



Publication of Marginal Abatement Cost Curves report

Date Submitted:	16 January 2020	Tracking #: 2020-B-06369	
Security Level	In confidence	MfE Priority:	Urgent

	Action sought:	Response by:
To: Hon James Shaw, Minister for Climate Change	Approve the publication of the report	23 January

Actions for Minister's Office Staff	Forward this report to Ministers of Finance, Environment, Energy and Resources, Transport, Agriculture, and Forestry. Return the signed report to MfE.
Number of appendices and attachments 1	Titles of appendices and attachments (ie separate attached documents): 1. Ministry for the Environment Marginal Abatement Cost Curves (MACCs) Analysis report

Ministry for the Environment contacts

Position	Name	Cell phone	1 st contact
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Publication of Marginal Abatement Cost Curves report

Key Messages

1. The purpose of this briefing is to seek your approval to publish a technical report on marginal abatement cost curve analysis developed by the Ministry and to inform you about the results of the analysis. The report is attached as appendix two.
2. Over 2019 MfE developed a comprehensive set of marginal abatement cost curves (MAC curves or MACCs) to support strategy development in the transition to a low emissions economy. The MACCs are a dataset of abatement opportunities to reduce greenhouse gas emissions across all sectors. The MACCs combine the total amount of abatement that each technology or option could deliver, with its total economic cost or benefit.
3. The results show that there are a range of options to reduce gross emissions in New Zealand at moderate emissions prices under \$50 /tonne – particularly through:
 - a. Greater energy efficiency in industry
 - b. Accelerating uptake of electric vehicles
 - c. Moving baseload electricity generation from gas to renewables.
4. In the land sector the results show that there are moderate on-farm emission reductions opportunities with existing approaches that would also enhance profitability. The scope of land-use change from sheep and beef farming into forestry is very high at even moderate carbon prices below \$50 /tonne. This analysis, however, excludes any real-world constraints on land-use change and solely considers the economics of conversion.
5. The MAC analysis was used to inform the development of the proposed provisional emissions budget and associated NZ ETS settings that are currently out for consultation. The MACCs were used to identify the options that could be implemented in the short-term to 2025 that are consistent with the proposed draft price controls included in the consultation document.¹ The provisional emissions budget is an estimate of the amount of abatement below forecast business as usual emissions that the government should target over the next five years. The MACCs underpin those estimates by quantifying the impact of individual technologies and options for emissions reductions.
6. The consultation on the provisional emissions budget is ongoing until the end of February with consultation meetings scheduled for the first two weeks of February. We propose to publish the MACC report to support the consultation meetings and provide an evidence base for the provisional emission budget under discussion. Having the background knowledge of what abatement options exist and how significant they each could be is essential for submitters to meaningfully comment on different options for the abatement levels to be set over the next five years.
7. We are preparing key messages relating to the report and the issue of land-use change in particular, alongside the Ministry of Primary Industries. The messages will cover the work the government is doing to ensure reductions in gross emissions occur and to potentially limit land-use change. These key messages will be used in publishing the report and in consultation meetings on the provisional emissions budget.

¹ This analysis went beyond that included in the MACCs by also assessing how quickly different types of abatement options could ramp up.

Recommendations

8. We recommend that you:

- a. **Approve** the publication of the attached technical report on Marginal Abatement Cost Curves Yes/No

- b. **Refer** this briefing and report to the Ministers of Finance, Environment, Energy and Resources, Transport, Agriculture, and Forestry for their information Yes/No

- c. **Agree** that this briefing will be released proactively on the Ministry for the Environment's website within the next eight weeks Yes/No

