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A Forestry-Centric Investigation of the New Zealand Emissions Trading Scheme

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1.0 Introduction

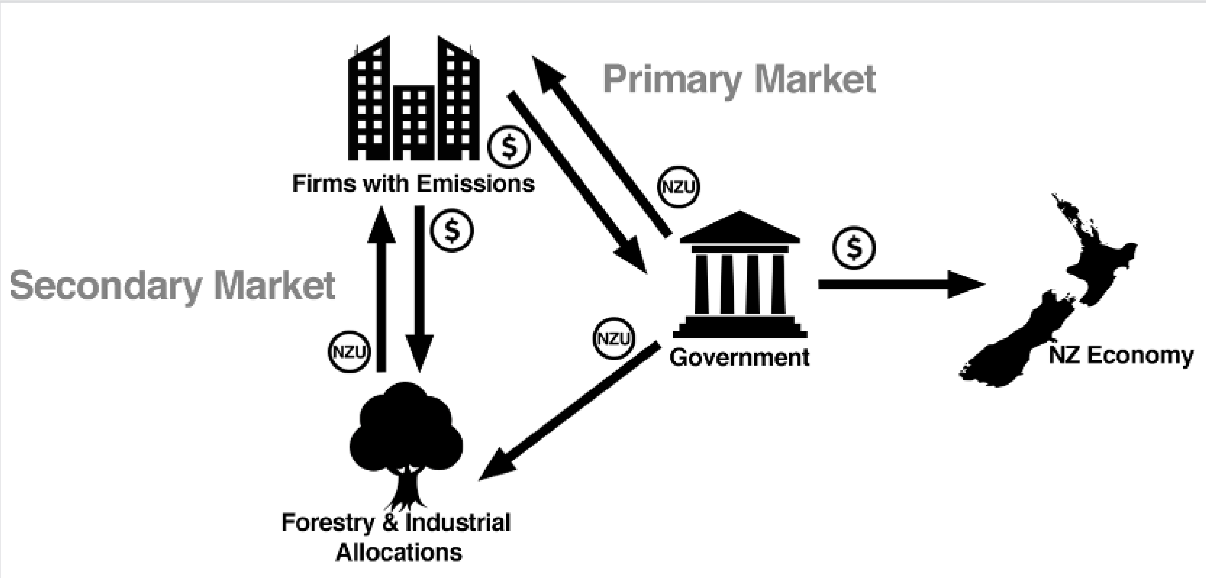
1.1 Purpose

This paper aims to explore the New Zealand Emissions Trading Scheme (NZ ETS) in detail, from a forestry-centric perspective and to offer suggestions for further reform. The paper will aim to provide a comprehensive examination of both the existing and the proposed New Zealand schemes centred around the forestry sector. It will also investigate the California-Québec scheme and the possibility of linking the two schemes and the implications of linkage for the forestry sector in New Zealand. Finally, it will investigate the reasons for New Zealand's relative lack of effectiveness as well as exploring options from both California-Québec and beyond to expand the scheme. It is hoped that this paper has particular relevance given the importance of forestry within New Zealand's economy and given the discussions that are currently happening around potentially linking the California-Québec ETS with the NZ ETS.

1.2 Background

An Emissions Trading Scheme (ETS) is a policy framework that puts a limit on the level of emissions that can be produced by sectors of the economy. This limit is enforced through tradable emissions units, which are permits that grant the emitting firm the allowance of typically one tonne of emissions. These units are returned to the government in exchange for the emissions. Permits are tradeable and purchasable from auctions and, as a result, a market for permits is formed and therefore a market for emissions is also formed. The government has control over the supply within this market and can directly control the amount of emissions within the covered sectors of the economy. These schemes are often referred to as 'cap-and-trade' programmes. Revenue from the sale of emission permits, called New Zealand Units (NZUs), is returned into the economy through government spending.

Figure 1: Emissions Trading Scheme overview
Source: Paddy Baylis



2.0 New Zealand

2.1 New Zealand's current ETS

The NZ ETS was first enacted in 2008 and has undergone several amendments since. The scheme was one of the first in the world that aimed to cover all economic sectors over time. However, agriculture – the leading sector in emissions with 48% of all emissions in 2018 (Ministry for the Environment, 2018) – was deferred indefinitely from obligations under the ETS. The NZ ETS covers carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

Various industrial firms receive free unit allocations from the government in order to reduce the financial impact of the ETS, particularly in terms of their international competitiveness. These are called EITE allocations and may be banked or traded. Other firms must purchase emission units from a secondary market, or directly from the government, which can provide unlimited units at a fixed price of $25 (under the condition that these units cannot be banked or traded). This price will be moved to $35 by the end of 2020. Units are also allocated to firms that actively reduce greenhouse gases. Should they choose to register in the scheme, forestry firms operating forests planted from 1990 onwards are allocated units based on the level of carbon dioxide the trees absorb. Forest owners also face obligations upon deforestation and harvest. Forestry firms that own forests planted before 1990 are mandatory participants in the ETS, but they cannot receive units as they are regarded as baseline forest. They were granted a one-off allocation of units to adjust for the loss of land value associated with the ETS. The ETS includes emissions obligations for deforestation so forest owners could incur unit costs if the use of the land was changed through deforestation. Additionally, offset units are allocated for the destruction or export of synthetic greenhouse gases such as hydrofluorocarbons and perfluorocarbons.

From 2008 to 2015, the system was linked globally under the Kyoto Protocol with firms able to trade 'Kyoto Units'. In 2012, New Zealand chose not to commit to the second commitment period of the Kyoto Protocol, and instead chose to follow emission obligations under the United Nations Framework Convention on Climate Change (UNFCCC). New Zealand's choice not to take a Kyoto Protocol commitment meant that it was unable to trade Kyoto units internationally. As a result, New Zealand moved away from an international system and allowed firms to exchange their Kyoto Units for NZUs. The system became entirely domestic in May 2015. When the move to a domestic-only system was announced, the price of NZUs rose and the government's surrender option allowed for firms to stockpile NZUs below market price by trading for Kyoto Units and surrendering them in exchange for higher valued NZUs. As the New Zealand ETS allows for participants to bank units for future use, this led to a stockpile of approximately 140 million NZUs in private accounts – far greater than the typical annual unit demand of around 30 million (Leining and Kerr 2016).

2.2 New Zealand's new ETS

The NZ ETS was reviewed following the change in government in 2017. The Climate Change Response (Emissions Trading Reform) Amendment Bill was passed in June 2020 bringing several new changes to the ETS which come into effect in 2023. The bill included a government decision to allow the agricultural sector to develop their own pricing mechanism for emissions, separate from the NZ ETS by 2025, with the caveat that if satisfactory progress was not made in doing so by 2022, the sector would be brought into the amended ETS. Industrial allocations will now be reduced through a minimum phase-down rate which is set at 1% for the 2021–2030 period and increases to 2% and 3% for the 2031–2040 and 2041–2050 periods respectively. Penalties for non-payment will be set at three times the carbon price.

From a general standpoint, the ETS reform aims to align with the 2016 Paris Agreement, which sets our commitment to reduce emissions to 30% below the level of 2005 by 2030. The changes will also involve setting a domestic cap on emissions via an auction process. This will allow the government greater control in emissions reduction, as well as remove the $25 fixed price option, potentially setting a price floor for NZUs. [Perhaps the 'and' could be deleted like this, then? Otherwise it just reads slightly oddly.] The changes also involved several adjustments for forestry in the ETS which will be discussed in further detail in the coming section.

3.0 Forestry

Forestry has a fairly unique role in the economy in terms of emissions. Forests help balance global levels of carbon dioxide by being 'carbon-sinks': they absorb carbon dioxide from the air, which is then stored within the tree. However, a significant amount of forestry in New Zealand is commercial forestry which involves growing trees and harvesting them approximately every 30 years for timber (New Zealand Forest Owners Association & Ministry for Primary Industries, 2019).

Forestry is a major industry in New Zealand's economy, contributing around 1.6% of GDP (approx. $3.3 billion USD). New Zealand contributes 1.3% of the global trade in forest products and exports $6.8 billion NZD from the forestry sector annually (Ministry for Primary Industries, 2020). Forests cover approximately 40% of the land (10.5 million ha), of which around 1.7 million ha are plantation forest and 7.8 million ha are native forest. The forestry industry in New Zealand generally involves the planting of radiata pine, which is then harvested typically 26–32 years after planting and sold either domestically or through exports. Radiata pine is the typical species of choice because it has an extremely fast rate of growth and is well suited to New Zealand's climate. The forestry industry is expected to grow over the coming decade as a significant amount of radiata pine reaches harvesting age (Parliamentary Commissioner for the Environment, 2019).

The issue with including carbon sequestration forest offset credits in an ETS is the non-permanence of the forest. While carbon is absorbed as the tree grows, it can be released back into the atmosphere upon tree death, harvesting or natural disaster. With a significant amount of commercial forestry taking place, there can be a number of factors affecting sequestration. As a result, ETS schemes must have a method of calculating carbon stock through changes like harvesting. This is called the carbon accounting method.

One point that is commonly raised by activists is that encouraging forest sinks as an option for reducing emissions, in order to meet emissions targets, can delay and understate the importance of reducing gross emissions. Essentially, in order to meet net emissions targets, both offsetting measures like forest sinks and a reduction in gross emissions through improved technology will be necessary (Friends of the Earth Europe, 2010).

3.1 Forestry in the current ETS

Forestry is a key factor in reducing New Zealand's carbon emissions, with many suggesting New Zealand's ability to reduce emissions to a zero net carbon output by 2050 is largely contingent on forestry. Radiata pine particularly is an incredibly effective species at storing carbon, with Te Uru Rākau estimating that it is twice as effective as native species, and third-party estimates placing it at as much as three times as effective. During a period of well over 100 years, native species sequester more carbon, but grow far more slowly (Gibson, 2019). As a result, NZUs are allocated to forestry firms for planting trees. However, they also must surrender NZUs for emissions in harvesting and resulting changes in carbon stock.

Forestry in the ETS is separated into two categories – pre-1990 forest land and post-1989 forest land.

As the name suggests, pre-1990 forest land covers any forest planted prior to 1990. This is regarded as baseline forest for New Zealand. As a result, any owners of a forest planted before 1990 are mandatory participants in the emissions trading scheme but cannot earn units for carbon sequestration. This means owners must pay liabilities if the land is deforested. This does not mean the forest cannot be harvested, however, in order to avoid penalties, the land must be replanted within four years from the first clearing of trees and must be planted in a way that constitutes a forest under the ETS definition. The deforestation penalties for pre-1990 forest land tend to be heavier than those for post-1989 forest land. As mentioned earlier, pre-1990 forest owners were granted a one-off allocation of NZUs as compensation for the reduction of value due to the land becoming less versatile. This ranged between 18 and 60 NZUs per hectare, depending on several factors.

Post-1989 forest land covers all forest that was first planted from 1990 onwards. This forest is not required to be registered in the NZ ETS. However, participating in the ETS allows owners of post-1989 forests to receive NZUs for the amount of carbon stored in the forest. It also obligates them to repay units for any decreases in carbon within the forest. This reduction in carbon can occur during thinning and during harvesting of trees. Owners must repay units regardless of whether the decrease in carbon is due to human intervention (e.g. harvesting) or natural events (e.g. wildfire). The NZ ETS also stipulates that participating owners of post-1989 forest land cannot be required to repay more NZUs than they have received, even if the carbon released exceeds carbon stored within the forest. Deforestation of post-1989 forest land not in the scheme does not cause any additional penalties (Controller and Auditor-General, 2011).

One of the most important parts of the ETS, in terms of forestry, is the method for determining these allocations of offset units and the repayment of these for harvesting or felling. The current accounting system for these carbon changes is a 'sawtooth' method. Essentially this method tries to directly account for the carbon removed by the planted forest year by year until harvest. When harvest occurs, the system assumes that some wood is removed as product while the remaining residue is left on site. This residue is the portion which forest owners are not expected to initially repay while units for the wood removed are expected to be repaid. The residue is assumed to decay over a period of ten years and forest owners are liable for this over this period rather than immediately (Te Uru Rākau, 2018a).

There are several issues with this current approach.

As mentioned above, any removal of wood from harvesting is currently classed as instant emissions, meaning they must repay the carbon equivalent in NZUs of the removed wood. This policy, whether intentional or not, discourages the harvesting of wood as it effectively increases the cost of doing so. Currently, this is not a major issue as carbon prices are low and the relative cost of repaying units is heavily outweighed by the benefit of having timber to sell. However, as carbon prices start to rise, there is a serious risk that forest owners will choose to leave commercial pine forests in the ground either for significantly longer rotations or permanently. Sawtooth accounting especially exacerbates this risk as units are provided exactly for changes in carbon stock. If forest owners don't harvest, they continue to receive units and don't have to repay any.

Forestry is New Zealand's third largest export currently, with around 50% of harvested wood exported overseas, and exports are expected to increase over the coming decade (Manley and Evison, 2017). If carbon prices reach a point where a significant reduction in harvesting occurs, both the domestic market and exports will suffer. Domestic products typically produce a greater profit so are likely to be less affected initially, however, when exports and harvesting decrease, the local economy will be stunted. Jobs around harvesting, trucking, processing and shipping will reduce. Reducing exports also directly reduces GDP, and under the Solow growth model will negatively affect future economic growth in New Zealand (Solow, 1956). While a shift to averaging accounting will help alleviate this problem for new forests that qualify for averaging, there is a real risk of issues developing in terms of forest permanence in the future as a domestic emissions cap is put into place.

