He Pou a Rangi
Climate Change Commission

Draft advice on Aotearoa New Zealand's fourth emissions budget

April 2024

Haere mai – welcome

Disclosure statement

As anticipated by the appointment criteria, the Climate Change Commissioners come from varying fields such as adaptation, agriculture, economics, te ao Māori and the Māori–Crown relationship. While a number of board members continue to hold roles within these fields, our advice is independent and evidence based. The Commission operates under its Interests Policy, which is derived from the Crown Entities Act 2004. You can read more about our board members on the Climate Change Commission website. The Commission regularly updates and publishes on its website a register of relevant board interests.

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Takamua

E tono ana mātou ki Aotearoa New Zealand ki o whakaaro mō ētahi mahi rerekē e toru nei otiia, hono tonu ana, kia tautoko mai i a mātou ki te whakawhanake he tohutohu mā te Kāwanatanga. Ka whai pānga āu kōrero mai kia whakamātauhia tā mātau arotakenga me a mātau kitenga anō hoki. I tēnei e tautoko ai te whakatūturutanga o ā mātou tohutohu e whai take nei ka whai mōhiotanga ai i āu hiahia, tirohanga, āwangawanga anō hoki. Whakamahia ai e te Kāwanatanga i ēnei tohutohu e toru kia whai whakatau me pēhea rā te whenua nei e whakamimiti i ngā haurehu tūkino taiao.

Āu whakahoki kōrero

He mea hira koe ki tā mātou tukanga, ā, kei te hiahia rongo mātou i o whakaaro.

Nā te whakarongo, titiro me te whakaaro ka puta mai i te kōrero.

He mea nui ia, ko a mātou tohutohu e whai reo ai i ngā whakaaro maha kē atu me ngā whakaarotau puta noa i te motu. Ko te whakawhitinga atu ki tētahi ao tukuwaro iti, ki tētahi ao manawaroa hoki e hua ai he angitūtanga, he hua, he wero, he utu anō hoki. Ko ngā pānga – pai mai, kino mai – e rongo ai i a tātou katoa atu.
E kimi ana mātou i ngā taunakitanga, ngā whakaaro kē, ngā whakamōhiotanga me ētahi pārongo kē atu e whakamātautia ai tā mātou ara mahi arotakenga hoki, ā, ka tautoko mai i a mātou kia tomo i ngā whiringa kē. Nā konei e whakapai ake ai ā mātou tohutohu whakamutunga ki te Kāwanatanga me ahu pēhea atu te whenua, ā, ka pēhea rā te āhua o te ao mō ngā uri o inamata, ā, anamata ake nei.

He aha rā tēnei uiuinga e kapi nei?

Koia tēnei tētahi anake o ngā puka uiui e toru, ko tēnā me tēnā he tohutohu e whakawhanakehia ana e mātou. Ko ngā tohutohu e toru nei, he noho wehe otiia, ka whai hononga (**whika 1**). He hira ēnei katoa kia whakamahere tā Aotearoa New Zealand kokenga kia whakatutukitia ai te whāinga tukuwaro whakamimititanga i mua mai i te tau 2050, ā, ki tua atu.

He whakawhanaketanga tēnei puka uiui i ngā mahi i mua, tae ake ki tā mātou rīpoata 2021 *Ināia tonu nei*, ā, ko ngā *Tohutohu 2023 mō te ahunga atu o te kaupapa here mā te Kāwanatanga whakamimititanga tukwaro mahere tuarua*. I whai mōhiotanga mai anō hoki nā tā mātou karanga ki te tūmatanui mō ngā taunakitanga i te tau 2023.

Koia kei ēnei puka:

- **Ngā puka matapakina e rua** – ko tētahi o tā mātou arotakenga o tā Aotearoa New Zealand whāinga whakamimititanga tukuwaro; ā, ko tērā atu i tā mātou arotakenga mēnā rānei me whai wāhi mai ki tēnei whāinga anō hoki ko ngā tukuwaro nā te kawe ō ā-ao mā te poti, mā rererangi rānei, ā, mēnā rānei āe, me pēhea hoki.
- **Ko tētahi tohutohu hukihuki** – mō te tahua tukuwaro tuawhā (2036-40), ā, mēnā rānei ko ngā tahua tukuwaro tahi, rua me te toru me whakahou.

Ko te whāinga whakamimititanga tukuwaro 2050 (**whika 2**) he mea whakatakoto nā te Paremata kia aro ai a Aotearoa New Zealand ki ngā hohenga manaaki taiao. Ka whakaratohia he tohu toitū ki te kāwanatanga me ngā hapori e taea ai e rātou te whakamahere hohenga pae tawhiti, haumitanga anō hoki. Kua herea te Kōmihana kia tātaringia ai te whāinga i ia rima tau ki ētahi paearu, ā, ka whakarato tohutohu mēnā rānei me panoni e noho tonu ai te whenua ki te ara tika.

Kei te rangahau hoki mātou i ngā tukuwaro o te ao waka rererangi, poti anō hoki i Aotearoa New Zealand, ki Aotearoa nei hoki, ā, mēnā rānei me whai wāhi mai ki te whāinga whakamimititanga tukuwaro – mēnā āe, me pēhea hoki.

Ko ngā arotakenga e rua tahi nei e whai whakaaro ana mēnā rānei me whai panonitanga mai te whāinga nei.

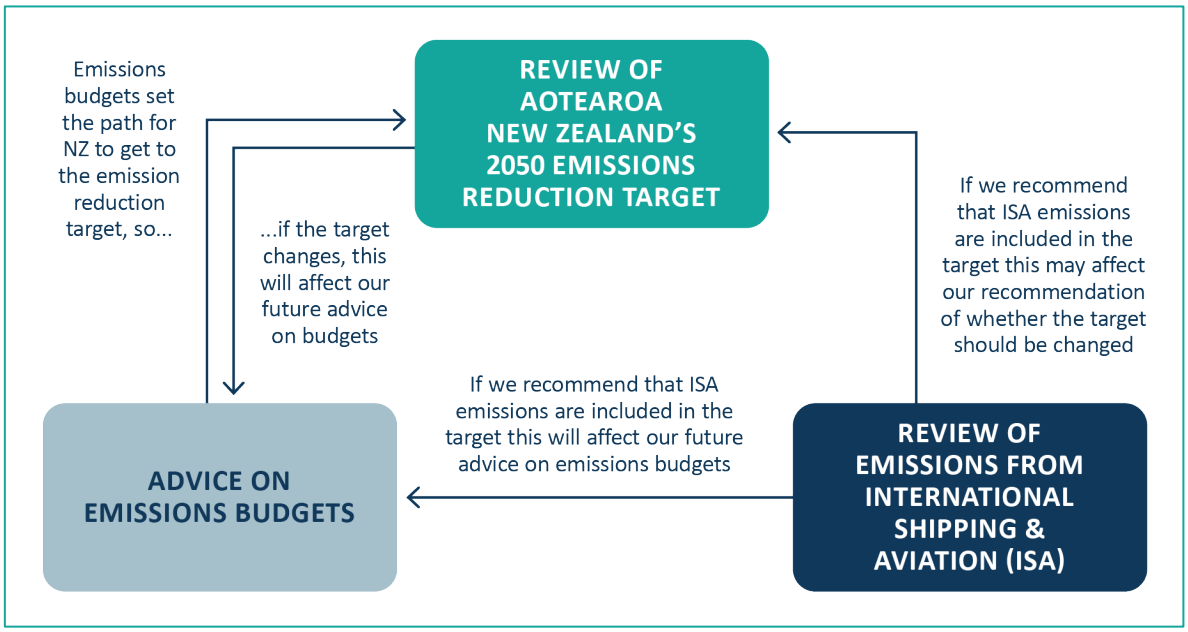
Ko ngā tahua tukuwaro he wāhanga pakupaku kau iho o tā Aotearoa New Zealand whāinga nui. Ka whakatakoto mai te nui o ngātukuwaro haurehua kati mahana e whakaaetia ana a i ia wāhanga rima tau te roa, ā, ka paku iho i ia tahua, o tō mua mai, e whakamimiti ai ngā haurehu Tūkino taiao takahanga o te wā. Ko tā te tahua tukuwaro hukihuki tohutohu he whakarato mai i tā te ināia nei whāinga tukuwaro 2050.

Ko ngā whakatau a te Kāwanatanga mō ā mātou tohutohu whakamutunga me panoni rānei te whāinga, ā, kei te tuawhā o ngā tahua tukuwaro e whakatakoto ai he terenga mō ngā kaupapa here taiao mō ngā tekau tau te taka mai nei. Me tere tika ai ā te Kāwanatanga kaupapa here ki ngā hiahia e whakatutuki ai a Aotearoa New Zealand i tōna oati whakamimiti tukuwaro (**whika 3**). Mā tēnei mahi e whakarato ai ngā taunakitanga ki te Kāwanatanga e hiahiatia ana kia mahi whakatau tika. He mea whakaatu mārama nei, e taea ai e te tūmatanui te whakaheretia te Kāwanatanga. Ko te ara whakawhiti tōkeke ki ngā tukuwaro iti me āta whakahaere puta i ngā tari kāwanatanga maha, waihoki ki ngā iwi me te Māori anō hoki.

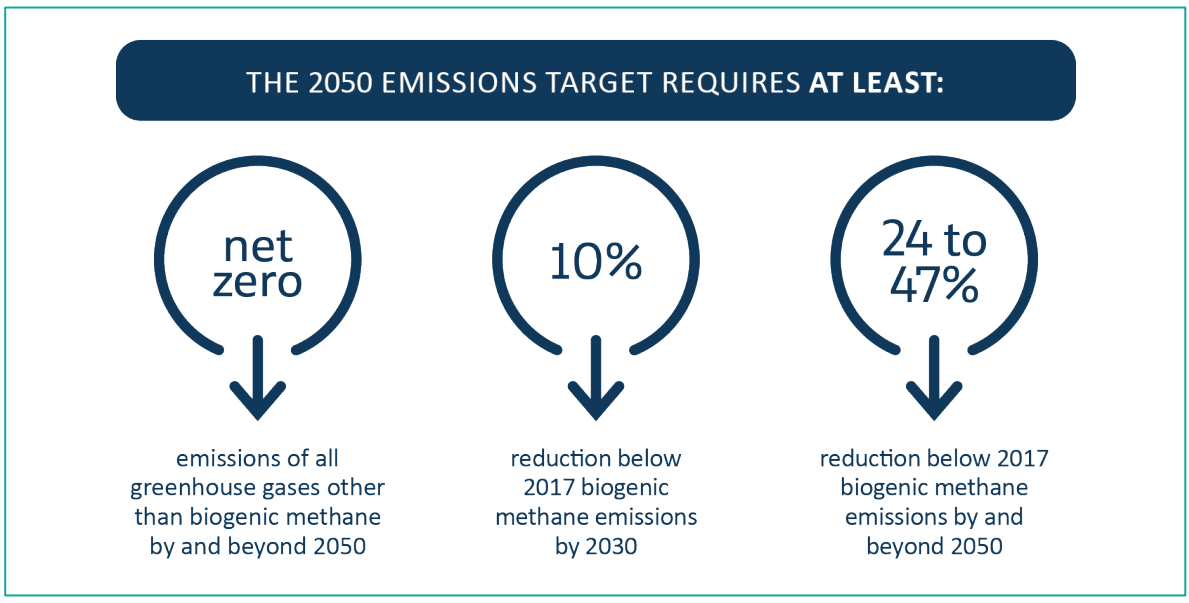
Ko tā mātou he whakatakoto tohutohu motuhake, tōkeke anō hoki. Ko tā mātou he tiro ki ngā pūtaiao, ka mahi kia whai māramatanga o te oranga wheako, ā, ka whakawhitiwhiti whakaaro ki ngā tāngata e whai mōhiotanga ai ki a mātou tohutohu.

He whiringa kei te Kāwanatanga ka aha rā. Ko a mātou tohutohu he whakarato māramatanga ki ngā whiringa rerekē, ā, ka pēhea te whai pānga. Ehara i te mea me manaaki mai te Kāwanatanga a mātou tohutohu otiia, ki te kore, ka kōrero pea ka aha kē rā. Ko te taunga o tēnei waka he mea hira – waihoki, te pēheatanga e ū ai ki reira.

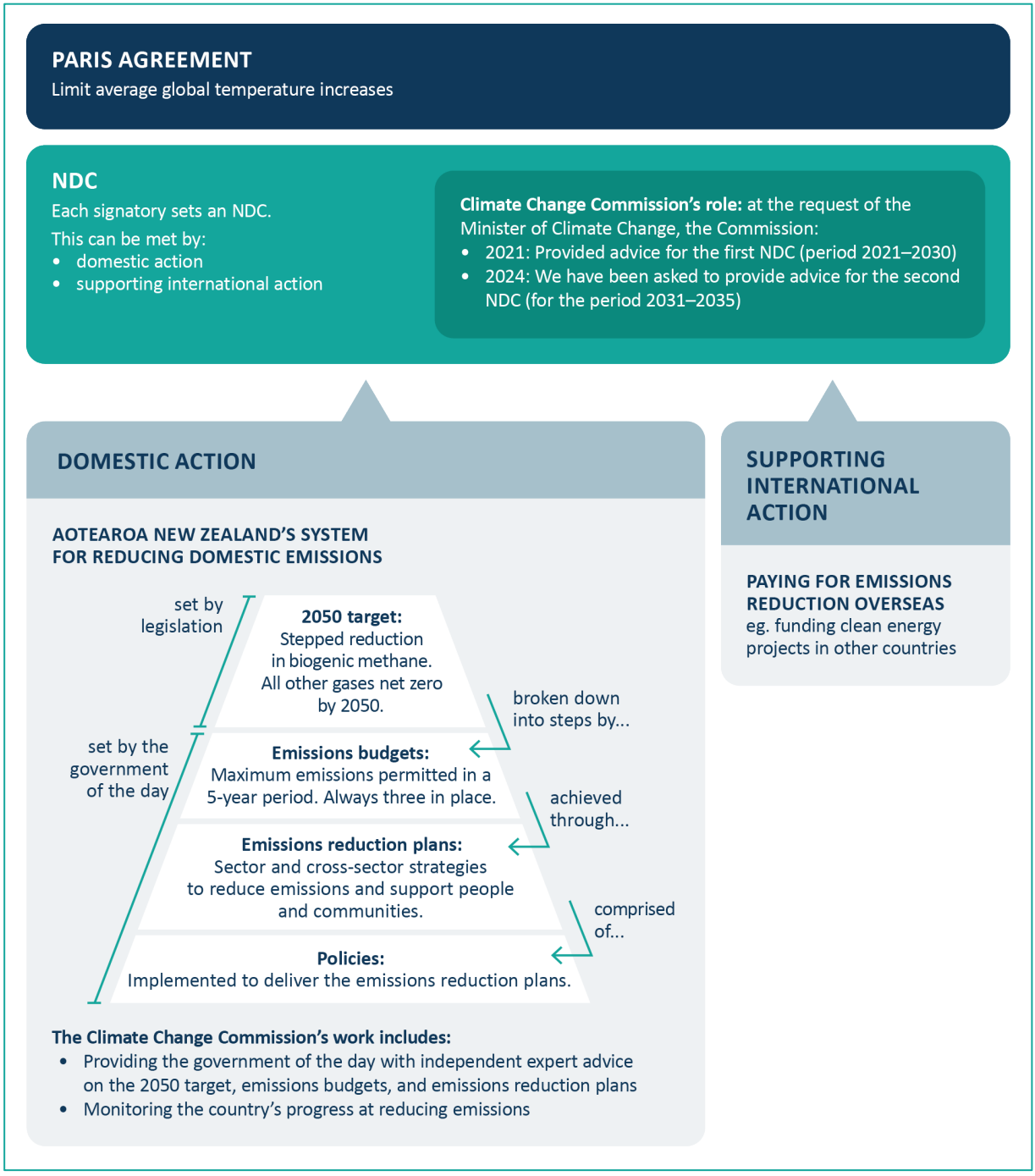
Whika 1. Te honotanga o ēnei mahi e toru. *Ko te whāinga whakamimititanga tukuwaro 2050 tērā e arongia ana e te motu. Ko ngā tahua tukuwaro ka whakaritea mai te ara – tēnā, ki te panoni te whāinga, ka whai pānga tērā ki ngā tohutohu anamata ka tukuna e mātou mō ngā tahua tukuwaro. Mehemea ka whaikuputia e mātou kia whai wāhi atu anō ngā tukuwaro ngā kawenga ō poti me ngā rererangi ā-ao ki te whāinga 2050, tēnā pea ka whai pānga tēnei ki tā mātou whaikupu mēnā rānei me panoni te whāinga, ā, ka whai pānga ki a mātou whaikupu anamata mō ngā tahua tukuwaro.*



Whika 2. Te whāinga whakamimititanga tukuwaro 2050. *He whāinga 'wehenga haurehu' tā Aotearoa New Zealand mō ngā tukuwaro ā-whenua nei, ā, koia tēnei he whakawehe mewaro rauropi ora i ērā atu haurehu kati mahana. Ka whakaaturia tēnei ngā pānga rerekē o tērā tā te mewaro ki ētahi haurehu kati mahana kē atu pēnā me te hauhā. E toru ngā wāhanga o te whāinga. Tuatahi ake, he whakamimiti i ngā haurehu kati mahana (hāunga te mewaro rauropi ora) kia heke ki te kore heke iho rānei i mua i te 2050 ki tua haere ake. Ko ngā toenga wāhanga nei e rua e arongia ana kia whakaheketia ngā mewaro rauropi ora kia 10% te itinga iho i ngā taumata o te tau 2017 i mua mai i te 2030; ā, 24-47% i raro iho i ngā taumata 2017 i mua mai i te tau 2050 ki tua haere ake.*



Whika 3. Ko ngā oati whakamimititanga tukuwaro me te pūnaha e whakatutukihia ai ēnei.
Nā te waitohu i te Whakaaetanga Pārihi, kua ngākau titikaha a Aotearoa New Zealand kia pupuri "te toharite o te pikinga mahana ki rawa raro i te 2°C nui ake i tērā o ngā taumata i mua mai i te whānautanga ahumahitanga" me whai atu i te "herea te pikinga mahana kia 1.5°C nui ake i tērā o ngā taumata i mua mai i te whānautanga ahumahitanga." Tā ia waitohu me whakarite mai he rouroutanga ā-whenua (NDC) e haere ai i te tekau tau mai i te 2021-2030. Ko ngā NDC ka whai ake e kapi ai kia rima tau te roa, ā, me poto ake ai haere nei te wā. Ka whakatutukihia atu ngā NDC mā te whakamimiti haeretanga o ngā tukuwaro ā-whenua, waihoki mā te utu tukuwaro i rāwāhi – ina koa mā roto mai i te haupūtanga atu i ngā hinonga i whenua kē atu. Ko te whāinga 2050 me te tahua whakamimiti (tahi nei me ngā mehere whakamimiti tukuwaro) he wāhanga o tā Aotearoa New Zealand pūnaha mō te whakamimiti tukuwaro ā-whenua nei.



Tā mātou tūranga

Ko ngā kāwanatanga kē o te wā i oati nei kia whakamimiti i ngā haurehu tūkino taiao o Aotearoa New Zealand. Ko tā mātou mahi nei he whakarato tohutohu motuhake, tōkeke hoki mō ngā whiringa kei te kāwanatanga o te rā kia uruparehia te whakamahanatanga o te ao. Ko tā mātou motuhaketanga he whakaūtanga ki Aotearoa – ā-ao anō hoki – mō te kaha o tā Aotearoa New Zealand hohenga mō te whakamahanatanga o te ao.

Tā te Ture Urupare Whakamahanatanga Ao e whakatakoto ai he aha ia ngā mea tā te Kōmihana me tuku tohutohu, ā, me whai whakaaro anō mātou nō mātou e mahi nei i tēnei mahi. He mea whakatakoto paearu me whai ai e a mātou tahua tukuwaro, ā, he whakarite mai anō te whānuitanga o a mātou arotakenga e rua o te whāinga 2050 me ngā tukuwaro i ngā poti ā-ao me ngā rererangi.

