THE NZ ETS CAP EXPLORER TOOL: DESIGN AND KEY INSIGHTS

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Shaan Badenhorst, Sophie Hale, Catherine Leining, and Dr Suzi Kerr

Motu Economic and Public Policy Research
catherine.leining@motu.org.nz

https://moturesearch.shinyapps.io/etscapexplorer/

SUMMARY HAIKU

Changes in the cap
affect emissions and prices.
With tool, knowledge blooms.

INTRODUCTION

The New Zealand Emissions Trading Scheme (NZ ETS) Cap Explorer tool was created to help individuals understand how NZ ETS design features and drivers of greenhouse gas (GHG) emissions could influence domestic emissions, emission price, and fiscal outcomes. In this Note, we discuss how the tool works, share some insights from using the tool, and detail the tool's key assumptions and limitations.

This tool uses data derived from modelling of hypothetical scenarios which do not align with current government targets or policies. It is intended to be educational, and its outputs should not be interpreted as predictions or recommendations for future emission levels, emission prices, or fiscal impacts under the NZ ETS.

WHAT IS THE ETS CAP EXPLORER?

The ETS Cap Explorer is an interactive web-based tool[1] which helps individuals understand the dynamics of the NZ ETS. The data inputs are derived from modelling conducted for the Productivity Commission's Low-Emissions Economy report.[2] The tool is designed to highlight complex ETS dynamics using plausible – although not predictive – emission levels and prices. It has six sections exploring the impacts of different variables on the NZ ETS over 2021–2050. The impacts are assessed for domestic emissions, emission prices, government auction revenue, and costs to government of purchasing offshore mitigation. The tool enables users to adjust key parameters in the tool to investigate their effect.

WHO ARE THE INTENDED USERS?

The primary audience for the ETS Cap Explorer tool includes policy makers, market participants, and researchers with some base knowledge about the NZ ETS who wish to understand the potential dynamics of New Zealand's carbon market. The tool is suitable for anyone interested in learning about the NZ ETS but may require users to undertake additional learning to utilise it fully. A glossary is provided in the tool to assist users who are less familiar with the NZ ETS.

HOW DOES EMISSIONS TRADING WORK?

An ETS transforms a government emissions target into an emission price set by the market, creating economic incentives for participants to choose lower-emission alternatives without losing competitiveness. Under conventional ETS design, the government imposes a limit (cap) on the total emissions in covered sectors of the economy and issues tradable emission units (in our case, New Zealand Units or NZUs) equal to the level of the cap. Each unit corresponds to one tonne of emissions, and regulated participants must surrender emission units to cover the emissions for which they are liable. Units can be issued

1. https://moturesearch.shinyapps.io/etscapexplorer/
2. Concept Consulting, Motu Economic and Public Policy Research, & Vivid Economics. 2018. Modelling the Transition to a Lower Net Emissions New Zealand: Interim Results. Wellington: New Zealand Productivity Commission. Available at https://www.productivity.govt.nz/inquiries/lowemissions/.

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for free, sold at auction, or earned for removal activities (e.g. forestry). The establishment of a trading market and a fixed number of units generates a unit price. Constraining unit supply relative to demand raises emission prices and incentivises behaviour change.

WHAT KEY ASSUMPTIONS ARE MADE ABOUT NZ ETS DESIGN?

The key assumptions about NZ ETS design reflect those of the underlying modelling. Some of these are not consistent with current or planned government policy.

- The NZ ETS is assumed to cover all sectors of the economy: stationary energy, transport, industrial processes, waste, agriculture, and land use, land-use change and forestry (LULUCF). It excludes about 4% of gross emissions from wastewater and synthetic GHGs in imported products (which are subject to a levy rather than NZ ETS obligations).
- The NZ ETS cap is fixed in alignment with New Zealand's 2050 target pathway, and the government earns revenue from auctioning units.
- By default, free allocation to industry and agriculture starts at 90% and is phased out (on a linear basis) at 3 percentage points per year between 2020 and 2030 and 5 percentage points per year from 2030.
- The government manages all purchasing of offshore mitigation.
- Following international convention for national GHG inventories and the rules applicable to New Zealand's 2030 target under the Paris Agreement, the warming impacts of different gases are compared using 100-year Global Warming Potentials (GWPs).