Signature

Lewis Stevens
Acting Director
Climate Change

Hon James Shaw
Minister for Climate Change

Date

Publication of Marginal Abatement Cost Curves report

Supporting material

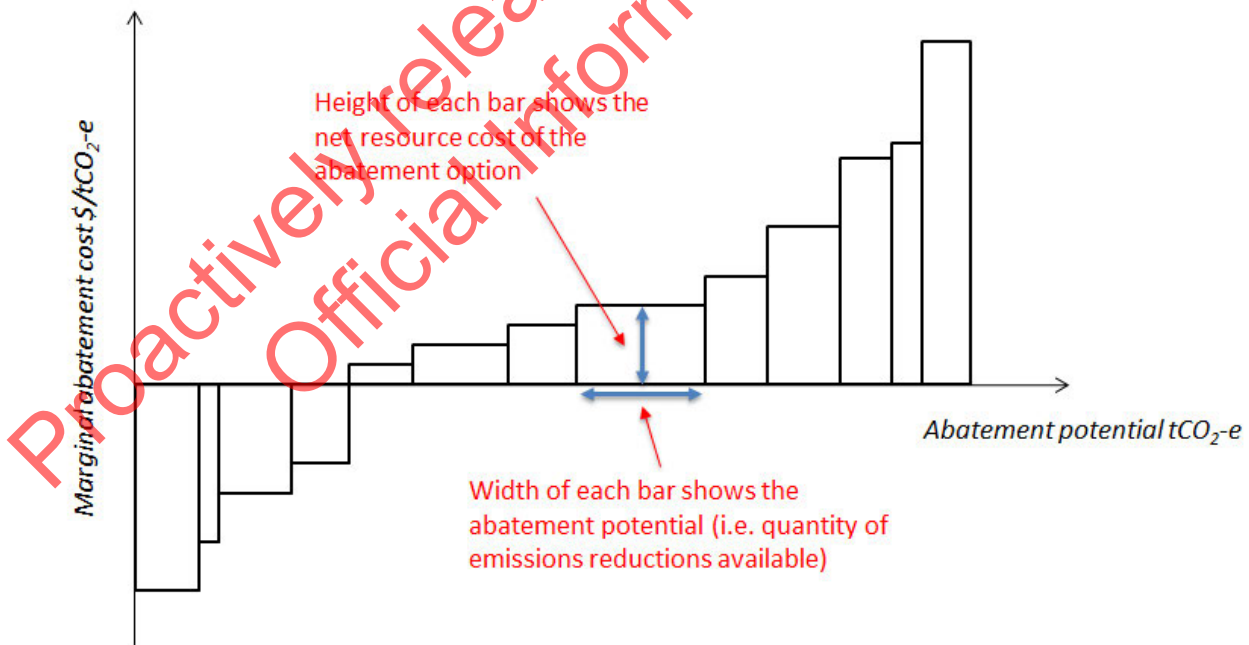
Purpose

1. We are proposing to publish the Marginal Abatement Cost Curves report that the Ministry produced in 2019. We propose to publish it imminently in the next 1-2 weeks to support and inform the ongoing consultation on the Provisional Emissions Budget and associated ETS settings. The report is attached as appendix two.

Context

2. Marginal abatement cost curves are a common tool for visualising the potential emissions reductions and cost-effectiveness of multiple abatement measures. MAC curves can be produced at different levels, including economy-wide, by sector (e.g. transport, agriculture) and by emissions source (e.g. light vehicles, milk drying plants).
3. Figure 1 is a conceptual example of a MAC curve. Each block in the graph represents a specific abatement measure. The height of the block (i.e. position on the vertical axis) shows the measure's marginal abatement cost. The width of the block shows the measure's potential abatement volume (expressed here as a reduction in emissions per year). The blocks are stacked in order from lowest cost to highest cost. This allows the reader to, for example, see the total volume of abatement that is available up to a given cost threshold.

Figure 1: Conceptual illustration of a MACC



4. The MACCs here were developed by combining the knowledge held across government agencies of abatement options, with additional technical assessments carried out specifically for this exercise. The MACCs were developed by the Transition team within MfE with the support of Simon Coates from Concept Consulting.