Ka herea anōtia e te Ture kia āta whai wāhi ki a mātou tohutohu. Ko te rongo i ngā whakaaro o te hunga whaipānga pēnā i a koe tonu he hira tonu mā mātou hei whakawhanake tohutohu e whai pānga ana ki te ao tūturu, ngā wheakotanga o ngā whānau, ngā hapori me ngā pakihi puta atu i te motu. Ko te whai wāhitanga he mana nui ki a mātou mahi. Mā āu whakahoki kōrero mai me ngā whakamōhiotanga mai e pakari ake anō ai a mātou tohutohu.

Ko āu whakaaro mai ki tēnei uiui e tautoko ai i a mātou ki te whakamātau i te āhua o tā mātou i tātaringia ai ngā taunakitanga, ka whakamātau anō a mātou kitenga, waihoki he whakaatu tauira mō te āhua o urupare e panoni ki tētahi, ki ngā arotakenga e rua rānei.

He aha e take nui ai a mātou mahi

Ko Aotearoa New Zealand, ki te taha o ētahi anō whenua 195, kua oati atu ki te ao kia tautoko te here whakamanatanga ao. E whakawhiti ana te ao ki tētahi anamata tukuwaro iti, me te aha, e hua mai ai he angitūtanga ohaoha hou me ētahi mahi hou kē atu. Me tīmata mai a Aotearoa New Zealand kia whai hua i ēnei angitūtanga, waihoki kei noho hei kaitukuwaro nunui. He tokomaha ngā kiritaki i te ao e tirohia ana te 'whakaritenga tukuwaro' i a rātou ake hanganga me ā rātou kaiwhakarato. Ko ngā hohenga e mahia ana e Aotearoa New Zealand aia nei me ngā whakatau hira te hou mai nei, he mea nui tonu mō tō tātou rongonuitanga i te ao, ā, tā tātou tomo ki ngā mākete o te ao.

Ko te tikanga o tēnei mahi he whakaū e whakawhiti tere ai a Aotearoa me ngā panga iti e taea ana ā-ohaoha, ā-hapori, ā-taiao, ā-ahurea anō hoki – ka mutu, ka whai hua nui ai ngā angitūtanga i aua mea anō rā i runga i te tōkeke mā te hunga katoa o Aotearoa. Ina koa, ko a mātou tohutohu hukihuki ki te tahua tukuwaro tuawhā e whakaaturia ana ko te whakawhitinga ki ngā waka hiko me te whakamimiti i te hautū wakatanga, kei te takiwā o te $23 miriona e penapenatia ai i mua i te 2040 mā te whakamimiti i ngā utu Hauora tūmatanui me te whakapaipaia ake i ngā mahi whakaputaputa. Waihoki, he whakapai ake i oranga tangata.

Kua rongo kē ngā pānga taiao i ngā hapori puta i te motu, ā, ka kaha ake nei te auautanga mai me te kinotanga o ēnei pānga. Kāore te ao i te ara tika kia herea te paemahana ki te 1.5°C. Ki te kore tēnei āhuatanga e arongia ai, ka tahuri kia hoki tere rawa atu nei ki raro ake i te 1.5°C. Tā ia hautanga te karo nei, te tahuri nei rānei e whai pānga tonu.

Ko te tahua whāinga me te tukuwaro 2050 e tautoko a Aotearoa New Zealand ki whakamimiti i ngā tukuwaro. Tā te whāinga he whakarato mahere pae tawhiti e tohua ai te anga whakamuatanga. Ko te tahua tukuwaro e whakawāhangatia te haerenga ka whakaaweawe ai ngā whakataunga pae tata me ngā hohenga. Ko ngā hohenga pae tata me tautoko ake i te whāinga pae tawhiti.

He rangirua te anamata otiia, kei whakatokangia ngā hohenga ina hoki ki te kore e arongia ai ka kikino kē atu ngā putanga. He mahi whakatau kei te Kāwanatanga hei ngā marama 20 te haere ake nei e whai pānga ai ki tā te whenua e whakamimiti iho hei ngā tau 5-30 te taka mai nei. He utu tā ēnei whakatau. Ko a mātou tohutohu e toru e toe nei e tautoko ake i te Kāwanatanga te whakaine tūraru me ngā angitūtanga kei ēnei whiringa e taea ai ngā whakatau mōhio.

Ko ngā tūraru e noho tahi nei ki te whakamahanatanga ao he nui kē, manohi anō ngā angitūtanga. Ko ngā whakatau mārama nei e aru whai whakaaro ana e tautoko ake he whakawhitinga pai atu, tōkeke atu anō hoki. Ko te tikanga o tēnei, ko te whakawhitinga e whakahaere pai nei i ngā pānga ki te tangata me te taiao heoi anō e whai hua nui ai i ngā angitūtanga i runga i te āhua e puta mai he hua ki te hunga katoa o Aotearoa.

Tā mātou kokenga

Ko te tūāpapa o tā mātou he taunakitanga otiia, ehara i te mea ko ngā raraunga inenga kau anake. Ka kitea e mātou te nui o ngā momo tohungatanga me ngā mātauranga kē atu. Kua tātaringia e mātou ngā raraunga hou rawa, kua whai whakaaro ki ngā take e herea ana mātou e te Ture kia arongia ai, ā, kua tohua ngā whakamōhiotanga me ngā taunakitanga i ngā whai wāhitanga ki ngā iwi.

Ka whai whakaaro ai mātou ki te hononga i waenga i te Karauna me te Māori, te ao Māori me ngā pānga tonu iho ki ngā iwi me te Māori anō hoki. Ko ā mātou arotakenga, whai wāhitanga atu anō ki ngā hapori e whakaaturia ana e tautoko ai tēnei he whakamimititanga tere ake nei me te tautoko mai anō he whakawhitinga tōkeke mō te hunga katoa o Aotearoa te hua.

Ko ā mātou arotakenga, tohutohu anō hoki he 'tirohanga pūnaha' te kawe, me te aha, ka whai whakaaro ai mātou ki te tūhonotanga o ngā kaupapa here a te Kāwanatanga, te ao ohaoha, te ao ahumahi, te papori me te taiao. Ko te whai wāhi atu ki te tangata me ngā hapori pēnā me koe he whakarato taunakitanga, arotakenga me ngā whakamōhiotanga i ngā whakaaro maha rerekē, ā, he mea nui tonu hei whakaū kia hāngai, kia taea ai te whakatinana, ā, he māramatanga pai o roto i a mātou tohutohu whakamutunga.

Ko te tikanga o tēnei tirohanga pūnaha nei e whaiwhakaaro anō mātou mō te urutau ki te whakamahanatanga o te ao ki te taha anō o ngā whakamimititanga tukuwaro. Me whaiwhakaaro anō ngā Kaupapa Here Whakamahanatanga Ao kaha nei te hanga, kia whakapaetia mā te aro ki tētahi take Kotahi kau nei e kikino ake ai ko tētahi take kē atu.

He uaua kia whakapaetia he aha rā kei te anamata. Whakamahia ai e mātou he tauira kia whai mōhiotanga he aha rā ngā pānga o ngā tū whakatau rerekē.

Ko tō tātau tauira whānui ā-ohaoha nei kua whakawhanakehia e ngā mātanga hou te rongo o te ao, ā, kua arotakengia motuhaketia ai. Ko a mātou tauira kua whakahoungia, kua arotakengia tāruatia hei wāhanga o te pūnaha tātaringa.

Ka whakamahia e mātou he tauira tūāhua kia whai māramatanga ki ngā momo hohenga me ngā taumata tahua e whakatutukihia e Aotearoa New Zealand te whāinga 2050. I pēnei ai mātou nātemea he ara maha e taea ana e Aotearoa. He rerekē ngā ara me ngā tūāhua ki ngā whakapae e whai take ai pea i te wā tata nei otiia, ka hē ana i a mātou ka whaiwhakaaro ai ki ngā whai pānga e mōhio pū ana mātou te hou mai nei, ā, ka whai pānga ki ō mātou āheinga kia whakamimiti iho i ngā tukuwaro, te urutau rānei ki ngā pānga.

Ka whai whakaaro ai mātou ki ngā utu, ngā hua me ngā pānga o ngā ara kē atu. Ka kore mātou e whakahaere tātaringa mō ngā hua utu hei wāhanga ki ā mātou tohutohu; koia tēnei te wāhanga o te pūnaha e ao kē ana mā te Kāwanatanga e mahi nō te wā ka waihanga kaupapa here nei e hāngai ana. He pēnei mai nātemea me whiri e te Kāwanatanga ko ēhea kaupapa here e whakamahi ana, ā, ko ngā kaupapa here kē he utu kē, he hua kē.

Hei muri i te uiuinga

Ka whai whakaaro ai mātou ki ngā whakahoki kōrero ka whakahokia mai ki a mātou. Ka whakamahia e mātou hei tōna wā e tika ana, kia arotake tāruatia tō mātou tūāpapa taunakitanga, tā mātou kokenga me ngā kitenga.

Ka whakarato mātou a mātou tohutohu e toru whakamutunga ki te Minita Whakamahanatanga Ao i mua i te 31 o Hakihea 2024.

I konei whai whakaaro ai te Kāwanatanga ki a mātou tohutohu, tae ake anō ki ngā whaikupu i mua i tana whakatau whakamutunga hei tēnei taha mai o te tau 2025.

Ki te hiahia whakawhiwhi whakahoutanga koe mō ēnei mahi, waitohu mai ki: bit.ly/TandB2024

Me pēhea koe e tuku tāpaetanga ai

Mutu ana i a koe te pānui mai i ngā puka uiuinga, ā, kua rite mai koe ki te whakahoki kōrero mai, he ara kē atu kia tuku mai ai tō tāpaetanga. Me tae ai ki a mātou i mua i te paunga o te Paraire 31 o ngā rā o Mei 2024.

Mā te ipurangi

E taea ana e koe te tuku tāpaetanga mai mā tā mātou atamira: haveyoursay.climatecommission.govt.nz

Ko te whakamahi i te atamira nei e taea ana e koe te whakarato whakahoki kōrero mai mā te whakautu pātai ki tētahi uiuinga ipurangi.

He whiringa kē atu anō

E taea ana e koe te tuku mai āu whakahoki kōrero ki:

- **Īmēra:** haveyoursay@climatecommission.govt.nz
- **Mā te pouaka:** Uiuinga – Whāinga me ngā tahua, Te Komihana Whakamahanatanga Ao, PO Box 24448, Wellington 6142

Kia mōhio mai: Ina taea ana, e tono ana mātou kia tuku ai a koutou tāpaetanga mā te atamira ipurangi. Nā konei, e āhei ai mātou ki te pupuri rekoata o āu whakapānga, he whakarato anō māu he pārongo matatapu hira, ā, he tono i tō whakaaetanga kia whakamahia, kia tāia i tāu nā tāpaetanga. Mēnā rā kāore koe e taea ana te tuku mai i āu whakahoki kōrero mā te ipurangi ka hiahiatia ai kia tuku mā te īmēra, mā te pouaka rānei, tēnā whakakīia te pepa whakapā me te whakaaetanga ka noho tahi mai ai ina tuku mai koe i tō tāpaetanga. Ki te kore koe e hōmai i ēnei pārongo, e kore e taea ana e mātou te kī mārika e whakaae ai tō tāpaetanga.

Whakapā mai

Ki te tono pepa whakapā me te whakaae, mehemea rānei he pātai āu mō tēnei uiuinga, he hiahia tomonga rānei āu kāore e whakaea ana i ngā whiringa o runga ake nei, tēnā īmēra mai ki a mātou ki haveyoursay@climatecommission.govt.nz

Foreword

We are asking Aotearoa New Zealand for your thoughts on three different but related pieces of work to help us develop advice for the Government. We will use what you tell us to test our analysis and findings. This will help ensure that our final advice is **relevant**, **practical** and **informed** by your needs, views and concerns. The Government will then use these three pieces of advice to make decisions on how the country can reduce climate polluting gases.

Your feedback

You are an important part of our process, we want to hear your thoughts.

Nā te whakarongo, titiro me te whakaaro ka puta mai i te kōrero.
Through listening, looking and thinking we receive wisdom to speak.

It is important that our advice reflects different perspectives and priorities from across the motu. The transition to a low emissions and climate resilient society brings a mix of opportunities and benefits, challenges and costs. The effects – good and bad – will be felt by all of us.

We are looking for evidence, perspectives, insights and other information that tests our approach and analysis, and helps us to assess the different options. This will improve our final advice to the Government on where the country should be heading, and what the future could look like for current and future generations.

What does this consultation cover?

This is one of three consultation documents, each about a piece of advice we are developing. These three pieces of advice are separate, but connected (**Figure 1**). They are all essential to plan Aotearoa New Zealand's journey get to the emissions reduction target by 2050, and beyond.

The consultation documents build on our previous work, including our 2021 report *Ināia tonu nei* and *2023 Advice on the direction of policy for the Government's second emissions reduction plan*. They have also been informed by our public 'call for evidence' in 2023.

These documents include:

- Two **discussion documents** – one on our review of Aotearoa New Zealand's 2050 emissions reduction target; and another on our review on whether emissions for international shipping and aviation should be included in that target, and if so, how.
- One piece of **draft advice** – on the fourth emissions budget period (2036–40), and whether emissions budgets one, two, and three should be revised.

The 2050 emissions reduction target (**Figure 2**) was set by Parliament to focus Aotearoa New Zealand's efforts on climate action. It provides a consistent signal to government, businesses and communities so they can plan long-term action and investment. The Commission is required to review the target every five years against a set of criteria, and provide advice on whether it needs to change to keep the country moving in the right direction.

We are also looking at whether emissions from shipping and aviation to and from Aotearoa New Zealand should be included in the emissions reduction target – and if so, how.

Both these reviews are considering whether changes to the current target are needed.

Emissions budgets are stepping stones towards Aotearoa New Zealand's 2050 target. They set out how much greenhouse gas emissions are allowed in each five-year period, and each budget is smaller than the one before so that climate polluting gases decline over time. The emissions budgets draft advice is about delivering the current 2050 emission reduction target.

The decisions the Government makes following our final advice about whether to change the target, and on the fourth emissions budget, will set the pace for climate policy over the coming decades. Government policy needs to keep pace with what is required to meet Aotearoa New Zealand's emissions reduction commitments (**Figure 3**). This work will provide the Government with the evidence it needs to make decisions. It also provides transparency so the public can hold the Government to account. An equitable transition to low emissions will require coordination across a wide range of government agencies and levels of government, as well as with iwi/Māori.

Our role is to provide independent, impartial advice. We look at the science, work to understand lived experience, and talk to people to inform our advice.

The Government has choices on how to act. Our advice helps it understand different choices, and how they add up. The Government does not have to take our advice, if it does not then it must say what it will do instead. Where we are going is important – so is how we get there.

Figure 1. How these three pieces of work are connected. *The 2050 emissions reduction target is what the country is aiming for. Emissions budgets set the path to the target – so if the target changes, this will affect the future advice we give on emissions budgets. If we recommend that emissions from international shipping and aviation are included in the 2050 target, this may affect our recommendation of whether that target should be changed, and will affect our future advice on emissions budgets.*

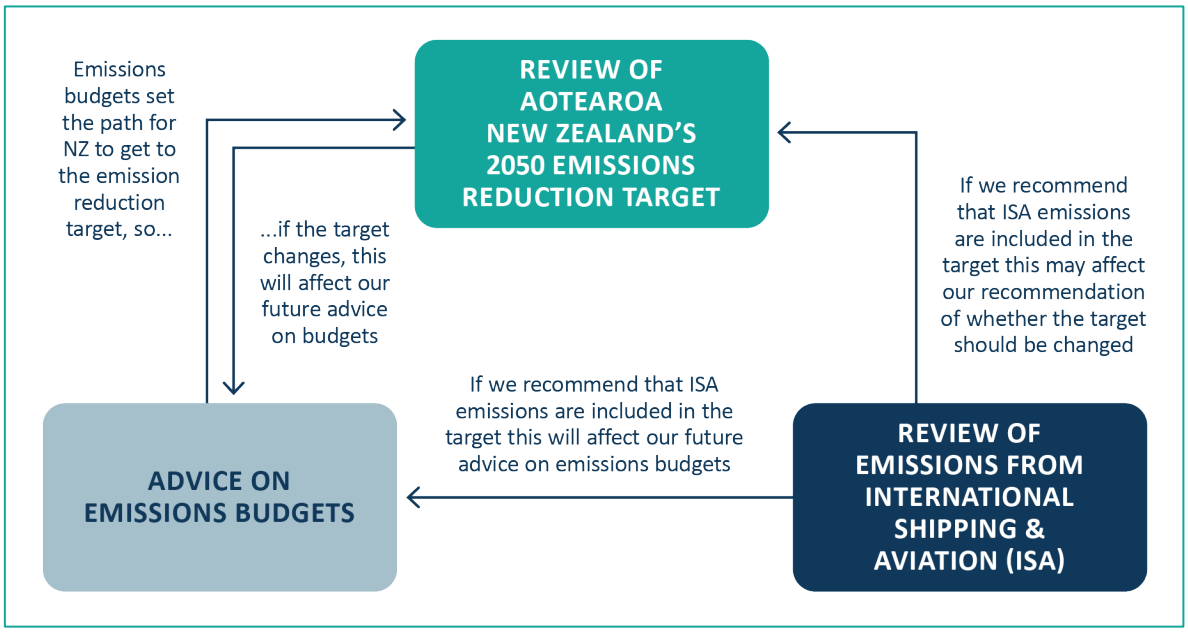


Figure 2. 2050 emissions reduction target. *Aotearoa New Zealand has a 'split gas' target for domestic emissions, which considers biogenic methane separately from all other greenhouse gases. This reflects the different impact that methane has compared with other greenhouse gases, such as carbon dioxide. The target has three components. The first is to reduce emissions of greenhouse gases (other than biogenic methane) to net zero or lower, by 2050 and beyond. The other two components are focused on lowering biogenic methane emissions by at least 10% below 2017 levels, by 2030; and 24–47% below 2017 levels, by 2050 and beyond.*