Measurement issues are another problem. Foresters with over 100 hectares must use the Field Management Approach (FMA) in order to calculate carbon offset within their forests. The FMA involves taking samples from a minimum number of sample plots that increases based on the forest size. These samples are measured by the foresters in several ways and this data is provided to the Ministry of Primary Industries (MPI), which uses a model to estimate growth and carbon yield (Te Uru Rākau, 2018b). The FMA provides a more accurate estimate but is a costly and time-intensive process (Ahmed, 2018). Foresters with less than 100 hectares may use tables provided by the MPI, but these tables may underestimate true carbon offset significantly (30–40%) when compared with the results from foresters using the FMA. In 2017, Motu interviewed forest owners and government, who were positive about the FMA in replacement of the look-up tables, largely because they already gather much of the data. However, this is less often the case for owners of smaller forests (Carver, et al., 2017). As a result, small foresters either are underestimating their carbon yield or undergoing a costly process to determine true yield. This can make the ETS more difficult for forest owners (particularly smaller forests) and discourages the registration of pre-existing forests in the ETS.

As discussed earlier, when commercial foresters harvest, they must repay a majority of their units. To some extent, this incentivises permanent forests over commercial forestry. Permanent forests do not provide timber revenue but do provide much greater revenue from NZUs, since they do not need to pay back units for harvesting. Due to the difficulty in measurement and the complexity of the scheme, estimating the cost of harvesting in terms of units is difficult. Since foresters struggle to estimate unit cost of harvesting and are aware that they must repay significant amounts of the units, they are unlikely to sell units and instead hold onto them so that they are able to repay upon harvesting and do not risk having to purchase more units, potentially at a higher cost. This accounting process can often result in a loss for forest owners. As carbon prices rise over time, the cost to repay units can exceed the initial value of the units provided. For example, if a forest owner receives 1,000 credits and sells them for a price of $15 but must pay back 800 credits for harvest when the price is $25, the cost of repayment exceeds the gain from selling the credits. When this occurs on a scale of millions of units the costs can be devastating. As a result, owners must hold on to the credits accumulated or risk significant loss upon harvest. This means very few units from forestry are traded or sold, reducing the value of the ETS to forest owners.

Overall, the current accounting system does not go far enough to incentivise planting, particularly non-permanent planting. It is complex and hurts smaller forest owners. More generally, there is the issue of offsetting carbon taking the place of emitters actually reducing emissions.

3.2 Upcoming ETS changes for forestry

From 2016 to 2018 the NZ ETS underwent a review process. A major part of this process in terms of forestry was evaluating the carbon accounting method for forests, and in 2019 it was announced that New Zealand would be moving from the sawtooth method to averaging accounting. The Ministry of Primary Industries review found that the previous accounting method was a barrier to participation in the ETS by foresters (the scheme is optional for post-1989 forest land), and it had limited incentives for afforestation.

This change will automatically apply to forests registered from 1 January 2021 and will be optional for any forests registered in 2019 and 2020. It is still optional for forests to join the scheme, however, the changes to the accounting approach should vastly reduce the barriers to new forest owners joining. Owners of forests established prior to 2019 will not be able to use averaging accounting at this stage, but this decision will be revisited in 2021 to investigate the possibility of this occurring on an optional basis.

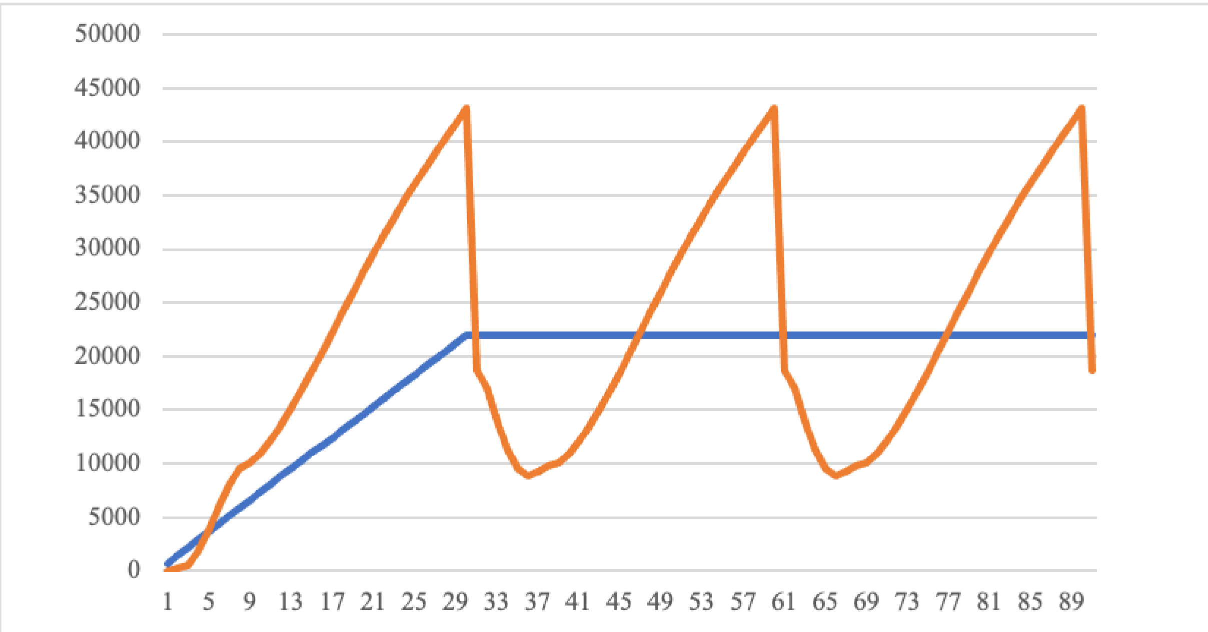
Averaging accounting involves only providing units on the first harvest rotation. Forest owners would receive NZUs for carbon yield up to a level of units that represents the forests long-term storage, either across multiple harvest rotations or as a permanent forest. Harvesting would no longer require repayment of units, but deforestation would still carry a penalty. Forest owners can earn additional credits after the first rotation by planting a higher carbon yield crop such as redwood (Te Uru Rākau, 2018a).

This is regarded as a more effective approach to use forestry within the ETS for a few reasons.

The most obvious is the simplicity of the scheme compared with the previous sawtooth method. Harvesting calculations through the FMA are not required, making it significantly easier and more cost effective for forest owners to participate, while also increasing equality between smaller and larger forest owners. Additionally, while forest owners previously were reluctant to spend NZUs due to the expectation of repayment upon harvest, now there are no penalties on harvest, which allows forest owners to trade NZUs without fear of future costs. As shown below, the number of 'safe' credits is significantly higher with averaging. This increases the financial return for new forests, and, along with the increased equality for smaller forests, this is expected to provide a far greater incentive for afforestation.

Modeling by Professor Bruce Manley of the University of Canterbury suggested that a change to average accounting would increase the rate of afforestation by at least 50% within New Zealand when compared to the previous ETS. It also suggested that the age in the first rotation where benefit is achieved by joining the ETS would increase from ten years to 17 years. This means that in addition to afforestation being incentivised, joining the scheme is further incentivised for current forest owners compared to the previous ETS. This said, currently owners of already established forest prior to 2019 are unable to join the scheme, meaning it will have little impact unless the government chooses to allow some choice of accounting approach when they revisit the issue in 2021 (Manley, 2019b).

Figure 2: Safe credit levels under different carbon stock approaches
Source: Paddy Baylis



This graph illustrates a simplified sawtooth method compared with average accounting over three harvest rotations. The number of 'safe' credits is illustrated for each model. It is clear why averaging is preferable for foresters.

Averaging accounting also does not favor permanent forests heavily over commercial forestry when compared to the sawtooth method. This is important because, especially at lower carbon prices, commercial forestry is often needed to make afforestation financially viable. By not favoring one or the other, this increases afforestation further, as commercial forestry becomes even more financially viable.

3.4 Other changes

The other major change that will affect forestry is the introduction of a domestic emissions cap on NZUs. Previously the ETS offered unlimited NZUs for purchase from the government at a fixed price of $25, which effectively limited the price of NZUs to a maximum of $25. The government chose this approach in 2008 as the New Zealand system was originally designed to function within the Kyoto Protocol with a global cap on emissions. When New Zealand became an exclusively domestic market for NZUs in 2015, this didn't change, which hurt the ability of the ETS to effectively reduce emissions within the economy (Leining and Kerr, 2016).

With the introduction of a domestic cap on NZUs, the government can now control the amount of emissions in the economy to a far greater degree. This cap is executed by the government selling a fixed number of NZUs annually in an auction process. The same process has been used successfully by several other schemes worldwide. Currently, the exact nature of the auction scheme is undergoing a consultation process before implementation. The government's preferred auction option currently would involve multiple auctions across the year, with an even number of units available at each, and with unsold units being added to the next auction up to a limit. The government is also considering the idea of a price floor in the form of a reserve price at auction. This would set a lower bound on carbon prices in the country. Additionally, the government favors a price ceiling – previously the price ceiling was the fixed option of $25. In the auction system, this is called a cost containment reserve and would involve additional units becoming available for auction if the bidding price reached a certain point. This would bring the price back down and keep prices below the ceiling. A cost containment reserve allows for the government to be able to keep prices affordable, however, the Minister for Climate Change would be responsible for ensuring that emissions are reduced in another way to match the increased units available. This keeps this emissions cap in place (Ministry for the Environment, 2019a).

While there are several variations on auction rules, they aren't necessarily particularly relevant to forestry. Instead, forest owners would largely participate in the secondary market, trading their obtained units between firms. For the forestry industry, this change to an emissions cap would have several effects. Pre-1990 forest owners would only have incentive to participate in the auctions if deforestation was planned, while owners of forests established from 1990 to 2018 would only participate in auctions if they needed to meet repayment obligations for harvesting or deforestation. For 1990–2018 forest owners, this is unlikely as rules with the carbon stock approach stipulate that forest owners cannot be liable to pay more NZUs than they have received, and forest owners currently registered in the ETS tend to hold their NZUs for repayment obligations, rather than trading them on the secondary market. Forest owners of new forests using the averaging accounting yield method will have very little incentive to use the auction process as they do not have NZU liabilities except on deforestation.

All this said, this auction process and domestic emissions cap will have an impact on carbon prices. Logically, we would expect to see NZU prices increase. Prices have been fairly stagnant around the $25 mark since early 2018 due to the fixed price option, and when this is removed, we will see the market adjust. As mentioned earlier, industrial allocations are also being phased down, which will further reduce the supply of NZUs in the market increasing prices. With this being said, we should not expect to see rapid, large changes in prices. The fixed price option is available until auctions begin, which should keep prices close to $25. In 2018, over 50% of surrendered units were from the $25 fixed price option (Environmental Protection Authority, 2019a), up from less than 0.1% in 2017 where the main units used were allocated forestry units (Environmental Protection Authority, 2018). During this period, the price of NZUs on the secondary market exceeded $25. This is because the $25 is only applicable if the units are surrendered in the following obligation period – units that do not need to be surrendered by a set time frame are more valuable as they are likely to be worth more than $25 in the future. The government also recently passed a bill to move the current ETS price ceiling of $25 to $35 by the end of 2020. This will have a significant immediate impact on NZU prices – prices have risen above $30 within a week of the announcement – and should allow for the scheme to become more effective in the period between now and the full implementation of the amended ETS.

Additionally, as discussed earlier, there are a very large amount of NZUs currently held in private accounts. While banking units is an important part of the scheme, especially for forest owners using the carbon stock approach, the number of units is as high as 140 million, which is many times the average annual surrender obligations of NZUs. This keeps the price more stable, as, when prices increase, more of these units are made available on the secondary market, pushing the price back down. As a result, because of these units and the fixed option, it may take several years before carbon prices change significantly. As a point of comparison, carbon prices worldwide (converted to NZD) range from $8 (the launch price for China's market) (Brittlebank, 2016), to $28 in California (California Air Resources Board, 2020), to as high as $50 in the EU (Ember, 2020). Fonterra expect a New Zealand price between $75–150 by 2030, while another dairy firm, Synlait, are making decisions based on a projection of $40 by 2023 (Coughlan, 2019).

The effect of these changes in carbon price on forestry is far greater than the direct impact of an auction system and emissions cap. Forestry is an industry that is currently subisidised through NZUs, despite the often-small returns in net NZUs over multiple harvesting rotations. This is because unless forest owners are deforesting, they cannot be liable for more units than they have received if they participate in the scheme and, as a result, across the forestry industry receive a net benefit from the ETS. As carbon price rises, the incentive to plant and to join the ETS significantly increases, especially under averaging accounting.

With around 21 million units being allocated per year (Environmental Protection Authority, 2019b) and annual forestry industry revenue of around $10 billion (export and import) (New Zealand Forest Owners Association & Ministry for Primary Industries, 2019), rising carbon prices can contribute to a significant amount of income for the forestry sector in New Zealand. A rise in NZU price from $25 to $35 is an increase of over $200 million per annum and if prices increase to the estimated low-end price of $75 by 2030 (Coughlan, 2019), the value of the ETS to the forestry sector would be over $1.5 billion without assuming any increase in forestry units, despite the new accounting and other changes to the ETS.