- Appendix one describes the limitations and caveats to the analysis and these are described further in the report itself.

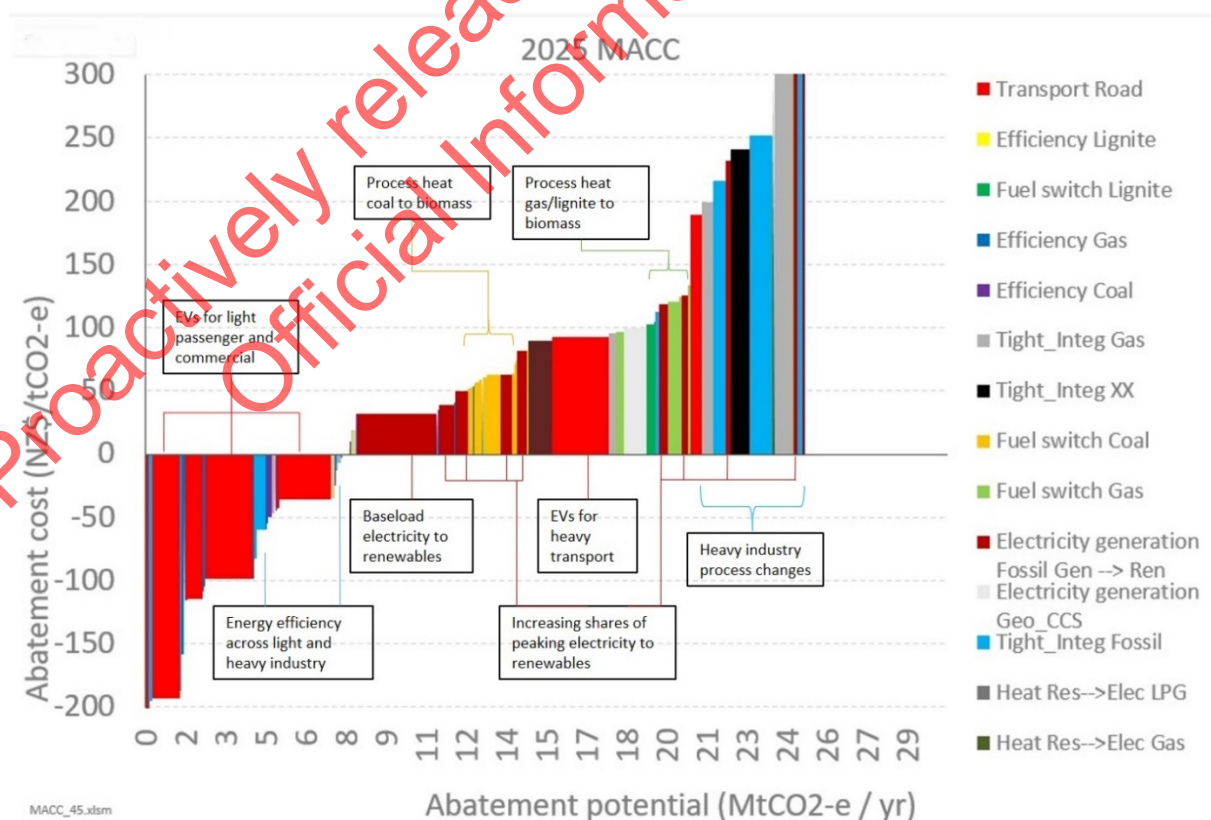
Results

- The biggest opportunities to cost-effectively reduce emissions through technology changes are in the energy, transport and industrial sectors. Across both energy emissions and the land sector there are a range of options that can be categorised as:
 - Negative cost – i.e. of net economic benefit even without a carbon price
 - Low cost (<\$50/tonne)
 - Moderate cost (\$50-\$120/tonne)
 - High cost (>\$120/tonne).
- The most significant options for energy emissions relate to process heat fuel switching, energy efficiency, greater use of renewable electricity and greater use of electric vehicles. In the land sector there are some on farm options identified through the work of the Biological Emissions Reference Group as well as land-use change options.
- In the land sector, the scale of the potential abatement from land use change is very high. Consequently we have presented the results for energy and the land sectors separately.