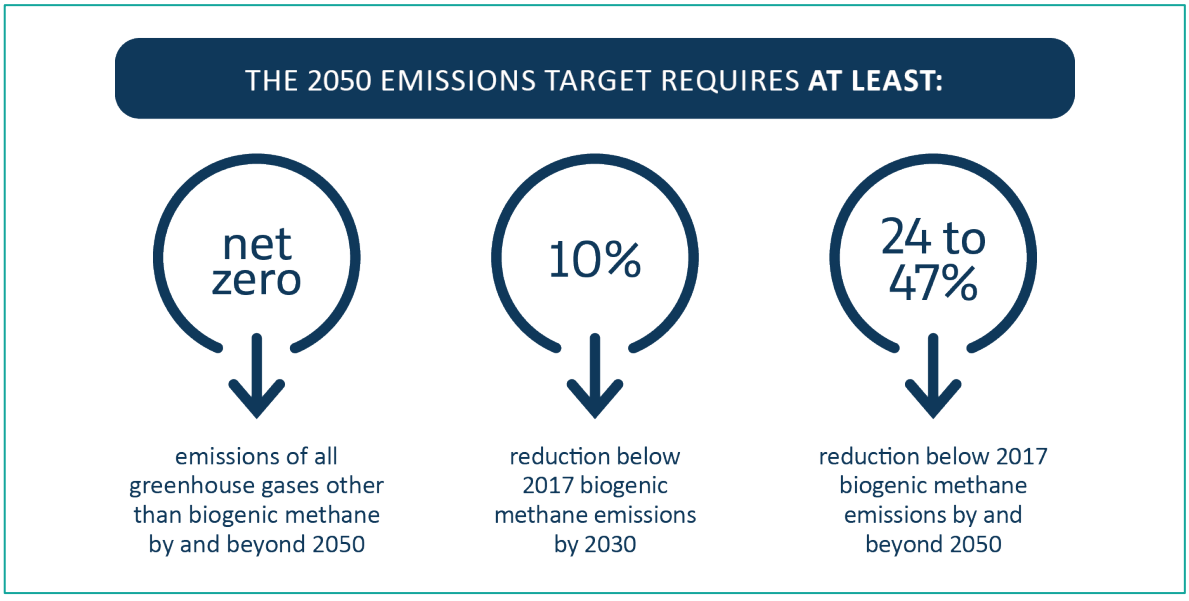
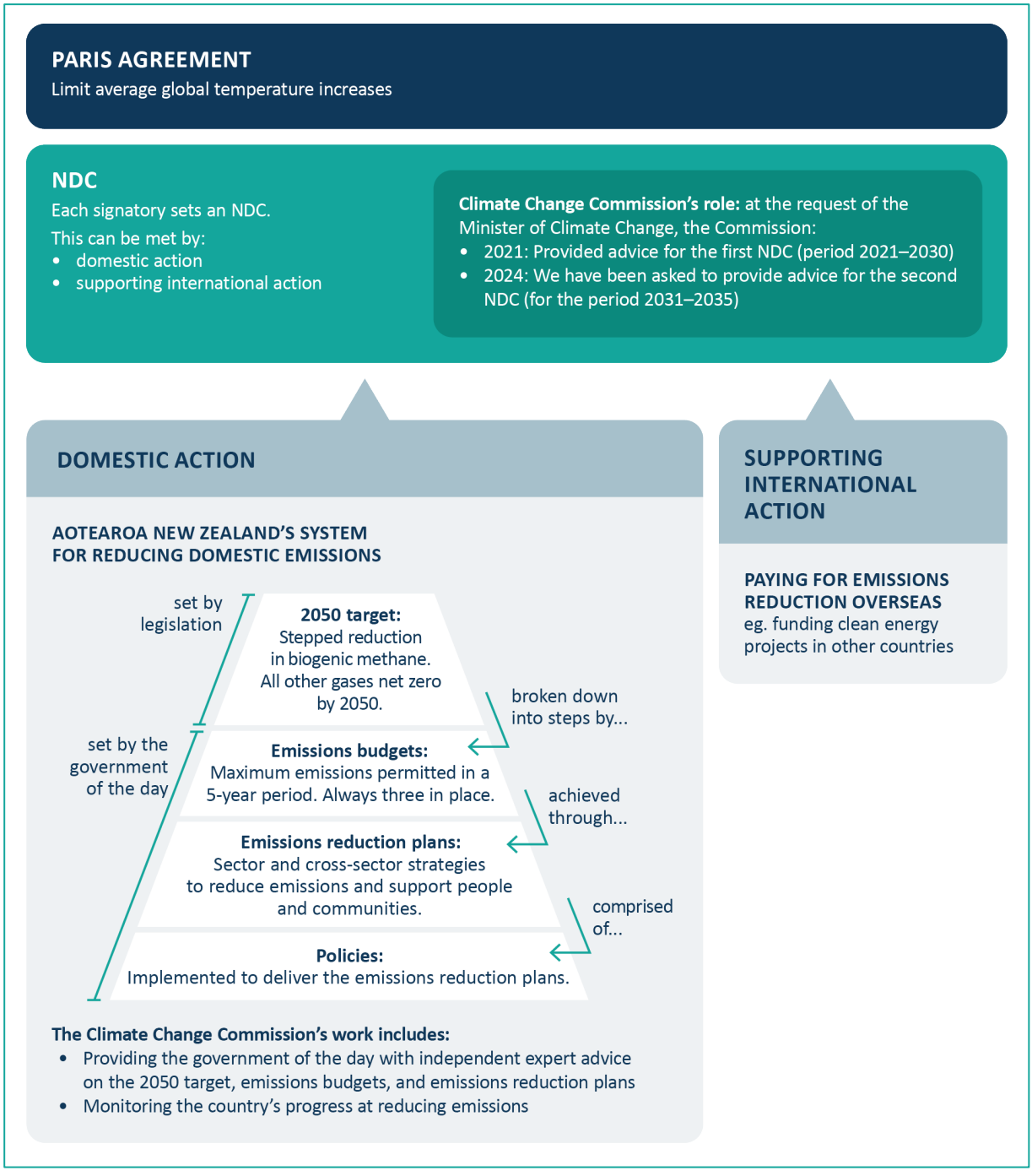


Figure 3. Emissions reduction commitments and the system for meeting them. *By signing the Paris Agreement, Aotearoa New Zealand committed to holding "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursuing efforts "to limit the temperature increase to 1.5°C above pre-industrial levels". Each signatory had to set a nationally determined contribution (NDC), covering the decade 2021–2030. Following NDCs will cover five-year periods, and must get more ambitious each time. An NDC can be achieved by reducing domestic emissions, and by paying for emissions reductions overseas – for example through funding clean energy projects in other countries. The 2050 target and emissions budgets (together with emissions reduction plans) are part of Aotearoa New Zealand's system for reducing domestic emissions.*



Our role

Successive governments have committed to reducing Aotearoa New Zealand's climate polluting gases. Our role is to provide independent, impartial advice about the choices the government of the day has to respond to climate change. Our independence provides assurance to New Zealanders – and internationally – about the credibility of Aotearoa New Zealand's action on climate change.

The Climate Change Response Act sets out what the Commission has to give advice on, and what we have to consider as we do. It sets criteria that our emissions budgets work has to follow, and sets the scope of our two reviews of the 2050 target and of emissions from international shipping and aviation.

The Act also requires that we proactively engage on our advice. Hearing the views of stakeholders such as yourself is critical for us to develop advice that reflects the real-world, lived experience of whānau, communities and businesses across the motu. Engagement is so valuable to our mahi. Your feedback and insights make our advice more robust.

Your input into this consultation will help us to test the way we have analysed the evidence, test our findings, and to present examples for how the target could be changed in response to one or both reviews.

Why this work matters

Aotearoa New Zealand, alongside 195 other economies, has made a global commitment to help limit climate change. The world is transitioning to a low emissions future, which brings new economic opportunities and new kinds of jobs. Aotearoa New Zealand needs to act to benefit from these opportunities, and to avoid being stranded as a high emissions producer. Many international customers are looking at the 'emissions profile' of their products and their suppliers. The actions Aotearoa New Zealand takes now, and in the important decisions to come, are important for our global reputation – and our access to global markets.

This package of work is about ensuring that Aotearoa New Zealand makes this transition in a timely way and with minimal economic, social, environmental, and cultural impact – and maximises opportunities for the same, in an equitable way for all New Zealanders. For example, our draft advice on the fourth emissions budget shows that transitioning to electric vehicles and reducing vehicle use could save $23 billion by 2040 by reducing public health costs and improving productivity. It would also improve quality of life.

Climate impacts are already being felt by communities across the motu, and will become more frequent and severe. The world is not on track to limit warming to 1.5°C. If this is not urgently addressed, then the impetus will be to ensure a return to under 1.5°C will be as quickly as possible. Every fraction of a degree averted or reversed makes a difference.

The 2050 target and emissions budgets help focus Aotearoa New Zealand's efforts to reduce emissions. The target provides a long-term goal that signals the direction of travel. The emissions budgets break the journey into steps and influence short-term decisions and actions. These short-term actions need to add up to the long-term goal.

The future is uncertain, but that cannot paralyse action because doing nothing will lead to worse outcomes. The Government has to make decisions in the next 20 months that will affect how the country reduces emissions over the next 5–30 years. These choices will have consequences. Our final three pieces of advice will help the Government assess the risks and opportunities around these choices, so it can make informed decisions.

The risks that climate change brings are significant, but so are the opportunities. Well-informed and considered decisions can support a smooth and more equitable transition. This means a transition that manages the impacts for people and the environment, while making the most of the opportunities in a way that benefits all New Zealanders.

Our approach

Our work is evidence based, but that doesn't just mean quantitative data. We value different types of expertise and forms of knowledge. We have analysed the latest data, considered the issues the Act requires us to address, and drawn on insights and evidence from engagement with people.

We consider the Crown–Māori relationship, te ao Māori and specific effects on iwi/Māori. Our analysis and engagement with communities shows this will support faster emissions reduction and help achieve an equitable transition for the benefit of all New Zealanders.

Our analysis and advice takes a 'systems view', which means we consider how government policies, economy, industry, society and the environment are all connected. Engaging with people and communities like you who can provide evidence, analysis and insights from different perspectives is essential to ensure our final advice is relevant, practical and well-informed.

This systems view means that we also consider adaptation to climate change alongside emissions reduction. Robust climate policy needs to take both into account, or action to tackle one problem could make another issue worse.

It's difficult to be certain what the future will look like. We use models to understand what the impacts of different choices might be.

Our economy-wide models have been developed by internationally renowned experts and independently reviewed. Our models have been updated, and re-reviewed, as part of this analysis.

We used scenario modelling to understand what types of actions and what budget levels could get Aotearoa New Zealand to the 2050 target. We did this because there are several pathways that Aotearoa New Zealand could take. Scenarios and pathways are different from forecasts and predictions which might be useful in the short term but will be wrong as we consider impacts that we know are coming and will affect our ability to reduce emissions or adapt to the impacts.

We consider the costs, benefits and impacts of different pathways. We do not conduct cost-benefit analysis as part of our advice; this is more appropriately done by the Government as part of its process when developing specific policies. This is because the Government needs to choose which policies it uses, and different policies have different costs and benefits.

After consultation

We will consider each piece of feedback we receive. We will use it, where appropriate, to re-evaluate our evidence base, approach and findings.

We will deliver our three pieces of final advice to the Minister of Climate Change by 31 December 2024.

The Government will then consider our advice, including any recommendations, before making its decisions by the end of 2025.

If you would like to receive updates on this mahi sign up to: bit.ly/TandB2024

How you can make a submission

Once you have read the consultation document(s) and are ready to provide your feedback, there are multiple ways to send us your submission. These need to be received by the end of Friday 31 May 2024.

Online

You can make a submission via our online engagement platform: haveyoursay.climatecommission.govt.nz

Using this platform, you can provide your feedback by answering questions in an online survey.

Alternatively, you can upload your submission as a file, such as a PDF, Word document or spreadsheet.

Other options

You can send us your feedback via:

- **Email:** haveyoursay@climatecommission.govt.nz
- **Post:** Consultation – Target and budgets, Climate Change Commission, PO Box 24448, Wellington 6142

Please note: Wherever possible, we ask that you send your submission using our online engagement platform. This allows us to keep a record of your contact details, provide you with important privacy information, and ask your permission to use and publish your submission. If you cannot submit your feedback online and wish to send it by email or post, please complete the contact and consent form and include it when you send in your submission. **If you do not provide this information, we cannot guarantee that your submission will be accepted**.

Get in touch

To request the contact and consent form, or if you have questions about this consultation, or if you have accessibility requirements not met by the submission options above, please email us at haveyoursay@climatecommission.govt.nz

Chair's message

Well-informed, properly considered emissions budgets provide certainty for businesses, government, households and communities to plan, invest and act. They can also support a smoother, sustained and more equitable transition to a low emissions economy and society.

Aotearoa New Zealand needs to set emissions budgets that keep the country on track for the 2050 target. Our analysis shows that Aotearoa New Zealand can reduce emissions faster and sooner than previously projected – and that overall, it benefits the country and all of us to do this.

Achieving the proposed emissions budget (for 2036–40) will result in Aotearoa New Zealand having more choices to meet future emissions budgets – and to meet potential future global expectations or new requirements of overseas markets. It also makes it more likely that Aotearoa New Zealand will maintain the goal of net zero emissions of all greenhouse gases (except biogenic methane) beyond 2050.

Because circumstances have changed since the first three budgets were set, we are proposing that emissions budgets one, two and three be revised so they will guide action to reduce emissions that is consistent with making the proposed fourth emissions budget achievable.

No one knows exactly what technologies will be available and at what cost over the next 10–15 years, or how the domestic and global situations will change. Being able to revise emissions budgets is a critical strength of the system. If projections are wrong and emissions budgets could not be changed, then Aotearoa New Zealand could miss its emissions reduction target, create problems for future generations, or produce goods and services that the world does not want.

What we do know is that others are taking action to move to low emissions products, services and societies because it makes economic sense. For example, the USA's massive investment in clean tech and green tech is expected to boost long-term competitiveness, insulate the economy from shocks, and create jobs due to increasing efficiency and reliability and lowering transportation costs. An increasing number of countries have managed to decrease their gross emissions of greenhouse gases while increasing their wealth and incomes.

2036 may seem a long way off – but by the time the fourth emissions budget is locked in it will only be ten years away. Ten years is the foreseeable future, but technologies and behaviours can change with unforeseen speed. Personal computers, mobile phones, the internet, social media, online learning and remote working, batteries, solar panels, and heat pumps all went from new or rare to run-of-the-mill inside a decade. Few of us predicted the scale and pace of change.

We need your feedback to help us ensure that our final advice recommends levels for Aotearoa New Zealand's emissions budgets that are achievable, but ambitious enough to help drive the scale and pace of change needed to respond to climate change.

Dr Rod Carr, Chair

Chief Executive's message

Emissions budgets are stepping stones towards Aotearoa New Zealand's 2050 emissions reduction target. They show the maximum amount of climate pollution Aotearoa New Zealand can produce in a five-year period, if we want to stay on track for the 2050 target. Each budget is smaller than the one before it.

Emissions budgets help guide government policy on domestic climate action and are a critical part of the system for reducing Aotearoa New Zealand's emissions. The Government has choices about how it delivers on emissions budgets. These choices need to add up to deliver the long-term goal, which is meeting the emissions reduction target by 2050 and beyond.

By the end of 2025, the Government needs to set the next stepping stone – the fourth emissions budget. This consultation document shares our draft advice on what the maximum level of this budget should be.

We are also required to provide advice on whether the existing emissions budgets (one, two and three) should be revised. This is the first time we have reviewed emissions budgets that are already in place. This 'safety check' is a vital part of the process to help keep emissions budgets aligned – with each other and with achieving the 2050 target.

Setting emissions budgets one, two and three was a starting block for the transition. Covering the period 2022–2035, they guide our actions now and in the immediate future. In contrast, the fourth emissions budget (covering 2035–2040) is about looking ahead – it will come into effect 10 years from now. This is the system working as intended – it enables the Government to plan the next stage of the country's journey and provides businesses and communities with a clear advance signal on the direction of travel.

Our modelling and analysis approach builds on and updates what we used for our previous emissions budget advice, which was robustly tested and validated by international experts. The future is uncertain, and circumstances change – this is why we use scenarios that incorporate 'what ifs' and recommend a pathway to guide the transition, rather than a detailed step-by-step plan that relies on forecasts about exactly what will happen.

In our analysis, we have considered the Crown-Māori relationship, te ao Māori, and specific effects on iwi/Māori. We have also considered the impacts – both positive and negative – that the proposed fourth emissions budget will have on society and the economy.

We want to hear from you. It is important for us to hear about the challenges you face, the opportunities you are creating, and the actions that would make a real, positive impact in your communities. We will consider this draft advice against the evidence and insights we gather. Following consultation, we will review all submissions and take another look at our evidence base to develop final advice enhanced by what we have learnt from you through consultation.

Our objective is to recommend the 'best buy' pathway for Aotearoa New Zealand and its people, not simply the fastest or the cheapest. This means a pathway that will keep us on track to the 2050 target – but that also maximises the opportunities and co-benefits in an equitable way and minimises the negative impacts wherever possible.

This work has already been informed by submissions in response to a specific 'call for evidence' we ran in 2023. This information has helped us to test our assumptions and understand the broader context around some of the actions that we are assessing, including biogas, decarbonising energy and industry, and freight. Ngā mihi to everyone who has already contributed to this mahi, and to all who provide a submission in this consultation.

I encourage everyone to make a submission on this draft advice. We want to hear whether you agree with our analysis and recommendations, or whether there is information and insights from your sector or community that we are missing. We look forward to hearing from you.

Jo Hendy, Chief Executive

Executive summary

Under the Climate Change Response Act 2002 (the Act), He Pou a Rangi Climate Change Commission (the Commission) must provide the Government with advice on setting Aotearoa New Zealand's fourth emissions budget by the end of 2024.

As part of this work, we will also advise on the rules that apply to emissions budgets and whether revisions are needed to the first, second and third emissions budgets.

This draft version of our advice sets out our initial thinking about the fourth emissions budget and how Aotearoa New Zealand can best take advantage of the benefits and opportunities presented by the transition to a thriving, low emissions economy.

We are seeking your feedback on how we are approaching this work so far, and whether our proposed recommendations to the Government are on the right track. Our aim is to test and strengthen our understanding of the issues, impacts and evidence that will inform our final advice and recommendations, due to the Government at the end of this year.

While it is our role to advise on emissions budgets, the Government sets these budgets and ensures they are met. The Minister of Climate Change will set the fourth emissions budget by 31 December 2025.

The next step in Aotearoa New Zealand's transition to low emissions

Emissions budgets limit the amount of greenhouse gases Aotearoa New Zealand can emit in a five-year period. They act as stepping stones, guiding the country's path to meeting the 2050 target in an ambitious, achievable, and measurable way.

In 2022, the Minister of Climate Change, with cross-party support, set Aotearoa New Zealand's first emissions budget (2022–2025), second emissions budget (2026–2030), and third emissions budget (2031–2035).

Soon, the Government will need to set the fourth emissions budget (2036–2040), as the next step in the country's transition to low emissions.

The Government has made its commitment to achieving the 2050 target clear. Our final advice will provide the Government with independent, expert advice on the choices it has in setting the level of the fourth emissions budget, and on the path to follow to achieve those emissions reductions. The decisions the Government makes will affect what kinds of benefits and opportunities are available to households, businesses and communities, and how Aotearoa New Zealand is able to manage risks and uncertainties in the years ahead.

What this consultation is about

At the end of 2024, we will provide the Government with advice that answers the following questions:

- What should the fourth emissions budget be?
- By how much should emissions of each greenhouse gas be reduced to meet the fourth emissions budget?
- How should the country balance reducing emissions at their source and removing carbon dioxide from the atmosphere through planting trees?
- Should the first, second and third emissions budgets be revised?
- Should any changes be made to the rules used to measure progress towards meeting emissions budgets and the 2050 target?

In this draft advice, we are proposing to recommend the Government set the fourth emissions budget at 134 $MtCO_2e$. We are also proposing to recommend that the Government amend the first, second and third emissions budgets.

Before we complete our analysis and finalise our recommendations to the Government, we want to hear from you. Do you agree with our overall approach? Have we missed any important information or evidence? What factors do you want the Commission, and eventually the Government, to prioritise?

Our final advice will incorporate feedback from this public consultation, as well as updated information about government policy and the latest release of official data on Aotearoa New Zealand's emissions, expected in April 2024.

This is one of three separate, but connected, pieces of advice we are consulting on at the same time. For more information on this consultation and how to provide your feedback, see the *Foreword.*

Introduction

Emissions budgets lay the path towards a thriving, low emissions future

In response to the sharpening climate change challenge, the world is intensifying efforts to limit global warming by reducing greenhouse gas emissions. Aotearoa New Zealand has committed to this global response and is building its own transition to a thriving, low emissions economy.

This transition can support people, businesses and communities in Aotearoa New Zealand to respond to the opportunities opening up in a global low emissions economy, while building the resilience the country needs to adapt to the climate impacts already felt across the motu. It presents a range of benefits – including new market openings, cleaner air, lower overall energy costs, and healthier oceans – and it also presents challenges and risks that require careful consideration to ensure success.

The 2050 target represents Aotearoa New Zealand's long-term commitment to reducing its emissions to contribute to global efforts to limit warming to 1.5°C above pre-industrial levels, which evidence shows will help avoid the worst impacts of climate change.

Emissions budgets help turn this long-term commitment into tangible, measurable and achievable steps.

At all times, there are at least three emissions budgets in place, giving households, businesses and communities a view of Aotearoa New Zealand's emissions reduction path at least 10 years into the future. When people are clear on the way forward, they can make informed planning decisions and invest confidently in low emissions alternatives, such as heat pumps and electric vehicles.

