS[40] and TGET[41] proposes to provide compensation for 100% of the carbon cost impact initially and over time move to compensation based on a benchmark level of emissions (such as world's best practice). This may result in some emissions-intensive, trade-exposed industries receiving less than full compensation for their carbon costs, after a benchmark approach is introduced.

The NETS modelling presented in the discussion paper estimates that there would be a need to allocate 80-95% of value of permits in compensation (across both generators and emissions-intensive, trade-exposed industries). While the TGET does not present any modelling, it notes that the approach should leave a 'significant proportion' of permits for auction.

The economic literature on compensatory permit allocations predicts only a relatively small proportion of permits need be given free to meet such compensation objectives.[42] Even those sectors most affected by carbon pricing need less than 50% of their permits allocated freely.[43] This is in contrast to the high proportion of permits assumed in NETS modelling. This literature is specifically referenced by the TGET.

Thus, there appears to be some differences in how the compensation under the different scheme designs is expected to work and this may have implications for wood products. However, it is not possible to be conclusive at this stage given the limited information available about this aspect of the proposals.

Wood products industry participants should monitor this issue as additional details of the different proposals become available.

3.3.4 Treatment of carbon stored in wood products

Carbon sequestration can be used to offset emissions that would otherwise have occurred. This reduction in emissions can be recognised under a carbon trading scheme, resulting in credits that can be traded to liable parties to meet their emission targets. Offsets can be allowed from sectors other than those with liabilities under the scheme. Both NETS and TGET support offsets being allowed from a wide variety of sectors and activities, including forestry.

Numerous offset activities have been recognised under different carbon trading schemes in operation around the world, including sequestration in forests. While there are no examples yet where wood product storage has been recognised as an offset activity, conceptually, carbon stored in wood products is no different to other forms of offsets.

The key barriers to the recognition of carbon stored in wood products in trading are the need for reliable estimates of the amount of carbon stored and for workable approaches to scheme participation that avoid excessive transaction costs.

The state of knowledge about the amount of carbon stored in wood products is improving all the time. Sufficiently accurate and robust approaches have been developed to enable recognition of wood product carbon storage in national accounts (see section 2.2.1 above).

Further, perfect accuracy is not required to enable trading. Current approaches to forestry credits include an uncertainty allowance. For example, under the NGGAS forest offsets may be claimed up to the level where it is 70% probable that increase in carbon stock is greater than the amount claimed.[44]

Tools suitable for estimating storage by a particular producer and to support participation in trading have also been developed, such as TimberCAM - Timber Carbon Accounting Model. However, these still require significant amounts of information to be available to the producer, in particular, about what products the wood will ultimately be used in. There is further scope to lower compliance costs through, for example, by adopting a factor-based approach to wood product destinations, based on a typical bundle of products for Australia. Alternately, a national estimate of carbon stored in wood products each year could be made by government with each producer able to apply for their share of the total pool.

3.3.4.1 Impermanence

A common requirement for offsets is that the emission saving be permanent. This requirement presents challenges in the context of wood products, as, while storage may be very long term, at the end of a product's life, the stored carbon is likely to be released.

One way to address impermanence is to manage credits in a pool. Each year the storage in new wood products is added to the pool and any products that have reached the end of their life are removed from the pool. Credits are claimed only for the net increase in carbon storage. This is similar to the approach used in national carbon accounting. However, from the perspective of an individual producer, this results in very long-term obligations that may act as a deterrent to participation.

As noted in 2.2 above, 100 years is sometimes taken as the threshold for recognition of impermanent carbon stores for greenhouse purposes. For example, in order to create a forest sequestration credit under the NGGAS, the forest owner must put systems in place to guarantee that the carbon will remain stored for 100 years.

Few wood products would have useful lives of 100 years. However, if recognition were also given that carbon remains stored in wood products after disposal, this 100-year benchmark would be reached for much of the wood produced in Australia. Thus, recognising landfill storage reduces the reliance on product life for determining the duration of carbon storage[45] and significantly lowers the transaction costs associated with trading, by avoiding the need for detailed product destination information.

However, it should be noted that there is a large amount of timber already in landfill. Whether timber is landfill is a net source or sink depends on the decomposition rate relative to the rate of addition to the landfill wood products pool. In order to receive the benefits associated with timber being added to landfill, the industry may need to take on the liability associated with the current landfill storage pool. This risk should be considered and weighed against potential benefits by the industry before adopting any position on credits for carbon stored in wood products in landfill.

3.3.4.2 Eligibility

If forest sequestration is taken as a model, eligibility for wood product sequestration credits may be restricted to forests that meet the criteria set out under the Kyoto Protocol and Marrakech Accords ('Kyoto-compliant forests').[46] Kyoto-compliant forests are those that have been induced by human activity on land that was not under forest on 31 December 1989.

It appears that this rule was chosen primarily as a political compromise to restrict the volume of forest credits that could be used toward targets under the Kyoto protocol. It does not relate to the actual ability of forests to sequester carbon, as any increase in forest cover, whether in existing or new forests, increases total sequestration. There is no such restriction under the UNFCCC, which adopts comprehensive carbon accounting. Accordingly, it is not clear whether this restriction would continue to apply to forests in any post-Kyoto agreement.

One possible rationale for the restriction of credits to Kyoto-compliant forests is that in mature forests, sequestration reaches close to a steady state, with little increase or decrease in stored carbon. Significant changes in carbon storage relate only to the clearing or planting of new forests, which are those that the Kyoto-compliant forest definition seeks to identify. Thus, the restriction can be seen as a simplifying assumption enabling focus to be on those forests with the greatest potential to increase or decrease carbon storage.

This rationale is not applicable to wood products. A mature forest can continue to contribute significantly to harvested wood product sequestration even when forest sequestration has stabilised. In fact, mature forests are likely to be able to sustain higher levels of harvest without diminishing forest size than new forests. Thus, it is particularly inappropriate to apply the Kyoto-compliant forest definition to wood product offsets.

It is open to any government in establishing a national carbon trading scheme to adopt rules different from those agreed between nations in the relevant international agreements.

If Australia chose to apply a Kyoto-compliant forest restriction to harvested wood products, this would limit the incentive of carbon credits to a small section of the industry. It is estimated that around 40% of the Australia's plantation estate would qualify as Kyoto-compliant forests.[47] Of these, around 73% is hardwood, much of which is short rotation plantings, primarily for wood chips.[48] Thus, only a small proportion of Australia's wood products are produced from Kyoto-compliant forests and restricting credits in this way would result in only a small proportion of the potential benefits to the environment and to the industry being achieved.

Another approach that would enable restriction of carbon credits, while still providing incentives to all growers would be to allow a proportion of the storage to be recognised for all harvested wood, in proportion to the share of Kyoto-compliant forests in the total plantation estate.

Offsets are only briefly addressed in each set of proposals for a national carbon trading scheme. Thus, it is not yet clear whether harvested wood products would be eligible for crediting under either.

The NETS proposals favour maintaining a high level of consistency with international agreements,[49] including adopting Kyoto-compliant forest restrictions for forestry offsets.[50]

The TGET proposals, while more brief, appear more favourable to harvested wood product credits, including them in a list of priority offset areas.[51] Further, the TGET proposals note that there is scope to improve on existing international methodologies for offsets and states that '[b]y establishing and demonstrating sink and offset methodologies … Australia would be well positioned to influence the evolution of international rules in this area'.[52] Australia is particularly well placed to make a contribution to international understanding of how to operationalise trading in harvested wood product credits.

4 Modelling

4.1 Modelling approach

A spreadsheet model was established to enable a range of scenarios to be examined.

The model has taken the emissions profiles set out in Table 2 above as its basis.

The price per tonne for each material assumed in the model is as follows:

- Aluminium $3,391;[53]
- Steel (blast furnace production) $741;[54]
- Steel (scrap-based electric arc furnace production) $564;[55]
- Cement $140;[56]
- Hardwood (rough sawn kiln dried) $900;[57] and
- Softwood (rough sawn kiln dried) $800.[58]

Emissions are split into direct and indirect electricity emissions for the purposes of identifying the impact under different scenarios. For timber products only energy emissions are considered, consistent with approaches likely to be adopted for carbon trading in Australia. Other indirect emissions, such as transport and offsite waste disposal have been excluded from the analysis. These are generally a minor part of the overall emissions profile of products.

Carbon prices are applied in proportion to the relevant emissions per tonne of material to determine the carbon cost per tonne of material under each scenario. Under carbon trading the cost of carbon will become a variable production cost.

As discussed in section 2.1 above, different quantities of each material will be required for a particular application. Thus, in considering the carbon cost impact for a particular product application, comparisons should consider both the emissions per tonne and the tonnage required of each material for the application being considered. An example of a product comparison is presented in section 4.2.5 below.

Results are gross cost impacts, without considering the potential for cost pass through or to reduce emissions internally at a cost lower than the market price for carbon. This assumption is discussed further below (section 4.2.1).

The modelling in this report treats the carbon price as independent of other aspects of the carbon pricing regime such as sector coverage. However, in practice, carbon prices are determined by supply and demand for tradeable permits and demand is strongly affected by a range of factors including sector coverage.

Other assumptions relevant to each scenario modelled are discussed in the modelling results (section 4.2 below).

Throughout, the modelling, results focus on a central scenario of broad emissions coverage and a $30 carbon price, which is a possible medium-term outcome.

4.2 Modelling results

4.2.1 Carbon prices

Future carbon prices are highly uncertain, especially in the absence of specific regulatory proposals. Forecasts of future carbon prices vary significantly depending on the assumptions adopted. Some detailed attempts to model carbon price outcomes resulted in estimates of:

- \$186 per tCO_2-e in 2050 - Allen Consulting Group modelling of an 'early action' scenario to reduce greenhouse gas emissions by 60 percent from year 2000 levels by 2050.[59]
- \$77 to \$525 (2005 A\$) per tCO_2-e in 2050 – Australian Bureau of Agricultural and Resource Economics (ABARE) modelling across a range of scenarios to reduce global CO_2 emissions by 40% by 2100 relative to the reference case.[60]

These variations result in part from different reduction targets contemplated, but also reflect uncertainty about how costly it will be to achieve the targeted greenhouse gas reductions.

As discussed in section 3.3.1 above, neither the TGET nor the NETS proposals contain any specific guidance on targets or likely carbon prices. However, NETS modelling predicted carbon prices associated with the *indicative* short-term targets would initially be in the range of \$6-12 per tCO_2-e rising to around \$28-34 per tCO_2-e by 2030.