HOW IS THE TOOL STRUCTURED AND WHAT DOES IT DEMONSTRATE?

The tool guides users through a sequence of six sections in which key parameters can be modified to explore the implications. Below, a brief description of each section is followed by some of the insights that can be gained from applying the tool.

1. Different 2050 targets for domestic net emissions

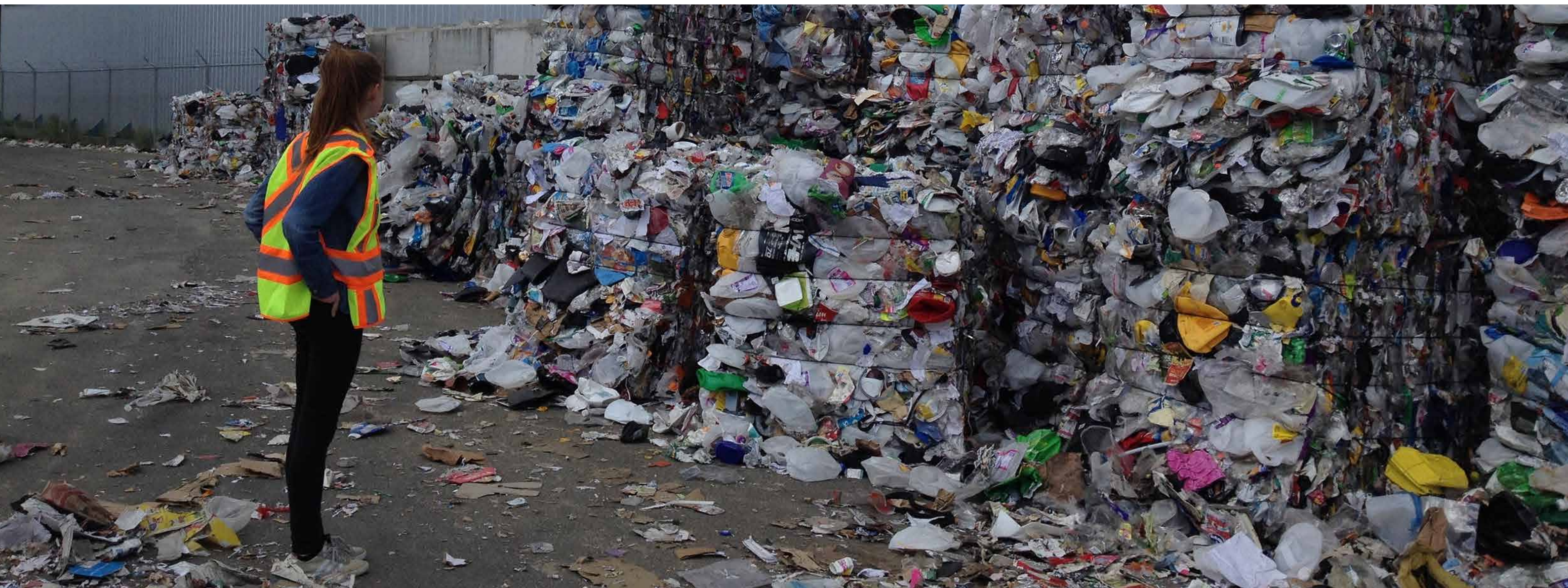
The user can choose between two 2050 target options for net CO2-equivalent emissions: zero and 25 Mt. The user's choice will apply throughout the remainder of the sections. Note that neither of these targets corresponds precisely to the 2050 target in the Zero Carbon Act.

Tool insight: The more stringent target would produce lower domestic emissions and higher forestry removals under a higher domestic emission price.

2. Externally driven changes in energy, industrial, and waste emissions

This section discusses the implications of an externally driven change in energy, industrial or waste emissions (henceforth non-agricultural emissions). For example, a new battery technology could dramatically improves the efficiency of electricity storage. An extended drought could reduce hydroelectric output and increase thermal generation. We assume no consequential adjustment to the NZ ETS cap or government purchasing of offshore mitigation.