Because emissions budgets are set as a net volume of greenhouse gas emissions, they can be met through a combination of actions, including:

- reducing gross emissions (reducing emissions at their source)
- removing carbon dioxide from the atmosphere[i]
- in limited circumstances, using offshore mitigation (when Aotearoa New Zealand pays for emissions reductions or removals that occur overseas).

Our approach to developing this draft advice

The Commission's approach to this draft advice has drawn extensively on the approach and process developed when the Commission advised on the first three emissions budgets in *Ināia tonu nei.*[1]

As an independent Crown entity, we base our advice on research, evidence and modelling, and draw on the expertise of our Board of Commissioners, He Pou Herenga (a Māori advisory body to the Board), and staff. In preparing this draft advice on the fourth emissions budget, we have examined the latest publicly available data on the country's emissions profile and the scientific evidence about options for reducing emissions. We are informed by evidence and insights gathered by engaging with people on the ground. This is built into our modelling approach for the proposed fourth emissions budget, which refines the process used for the first three budgets. To understand what our proposed recommendations could mean for Aotearoa New Zealand, we considered a wide range of factors as required by the Act, including te ao Māori, how the country can realistically meet our proposed fourth emissions budget, and the likely impacts on the economy, society, the environment and future generations.

[i] Currently, planting and growing trees is the only method of removing and storing carbon dioxide from the atmosphere in Aotearoa New Zealand.

Our work has also been informed by what we heard through our call for evidence, which we ran from 31 March to 31 July 2023. We heard from a mix of individuals and organisations who provided a range of evidence and perspectives, including on the potential for biogas integration, and on the opportunities for industry and energy to reduce net emissions through carbon capture and storage, green hydrogen, electricity grid management and storage, and cement and concrete production. We also heard about options for decarbonising rail.

Through these submissions, we were able to test our assumptions and build on our understanding of the future actions Aotearoa New Zealand can take to reduce its emissions. We are now inviting further input from the public before we finalise our advice and recommendations to the Government. We look forward to engaging with people to test and strengthen our analysis through this public consultation process.

How we reached our proposed recommendations on the fourth emissions budget

Our analysis shows there are multiple ways Aotearoa New Zealand could achieve the 2050 target. The Government has choices about what level it will set for the fourth emissions budget, and the path taken to achieve those increased emissions reductions.

To develop our draft advice on the fourth emissions budget, we built on the strengths of our approach in *Ināia tonu nei,* where we gave advice on the first three emissions budgets. We looked at what has changed since the first three emissions budgets were set by the Government, and identified what options are now available for Aotearoa New Zealand to reduce its emissions. Those changes include:

- new data showing higher than anticipated rates of forest planting between 2020–2022, which was expected to continue for 2023
- new information about how changes such as the early closure of the Marsden Point refinery and the announcement of an electric arc furnace for steel will affect Aotearoa New Zealand's emissions
- improvements in how New Zealand's Greenhouse Gas Inventory (GHG Inventory) measures and reports Aotearoa New Zealand's emissions
- new information and evidence about the opportunities to reduce emissions in each sector of the economy, such as using new methane reduction technologies in agriculture and displacing coal in cement production.

Using this information about what emissions reductions and removals are now possible, we modelled different scenarios to help us understand what mix of actions and levels could achieve the 2050 target. Scenarios help us to explore what actions could get us to the 2050 target.

To illustrate how budgets could realistically be met we have developed a draft 'EB4 demonstration path', which is a set of actions that would achieve the proposed budget.[ii] We have used this draft EB4 demonstration path to arrive at the level of the proposed fourth emissions budget, and the proposed breakdown of greenhouse gases.

Our draft recommendations on the fourth emissions budget reflect our initial judgements of what decisions will be ambitious and achievable, provide flexibility for the future, and offer lasting economic, societal and environmental benefits that will likely exceed overall costs.

[ii] This is a path for how Aotearoa New Zealand could meet our draft fourth emissions budget. The EB4 demonstration path is a tested set of measures and actions within each sector that would deliver our proposed emissions budget. It is not the only option, it is not a forecast of what will happen, and it is not a strict plan that Government must follow.

How we reached our proposed recommendations on revising the first, second and third emissions budgets

Part of our task in advising on emissions budgets is to look back at the budgets that have already been set, and consider whether any revisions are needed. This is our first review of set emissions budgets, and we have developed a new process for this work, based on the requirements in the Act.

We can only advise a change to emissions budgets if we find evidence that specific circumstances have changed since the budgets were originally set. As Aotearoa New Zealand is currently in the first emissions budget period, the Minister of Climate Change can only revise this budget under exceptional circumstances. These requirements set a high bar for change, helping to ensure stability for households, businesses, and communities while still allowing flexibility for the country to respond to significant changes in circumstance.

For set emissions budgets, the two kinds of change we check for are:

- **methodological changes** to the way the GHG Inventory calculates and reports greenhouse gas emissions and removals
- **significant changes** in circumstances (such as economic circumstances, scientific advice and technological developments) since the emissions budgets were set.

Our proposed recommendations on revising the first, second and third emissions budgets reflect the impacts of the methodological and significant changes we found. Our initial analysis shows our proposed revisions would bring the first, second and third emissions budgets back in line with the original intent when they were set.

Our proposals for the fourth emissions budget

We are proposing the fourth emissions budget be set at 134 $MtCO_2e$, which means emissions will be 63% lower across the budget period than in 2021.

The choices that Government has in how it meets the proposed fourth emissions budget involve decisions around the mix of actions and policies to reduce emissions, and how much forestry will play a role to remove carbon from the atmosphere. These choices matter, as each decision will have benefits and consequences.

The Act requires that our advice on the fourth emissions budget includes how we expect the budget, and the 2050 target, could be realistically met – and must show the corresponding levels of gross emissions reductions and removals, and the contribution of each greenhouse gas. To do so we have looked at what we think is the best course of actions for Aotearoa New Zealand, with consideration to a range of matters under the Act.

This advice when finalised will provide the Government with the basis to decide on a fourth emissions budget level, which will determine the trajectory of Aotearoa New Zealand's emissions reduction out to 2050. It will also set a path for decisions that need to be made about how the emissions budget can be achieved through specific policies and actions – which will be set out by Government in the emissions reduction plan for that period.

Our analysis shows that there are opportunities to reduce gross emissions on the path towards the fourth emissions budget that would bring a wide range of benefits for Aotearoa New Zealand. Analysis also shows that higher than projected rates of forestry planting in the last couple of years mean that less afforestation would be needed in the future to reach the net zero component of our 2050 target. This in turn means that investing in carbon capture and storage technologies may not need to play a large role before 2050.

Achieving the fourth emissions budget this way would allow the country to reduce emissions in line with meeting the 2050 target, while accessing a range of opportunities and benefits for the economy, society, the environment and future generations. It would give Aotearoa New Zealand flexibility to respond to new information about the viability of different emissions reduction technologies and opportunities.

What the proposed fourth emissions budget might mean for people, the economy and the environment

The Commission's role in advising the Government requires us to consider the implications of decisions about emissions reduction for the country as a whole. This is fundamental for informing the judgements we need to make in preparing advice on the fourth emissions budget, and will be important for the Government to consider when making final decisions.

Setting the level of an emissions budget does not on its own have direct impacts on people. It is the choices made to achieve the budget that determine the impacts that the budget creates. Some of these choices are made by government, others by individuals, businesses, industries or even the international community.

Consideration of impacts means taking into account all the changes that can be expected, both positive and negative, from the actions required to meet an emissions budget. Understanding the likely opportunities and challenges enables us to understand how New Zealanders will be affected by the fourth emissions budget, and if the impacts on the economy, businesses, households and whānau, regions and communities, iwi/Māori, and the environment can be managed in an equitable way.

Assessing the consequences of choices for a future period is challenging, even as an idea. We have built on the process used for our earlier work on the first three emissions budgets, as set out in *Ināia tonu nei*.

Our analysis uses modelling to compare what outcomes need to be achieved (as in our draft EB4 demonstration path) with what is expected to happen given the facts on the ground if things stay as they are (as shown in our reference scenario, which is based on government agency projections from policies as of 1 July 2023). For example, when we look at the savings from electric vehicles, we estimate this by looking at only the number of electric vehicles added in the EB4 demonstration path, beyond the number already included in the reference scenario.

We assessed the potential economic impacts of the proposed fourth emissions budget

We used a range of models and approaches, which provide different perspectives and insights. This is important to do because focusing on a single perspective alone would provide an incomplete picture of the overall outcomes from the EB4 demonstration path and potentially be misleading.

Our work suggests that meeting the fourth emissions budget would result in overall net economic benefits. In other words, the benefits of actions taken in our EB4 demonstration path are likely to exceed the costs.

Our economic modelling shows that the overall impact on the level of activity in the economy would be minor and more than made up for by the economic benefits from action.[iii] Significantly, our work shows that reducing transport fuel use would improve air quality, saving the country on average $2.7 billion a year when compared to the reference scenario. This is the first time we have had the data to be able to quantify those health benefits.

[iii] For the fourth emissions budget period the difference in GDP between proposed budget path and the reference scenario is a reduction in the level of GDP of on average 0.5%, or around $2 billion (2023 prices)

The Crown–Māori relationship, te ao Māori, and specific effects on iwi/Māori

We have considered specific effects for iwi/Māori, as well as wider matters relating to te ao Māori and the Crown–Māori relationship. We found that the large share of iwi/Māori interests in the land sector and the higher proportion of lower income households that include Māori may expose iwi/Māori to greater costs or make the transition harder. This is set out in more detail in *Chapter 5*.

We understand from earlier engagement and consultations, and from our research, that strong climate action is an opportunity to support te ao Māori, mātauranga Māori and for iwi/Māori to provide leadership. This is provided the right resources and solutions are in place. Actual impacts on iwi/Māori – both in terms of opportunities and challenging effects – will depend on the policy choices made by Government. Care will be needed to ensure that action makes the most of these opportunities and does not exacerbate historical inequities.

Choices made about actions to meet the fourth emissions budget also present opportunities and risks for the Crown–Māori relationship. An effective relationship between iwi/Māori and the Crown and private entities is more likely to lead to effective and durable emissions reductions, avoiding unnecessary delays and costs.

The Government has a role in ensuring an equitable transition to low emissions

While many actions to meet the fourth emissions budget will have positive impacts, some actions or changes may be harder to navigate – particularly for certain sectors, communities, some iwi/Māori, and households.

While household electricity bills are unlikely to significantly change, there may be some upward pressure on prices. Lower income households may be less able to switch to more energy-efficient low emissions technology such as electric vehicles, and may be more exposed to any increasing costs without additional support.

For fossil fuel sectors such as coal, mining and gas, the transition to a low emissions economy is expected to result in reduced revenue and opportunities for employment. For agriculture, while reducing emissions in line with meeting our proposed fourth emissions budget is not expected to significantly diminish profit levels, there is expected to be an effect on the growth of revenue. Managing impacts in specific subsectors will likely require changes in operating practices, informed by education and training, as well as support from the Government.

By clearly signalling its transition plans, the Government can help to provide certainty and time for sectors and communities to plan and change. Targeting policies, investment and support to those who will face the greatest relative costs will be important for managing impacts.

We are proposing revisions to keep the first three emissions budgets ambitious and achievable

Part of our work providing advice on setting a new emissions budget includes looking back at the emissions budgets that have already been set, and considering whether any revisions are needed. These reviews help ensure that previously set budgets remain ambitious, and technically and economically achievable over time, and that Aotearoa New Zealand stays on track to meet the 2050 target.

Achieving the fourth emissions budget will depend on actions taken during the first three emissions budgets to reduce emissions, including building renewable energy infrastructure, transitioning to electric vehicles, and improving the productivity of agriculture.

We can, however, only recommend revisions to emissions budgets that are already in place, if there have been changes to the way the country's emissions are calculated and reported, or if significant changes in circumstances have occurred since the budgets were originally set.

Our assessment is that there have been methodological changes and significant changes in circumstance. In response, we are proposing to recommend two changes to the existing emissions budgets.

Our first proposal is to revise the first emissions budget to reflect recent methodological changes to the GHG Inventory. This would reduce that first emissions budget from 290 $MtCO_2e$ to 281 $MtCO_2e$.

We are also proposing a recommendation to revise the second and third emissions budgets. These changes would reflect the methodological changes mentioned above, as well as changes to the rates of forest planting. Our proposals would reduce the second emissions budget from 305 $MtCO_2e$ to 286 $MtCO_2e$, and the third emissions budget from 240 $MtCO_2e$ to 221 $MtCO_2e$.

Rules for measuring progress

Our role advising on emissions budgets includes reviewing the rules that apply for measuring progress towards meeting those budgets and the 2050 target, and considering whether any changes are needed.

We first advised on these accounting rules in *Ināia tonu nei*. When the Government set the first three emissions budgets, it put in place rules that were largely in line with our advice. Under these rules, all emissions produced within Aotearoa New Zealand count towards emissions budgets. The current rules also have a specific way of calculating emissions related to planting and clearing forests.

For this draft advice, we are not proposing any changes to the current accounting rules. However, the Government has indicated it plans to make two changes in its approach to measuring and reporting emissions, which may impact emissions budgets:

- The Government has said it intends to make changes that will allow emissions and removals from pre-1990 forest management activities to be included when calculating Aotearoa New Zealand's emissions.
- It has started work to include new, additional sources of emissions and removals, which are not counted under current accounting rules.

Without careful consideration, these changes could make it possible to achieve set emissions budgets without meaningfully reducing gross emissions. This would impact how effectively these budgets can help Aotearoa New Zealand step down its emissions in line with achieving the 2050 target and contributing to global efforts to limit warming to 1.5°C above pre-industrial levels.

By applying principles of additionality (where removals are only counted if they are 'additional' to the status quo) and permanence (which considers how long that removed emissions can be stored) to accounting rules, the Government can help ensure Aotearoa New Zealand's efforts to reduce emissions are not unintentionally undermined by any changes to how emissions are measured and reported.

We are proposing a recommendation to the Government that it adopt these two principles and include them as criteria when calculating removals. We are also proposing to recommend that the Government develop and implement long-term plans for measuring and monitoring the new sources of emissions and removals, and managing related risks and uncertainties.

Our proposed recommendations

Under the Act, we are required to provide the Government with advice on specific matters related to the fourth emissions budget.

This section outlines what we are proposing to recommend to the Government at the end of this year. We are seeking your feedback on these proposals to inform our final recommendations.

Proposed Recommendation 1 – Proposed budget level	
We propose that the Government set the fourth emissions budget (2036–2040) at:	134 $MtCO_2e$ (total, AR5) 26.8 $MtCO_2e$ (annual average, AR5)

Proposed Recommendation 2 – Breakdown of the fourth emissions budget		
We propose that, to meet the fourth emissions budget (2036–2040), the Government implement policies that result in a balance of emissions and removals as outlined in the table* below:		
Total net emissions Annual average		134 $MtCO_2e$ 26.8 $MtCO_2e$
Total carbon dioxide removals Annual average		119 $MtCO_2e$ 23.7 $MtCO_2e$
Emissions – all greenhouse gases, except biogenic methane Gross greenhouse gases	Carbon dioxide Nitrous oxide F-gases Non-biogenic methane	79 $MtCO_2e$ 30 $MtCO_2e$ 3 $MtCO_2e$ 2 $MtCO_2e$
Emissions – biogenic methane Gross biogenic methane		4.97 $MtCH_4$

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

Proposed Recommendation 3 – Reductions by greenhouse gas to meet the emissions budget

We propose that, to meet the fourth emissions budget, the Government implement policies that deliver emissions reductions of each greenhouse gas as outlined in the table* below:

	2021	Fourth emissions budget (2036–2040)
Total net emissions ($MtCO_2e$/yr) Annual average Reduction from 2021	73.3 $MtCO_2e$	 26.8 $MtCO_2e$ 46.5 $MtCO_2e$
Total gross emissions ($MtCO_2e$/yr) Annual average Reduction from 2021	80.3 $MtCO_2e$	 50.6 $MtCO_2e$ 29.8 $MtCO_2e$
Broken down by:		
Carbon dioxide ($MtCO_2e$/yr) Annual average Reduction from 2021	34.7 $MtCO_2e$	 15.8 $MtCO_2e$ 18.9 $MtCO_2e$
Nitrous oxide ($MtCO_2e$/yr) Annual average Reduction from 2021	7.1 $MtCO_2e$	 6.0 $MtCO_2e$ 1.1 $MtCO_2e$
F-gases ($MtCO_2e$/yr) Annual average Reduction from 2021	1.5 $MtCO_2e$	 0.6 $MtCO_2e$ 0.8 $MtCO_2e$
Non-biogenic methane ($MtCO_2e$/yr) Annual average Reduction from 2021	0.8 $MtCO_2e$	 0.3 $MtCO_2e$ 0.5 $MtCO_2e$
Biogenic methane ($MtCH_4$/yr) Annual average Reduction from 2021	1.30 $MtCH_4$	 0.99 $MtCH_4$ 0.30 $MtCH_4$

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

Proposed Recommendation 4 – Limit on offshore mitigation for the fourth emissions budget and circumstances justifying its use

We propose that, to meet the fourth emissions budget (2036–2040), the Government:

a. limit offshore mitigation for the fourth emissions budget to 0.0 $MtCO_2e$
b. only use offshore mitigation as a last resort in exceptional circumstances beyond the Government's control, such as force majeure events, where domestic measures cannot compensate for emissions impacts.

Proposed Recommendation 5 – Revisions to the set emissions budgets

We propose that the Government revise the first, second and third emissions budgets as outlined in the table* below:

	Emissions Budget 1 (2022–2025)	**Emissions Budget 2 (2026–2030)**	**Emissions Budget 3 (2031–2035)**
Notified budgets (total net emissions)	290 $MtCO_2e$	305 $MtCO_2e$	240 $MtCO_2e$
Difference due to methodological changes	-9 $MtCO_2e$	-8 $MtCO_2e$	-7 $MtCO_2e$
Difference due to significant changes	0 $MtCO_2e$	-11 $MtCO_2e$	-12 $MtCO_2e$
Recommended budgets (total net emissions)	281 $MtCO_2e$	286 $MtCO_2e$	221 $MtCO_2e$
Annual average	70.3 $MtCO_2e$/yr	57.2 $MtCO_2e$/yr	44.2 $MtCO_2e$/yr

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

Proposed Recommendation 6 – Rules to measure progress

We propose that as the Government considers whether to include any new sources of emissions or carbon dioxide removals in its accounting for emissions budgets, it:

a. adopts the principles of additionality and permanence (durability) and includes them as criteria for any carbon removal activities, along with other key characteristics including removal capacity, measurability cost, and acceptability
b. develops and implements a long-term plan for measuring and monitoring additional sources, sinks, and changes in management activities, including how the plan will be funded
c. develops and implements a plan for how the Government will manage accuracy and uncertainty risks, limiting the risk that over- or under-estimation will impact long-term emissions trajectories and associated emissions reduction efforts.

CHAPTER 1

Introduction

This chapter introduces emissions budgets, and the approach we are taking in preparing draft advice on the fourth emissions budget.

In the face of the sharpening climate change challenge, the world is intensifying efforts to reduce greenhouse gas emissions (GHG) in ways that will sustain and keep their communities safe. Aotearoa New Zealand has committed to this global response and is building its own transition to a thriving, low emissions economy.

This transition can support people, businesses and communities in Aotearoa New Zealand to respond to the opportunities opening up in a global low emissions economy, while building the resilience the country needs to adapt to the climate impacts already felt across the motu.

This draft advice focuses on the next step the country needs to take in navigating that transition – setting the fourth emissions budget for 2036 to 2040, on the country's path towards the 2050 emissions reduction target.

Emissions budgets are important tools used to set limits on the amount of greenhouse gases that can be emitted over a specific time period. They act as stepping stones, guiding Aotearoa New Zealand's emissions reduction path in an ambitious, achievable and measurable way.

