Submission on the Garnaut Review Issues Paper 1

Climate Change: Land use - Agriculture and Forestry

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Introduction

This submission is in response to the *Garnaut Review Issues Paper 1 - Climate Change: Land use - Agriculture and forestry* [31]. We attempt to answer some of the questions raised in the issues paper and provide some policy suggestions. We shall also do some quantitative analysis where we estimate the impacts of the policy measures discussed on Australia's emissions in 2020.

In Section 1 we summarise Australia's emissions from agriculture, land use, land use change and forestry. In Section 2 we discuss the roles of mitigation, adaptation and emissions trading. We discuss considerations for deciding what should be included in an emissions trading scheme and argue that enteric (methane) emissions from livestock could be included. We also discuss how this could be done.

In Section 3 we discuss emissions from land clearing and deforestation. These activities present an opportunity to reduce emissions at very low cost. We suggest some options that would reduce these activities. We also discuss how measurement and accounting of some of these activities could be improved so that more activities are covered and there is less risk of perverse outcomes.

Section 4 could perhaps be thought of as the main policy innovation discussed in this submission. This is to fund activities involving revegetation, afforestation or reforestation using funds raised from auctioning emissions permits. There would be advantages in terms of increased biodiversity cobenefits and improved credibility that this form of financing would have over direct inclusion in an emissions trading scheme. A greater amount of different activities could be included than would be able to be credibly financed using offsets. The activities funded would also provide valuable information about how much carbon is sequestered by different activities. This could facilitate some of these activities being included in an ETS at a later stage.

In Section 5 we make use of Australia's emissions projections to estimate the impact that the above measures could have on Australia's emissions in 2020. We so this by examining the level of the cap in an emissions trading scheme that would be required to reduce Australia's total emissions by a given amount. The results we obtain suggest that the policy measures analysed would have a very significant impact on the cap required. Deep cuts that would otherwise be very difficult become achievable. In Section 6 we summarise the recommendations of this submission.

1. Summary of Australian Emissions from Agriculture, Land Use, Land Use Change and Forestry

Each year the Australian Greenhouse Office produces two documents estimating Australia's greenhouse gas emissions which each use slightly different accounting and reporting requirements. The Australian Greenhouse Gas Inventory 2005 [1] uses Kyoto accounting, Australia's submission to the UNFCCC on 2005 emissions [2] uses UNFCCC accounting. With Kyoto accounting, the forestry sector has a narrower definition than under UNFCCC accounting [1, p15].

According to the Australian Greenhouse Gas Inventory 2005 [1], Australian emissions from agriculture in 2005 were 87.5 Mt CO_2-e, 15.7% of total emissions. According to Australia's submission to the UNFCCC on 2005 emissions [2], Australia's emissions from agriculture were 87.9 Mt CO_2-e.

By far the most significant emissions from agriculture were from livestock, which were 62.1 Mt CO_2-e, 70.7% of the agriculture sector's emissions and 11.1% of national emissions. Most of these emissions were from enteric fermentation, where methane is produced during the digestion of plant material. After direct emissions from livestock, the next most important agricultural subsector is nitrous oxide emissions from agricultural soils, responsible for 16.6 Mt of emissions, followed by prescribed burning of savannas, responsible for 8.7 Mt of emissions.

Methane has a much higher impact on radiative forcing (so contributes more to global warming) than carbon dioxide, but a shorter lifetime. Greenhouse gas accounting converts the impact of gases such as methane to carbon dioxide equivalent (CO_2-e) using *global warming potentials,* (GWPs) which estimate the impact of a certain gas over a given time horizon. The Kyoto and UNFCCC accounting requirements use a 100 year time horizon and 100-year GWPs based on the IPCC Second Assessment Report. These are 1 for CO_2, 21 for methane, and 310 for nitrous oxide [2, p13]. Because of methane's shorter lifetime, its 20-year GWP is 72. In the Fourth Assessment Report of the IPCC the 100-year GWP of methane has been revised upwards to 25 [4, p212], this suggests that our actual emissions from enteric fermentation in livestock are higher by a factor of 25/21 than those in Australia's greenhouse accounts, due to the higher GWP.

According to the Australian Greenhouse Gas Inventory 2005 [1], Australian emissions from land use, land use change and forestry (LULUCF) were 33.7 Mt CO_2-e (53.3 Mt CO_2-e deforestation and -19.6 Mt CO_2-e afforestation and reforestation), 6% of total emissions. Australia's submission to the UNFCCC [2] gives a lower figure of emissions from LULUCF being -3.2 Mt CO_2-e (divided into -51.5 Mt CO_2-e from forestlands, -4.5 Mt CO_2-e from croplands, 57.8 CO_2-e from grassland and 5 Mt CO_2-e other), -0.6% of total emissions. Because LULUCF has the potential to be a sink, its importance is much higher than its relative percentage of Australian greenhouse gas emissions, because the potential to reduce emissions is greater than its percentage of emissions.

Australia's emissions can also be disaggregated by economic sector using the Australia-New Zealand Standard Industry Classifications. This is done in Australia's National Inventory by Economic Sector 2005 [3]. The emissions from Agriculture, Forestry and Fishing as an economic sector in 2005 include land use change emissions and were 128.2 Mt CO_2-e, 22.9% of emissions. Beef is the commodity produced in Australia with the most emissions associated with its production, followed by non-ferrous metals. Direct and indirect emissions from beef production in 1999 were 109 Mt CO_2-e [5, Table 5.13, p91]. For comparison, Australia's residential sector emissions in 2005, including emissions using transport and indirect emissions from electricity use, were 104.4 Mt CO_2-e, 18.7% of emissions.

2. Mitigation, Adaptation and Emissions Trading in Agriculture and Land Use Sectors

Adaptation and mitigation are interrelated, the use of a particular area of land may involve both sectors. Some mitigation policies will provide adaptation benefits.

Both the agriculture and LULUCF sectors are involved in the use of land, and economic activities which influence emissions in one sector are likely to influence emissions in the other. For example, 55 Mt CO_2-e of emissions from land clearing in

1999 were livestock-related [5, p92]. Climate change is likely to have significant costs and impacts on economic activities within these sectors and on the land. Climate change is likely to increase climate variability and increase the likelihood of droughts. The 2002-03 and 2006-07 drought were estimated to cost Australia 0.7-0.8% of GDP [6], [7], [8]. Well designed policies which encourage the use of land as a greenhouse gas sink could provide adaptation benefits by providing farmers with new sources of income, and decrease the ecological impacts of climate change by increasing habitat and reducing habitat fragmentation. We should therefore assess the impact of policy measures by examining the role they play in adaptation and mitigation in both the agriculture and LULUCF sectors.