Tool insight: An externally-driven increase in non-agricultural emissions would put pressure on the NZ ETS cap and result in a higher domestic emission price. Both agricultural and non-agricultural emissions would decrease to compensate following this price change, although the change in agricultural emissions is comparatively small. Net removals from land



use, land-use change and forestry (LULUCF), on the other hand, would increase given the greater incentive to mitigate and the relatively lower cost of mitigation. Following this price change, we would also observe increases in auction revenues.

The opposite is true in the case of an externally-driven decrease in non-agricultural emissions. Emission prices would fall and emissions would rise elsewhere under the fixed NZ ETS cap. This ultimately would lead to a reduction in auction revenue.

3. Externally driven changes in biogenic agricultural emissions

This section discusses the implications of an externally driven change in biogenic agricultural emissions. For example, agricultural emissions could be reduced by a methane vaccine, an alternative technological advancement, a new policy that targets this industry, or changes in dietary preferences. They could be increased by higher export demand for New Zealand's meat and dairy products. We assume no consequential adjustment to the NZ ETS cap or government purchasing of offshore mitigation.

Tool insight: An externally driven increase in agricultural emissions would put pressure on the NZ ETS cap and result in a higher domestic emission price. Non-agricultural emissions would decrease following this price shock, whereas net removals from LULUCF would increase given the greater incentive to mitigate and the relatively lower cost of mitigation. Following this price shock, auction revenue would decrease – in contrast to the situation where non-agricultural emissions increase due to external factors. This occurs because of a relative reduction in auctioned units. Agricultural emissions are eligible for free allocation, whereas most non-agricultural emissions are not. As a result, increased agricultural output diverts further unit supply from auctioning toward free allocation.

The opposite is true in the case of an externally-driven decrease in agricultural emissions. Emission prices would fall, and emissions would increase in non-agricultural sectors. This would increase auction revenue.

Sections 2 and 3 are influenced by an underlying feature of the modelling, an assumed low responsiveness by agricultural emitters to an emission price. The modelling suggests that externally driven changes in emissions from any sector primarily result in adjustments in non-agricultural emissions and forestry removals to maintain the ETS cap. When future modelling is better informed about the responsiveness of biogenic agricultural emissions to emission pricing, these results may change.

4. Free allocation and government auction revenue

This section looks at the implications for government auction revenue when the rate of free allocation is adjusted. The user can adjust the default phase-out rate for both the 2020–2030 and post–2030 period to investigate implications for auction revenue. As explained further below, the tool does not account for the price responsiveness of sectoral output and emissions as free allocation is phased out.

Tool insight: Holding the emission prices and demand constant, a faster phase-out of free allocation leads to relatively higher government revenue from a higher auction volume under the fixed cap. The overall change in government auction revenue would likely be smaller than shown if emission prices and demand were not held constant. This is because phasing out free allocation (in the absence of compensatory improvements in efficiency) would be expected to reduce sectoral output, leading to a lower emission price under the cap. The market would then continue to adjust until a new equilibrium was reached.

5. Fiscal implications of government purchasing of offshore mitigation

This section considers the implications of government-led purchasing of offshore mitigation to increase the supply of NZUs in the domestic market and reduce domestic emission prices. The user can relax the modelled ETS cap by 5, 10, and 15% through government purchasing of offshore mitigation.

Tool insight: As a result of relaxing the NZ ETS cap and increasing domestic unit supply, domestic emission prices would decrease, domestic gross emissions would increase, and LULUCF net removals would decrease. This reduction in the

domestic emission price could reduce the cost to consumers of emissions-intensive goods and services. Although the government would be auctioning more units in the NZ ETS, the auction revenues would be net of purchasing costs for offshore mitigation and would be reduced by lower domestic emission prices. The government would need to consider the fiscal trade-offs between increased purchasing costs for offshore mitigation and increased economic growth from lower emission prices.

6. Changes to international emission prices

This section illustrates the fiscal impacts of a changing international emissions price. The user can adjust the international emission price applied by default in the modelling by 20% in both directions.