In 2022, the Government published Aotearoa New Zealand's first emissions budget (2022–2025), the second emissions budget (2026–2030), and the third emissions budget (2031–2035).

Under the Climate Change Response Act 2002 (the Act), He Pou a Rangi Climate Change Commission (the Commission) must provide the Government with advice on setting Aotearoa New Zealand's fourth emissions budget (2036–2040) by the end of 2024. As part of this work, we may also advise on whether the first, second and third emissions budgets should be revised.

This draft advice outlines the approach we have taken and shares what we are proposing to recommend. We are asking for your feedback on our approach and our proposed advice.

Our consultation aims to ensure that our advice is effective, practical and relevant, and that it is informed by the different needs, perspectives and concerns of people from across the motu. For more information on this consultation, including how this work connects to two other related but separate pieces of work we are consulting on at the same time, see the *Foreword*.

The following pages set out how emissions budgets work, how we have approached our work to advise on the country's fourth emissions budget, and how this document is organised – including the kind of feedback we are asking for at different points.

About emissions budgets

Emissions budgets represent the total allowable net emissions of greenhouse gases across a five-year period, known as a budget period.[iv]

The Act requires three emissions budgets to be in place at all times – one for the current period, and two further budgets covering the following two consecutive budget periods. This gives households, businesses and communities a view of Aotearoa New Zealand's emissions reduction path at least 10 years into the future, providing them with information they need to make important planning and investment decisions.

Because emissions budgets are set as a net volume of emissions, they can be met through a combination of actions, including:

- reducing gross emissions (reducing emissions at their source)
- removing carbon dioxide from the atmosphere (through growing trees)
- in limited circumstances, using offshore mitigation (when Aotearoa New Zealand pays for emissions reductions or removals that occur overseas).

Emissions budgets act as stepping stones to achieving the 2050 target

As set by the Act, the 2050 target represents Aotearoa New Zealand's domestic contribution to the global effort to limit warming to 1.5°C above pre-industrial levels. Emissions budgets must be set in line with meeting the 2050 target.

Aotearoa New Zealand has a 'split gas' target for domestic emissions, which considers biogenic methane separately from all other greenhouse gases. This reflects the different impact that methane (short-lived) has compared with other (long-lived) greenhouse gases, such as carbon dioxide.

The first component is to reduce emissions of greenhouse gases (other than biogenic methane) to **net zero** or lower, by 2050 and beyond. 'Net' zero means that the Government can decide how to get to the target via a combination of *gross reductions* (fewer greenhouse gas emissions) and *removals* (capturing carbon dioxide by natural or artificial means).

The other two components are focused on lowering **biogenic methane** emissions by:

- at least 10% below 2017 levels, by 2030.
- 24–47% below 2017 levels, by 2050 and beyond.

These two components are both gross targets rather than net targets. This means efforts need to be focused on reducing the amount of biogenic methane added to the atmosphere.

The Government is responsible for setting emissions budgets and ensuring they are met

While the Commission is responsible for providing the Government with advice on the level of each emissions budget, the Government is ultimately responsible for setting budgets and ensuring they are met.

Under the Act, the Government must produce emissions reduction plans that set out the strategies and policies for meeting each budget period.

[iv] The first budget covered a four-year period from 2022–2025

The Government released their first emissions reduction plan in 2022. This plan covered the first budget period (2022–2025). The second emissions reduction plan covering the second budget period (2026–2030) is due to be published before the end of 2024.

The Act also sets out processes to monitor and report progress on meeting emissions budgets, to ensure Aotearoa New Zealand is on track to meeting the 2050 target. The Commission is due to publish the first annual progress report in 2024, and the first end of budget report before the end of 2027. These reports will be important for determining advice on future emissions budgets.

The New Zealand Greenhouse Gas Inventory is a key source of data used for informing our advice on emissions budgets

Aotearoa New Zealand's Greenhouse Gas Inventory (GHG Inventory) is produced annually and is the key source of evidence on Aotearoa New Zealand's emissions. These data sources are used for international reporting as part of New Zealand's obligations under the United Nations Framework Convention on Climate Change (UNFCCC). The GHG Inventory is also used domestically to inform policy development and to measure progress against emissions budgets and the 2050 target.[2]

International reporting guidelines govern what the GHG Inventory covers and when it is submitted. This is why the GHG Inventory is 15 months behind the current calendar year. The latest GHG Inventory data was published in April 2023 and contains data from 1990–2021. The next GHG Inventory is due to be published in April 2024 and will contain data from 1990–2022.

Each year when the GHG Inventory is produced, it may include improvements to reflect latest scientific knowledge or improvements to how emissions data are assessed. When the methodology or underlying data changes, the whole inventory time series from the base year to the latest year is recalculated.

Emissions budgets support meeting Aotearoa New Zealand's international emissions reduction commitments

Under the Paris Agreement, every five years participating countries submit an updated nationally determined contribution (NDC) to the UNFCCC. NDCs represent the part each country is committing to play to reduce emissions and adapt to the impacts of climate change and must reflect the country's highest possible ambition.

In 2021, the Government updated Aotearoa New Zealand's NDC, which is now to reduce net emissions by 50% below gross 2005 levels by 2030. The expectation is that this target will be met through a combination of domestic actions to reduce emissions and carbon removals by forests. NDCs can also be met through offshore mitigation, which is when Aotearoa New Zealand pays for emissions reductions or removals that occur offshore.

The more Aotearoa New Zealand does to reduce emissions domestically through its emissions budgets – the less it will need to pay in offshore mitigation.

Our approach to developing this draft advice

The Commission's approach to this draft advice has drawn extensively on the approach and process developed when the Commission advised on the first three emissions budgets in *Ināia tonu nei*.

As an independent Crown entity, we base our advice on research, evidence and modelling, and draw on the expertise of our Board of Commissioners, He Pou Herenga (a Māori advisory body to the Board), and staff. In preparing this draft advice on the fourth emissions budget, we have examined the latest publicly available data on the country's emissions profile and the scientific evidence about options for reducing emissions. We are informed by evidence and insights gathered by engaging with people on the ground. This is built into our modelling approach.

Our draft advice on emissions budgets

The Act sets out specific requirements for what should be contained in our advice on emissions budgets. These requirements help to ensure the Government has all the information it needs to make a decision on an emissions budget, to ensure the emissions budgets it sets are consistent with meeting the 2050 target.

This includes:

- the recommended quantity of emissions that will be permitted in each emissions budget period (in this case, the first, second, third and fourth emissions budgets)
- the rules that will apply for measuring progress towards meeting emissions budgets and the 2050 target
- how the emissions budgets, and ultimately the 2050 target, may realistically be met, including through pricing and policy methods
- the proportions of an emissions budget that will be met by domestic action to reduce emissions compared to the amount of carbon dioxide removals by forests
- the amount by which emissions of each greenhouse gas should be reduced to meet the emissions budgets and 2050 target
- the appropriate limit on offshore mitigation that may be used to meet an emissions budget, and an explanation of the circumstances that justify its use.

We may also give advice on recommended revisions to the emissions budgets that are already in place, if there have been changes to the way emissions are calculated and reported in the GHG Inventory, or if significant changes in circumstances have occurred since the budgets were originally set.

This report contains our draft advice on the matters above, including our proposed recommendations.

Matters we considered in developing this advice

The Act sets out a range of matters the Commission must consider when we develop advice on emissions budgets. Consideration of these matters is fundamental for informing key judgements we need to make in our advice on emissions budgets.

What the Act requires of us, the outcomes we are seeking and the key judgements we make were set out in *Ināia tonu nei* and are shown below in **Figure 1.1**.

Figure 1.1: *What the Act requires of us, the outcomes we are seeking and our judgements in budgets*

Source: Figure 5.1 in *Ināia tonu nei* (p.63)

Our analytical approach

Our work utilises the latest scientific evidence and insights gained through engagement

In preparing this advice, we have used the latest publicly available information from the GHG Inventory and government projections to ensure our advice accurately reflects Aotearoa New Zealand's emissions profile and latest methodologies used to report and calculate emissions.

We have undertaken research to understand the latest scientific evidence on opportunities and costs of different actions that could support Aotearoa New Zealand's transition, such as agricultural mitigation technologies and impacts on air quality.

We have engaged with a variety of stakeholders, including through our call for evidence in 2023 (see **Box 1.1**), to understand the broader context around some of the actions that we are assessing, gain insights into latest trends, and test our assumptions. Through public consultation, we aim to further improve our evidence base.

Before finalising our advice to Government at the end of the year, we will update our evidence base to reflect any changes in circumstances, updates to the GHG Inventory and government projections – as well as incorporating the feedback we hear from New Zealanders.

Box 1.1: What we heard in the call for evidence

- There were 26 respondents in total across the three projects we are currently consulting on, including the international shipping and aviation review and the 2050 target review. 14 respondents provided evidence or information relating to the fourth emissions budget advice.
- A mix of individuals and organisations provided a range of evidence and perspectives on the potential for biogas integration, and for emissions reduction potential for industry and energy through options such as carbon capture and storage, green hydrogen, electricity grid management and storage, and cement and concrete production, as well as options for decarbonising rail.
- We have considered and reflected the evidence, perspectives and discussions where appropriate in our analysis.

Our models are tested and improved over time

Our emissions budgets are informed by evidence from economic models (refer to **Box 1.2**). These models have been developed by internationally renowned experts and were reviewed by experts from Aotearoa New Zealand and around the world, during the course of giving advice on the first three emissions budgets in 2021.[v]

Box 1.2: Our advice draws on economic modelling

Using models is helpful to ensure consistent assumptions are applied across sectors, and that the interactions between actions are captured. The primary models we have used are:

ENZ (Energy and Emissions in New Zealand): an economy-wide model that covers all the main emitting sectors in Aotearoa – energy, industry, transport, agriculture, forestry, product use and waste. ENZ captures the major interactions within the energy system and between different sectors.

C-PLAN (Climate Policy Analysis): a global Computable General Equilibrium (CGE) model that takes data on the interactions between various economic actors and introduces a change to understand how the structure of the economy is affected.

ENZ gives the scale of emissions reductions that are achievable in each sector, by factoring in specific technologies and options to reduce emissions. The C-PLAN model allows us to understand the overall impact of our recommended emissions budgets on GDP, including how different sectors could expand and contract.

In *Ināia tonu nei* our impact analysis drew on the DIM-E model to understand effects on employment across sectors, regions, demographic groups and socioeconomic groups. We have not repeated this analysis for the fourth emissions budget as we expect changes in patterns of employment to be similar to what was estimated in our 2021 advice. Instead we have focused our analysis on areas that have changed.

Further details on these models and results can be found in *Ināia tonu nei* and *Technical Annex – Modelling and analysis to support the draft advice on Aotearoa New Zealand's fourth emissions budget*.

Since *Ināia tonu nei* and through engagement with the sector we have had the opportunity to further refine our approach to modelling for this draft advice. This has included:

- updating our assumptions to include new evidence and data
- updating and improving our models to include new features to support integrating new evidence
- making our models more robust by improving the way our models interact across different assumptions (such as in the aviation sector we now have more integrated and detailed information)
- having these updates reviewed by the experts who developed these models.

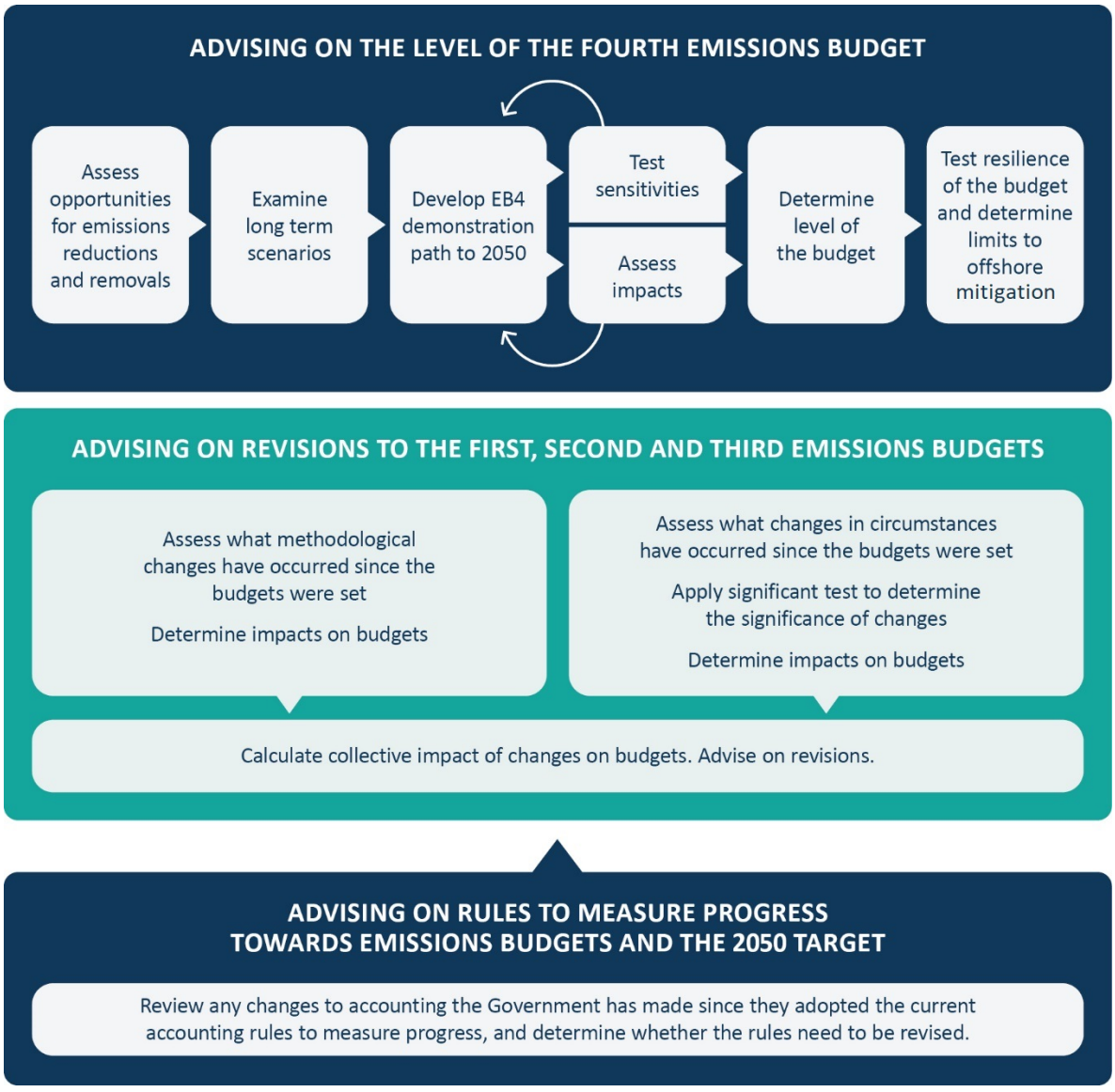
Through public consultation, we are seeking to test our modelling approach and assumptions and will further refine our modelling for our final advice. More detail on our models and underlying assumptions can be found in the *Assumptions Log.*

[v] More information on the expert reviews of our models can be found here: https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/modelling/

Our process for developing this draft advice

Ināia tonu nei set strong foundations for a robust process to determining emissions budgets. Our draft advice on the fourth emissions budget builds on this process, including a new stage of work on assessing revisions to existing budgets. This is shown at a high level in **Figure 1.2** and explained further below.

Figure 1.2: *High level illustration of the process for developing our advice*



Source: Commission analysis

Advising on the level of the fourth emissions budget

We carried out detailed assessments of the opportunities to reduce and remove emissions in each sector, using the latest scientific evidence and insights learned through engagement. These opportunities included systems changes (behaviour or practice changes), and existing and anticipated technologies. For example, a systems change could be using public transport or walking or cycling rather than driving. The assessment included analysing the options considered in *Ināia tonu nei* as well as new options based on information or evidence that has come to light since *Ināia tonu nei*.

We used scenario modelling to understand what types of actions and what budget levels could get Aotearoa New Zealand to the 2050 target. We did this because there are several pathways that Aotearoa New Zealand could take. Scenarios and pathways are different from forecasts and predictions which might be useful in the short term but will be wrong as we consider impacts that we know are coming and will affect our ability to reduce emissions or adapt to the impacts.

We used evidence gained through our assessment of emissions reductions and removals and insights from our scenario analysis to develop a projected path to 2050 for Aotearoa New Zealand (EB4 demonstration path). This involved applying our expert judgement, with consideration to all the matters specified under the Act, to determine what the best course of actions could be. This was an iterative process where we considered the principal uncertainties of different actions through sensitivity analysis and the impacts as required by the Act, as we developed the path.

From the EB4 demonstration path we were able to determine the proposed budget level for the fourth emissions budget. We tested that this proposed budget was resilient to future uncertainties by developing alternative paths which explored scenarios where technology and system change didn't happen at the same speed, or scale, as in the EB4 demonstration path.

Advising on revisions to the first three emissions budgets

We developed a process for assessing the impacts of methodological changes and significant changes. This was to understand what changes have occurred since the budgets were originally set, in order to ensure integrity of the ambition of those budgets. Developing a robust approach to assessing these changes is important for ensuring this can be consistently applied in the future. More detail on this process can be found in *Chapter 6: Proposed changes to the first, second, and third emissions budgets.*

Advising on the rules to measure progress towards emissions budgets and the 2050 target

We looked at whether the Government has updated their approach to accounting since our previous advice in *Ināia tonu nei* to understand whether changes are needed to the rules to measure progress towards emissions budget and the 2050 target. More detail on this process can be found in *Chapter 7: Measuring progress towards emissions budgets and the 2050 target.*

How we have structured our draft advice

This draft advice is structured by chapters; these chapters reflect the analysis we have undertaken to fulfil our statutory obligations under the Act and support readers to provide submissions.

Context setting	
Chapter 1: Introduction	This chapter provides context, explaining what emissions budgets are and our task for this draft advice. It sets out our analytical approach and describes the high-level process for how we have developed our draft advice.
Advising on the level of the fourth emissions budget	
Chapter 2: The proposed level of the fourth emissions budget	This chapter sets out our proposed budget level for the fourth emissions budget (2036–2040) and our analysis that supports this recommendation. This includes matters we have considered in determining the proposed budget, how we have tested the resiliency of the budget, limits to offshore mitigation, and information on likely actions needed to meet the fourth emissions budget. **We are seeking your feedback on our assessment of considerations that have informed our proposed budget level.**
Chapter 3: Developing the path to the fourth emissions budget	This chapter provides an overview of how we developed the path to the fourth emissions budget, including key insights from our analysis. It covers the current trajectory for emissions in Aotearoa New Zealand, our assessment of opportunities to reduce and remove emissions, our long-term scenarios out to 2050 and beyond, and our EB4 demonstration path. **We are seeking your feedback on our overall approach to developing advice on the fourth emissions budget.**
Chapter 4: Sector contributions to meeting the fourth emissions budget	This chapter describes what changes happen across Aotearoa New Zealand in the EB4 demonstration path. It explains what evidence or key judgements were made in determining the assumptions that underpin these changes. **We are seeking your feedback on whether the changes we assume across sectors are plausible and achievable, and whether there is any additional evidence or insights that could contribute to our analysis.**
Chapter 5: The impacts of meeting the fourth emissions budget on New Zealanders	This chapter shows the potential opportunities and challenges for Aotearoa New Zealand under the EB4 demonstration path. **We are seeking your feedback on our assessment of the impacts, and whether there is any additional evidence we should be considering.**
Advising on revisions to the first three emissions budgets	
Chapter 6: Proposed changes to the first, second and third emissions udgets	This chapter contains our analysis and recommendations for revising emissions budgets that have been set. It lays out the rationale for these changes based on the requirements under the Act. **We are seeking your feedback on our approach to assessing changes and how we have applied that approach.**
Advising on rules to measure progress	
Chapter 7: Measuring progress towards emissions budgets and the 2050 target	This chapter looks at the accounting rules the Government has adopted to measure progress against meeting emissions budgets and the 2050 target. **We are seeking your feedback on our assessment of the rules, and any other considerations we should we be taking into account.**

CHAPTER 2

Proposed level for the fourth emissions budget

The fourth emissions budget represents Aotearoa New Zealand's next step in the transition to a thriving, low emissions economy and towards achieving the 2050 emissions reduction target.

