ECONOMIC VALUATION OF GREENHOUSE GAS EMISSIONS

A technical paper related to the *Monetised benefits and costs manual's* updated section 3.4 Impact of greenhouse gas emissions

30 July 2021

This technical paper provides a summary of contextual and technical information for the changes that have been made to the economic valuation of the benefit from the *Land Transport Benefit Framework* related to greenhouse gas (GHG) emissions, *Impact on greenhouse gas emissions*, in the 2021 version of the *Monetised benefits and costs manual* (MBCM). This note uses the information available at the time of writing.

New Zealand Government

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INTRODUCTION

The New Zealand government has committed to GHG emissions reduction targets out to 2050 (Zero Carbon Act 2019)[1] and for the period 2021–2030 (National Determined Contribution under the Paris Agreement). Therefore, the government's policy decisions and investments must not lock Aotearoa into a high emissions development pathway or increase exposure to the impacts of climate change.[2]

The commitment to reach these targets has implications for evaluating new investment decisions. New investments that increase greenhouse gas emissions imply an economic or fiscal cost (or disbenefit) in that an equivalent volume of emissions will have to be reduced elsewhere. Likewise, decisions that result in reduced emissions imply a benefit in the form of the avoided cost of reducing an equivalent volume of emissions elsewhere. These benefits (including disbenefits) of emissions (or avoided emissions) should be included when a transport sector activity is monetising costs and benefits to calculate a benefit–cost ratio (BCR) as part of an investment proposal's economic evaluation.

In this paper, GHG emissions and carbon dioxide (CO_2) are used interchangeably, as the majority of GHG emissions from transportation are CO_2 emissions resulting from the combustion of petroleum-based products, such as gasoline, in internal combustion engines. Relatively small amounts of methane (CH_4) and nitrous oxide (N_2O) are also emitted during fuel combustion. These additional emissions could be included in the economic evaluation through CO_2 equivalent[3] (CO_2e) estimates.

The new procedure is a replacement for a procedure for measuring and monetising CO_2 emissions that was included in previous versions of the MBCM and was used by the sector. The aim of this change is to improve the economic valuation of GHG emissions in alignment with the commitment of Waka Kotahi towards achieving the government targets.

The previous procedure was based on the direct relationship between CO_2 emissions and fuel consumption. Therefore, emissions were calculated using different procedures for road links and for intersections. The value of NZ$65.58 per tonne of CO_2 (as at June 2016), based on the Austroads (2012) value, was available to be used for project evaluation.

The new methodology utilises the Vehicle Emission Prediction Model (VEPM) for measuring changes in the level of carbon emissions as the result of transport interventions, and uses the whole of government agreed shadow price of carbon to monetise the impact.

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[1] Ministry for the Environment 2021.

[2] Climate Change Commission 2021a

[3] CO_2 and CO_2e are not same metrics. GHGs differ in how long they last in the atmosphere and how effective they are in absorbing heat radiation. For carbon accounting purposes emitted gases are converted to a common measure expressed as a 'global warming potential' (GWP), which is a measure of the relative warming effect of a quantity of the gas over a 100-year period, the unit of which is commonly expressed as CO_2 equivalents (CO_2e). This way, the main difference between CO_2 and CO_2e is that CO_2 only accounts for carbon dioxide, while CO_2e accounts for carbon dioxide and all the other gases as well, which allows them to be reported consistently.

USE OF VEPM FOR ASSESSMENT OF CHANGES IN THE LEVEL OF GHG EMISSIONS

Background

Through the MBCM improvement programme the methodology for measuring the changes in the level of GHG emissions for any appraised options was highlighted as an area that required refinement.

Previously in the MBCM, changes in CO_2 emissions was a factor of changes in vehicle operating cost (VOC); for example, light vehicle CO_2 (in tonnes) = VOC($) × 0.0009.

This methodology was not directly related to any available analytical tools that are used for measuring GHG emissions and had not been updated regularly, as it was a factor of VOC that hasn't been updated in the last few years.

The first step in the investigation of the feasibility of potential research to update the methodology was to review the literature that had been already done and seek insights from internal Waka Kotahi subject matter experts (SMEs). On 24 November 2020 a hui[4] was held with Waka Kotahi SMEs to discuss the potential use of any available methodologies and to:

- investigate the feasibility of potential research to update, and
- receive SMEs' insights and discuss any relevant pieces of work that have been done or is underway to avoid duplication of efforts.

The hui made the decision that Vehicle Emissions Prediction Model (VEPM) is the best[5] available tool to be utilised in the MBCM for measuring the changes in CO_2 emissions, similar to its usage for the impact of air emissions on health in the manual.

Vehicle Emissions Prediction Model

VEPM was developed by Waka Kotahi and Auckland Council to predict emissions from vehicles in the New Zealand fleet under typical road, traffic and operating conditions. The model provides estimates suitable for air quality assessments and regional emissions inventories. VEPM requires a detailed breakdown of kilometres travelled by the fleet. Fleet-weighted emission factors are calculated by multiplying the emissions factors in grams per kilometre for each vehicle class by the proportion of kilometres travelled by that class for any given year.