4.0 California & Québec

4.1 California

California's ETS is also a cap and trade system and was established in 2013. California's system is one of the largest carbon markets globally and is a closed system like New Zealand's in that it does not operate under a global framework. The system initially covered only the industrial and electricity sectors of the economy, but, in 2015, expanded to include transportation fuels and natural gas. As of today, the California ETS covers around 85% of state emissions – notably significantly more than the 49% covered in New Zealand's ETS. This is entirely because New Zealand does not include agriculture in the ETS, and New Zealand's agricultural sector is responsible for a far higher proportion of the country's emissions (48%) than the agricultural sector in California. Like the New Zealand system, the California system covers carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

Unlike New Zealand's system, the California system has always operated under an emissions cap. Given that California is a state of the USA, rather than a nation, it has different obligations under the Kyoto Protocol, so the system was not designed to work under a global emissions cap. The target for emissions in the California system initially was to reach 1990 levels of emissions by 2020. The ETS is managed by the California Air and Resources Board who, after collecting data on state emissions and on 1990 emissions, set a cap that reduces every year in order to meet the target on time (International Carbon Action Partnership, 2019a).

4.2 Québec

Québec introduced their emissions trading scheme in 2013 and it covers the same gases as both New Zealand and California. During the first compliance period (2013–2014), the scheme covered both the electricity and industrial sectors but it has since expanded to cover fuels. It also allows for firms that are not covered to register in the scheme and potentially receive free allocations. The scheme currently covers around 85% of emissions within the economy.

4.3 The California-Québec Scheme

California's programme has been linked with Québec since 2014 (International Carbon Action Partnership, 2019b). This is particularly relevant because this paper aims to investigate potential factors warranting consideration when looking at the linkage of the New Zealand scheme into this system in the future. Québec is also much more similar to New Zealand than New Zealand is to California. Québec's population is 8.4 million (Encyclopaedia Britannica, 2020a) compared with New Zealand's 5.0 million (Encyclopaedia Britannica, 2020b) and California's 39.5 million (Encyclopaedia Britannica, 2020c). In 2017, Québec emitted 77.9 million tonnes of carbon (Government of Canada, 2018) while New Zealand emitted 80.9 million tonnes (Ministry for the Environment, 2018). GDP per capita is almost identical – Québec $37,888 USD in 2016 compared with New Zealand's $38,092 USD in 2016 (Gouvernement du Québec, 2017). Forestry is also a significant industry in both Québec and New Zealand, making it a useful point of comparison when considering the effects of the ETS on the forestry sector.

The California-Québec ETS is remarkably effective. California reached their 2020 target of below 1990 emissions by 2016 (Barboza and Lange, 2018). In comparison, in 2018, New Zealand produced 24% over the 1990 level in emissions (Ministry for the Environment, 2018). Québec set an even more ambitious target than California, aiming for 20% below 1990 levels by 2020. As of 2017, they sat 9% below 1990 levels with the lowest emissions per capita in Canada – less than half the Canadian average (Gouvernement du Québec, 2018) and more than 40% below New Zealand's average (Ministry for the Environment, 2018). California's per capita emissions are only slightly higher than Québec's and are over a third lower than New Zealand's (California Air Resources Board, 2019a). Later in this paper, some potential reasons for the disparity in effectiveness will be given.

Currently both schemes are undergoing changes and reviews. California has set a new target of 40% below 1990 emissions by 2030 (International Carbon Action Partnership, 2019b), while Québec has set a target of 37.5% below 1990 emissions by 2030 (International Carbon Action Partnership, 2019a).

5.0 Forestry in the California-Québec ETS

5.1 California

California involves forestry in its ETS scheme through an offsets protocol. While there are several ways to earn offset credits in the California scheme, 80% of these come from the US Forests Protocol which is what forestry falls under (Haya, 2019). Three types of activity are eligible for offset credits under the current ETS.

The first is reforestation which is classed as being forest projects that restore tree cover on land that is not at an optimal stocking level. This is not just planting for commercial forestry – land must have had less than 10% tree cover for ten years or more or must have had a disturbance that resulted in reduction of tree cover by at least 20%, such as a wildfire. It can only be used for commercial forestry if the harvesting is needed to prevent disease and it requires special approval.

The second is improved forest management. This involves any of the following:

- increasing forest age (leaving trees to grow longer before harvesting);
- increasing forest productivity through pruning or thinning suppressed trees;
- managing brush and short-lived forest species;
- maintaining stocks at a high level.

The third is 'avoided conversion'. This involves projects that prevent the conversion of forestland to non-forest use through qualified conservation easement or transfer to public ownership.

Typical forestry activities do not earn offset credits in the same way. Essentially, the only ways to earn credits for typical forestry firms are to find ways to improve carbon sequestration in existing forests (improved forest management) and by planting new forests or restocking damaged forest (reforestation) (California Air Resources Board, 2015).

California took this approach instead of involving forestry in the scheme in the same way as New Zealand, largely for administrative reasons. They decided that placing forests under a market cap, as New Zealand has, would make it extremely difficult to enforce compliance, given the number of private forest parcels (Tuttle, 2019). By comparison, New Zealand does not make it mandatory for forests to be registered in the ETS, but allows them to earn credits if they do. Baseline forests (pre-1990) are subject to compliance in terms of deforestation penalties and cannot register to earn credits. New Zealand's scheme uses forestry far more as a path to emissions reduction than California, who cap offset credit surrendering at 8% (International Carbon Action Partnership, 2019b). The benefits of California's offset cap can be faster emissions reduction and revenue for the forestry industry, but it can also reduce the effectiveness of the scheme in reducing gross emissions.

The improved forest management protocol in the California system has come in for a significant amount of flack particularly from academics who claim that it allows for offset credits to be overestimated. A 2019 policy brief from UC Berkeley suggested that as many as 82% of the 80% of offset credits issued under this protocol did not accurately represent real world emissions reductions. The issue here is that the policy underestimates carbon leakages. Carbon leakages occur when harvesting reduces at one site, leading to additional offset credits for improved forest management. This decrease results in increased harvesting at another site in order to maintain the level of timber harvested.

The policy brief suggests this overestimation occurs in three ways. The first is that the current offset protocol assumes a 20% leakage rate – much lower than the 80% rate supported by studies. Secondly, the current protocol gives offset credits immediately for improved forest management, but only requires the leakage to be repaid over 100 years because of harvesting assumptions. Finally, the protocol is ambiguous when it comes to whether forest owners must maintain forest growth over 25 years or 100 years to cover the leakages, which results in forest owners able to receive offset credits with no ultimate change in carbon storage. To fix this, the policy brief suggests that the protocol needs to be adjusted with a leakage rate of 80% and both offsets and leakages calculated on a yearly basis (Haya, 2019). However, the policy brief is contested by several other academics as well as the California Air Resources Board who oversee the ETS. They claim that the 80% leakage rate is a misreading of the paper that suggested it, and that this was a specific example rather than a general rate to be used (California Air Resources Board, 2019b). The paper's author Brian Murray agrees (Murray, 2019).

5.2 Québec

Québec, while currently offering some activities that provide offset credits, currently do not have a protocol in place for forest on private land. This protocol is currently being designed. While the exact details of the protocol are yet to be publicly revealed, there's a significant amount of material suggesting how the protocol will work.

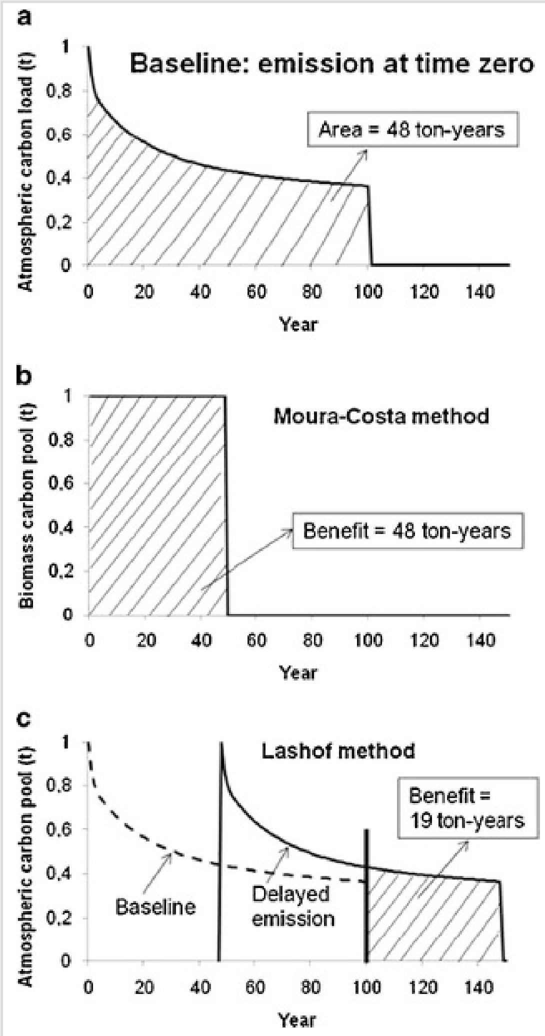
A 2017 financial study by the Ministry of Forestry, Wildlife and Parks compared different financial accounting methods for offset credit calculation. The protocol compared ex-post and ex-ante accounting. 'Ex-post' means that offset credits are issued after sequestration and climate benefits occur. This, therefore, takes into account harvesting and the effects on the trees and carbon storage over time before issuing offset credits. 'Ex-ante' involves providing offset credits before or while projects are put into place and typically requires that a proportion of credits are held in a reserve fund so that they can be repaid upon carbon loss. The advantages of an ex-post system are lower fixed costs, making afforestation projects more financially viable for smaller land owners. Further, ex-post does not require constant monitoring as an ex-ante system does, which helps to keep a high profitability and allows owners more latitude as forest projects can be changed at any time. Since credits are calculated over such a long period, permanence is encouraged but not essential. However, with this ex-post system, accumulation takes longer and total credits issued are lower. Ex-post can also be more restrictive – credits are not issued until all required parts of the offset project have been met unconditionally. However, because permanence is not a necessity this becomes less of an issue, and the restrictiveness helps to maintain the environmental integrity of the system. This means that while initial forest projects have tighter guidelines, once these guidelines have been successfully met, owners have more freedom in terms of land use (Ministère des Forêts, de la Faune et des Parcs, 2017).

The Québec system is an example of tonne-year accounting which was originally proposed by the Intergovernmental Panel on Climate Change. One of the major issues with forestry in an ETS is the concept of permanence. Credits are awarded based on a permanent reduction in emissions, but as forests are harvested or deforested, that permanence cannot be assured in the same way as other offset qualifying activities.

The tonne-year approach is a solution to this issue. Instead of issuing credits based on the carbon stored in the tree – as with New Zealand's or California's system – it issues credits based on the impact of sequestered carbon over 100 years. The approach is slightly harder to grasp but it involves an initial reduction in carbon. For example, imagine a one-tonne reduction from a forest. Carbon dioxide decays in the atmosphere over hundreds of years following an exponential curve. To calculate the change in emissions because of sequestration, we calculate the area of the carbon decay curve and compare it to a scenario where carbon is sequestered for a year. This can be calculated through integrals: by getting the integral of the carbon decay curve for 100 years, we know the total 'tonne-years' of carbon that $CO2$ would normally last for. Tonne-years refers to the number of total years that a full tonne of carbon would be in the air (less than 100 because it is decaying). This integral is compared to a situation where that tonne of carbon has been stored and the value in tonne years of that storage is calculated by finding the difference between the two curves. Essentially, Québec aims to find how many tonnes of carbon a forest has removed for 100 years (permanence) when compared to how that carbon would have typically decayed in the atmosphere without sequestration (Fortin, 2019). This approach results in a slower, but longer, yield of credits, which is effective for Québec given their much longer harvest rotation lengths (70–100 years instead of New Zealand's 25–35 years) (Bergeron et al., 2017).

Tonne-year accounting is a difficult concept to understand but the graphic below may help.

Figure 3: Tonne year accounting approaches
Source: Annie Levasseur of École de Technologie Supérieure



There are two typically referenced methods of accounting for tonne-year. Moura Costa accounting assumes that maintaining a sequestered tonne of carbon is equivalent to maintaining another tonne of carbon the next year. As a result, Moura Costa overestimates the climate benefits of sequestration. Lashof accounting assumes that carbon sequestration postpones the emission – it is calculated by shifting the carbon decay curve further by the sequestration time and then calculating the integral of the curve that exceeds the 100-year permanence period. However, this underestimates potential emission benefits when dealing with periods of sequestration that are less than 100 years. Instead, the proposed Québec accounting method is called an FG approach which involves calculating sequestered emissions periodically and calculating the climate benefit for each emissions sequestration period individually before summing them. This works well for forestry, particularly where sequestrations are different and additive year to year. It fits in between Lashof and Moura Costa in terms of credit return (Fortin 2019).