Tool insight: With lower international emission prices than assumed in the modelling, the government would pay less to purchase offshore mitigation and relax the NZ ETS cap. With government-led purchasing, any gains from purchasing relative to domestic auction prices would accrue to taxpayers. The opposite would be true if the international emission prices were higher than assumed in the modelling. If the international emission prices were also higher than the domestic auction prices, relaxing the NZ ETS cap would come at a cost to taxpayers.

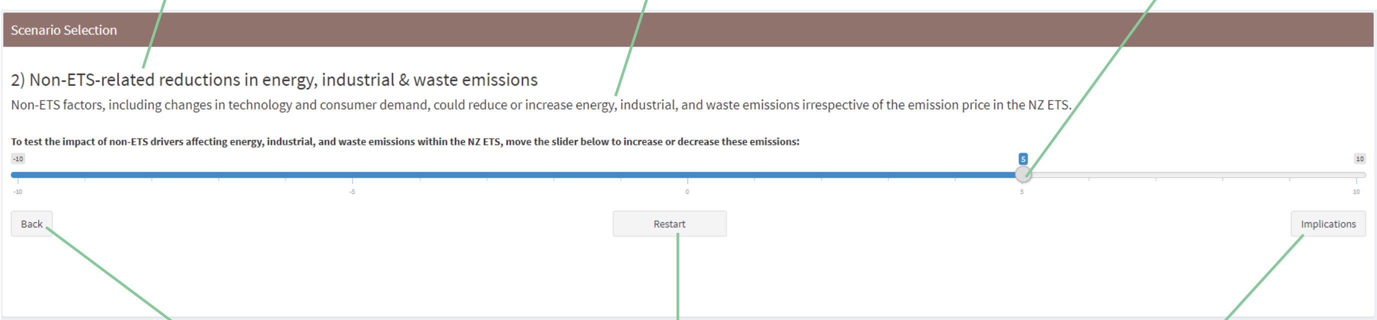
In reality, the effects of a change in the international carbon price may impact the level of offshore mitigation which would, in turn, affect the level and mix of emissions as well as the domestic price. The effects of increased offshore mitigation are highlighted in section 5. Please refer to the 'Assumptions and Limitations' chapter of this Note for further details about how we've calculated government purchasing costs.

HOW TO USE THE TOOL I

Indicates the section of the tool currently in use. There are six sections.

Presents the scenario to the user and prompts the user to change a parameter to investigate its effect.

Sliders enable the user to select a value corresponding to a change in a parameter within the modelling. Here the user has increased energy, industrial & waste emissions by 5% to investigate the effect of an external increase in demand.

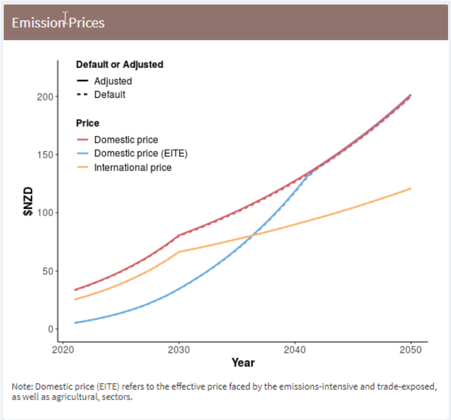


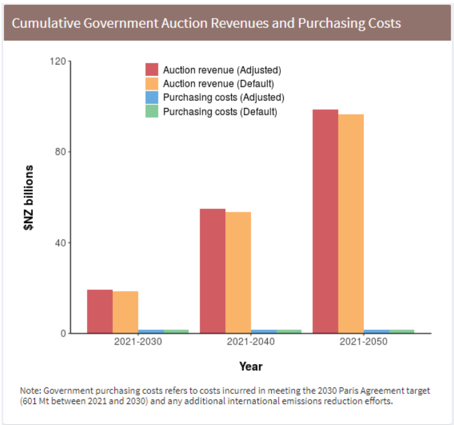
The 'Back' button allows the user to navigate to the previous screen at any point throughout the tool. The previous screen will not reset if a user moves forward; enabling the user to navigate backwards to quickly review what was just observed.