Emissions budgets signal the pace and scale of change required across the country to reach the 2050 target. It is important they are set at a level that is economically and technically achievable. Our proposed recommendation for the level of the fourth emissions budget is 134 $MtCO_2e$. This means emissions will be 63% lower across the budget period than 2021.

The Government has choices in how it meets the proposed fourth emissions budget. These choices involve decisions around the mix of actions and policies to reduce emissions, and how much forestry will play a role to remove carbon from the atmosphere. These choices matter, as each decision will have benefits and consequences.

The Climate Change Response Act 2002 (the Act) sets out specific requirements for how the Commission advises the Government on emissions budgets. This includes providing recommendations on the level of the emissions budget, and how much should be met by gross emissions reduction and how much can be contributed through removal of greenhouse gases (such as carbon dioxide absorption in forests). It also requires levels to be specified for different kinds of greenhouse gases in the budget, and an outline of the likely actions needed to meet the budget.

We are required to look at a broad range of matters as we develop a proposed emissions budget. This includes how the country can realistically meet our proposed fourth emissions budget, the Crown–Māori relationship, te ao Māori, and specific effects on iwi/Māori, and the likely impacts on the economy, society, the environment, and future generations (see *Chapter 1*, under *Matters we considered in developing this advice*).

This advice when finalised will provide the Government with the basis to decide on a fourth emissions budget level, which will determine the trajectory of Aotearoa New Zealand's emissions reductions out to 2050 and beyond. It will also set a path for decisions that need to be made about how the emissions budget can be achieved through specific policies and actions – which will be set out by Government in the emissions reduction plan for that period.

Our analysis shows there are opportunities to reduce gross emissions on the path towards the fourth emissions budget that would bring a wide range of benefits for Aotearoa New Zealand. Analysis also shows that higher than projected rates of forestry planting in the last couple of years mean that less afforestation would be needed in the future to reach the net zero component of our 2050 target.

Achieving the fourth emissions budget this way would allow the country to reduce emissions in line with meeting the 2050 target, while accessing a range of opportunities and benefits for the economy, society, the environment and future generations. It would give Aotearoa New Zealand flexibility to respond to new information about the viability of different emissions reduction technologies and opportunities.

This chapter provides our draft advice and proposed recommendations for setting the fourth emissions budget. It outlines the matters we have considered, and how they have factored into determining this advice, including the key judgements we have made.

We are seeking your feedback

In this chapter we are seeking your feedback on our draft proposals on the fourth emissions budget. In particular, we want to know:

- Do you agree with our assessment of the considerations that have informed our proposed budget level, including key judgements? If not, why not?
- Are you aware of any further evidence that the Commission should consider in making its assessment of feasibility, cost, and implications of potential abatement options in the fourth emissions budget period?

What the Act requires for our advice

As detailed in *Chapter 1: Introduction*, the Act sets out the requirements for our advice on emissions budgets, including areas for the Commission to advise on and matters for the Commission to consider or have regard to. Our advice is framed to address these requirements of the Act, including our recommendations to Government, and has supporting analysis in all the chapters in this draft advice.

In addition to proposing a recommended emissions budget level, the Commission must also advise on:

- the proportion of the emissions budget that will be met by domestic emissions reductions and removals, and the amount each greenhouse gas should be reduced
- the appropriate limit on offshore mitigation that can be used to meet the emissions budget, including an explanation of the circumstances justifying its use
- how the emissions budget, and ultimately the 2050 target, may realistically be met, including pricing and policy methods.

Box 2.1 below provides further details on the 2050 target, and how the Act requires the Commission to advise on our proposed emissions budgets.

Box 2.1: The 2050 target and the Commission's usage of global warming potential values for emissions budgets

As stipulated in the Act, Aotearoa New Zealand has a 'split gas' target for domestic emissions. Our 2050 target considers biogenic methane (from livestock and waste) separately from all other greenhouse gases by identifying specific gross reduction goals for biogenic methane emissions.

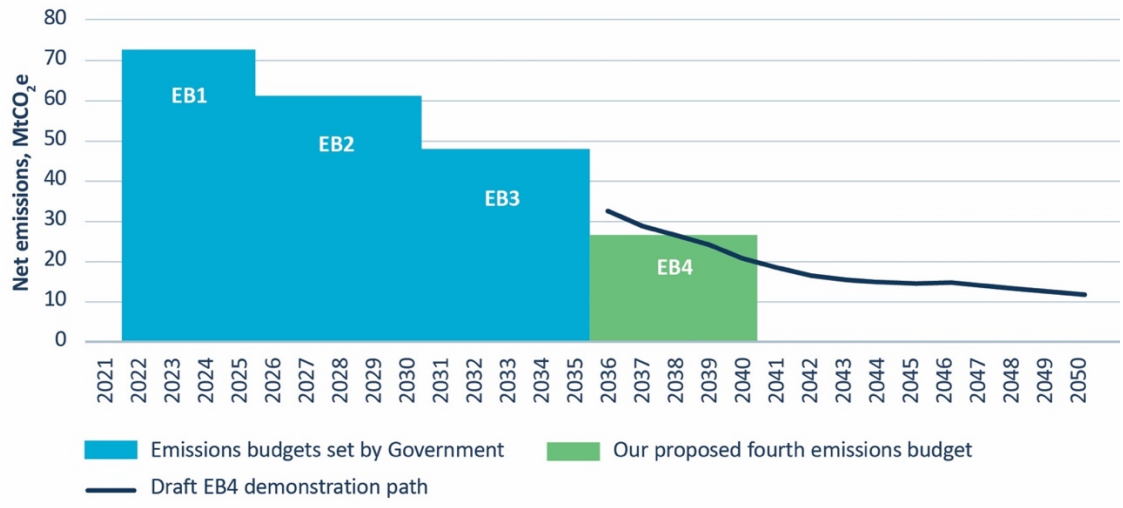
While Aotearoa New Zealand has a 'split gas' target, the Act requires the Commission to recommend emissions budgets that are a total quantity of emissions for all greenhouse gases, in terms of the equivalent volume of carbon dioxide. Our recommendations use the global warming potential (GWP) values that are reported by the Intergovernmental Panel on Climate Change (IPCC). This ensures consistency with the methods agreed to by the Conference of Parties to the United Nations Framework Convention on Climate Change under the Paris Agreement. At present, this means the Commission must apply the IPCC's Fifth Assessment Report (AR5 methodology) which uses GWP_{100} values.[3]

Our proposed level for the fourth emissions budget

We are proposing a fourth emissions budget of 134 $MtCO_2e$, which means emissions will be 63% lower across the budget period than 2021. **Figure 2.1** below shows the relationship between the first, second and third emissions budgets and the fourth emissions budget.[4] This draft recommendation reflects our initial judgements of what decisions will balance ambition and achievability, provide flexibility for the future, and offer lasting economic, societal and environmental benefits that will likely exceed overall costs.

Details on the fourth emissions budget demonstration path (the EB4 demonstration path) underpinning this budget level can be found in *Chapter 3: Developing the pathway to the fourth emissions budget* and *Chapter 4: Sector contributions to meeting the fourth emissions budget,* and *Chapter 5: The impacts of meeting the fourth emissions budget on New Zealanders.*

Figure 2.1: *Our draft fourth emissions budget alongside our draft EB4 demonstration path to 2050 and current budgets set by Government, net emissions of all greenhouse gases (using AR5 metrics for conversion)*

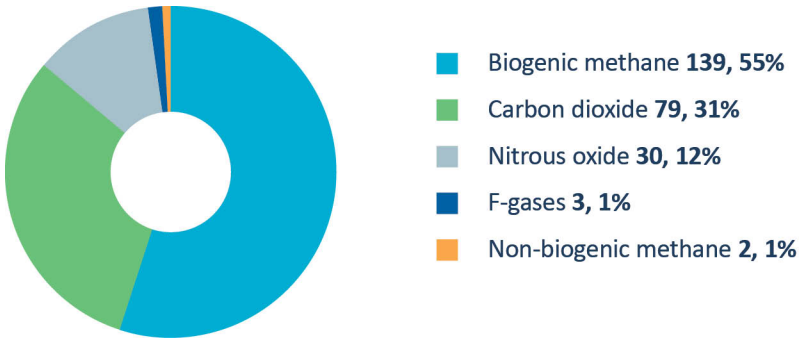


Source: Commission analysis

Breakdown of gross emissions by gas

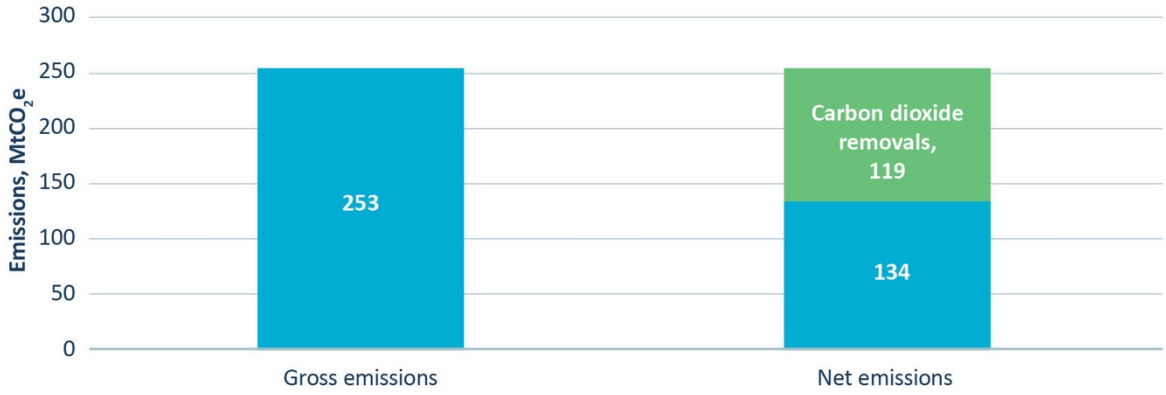
In terms of a breakdown of gross emissions of all greenhouse gases in the draft fourth emissions budget, biogenic methane contributes to 55% of these emissions, followed by carbon dioxide (31%), nitrous oxide (12%), fluorinated gases (F gases) (1%) and non-biogenic methane (1%) (**Figure 2.2**). Carbon dioxide removals by forests will balance out approximately 47% of total gross emissions (**Figure 2.3**).

Figure 2.2: *Breakdown of gross emissions in our draft fourth emissions budget by greenhouse gas (in $MtCO_2e$, AR5)*



Source: Commission analysis

Figure 2.3: *Comparing gross emissions and net emissions in our draft fourth emissions budget (in $MtCO_2e$, AR5)*

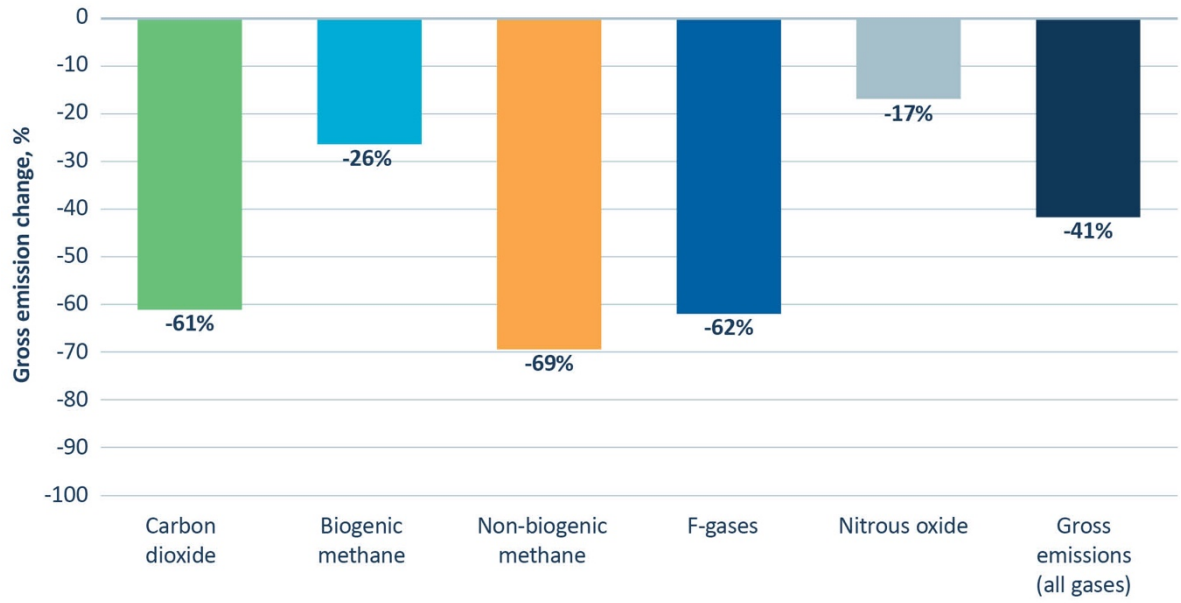


Source: Commission analysis

Reductions in gross emissions and level of removals by 2040

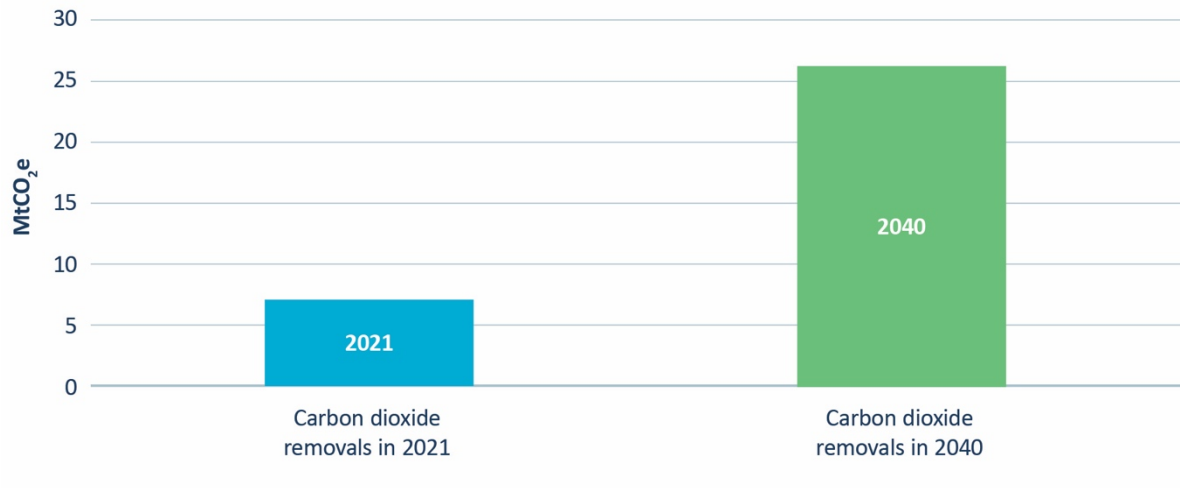
When comparing expected emissions in 2040 (the end of the fourth emissions budget period) to actual emissions in 2021[5], gross emissions of all greenhouse gases will reduce by 41% (**Figure 2.4**) while carbon dioxide removals by forests will increase from 7 $MtCO_2e$ to 26 $MtCO_2e$ (**Figure 2.5**). Reductions in carbon dioxide (61%) and biogenic methane (26%) will contribute most to overall reductions in gross emissions in 2040.

Figure 2.4: *Changes in gross emissions by greenhouse gas by 2040 under the EB4 demonstration path, relative to 2021*



Source: Commission analysis

Figure 2.5: *Comparing carbon dioxide removals by forests under the EB4 demonstration path in 2040, compared with 2021*



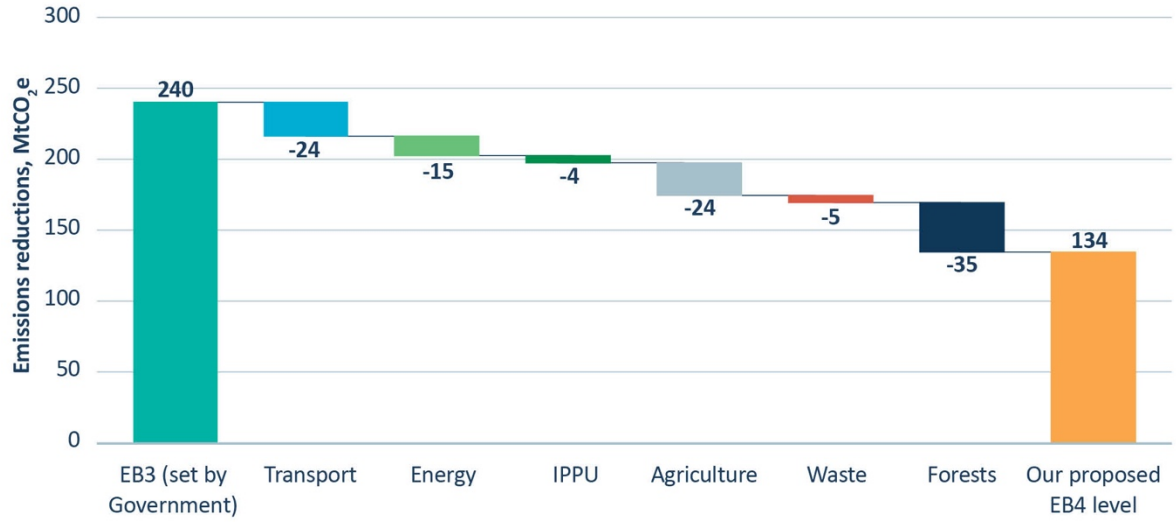
Source: Commission analysis

Sector contributions to emissions reductions for our proposed budget

Comparing our proposed fourth emissions budget level to the third emissions budget as set by Government[vi], the largest reductions in gross emissions come from transport (24 $MtCO_2e$), agriculture (24 $MtCO_2e$) and energy (15 $MtCO_2e$) sectors.

In terms of reductions by percentage of total emissions, the transport (46%) and industrial processes and product use (IPPU, 28%) sectors' gross emissions will reduce by the largest percentage. The forestry sector will increase carbon dioxide removals by 41%, with afforestation of exotic trees peaking in 2023. Native afforestation peaks in 2031 and then plateaus to 2050. Reductions across sectors are summarised in **Figure 2.6** below. Details on specific sector activities in the EB4 demonstration path will be covered in *Chapter 4: Sector contributions to meeting the fourth emissions budget*.

Figure 2.6: *Emissions reductions by sector for meeting our proposed level for the fourth emissions budget*[vii]



Sources: the third emissions budget notified by Government, Commission analysis from our advice on the second emissions reduction plan and our advice for the fourth emissions budget

[vi] This analysis draws on our 2022 update to our demonstration path as this aligns to the emissions budgets set by Government. The demonstration path was updated as part of our advice on the second emissions reduction plan.

[vii] In this advice we have included F-gases as part of industrial processes and product use (IPPU)

The considerations that inform our proposed budget level

Under the Act, there is a wide range of matters we need to consider as part of our functions, including matters specific to advising on emissions budgets. These are outlined in *Chapter 1: Introduction*. We have summarised below how we have considered these matters and how they have informed our draft advice.

Latest information and trends on greenhouse gas emissions and removals

We have reviewed and updated our analysis to include the latest information on greenhouse gas emissions. The most significant changes were:

- Data released in the Government's Afforestation and Deforestation Intentions Survey 2022[6] shows the actual planting rates for forests between 2020 and 2022, and anticipated for 2023, have been much higher than previously projected. The higher levels of afforestation in these years mean lower net emissions for future budgets than what was projected in our previous analysis, noting feedback from the sector suggests lower levels of planting in the immediate future.[viii]
- Improvements made to the methods for calculating and reporting emissions through the GHG Inventory[7] have resulted in overall lower historical emissions reported and projected.
- Announcements on the introduction of electric arc furnace for steel (at 50% of production).
- Early closure for the Marsden Point refinery.
- Aluminium smelter no longer expected to close before 2040.
- Faster short-term growth in electric vehicle (EV) uptake and slower growth projected in vehicle kilometres travelled (VKT) to 2030.