5.3 Offsets

Another major difference between New Zealand and California-Québec is the number of offsets able to be used. New Zealand has no limit on the use of offset credits by firms, whereas California and Québec limit offset use to 8% of obligations (International Carbon Action Partnership, 2019a; 2019b). These offset caps disincentivise offset programmes in favor of reducing emissions directly.

In 2018, New Zealand issued 23 million NZUs for offset projects, of which 21.4 million were due to forestry projects and 1.75 million were from other offset projects (Environmental Protection Authority, 2019b). California, in 2018, issued around 40 million CCO credits (Stillwater Associates, 2018) while Québec has issued a total of just over 850,000 from 2014 through 2019 (Environnement et Lutte contre les changements climatiques, 2020). New Zealand has a higher relative offset issuance relative to California and Québec for several reasons. Most importantly, both California and Québec limit the use of offsets in their scheme to 8% of surrender obligations. This is moving to 4% in 2021 and then to 6% from 2026 to 2030 (International Carbon Action Partnership, 2019a; 2019b). As a result, offsets are significantly less valuable to firms, so fewer offset projects take place. Additionally, New Zealand involves the forestry industry in their offset issuances more than California, while Québec does not involve the forest industry at all yet. California also has extremely strict rules around their forest offset projects that can make it difficult for forests to qualify. For example, the New Zealand ETS classes a forest as a hectare or more of trees in one area carrying a forest species that is capable of growing to at least 5 metres tall and is planted or stocked at a density that has the ability to exceed 30% tree crown cover on each hectare (Te Uru Rākau, 2018a). Meanwhile the California protocol has very stringent eligibility requirements, including aiming for 95% native species, a mixture of species, 40% minimum canopy cover, uneven aging for harvesting, and an area of over 20 acres (8 hectares) (California Air Resources Board, 2015). Forest projects are where the vast majority of both California and New Zealand's offsets come from, and, thanks to New Zealand's wider rules, more offset credits are issued.

While California and Québec have been more successful than New Zealand's system, it is reasonable to assume that this is largely due to other issues rather than the offset limit. It will be worth examining Québec's protocol and whether it changes when their forestry protocol is introduced.

5.4 Targets

In terms of targets, California, as mentioned earlier, is well ahead of their 2020 target, but trends suggest it is tracking away from keeping to its ambitious 2030 target (Busch and Orvis, 2020). Québec is likely to miss its 2020 target narrowly (it is around 9% below 1990 levels currently and the target is 20% below 1990 levels), but recently doubled down on its commitment to achieving its 2030 target (Shingler, 2018). New Zealand will likely achieve their 2020 target thanks to significant offsets from forestry, but the 2030 target will be more challenging, despite the changes to the ETS.

I would expect there is a strong possibility that the 2020 emissions for New Zealand will be under the target pace, however, this is not necessarily indicative of true emissions reduction; as a result of COVID-19 and the resulting economic slowdown, emissions will be lower. Additionally, with the changes to the ETS and the fixed price ceiling option, carbon prices have rocketed to all-time highs, despite the slowdown, and as a result I expect emissions to be reduced. These effects coupled together may well put emissions below pace to meet the 2030 target, but it does not necessarily indicate that this reduction will carry over through 2021 and beyond.

6.0 Forestry accounting comparison

6.1 Methodology

In this section, I will calculate the carbon offset credits awarded for afforestation. I will look at a 50-hectare area of radiata pine over a 30-year period, assuming full harvest at 30 years. In order to maintain consistency across the approaches, we will use the MPI look-up tables for Gisborne, as Gisborne has the highest values, and the MPI tables underestimate carbon stocks (Te Uru Rākau, 2020a). For simplicity, I will ignore carbon emissions released during harvest (i.e. machinery emissions etc.) as well as soil carbon. All costs and effects other than simply tree and root growth and harvest will be ignored. I will assume the same species of trees and harvest rotations, despite likely differences between regions, just to show a simple example of how each accounting approach differs.

6.2 New Zealand

First, I will look at awarded NZUs. This is trivial: as this is afforestation, this is just equal to the 30-year value of tonnes of carbon per hectare multiplied by the area of the forest. At 30 years the tables indicate stored carbon of 861 tonnes per hectare. We have 50 hectares in our example, so we look at 861*50 and get a total credit return of 43,035 NZUs.

Now to calculate harvest we must calculate the remaining carbon stock after clearing. The MPI tables indicate a value of 373 metric tonnes. It is worth noting here that this must be repaid as well over a 10-year decay period. However as we are calculating net credits at the harvest point, we don't need to think about this yet.

861 – 373 = 488 so we have a liability of 488 units per hectare. 50*488 is 24,400 so this is our total liability after full harvest. 373*50 = 18,650 which is our net return on credits at the 30-year mark under the old New Zealand system after harvest.

6.3 California

California's system is largely the same. For consistency I am using the same numbers so the initial credit award will be 43,035 units at the 30-year mark prior to harvesting. California's system differs slightly in terms of how it deals with harvesting (classed as an intentional reversal).

Evaluate: (Δ AConsite) + (ACwp, y) * 0.80

Note that this equation is slightly different from the official protocol which includes baseline stock calculations. This is again for simplicity

Δ AConsite represents the change in carbon stock on site. In this case, following harvest this change is the same as our liability in the NZ model as we are using the same value for remaining carbon. This is -24,400. ACwp is the amount of carbon stored in wood products. As discussed earlier, California's model accounts for carbon that remains stored in harvested wood such as buildings. This can get very specific based on type of wood, use of the wood, how much it is processed, etc., so for the purposes of this exercise I will use a fairly conservative 100-year storage estimate of 0.35, as radiata pine is softwood. The 0.8 here is leakage; as mentioned earlier, it is assuming that the market will adjust for 20% of wood product.

-24,400 + 0.35*24,400*0.8 = -17,568

So, this is the liability of harvest under the California system, leaving a net credit of 25,467 under the California protocol.

6.4 Québec

While the details of Québec's system are still confidential, we can use the fact that it is tonne-year accounting to estimate a credit return after 30 years. Tonne-year accounting is difficult, so in order to calculate an estimate for provided units, I created a simple model. The model uses a simple BERN carbon cycle model, simplified FG accounting and the MPI tables and calculates units provided as tonne-years.

Bern: 0.175602 + 0.137467 exp(-t/421.093) + 0.185762 exp(- t/70.5965) + 0.242302 exp(-t/21.42165) + 0.258868 exp(-t/3.41537)

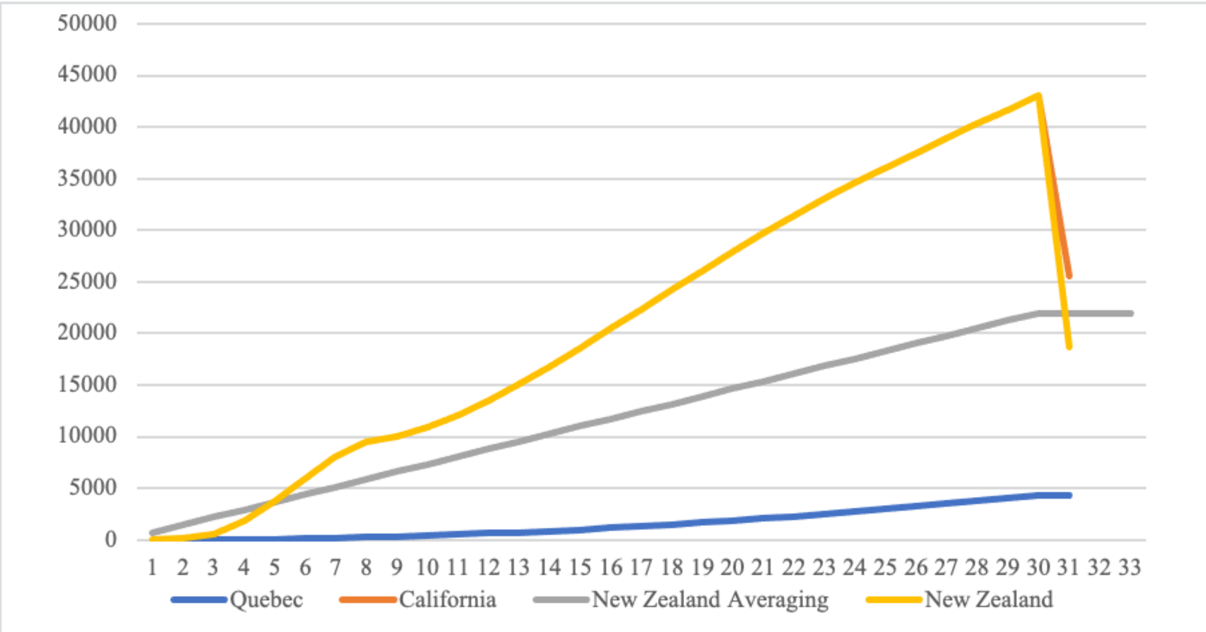
The net return of credits ends up being 4,266 over the 30-year window but this is likely fairly inaccurate due to the lack of an official protocol and simplifications made for calculations. It is also worth noting that this system continues to accrue credits over a much longer period, assuming trees stay being replanted. Harvesting would result in a similar rate for the next 30 years but, as Québec forestry rotations tend to be far longer, credit accrual would occur at a higher rate as carbon continued to be sequestered and stored for far longer.

6.5 NZ averaging accounting

In order to calculate averaging we need to look at the carbon stock approach and find the average long-term effect. I set up a simple model that calculated net credits every year during three harvest rotations and calculated an average of the results. This resulted in a net credit return of 21,971. Once allocated credits reach this point, allocations cease.

6.6 Conclusions

Figure 4: Carbon stock approaches
Source: Paddy Baylis



7.0 Comparing the two schemes

By almost every possible metric, New Zealand's ETS is not performing as successfully from an emissions reduction standpoint as the California-Québec system. New Zealand's ETS was created to meet two goals; fulfilling our international obligations for reporting via units under the Kyoto Protocol, and to reduce our domestic emissions to a target level. The ETS was a successful tool for the first goal but has failed to achieve any clear progress in reducing domestic emissions. There are multiple reasons for this, of which many are addressed in the upcoming reform to the ETS.

7.1 Emissions coverage

The first reason is emissions coverage. While New Zealand's ETS was heralded in 2008 for being the first ETS to cover all economic sectors, it has failed to deliver on this by delaying the inclusion of agriculture for over a decade. The New Zealand ETS covers just over 50% of emissions in the economy currently (MfE, 2019b), despite covering more sectors than California or Québec.

The issue is that agriculture is New Zealand's primary industry and is also extremely emissions heavy. The lack of emissions policy on agriculture means the 48% of total emissions produced by the sector is currently unaccounted for in the ETS (Ministry for the Environment, 2018). By comparison, both California and Québec's ETS schemes cover over 85% of each economy's emissions (International Carbon Action Partnership, 2019a; 2019b). This makes the policy much more effective, as the government can exercise far greater control by being able to limit the vast majority of emissions within the economy. If the Emissions Trading Scheme was successful in reducing emissions by 10% over the next five years, it would only result in around 5% emissions reduction for New Zealand as the scheme only covers around 50% of emissions due to agriculture. That 5% may be even lower, given that agricultural emissions have increased since the beginning of the scheme. Comparatively a reduction of 10% by California or Québec's schemes results in a net reduction of around 8.5%.

In New Zealand, since the introduction of the ETS, agriculture has increased from 35.75 megatonnes of emissions in 2008 when the ETS came into effect, to 37.7 megatonnes in 2018 (Ministry for the Environment, 2018). Farming efficiency has increased significantly over the last 30 years which theoretically should result in decreased emissions. Instead, farming output has increased at a higher rate, leading to an increase in emissions from the sector (Parliamentary Commissioner for the Environment, 2019). The only other major sector to increase over this period is the industrial sector which is accounted for in the ETS, but is provided free allocations of NZUs (Ministry for the Environment, 2018).

In order to meet emissions targets, agriculture must be accounted for in some way. This is one of the changes being made in the new ETS. While agriculture will not initially be included in the ETS, farmers have five years to develop an agriculture-specific pricing mechanism for emissions that will run separately from the ETS. If this is not enacted by 2025, the government will fold agriculture into the current ETS and has the ability to do so from 2022 should progress be too slow (Ministry for the Environment, 2019b). In terms of emissions and effectiveness of the ETS, this is not a perfect solution. Given the significance of agriculture in our emissions landscape, New Zealand's ETS sits at a significant disadvantage compared to Emissions Trading Schemes globally. It is vital that agriculture is held accountable for emissions so that there is incentive for the sector to find ways to cut emissions. Involving agriculture in the ETS in some way allows for the effect of rising carbon prices due to caps to incentivise uptake of technology that reduces emissions. Allowing the agricultural sector to create their own plan reduces the government's control over net emissions and hurts the chances of reaching emissions targets. In order to meet 2030 obligations, New Zealand must reduce emissions to 58mt. In 2018, agriculture made up 37.7mt while all other sectors made up 41.1mt. Delaying agriculture to 2025 means that other sectors must decrease by over 25% to be on target for the 2030 emissions goal (Ministry for the Environment, 2018).