The following carbon prices have been used in the modelling:

- \$10 – A possible near-term price in the early years of trading;
- \$30 – A possible medium-term price; and
- \$50 – A possible long-term price during later phases of trading when deep cuts are pursued.

The cost impact of these carbon prices on wood and competitor materials is shown in Figures 2 and 3 below for a scenario that shows close to the full potential of a carbon trading scheme (a comprehensive carbon regime). Aluminium is shown on the right axis, due to the difference in scale of the impact.

As discussed elsewhere (see for example section 3.3.3 above), near term impacts are likely to be lower.

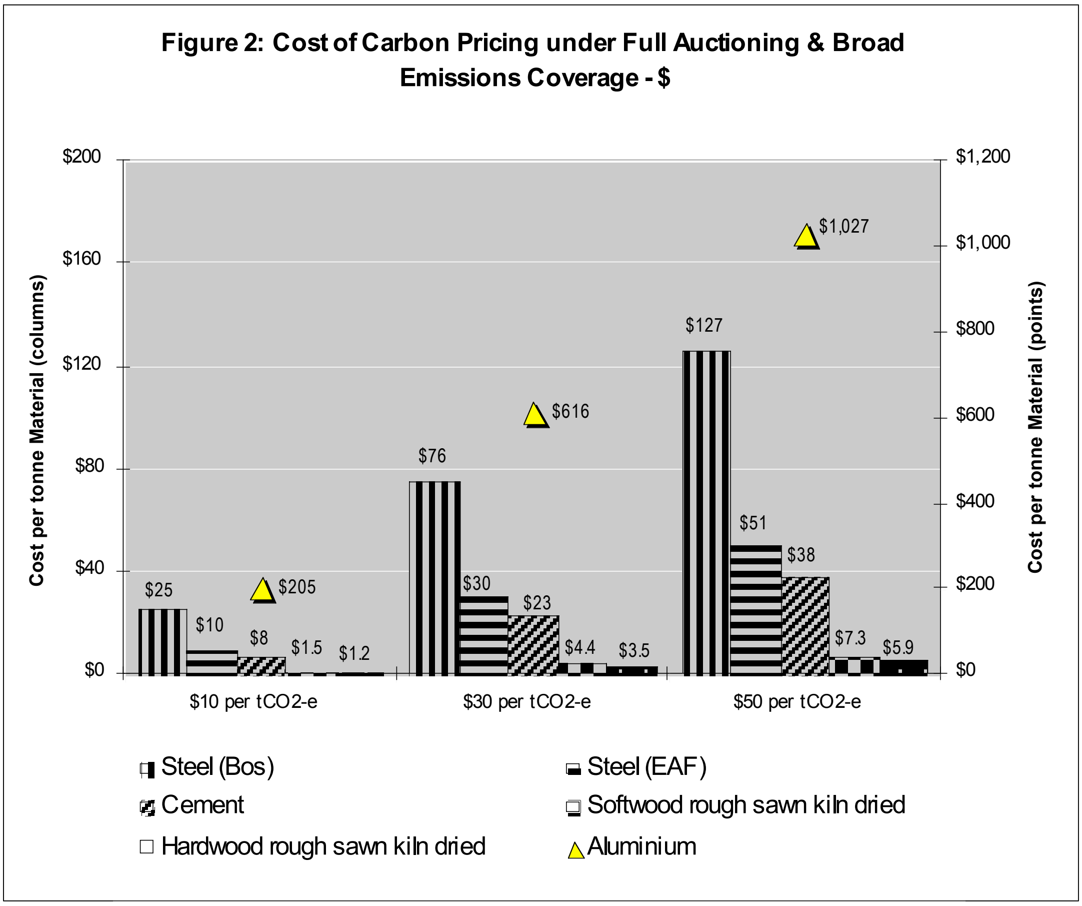


Figure 2: Cost of Carbon Pricing under Full Auctioning & Broad Emissions Coverage - $
Cost per tonne Material (columns)
Cost per tonne Material (points)
$200
$160
$120
$80
$40
$0
$1,200
$1,000
$800
$600
$400
$200
$0
$25
$10
$8
$1.5
$1.2
$205
$76
$30
$23
$4.4
$3.5
$616
$127
$51
$38
$7.3
$5.9
$1,027
$10 per tCO2-e
$30 per tCO2-e
$50 per tCO2-e
Steel (Bos)
Steel (EAF)
Cement
Softwood rough sawn kiln dried
Hardwood rough sawn kiln dried
Aluminium

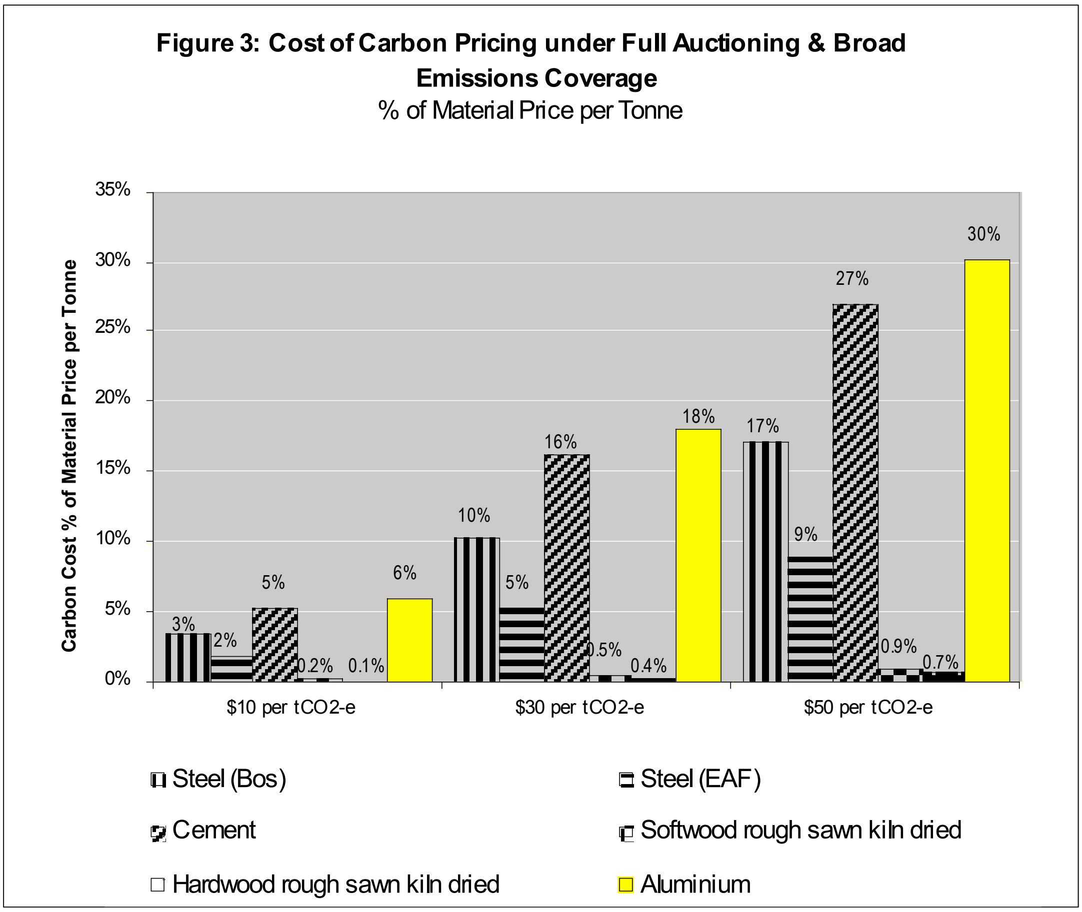


Figure 3: Cost of Carbon Pricing under Full Auctioning & Broad Emissions Coverage
% of Material Price per Tonne
Carbon Cost % of Material Price per Tonne
35%
30%
25%
20%
15%
10%
5%
0%
3%
2%
5%
0.2%
0.1%
6%
10%
5%
16%
0.5%
0.4%
18%
17%
9%
27%
0.9%
0.7%
30%
$10 per tCO2-e
$30 per tCO2-e
$50 per tCO2-e
Steel (Bos)
Steel (EAF)
Cement
Softwood rough sawn kiln dried
Hardwood rough sawn kiln dried
Aluminium

Carbon pricing under this scenario results in far lower impacts on timber than on its key competitors. At a carbon price of $30 per tonne, the impact as a percentage of the price per tonne of material is less than 1% for rough sawn hardwood and softwood, compared to EAF steel (5%), blast-furnace steel (10%), cement (16%), and aluminium (18%).

The elasticity of demand (the extent to which customers respond to price increases by reducing the amount they consume) determines whether the supplier or customer bears this cost - the higher the elasticity of demand, the greater proportion borne by the supplier. In the context of carbon trading, products with the highest elasticity of demand are those that are internationally traded and undifferentiated commodities. This is because, in the absence of similar carbon pricing regimes in all competitor countries, prices will be set in international markets without reference to carbon prices. So, there will be very limited opportunity to pass through increased costs. Thus, aluminium, blast furnace steel, and, to a lesser extent, cement are particularly exposed. However, even these materials are likely to be able to pass through some cost increase, particularly on production for domestic consumption.

High carbon prices entail severe cost impacts for emissions-intensive products, such as aluminium and, to a lesser extent, cement, and steel. If emissions-intensive activities cease to cover variable costs of production they would choose to shut down rather than operate at a loss.

Increases in the carbon price result in broadly proportionate increases in modelled cost impact. If the potential for in-house abatement and cost pass through were included, this may alter the pattern of increase, as higher carbon prices would:

- Make cost pass through more difficult, as the elasticity of demand will be higher at higher prices. Most products would face a ceiling price beyond which consumers would cease to use that product and switch to alternatives.
- Result in an increasing amount of in-house abatement. At low carbon prices, it is expected that there would be minimal opportunities to reduce emissions at costs lower than market prices. This is particularly the case in sectors where there are existing greenhouse gas emission reduction programs. The more the carbon price increases, the more in-house abatement is likely to become economic.

These two factors operate against one another. Which factor is dominant at a given carbon price will vary from product to product.

All the modelled materials face competition either from imports or from substitute products and, thus, all face comparatively high elasticity of demand. Nonetheless, there are some differences in the ability to pass through costs. Overseas studies indicate that aluminium has a particularly high elasticity of demand, followed by blast-furnace steel, and cement.[61] For cement, proximity to seaports is a key determinant of elasticity. Cement can be transported for long distances at sea at comparatively low cost, whereas land transport is cost prohibitive and so acts as a barrier to trade.