Energy/industry emissions

- Across energy and industrial emissions there are a wide range of options to reduce emissions, as illustrated in Figure 2 below.

Figure 2: Marginal abatement cost curve for the energy and industrial sectors



Negative cost opportunities

10. The biggest negative cost opportunities to reduce emissions from energy are:

- Switching incoming new and used light vehicles to electric – lifetime fuel savings and health benefits of avoiding diesel result in high net benefits over the life of the vehicle.
- Electrifying buses – very low emission reductions potential, but very high health benefits far outweighing the overall cost.
- Moderate energy efficiency gains in both heavy industry and light industry.

Low cost opportunities (0-\$50)

11. There are some low cost emission reductions that we expect to be incentivised through the NZ ETS at prices below \$50/tonne:

- Baseload electricity generation from gas switching to renewables
- First 30% of peaking capacity switching to renewables (largely wind).

Moderate cost opportunities (\$50-\$120/tonne)

12. At prices between \$50 and \$120/tonne there are a range of possible options. In addition to bridging the price gap, some of these options may require additional policies beyond emissions pricing to bring about. For example, carbon capture and storage for geothermal emissions is likely to require regulatory changes before it could proceed. Key options in this range include:

- Fuel switching in food processing and other industries
 - Away from coal ~\$70/tonne
 - Away from gas ~\$120/tonne
- Second 40 per cent of peaking capacity switching to renewables
- Carbon capture and storage for emissions from geothermal electricity generation
- Electrification of heavy trucks.²

High cost opportunities (>\$120/tonne)

13. Remaining mitigation options above \$120/tonne are considered high cost. Most of these relate to process changes to existing heavy industries in New Zealand. The main other opportunities here are:

- Electrifying remaining heavy trucks
- Last 30 per cent of electricity peaking capacity switched to renewables (overbuilding or batteries).

Land sector

14. In the land sector, abatement options are generally either on-farm options to reduce agriculture emissions, or land-use change options to enhance sequestration.³

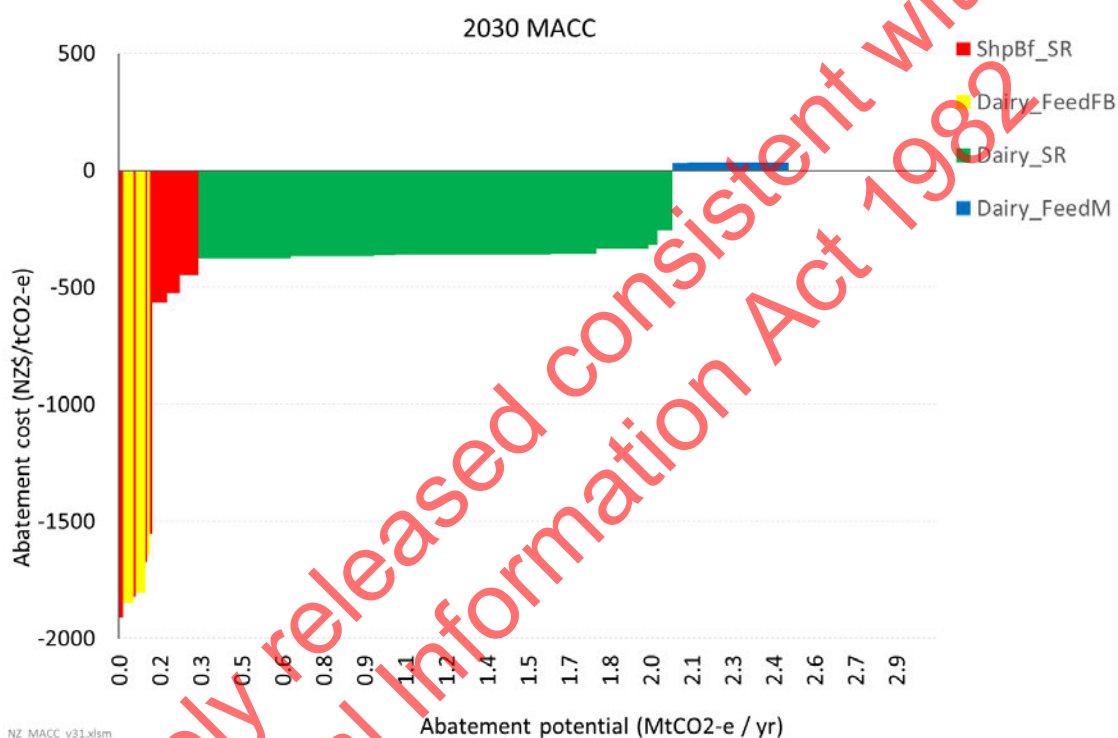
² The report goes into some detail about the relative merits of hydrogen, and battery technologies for heavy transport. For trips that are amendable to being fuelled by a single overnight charge, electrification is likely be significantly more cost-effective than alternative decarbonisation technologies.