Significant parts of these sectors are associated with Australia's croplands and rangelands. Policy measures should take into account the diverse economic, environmental and social issues concerned. Good policies need to take into account a wide variety of stakeholders including Aboriginal people, who make up a significant proportion of the rangeland population [23].

As well as land users having new sources of income in the LULUCF sectors, there are likely to be other sources of income involved with climate change mitigation. One interesting potential source of income is the use of biomass as a source of power. One such fuel is mallee eucalypt, which has an underground root mass and branches which can be harvested that will grow back from the root mass [27, p82]. The branches can be re-harvested every 2-3 years for about 100 years.

Considerations when deciding on what activities should be included in an ETS.

For there to be effective climate change mitigation it is vitally important that there is a carbon price. It is likely that this will take the form of an emissions trading scheme (ETS). It is important that a ETS covers as much of Australian emissions as possible for several reasons:

- The greater the coverage, the greater the amount of abatement that is possible, improving the effectiveness of the scheme.
- More coverage means more choice about where the reductions are made, leading to more liquid markets and decreasing the cost of the scheme.
- Not covering some sectors or subsectors could lead to perverse incentives to increase emissions in the areas not covered. For example, suppose that an ETS did not cover fugitive emissions from open cut coal mines (which are hard to reduce) but did cover fugitive emissions from underground coal mines (which are easier to reduce), this would provide an incentive to construct open cut mines, possibly increasing emissions.
- Having coverage as broad as possible increases the perception of fairness of the ETS, increasing its credibility. Broader coverage means better adherence to the 'polluter pays' principle.

Factors that are important when deciding on what should be included in an ETS are:

- How easy is it to measure emissions accurately and verify them? If emissions are not measured directly and a proxy is measured, then how easy is it to measure the proxy? If emissions measurements are not sufficiently transparent or accurate, this could undermine the credibility of the scheme.
- What are the transaction costs involved with reporting, measuring, and verifying emissions, and administration? It is usually the case that in order to

minimise these costs, a cut-off threshold is applied where facilities or firms whose emissions are less than this threshold do not have to report emissions, and therefore would not be included in an ETS. This is the case with the *National Greenhouse and Energy Reporting Bill 2007.*

- What is the capacity to reduce emissions in the activity being included? If an activity has a strong capacity for reducing emissions, there would be a large opportunity cost in not including it in an ETS. However, if an activity may not easily reduce emissions, it is still possible that it should be included in an ETS. Not including such an activity could lead to perverse incentives to further engage in that activity, as mentioned above. Because an ETS will lead to reductions in emissions in activities where there is the capacity to most reduce these emissions, the significant costs in including extra activities are the transaction costs. Furthermore, with an ETS the market decides where the most economical emission reductions are - the only way it can do this as effectively as possible is if as many activities as possible are included. Where reductions are accomplished should be left up to the ETS as much as possible.

Enteric emissions from livestock are the most significant source of emissions from agriculture and could be included in ETS.

We shall now investigate how the above criteria apply to the most significant agricultural subsector in terms of magnitude of emissions, emissions from livestock. As well as reducing animal numbers, short to medium term options for reducing enteric emissions include improving animal genetics, nutrition and feed management such as supplementation with tannin or dietary oils, and other forms of animal management such as extended lactation [9].

It has been sometimes been claimed [10], that “emission reductions from reduction in production are simply replaced offshore”. For this to be the case with emissions from livestock, then either the price-elasticity of demand would have to be zero, or the price elasticity of supply would have to be infinite. Inelastic demand is associated with necessities, while beef and lamb are less “necessary” than staple food items such as grains and vegetables. The price elasticity of demand is influenced by substitutability, and consumption of beef and lamb can be substituted with consumption of other meat products such as chicken or kangaroo. The price elasticity of supply depends on the spare production capacity, which will be limited by the time required to breed more livestock and the resources required to maintain increased stocking rates. Reduced livestock numbers will therefore lead to real reductions in emissions. While there would be some carbon leakage, it is better to address the issue of carbon leakage and spillovers as a whole, by activities that facilitate international cooperation such as transferring technology to developing countries. Conversely, not engaging in some mitigation activities or not including them in an ETS because of carbon leakage concerns would lead to risks of carbon leakage towards Australia.

As well as emissions from enteric fermentation, livestock also contribute to emissions by reducing carbon stocks from soil and biomass. Overgrazing, especially when combined with drought, can lead to soil and vegetation degradation, which will release carbon into the atmosphere [11, pp92-93], [12, p76]. Erosion can also lead to carbon being released from soil. It has also been suggested that reducing stocking rates to increase perennial grass cover could sequester up to 315 million tonnes of carbon per year in the top 10cm of soil over 30 years [12, p77]. It has also been suggested that completely destocking West Australian rangelands would sequester 290-1170 Mt CO_2-e over 20 years [13], [14]. Some of these emissions could be included in Article 3.4 of the Kyoto Protocol, a first step towards Australia reducing these sorts of emissions would be to commence measuring or estimating emissions that could be considered Article 3.4 emissions, including emissions from grazeland management.

The methodology for estimating emissions from enteric fertilisation is described in [15, pp. 5-16]. For cattle, Australia's total emissions are estimated by adding together the product of the numbers of cattle in each state, region, season, and class by estimated emissions per head for each state, region, season, and class. Similar methodologies are used for other animals. It is therefore possible to use livestock numbers as a low cost proxy for enteric emissions. More complex methods of measuring emissions will probably be needed to reduce emissions using some of the methods mentioned above which do not reduce livestock numbers. One way of achieving this at low cost would be for farmers to have a “baseline” measurements based on the amount of different classes of livestock they own, and be able to opt-in to a more complex measurement system if they want to make use of emission reduction technologies. A similar opt-in approach may be possibly used to reduce nitrous oxide emissions from soils by applying nitrification inhibitors.

One possibility for including emissions from livestock in an ETS would be to have the processing sector as the point of obligation. This would reduce transaction costs and has been proposed for the New Zealand ETS. It may also be possible to reduce costs by cooperating with or linking with New Zealand's ETS.

It is therefore possible to include enteric emissions from agriculture in an ETS. Because enteric emissions from livestock represent a very large source of emissions, including it in an ETS would be a wise policy choice. Inclusion of enteric emissions could start with large specialist livestock producers and progressively include smaller producers. The regulations for the *National Greenhouse and Energy Reporting Bill 2007* and possibly the bill itself may need some amendments. The first reporting period of the bill will be 2008-2009, if enteric emissions were reported from 2009-2010, then these emissions could be included in an ETS by mid-2010.

Impacts that an ETS covering stationary energy and transport will have on agriculture, forestry and fishing.