Abatement opportunities are likely to differ more between products, and thus be more significant, than elasticity differences.

Energy efficiency represents an emissions reduction opportunity for all materials. Those competing most in international markets, such as aluminium, blast-furnace steel, are likely to have the least unexploited potential to reduce energy-related emissions. But even here, opportunities remain. For example, Australian steel producers use around 26 gigajoules (GJ) of energy per tonne of steel produced, compared to Japan's average of 22 GJ and worlds' best practice of 19 GJ per tonne.[62]

Where the majority of energy-needs are met from electricity rather than direct energy, as with aluminium and EAF steel, reduction opportunities are likely to be more limited, as reductions must focus on reducing electricity and cannot influence the emissions intensity of generation. However, at high carbon prices, on-site generation may become viable.

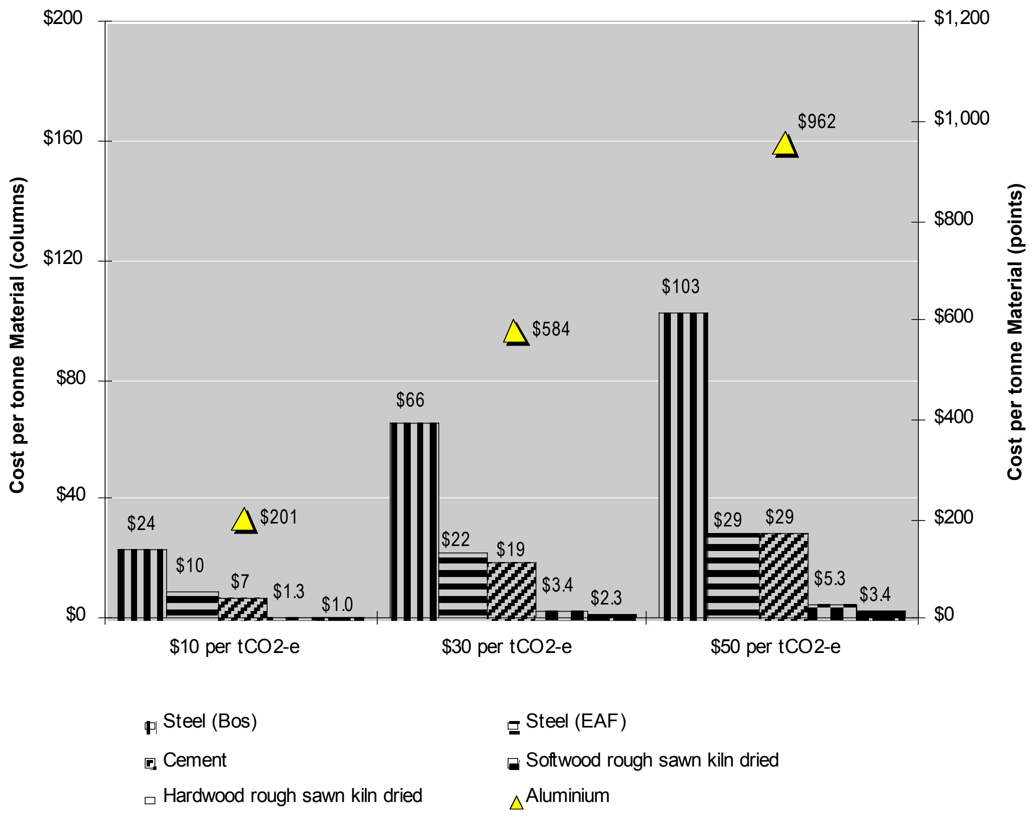
Wood may be able to further reduce energy emissions by increasing use of residues for energy. However, it is not clear to what extent residues are currently under-utilised. A potential flow on affect is that products that use residues as an input to production may see increased prices as carbon pricing increases demand for wood residues for fuel. Further work is required to clarify the significance of this opportunity for the industry and to examine potential flow on effects. Beyond increased use of residues, abatement opportunities would be limited.

There is also some emission reduction potential for materials with significant process emissions - emissions that result from the chemical processes of manufacture. Increased use of supplementary cementious materials in cement is a particularly significant opportunity. Increased use of scrap as a feedstock to blast furnace steel production offers some potential, but is constrained by scrap-availability. There is also some potential for aluminium smelters to reduce emissions of perflurocarbon emissions (a powerful greenhouse gas) through changes in processes and technology upgrades.

However, all of these materials face technological limits to emissions reductions. While some reductions may be possible, there is a level beyond which further reductions cannot be achieved without adopting a different technology. No such 'break-through' technologies are yet available. Thus, if these materials were exposed to high carbon prices in the short-term, it is likely that reduction opportunities would be fully exploited and all would face the market price for carbon on the bulk of their output.

Figure 4 illustrates how in-house abatement can reduce carbon cost impacts. There is very little information available upon which to base specific estimates of abatement potential for different materials. Accordingly, values should be considered illustrative only and do not reflect actual abatement cost or potential at each carbon price.

Figure 4: Cost of Carbon Pricing under Full Auctioning & Broad Emissions Coverage - $ - With In-house Abatement



In this example, it is assumed that a percentage of carbon abatement can be met in-house for each material at an average price equal to half the market price for carbon. As the carbon price increases, an additional percentage of abatement is assumed to be able to be met in house, as the higher carbon price makes additional abatement options economically viable.

Thus, for BOS steel in house abatement reduces carbon costs by only 5% at a carbon price of $10 per tonne, but this increases to an 18.5% reduction in carbon cost at a carbon price of $50 per tonne

EAF steel production is assumed to have very limited abatement potential until the carbon price reaches $30 per tonne. At a $10 carbon price, in house abatement reduces carbon costs by only 2.3%, whereas at a $30 carbon price, the reduction in 27%. This is consistent with a step-change in the abatement cost curve, where at a particular carbon price, a large internal abatement project becomes viable. For EAF, this could be on-site electricity generation, for example.

4.2.2 Emission coverage

The two current proposals for an Australian national carbon trading scheme have been used as the basis for the emission coverage scenarios in the modelling:

- TGET or broad coverage – includes including all energy, industrial and fugitive emissions.

- Initial NETS or narrow coverage – includes only the stationery energy sector (electricity generation) only.

Modelling has not considered any minor difference between which electricity generating units the two sets of proposals would apply to.

The impact of different emissions coverage on the carbon cost per tonne of each material is shown in Figures 5 and 6:

Figure 5: Impact of Emissions Coverage on Carbon Cost
($30 Carbon Price, Full Auctioning) - $

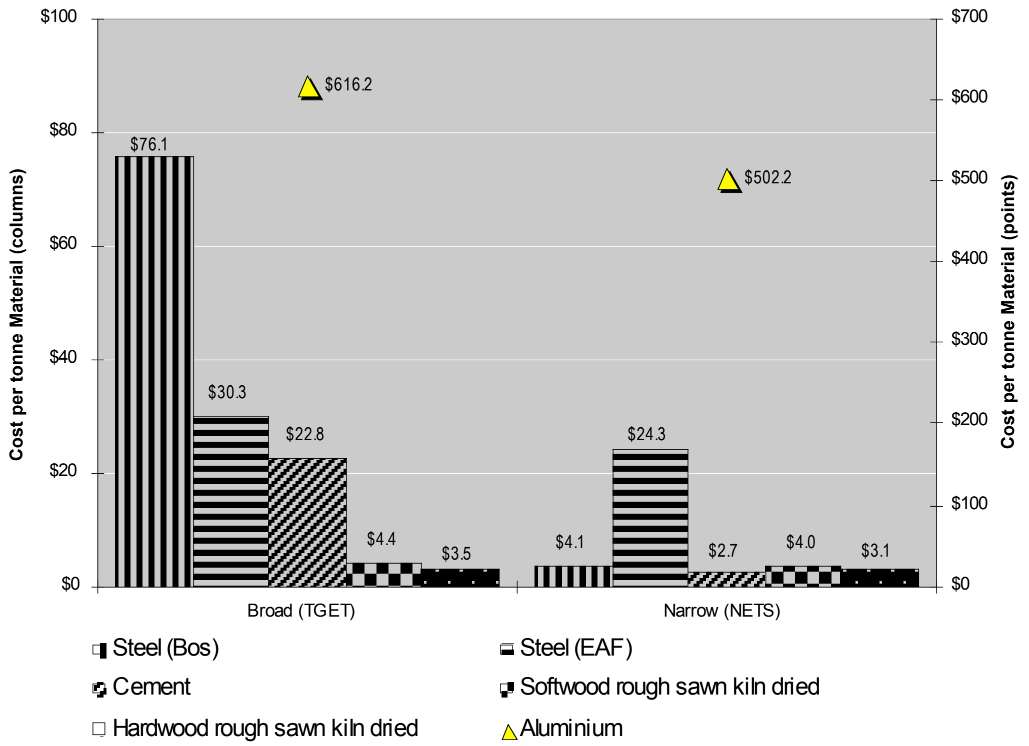
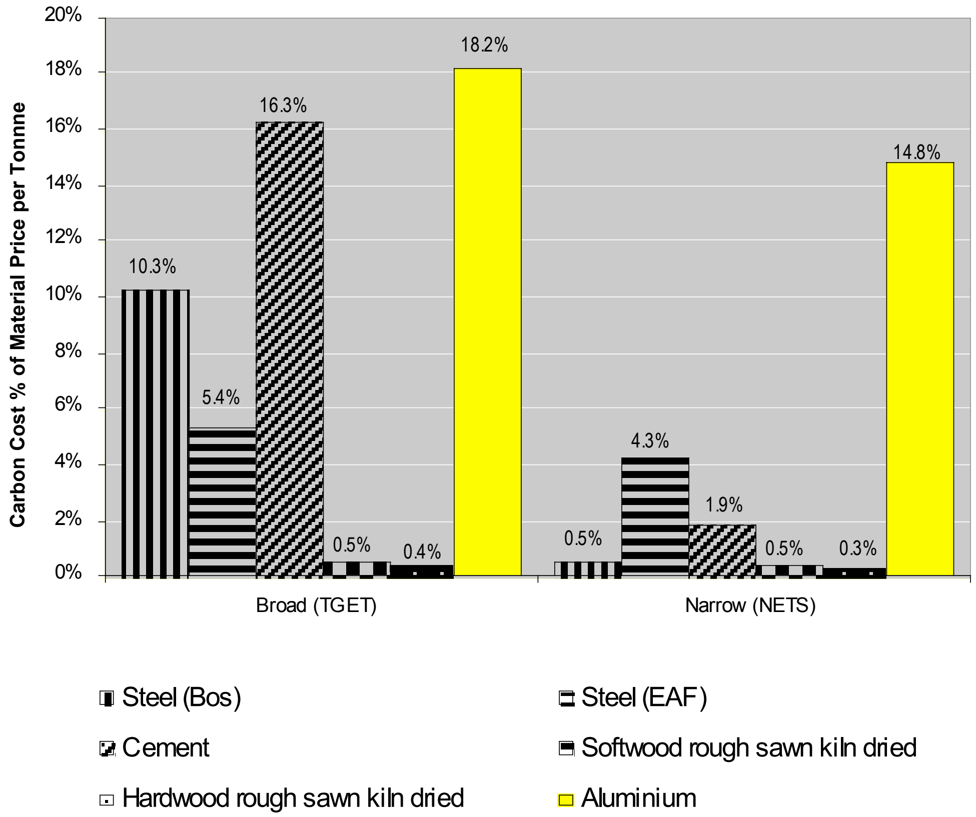