³ In general, when considering land-use change from agriculture to forestry, the sequestration from forests is much more significant than the reduced emissions from agricultural activity.

On farm options

15. The Biological Emissions Reference Group's report (BERG report) identified on farm practices that could improve reduce emissions in the agriculture sector. The MAC includes options where costs and emissions savings data could be estimated in particular:
 - a. Improving animal performance while reducing stocking rates (dairy, sheep and beef)
 - b. Increased use of low-nitrogen supplementary feeds (dairy only)
 - c. Removing nitrogen fertiliser and reducing production (dairy only).

Figure 3: MACC for on-farm abatement options in 2030



16. Most of the potential abatement comes from dairy (2.3 Mt CO₂-e/year or ~11 per cent of projected dairy emissions) with a much smaller contribution from sheep and beef (0.2 Mt CO₂-e/year or 1.5 per cent of projected sheep and beef emissions).
17. Analysis indicates most of this abatement potential could be achieved at negative abatement cost, i.e. it is cost-effective even at a zero emissions price. This is because implementing the practice changes can improve farm profitability.
18. However the overall abatement potential for these on-farm options is relatively low – approximately 6 per cent of total agriculture emissions.

Land use change

19. When land-use change is considered, it shows a very high quantity of abatement/sequestration is possible. Figure 4 shows a total abatement potential of over 140 MtCO₂-e/year, close to double New Zealand's current annual gross emissions. This includes both the reduction in agricultural emissions (totalling about 31 MtCO₂-e/year) and the forestry sequestration resulting from the land use change.
20. It is important to highlight here that the MAC analysis does not include any constraints on conversions to forests (and the report makes this clear). While this is unrealistic, it is useful

to give a sense of the scale of abatement technically available over time at different levels of cost. In reality, the available land will be significantly lower than presented here as other factors, such as local planning rules, constrain the available area for afforestation.

Figure 4: Land sector MACC including land use change options in 2030



21. Figure 4 shows that even at relatively low carbon prices below \$50 /tonne, the economic returns from forestry are more favourable than sheep and beef farming for the same types of land. The total amount of sequestration that could be economically delivered through land-use conversions are more than is needed to offset all of New Zealand's current emissions, and land-use conversions at that scale would have significant social effects on rural communities.

22. This highlights that deciding and limiting how much afforestation is included in New Zealand's transition to a low emissions economy will be an important issue to address in establishing the emissions reduction plan under the Zero Carbon Act.