According to [5, Table S3, Page v], emissions in 1999 from transport and stationary energy in agriculture, forestry and fishing as an end use sector were 7.6 Mt CO_2-e for stationary energy and 6.6 Mt CO_2-e for transport. This represents 9.8% of the emissions from this sector. While an ETS covering stationary energy and transport will have some impacts of this sector, they are dwarfed by the other emissions within this sector. Impacts from climate change are also likely to increase costs in this sector by a greater amount than the impact of an ETS on transport and stationary energy.

Permit allocation issues for enteric emissions from livestock.

An important question is if certain sectors of agriculture and LULUCF are included, how should permits be allocated? Permits can either be auctioned, handed out for free or a mixture of both. There are a whole lot of reasons why it is much better in general to auction permits than to hand them out for free [22]. The ‘polluter pays’ principle is based on the premise that the right to a clean environment is owned by the public. Therefore, if a firm wants to pollute, it should purchase the right to do so from the public. Handing out free permits also can be highly regressive, and can be thought of as a transfer of wealth. If permits are grandfathered there can be a perverse incentive to increase emissions before an ETS is introduced in order to increase the number of permits allocated.

However, farmers are more likely to be adversely impacted by climate change than other industries and emissions from land use change have been significantly reduced because of regulation. What is most important is that there is a perception of fairness so that the stability and integrity of the ETS is maintained. Furthermore, if there is not a perception of fairness on the part of farmers, it may be harder to facilitate their cooperation with respect to climate change and other environmental issues. If the point of obligation in an ETS was in the processing sector and free permits were allocated to that sector, then it is likely that costs would be passed upstream to farmers. It may therefore be more appropriate to compensate farmers adversely affected by an ETS by direct payments rather than an allocation of free permits. On the other hand, money may be better spent paying farmers to reduce emissions. Whether permits are handed out for free, auctioned, or auctioned in the presence of compensation payments, it will still be preferable to include enteric emissions from agriculture in an ETS because of the “Coase theorem”. As long as enteric emissions are covered, their will be an incentive to reduce these emissions.

3. Reducing Emissions from Land Use Change (Deforestation)

Land clearing and deforestation are often a case of market failure, there are substantial opportunities to reduce emissions at low cost.

In 2005, emissions from land use change (deforestation) were 53.3 Mt CO_2-e, 9.5% of emissions [1], which is considerably less than 1990 levels of 128.9 Mt CO_2-e, but is still significantly high. Reducing emissions by avoiding deforestation is likely to be significantly cheaper than reducing emissions by afforestation or reforestation and will have much greater environmental cobenefits. It has been estimated that the opportunity cost of avoiding deforestation in developing countries would be around $1-2/t CO_2-e [25, p217]. The opportunity cost of avoiding deforestation in Australia is likely to be higher, but is still likely to be less than the carbon price in many cases. Deforestation/land clearing usually takes place to either clear land for agriculture (especially beef production) or for the timber produced. When the value of carbon, avoided salinity, and ecological value of the land that is cleared is greater than the value of clearing the land, then land clearing is a clear example of market failure.

The states with the most land clearing are Queensland, with 30.5 Mt CO_2-e of emissions from land use change, NSW with 10.4 Mt CO_2-e, and Tasmania with 5.1 Mt CO_2-e [23]. Much of the reduction in land clearing emissions has been due to regulations against land clearing in Queensland and NSW.

Possible ways of avoiding deforestation and the associated market failures include:

- Including land use change activities that involve converting Kyoto forest into grassland or cropland in an ETS. If a landholder wants to clear land then carbon measurements will need to be made and emission credits will need to be purchased.
- Strengthening regulations that prevent land clearing and enforcing them more effectively.
- Payments to landholders for the carbon stored in soil and biomass of land which contains vegetation. This could involve payments in exchange for changing the title of the land in such a way that the land can no longer be cleared at a later date, or if the land is cleared these payments would be forfeited.

It is likely that a combination of the above approaches would be most effective. Avoiding deforestation and land clearing is likely to reduce climate change at a lower cost than other forms of global warming abatement and hence the sooner these measures are introduced the better. Because of the market failure involved, this may be a policy area where strong regulation would provide significant benefits. In Section 4 we shall discuss how payments for avoided deforestation could be funded from auctioning permits. In Section 5 we shall demonstrate that ending deforestation would make it significantly easier for Australia to meet emission reduction targets by 2020.

Measurement of land use change.

Under the UNFCCC and the Kyoto protocol, emissions from forest harvesting are not included unless the land use is changed to something other than forestry [24, p14], [2, Volume 2, Part A, Page 19]. When forests are logged for timber some of the carbon remains in long lived forest products but after logging the forest is usually burned which will release carbon that is stored in soil and biomass. It is likely that when a previously unlogged forest is logged, the forest that grows back will have a lower carbon content than before.

Land clearing of vegetation that is not a Kyoto forest, and logging of Kyoto forests that remain Kyoto forests after harvesting both involve greenhouse gas emissions that are not measured under the Kyoto protocol but will still contribute to global warming. Other activities not measured include loss of carbon from soils and biomass due to overgrazing, increases in carbon stored in soils due to reduced tillage, and increases in carbon stored in soils from destocking rangelands.

These issues suggest that while these activities may not play a role in Australia meeting it's Kyoto target, they could play a very important role in meeting future targets, such as a 2020 target. Some of these activities may potentially be included under article 3.4 of the Kyoto protocol. Including more activities would provide more opportunities for climate change abatement, and reduce some of the perverse outcomes described above. Australia should include reporting of these activities as soon as possible, even though they may not be part of accounting for Australia to meet its requirements under the Kyoto protocol. Options for including all lands in greenhouse gas accounting in such a way that it measures human induced carbon changes are described in detail in [26]. Australia would benefit from a wider range of activities being included in greenhouse gas accounts and there would also be global benefits. It could be in Australia's interests if it encourages the inclusion of such activities when it participates in international climate negotiations.

4. Financing Environmentally Appropriate Mitigation Strategies Using Money Raised from Auctioning Permits

LULUCF has great potential to reduce emissions, but uncertainty makes it difficult to include in an ETS.

Because LULUCF has the potential to be a net sink, the potential to use this sector to reduce Australia's emissions is far greater than Australia's emissions in this sector. It has been estimated [14] that in Western Australia, reforesting 16.8 Mha of cleared farmland would sequester 2200 Mt CO_2-e, and destocking 94.8 Mha of rangelands would sequester between 290 and 1170 Mt CO_2-e. These figures represent all farmland and rangeland in WA and therefore can be thought of an an approximate upper limit in that state. We shall demonstrate in Section 5 that if between 50 and 100 Mt CO_2-e are sequestered via LULUCF each year then in order for Australia to meet a particular greenhouse gas reduction target the amount of reductions that would need to take place in an ETS covering other sectors would be significantly less. This would mean that reduction targets that would otherwise not be feasible could become achievable.