7.2 Emissions cap

The other major reason for the lack of effectiveness is the lack of an emissions cap in the New Zealand system. An emissions cap works to reduce emissions in the following way: the government sets a cap on emission permits. This is effectively used to determine the amount of emissions that will be allowed in the economy for the year. For California and Québec, this emissions cap is approximately 85% of the target for the year as the scheme covers 85% of emissions. This is the maximum amount of permits available for that year and the price of carbon is determined via demand for these permits. Financial penalties apply if firms do not pay for enough units – typically carbon price plus a percentage – so firms must buy enough permits to cover their emissions or find a way to reduce their emissions. At low prices, firms will buy permits to cover emissions, but as carbon prices rise, these permits are costlier and it becomes cheaper for firms to find a way to reduce emissions, be it through technology, efficiency improvement or otherwise.

As discussed earlier, New Zealand's system has operated without a cap on NZUs – allowing multiple to be purchased from the government at a price of $25, effectively limiting prices. As a result, the impact of the ETS reaches a limit of effectiveness once carbon prices reach $25. At this price level, the government still earns revenue from the sale of NZUs, however, the incentive to reduce emissions no longer increases. By operating without an emissions cap, the incentive to reduce emissions is less: firms know there is no risk of increased carbon prices or inability to repay since they can always buy units from the government for $25.

In 2018, over 50% of surrendered units came from this fixed price option, indicating significant failure in terms of lost revenue and lost emissions reductions from a policy standpoint (Environmental Protection Authority, 2019a). Comparatively, California and Québec have both operated with a reducing emissions cap since inception. Additionally, the $25 price option did not change from 2008 to 2019, despite inflation causing the cost to fall from $25 in 2008 dollars during 2008, to $20.39 in 2008 dollars during 2019. As a result, the price ceiling for carbon in New Zealand reduced over time, so the cost to firms of covering emissions actually fell. A $25 price ceiling also allows firms to pass costs on to the consumer easily and even to profit from the fixed price option, as the units don't have to be surrendered until the next obligation period, allowing a profit through inflation. By increasing the prices firms charge consumers early in the ETS' inception, the resulting fall in real price due to inflation allows firms to turn a profit (personal communication, Elvidge, 2020). Comparatively prices in the California-Québec system (as the schemes are linked there is only one carbon price between the two) rose from $12 in 2014 to $17 in 2019 (California Air Resources Board, 2020). This lack of an emissions cap obviously hurts emissions reduction as the government has no control over the level of emissions and nor is there much incentive for firms to find ways to reduce emissions as there is no fear of higher emissions costs.

Fortunately, under the new legislation, New Zealand will implement a domestic cap via an auction system, which should help to resolve the issues associated with the transition from the Kyoto Protocol. The $25 option has also been raised to $35 beginning in 2021. This will allow the scheme to be more effective in the interim period before the new system is put into practice.

7.3 Surrender options

Finally, there are a multitude of issues around unit surrender options that are contributing to the lack of effectiveness of the New Zealand ETS compared with the California-Québec scheme.

New Zealand began its ETS under the Kyoto Protocol and, upon withdrawing from the programme to move to a domestic-only market, allowed for internationally traded Kyoto units to be surrendered in exchange for NZUs. During this period 2011–2015, a significant amount of these Kyoto units were issued by Ukraine and Russia. A 2015 report suggested 90% of issued units came from Ukraine or Russia, with 89% of Ukraine units and 83% of Russian units having questionable or low environmental integrity (Simmons and Young, 2016).

Another reason for the influx of these credits is due to the concept of baseline accounting. Emissions targets for countries are set compared to the baseline of 1990 under the Kyoto Protocol. New Zealand is fairly fortunate in this regard – significant afforestation occurred in the early 1990s resulting in emissions reduction. Ukraine and Russia are also fortunate as in 1991 emissions plunged due to the dissolution of the Soviet Union. As a result, both Ukraine and Russia have sat significantly below 1990 emissions, and they meet emissions targets with ease. These surplus emissions are able to be sold to other countries to help them meet their emissions targets, and, thanks to the weak targets, there was a large available supply and, as a result, the units were extremely cheap (personal communication, Elvidge, 2020). This remains an issue in the future under the Paris Agreement as New Zealand may need to purchase units from other countries to meet obligations if New Zealand falls short of emissions targets (United Nations Framework Convention on Climate Change, 2016). As New Zealand businesses were allowed to use these credits, the Emissions Trading Scheme had very little effect because these surrendered credits were not linked to any appreciable change in emission offsets. These units flooded the market and the price of units fell below $0.15. A Morgan Foundation report in 2016 suggested 99% of New Zealand's held Emission Reduction Units (ERUs) came from either Ukraine or Russia at a cost of around $200 million to New Zealand businesses purchasing the units. In 2013 and 2014 these units comprised over 90% of surrendered units to the New Zealand government. To this day, an enormous number of NZUs remain banked in private accounts as a result of this period.

The Morgan Foundation labelled this 'climate fraud' (Simmons and Young, 2016). New Zealand businesses paid essentially nothing towards climate obligations in 2013 and 2014, and the price of carbon in New Zealand took years to recover thanks to the influx of these units, further damaging the effectiveness of the ETS. It also significantly hurt trust in the scheme, both from forestry and involved firms, as well as the public.

This had an especially large impact on the forestry sector. The forestry sector's role in the ETS is a net sink – it reduces emissions as a whole in the economy – and as a result it is compensated via NZUs. When these ERUs became available, and comprised such a large proportion of surrender obligations, NZUs price fell, since demand was far lower. As a result, the benefit to forestry sectors of being within the scheme is directly tied to the price of NZUs. From November 2010 to March 2013, the price of NZUs fell from $20.61 to $1.89 – a decrease of 91% (theecanmole, 2017). This resulted in the value of the ETS to the forestry industry falling by the same 91%. Even today, the privately banked number of NZUs exceeds the annual demand by over four times (Environmental Protection Authority, 2019b). In 2010 and 2011, approximately 36.5 million units were provided to forestry overall, both via one-off allocations to pre-1990 forests and as allocations for post-1989 forests involved in the scheme (Environmental Protection Authority, 2013). In late 2011, the price of NZUs was $13 (theecanmole, 2017) resulting in a valuation for these units of around $475 million. By March 2013, the price had fallen to $1.85 (theecanmole, 2017) resulting in a valuation of under $70 million, an unrealised loss of over $400 million for the forestry sector. Many forest owners used this opportunity to de-register from the scheme and surrender liabilities for doing so. In 2013, 346 forestry participants de-registered from the scheme, and forest owners who did so, and re-registered years later, could earn revenue in the form of NZUs, thanks to the scheme moving to domestic-only (Carver et al., 2017).

Up until 2017, the scheme also allowed for a two-for-one surrender option where emitters only needed to surrender one unit for two tonnes of emissions. It wasn't until 2019 that full surrender obligations were in place (Ministry for the Environment, 2016). Again, this significantly hurts the effectiveness of the scheme; it is vital that costs for emitters are high enough to force behaviour change.

7.4 Allocations

Units are allocated to the industrial sector in order to increase competitiveness of exports. This is important because New Zealand is a small country and a small economy globally. We cannot mass produce in the same way large economies like China and the USA can, so we do not reap the same benefits of economies of scale. As a result, profit margins here can be significantly smaller when exporting as businesses have to compete in the international market against larger firms from these economies. The industrial sector is a sector that is classed as a risk for carbon leakage. Essentially this just means that the sector activities release a relatively large amount of emissions compared to other industries. Emissions units are a cost to businesses, and for businesses releasing emissions in the way the industrial sector does, they can be a significant cost. Because of the low profit margins on exports and the associated costs that come with the ETS, these sectors are provided free allocations of units (Leining and Kerr, 2016). These same allocations are provided in the California-Québec schemes. However, because these schemes operate with a reducing cap, these allocations are reduced year to year based on how much the cap decreases (International Carbon Action Partnership, 2019a; 2019b). This allows the government to support these industries with the costs of the emissions regulations, while also slowly moving them to find ways to reduce emissions over time.

In New Zealand, these allocations have remained constant over the last decade which means that the industrial sector has little incentive to find ways to reduce emissions. This is apparent as the industrial sectors emissions have risen from 4.3 megatonnes in 2008 when the scheme took effect, to 5.2 megatonnes in 2018 (Ministry for the Environment, 2018). Industrial allocations are, however, being changed in the upcoming ETS. As mentioned earlier, the new ETS involves a 'phase-down rate' for industrial allocation which reduces allocations by a minimum of 1–3% per year depending on the decade (Cabinet Environment Energy and Climate Change Committee, 2019). This will help to increase the effectiveness of the New Zealand ETS, although it is worth noting that the industrial sector is a relatively small part of the economy in terms of net emissions.

8.0 Linking

California's system is currently linked with Québec's. This means the systems use the same units, and these units can be traded between firms in both regions.

Linking has several advantages – most notably, it allows for greater economic efficiency (International Carbon Action Partnership, 2015). A perfect ETS would be a global system, but this has been shown to be largely infeasible.

In this section, I want to examine briefly some of the implications of linking our system with the California-Québec system.

8.1 Prices

This first implication of linkage is a shared carbon price (International Carbon Action Partnership, 2015). If our system linked with the California-Québec system, the price across the two systems would become uniform, as it would become a single market. When the markets linked, the change in price would be dependent on the number of units circulating in each market. In 2017, California emitted 434 million metric tonnes of carbon equivalent, Québec 77.9 million metric tonnes and New Zealand 80.9 million metric tonnes. As the Québec and California systems are linked there are approximately 435 million units circulating in the market compared to New Zealand's 40 million, since Québec and California cover 85% of emissions while New Zealand covers 50%. As a result, we would see New Zealand's price change heavily, while California-Québec prices would only change marginally.

Price changes are slightly difficult to ascertain due to the changes in the ETS in New Zealand. Prices have already risen to over $30 on the back of the passing of the reforms and will likely move to $35 by year end. California's price during 2019 moved towards $18USD (around $27.50 NZD). As linkage would likely not occur at least until 2023 (when the new ETS is fully in effect), we will examine price forecasts to get an idea of how linkage would change prices.

In 2017, the University of California – Berkeley predicted California carbon prices to sit around $50USD ($77 NZD) in 2030. Meanwhile Fonterra in New Zealand predict a carbon price of $75–150 NZD by 2030. While forecasts are difficult to manage, it seems likely that, given the significant changes to New Zealand's policy, the New Zealand price, at least in the shorter term – 2–3 years, will increase at a more rapid rate than California-Québec. This will widen the gap between the two market prices.

For simplicity we will assume the markets are linking in early 2024, and that New Zealand's price will be trending from $30 NZD to $100 NZD by 2030 at a linear rate of $7 NZD per year. We will assume California's price will move from $18 USD to $50 USD by 2030 at a linear rate of $3.20 USD per year. This would mean at 2024, when the markets linked, we would be using a New Zealand price of $58 NZD and a California price of $30.80 USD ($47 NZD). When the markets link, the price will be split between the two, based on the number of units in each. Finding the weighted average results in a price of $48 NZD after merging – a decrease of $10 for New Zealand's system and an increase of $1 NZD for the California-Québec system.

There are several implications for New Zealand in this price decrease. Forestry would be negatively affected as the price of the provided credits would fall, resulting in a loss of revenue. Emitters within the New Zealand market would be positively affected as costs associated with covering emissions would fall, and we would expect our rise in prices to slow considerably and be more in line with the California-Québec price trend. The lower price would hurt the effectiveness of our scheme as it would incentivise buying emissions permits rather than reducing emissions. The price would likely be more stable and there would be a larger market for unit trading, which would help to mitigate some of the negative impacts of a lower price for forestry.

Overall, from a price perspective, this change would likely not be useful in assisting the ETS in accomplishing our net emissions targets and might well be harmful.

8.2 Caps

Another difficulty when linking systems is differences in caps.

If systems link entirely, caps are shared across all schemes, so if targets are not aligned, countries with more ambitious targets than other countries in the linkage will have an excess of units to meet targets, and vice versa for countries with less ambitious targets. Linking systems that have different ambitions in terms of emission reduction can be complex and can have negative economic and environmental side effects (Asian Development Bank, 2016).

On the positive side, New Zealand, California and Québec all have emissions targets in the same format – % below 1990 levels by 2030. However, while California and Québec's 2030 targets are fairly similar (37.5% below 1990 by 2030 for Québec and 40% below 1990 by 2030 for California) (International Carbon Action Partnership, 2019b), New Zealand's target is comparatively much lower (11% below 1990 by 2030) (Ministry for the Environment, 2018). From a percentage change standpoint, New Zealand's target represents a 28% reduction from 2017 emissions to the 2030 target. California's target represents a 39% reduction from 2017 emissions to the 2030 target and Québec's target represents a 28.5% reduction from 2017 emissions to the 2030 target.

Since New Zealand's target fits into this, it is possible that caps will not be an issue if the systems link, however, it is something that will need to be considered.

8.3 Offsets

Different offset provisions can cause harm upon linkage (International Carbon Action Partnership, 2015). While California and Québec have managed to succeed in overcoming this, despite differing offset protocols, it will be something to be wary of when considering linking.