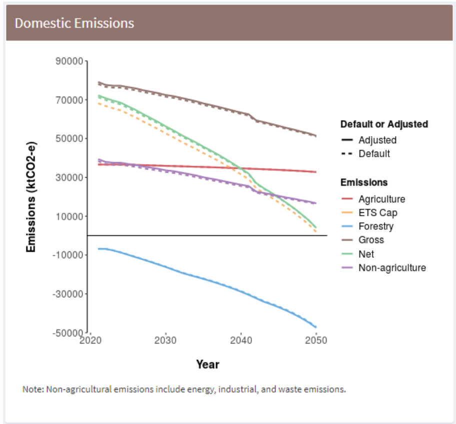
The 'Restart' button allows the user to reset all inputs to their original values and to be taken back to the starting screen.

The 'Implications' button allows the user to progress to the next part of this section, which is a summary of the implications of the change made by the user.

HOW TO USE THE TOOL II







The 'Emission Prices' box highlights the domestic, domestic emissions-intensive trade-exposed (EITE) and international emission prices under the various targets and scenarios of the tool. It shows both the default and adjusted (user input) prices. The graph shows annual emission prices from 2021 through to 2050. The intersection of the domestic and domestic (EITE) prices indicate the year in which free allocation is phased out entirely.

The 'Cumulative Government Auction Revenue and Purchasing Costs' section of the tool highlights the fiscal implications of the various targets and scenarios. Cumulative government revenues and costs are presented for the decades: 2021–2030, 2031–2040, and 2041–2050. We show both the default and adjusted (user input) values to highlight the scale of the effect of a change.

The 'Domestic Emissions' box highlights the emissions trajectory of the target and user-specified scenario. It shows both the default and adjusted (user input) emissions trajectories (refer to legend). Annual emissions from 2021 through to 2050 are graphed and are presented in ktC02-equivalent units.

ASSUMPTIONS AND LIMITATIONS OF THE TOOL

Where does the tool derive its data?

As noted above, the scenarios and underlying data applied in the tool are derived from modelling by Concept Consulting, Motu Economic and Public Policy Research, and Vivid Economics. This was conducted for the Productivity Commission to assist with its inquiry into a transition to a low-emissions economy. The modelling results also fed into climate-policy advice at the Ministry for the Environment.

The core modelling runs used by the Productivity Commission in its final report reflect three scenarios for technology development (Policy Driven, Disruptive Decarbonisation, and Stabilising Decarbonisation) and two 2050 target options (economy-wide net emissions of 25 or 0 megatonnes of CO2-equivalent). The tool uses only the Policy Driven scenario with both target options. The Policy Driven scenario was chosen as a moderate option. As with the modelling, neither of the 2050 targets used in the tool matches the government's 2050 targets under the 2019 Zero Carbon Act. However, the tool still offers relevant and valuable insights on interactions between target choices, NZ ETS caps, and emission and fiscal outcomes.

The tool illustrates broad relationships under hypothetical scenarios. It does not predict or recommend future emissions, emission prices, or fiscal implications of auctioning units and/or purchasing offshore mitigation. The choice of scenarios and emission targets used in the tool does not imply any assessment of their likelihood or preferability on the part of the developers relative to the other modelled scenarios or the government's official 2050 target.

The ETS Cap Explorer Tool applies the original modelling for the Productivity Commission in ways which extend beyond the modellers' scope and methodology. This is a prototype and will continue to evolve over time. We welcome suggestions for improvement.

How does the tool present emissions?

Emission outcomes are reported using the following categories:

- Biogenic agricultural emissions (methane and nitrous oxide)
- Non-agricultural emissions (all gases from stationary energy, transport, industrial processes (including synthetic GHGs), and waste)
- Net removals from LULUCF.

Gross emissions are those from all sectors excluding LULUCF. Net emissions are gross emissions plus emissions and removals from LULUCF. As noted above, the tool applies 100-year GWPs.

How does the tool assess government costs and revenue?

The tool considers only government costs for purchasing offshore mitigation. We assume the government (and not NZ ETS participants) would conduct all international purchasing.