The problem is that many LULUCF related emissions or reductions in emissions are difficult to quantify. This is also true with some subsectors of agriculture. Inclusion of LULUCF in an emissions trading scheme could lead to significant reductions in emissions and possibly in the carbon price, but if reductions in emissions are difficult to quantify this would undermine the credibility of the ETS. Credibility is essential for an ETS to be effective. At the same time, if carbon finance can be harnessed to reduce emissions in LULUCF sectors it would contribute to a significant reduction in Australia's emissions. The central problem is how can we harness carbon finance to reduce emissions in LULUCF and agriculture without undermining the credibility of an ETS? A solution to this problem is to use some of the funds raised from auctioning permits to fund mitigation in the LULUCF sector. It will be useful for us to elaborate on the problem further before describing the solution in detail.

Reforestation activities that are currently easy to measure are likely to have less adaptation benefits and environmental cobenefits than activities that are not.

Some reforestation activities such as monoculture tree plantations and planting rows of mallee trees on farmland will lead to reductions in emissions that are real, permanent, measurable, verifiable, and additional. These abatement activities are likely to be eligible as offsets such as the Australian Government's *Greenhouse Friendly* initiative. The potential for emission reductions in these sorts of projects is limited in various ways. Monoculture tree plantations require high rainfall (> 600 mm/yr) [13], limiting the amount of land that can be used for these types of projects. Planting strips of mallee eucalypts on farmland is possible on lower rainfall areas (300-500 mm/yr), but there still are rainfall requirements. Because these projects are a form of monoculture, the cobenefits in terms of biological diversity are low. While tree plantations provide a new income source for farmers, this will only be the case if rainfall is sufficiently high. If any of these activities replace remnant vegetation then there could be perverse impacts if the only way of funding afforestation/reforestation activities was from offsets.

Plantations involving mixed species can provide important additional cobenefits. Species loss in Australia has been driven by habitat destruction, habitat fragmentation and habitat degradation [16]. Much of this has been driven by land clearing and deforestation. Halting and reversing this habitat loss is essential to halting biodiversity loss in Australia. Global warming is likely to lead to species movement as habitats change in response to temperature increases. Destruction and fragmentation of habitat makes this more difficult. It has been suggested that decreased geographical ranges associated with global average temperature rises of 1.8-2.0˚C could lead to extinction rates of between 15-37% [17], [25, p80]. Policies which provide habitat benefits therefore have an important climate change adaptation role. Policies which reduce species loss also play a role in Australia complying with its obligations under the UN Convention on Biological Diversity [18].

Monocultures and irrigated systems are likely to be vulnerable to introduction of pests and diseases, climate variability, climate change and salinity [18, p347]. Ecosystems with greater diversity, spatial heterogeneity, and genetic base are more likely to have greater resilience [18, p348]. Plantations with these properties have a greater likelihood of permanency. Biodiversity plantings are also possible in all rainfall zones [13].

Unfortunately, while estimating the carbon content of a single species tree plantation is straightforward, estimating the carbon content for mixed species plantings is more difficult. This is partly because fewer older mixed species plantings are available [13].

Funding environmentally responsible mitigation practices using money raised from auctioning emission permits is a method to achieve emission reductions in the presence of uncertainty.

A solution to the problems described above is to fund environmentally responsible mitigation practices using money raised from auctioning emission permits in an ETS. This way we can harness carbon finance to engage in emission reductions with strong environmental cobenefits which do not undermine the credibility and integrity of the ETS. It also increases the amount of land that can be used for reducing emissions, because activities can be funded in all rainfall zones. This would provide an adaptation benefit to farmers by providing a new source of income from sequestering carbon in soil and biomass, even in areas with low rainfall. This is particularly important to farmers affected by drought, low rainfall, or climate variability. If farmers who are affected by low rainfall still have opportunities to be paid to sequester carbon it could facilitae them staying on the land or leaving the land in such a way that they have financial benefits and the land has environmental improvements.

Possible activities that could be funded would include mixed species plantings using locally indigenous species (biodiversity plantings), sequestering carbon through destocking rangelands, no-till farming, avoided deforestation, and possibly some forms of forestry where biomass is used as an alternative energy source. One of the most important potential benefits of this policy measure would be that the carbon sequestered from these projects could be measured. This would provide a wealth of information that otherwise might not have been available. This information could be used to better target funding of sequestration measures. It could also be used to include some of these activities in an ETS at a later stage.

A possible mechanism for allocating funds to biodiversity plantings would be for plantings that are environmentally appropriate to be funded according to an estimate of the carbon sequestered. Another possibility would be to also fund these plantings according to habitat benefits provided, this way more of the positive externalities are monetised. Factors which affect the suitability of revegetation projects for habitat and conservation purposes include species diversity, which is integral to maintaining ecological processes; structural diversity, including having vegetation at different heights and with spatial heterogeneity; and diversity in the soil and litter layer [19, p31]. Use of locally indigenous species should be encouraged [19, p45]. In many cases it will be useful to take advantage of knowledge from local Aboriginal elders, and biodiversity plantings could provide opportunities for indigenous employment.

The projects described above have some similarities to some projects funded from Natural Resource Management (NRM) grants, such as the *Gondwana Link* project. The projects described here are different because their primary focus is carbon sequestration. While these projects complement NRM projects quite well by providing extra habitat, they are not a substitute. However, many NRM projects would also sequester carbon in soil and biomass. It could therefore be argued that NRM projects should also be allocated a share of the finances from auctioning emission permits.

For emission reductions achieved from biodiversity plantings to be real, they will need to be likely to be permanent. One way of facilitating this would be if payments are made for plantings, some sort of change is made to the land title which would mean that if the land is cleared, the payments would have to be returned or emissions permits would need to be purchased.

While these activities would be funded from auctioning permits in an ETS, they could commence before the introduction of an ETS, with alternative funding arrangements.

In Section 5 we shall demonstrate that afforestation/reforestation could contribute to significant reductions in emissions, so a significant portion of the money raised from auctioning permits could be spent on these activities. Other possibilities for spending money from auctioning permits include compensating households (especially low income households) for the regressive impacts for an ETS; research, development, demonstration and possibly deployment of low emission technologies, and measures to encourage energy efficiency such as the deployment of smart electricity meters. The residential sector is responsible for slightly less than 20% of emissions, so a similar portion of the money raised from auctioning permits could be spent on compensating households. The rest could be divided up between environmentally responsible mitigation in the LULUCF sector and other activities.

The issues paper [31, p8] discusses the possibility of a transitional approach that phases agriculture and forestry into an ETS. This initally would test a range of implementation solutions. The policies described above would provide a far greater variety of implementation solutions to test than would be available from offsets. The research and experience provided by these activities could make it possible to include agriculture and forestry in an ETS at a later stage.

5. Quantitative Analysis of Policy Options

It is possible to make use of projected emissions by 2020 to estimate what reductions in the cap for an ETS would be required to reduce Australia's total emissions by a given amount.