Figure 6: Impact of Emissions Coverage on Carbon Cost
($30 Carbon Price, Full Auctioning)
% of Material Price per Tonne



From these results it can be seen that:

- More narrow coverage significantly reduces the cost impact of carbon pricing for most materials.
- Different products fare differently under a more narrow coverage, depending on the share of electricity emissions in their total emissions profile:
  - Blast furnace steel is the greatest beneficiary of narrow coverage, as it has the greatest proportion of direct emissions. The cost impact as a percentage of material price per tonne reduces from 10.3% under broad coverage, to 0.5% under narrow coverage.
  - The different approaches to coverage do not alter the impact on wood significantly as the majority of emissions subject to carbon pricing under either coverage approach relate to electricity.

For wood products a more comprehensive coverage of emissions, including all energy emissions and process emissions, would be preferable to a narrow coverage focussed only on electricity.

4.2.3 Permit allocation methods and concessions

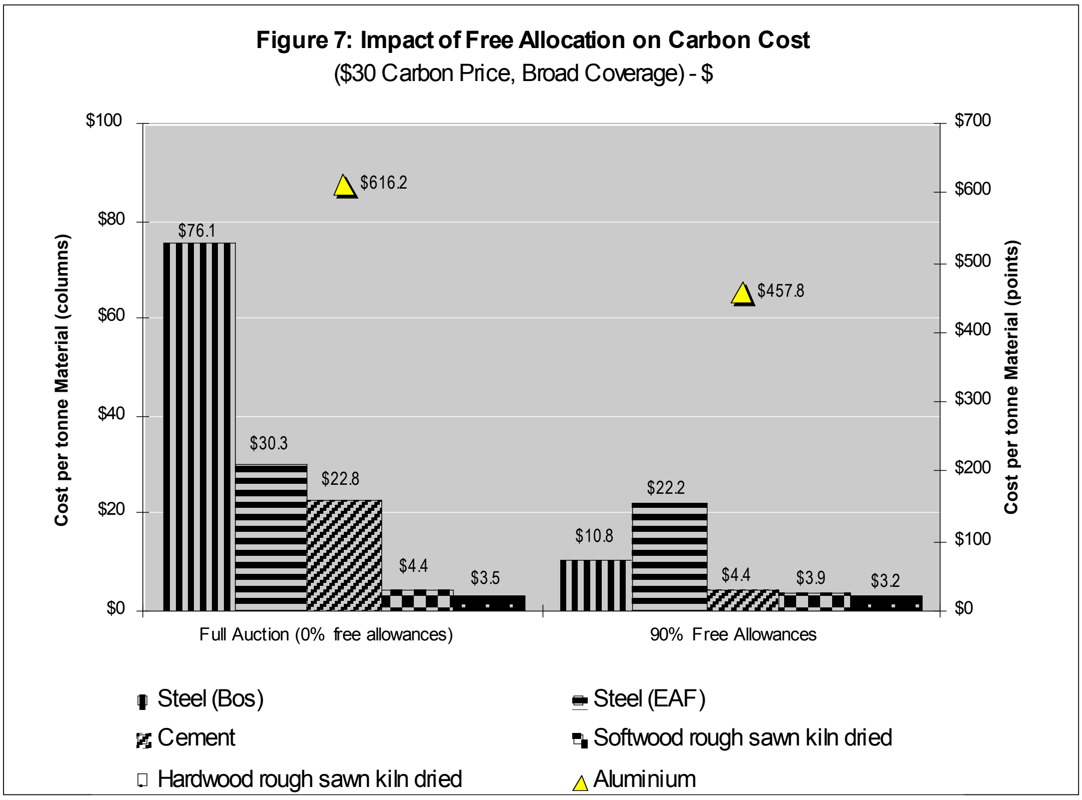
Modelling has considered the following approaches to permit allocation:

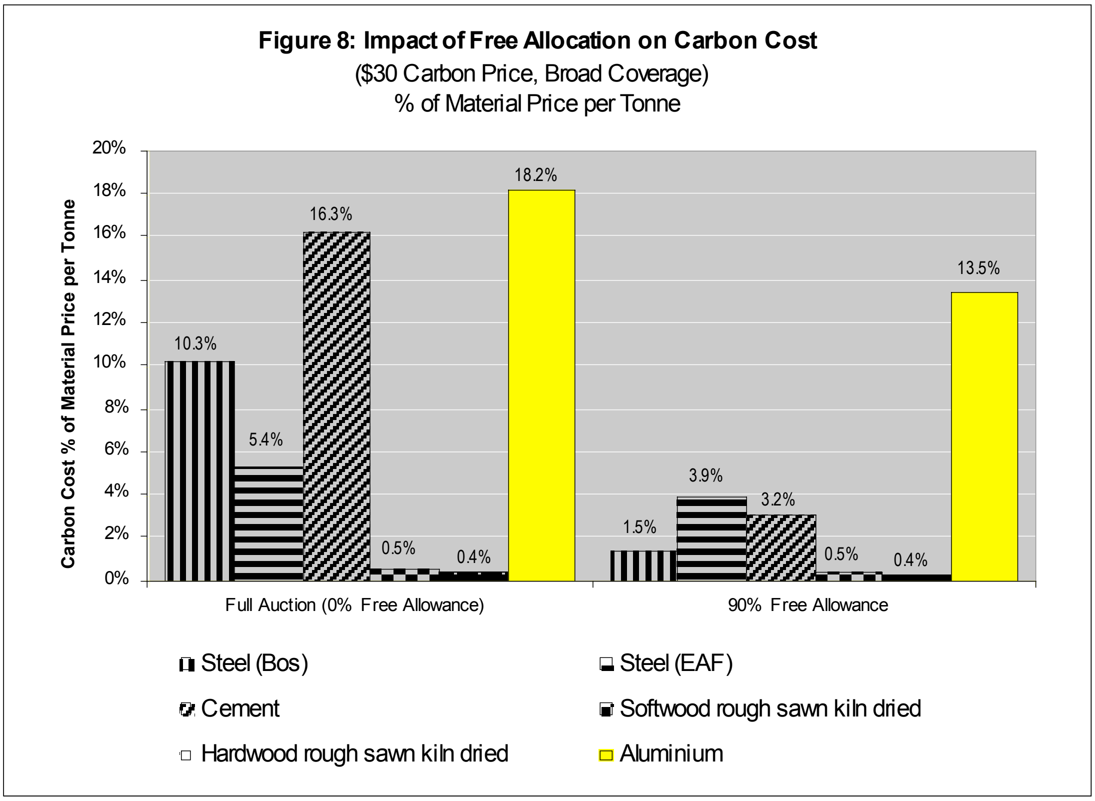
- 100% auctioning - where participants are required to pay for all permits.
- 90% free allocation – where participants are required to pay for only 10% of required permits.
- Free allocations used to compensate for loss of value in adversely impacted companies.
- Free allocations to energy-intensive trade-exposed industries to eliminate the cost impact of carbon pricing as well as to other companies compensate for loss of value.

Under 100% auctioning, the carbon price becomes a cash cost that generators must recover in order to be remain profitable. Because electricity has a particularly inelastic demand, high levels of pass through would be possible. For modelling purposes, we have assumed that electricity generators will pass through close to the full cost of carbon (90%) in electricity prices.

Where free allocations are granted, the carbon price is only an opportunity cost, as generators have not had to pay anything for the permits. Despite the fact that their underlying costs have not increased, it is expected that generators will seek to recover this opportunity cost through increased electricity prices (as discussed in section 3.3.3 above). The key determinant of the extent of pass through will be the level of competition between generators. Where there is an excess of demand for electricity, such as currently exists in the national electricity market, it is likely that a large proportion of the carbon opportunity cost will be passed through to customers. For modelling purposes, we have assumed that cost pass through under free allocations is only slightly lower than under auctioning (80%). That very high levels of pass through can be expected, even where there have been extensive free allocations, is supported by experience under the EU ETS.

The impact on wood and key competitors of full auctioning is compared to 90% free allocations in Figures 7 and 8:





Compared to full auctioning, under free allowances:

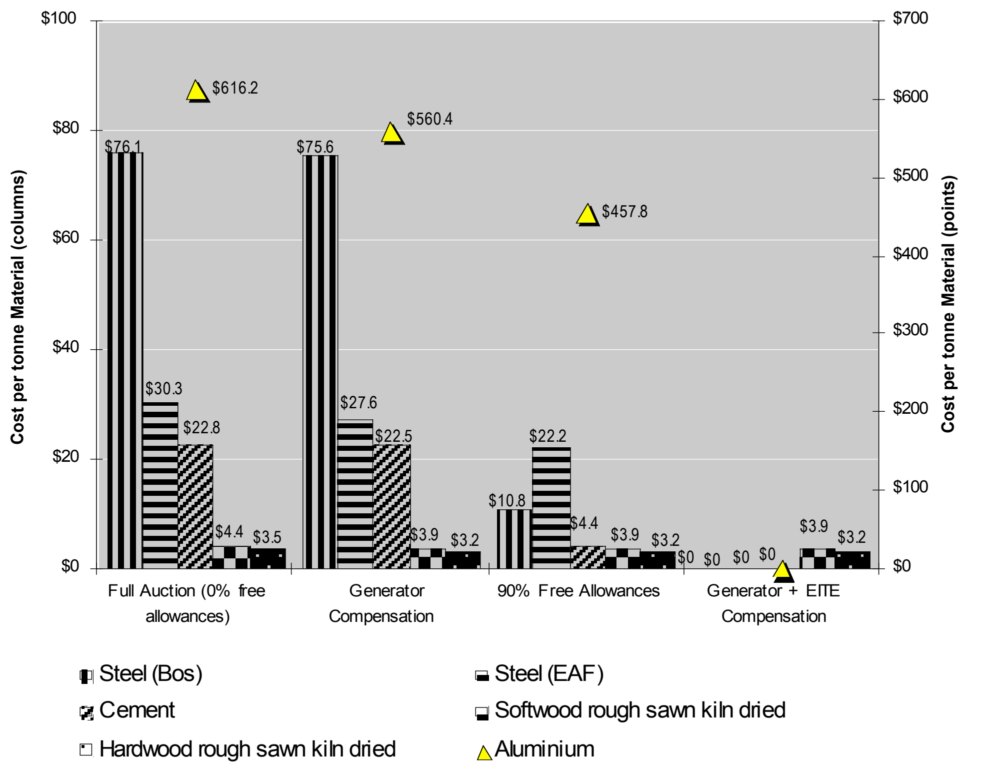
- Costs associated with direct emissions are proportionately reduced.
- The cost of indirect electricity emissions are reduced only slightly, due to opportunity cost pricing.