There are some differences between New Zealand and California-Québec in terms of offsets and it is important to be cautious around these. One is that both California and Québec have a limit on the proportion of offsets that can be used in settling carbon debt. (Both allow a maximum of 8%.) This may cause an issue with New Zealand's current system which does not cap the amount of offset credits that can be used. Projects in California and Québec are cheaper, as are offset units, because of the offset caps. Additionally, California recently adopted a tropical forest protocol allowing for offset projects to take place in forests like the Amazon rainforest. This has been controversial because of risks of 'fake offsets' and non-permanent changes especially when dealing with a government in Brazil renowned for deforestation. Norway has previously adopted a similar policy and abandoned it after disappointing results (Fitzner, 2019).

These policies could open the offset system up to further abuse and could allow New Zealand firms cheaper credits without tangible emission reductions – eerily similar to the issues with Ukraine and Russia when New Zealand's system operated under the Kyoto protocol. Specifically, an issue that could arise is New Zealand firms running cheaper or even ineffective offset projects in California or Québec and using these to pay off carbon debt, thus reducing the effectiveness of our scheme domestically as well as compromising the integrity of the schemes as a whole.

8.4 Other factors

The other issues relating to linkage are more general. When linking, New Zealand will lose a significant level of control over the system. For example, caps are shared across the three systems. This is a negative impact. While California has a more similar political culture to New Zealand than much of the rest of the United States, this is an important factor to consider, especially given that if California changed their ETS significantly as a result of a political change, we would be affected.

On the beneficial side, the link would likely significantly reduce compliance costs. Québec was predicted to reduce compliance costs by over 50% (over $380 million USD) when it linked with the California system and California had net gains from trade of over $250 million. Overall costs were predicted to reduce by around 30% between the two systems. Administration is made easier and carbon leakage distortions are reduced by linking (Purdon et al., 2014).

Deciding to link systems is a move that will require a significant amount of forethought and research. While significant benefits are possible, from increased economic efficiency and reduced leakages and administration, there are risks to the integrity of the scheme, and we would lose a level of control over the scheme and over carbon prices.

When discussing these changes with some members of the forestry industry, opinions on this were more on the negative side. While a stable price is beneficial, a lower price hurts both forestry and the effectiveness of the scheme in holding emitters accountable for emissions.

Misalignments between the schemes are very important to control for – differing offset protocols and caps can wreak havoc on the effectiveness of multiple schemes. An option to reduce the negative effects of misalignments without significant changes to our scheme could be to link in a limited capacity – for example, only trading offset credits or similar.

In terms of the government, this is a decision being seriously considered largely because of our risk of missing our 2030 nationally determined contribution. This will require the use of ITMOs (internationally transferred mitigation opportunities), which will involve exchanging carbon reductions across countries to enable countries to meet their targets through other countries reductions. This is still a topic of negotiation in the Paris Agreement and will involve significant safeguards to prevent the issues that stemmed from the Kyoto Protocol around illegitimate units (Gass et al., 2019).

Linking the system to another system overseas would likely streamline this process for the government and save money should targets be missed.

Before considering this decision, New Zealand should first implement the new ETS and observe the effectiveness of the changes before investigating potential effects of linking. It is also worth considering who the best partner to link with is. The EU has a linked system and several other countries have implemented or are implementing ETS schemes that may serve better for linkage than the California-Québec scheme.

9.0 Areas of potential improvement

As a whole, while California and Québec have enjoyed more success with their schemes to date, the changes to the New Zealand scheme coming into place in 2023 will allow for a significantly more effective scheme and a higher carbon price, resulting in emissions reductions and economic benefit for the forestry sector. These changes will contribute to a vastly more effective scheme from an emissions-centric perspective. Linking schemes could also provide benefits in terms of effectiveness at reducing emissions but it is a complicated process that would require detailed analysis to ensure that linking is mutually beneficial for all parties.

Emissions reduction is vital and is mandated under both binding international and domestic targets. An emissions trading scheme also provides a framework to significantly shape the future of our economy in ways beyond just pure emissions reduction. It provides a reasonably significant amount of revenue currently per year, and, with these changes, the resulting higher carbon prices, and the inclusion of agriculture, this revenue is set to increase dramatically. By using the framework and resulting revenue to its full potential, the New Zealand government can drive the economy to a desired sustainable future. However, in its current form, the scheme's focus on reducing emissions can contribute to future issues. Finding a balance and utilising other policy and regulation within the framework is essential in reaching a sustainable economy.

9.1 Harvested wood products

One lesson from California's system that could come into play in New Zealand is the inclusion of harvested wood products as carbon stores.

California does not require credit repayment if the wood products from harvest will maintain carbon storage for 100 years. These harvested wood products can be wood products in use or in solid-waste disposal sites, and can decay or be burned without producing energy (California Air Resources Board, 2015). California calculate this rate based on several factors – including sawmill efficiency, type of wood product and how the product is being used, in order to obtain a proportion of harvest that will continue storing carbon after a 100-year period. There is a significant amount of literature around the accounting process for this, as well as calculators such as Berkeley's Carbon Calculator that allow estimations. Stewart and Nakamura found that including harvested wood products in a forest protocol led to significantly increased climate benefits, especially when using wood residues that would normally decompose in the forest, in wood-fired energy plants. They concluded that greater financial recognition of the benefits not accounted for could substantially improve climate benefits and economic sustainability in the forest sector (Stewart and Nakamura, 2012).

In the New Zealand context, a Manley and Evison paper in 2017 suggested that carbon stocks in exported HWP from New Zealand had an average increase of 3.9 million tonnes of carbon per year, while another New Zealand paper also by Manley indicated that including either HWP or averaging accounting could double afforestation. While the effects are not additive, he suggested that implementing both would drive afforestation higher (Manley and Evison, 2017). Discussions with members of the forestry sector yielded mixed opinions. While it would almost definitely increase the rate of planting, the difference could vary significantly (personal communication, Weir 2020; Weblin 2020).

New Zealand implementing a similar policy could increase afforestation, help to develop a larger domestic market for wood/biomass products and reduce the current disincentive of harvest for forest owners. Specifically, this protocol could help to increase wood in long-term uses like building, resulting in significant climate benefits and a greater permanence of carbon sequestration from forests.

The New Zealand government also already calculates this for their international reporting under the Paris Agreement and currently does not devolve the credits for HWP. The reason for this is that the decision on how to distribute the credits is a difficult one (personal communication, Elvidge, 2020). Providing the credits to forest owners would likely have at least a small impact on the planting rate. But the credits could also be used as an incentive for using timber in housing – which is significantly more sustainable than other material options. Many processing plants argue the credits should go to them as they are processing the wood to go into products (personal communication, Weir, 2020). They could also go towards funding mills in high timber areas like Gisborne, which currently operates with just one timber treatment plant (personal communication, Elvidge, 2020). However, should a building subsidised via HWP credits burn down, it would be important that there was a regulatory incentive to ensure that it was rebuilt using an equivalent volume of wood in order to protect carbon stock integrity. Peter Weir of Ernslaw One suggested this requirement would need to not include additional HWP credits (personal communication, Weir, 2020).

Finding the right place to provide HWP credits is especially important, as the development of a significant biomass market could be a major factor in reducing emissions and creating a sustainable economy. It would also increase forestry sector profits by selling more wood domestically; minimise the sector's reliance on exports, particularly to China; and create jobs within New Zealand in associated industries.

Overall, harvested wood products' inclusion in the ETS would have several impacts. It would increase incentives for forest owners to join the ETS and would increase the return and economic viability of forest projects. It may also reduce exports somewhat in favor of domestic wood products – depending on how exports are treated in such a protocol. We would potentially see more of a biomass market in New Zealand in terms of housing, which has significant carbon store potential. Additionally, we may see much of our current use for timber harvest change, moving away from paper and other short-term uses into longer carbon stores, in order to take advantage of the potential return.

9.2 Wood burning

When logs are processed domestically, residue lost in the processing can be easily used as biomass fuel in wood burning, which helps to utilise stored carbon efficiently. SCION calculated in 2007 that around 75% of processing residues in New Zealand are already used and a further 19% are possibly available to use (Hall and Gifford, 2007). A significant amount of wood is also exported unprocessed, and as a result, a country importing this wood can receive this benefit instead. By incentivising a biomass market domestically, through processing wood domestically, New Zealand can reap this benefit and shift away from the usage of gas and coal. Processing more wood here, and increasing the current use of processing residue as fuel, could offer a significant further increase in wood-burning energy, and ideally a corresponding reduction in fossil fuel usage, resulting in emissions reduction.

While this is absolutely a potential source of benefit, it is important to consider the efficiency of wood usage and the log price factor. Forestry relies heavily on exports and will continue to do so for the foreseeable future. While a biomass market will help to reduce this reliance, it will still exist, given the significant proportion of exports of timber. Log prices likely already have this potential benefit baked into them, including the labor cost difference. A policy that made processing mandatory, or imposed costs on exporting unprocessed wood, could harm the forestry sector by damaging international competitiveness. Additionally, many countries use our wood extremely efficiently (personal communication, Elvidge, 2020) and if exports were to reduce, it would be important from a climate perspective to find ways to maximise the usage of our wood. This being said, the HWP credits are a great opportunity to help the domestic market develop via subsidy instead of imposing costs, whether direct or indirect, on exporting, and a larger domestic market would provide a larger amount of renewable energy from processing residue.

Additionally, an extremely large amount of wood residue is left to decay in the forest following harvest. SCION estimate that residues of around 8.5 million tonnes will result from harvest in 2020-2025, while systems as of 2007 existed to take only 250,000 tonnes of residue out of the forest per year (Hall and Gifford, 2007). Currently there is actually a financial incentive for forest owners to leave residue to decay in the forest rather than use it for wood energy (personal communication, Elvidge, 2020). This is another example of a policy that is important in order to regulate the carbon-centricity of the ETS.

Wood energy is a form of renewable energy, and a protocol that takes into account the use of wood residue as energy (instead of it decaying in the forest), could offer further incentive for renewable energy. Wood-burning emissions cannot exceed carbon stock held in the wood, which is why it is regarded as renewable. Assuming that residue is typically left to decay, the emissions would be the equivalent of burning it, however, burning would also provide energy. As a result, ignoring emissions from the act of removing residue, burning all residue would not increase emissions at all, but would provide additional energy that could be rerouted from heavy emissions activities like burning coal. Coal particularly, but also natural gas and other fossil fuels, are inefficient from an emissions standpoint, releasing significantly higher emissions for the same energy generation as other methods. Moving away from coal and gas energy and replacing them with wood energy – especially wood energy generated from residue that is already decaying in the forest – could yield significant climate benefits (Stewart and Nakamura, 2012), along with additional revenue for the forestry sector, and it could help New Zealand reach renewable energy targets. Using residue for burning is more than ten times more efficient, emissions-wise, than coal, and more than four times more efficient than natural gas (Stephenson and Mackay, 2014). One of the reasons for New Zealand's continued usage of fossil fuels is the flexibility they offer. Geothermal, hydroelectric, solar and wind energy are all reliant on conditions and often these conditions can become more challenging at the same time as demand increases, for example, during the winter months (Bennett, 2018). With New Zealand needing to find alternative sources of renewable energy that are flexible seasonally, wood burning could be a great option.

A case study in Rotorua investigating the use of forestry residues as biomass fuels suggested that by fully utilising currently wasted forest residue, wood burning could increase from contributing 26% of electricity demand in Rotorua to over 65% (Nielsen and Gifford, 2013). A SCION paper suggested, from a cost perspective, that wood burning was often not as economically viable as coal due to barriers such as a lack of wood burners, mismatched supply and demand (large forests are often not near cities which demand significant electricity) and lack of certainty around fuel quality (Hall and Gifford, 2007). These are areas that costs would reduce in with scale and could possibly be helped through a subsidy from HWP credits. The paper also calculated that forestry residue alone could contribute 17% (32 PJs) of national electricity demand compared to less than 1% currently. (Hall and Gifford, 2007) An increase of 30PJs from wood would be enough to replace more than half the amount of coal used (53PJs) in the primary energy supply (Ministry of Business, Innovation & Employment, 2019).

The Huntly Power Station contributes as much as over half of New Zealand's emissions from electricity generation (Office of the Prime Minister's Chief Science Advisor, 2009), which in turn make up just over 10% of total emissions (Ministry for the Environment, 2018), meaning that the Huntly Power Station alone can be responsible for more than 5% of our total emissions annually. Despite being slated for closure in 2018, it was renewed through to 2022 (Genesis Energy, 2016).

This is clearly an area where there is potential for significant emissions reductions (truly carbon neutral energy could eliminate this 5+% entirely) and wood burning may be a vital part of that.

Further, with the ETS contributing to a higher rate of afforestation and an increase in forest land, the value of using wood residue efficiently becomes even higher. Additionally, a significant amount of forest will be harvested in the coming decade thanks to high afforestation rates in the 1990s coming of harvest age (Indufor Asia Pacific, 2016). A policy like this that provided additional value for harvesting would also minimise the risk of forest owners choosing not to harvest when carbon prices rise, as it would require a higher carbon price in order to exceed the increased value of harvesting the timber. This is important to keep the commercial forestry sector viable economically.

However, there is some research to suggest that wood energy may not be fully carbon neutral because of the time taken for forests to grow (Scientists Concerned About Climate and Biodiversity Impact of Logging, 2020), so it is important that the neutrality of wood is well researched, and that wood burning occurs in place of fossil fuel usage instead of in place of potentially more sustainable methods. Increasing revenue from residue could also encourage earlier harvesting age which reduces carbon stock (although this is likely not on a significant level). Additionally, it would be important to ensure that unused residue was the primary material burned to maximise efficiency rather than using timber that could otherwise be used in wood products.