Consider the problem of reducing Australia's greenhouse gas emissions by a given percentage by a given year. Because an ETS will most probably not include 100% of the emissions in the economy, the reduction in the ETS cap by that year will be different to the reduction in Australia's emissions. As an example, the 2007 Prime Ministerial Task Group on Emissions Trading proposed a scheme where facilities which emit greater than 25 kt CO_2-e per annum in sectors outside of agriculture, LULUCF, and waste were included. This would amount to around 80% of emissions outside of agriculture, LULUCF and waste, or around 55% of total emissions. Some smaller sources of emissions would also be included by imposing a liability on fuel suppliers [20 , pp106-107].

One way of estimating how emissions that are not covered by an ETS will behave is by considering the Australian Greenhouse Office (AGO) projections [21]. The AGO projections for 2020 [21, p19] include 'Business as Usual' projections, and 'With Measures' projections, which take into account the impact of policy measures currently in place. These projections are inherently uncertain however. Recent emissions and AGO “With Measures” projections are listed in Table 1.

Sector	***Emissions (Mt CO2-e)***		
	AGO Data		***AGO Projections***
	1990	***2005***	***2020***
Stationary Energy	196	279.4	361
Transport	61.9	80.4	99
Fugitive	29.1	31.2	55
Industrial processes	25.3	29.5	50
Agriculture	87.7	87.9	101
Waste	18.3	17	11
Land clearing	128.9	53.3	45
Forestry	0	-19.6	-20
Total	**547.1**	**559.1**	**702**

Table 1: *Measured and projected emissions in 1990, 2005 and 2020*

A simple way of estimating the emissions from the part not included in an ETS of a given sector is to multiply the projected emissions from that sector by the percentage of that sector not covered. This leads to the following formula for estimating Australia's projected emissions if an ETS is in place:

$$\text{Emissions} = \text{Cap} + \sum_{\text{sectors}} \big(\text{Projected 'With Measures' emissions from sector} \times \text{Proportion of sector not covered by ETS} \big)$$

In other words the estimated total emissions are equal to the emissions covered by the ETS (determined by the cap), plus the sum over each sector of the projected emissions from that sector times the proportion of the sector not covered by the ETS. We shall use this approach to examine Australia's emissions in 2020, using the “With Measures” projections.

There are some limitations to this approach that it is important to be aware of:

- The projections themselves are highly uncertain.
- The approach assumes that emissions within each sector are uniform and there are not perverse effects where decreases in activities covered by an ETS lead to increases in activities not covered by an ETS.
- The approach does not consider the impact that an ETS will have on measures that are already in place.

The main advantage with this model is its simplicity. Furthermore, the inherent uncertainty in the AGO projections suggests that there would be little to be gained from a more complex approach.

Using this approach we can estimate the reduction in the cap that would required to achieve a given reduction in total emissions. We can do this for a given choice of what proportion of each sector is included in an ETS. Projections are often also available for each subsector, so we can easily use this approach to deal with subsectors as well. We can also use this approach to examine other policy measures, for example we can consider the impact of a halt to land clearing by setting the projected emissions from deforestation to equal zero.

We consider the situation where an ETS includes 80% of each sector except for agriculture, LULUCF, and waste. We shall estimate the cap reduction needed to achieve a given total emissions reduction for the following policy measures:

- Including enteric emissions from livestock in an ETS.
- A halt to land clearing; a halt to land clearing and increasing carbon sequestered in soil and biomass to 50 Mt CO_2-e per annum; a halt to land clearing and increasing carbon sequestered in soil and biomass to 100 Mt CO_2-e per annum.
- Having the ETS cover 100% of each sector except for agriculture, LULUCF, and waste.

We consider total reductions in emissions by 2020 with respect to 1990 levels. We estimate required reductions in the ETS cap with respect to what it would have been in 2005. The results are displayed in Figure 1 and Figure 2, and are listed in Table 2.

These results suggest that all of these policy measures could make it significantly easier to reduce emissions. For example, we estimate that to reduce total emissions by 30% would require 35-60% reductions in the ETS cap when there are no policies measures to reduce emissions from agriculture and LULUCF. However, if all enteric emission from livestock are included in an ETS, land clearing is halted and 100 Mt CO_2-e are sequestered each year, then we would only need to reduce the level of the cap in the ETS by 3-18%. The ranges in percentages (i.e. whether the cap needs to be reduced by 3% or by 18%) depend on what proportion of the other sectors is included in an ETS.

Policies not analysed here but worth considering using this methodology include emissions from waste and other subsectors of agriculture such as emissions from soils. It would also be beneficial to analyse other sectors that are included in an ETS. This would include analysing the choice of a cutoff threshold and upstream and downstream measures such as fuels.