The tool calculates government revenue from the volume of auctioned units in the NZ ETS at the domestic emission price in each year. It does not assess other fiscal impacts, such as changes to tax revenue associated with changes in economic output. To discount government revenues and costs to 2021 New Zealand dollars, we use a discount rate equal to 2.9 percent. This is the average of 10-year government bond yields over the past five years rounded to one decimal place.

The government costs and revenue reported by the tool are cumulative over successive decadal periods.

How does the tool assess the purchase of offshore mitigation?

To meet the 2030 Paris Agreement target of 601 megatonnes CO2-equivalent between 2021 and 2030, the government will need to purchase offshore mitigation to bridge any gap between the target and domestic net emissions.

In sections 1–4, the tool assumes that the government purchases 10% of the required offshore mitigation annually at the prevailing international price over this 10-year period, and conducts no further purchasing of offshore mitigation in subsequent decades.

In the section 5, government costs associated with offshore mitigation for the period 2031–2050 are calculated as differences between the default net emissions and the adjusted net emissions (following user input to increase the NZ ETS cap) annually at the prevailing international emission price.

In section 6, changes to international emission prices are only shown to have an effect on government costs associated with purchasing offshore mitigation. In reality, the effects of a change in the international carbon price may impact the level of offshore mitigation which would, in turn, affect the level and mix of emissions as well as the domestic price. The effects of increased offshore mitigation are highlighted in section 5.

How does the tool manage interactions between sectors?

The tool enables emissions in one sector grouping (e.g. agriculture versus non-agriculture versus LULUCF) to adjust to an increase/decrease in the other sector grouping(s) within the target pathway and NZ ETS cap. The tool is not sophisticated

enough to account for second-order interactions between sectors. For example, a reduction in agricultural emissions due to lower livestock numbers could also reduce energy demand for food processing and transportation, but this is not reflected in the tool's outputs.

How does the tool account for free allocation?

As with the underlying modelling, the tool assumes by default that free allocation to industry and agriculture starts at 90% and is phased out (on a linear basis) at 3 percentage points per year between 2020 and 2030 and 5 percentage points per year from 2030. When users adjust the phase-out of free allocation relative to the default, the tool does not determine associated changes in output by free allocation recipients as they are more or less exposed to emission prices. It only assesses the fiscal impact of changing the volume of free allocation relative to that of auctioning. This is a simplification and limitation of the tool and reflects a lack of information.

How does the tool determine elasticities for how sector emissions respond to changes in emission prices?

For the agricultural sector, we chose two sets of modelling runs that differ only in their inclusion or exclusion of biogenic agricultural emissions in the NZ ETS, and used these to derive an elasticity with respect to price for these emissions. This method allows increased precision in deriving elasticities, given that everything else in the models is left unchanged. This method shows a very inelastic demand for NZUs by biogenic agricultural emitters. Note that for our elasticities we use 2050 emission levels and 2021 prices, with the intuition that a price in 2021 sets the emissions trajectory over time. These two modelling runs are separate from the results of the Productivity Commission report.

For elasticities in other sectors and the NZ ETS overall, we had to employ a different method. In this instance we instead used the two different 2050 targets (net zero and 25 megatonnes) under the Policy Driven scenario to derive elasticities given the different price and emission paths that these scenarios follow. As an additional check, we have performed the same estimation of elasticities using the Disruptive Decarbonisation and Stabilising Decarbonisation scenarios and found all three to be broadly consistent.

How does the tool account for the timing of impacts from NZ ETS design choices or external emission drivers?

Any changes to various NZ ETS design features and emission drivers likely to have an impact on the domestic emission price are assumed to occur in 2021, and we maintain the linear trend modelled for the Productivity Commission to 2050.

Any externally driven change to emissions is calculated as a percentage change in 2050 and we maintain the linear trend modelled for the Productivity Commission from 2050 through to 2021. For example, if we expect biogenic agricultural emissions to be 5% lower in 2050 than modelled, we would lower the endpoint by 5% and then project the growth rate backwards to 2021. Similarly, in the cases where we employ elasticities to calculate responses, a 2050 emissions shock would result in a 2021 emission price change which then follows the same linear trend to 2050 as was modelled originally.

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