This is an area that should be strongly considered but treated with caution to ensure that burning residue would result in climate and economic benefits.

9.3 Improved forest management

Another possible subject of further research into ways New Zealand could improve by looking to California's offset protocol, is the inclusion of improved forest management as an option to gain credits. As discussed, California's protocol allows forest owners to find ways to increase carbon stock in their forests and earn offset credits for the carbon saved.

Improved forest management is the main offset project within California's market. Some of the ways that projects can qualify for this protocol are changing the type of tree grown (redwoods for example hold significantly more carbon than most other trees), increasing productivity through trimming, longer harvest rotations and harvesting fewer trees (California Air Resources Board, 2015). Being the largest part of California's offset protocol, IFM has undergone significant review and research, and is generally well regarded as maintaining the integrity of the system. There is some research to suggest the protocol could improve somewhat from an ecological sustainability perspective, but it concedes that the protocol has significant mandates to enforce sustainability (Hertog, 2018).

Introducing an equivalent protocol into New Zealand would allow for the opportunity to improve baseline forests, both in terms of carbon sequestration and other desired changes such as species composition and pest control. One potential issue with New Zealand's ETS is the lack of participation by post-1989 forest owners, and the lack of involvement of pre-1990 forest owners beyond liability for removal. Introducing IFM as an option would allow them to enter the scheme in a different capacity and would provide incentive for commercial forestry to find ways to maximise carbon efficiency which would be hugely beneficial in reducing emissions. As baseline forests currently cannot enter the scheme, they have no incentive to find ways to maximise the benefit of their forest to New Zealand. A protocol like this would use the existing ETS framework to incentivise activities like enrichment planting and erosion control.

An option similar to this has been put forward to the government by the Iwi Chairs Forum (assuming this is what is meant?) and the management company of Kaingaroa forest (personal communication, Weir, 2020). IFM could help the forestry sector from an economic perspective, as well as allowing for a potential additional stream of revenue for forest owners and managers. There is a risk that doing so might result in native baseline forest being cut down and replaced with pine or for the use of pine in forest to become more pervasive. However, an IFM protocol carefully tailored to what an ideal baseline forest should look like could present opportunity to increase planting of natives in the form of enrichment planting. Additionally, there is some evidence to suggest that other forest management practices such as pest control could increase carbon sequestration (Holdaway et al., 2012). This could be a way to incentivise pest control – a conservation priority – while providing benefit to forest owners.

There are some risks, however: an Improved Forest Management protocol may reduce species diversity (there would be incentive to move more forests to faster growing, higher carbon species like radiata pine) and incentivising maximum carbon storage through pines could lead to adverse effects on soil, water and so on (Gibson, 2019). Similar issues to those of FMA apply here as well. Forest owners would now be expected to compute another figure entirely for carbon stock, and to an accurate degree. Often changes will be fairly small, so if it is not computed accurately, costs could outweigh benefits for forest owners (personal communication, Elvidge, 2020).

Again, this is a protocol that could provide benefits for both the effectiveness of the New Zealand ETS and the economy of the forest sector, however, it also would require forethought and research to ensure that both the integrity of the ETS and the environment would be secure, while allowing the process to be simple for forest owners to partake in.

9.4 Tropical Forest Standard

The other protocol worth considering for New Zealand from California's system is the tropical forest protocol.

In October 2019, California passed a controversial change to its ETS called the Tropical Forest Standard. The Tropical Forest Standard allows the gain of offset credits through avoided deforestation while funding sustainable and economically viable forest activities in tropical forests like the Amazon rainforest (California Air Resources Board, 2019a). The plan is supported by a range of people, from Indigenous representatives to experts in the emissions field and conservation groups (Conservation International, 2019). It will aim to reduce deforestation in forests like the Amazon (deforestation in tropical rainforests accounts for almost 20% of global emissions (Asner, 2009)), while empowering Indigenous communities. It aims to also protect biodiversity while having a tangible impact on California's climate (California's rainfall is extremely dependent on the Amazon rainforest (Medvigy et al., 2013)). This is another potential way to gain offset credits, but currently the offset credits generated are not able to be traded or used in the California-Québec system, and it is likely that they will not be able to be traded or used for some time.

However, the protocol has attracted a significant amount of criticism. Detractors discuss the incentive it provides for polluters to not reduce emissions and cite failed projects from other countries in the same vein that provided little benefit and hurt Indigenous communities. A large part of the reason for this is because of the lack of verification in previous projects – think New Zealand's fake credit issues with Ukraine and Russia. Norway's failed effort in tropical forestry also cited leakage concerns, with protecting some forest leading to deforestation elsewhere. Additionally, credits could be provided, only for trees to be cut down just years later (Song, 2019). While the California programme is far from implemented, there are some real concerns around the programme. It is clear that the programme could be a success, but in order for it to be successful, there must be very rigorous accounting throughout the process; validation of carbon within trees, validation that the trees are not being quietly deforested, validation that leakages are properly accounted for, and that Indigenous communities are being empowered not affected.

It is also worth noting that California only allows around 2–4% of out-of-state offsets to be used by firms (Busch and Nepstad, 2019), so even if this project is a failure, the impact on the integrity of California's scheme should be minimal. Additionally, credits for these programmes are often rewarded for avoiding deforestation. While permanence may not be assured under a system that provides incentives and does not impose liability for lack of permanence, the delay of deforestation is still a benefit. Rigorous verification makes a significant impact on the success of the programme but any benefit that occurs even temporary is still a benefit (personal communication, Elvidge, 2020).

In terms of whether New Zealand should implement this, it is clear that caution is necessary. With the ETS moving into significant changes, and the California protocol not yet in effect, it seems that the best option will be to wait and observe both how our new ETS functions and how the California protocol is working, before deciding whether to implement. California's protocol mentions the expectation that many other countries and states will utilise their tropical forest protocol in the future (California Air Resources Board, 2019c) so if it is a success, it may be an effective and easily implemented (given the groundwork done by California) way for New Zealand to fund sustainable development in less wealthy countries while reducing emissions on a more global scale. The success of protocols like this is massively important in terms of global emissions reduction, given the enormous role of deforestation in global emissions.

9.5 Central authority

Another minor change is the development of a central secondary market source for NZUs.

While auction information would be publicly available, a potential change could be for the government to operate or fund a central authority for NZU prices and trading within New Zealand. Several third-party sites currently exist but carbon prices can be hard to track accurately, and third-party marketplaces are unlikely to gain significant engagement from parties. Even finding historical carbon prices is difficult, with the information not available from a clear, official source. A central price source would allow greater transparency for forest owners in terms of estimating profitability, and may allow for greater efficiency in the secondary market.

However, this is also made difficult by market splits around credits. Especially if rules come into place around offset usage, carbon prices for different types of units may move further away from each other, resulting in several different levels of pricing for different types of NZUs. This would make it difficult to keep a clear price public. Tagging units based on the type of credit, as discussed below, could help with this issue. Motu also noted in their 2017 paper that more financial regulation could allow for NZUs to be engaged with further by financial institutions (Carver et al., 2017). With carbon prices set to rise, holding carbon credits could be a smart financial decision, and encouraging this, with regulation, could result in a more immediate rise in carbon price. On the negative side, a rapid rise in carbon price would make obligations difficult for firms to meet – a gradual price increase allows firms to plan for the future by investing in ways to reduce emissions and thus save money when carbon prices become too high. Regardless, this is an option worth exploring, even in some limited capacity, as a potential way to increase carbon prices and thus increase the efficacy of the scheme.

10.0 Afforestation changes

A primary way New Zealand aims to reduce emissions to meet targets is through afforestation (New Zealand Productivity Comission, 2018). This offsetting is especially important given the high proportion of emissions stemming from the agriculture sector without it being involved in the scheme. As a result, expecting emissions targets to be met through lowering emissions directly is misguided – until agriculture is held to a high emissions standard, the majority of net emissions reductions will stem from carbon sinks, particularly afforestation.

Afforestation in the ETS is an area that carries a significant risk – as carbon prices rise, afforestation will increase. If carbon prices rise too high, because of the current settings of the ETS, we may see pine planting occurring at a level far beyond what is beneficial to New Zealand. Compared to indigenous species, pine is worse at controlling erosion, it has a far shorter lifespan than indigenous species, it provides few benefits in terms of water and nitrate and it can compromise land for future use. But pine is significantly cheaper to plant than native forest and provides a far greater credit return under the current ETS. As a result, it is important to incentivise afforestation but to do so in a way that is sustainable and future proof.

10.1 One Billion Trees & enrichment planting

Currently one of the main structures for encouraging this afforestation is the One Billion Trees programme. The programme assumes that 500 million trees will be planted over the next ten years as a result of commercial forestry, and thus aims to help fund a further 500 million by 2028. The programme provides funding for planting, with natives funded at a higher rate than exotic species such as radiata pine (Te Uru Rākau, 2020b).

As carbon prices rise, the incentive for planting rises even further, especially with a simpler accounting system in averaging accounting. The issue with planting native trees is the low carbon sequestration of native species – often three times less than radiata pine (Gibson, 2019). Therefore, planting natives is less economically or environmentally viable for land owners even with higher One Billion Trees funding. However, native species planting is crucial for diversity, forest and soil health and so on (Gibson, 2019). As a result, the question becomes how natives can be a financially viable option.

Research by Adam Forbes investigated the possibility of growing natives and radiata pine at the same time. This allowed the pine to grow quickly and provide canopy for the slower growing natives. This prevents scorching of native plants and allows them to grow successfully over time while also providing the instant emissions reduction and price benefits of pine. Forbes concluded that through options such as crediting pre-1990 forests to improve management through programmes like planting natives under pine canopy, the New Zealand government and One Billion Trees could better encourage planting while improving the effectiveness of their forest as a carbon sink. Adam Forbes' research particularly favors the use of native planting in already mature permanent pine forest as a means of restoration. It also requires forest to be permanent so is best suited for areas that are less viable for commercial forestry.

Peter Weblin of Aowhanui Wood viewed the planting of pine followed by native planting as key to achieving targets while maintaining species diversity. He said, 'I think the pine to native succession to a permanent forest is grossly under recognised in New Zealand.' Planting pine initially allows the forest to grow quickly and provide credits, and planting natives after means the natives have shade cover and can grow more effectively. Over time, the pine decays and native forest remains. This is very similar to the research conducted by Adam Forbes and offers a very strong potential for use in conjunction with the ETS (personal communication, Weblin, 2020).

Forbes also noted that the ETS does not provide credits for pre-1990 forests made up of natives but does not impose penalties for the conversion of these forests to commercial forests. This is another area that is important to change – natives continue to sequester carbon for extended periods, and it is important to maintain native species stocks for biodiversity, water quality, nitrates and other benefits to the ecological system. He suggests this loophole be closed, while also suggesting a similar protocol to the IFM outlined above – pre-1990 permanent pine forests could increase carbon sequestration through native enrichment planting, while also restoring indigenous forest and gaining the benefits associated with doing so (Forbes et al., 2020).

This is another potentially beneficial option to consider that would allow pre-1990 forests to be involved in the scheme to an extent.

10.2 Conversion of farmland

While helping pre-1990 forests improve management is an important potential change, the biggest factor in afforestation is the conversion of existing farmland. Around 12 million hectares of land in New Zealand is currently agricultural land via dairy, sheep or horticultural farming. A Productivity Commission report agreed that forestry would need to be the primary driver of emissions reductions and estimated that between 1.5 and 2.2 million hectares of forest needed to be planted in order to reach the 2050 net emissions target.

It estimated, through several models involving different levels of technological change, electricity usage and forest conversion, that emissions prices by 2050 need to be at a minimum of $55 to achieve this and a maximum of $220 (New Zealand Productivity Comission, 2018). At these rates, farmers will sell their land (initially just unproductive land) to foresters or plant their land themselves.

The clear change affecting this area, while not having as large an effect on forestry, will be the decision on how to include agriculture within the scheme or an equivalent emissions accountability process. The current plan is called He Waka Eke Noa and is a partnership between the Ministry of Primary Industries, the Ministry for the Environment and several major agriculture stakeholders and firms. This plan involves the development of an agricultural emissions accounting system by 2025 and as early as 2022. If progress is not made, a contingency policy will allow the government to bring agricultural into the main ETS (Ministry for the Environment, 2019c).

Most likely this system will begin with a large allocation of units to the sector that will decline over time, thus keeping agriculture strong economically while incentivising the adoption of sustainable methods as allocations decline. Additionally, farms will likely be held accountable on an individual basis. By doing so, a carbon footprint for each farm can be calculated, including sequestration from trees on the property (personal communication, Elvidge, 2020). This will allow farms to benefit from similar offset protocols to forestry. However, this benefit will be on an individual tree basis and, like One Billion Trees, will ideally encourage the idea of 'right tree right place' and the planting of native trees. Farms will not make revenue from this tree planting as it will instead reduce their liability for emissions. This is particularly important as it is highly unlikely that farms, particularly dairy and sheep farms, will be able to reduce gross emissions towards zero. By allowing farmers to sequester carbon on a small scale throughout their farm, they can work towards carbon neutrality, and even operate at carbon neutrality as emissions efficiency increases over time with technology and reduces gross emissions.