Thus, blast-furnace steel, which has the highest proportion of direct emissions, benefits greatly from free allowances (the impact reduces from 10.3% of the price per tonne of material to 1.5%), aluminium also benefits (the cost impact reduces from 18.2% to 13.5% of the price per tonne of material), and wood products not at all.

Where free allowances are provided as compensation for loss of value from carbon pricing, it is expected that a large number of electricity generators (particularly the most emissions-intensive coal generators) would qualify for compensation. However, this is not expected to impact cost pass through by compensated industries. So, compensatory allocations have little impact on downstream entities not in direct receipt of compensation.

The results of providing compensation to generators but not emissions-intensive trade-exposed industries are shown in Figures 9 and 10, labelled 'Generator Compensation'. This illustrates how eliminating the loss of value suffered by generators has little benefit for downstream industries. For example, the impact on BOS steel is to reduce the cost impact be 0.1% in terms of price per tonne of material (from 10.3% to 10.2%), compared to a reduction of 8.8% (reducing from 10.3% to 1.5%) where 90% free allocations are used.

Figure 9: Impact of Permit Allocation Method on Carbon Cost
($30 Carbon Price, Broad Coverage) - $



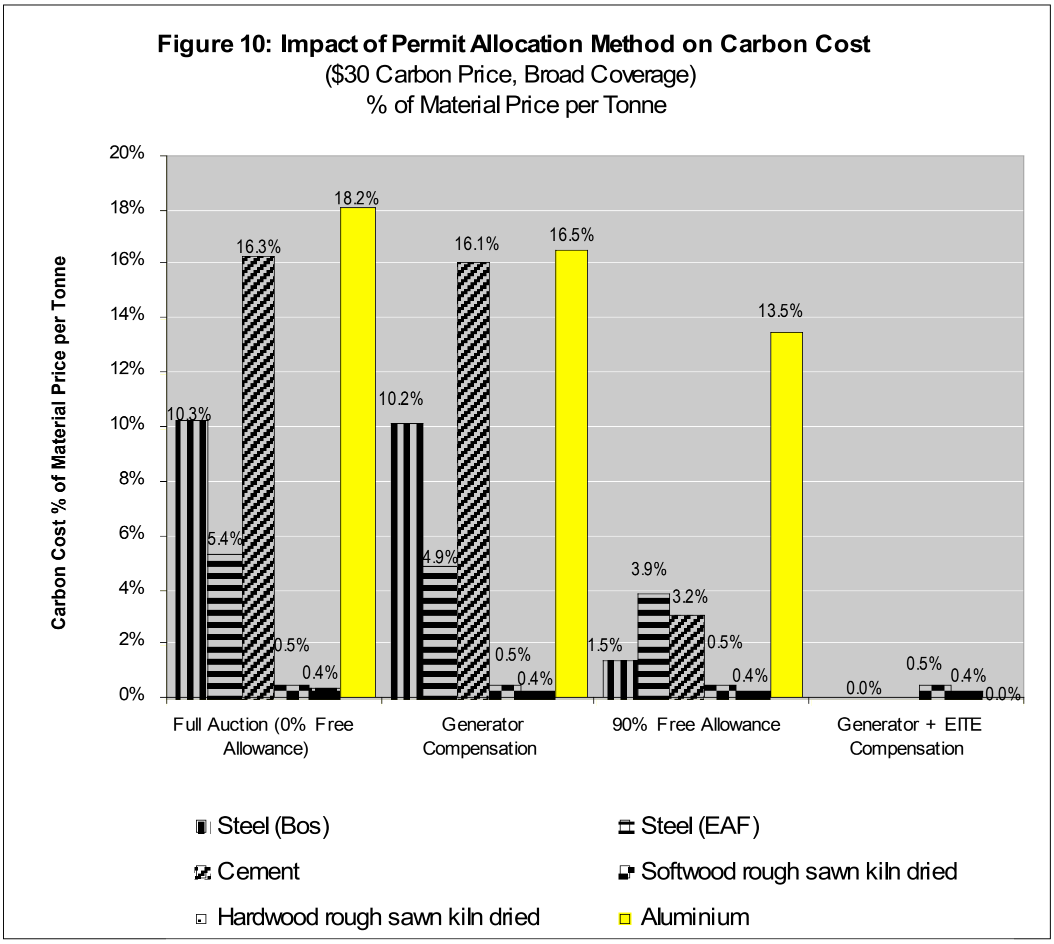


Figure 10: Impact of Permit Allocation Method on Carbon Cost
($30 Carbon Price, Broad Coverage)
% of Material Price per Tonne

Under compensatory allocations, it is not clear what proportion of permits would be allocated free to each sector. While the economic literature suggests that even those sectors most affected by carbon pricing need less than 50% of their permits allocated freely,[63] this does not necessarily translate to 50% of the required permits per unit output.

The economic studies have typically assumed that output from affected industries would decrease. Assuming that they were allocated permits based on historical levels of output and emissions, the proportion of permits allocated free per unit of output would be higher than the overall proportions stated. For example, if a company was allocated permits equivalent to 50% of its historical emissions and its output contracted by 30%, the proportion of free permits per unit output increases to 71%.

Further, there have not been any detailed studies completed in an Australian context. Accordingly, in the modelling we have assumed that compensatory approaches will fully eliminate cost impacts per unit output and no more.

The scenario where compensatory free allocations are provided for loss of value and to emissions-intensive trade-exposed industries is shown in Figures 9 and 10, labeled ‘Generator + EITE Compensation’.

Under this scenario any positive relative cost impact from carbon pricing for wood products is eliminated. Most of wood’s key competitors are fully shielded from the cost impact of carbon pricing. This leaves wood, as an uncompensated industry, in a worse competitive position as a result of carbon pricing, despite its low emissions status.

4.2.4 Treatment of carbon stored in wood products

Carbon storage associated with wood products, as discussed in section 2.2 above, includes:

- Carbon that has been absorbed as the wood grows, which remains stored in the wood product during its service life;
- Wood residues from production of timber products and other forms of wood waste that are used as an energy source result in an emission saving when used to displace fossil fuel energy sources; and
- Wood products and residues that are disposed of in landfill, which have been found to store carbon for long periods after disposal.

All of these carbon stores (and savings) have potential to be recognised as abatement (or offset) activities under a carbon trading scheme.

Five possible approaches to recognising the carbon stored in wood products have been modelled:

- No wood product credits (base case).
- Partial credit allowed for carbon stored during the product's life. A partial credit would be consistent with an approach that includes an allowance for uncertainty. Seventy percent has been used in the modelling.
- Full credit allowed for carbon stored during the product's life.
- Credit allowed for carbon stored during the product's life and in landfill after disposal.
- Credit for all emissions savings associated with wood products – storage while in service, storage after disposal in landfill, and fossil fuel displacement from residues associated with the products production.

For modelling purposes, the amount of carbon stored has been estimated using TimberCAM for a long-lived product (service life of 50 years), using the default values for the 'hardwood' and 'softwood' product categories.[64]

TimberCAM assumes that a small amount of the stored carbon is released over the product's service life. In the modelling, we have used the value at the end of the storage life (the minimum storage that exists over the entire period).

For carbon storage in wood products in landfill, it is assumed that a small proportion of carbon (3% over 100 years) is released over the landfill storage period. This amount has been excluded from the stored carbon, but the emissions have not been netted off against storage. As methane is a more potent greenhouse gas than carbon dioxide, netting off would result in a reduction in carbon storage recognised. However, as only very small amounts of methane are released, this is not considered significant to the results.

Where fossil fuel displacement is considered, the saving is calculated on the basis that the wood is displacing use of fuel oil.

While fossil fuel displacement is likely to receive recognition under carbon trading, it is not clear to whom the credit would accrue. Not all of the wood used for energy is used by the timber producer or even within the timber industry. It is likely that the credit would accrue to the user of the wood as fuel. Thus, the benefit to the timber industry may be limited to its own use of wood for energy.

Figures 11 and 12 show the impact of the different approaches to timber product credits under both a full auctioning scenario and one where compensatory free allocations are provided.