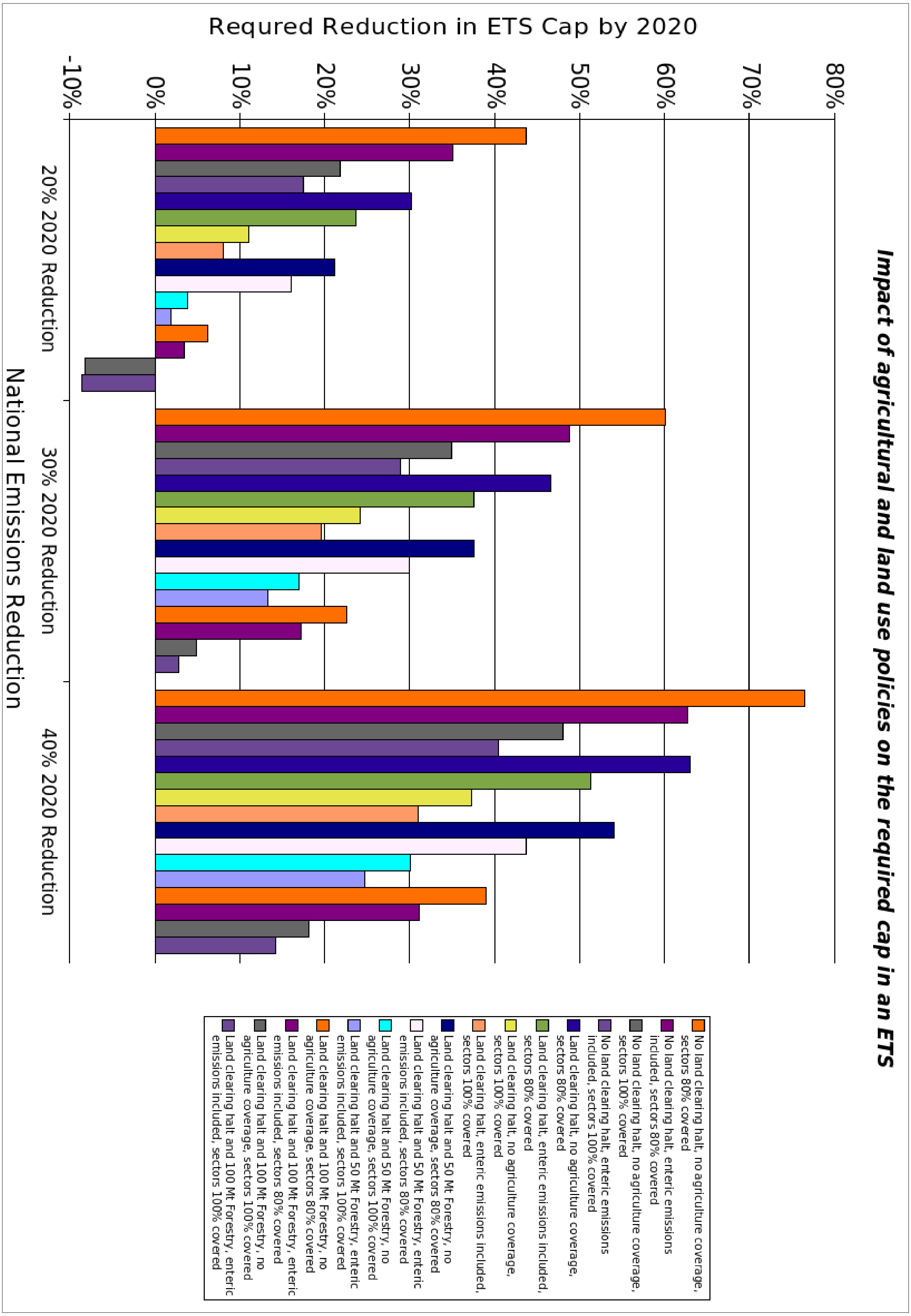

Figure 1: *Summary of policy measure impacts on the estimated level of the ETS cap required to achieve total emissions reductions of 20%, 30% and 40% of 1990 levels by 2020.*

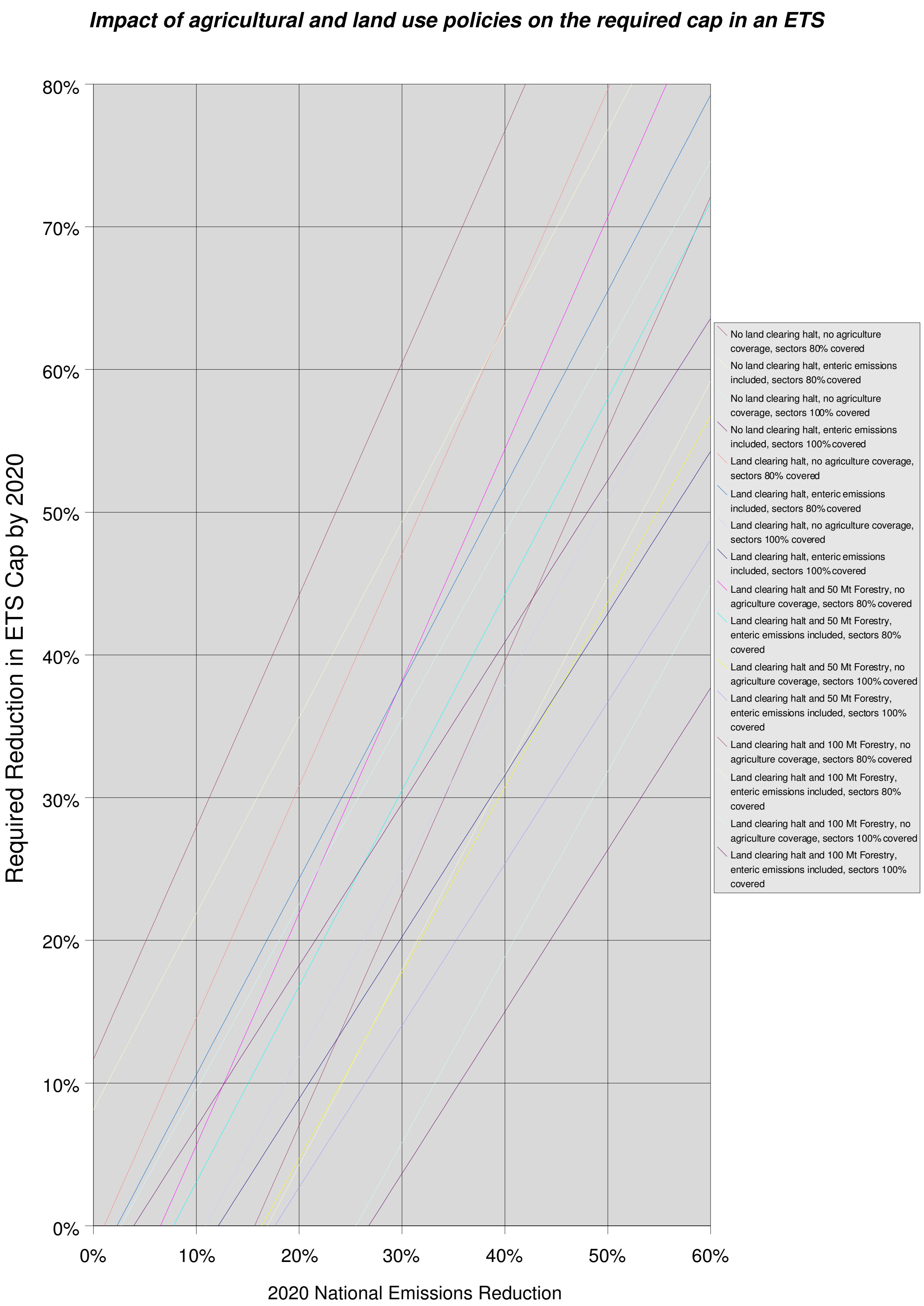

Figure 2: *Summary of policy measure impacts on the estimated level of the ETS cap required to achieve given total emissions reductions by 2020*

Cover all of each sector?	*Include enteric emissions?*	*Land clearing halt? Forestry?*	***Required Reduction in Cap*** *20% 2020 Reduction*	*30% 2020 Reduction*	*40% 2020 Reduction*
N	N	N	44%	60%	77%
N	N	Y	31%	47%	63%
N	N	Y, 50Mt Forestry	22%	38%	54%
N	N	Y, 100Mt Forestry	7%	23%	40%
N	Y	N	36%	49%	63%
N	Y	Y	24%	38%	52%
N	Y	Y, 50Mt Forestry	17%	31%	44%
N	Y	Y, 100Mt Forestry	4%	18%	32%
Y	N	N	22%	35%	48%
Y	N	Y	11%	24%	37%
Y	N	Y, 50Mt Forestry	4%	17%	30%
Y	N	Y, 100Mt Forestry	-8%	5%	18%
Y	Y	N	18%	29%	40%
Y	Y	Y	8%	20%	31%
Y	Y	Y, 50Mt Forestry	2%	13%	25%
Y	Y	Y, 100Mt Forestry	-9%	3%	14%

Table 2: *Estimated reduction in ETS cap required to achieve reduction in total emissions given different policy measures.*

Analysis of results.