Since its release in 2008, VEPM has been successfully used around New Zealand to estimate vehicle emissions in air quality assessments for road projects. The model is renewed on an almost annual basis and the latest version at the time of writing this paper is 6.1, which was published in 2020. Version 6.2 has also been finalised and will be published on the VEPM page on the Waka Kotahi website shortly.

VEPM is designed to calculate harmful emissions and fuel consumption of vehicles. It was developed to predict emissions from vehicles in the New Zealand fleet under typical road, traffic and operating conditions. VEPM is an average speed based model with emission factors taken from international emissions databases and New Zealand real-world emission datasets[6]. The New Zealand fleet profile for

[4] Attendees: Rob Hannaby, Sharon Atkins, Jannette Farley, Colin Morrison, Jonathan Boow, Chamika de Costa, Ian Binnie, Marcia Nugent, Helen Lane, Ben Smith and Mehrnaz Rohani.

[5] Strengths: the model enables reasonably robust emissions calculations of a specified New Zealand fleet, providing important insights into how the emission profile changes over time as new and different vehicles are introduced into the fleet. The model is regularly updated and opportunities for improving the model are actively pursued. The model is an important input into other models, including the Vehicle Emission Mapping Tool (VEMT).

Weaknesses: in terms of mode shift, the main limitation of VEPM is that GHG emissions reductions or changes due to modal shift are calculated indirectly through the change to the fleet and vehicle kilometres travelled (VKT), eg by calculating avoided VKT. Bus emission factors are included in the model, but rail transport is not currently included.

[6] VEPM 6.1 incorporates New Zealand real world fuel consumption correction factors for diesel passenger cars and diesel light commercial vehicles. See Emission Impossible 2020.

the years up to 2050 is provided from the base case Vehicle Fleet Emissions Model (VFEM). The VEPM can quantify the emissions associated with a specific fleet profile and from changes in the types of vehicles used in the fleet.[7]

In combination with transport models, VEPM can be used to understand the implications of both technological change to reduce transport emission, such as the greater use of electric vehicles (EVs), and implications of land use changes and mode shift on emissions[8]. VEPM provides a foundation for other analysis in the transport sector; for example, it can be combined with other models to understand regional emissions from transport in Auckland. Future updates to the model, such as including rail and real-world emissions data, may mean VEPM can be used to provide greater data for helping to analyse mode shift interventions that are modelled more directly in other transport models.

The upcoming version 6.2 of VEPM will include emission factors for methane (CH_4) and nitrous oxide (N_2O), which allows for calculation of CO_2e emission factors.

SHADOW PRICE OF CARBON

Background

A shadow price places a value on future GHG emissions emitted or reduced, usually concerning international and/or national emissions goals. Typically, a shadow price is applied to each future year over a given period, creating a ‘shadow price path’. The path itself is typically updated regularly as new information comes to hand on the costs and benefits of emissions reductions.

Shadow pricing can be based on an estimate of the damage caused by each additional tonne of CO_2e (social cost of carbon) or on the full marginal cost of achieving a given domestic or international emissions reduction target (target consistent shadow price). The majority of international jurisdictions use the latter approach because of its stronger empirical basis and link to defined targets.

Shadow prices are different from market traded prices in the Emissions Trading Scheme (ETS), which do not currently reflect the full marginal cost of achieving New Zealand’s emission targets. An ETS is typically only one of the many policies that governments implement to meet their climate targets.

Whole-of-government agreed shadow price of carbon

Waka Kotahi joined an interagency group in the second half of 2020 to improve the consistency of carbon pricing in government analytical outputs. The group included representatives from the Ministry for the Environment, Ministry of Transport, Treasury, and the Energy Efficiency and Conservation Authority. Those agencies, plus the Ministry for Primary Industries and Ministry for Business Innovation and Employment, were consulted on the whole-of-government agreed shadow price of carbon. The approach was also discussed with the Climate Change Commission and the Infrastructure Commission. The whole-of-government agreed interim emissions values were approved by the Treasury and Ministry of Finance, and has been included in the Treasury’s CBAx cost–benefit analysis guidance since late 2020.

There were a number of potential price paths to choose from, all with pros and cons; however, the group decided on using the High-Level Commission on Carbon Prices (HLCCP) price paths, even though they are aligned to a target of limiting global warming to less than 2 degrees Celsius (rather than less than 1.5 degrees which is the preferred Paris Agreement target). Shadow prices will be updated annually as information on the future cost of abatement improves. The shadow prices are also used in ClPA (climate implications of policy assessment) to value increases or decreases emissions for applicable Cabinet papers.

As the result, the group recommended that the agencies should use the target-consistent shadow emissions value range in Table 1 to monetise the impact of emissions or avoided emissions. The range was provided to cover uncertainty by enabling sensitivity analysis.

[7] AECOM 2020.
[8] It is already used in this way in the sector, for example, in Auckland Forecasting Centre modelling.