On balance, these changes mean further reductions in gross and net emissions are possible for Aotearoa New Zealand than projected in our previous analysis.

New opportunities for emissions reductions and removals

We reviewed current evidence, alongside insights gained from engaging with sector stakeholders, to ensure we used the latest available information to understand what is possible and desirable for the fourth emissions budget. This included reviewing assumptions from mitigations considered in our previous advice, as well as potential new mitigations. Our analysis has considered abatement potential for mitigations alongside expected costs.

New evidence, including feedback from sector stakeholders, suggests further opportunities to reduce gross and net emissions of all greenhouse gases other than biogenic methane. These include information that supports the potential to increase the proportion of steel produced by the electric arc furnace process from 50% to 75% by 2040, and new technology to provide carbon capture and storage for some geothermal.

[viii] Feedback from stakeholders suggests afforestation in the short term will be at lower levels than the past few years, citing current policy uncertainty and other unfavourable conditions.

A key judgement was made on how to incorporate the effect of new biogenic methane technologies when recommending the budget level

We also have evidence[ix] suggesting further reductions in biogenic methane could be feasible by the fourth budget period, primarily through adoption of new methane reducing technologies in agriculture. The potential technologies include methane vaccines, inhibitors and adoption of breeding for low-methane animals.

Methane inhibitors are already proven, but current inhibitors are less suitable for Aotearoa New Zealand's pasture-based systems.[x] The research we have commissioned suggests that methane vaccines for sheep, cattle and dairy cows and low-methane breeding for dairy cows and cattle are expected to become available in the future. As some of these technologies are expected to be ready for deployment in the fourth emissions budget period, we have included the effect of their adoption in arriving at our advice on the draft fourth emissions budget level.

While our evidence suggests that methane-reducing technologies are expected to be available, their timing, cost and effectiveness are still uncertain. We have accounted for this in the design of our EB4 demonstration path. In the event some of these technologies are not available, our assumption is that those that are available can still achieve the level of reductions in biogenic methane required to achieve our proposed budget.

See *Chapter 4* for more details on these new technologies in our EB4 demonstration path.

The role of gross emissions reductions in the fourth emissions budget

In our previous advice on budgets and the emissions reduction plans to meet them, the Commission has consistently advised that pathways to meeting the 2050 target which focus on reducing gross emissions are needed to transition Aotearoa New Zealand to an inclusive and low emissions economy.

While there will be an important role for forests to help meet the 2050 target, achieving and maintaining net zero emissions of all greenhouse gases (except biogenic methane) beyond 2050 will require gross emissions reductions. Gross emissions reductions provide effectively permanent reductions in the level of emissions, while removals of carbon dioxide from the atmosphere by forests only reduce the level of emissions while the trees are growing.

Reducing gross emissions often provides broader positive benefits to society – such as improved air quality,[8] warmer heathier homes,[9] health benefits from active transport, jobs in new and innovative sectors,[10] and a more timely transition to a low emissions economy, which would not be achieved through simply increasing removals by forests.

For this advice we have also considered the risks and uncertainties associated with different pathways to meet the 2050 target. We found if the country meets its net zero component of the 2050 target by achieving more gross emissions reductions on top of higher removals by forests – this will reduce the need to continue to add to the amount of carbon dioxide stored in forests. This approach will also result in lower residual emissions in the future, meaning it can help mitigate impacts of future damage and disturbances to forests. Additionally, this approach gives greater certainty in maintaining net zero emissions of all greenhouse gases (except biogenic methane) beyond 2050 and allows flexibility for future changes in accounting methodologies.

[ix] We commissioned analysis from The Agribusiness Group on abatement opportunities for agriculture for the fourth emissions budget. We are publishing this as supporting evidence for our advice.

[x] 3-nitrooxypropanol (3-NOP) is currently proven and is expected to be available for use soon. However, it is not well suited for Aotearoa New Zealand's pasture-based dairy systems. A slow-release bolus for 3-NOP is in development may be better suited to pasture-based systems.

The expected economic impacts of meeting the fourth emissions budget

We have assessed the likely impacts – both positive and negative – from meeting the fourth emissions budget on our economy and society. To do so we have used a range of models and approaches, which provide different perspectives and insights on the potential impacts, to make our assessment. We consider that it is only appropriate to draw conclusions about the likely impacts by considering the results of these analyses together. Focusing on a single perspective alone would provide a misleading and incomplete picture of the overall outcomes of the EB4 demonstration path.

Our analysis suggests that meeting the fourth emissions budget by following the actions in the EB4 demonstration path would result in overall economic and social benefits. While our modelling indicates there would be a reduction in the overall level of activity in the economy (as measured by gross domestic product, or GDP), our analysis overall suggests the broader benefits of actions taken in our EB4 demonstration path are likely to exceed the costs. We have also quantified the benefits of improved air quality from a faster transition to electric vehicles and reducing private vehicle use, which provide average annual benefits of around $2.7 billion a year over the fourth emissions budget period.

These impacts are discussed in more detail in *Chapter 5: The impacts of the fourth emissions budget on New Zealanders*.

Crown–Māori relationship, te ao Māori and specific effects on iwi/Māori

We have considered specific effects for iwi/Māori, as well as wider matters relating to te ao Māori and the Crown–Māori relationship. We found that the large share of iwi/Māori interests in the land sector and the higher proportion of lower income households that include Māori may expose iwi/Māori to greater costs or make the transition harder.

We have previously heard from iwi/Māori that strong climate action is an opportunity to support te ao Māori, mātauranga Māori and for iwi/Māori to provide leadership. This is provided the right resources are in place and solutions reflect the diversity of iwi/hapū. Actual impacts on iwi/Māori – both in terms of opportunities and challenging effects – will depend on the policy choices made by Government. Care will be needed to ensure that action makes the most of these opportunities and does not exacerbate historical inequities.

An effective Crown–Māori relationship, that upholds Te Tiriti o Waitangi/The Treaty of Waitangi, will be critical for an equitable transition for the benefit of all people of Aotearoa New Zealand.

This is covered in greater detail in *Chapter 5: The impacts of the fourth emissions budget on New Zealanders*.

Contribution to the global effort to limit warming

By defining the 2050 target in the Act, Parliament has set the direction for what domestic contribution Aotearoa New Zealand will make to the international effort to restrict global warming to 1.5°C above pre-industrial levels. Emissions budgets need to be set at a level that will support meeting the 2050 target.

In this draft advice, we have developed scenarios and our EB4 demonstration path consistent with meeting the current 2050 target. We are consulting on two other pieces of work at the same time as this draft advice – including the review of the 2050 target. You can find more information on the two other documents in the *Foreword.*

Slower action on gross emissions would not be in Aotearoa New Zealand's best interests

While it is possible to meet our 2050 target with fewer emissions reductions than our proposed budget level, our analysis suggests these are less advantageous pathways for Aotearoa New Zealand to take. In testing our EB4 demonstration path we looked at what would happen if Aotearoa New Zealand took less action on gross emissions, across both biogenic methane and other greenhouse gases.

We found that while some impacts would be lower if less action on gross emissions was taken, there would also be a reduction in the benefits from transitioning away from fossil fuels. Overall, we considered that it would be in in Aotearoa New Zealand's interests to act to reduce gross emissions wherever there are technically and economically feasible options.

We have tested whether the proposed budget can be met by different actions

There are inherent uncertainties to arriving at a proposed budget level. Predicting the technologies and systems that will be available to contribute to emissions reductions in 12 years' time is a challenging task. This includes details on the effectiveness, cost, and scalability of new and emerging technologies from now to 2036 (and beyond, to 2050). To illustrate these challenges, international evidence suggests that even highly regarded projections regularly underestimated the level of deployment for renewable energy technologies while also overestimating their costs.[11]

There are a range of other factors that will also impact on Aotearoa New Zealand's ability to meet our proposed budget, including social factors (such as population growth), economic factors (such as GDP growth rates, oil prices, energy prices) and sector specific factors (such as stocking rates on farms, costs of EVs and batteries).

Our proposed budget level has been recommended in light of these uncertainties. This means the Government will have choices about how to meet the budget. The flexibility to meet emissions budgets through a range of different combinations of actions gives greater confidence that future governments can meet the budgets under a range of circumstances.

We looked at different paths that could achieve the fourth emissions budget

To test whether our proposed emissions budget is resilient to future uncertainty, we have developed two alternative paths which also meet the recommended budget level. These were developed to understand how future governments could adjust the actions taken to meet the budget should some actions develop more slowly than we currently anticipate. These alternative paths draw on the insights gained from our analysis of scenarios to 2050.

Alternative Path A examined a pathway that includes greater emphasis on systems change to achieve the budget level to compensate for slower progress on technology changes. In this pathway:

- 100% of steel production would be from electric arc furnace (up from 75% for EB4 demonstration path)
- there would be further reductions in stocking rates of sheep/cattle/dairy
- there would be a further reduction in heavy trucks and commercial vehicle kilometres travelled (VKT)
- no methane-reducing technologies would be applied
- there is slower conversion to high efficiency recovery boiler for wood/paper/pulp (2035 vs 2030 for EB4 demonstration path).

Alternative Path B examines the effects of meeting the budget through prioritising actions that apply new and emerging technologies – with less reliance on systems change to meet the budget. In this pathway:

- there would be faster cost reductions for EVs and batteries
- there is higher aviation electrification and higher use of biofuels in aviation
- there is full conversion to hydrogen for urea production (0% in EB4 demonstration path)
- there is a delayed phase out for pipeline fossil gas and LPG in residential/commercial/industrial uses (2060 vs 2050 in EB4 demonstration path).

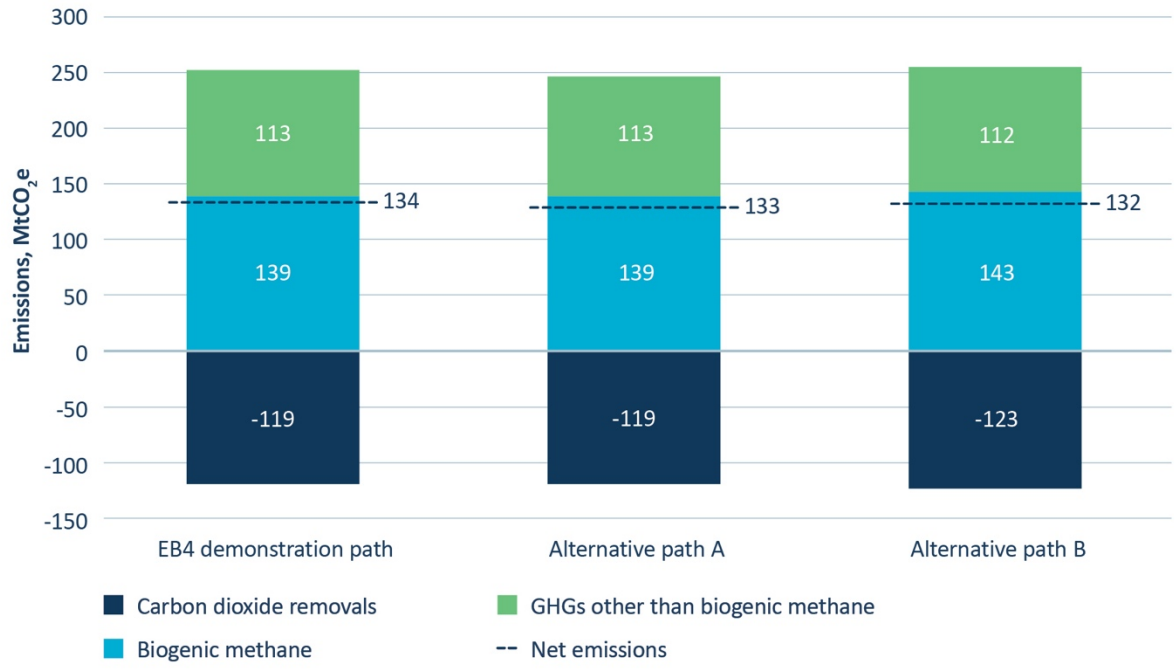
A summary of the different actions under the alternative paths can be found in our *Assumptions Log*.

Figure 2.7 below summarises the results of our analysis of these alternative paths. Both alternative paths at least match the total level of net emissions for the EB4 demonstration path. Further systems change in Alternative Path A results in 5 $MtCO_2e$ fewer emissions than the EB4 demonstration path as a result of greater reductions in all greenhouse gases other than biogenic methane. We have avoided alternative pathways that would increase levels of biogenic methane or gross emissions of all greenhouse gases other than biogenic methane as doing so could impact the country's contribution to warming and ability to meet the 2050 target.

Impacts to society and the economy vary depending on the pathway. We expect that meeting our proposed emissions budget through either of these three pathways can be achieved with the economy continuing to grow. While some impacts will be unevenly felt, policy can help mitigate their effects.

Our analysis suggests there will be multiple ways for the Government to achieve the fourth emissions budget at the level we are proposing to recommend. We therefore assess that there is sufficient flexibility for the Government to be able to meet the budget under a range of future circumstances.

Figure 2.7: *Emissions for the fourth emissions budget from our analysis of alternative paths*



Source: Commission analysis

Flexibility in meeting emissions budgets

The Act requires the Minister of Climate Change to set emissions budgets for Aotearoa New Zealand that can be achieved through domestic action. This differs from Nationally Determined Contributions (NDCs), which can be set on the basis that they can include offshore mitigation to supplement domestic action. This requirement has been central to our proposed level for the fourth emissions budget, including the ability to meet these through a variety of pathways.

There is always uncertainty when projecting forward in time. The Act does provide some flexibility to help manage this uncertainty, which we cover in this section.

Banking and borrowing between budgets

If total emissions at the end of an emissions budget are lower than the level for that budget, the excess reduction can be carried forward to the next emissions budget period. This means the emissions budget for the next period is increased by the amount carried over (banked).

If total emissions at the end of the budget period are greater than the level of the emissions budget, up to 1% of the next emissions budget can be brought forward (borrowed).

In *Ināia tonu nei* we noted the risks of borrowing, notably making it harder to meet subsequent budgets. We also viewed it as preferable that:

- the Government's emissions reduction plans aim to overachieve budgets
- borrowing is limited to when the Government finds itself in a position where there is insufficient time to adjust policies to ensure emissions meet the budget level.

The Commission is required to advise on banking and borrowing as part of our report at the end of an emissions budget period. These reports are due to the Minister no later than two years after the end of an emissions budget period (see Section 5(Z)(L) of the Act). Final decisions on banking and borrowing are made by the Minister of Climate Change.

The impact of banking and borrowing on both the adjacent budget and potentially later budgets should be considered. For example, if a gain from a budget period were banked, this would make the adjacent budget period easier to meet. Care would be needed to ensure efforts to reduce emissions are not lessened so later reductions can still be achieved, and to stay on course for meeting the 2050 target. Circumstances requiring banking or borrowing for the current budget will not be known until the first budget period finishes (the end of 2025).

Offshore mitigation

As emissions budgets are intended to be met through domestic action, the use of offshore mitigation should only be used as a last resort for meeting emissions budgets. In *Ināia tonu nei* we advised that offshore mitigation be limited to exceptional circumstances such as force majeure events, which are unpredictable, unpreventable and outside the control of the Government. These typically cause one-off increases in emissions, such as the need to rebuild following a disaster such as an earthquake or volcanic eruption. Other uncertainties should be accounted for in the planning, setting, and revising of emissions budgets, as well as how Government chooses to implement its emissions reduction plans.

In our advice on emissions budgets, the Act requires the Commission to also advise on a limit on offshore mitigation that can be used. In *Ināia tonu nei* we recommended that the limit on offshore mitigation should be zero for the first three emissions budgets. We also recommended that the only circumstances that should justify use of offshore mitigation is as a last resort in exceptional circumstances beyond the Government's control. We propose extending these recommendations to the fourth emissions budget.

Implications for policy

The choices that Government has in how it meets the proposed fourth emissions budget involve decisions around the mix of actions and policies to reduce emissions, and how much forestry will play a role to remove carbon from the atmosphere. These choices matter, as each decision will have benefits and consequences.

The Act requires that our advice on the fourth emissions budget includes how we expect the budget, and the 2050 target, could be realistically met – and must show the corresponding levels of gross emissions reductions and removals, and the contribution of each greenhouse gas. To do so we have looked at what we think is the best course of action for Aotearoa New Zealand, with consideration to a range of matters under the Act.

This advice when finalised will provide the Government with the basis to decide on a fourth emissions budget level, which will determine the trajectory of Aotearoa New Zealand's emissions reduction out to 2050. It will also set a path for decisions that need to be made about how the emissions budget can be achieved through specific policies and actions – which will be set out by Government in the emissions reduction plan for that period.

Our analysis shows that there are opportunities to reduce gross emissions on the path towards the fourth emissions budget that would bring a wide range of benefits for Aotearoa New Zealand. Analysis also shows that higher than projected rates of forestry planting in the last couple of years mean that less afforestation would be needed in the future to reach the net zero component of our 2050 target. This in turn means that investing in carbon capture and storage technologies may not need to play a large role.

Achieving the fourth emissions budget this way would allow the country to reduce emissions in line with meeting the 2050 target, while accessing a range of opportunities and benefits for the economy, society, the environment and future generations. It would give Aotearoa New Zealand flexibility to respond to new information about the viability of different emissions reduction technologies and opportunities.

In *Ināia tonu nei*, we included a number of policy implications of our proposed levels for the first three emissions budgets. A number of these remain highly relevant for the fourth emissions budget. We reiterate these, alongside further advice specific to what is required for policy for our proposed fourth emissions budget. Achieving our proposed fourth emissions budget will require:

- further electrification of light transport including phase out of light internal combustion engine (ICE) vehicle imports by 2040, low carbon fuel alternatives and reductions in vehicle kilometres travelled
- continued growth in renewable electricity generation, for example through wind, solar and geothermal. This growth will need to be at a sufficient rate to balance risks of under- or over-investment, while ensuring energy security and fair electricity prices are maintained across the transition
- further electrification of industrial processes and use of biomass (and ensuring sufficient supply of biomass to 2050 and beyond)
- going further on current available methane-reducing technologies and farm management practices and the introduction of new methane-reducing technologies that can contribute to emissions reductions for the fourth emissions budget

- a gradual decline in exotic afforestation from 2030 to 2050, with native afforestation increasing to 2030 and maintaining this level to 2050[xi]
- further increases to energy efficiency in residential, commercial, and public buildings
- increasing rates of active and public transport in urban areas.

The Government will need to use its policy levers to enable, incentivise, or require changes as appropriate. There will be challenges to meeting our draft fourth emissions budget, but these can be overcome through targeted policy within a comprehensive and coherent policy package. This will need to include considerations of equity (including intergenerational equity) and sufficient support for iwi/Māori and those in lower socio-economic communities.

In our previous analysis[12] we showed that the New Zealand Emissions Trading Scheme (NZ ETS) as currently structured is highly unlikely to drive the gross emissions reductions in line with our demonstration pathway (and the sector sub-targets set out in Aotearoa New Zealand's first emissions reduction plan), particularly in a way that can be sustained. While the NZ ETS creates strong economic drivers for planting trees, it also allows carbon dioxide removals by forests to undermine the incentive to reduce emissions at their source. In the near term, this is expected to result in the NZ ETS driving extensive afforestation but only limited gross emissions reductions. Government policies will need to encourage both gross emissions reductions and afforestation, as both have essential roles to play in an equitable and sustainable low emissions transition. **Box 2.3** below provides further insights from our 2024 advice on NZ ETS settings.

The Government will need to encourage a wider set of actions than the minimum necessary to achieve this emissions budget. Aiming to overachieve reduces the risk of not achieving emissions budgets, in particular if some technology is not available to the level required.

Flexibility in budgets means multiple possible pathways, and a diverse range of levers, for achieving them. This also allows government, industry, businesses, and households to be able to adapt to new information, technologies, and systems as they become available.