The impact of including enteric emissions from livestock in an ETS in the absence of LULUCF policies is illustrated in Figure 3. In this case including enteric emissions decreases the required reduction in the ETS cap by between 4% and 15%. The actual impact of including enteric emissions is likely to be higher, because inclusion of enteric emissions in an ETS could reduce the number of livestock, affecting land use change. A large amount of land clearing is driven by cattle farming, and destocking rangelands is likely to sequester considerable amounts of carbon in soil and biomass.

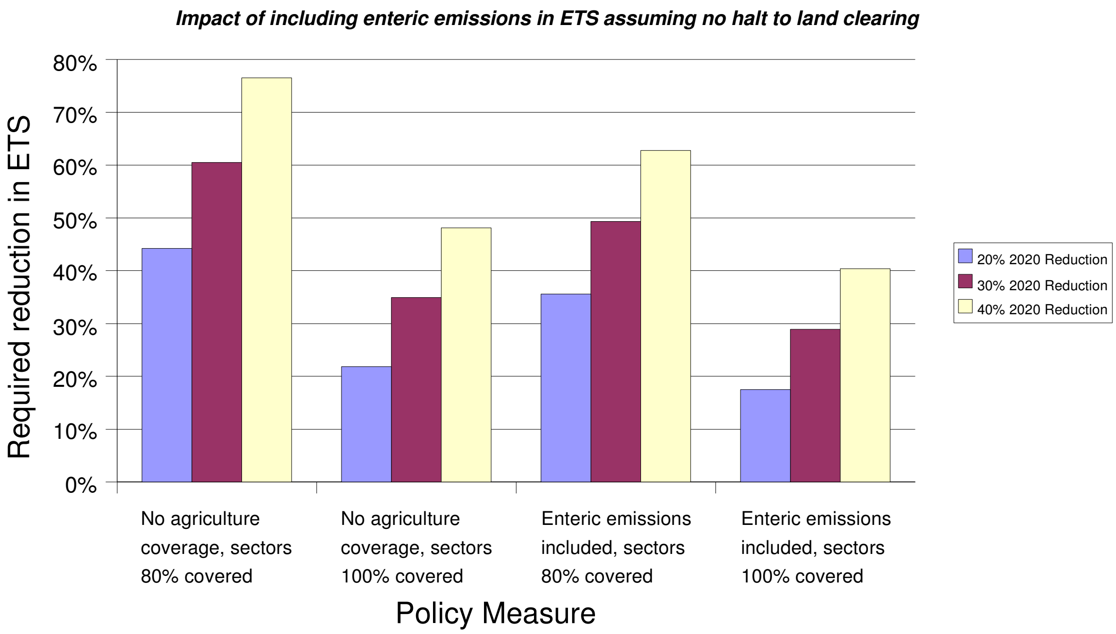

Figure 3: *The impact that including enteric emissions from livestock in an ETS will have on the estimated required reductions in the ETS cap.*

Halting land clearing and increases in emission reductions from forestry have significant impacts (Figure 4). Possible ways of achieve these reductions were described in Section 3 and Section 4. Because reducing emissions from deforestation and increasing emission reductions from revegetation makes it so much easier to reduce total emissions, it would be sensible if the proportion of funding from auctioning permits that goes towards these activities is large.

It has been suggested that cost of sequestering carbon through afforestation and reforestation is between 1.4 US$ and 22 US$/t$CO_2$ (1.6 A$ - 25 A$/t$CO_2$) [28, p552]. This suggests that sequestering 100Mt each year is likely to cost somewhere between 160 $million and 2.5 $billion per year. By funding these activities from auctioning permits it is likely that these activities would cost less than if they were entirely funded from offsets, because the diversity of possible activities would be greater. If all lands were included in LULUCF emissions, which would include forest management and grazeland management, the diversity of possible activities would also be increased.

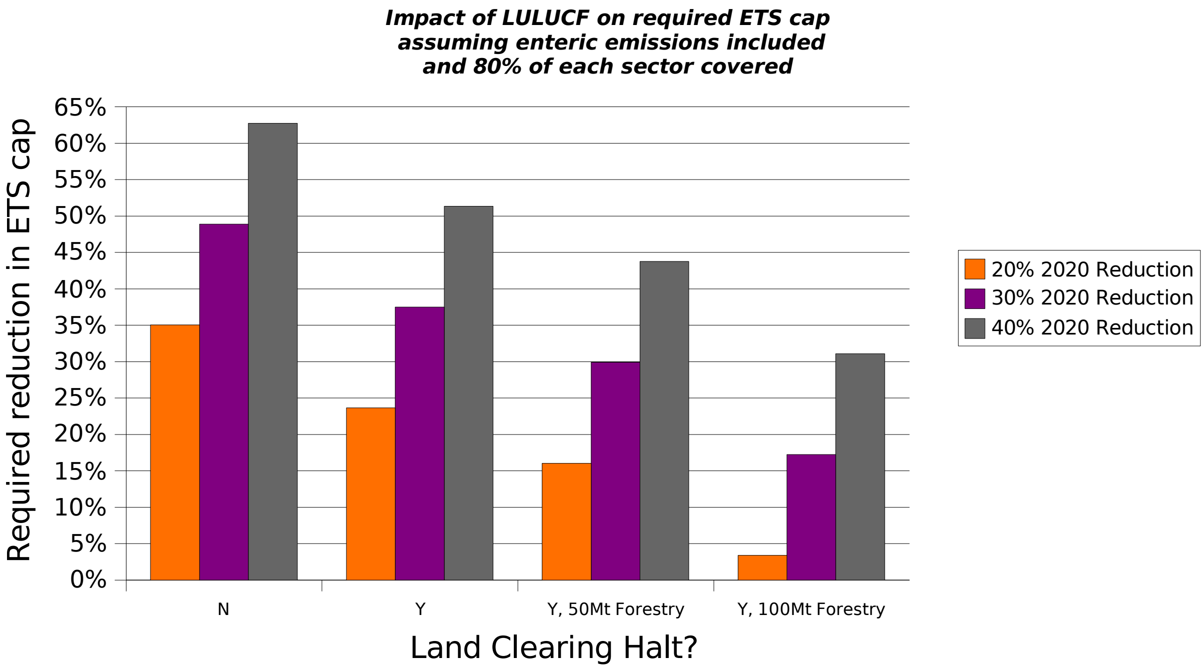

Figure 4: *Impact of Land Use, Land Use Change and Forestry policies on the ETS cap required to achieve given total emission reductions by 2020.*

The possibility of making deep cuts in Australia's emissions.