There are several important factors for the government to consider here. It will be important how this plan is communicated to farmers, and how advice is given on planting, to ensure that farmers are able to continue production at a high level, while maximising sequestration and, importantly, maximising the non-carbon-centric benefits of planting, especially around water and nitrate quality. The One Billion Trees programme, as well as providing planting funding, provides advice for planters on location, tree species and so on. This is part of the 'right tree right place' approach that the government aims to cultivate (Te Uru Rākau, 2020b). Farmers who take the time to understand both the policy, and the best practices for implementation, will stand to benefit in multiple ways compared to farmers who fail to be aware of the changes.

Currently the biggest obstacle in involving agricultural emissions is measurement issues. For the policy to be effective, cheap but accurate verification of emissions and sequestration is needed and currently accurate verification is costly and slow. Technology like drones will help to perform this faster and much more cheaply, so adoption of these technologies will be an important step.

Agricultural emissions must reduce in order for New Zealand to meet its targets, and a free allocation of units that is too high, especially if implemented as late as 2025, will hurt the effectiveness of the policy. A balance is needed to allow farmers to remain competitive, while also providing enough of an incentive to change behaviours. One way to enforce this balance would be to reduce allocations in favor of funding planting. For example, if the initial plan was to provide farmers with 95% free NZU allocations, this could be reduced to 90%. The cost of the 5% allocations could instead go towards funding planting specifically for farmers. This would save farmers money in the long term as planting reduces emissions, and therefore costs over a longer period, and would help to encourage farmers to understand and take advantage of the policy.

A well-crafted policy in this area will allow for a reduction of gross emissions from the sector, along with an increase in planting which will help New Zealand to meet emissions targets, while ideally benefitting the land and water, and keeping New Zealand's largest exports secure.

10.3 Separating forestry from the scheme

The Parliamentary Commission for the Environment suggested larger reform to forestry's role in the ETS. As discussed throughout this paper, New Zealand is a rarity in that forestry is included under the cap of our ETS.

The Parliamentary Commission suggests removing forestry from this cap and involving forestry in tandem with agricultural emissions – specifically methane. Methane is unique compared to other greenhouse gases: it has a significantly shorter life in the atmosphere, with the majority of warming effects gone by 12 years. Meanwhile carbon dioxide and nitrous oxide can last in the atmosphere for hundreds of years, continuing to warm the planet. Methane emissions are notoriously difficult to reduce without massive changes to farming. The commission also views fossil fuel gases, like carbon dioxide, as more dangerous due to their long-term warming effects, and this policy would force a gross reduction in these rather than just using temporary offsets to meet targets (Parliamentary Commissioner for the Environment, 2019).

Commercial forestry is also temporary – once trees are harvested, significant amounts of carbon are emitted back into the atmosphere. The 2018 Parliamentary Commission report suggests that a more elegant solution would be to use commercial forestry as an offset only for methane. This would maintain a lower price for agricultural emissions and commercial forestry, helping farmers to stay afloat and preventing excessive amounts of pine planting. It would stop commercial foresters from stopping harvesting thanks to a lower carbon price – a risk since some pine forests start to decay at around 60 years and therefore should only be used as 'permanent' forest selectively.

This policy could also be used to create a price split for NZU credits between natives and pine. An option under this changed system, would be to allow permanent native forests to be used in the regular ETS, and not just for methane. This would mean offset credits for native forest would be valued higher, and permanent native planting would be incentivised. A higher value for offset NZUs earned from native planting would incentivise permanent native forests – essential for meeting targets in a sustainable manner.

The major issue with this policy is that the ETS has just undergone reform and this would involve fairly significant further reforms. Some forest owners may be upset at lower carbon prices, and non-methane emitters would not view the changes favorably. However, there are notable benefits, and this is a policy worth considering into the future.

10.4 Offset cap

Another potential policy option to enforce this balance is an offset cap.

Both California and Québec operate with an offset cap of 8%. As a result, firms cannot use more than 8% of units allocated for offset protocols when paying their liability each year. These caps are set to decrease over the coming decade (International Carbon Action Partnership, 2019a; 2019b). The point of this is to maintain integrity for the scheme as any offsets that are not fully realised emissions reductions will have less of an impact on climate change. Most importantly, the cap forces emitters to reduce gross emissions rather than just offsetting emissions in the short term through forestry and greenhouse gas elimination.

However, New Zealand's system likely would not fare as well under such a low cap. In 2017, over 50% of surrendered units were forestry units (Environmental Protection Authority, 2018) and it is vital that New Zealand maintains high planting rates in order to meet our targets as discussed in the last section.

By capping offsets, the value of those particular NZUs allocated for forestry will fall, which would help to stop commercial forests becoming permanent. However, the market splitting with offset credits could be harmful as a lower price for forestry offsets could hurt the incentive for afforestation. As a result, an offset cap of 8% is likely not realistic, given New Zealand's reliance on forestry in the ETS. That said, a larger offset cap could improve the scheme. It would help to quell concerns around forestry allowing emitters to continue emitting, as it would force at least a portion of suppliers to make cuts in gross emissions in order to meet liabilities, especially when New Zealand remove the price ceiling and operate with a cap in 2023. The market splitting would help to reduce the carbon-centricity of the scheme, which is important to ensure that forestry within New Zealand is managed appropriately (not using land best suited for farming), especially as carbon prices rise.

An offset cap would be another way the government could continue to encourage the 'right tree, right place' approach that is being forwarded by the One Billion Trees programme. It is vital to keep the price of pine forest NZU credits low in order to give forest owners a reason to continue harvesting. In order to encourage planting of native trees, the government could allow a higher offset cap for use of credits generated by native planting, which would push the price of these credits higher, encouraging such planting. We already see the market for different types of NZUs splitting to a degree, with some firms favoring credits allocated for planting of native forest (personal communication, Elvidge, 2020). Credit prices changing in this way is good, as it allows for a higher incentive to plant native trees over pine which is vital for maintaining biodiversity, nitrate levels, water quality and etc. Allowing a higher portion of native-specific offset credits to be used would minimise the risk of firms favoring cheaper pine credits when margins become tighter, helping to regulate the planting of natives and pine. For example, allowing firms to surrender 15% of units from pine forest and 50% of units from native forest, would mean that native forest units were valued significantly higher. These being valued higher makes planting native forest financially possible. It increases the private benefit for landowners to plant native species which provide a greater public benefit than pine.

Under the new ETS, units from forests planted in the Permanent Forest Sink Initiative continue to be tagged so as to differentiate them from other units (Environmental Protection Authority, n.d.). This would be a way the government could subcategorise units for this approach and create a price split. Some emerging ETS initiatives recognise a third-party standard for offset credits called the Gold Standard. This verifies several aspects of offset programmes to ensure a number of benefits of credits beyond just environmental integrity such as impacts on gender equality, impact on sustainable development goals and wider impacts on social welfare. These credits are valued higher than other credits. This is another approach New Zealand could take. A standard or a set of standards could be created that was focused around the less carbon-centric benefits of planting – use of natives, type of land used, water and nitrate effects, species type, location and the like. Offset caps or an equivalent policy within the ETS framework could be used to regulate a higher value for these credits and create another incentive for 'right tree, right place'.

Again, these are policies that have massive potential use in the ETS but will require significant foresight in finding a balance that will move New Zealand in the intended direction both sustainably and economically.

10.5 Land classes

Perhaps the biggest risk of increasing afforestation comes in terms of land classes. In New Zealand, land is classed into several groups LUC 1 through LUC 8. LUC 1 represents land that is extremely well suited for planting and for farming. This land is much more valuable because it can be highly productive for farming. The risk of a significantly higher carbon price is that land in this class or similar high LUC classes may be purchased to turn into forest. This can harm the land for future use and massively reduce our economic outlook. As a result, it is vital that policy is regulated in a way that is not entirely carbon centric and that will prevent these issues from occurring as the carbon price rises. The government is currently working to protect important land, and this may involve empowering regional government to assess land usage and make decisions that will contribute to an appropriate balance (personal communication, Elvidge, 2020).

With these land use classes also comes an opportunity. LUC 7 & 8 typically represent land that is unsuitable for forestry or farming. It is often erosion prone land and because of its limited use, is significantly cheaper. A significant amount of this land is currently in Māori ownership and is not planted to full potential. There is massive potential here for New Zealand to make significant headway on the 1–2m hectares of afforestation needed to meet emissions targets, without compromising potentially useful land. Additionally, land at risk of erosion can be planted to bind the land and protect it. There is an enormous amount of public benefit possible by planting this land, however, it is vital that it is planted with native or other species because of the issues with pine in permanent forest and pine's inappropriateness on skeletal soils and some slope classes. Using policy like an offset cap, or specific funding in this area, the New Zealand government can provide private benefit for native planting in these iwi-managed areas and turn much of this unfavorable land into permanent native forest that act as emissions sinks. With significant public pressure currently around the afforestation risk to productive farmland, finding a way to encourage this planting would be a massive step in terms of quelling concerns while also preventing erosion, reducing emissions and creating permanent forest.

The government is focusing on a 'right tree, right place' approach to afforestation: while planting is beneficial, it's important that it's done using the right species for the locations and in locations that would benefit from trees (Te Uru Rākau, 2020). In 2019, some emitters including Air New Zealand and Z Energy formed a partnership called Drylandcarbon which encourages tree planting and provides capital to do so. They also aim to use a diverse range of NZUs including native offset credits, thus creating a higher value for native credits than pine credits (DrylandCarbon, 2020). This partnership is a logical step; however, the risk is that as carbon prices rise and costs increase for emitters, pine will become even more favored and the commitment to using native credits resulting from planting in appropriate areas will fade away in favor of financial viability.

It will be important for the New Zealand government to find a way to regulate the use of pine offsets through policy settings, rather than relying on company goodwill.

11.0 Conclusions

The Emissions Trading Scheme is New Zealand's primary tool in reducing emissions to comply with global targets set to prevent global warming. New Zealand's ETS has been unsuccessful since its inception in 2008, and as a result, New Zealand is on track to miss emissions targets set for 2030. This lack of success is especially apparent when compared to California and Québec's emissions trading schemes which helped California to meet 2020 targets years ahead of schedule. The New Zealand scheme's failure was driven by a low carbon price, particularly in 2012–2014, the lack of a cap, the exclusion of agriculture from the scheme despite its high emissions profile, a low price ceiling that even allows firms to profit from the scheme, and allocations that have not reduced. However, a review of the Emissions Trading Scheme has been conducted and the Climate Change Response Amendment Act has passed to reform the system. The changes made in the Act will have a significant impact on the effectiveness of the scheme. They implement a cap, increase and then remove the ceiling, reduce allocations over time and phase agriculture into the scheme or an equivalent scheme by 2025. This should help to move New Zealand closer to being on track for meeting 2030 targets and make the scheme far more effective at reducing emissions.

From a forestry perspective, the New Zealand ETS has been a source of instability in terms of policy and carbon prices. The ETS as it currently stands can provide a significant benefit for forestry thanks to forestry's role as an emission sink, but this is weighed down by difficult and often costly processes, an unstable carbon price and a lack of certainty in terms of future policy. The new ETS bill will help to alleviate many of these issues. It involves moving to an averaging accounting approach for allocations which will provide a significantly easier method of calculating offsets and encourage afforestation. It will also result in a significantly higher carbon price which will directly benefit forest owners and should allow them to better realise gains from credits that were previously at risk of becoming a liability.

With the New Zealand scheme finally reaching a level where it will be effective at reducing emissions, it is now a question of how to adjust the policy in order to guide New Zealand in the desired direction.

This paper has identified several potential options from the California-Québec system and beyond. While linking the New Zealand emissions scheme with other schemes worldwide could provide economic benefits, the risks are high, and it would be vital that New Zealand would benefit from doing so without compromising the scheme's integrity. There are, however, several domestic changes that could help to improve the scheme. Harvested wood product credits are used successfully in California and could help to encourage afforestation or develop a biomass market domestically and encourage the long-term use of wood in applications like housing. The current ETS incentivises leaving forest residue to decay, but this results in lost benefit. There is a significant amount of forest residue currently decaying in the forest that can be burned to provide energy and massively expediate New Zealand's move to renewable energy, reducing emissions. California's Improved Forest Management protocol could be applied to New Zealand, allowing baseline forest owners to reap rewards for managing their forest in a more sustainable and effective manner and reducing emissions by doing so.

In terms of afforestation, it is imperative that policy settings are adjusted carefully to prevent excessive use of pine. One way to do this is through an offset cap, with differing levels for pine and native. This would force a higher price for native offset credits, incentivising the planting of native forest instead of pine. Another option would be to investigate the proposal by the Parliamentary Commission for the Environment to utilise forestry offsets exclusively for agricultural emissions. This could help to solve some obstacles stopping agriculture from being included in the ETS while providing a more elegant solution for the temporary nature of forest offsets.

While the new ETS reform is a major step forward, it is important to start investigating necessary adjustments as early as possible. New Zealand is a small, wealthy country with significant forests. As a result, anything less than leading the charge on emissions reduction and climate change response should be viewed as a failure. There is massive potential within the current ETS framework to shape the future of New Zealand, and now is the time to find ways to tap into that potential.

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