Figure 11: Impact on Carbon Cost of Approach to Wood Products - $
($30 Carbon Price, Broad Coverage, 100% Auctioning)

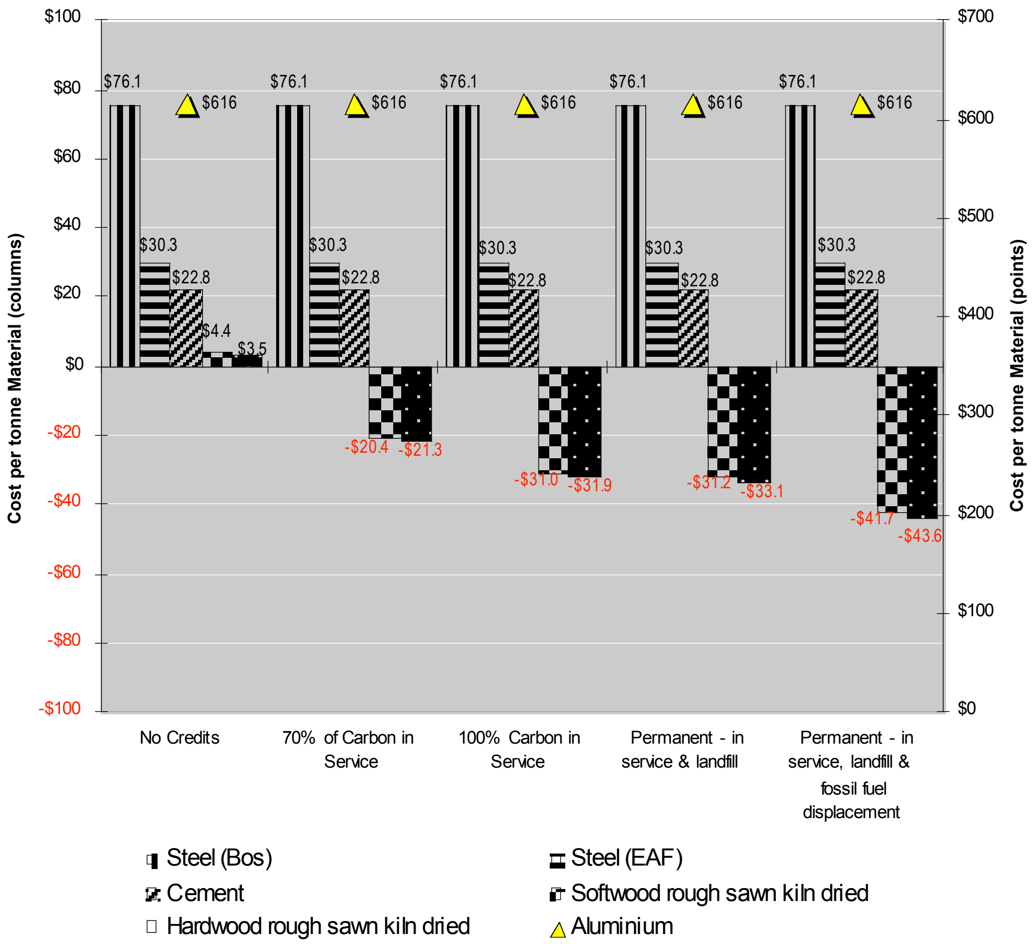
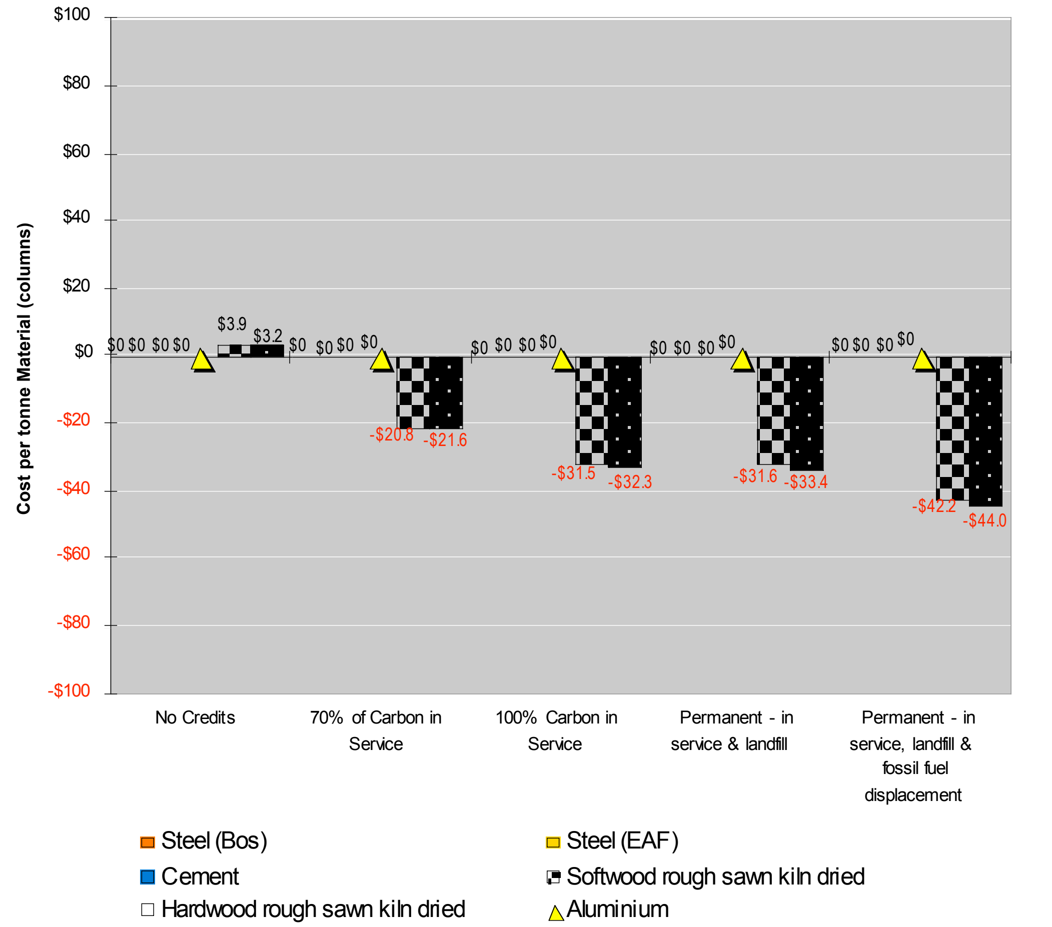


Figure 12: Impact on Carbon Cost of Approach to Wood Products - $
($30 Carbon Price, Broad Coverage, Compensatory Free Allocations)



All of the modelled approaches to harvested wood product credits would result in a significant benefit under a full auctioning scenario. At a carbon price of $30, full recognition of the carbon benefits of timber products results in a positive cost impact (i.e., net cost saving/source of revenue) for timber of $43.6 for hardwood and $41.7 for softwood. All of timber's competitors face a negative cost impact, ranging from $22.8 per tonne of material for cement to $616 for aluminium. However, as noted previously 100% auctioning is unlikely to be adopted except in the long term.

Even under a more realistic medium-term scenario, where free allocations are given to competitor industries, allowing credits for carbon storage in wood products results in some competitive advantage flowing to wood products under all approaches, helping to reduce the negative impact of the concessions likely to be provided to wood's key competitors. However, there are a number of potential restrictions on wood product credits, which are discussed below.

In this example, as the carbon stored during the product's life is the largest carbon pool, recognition of this results in most of the potential benefit of wood product credits being realised (73% of the maximum benefit). Recognition of fossil fuel displacement is the next most significant contributor (an additional 24%), with only modest benefit associated with recognition of carbon storage in wood products in landfill (2.5%).

While recognition of landfill storage is not significant to the quantum of the benefit from wood product credits, it may be important in addressing concerns about impermanence, as discussed in section 3.3.4.1 above, and, thus, may still be a significant issue for the industry.

4.2.4.1 Impact of potential restrictions on wood product credits

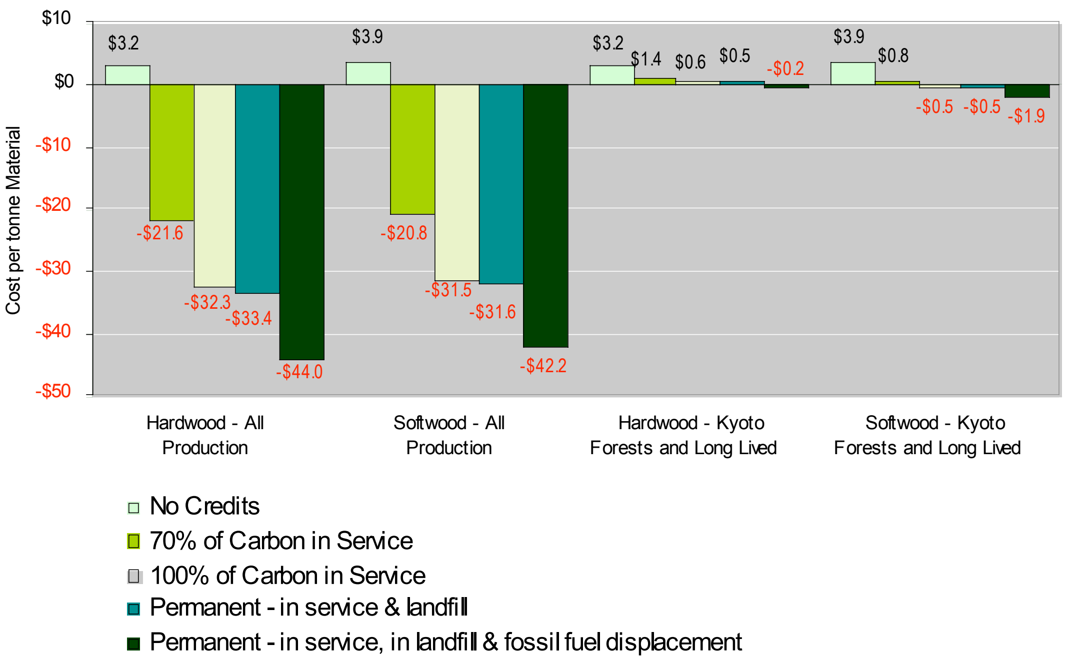
There are a number of potential restrictions on wood product credits.

Importantly, wood product credits are likely to be available only for some wood uses - those that are long-lived. For example, it is unlikely that wood used in paper production would be eligible and this is a large proportion of hardwood production. In Australia, the proportion of removals that go to long lived products is around 73% for softwoods and only 10% for hardwoods.[65] This would significantly reduce the benefits modelled above, especially for hardwoods.

As noted in section 3.3.4.2 above, eligibility for credits may be restricted to 'Kyoto-compliant forests' - those that have been induced by human activity on land that was not under forest on 31 December 1989. It is estimated that around 40% of the Australia's plantation estate is Kyoto-Compliant and approximately 73% of Australia's Kyoto-compliant forests are hardwood.[66] However, these Kyoto-compliant forests produce only a small proportion of sawlogs (which may be used in long-lived wood products), with the majority of production for pulp wood chips.

Figure 13 shows the combined impact of these two restrictions compared to a scenario where full credits are available for all production. In this example, we have assumed that the proportion of production from Kyoto-compliant forests that goes to long-lived products is 7.2% for hardwoods and 12.6% for softwoods.[67]

Figure 13: Impact of Restrictions on Wood Product Credits
$ ($30 Carbon Price, Broad Emissions Coverage, Compensatory Free Allocations)



The combined impact of these restrictions undoes most of the potential benefit from wood product credits for the industry. Under a scenario where competitors receive free allocations, hardwood would be worse off than its competitors under all approaches to wood product credits. Softwoods would still receive some competitive benefit under some scenarios, but the significance is greatly reduced.