If significant emission reductions are made in the agriculture and LULUCF sectors, then deep cuts in emissions which would otherwise be very difficult become achievable. The best six policy combinations (in terms of the lowest reduction in the ETS emissions cap) considered for reducing total emissions by 40% are displayed in Figure 5.

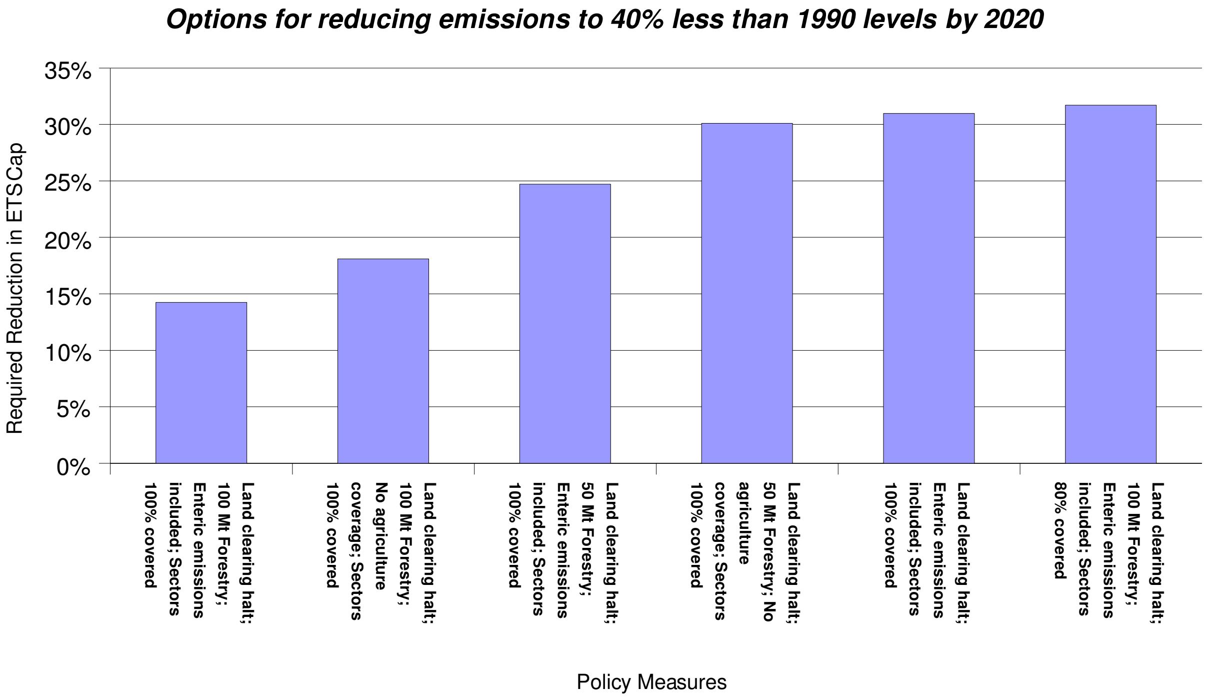

Figure 5: *Options for reducing total emissions to 40% less than 1990 levels by 2020. For each option, we plot the required reduction in the cap for the ETS.*

All of the above options include a land clearing halt, and all but one of the options include sequestering between 50 and 100 Mt CO_2-e in soil and biomass. It may be possible to reduce total emissions by 40% with a land clearing halt if an extra 45 Mt CO_2-e was sequestered in soil and biomass in 2020, but this would be more expensive, have worse biodiversity impacts, and would potentially ignore the market failures that cause land clearing in the first place. All but one of the above options include sectors other than agriculture, LULUCF and waste having 100% coverage by the ETS. This suggests that the coverage by the ETS of other sectors is very important. Four out of the six above options include covering enteric emissions from livestock in an ETS. The two options which are estimated to require the least reductions in the cap covered by the ETS both reduce the cap by less than 20%. Both of these options involve a halt to land clearing, sequestering 100 Mt CO_2-e in soil and biomass, and sectors other than agriculture, LULUCF and waste having 100% coverage by the ETS.

The possibility that Australia could reduce its emissions by 40% by the year 2020 would have significant implications for international climate change negotiations. Discussions at the UNFCCC COP 13 conference in Bali included the possibility that Annex I countries would reduce their emissions by 25-40% [29, Footnote 1], [30, Technical Summary, pages 39 and 90, and Chapter 13, page 776]. Because Australia's per capita emissions are very high, it is possible that Australia would need to make emission reductions close to 40%. The results here suggest that these reductions are achievable. Because Australia could be disproportionately affected by climate change, it would be in Australia's interests to support these proposals. If Australia makes deep reductions in emissions at low cost, it would send a strong signal to other countries with high per capita emissions that they could also make deep emission cuts.

6. Summary of Recommendations

The discussion in the previous sections suggests that the following policy measures would be wise:

i. Enteric emissions from livestock can be included in an emissions trading scheme and should be included before 2020, and preferably as soon as practicable. It may be possible to include these emissions by mid-2010.

ii. Emissions from land clearing and deforestation should be reduced to as close to zero as possible by either:

   (a) Including these activities in an ETS.

   (b) Having stronger regulations against land clearing with better enforcement.

   (c) Payments for the carbon stored on land that is not cleared.

   (d) A combination of the above approaches.

iii. Options for including all lands in greenhouse gas accounting such that human induced carbon changes are measured should be considered, particularly for post-Kyoto targets. These measurements should include:

   (a) Grazeland management, including carbon sequestered from reducing stocking levels in rangelands and carbon lost from soil and biomass due to overgrazing.

   (b) Farming practices that reduce tillage.

   (c) Harvesting a Kyoto forest even when the designated land use after harvesting is also a Kyoto forest.

   (d) Clearing land or vegetating land which does not result in the conversion of land to or from a Kyoto forest.

iv. A significant portion of the revenue raised from auctioning permits in an ETS should be spent on environmentally appropriate activities that sequester carbon in soil and biomass. These should include mixed species plantings that use locally indigenous species (biodiversity plantings) and could also include sequestering carbon through destocking rangelands, no-till farming, avoided deforestation, and possibly some forms of forestry where biomass is used as an alternative energy source. These activities would provide the research and experience that would be necessary to include agriculture and forestry in an ETS at a later stage.

v. If the above policies are put into place then it is likely that Australia could make cuts in emissions of 30-40% of 1990 levels by 2020 without too much cost. This is because the required reduction in the level of the cap for an ETS would be far less than if these policies were not put into place. Australia should endeavor to make deep cuts in its emissions by 2020 and should encourage international efforts to do the same.

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