The values are derived from an assessment of the future costs of reaching New Zealand's emissions reduction targets as well as values from the HLCCP, a widely known international benchmark.

The shadow price is calculated out to 2050. For situations where a longer-term shadow price is required, then the 2050 price can be rated forward by 2.25% each year.

Table 1: Shadow price of carbon (NZ$ per tonne of emissions) recommended by the interagency group

Shadow price path by year	Low – real	Central – real	High – real
2021	$61	$92	$122
2022	$63	$94	$125
2023	$64	$96	$128
2024	$66	$99	$131
2025	$67	$101	$134
2026	$69	$103	$137
2027	$70	$105	$140
2028	$71	$107	$143
2029	$73	$110	$146
2030	$74	$112	$149
2031	$76	$114	$152
2032	$78	$117	$156
2033	$80	$120	$159
2034	$81	$122	$163
2035	$83	$125	$166
2036	$85	$128	$170
2037	$87	$131	$174
2038	$89	$134	$178
2039	$91	$137	$182
2040	$93	$140	$186
2041	$95	$143	$190
2042	$97	$146	$195
2043	$99	$149	$199
2044	$102	$153	$203
2045	$104	$156	$208
2046	$106	$160	$213
2047	$109	$163	$217
2048	$111	$167	$222
2049	$114	$171	$227
2050	$116	$174	$232

CLIMATE CHANGE COMMISSION DRAFT AND FINAL ADVICE

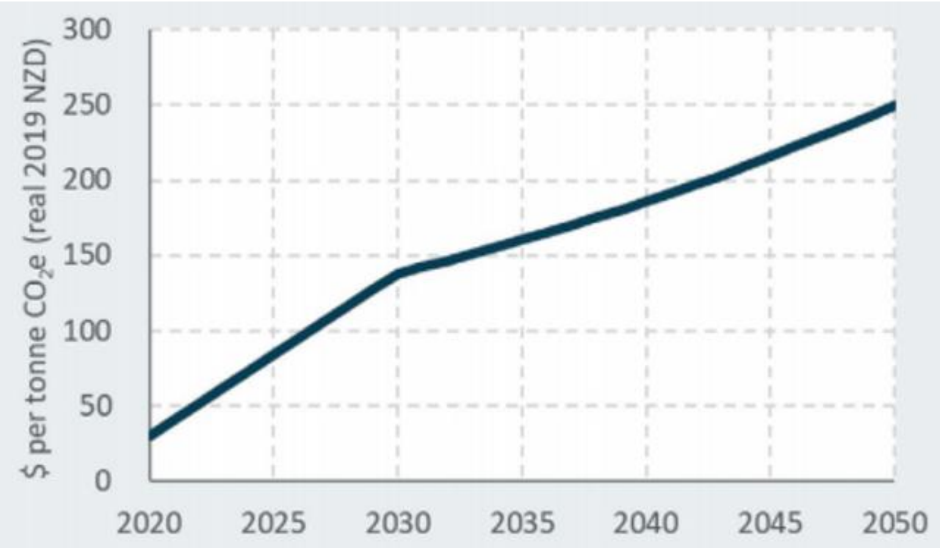
The Climate Change Commission (CCC) has provided advice for the government on how New Zealand can meet net-zero carbon requirements by 2050. The government will consider and respond to this advice later in 2021, before publishing an Emission Reduction Plan before 31st December 2021 (as required by the Climate Change Response (Zero Carbon) Amendment Act 2019).

The independent Climate Change Commission is developing emissions budgets, which will set a cap for emissions in five-year periods (2022–25, 2026–30 and 2031–35). The CCC provided advice on the direction of policy required for an emissions reduction plan for the first budget earlier in 2021. The government will now respond with its plan to achieve the first budget by 31 December 2021. All investment decisions will need to be consistent with the transport component of that plan, which will be informed by the Transport Emissions Action Plan.

The CCC released its draft advice[9] in January 2021, in which it advised that it is important that policy decisions and investments made now do not lock Aotearoa into a high emissions development pathway. Safeguards and signals will be needed to prevent this, including a specific focus on ensuring long-lived assets such as infrastructure are net-zero compatible. To achieve this, they included a list of recommendations for the government in the first budget period. The first recommendation was about the use of a shadow price in investment decision making: 'Immediately start to factor target-consistent long-term abatement cost values into policy and investment analysis in central government. These values should be informed by the Commission's analysis which suggests values of at least $140 per tonne by 2030 and $250 by 2050 in real prices.'

The final advice[10] (May 2021) emphasises that incorporating long-term abatement cost values consistent with climate change goals (ie shadow price) into the government's cost–benefit or cost-effectiveness analysis would have a powerful effect in helping to make sure policy and investment decisions are net-zero compatible. And the shadow price of around $250/tonne of emissions is suggested as the required value to eliminate fossil fuel emissions from transport and energy sector in 2050. This is a consistent with the value suggested by the interagency group.

Figure 1: Emissions values for the transport and energy sector based on CCC modelling



Source: Climate Change Commission 2021b

[9] Climate Change Commission 2021a

[10] Climate Change Commission 2021b

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