While the restriction based on service life may be valid from the perspective on environmental benefit achieved, this is not so of the Kyoto-compliant forests restriction, as all forests - both Kyoto-compliant and non-compliant - have equal potential to add to the carbon stored in wood products.

4.2.5 Carbon impact on products - windows

The way in which carbon prices impact on product cost and prices will depend on both the relative emissions intensity of the input materials and the amount of different materials required for the product application. This is illustrated in Figures 14 and 15 in relation to window systems made from different framing materials.

The modeling has used the average cradle to gate emissions per square meter of window (kg CO_2-e/m^2) for each type of window system in the study.[68] All emission sources are included in the scope of the analysis, including indirect emissions from electricity, fugitive emissions, and transport emissions to the gate, but excluding transport emissions in distribution.[69]

Modeling considers emissions in producing the window system only. These emissions will impact the production cost under a carbon pricing regime. Where this additional cost flows through to purchase price of the window systems this will have the potential to influence consumer preferences. Consumer preferences may also be influenced by the impact of carbon pricing on operational costs. The type of window system affects heating and cooling needs and, hence, energy demand. Differences between window systems in terms of operational cost are expected to be accentuated by carbon pricing. However, the principal driver of these differences is the type of glazing, rather than the framing material.

Figure 14: Carbon Cost Impact on Window Systems - Single Glazed

(100% Auctioning, Broad Coverage, $30 Carbon Price)

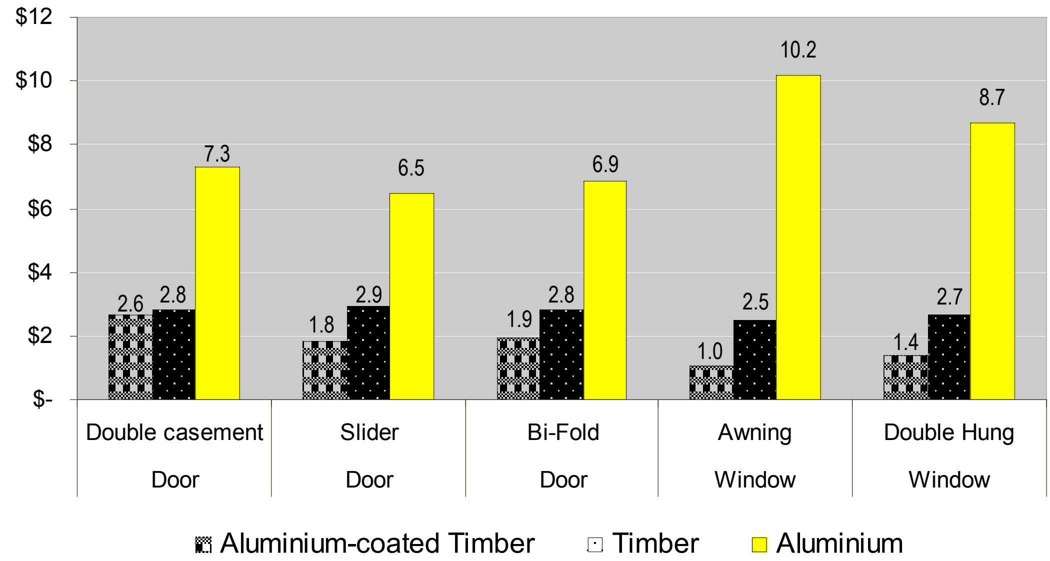
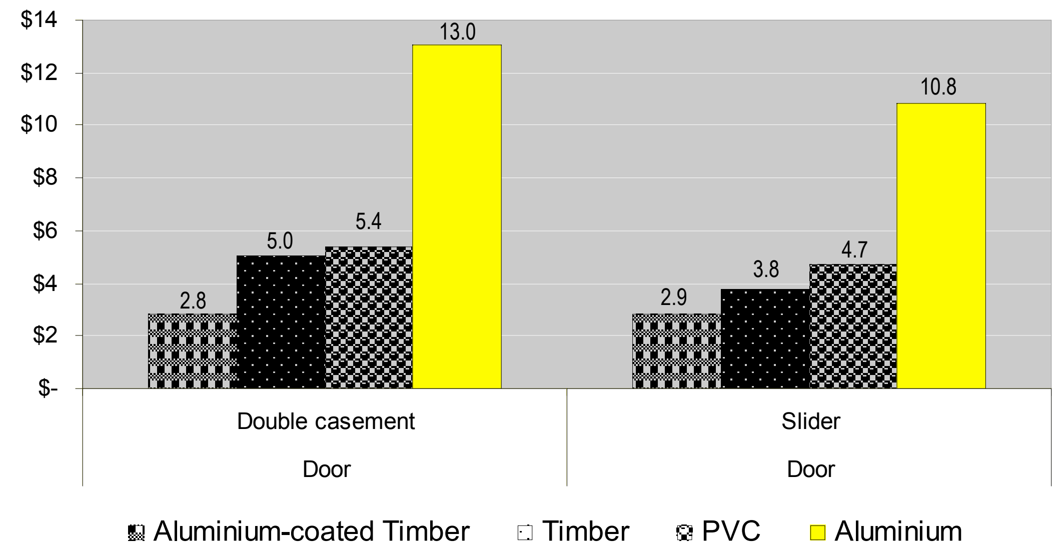


Figure 15: Carbon Cost Impact on Window Systems - Double Glazed
(100% Auctioning, Broad Coverage, $30 Carbon Price)



Under a full cost carbon pricing regime (100% auctioning of permits), aluminium window systems experience the largest cost impact – in the range of 2 to 4 times the impact experienced by timber windows. In the most extreme case of single-glazed awning window systems, the modeled impact on aluminium windows is $10.2, compared to $2.5 for timber and $1 for aluminium-coated timber windows.

While these differences are significant, they are smaller than the differences in impact per tonne of material, principally due to the different tonnage of each material required for the application. This highlights the importance of product specific analysis.

The modelling assumes a full cost regime, where all greenhouse gas emissions are fully priced for each material. Thus, near term impacts are likely to be lower. In particular, if aluminium is given special treatment as an emissions-intensive trade-exposed industry, aluminium products will experience no carbon cost impact, leaving all competitor materials comparatively worse off. In this case, aluminium windows would receive a competitive boost from carbon pricing and the cost impact on aluminium-clad timber windows would be reduced.

5 Summary and conclusions

Use of wood products results in greenhouse benefits in a number of ways:

- The manufacture of wood products results in lower emissions than competitor products in many applications.
- Wood products store carbon during their useful lives and may continue to do so much longer if disposed of in landfill.
- Wood residues and products discarded at the end of their useful life can be used as a carbon-neutral energy source,[70] displacing emissions-intensive fossil fuels.

Despite this, there is a high risk that carbon trading will be implemented in such a way that it will negatively affect wood's position relative to its key competitors.

Modelling shows that the most significant issue for wood is the potential for emissions-intensive and trade-exposed industries to be compensated for the impacts of carbon trading.

Under both current proposals for an Australian national carbon trading scheme the majority of wood's key competitors, including, aluminium, steel, and cement, are likely to be eligible for compensation. To the extent that compensation is provided, these materials will be sheltered from the cost impacts of carbon pricing. This prevents wood from realising the benefits of its low emissions status. Rather wood, as an uncompensated industry, may be left in a worse competitive position as a result of carbon pricing. For example, where compensatory free allocations are provided to wood's key competitors, wood products have the highest impacts – 0.5% increase in cost as a percentage of price per tonne of material for softwood, 0.4% for hardwood and 0% for all competitor materials (steel, cement, and aluminium). This contrasts with a 90% free allocation approach (another possible near term scenario), which would result in wood having a smaller cost impact than all of the competitor materials modelled. Impacts under the 90% free allocation approach as a percentage of price per tonne of material range from 3 times the impact on wood for BOS steel to 27 times for aluminium.

The other critical issue for the wood products industry is whether the carbon storage in harvested wood products is recognised under the trading scheme and on what basis. The carbon stored in harvested wood products far exceeds any emissions associated with their production. Thus, recognition of this carbon storage has the potential to eliminate fully any cost impacts of carbon trading on wood products.

If international approaches are adopted in Australia, carbon credits for wood products may only be available where carbon is stored for very long periods (e.g. greater than 100 years). If so, recognition of carbon stored in wood products in landfill after disposal may become significant as it has the potential to greatly extend the period of storage and, thus, address concerns about the impermanence of the carbon stored in wood products.

Even if wood product credits are allowed, they may be limited in a number of ways. Not all wood products go to long-lived uses. On average, 48% of timber removals go to long lived products (73% of softwoods, but only 10% of hardwoods).[71]

Credits may also be limited to products from 'Kyoto-compliant forests' – those planted since 1990. While around 40% of the Australian plantation estate meets the definition of a Kyoto-compliant forest,[72] only a small proportion of these newer plantations are involved in the production of long-lived wood products. The combined impact of these two restrictions has the potential to eliminate the majority of potential benefit from such credits. Modelling shows that if both these restrictions are imposed where competitors are shielded from the impacts of carbon pricing, on average across the industry:

- Hardwoods receive no competitive advantage from carbon pricing, but rather are worse off than competitors.
- Softwoods receive a very small competitive advantage from carbon pricing under some scenarios.

It is noted that restricting credits to Kyoto-compliant forests is a poor match to environmental benefits all forests - both Kyoto and non-Kyoto - have equal potential to add to the carbon stored in wood products.

There may be scope to increase the use of wood residues from Australian wood industries for energy, representing potential carbon savings. Further work is required to clarify the significance of this opportunity for the industry and to understand potential negative impacts on those currently using residues as an input.

Proposals for a national carbon trading scheme for Australia are still in development. Thus, there remains an opportunity for the industry to engage with policy makers and pursue an approach that recognises the greenhouse benefits that flow from increased use of wood products.

5.1 Implications for policy makers

The potential environmental benefits from increased use of wood products may not be realised where carbon trading proposals favour emissions-intensive industries at the expense of their lower emissions competitors.

Compensation to emissions-intensive trade-exposed sectors provides an advantage to wood's key competitors that would:

- Deny the wood products industry the benefits that should flow to it from carbon pricing due to its low emissions status; and
- Be a double loss for the environment, as demand will tend to shift to more emissions-intensive products adding to greenhouse gas emissions and the opportunity to boost carbon storage from increased use of wood products will also be missed.

Recognition of the carbon stored in harvested wood products may act as a counter-balance, restoring some of the competitive advantage that should arise to wood from carbon pricing. However, this will only be the case where wood product credits are not artificially restricted only to Kyoto-compliant forests.