23. [Redacted] s 18(d)

Gaps and potential areas for future work

24. The report describes the identified gaps and areas for future work. Across all sectors a major area of further work is to estimate rates of uptake over time by accounting for practical limitations to technology and behaviour change.

25. In the land sector, the MAC analysis included some of the on-farm options identified by the BERG, and land-use change into native or plantation forest. In future, we would like to include additional options, particularly:
- a. Land-use change into horticulture
 - b. Carbon farming (i.e. permanent exotic forests)
 - c. Biomass plantations
 - d. Extended forest rotations
 - e. Carbon stock enhancement of existing forest land i.e. planting forest into "scrub" land.
26. Work on the MACCs is currently focused on disseminating and using the work done to date. Further developing the MACCs to include these improvements will be considered later in 2020.

Publishing the report

27. The Ministry for the Environment has been using the data and insights from the MACCs in its policy analysis. In particular it informed the development of the proposed provisional emissions budget by identifying the amount of abatement that is available and amenable to being incentivised by higher carbon prices.
28. The provisional emissions budget and associated ETS settings are out for consultation now, until the end of February, with consultation meetings tentatively scheduled for the first two weeks of February. As a key part of the analysis that underpins the provisional emissions budget, we propose to publish the MACCs report as soon as we can so it can inform organisations and individuals providing feedback through the consultation.

Consultation and Collaboration

29. The MACC report itself has been developed in consultation and collaboration with other government agencies, particularly the Energy Efficiency and Conservation Authority, the Ministry of Business, Innovation and Employment, and the Ministry for Primary Industries.
30. The Ministry for Primary Industries was consulted about this briefing and supports the release of the report. We have informed other agencies involved in the production of the MACCs report ahead of release. We do not expect other agencies to raise concerns with publishing the report, but we will notify your office if there are concerns raised.
31. Given the cross-cutting nature of the MACCs and the significance of forestry and land-use change in the results, we suggest that you forward this briefing to other relevant ministers for their information, and confirm their comfort with its proactive release.

Risks and mitigations

32. The scale of land use change that is economic at low-moderate carbon prices will likely attract attention through the consultation. Farmers and farming groups such as 50 shades of Green have been raising their concerns about the scale of land-use change for some time and will likely raise them through the consultation whether or not the report is published.

33. [REDACTED] s 9(2)(g)(i)

s 9(2)(g)(i)

Next Steps

35. With your approval, we will publish the report on the Ministry for the Environment's website before the end of January to allow submitters to consider it before public submissions on the provisional emissions budget closes at the end of February.

Proactively released consistent with the
Official Information Act 1982

Appendix one – Limitations and caveats to the MAC analysis

37. There are several key limitations and caveats to be aware of when considering the results of the MAC analysis, detailed within the report:
38. Costs are analysed from a *national economic perspective*, i.e. they inform on the costs and benefits to *New Zealand* of an abatement option being implemented. In many cases these will differ to the costs and benefits faced from a private consumer perspective as costs and benefits spread across multiple participants as well as government are aggregated together.
39. The analysis does not predict the market response to an emissions price. The estimated marginal abatement cost should therefore not be conflated with the required emissions price in the New Zealand Emissions Trading Scheme (NZ ETS).
40. The analysis excludes most co-benefits of climate policies – such as water quality co-benefits from agriculture policies, or health benefits from active transport. These were generally unable to be included in the time available, but will likely be a focus of future work.⁴
41. The abatement potential shown is the *technical potential*. This assumes there are no non-cost barriers to implementation, such as infrastructure constraints, supply constraints, and behavioural barriers. For example, in the land-sector the analysis does not include any real-world constraints on the amount of land-use change but solely considers how much would be economic to undertake. It also does not take into account the time required to implement policies and build scale. The *realisable potential* is therefore likely to be smaller, particularly in the near-term. It is intended that future work will be undertaken to assess realisable potential.

⁴ The exception is that the health benefits from better air quality from switching away from diesel vehicles were included in the analysis.