Concerns about the impermanence of carbon stored in wood products may be addressed through recognition that carbon remains stored in wood products even after disposal in landfill. Such an approach would lower transaction costs and eliminate the prohibitive long-tail obligations associated with monitoring the change in wood product pools for years after credits are created. This would enable a greater number of producers to participate in carbon trading, increasing the supply of low cost credits.

6 References

[1] Based on estimate of 'Kyoto-compliant forests' in the plantation estate as at 2003. Estimated from data presented in Australian Greenhouse Office (2006) *Forestry Sector Greenhouse Gas Emissions Projections 2006*, p10, available from http://www.greenhouse.gov.au/projections/pubs/forestry2006.pdf; and Bureau of Rural Sciences (2003) *Australia's State of the Forests Report 2003*, p30, available from http://affashop.gov.au/product.asp?prodid=12858.

[3] Gustavsson, L. (2006) 'The Role of Wood Material for Greenhouse Gas Mitigation', 11 *Mitigation and Adaptation Strategies for Global Climate Change,* pp1097-1127, p1101.

[4] Ibid.

[5] Total GHG emissions from aluminium production on a cradle to gate basis from Norgate, T, Jahanshahi, S, and W, Rankin, 'Assessing the Environmental Impact of Metal Production Processes' (2007) 15 *Journal of Cleaner Production* 838, 844. Proportion from electricity estimated by the author based on a number of sources.

[6] Emissions and proportion from electricity based on *Potential Earnings Impacts from Climate Change: Steel* (2007) available from http://www.igcc.org.au/content/publications/

[7] Ibid

[8] Emissions and proportion from electricity based on *Potential Earnings Impacts from Climate Change: Construction Materials* (2007) available from http://www.igcc.org.au/content/publications/

[9] All wood product data in this table provided by Tim Grant, RMIT Centre for Design. Data is based on a single site cradle to gate life cycle analysis, excluding biomass savings.

[10] There are six main greenhouse gases that are the focus of regulatory responses to climate change, such as the Kyoto Protocol - carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). Overall, carbon dioxide is the most significant contributor to global warming due to the large volume of emissions of this gas.

[11] Ibid, p1107.

[12] Forest and Wood Products Research and Development Corporation (FWPRDC) and the Cooperative Research Centre for Greenhouse Accounting (2006) *Forests, Wood and Australia's Carbon Balance*, p1, available from www.fwprdc.org.au

[13] Calculated using the TimberCAM Timber Carbon Accounting Model. Available for download from http://www.greenhouse.crc.org.au/tools/models/timbercam/

[14] Above note 12, p3.

[15] Full fuel cycle emission factors for electricity end use from Australian Greenhouse Office (2005) *AGO Factors and Methods Workbook,* pp43-45 available from http://www.greenhouse.gov.au/workbook/pubs/workbook-2005.pdf

[16] Miner, R., and Lucier, A. (2004) *A Value Chain Assessment of Climate Change and Energy Issues Affecting the Global Forest-based Industry*, available from http://www.wbcsd.org/web/projects/forestry/ncasi.pdf

[17] Gardner, W., et al (2002) *Decomposition of Wood Products in the Lucas Heights Facility*, quoted in Ximenes, F. (2006) *Carbon Storage in Wood Products in Australia: a review of the current state of knowledge*, p9, available from www.fwprdc.org.au

[18] Above note 13.

[19] Gardner, W., Ximenes, F., and Cowie, A., (unpublished paper) *Carbon Storage Due to Wood Products: A Method for Estimating Long-term Carbon Storage attributable to Wood Products, that Considers the Fate of Residues and Redundant Products*, p8.

[20] Intergovernmental Panel on Climate Change (IPCC) (2003) *Good Practice Guidance for Land Use, Land-use Change and Forestry*, Appendix 3a.1 sets out available accounting approaches for wood products, available from http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_contents.htm

[21] Voluntary reporting on wood product pools was enabled by the decision of the Subsidiary Body for Scientific and Technological Advice at its 24th session. See the Report of the Meeting, paragraph 68 available from http://unfccc.int/resource/docs/2006/sbsta/eng/05.pdf.

[22] The requirement that the stock of wood products be increasing is included in the IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry*, above note 20.

[23] *United Nations Framework Convention on Climate Change*, opened for signature 4 June 1992, 1771 UNTS 107, 31 ILM 849 (1992), (entered into force 21 March 1994) available at http://unfccc.int/essential_background/convention/background/items/2853.php

[24] Derived from Australia's National Greenhouse Accounts available at http://www.greenhouse.gov.au/inventory/index.html

[25] Australian Greenhouse Office (2006) National Inventory Report 2005 – Vol 2, p125, available from http://www.greenhouse.gov.au/inventory/2005/national-report.html
[26] Australian Greenhouse Office (2006) *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005 – Land Use, Land Use Change and Forestry*, pp127-128, available from http://www.greenhouse.gov.au/inventory/methodology/index.html
[27] National Emissions Trading Taskforce (2006), *Possible Design for a National Greenhouse Gas Emissions Trading* Scheme, available from www.emissionstrading.nsw.gov.au
[28] Task Group on Emissions Trading (2007) *Report of the Task Group on Emissions Trading*, available from http://www.pmc.gov.au/climate_change/emissionstrading/task_group.cfm
[29] Australian Labor Party, *An Action Agenda for Climate Change* (2007) available from http://www.alp.org.au/media/0507/speloo300.php
[30] Ibid
[31] Above note 27, p xii.
[32] Above note 29.
[33] Above note 27, p xxi.
[34] The objective of the principal international agreement on climate change, the United Nations Framework Convention on Climate Change, is to avoid 'dangerous' climate change. What exactly 'dangerous' climate change is and the greenhouse gas concentration level that would trigger it is still the subject of significant debate.
[35] Above note 28, p107.
[36] Above note 27, p17.
[37] National Emissions Trading Taskforce (2007) http://www.emissionstrading.nsw.gov.au/key_documents/nett_terms_of_reference,_july_2007 at 10 August 2007.
[38] Only four governments auctioned permits: Denmark, Hungary, Lithuania, and Ireland, for 5, 2.5, 1.5, and 0.75 percent of their respective totals. Ellerman, A., and Buchner, B., 'The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results' (2007) 1 *Review of Environmental Economics and Policy* pp66-87.
[39] Numerous publications have discussed this issue. For a thorough treatment, including estimation of the size of windfall profits, see IPA Energy (2005) *Implications of the EU Emissions Trading Scheme for the UK Power Generation Sector (Report to UK Department of Trade and Industry)* available from http://www.ipaenergy.co.uk/downloads&publications/FINAL%20Report%201867%2011-11-05.pdf.
[40] Above note 27, p135.
[41] Above note 28, p209.
[42] For a summary of the research in the area see Congressional Budget Office (2007) *Trade-offs in Allocating Allowances for CO_2 Emissions*, available from http://www.cbo.gov/ftpdocs/80xx/doc8027/04-25-Cap_Trade.pdf
[43] Ibid. For modelling of specific scenarios, see, for example, Bovenberg, A., Goulder, L., and Gurney, D. (2004) *Efficiency Costs of Meeting Industry-Distributional Constraints under Environmental Permits and Taxes*, available from http://www.nber.org/papers/W10059; and Demailly, D., and Quirion, P., 'CO2 Abatement, Competitiveness and Leakage in the European Cement Industry under the EU ETS: Grandfathering versus Output-based Allocation (2006) 6 *Climate Policy* 93-113.
[44] *Greenhouse Gas Benchmark Rule (Carbon Sequestration) No. 5 of 2003* (NSW) available from http://www.greenhousegas.nsw.gov.au/documents/Rule-CS-Oct03.pdf
[45] Above note 19, p3.
[46] *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, opened for signature 11 December 1997, art 3.3 (entered into force 16 February 2005).
[47] Above note 2.
[48] Ibid.
[49] Above note 27, p65.
[50] McLennan Magasanik Associates (2006) *Impacts of a National Emissions Trading Scheme on Australia's Electricity Markets*, p81, available from http://www.emissionstrading.nsw.gov.au/key_documents
[51] Above note 28, p113.
[52] Ibid.
[53] Average price per tonne in 2006 from Australian Bureau of Agricultural and Resource Economics (2007) *Australian Commodities* Vo14 (1), available from http://www.abareconomics.com/publications_html/ac/ac_07/ac_07.html.
[54] MEPS International, Asia long product price as at Dec 2006, www.meps.co.uk.

[55] Ibid, Asia flat products price as at Dec 2006.
[56] From personal communication with industry analysts.
[57] From personal communication with industry participants.
[58] Ibid.
[59] Allen Consulting Group (2006) *Deep Cuts in Greenhouse Gas Emissions: Economic, Social and Environmental Impacts for Australia*, p30, available from www.acfonline.org.au/uploads/res_BLRT_allensreport.pdf.
[60] Australian Bureau of Agricultural and Resource Economics (2006) *Economic Impacts of Climate Change Policy: the Role of Technology and Economic Instruments*, p4, available from http://abarepublications.com/product.asp?prodid=13454.
[61] See for example, Smale, R. et al, 'The Impact of CO2 Emissions Trading on Firm Profits and Market Prices' (2006) 6 *Climate Policy* 29-46, p39.
[62] Commonwealth Scientific and Industrial Research Organisation (2005) *Balancing Act: a Triple Bottom Line Analysis of the Australian Economy,* p174, available from http://www.cse.csiro.au/research/balancingact/.
[63] Above note 43.
[64] Above note 13.
[65] Total removals to saw and veneer logs and panel products from Australian Bureau of Agricultural and Resource Economics (2007) *Australian Forest and Wood Products Statistics – Dec 2006,* available from http://www.abareconomics.com/interactive/foreststats_may07/htm/publications.htm.
[66]Above note 2.
[67] No data was available on the destination of removals from Kyoto-compliant forests. These values were estimated by assuming that Kyoto-compliant forests follow the typical pattern of removals for the Australian plantation estate – refer note 65.
[68] Window system emissions data has been adapted from Branz (2007) *Comparative Service Life Assessment of Window Systems* available from http://www.fwprdc.org.au/news.asp?id=208. Data is grouped averages of the 51 archetypes in the study.
[69] This coverage is slightly more comprehensive than modelled elsewhere in this report.
[70] If a full life cycle accounting approach is adopted, biomass use results in a small quantity of emissions associated with emissions in growing, harvesting, processing, and transport.
[71] Above note 65.
[72] Above note 2.