There are a number of mitigations that offer low-regret choices alongside significant co-benefits beyond emissions reductions (such as cleaner air and water, better public health outcomes, improved biodiversity of native species). These options should continue to be leveraged on the pathway to 2050.

Some policies and approaches risk constraining future options. For example, some infrastructure investments and urban planning decisions could constrain lower emissions ways of transporting people and goods, or ways of living that make it hard to take advantage of new technologies in the future.

Aotearoa New Zealand can continue to build on its strengths, such as high rates of renewable electricity generation, as well as the significant growth in light EV uptake in recent years. As new opportunities arise that offer cost-effective reductions to high emitting activities, government can work with the private sector to ensure timely adoption of these systems and technologies, and management of risks where these are a barrier to investment.[13]

Uncertainty about the future is something to be managed, rather than a reason to delay further climate action. Having a diverse portfolio of levers ensures sufficient flexibility to manage uncertainties so that a low emissions future is achieved, alongside the benefits that a timely transition will offer for Aotearoa New Zealand.

[xi] Exotic afforestation is at historically high levels in recent years. While exotic afforestation offers quicker reductions in net emissions, planting natives offers a longer term carbon sink as well as improving biodiversity and reducing erosion risk of marginal land classes. Native afforestation will have to increase signficantly from recent levels to meet the level in our EB4 pathway, which peaks at 2030 and maintains this level to 2050.

Box 2.3: Our 2024 advice on NZ ETS settings

The Commission's *NZ ETS unit limit and price control settings 2025–2029* advice highlighted that, due to its current structure, the NZ ETS will have very little ability to drive gross or net emissions reductions to achieve the 2050 target beyond the mid-2030s, as the NZ ETS emissions cap will reach zero in 2037 under current policy and legislative settings. This point is discussed in the Commission's advice to the Government on its second emissions reduction plan.

This means that the Government will either need to amend the overall structure of the NZ ETS, or implement other policies, to keep driving emissions from NZ ETS sectors down to meet the 2050 target. This issue cannot be addressed or corrected for by amending the NZ ETS unit limit and price control settings, but is an issue for the Government to address as part of its emissions reduction planning.

Proposed recommendations

This proposed recommendation seeks to address a level for the fourth emissions budget to help enable Aotearoa New Zealand to stay on course to achieve the 2050 target.

Proposed Recommendation 1 – Proposed budget level	
We propose that the Government set the fourth emissions budget (2036–2040) at:	134 $MtCO_2e$ (total, AR5) 26.8 $MtCO_2e$ (annual average, AR5)

These proposed recommendations seek to address the balance of emissions and removals by gas, including reductions by gas needed relative to 2019 levels, to enable Aotearoa New Zealand to achieve our proposed budget level.

In our advice on the second emissions reduction plan, we recommended that the Government commit to specified levels of gross greenhouse gas emissions and carbon dioxide removals for the second and third emissions budgets. If this recommendation is taken on board, and the approach extended to the fourth emissions budget, the values in our Proposed Recommendation 2 can guide the Government's specified levels.

Proposed Recommendation 2 – Breakdown of the fourth emissions budget

We propose that, to meet the fourth emissions budget (2036–2040), the Government implement policies that result in a balance of emissions and removals as outlined in the table* below:

Total net emissions Annual average		134 $MtCO_2e$ 26.8 $MtCO_2e$
Total carbon dioxide removals Annual average		119 $MtCO_2e$ 23.7 $MtCO_2e$
Emissions – all greenhouse gases, except biogenic methane Gross greenhouse gases	Carbon dioxide Nitrous oxide F-gases Non-biogenic methane	79 $MtCO_2e$ 30 $MtCO_2e$ 3 $MtCO_2e$ 2 $MtCO_2e$
Emissions – biogenic methane Gross biogenic methane		4.97 $MtCH_4$

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

Proposed Recommendation 3 – Reductions by greenhouse gas to meet the emissions budget

We propose that, to meet the fourth emissions budget, the Government implement policies that deliver emissions reductions of each greenhouse gas as outlined in the table* below:

	2021	Fourth emissions budget (2036–2040)
Total net emissions ($MtCO_2e/yr$) Annual average Reduction from 2021	73.3 $MtCO_2e$	 26.8 $MtCO_2e$ 46.5 $MtCO_2e$
Total gross emissions ($MtCO_2e/yr$) Annual average Reduction from 2021	80.3 $MtCO_2e$	 50.6 $MtCO_2e$ 29.8 $MtCO_2e$
Broken down by:		
Carbon dioxide ($MtCO_2e/yr$) Annual average Reduction from 2021	34.7 $MtCO_2e$	 15.8 $MtCO_2e$ 18.9 $MtCO_2e$
Nitrous oxide ($MtCO_2e/yr$) Annual average Reduction from 2021	7.1 $MtCO_2e$	 6.0 $MtCO_2e$ 1.1 $MtCO_2e$
F-gases ($MtCO_2e/yr$) Annual average Reduction from 2021	1.5 $MtCO_2e$	 0.6 $MtCO_2e$ 0.8 $MtCO_2e$
Non-biogenic methane ($MtCO_2e/yr$) Annual average Reduction from 2021	0.8 $MtCO_2e$	 0.3 $MtCO_2e$ 0.5 $MtCO_2e$
Biogenic methane ($MtCH_4/yr$) Annual average Reduction from 2021	1.30 $MtCH_4$	 0.99 $MtCH_4$ 0.30 $MtCH_4$

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

Proposed Recommendation 4 – Limit on offshore mitigation for the fourth emissions budget and circumstances justifying its use

We propose that, to meet the fourth emissions budget (2036–2040), the Government:

a. limit offshore mitigation for the fourth emissions budget to 0.0 $MtCO_2e$
b. only use offshore mitigation as a last resort in exceptional circumstances beyond the Government's control, such as force majeure events, where domestic measures cannot compensate for emissions impacts.

CHAPTER 3

Developing the proposed path to the fourth emissions budget

This chapter sets out how we have developed our proposed path to reach the country's fourth emissions budget. It reflects an ambitious but technically and economically achievable way to reduce emissions.

To give advice on the fourth emissions budget, we need to consider what changes will need to happen across the country and whether those changes are technically and economically feasible for Aotearoa New Zealand. This chapter explains how we have developed a path that sets out the actions that the country could take to reach the fourth emissions budget.

There are multiple ways to meet the 2050 target. The choices made about the path taken to that target need to take into account the current progress on emissions reduction, long-term projections, practical matters about feasibility, and also the effects of the changes required. At the heart of the judgements required is the need to maximise the benefits and opportunities of this transition, and minimise negative impacts.

Since the Government set the first three emissions budgets in 2022, the outlook for Aotearoa New Zealand's emissions reduction has changed. There have been significantly higher rates of forestry planting in the last three years than previously projected. There are also new opportunities for emissions reductions. This needs to be considered in our advice to Government on setting the next steps on the path to meet the 2050 target.

For this advice, we have built on the analysis we did for the first three emissions budgets, using the best evidence and information available. We have assessed opportunities and carried out scenario analysis to update a draft demonstration path to 2050 (the EB4 demonstration path). This path takes into consideration a wide range of matters as required under the Act to demonstrate the proposals for the fourth emissions budget are achievable.

The specific actions to achieve emissions budgets are set out in the emissions reductions plan covering that period. He Pou a Rangi Climate Change Commission is required to provide advice on the contents of those plans, which are drafted and finalised by the Government. The process of setting emissions reduction plans one year prior to an emissions budget starting, allows government to make decisions on Aotearoa New Zealand's path to 2050 and 'course correct' using the most updated information. We note the Government will be consulting this year on the second emissions reduction plan, covering the second emissions budget (2026–2030).

This chapter sets out our approach to developing the draft EB4 demonstration path which is the foundation of our proposed fourth emissions budget (see *Chapter 2*). It covers the current trajectory for emissions in Aotearoa New Zealand, our assessment of opportunities to reduce and remove emissions, our long-term scenarios out to 2050, and presents our draft 'EB4 demonstration path'.

The action required in different parts of Aotearoa New Zealand's economy and society to move along that EB4 demonstration path is set out in *Chapter 4: Sector contributions to meeting the fourth emissions budget.* This is followed by our assessment of what those actions are likely to mean for people, in *Chapter 5: Impacts of meeting the fourth emissions budget on New Zealanders*.

We are seeking your feedback

In this chapter we are seeking your feedback on our approach to developing our draft advice on the proposals for the fourth emissions budget. In particular, we want to know:

- Do you agree with the approach we have taken to developing our EB4 demonstration path? If not, why not?
- Is there anything we haven't considered that we should be including in this approach?

Where Aotearoa New Zealand's emissions are heading

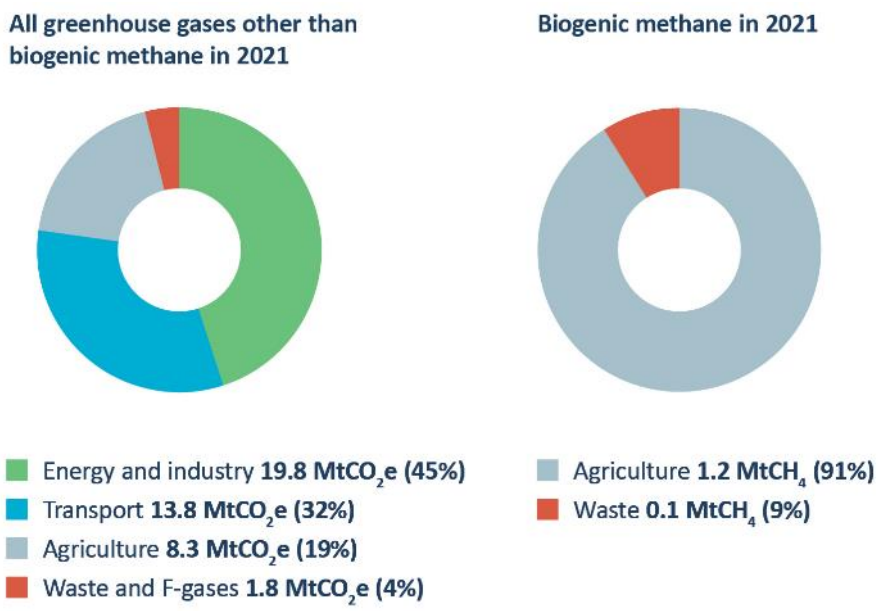
Aotearoa New Zealand's current emissions profile

The latest GHG Inventory data published by the Ministry for the Environment in 2023 shows that Aotearoa New Zealand reduced its gross greenhouse gas emissions between 2020 and 2021.[14] According to Stats NZ, that pattern of reduced emissions has continued to 2022, with total industry and household emissions decreasing by 3.9% from 2021 to 2022.[15] The GHG Inventory shows that in 2021, biogenic methane emissions totalled 1.3 $MtCH_4$, with gross emissions of all greenhouse gases other than biogenic methane equalling 43.8 $MtCO_2e$ (**Figure 3.1**).

In Aotearoa New Zealand, most biogenic methane emissions (approximately 91%) come from agriculture, primarily from ruminant livestock such as cows and sheep. The remainder (approximately 9%) come from the decay of organic waste.

More than three-quarters of long-lived greenhouse gas emissions come from transport, energy and industry, mainly through the burning of fossil fuels in vehicles, factories and homes. Around 20% come from agriculture, mainly nitrous oxide emissions caused by livestock urine and fertiliser use. The remainder come from F-gases (which are commonly used as refrigerants), wastewater treatment, and the burning of waste.

Figure 3.1: *Aotearoa New Zealand's emissions of all greenhouse gases other than biogenic methane and biogenic methane in 2021*



Source: Commission analysis of data from the 2023 GHG Inventory

Current policy is not on track to reach the 2050 target

Our analysis in this report draws on a reference scenario which allows comparison of our proposed EB4 demonstration path to current policies and measures. Our reference scenario draws on government agencies' "with existing measures" analysis (see **Box 3.1**).

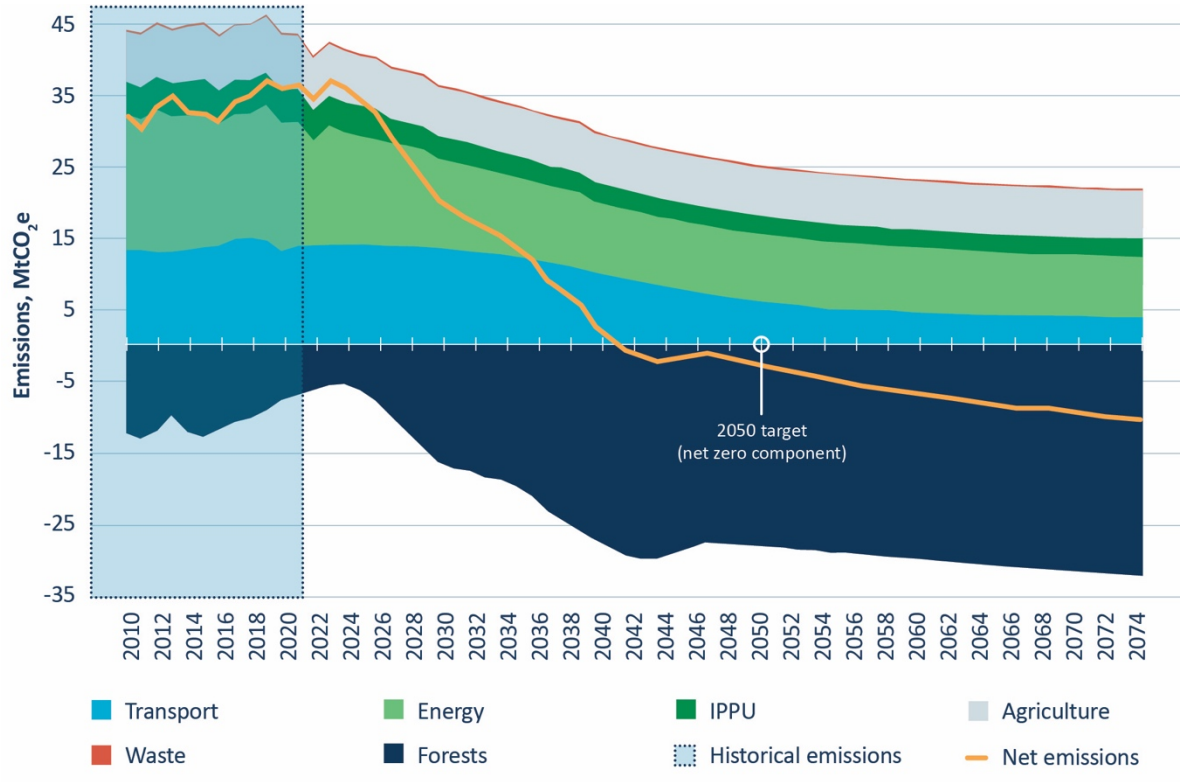
The reference scenario suggests gross emissions of all greenhouse gases other than biogenic methane will reduce by 26% by 2040 and 37% by 2050 from 2022 levels (**Figure 3.2**). The main contributors to this reduction in gross emissions come from transport – where take up of EVs is projected to reduce emissions, and energy – where increasing use of renewable energy for process heat is expected to reduce emissions.

As a result of 1,273,000 hectares of afforestation projected to 2050 in the reference scenario, removals of carbon dioxide by forests are projected to increase from 7 $MtCO_2e$ in 2021 to 28 $MtCO_2e$ in 2050. This suggests that Aotearoa New Zealand would be on track to meet net zero emissions of all greenhouse gases (except biogenic methane) in 2042.

Box 3.1: Updates to our reference scenario

This reference scenario was developed based on the government agency projections with policies as of 1 July 2023. These will change as the new Government enacts its preferred policies, and government agencies update their "with existing measures" analysis. While the reference scenario in this consultation draft is unable to reflect these new and future policies, we intend to include an updated reference scenario in the final draft of this advice that will be delivered to the Government by the end of 2024.

Figure 3.2: *Emissions of all greenhouse gases other than biogenic methane by sector in the reference scenario*[xii,xiii]



Source: Commission analysis

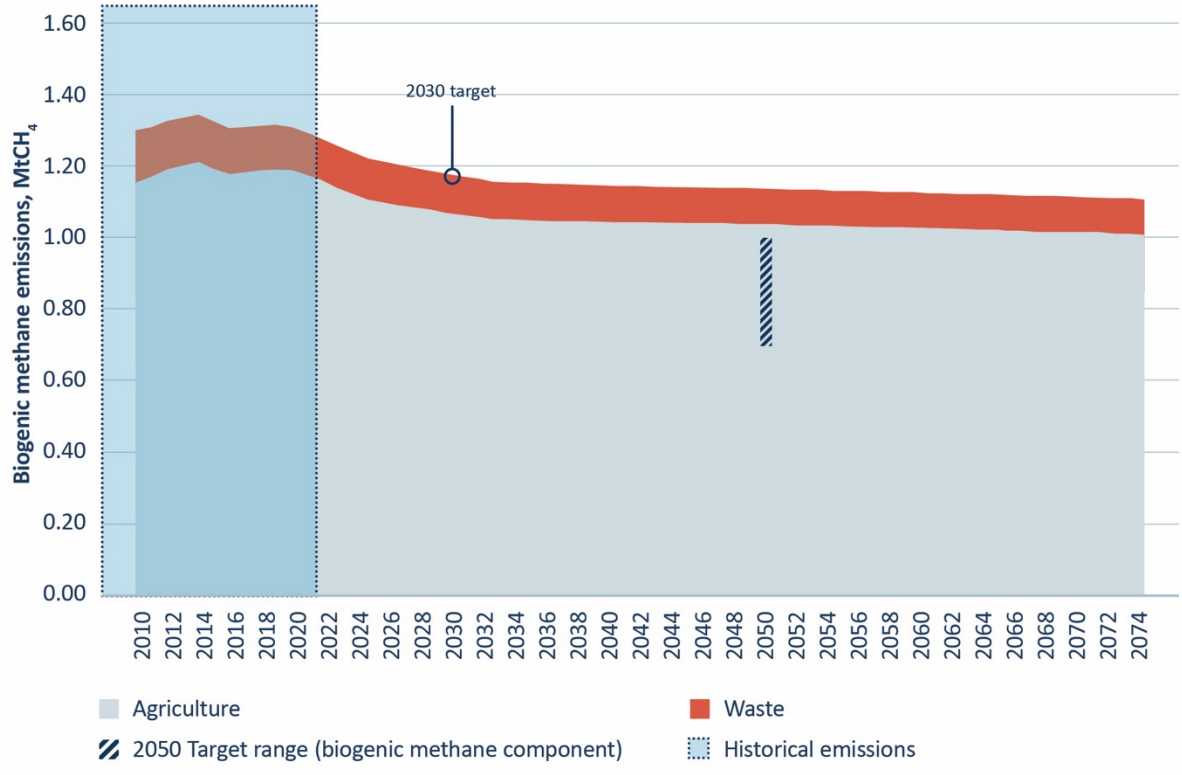
Reductions in biogenic methane in the reference scenario are the result of improvements in agricultural productivity, reductions in stock and land use change away from ruminant livestock. The level of reductions in this scenario, which estimates the impact of current policy, would not put Aotearoa New Zealand on track to meeting the biogenic methane component of the 2050 target – with a 13% reduction compared to 2017 levels projected by 2050 (below the minimum 24% reduction required by the target) (**Figure 3.3**).

It is important to note that achieving the 2050 target will require Aotearoa New Zealand to meet both the net zero component and the biogenic methane component of the target.

[xii] In this advice we have included F-gases as part of industrial processes and product use (IPPU).

[xiii] We have extended the timelines to 2075 to show the estimated impact of current policies beyond the 2050 target. There is uncertainty beyond 2050 as government projections do not always go beyond this year, for example afforestation projections from the Ministry for Primary Industries (which we have held constant at the 2050 value).

Figure 3.3: *Emissions of biogenic methane by sector in the reference scenario*



Source: Commission analysis

Assessing opportunities to reduce and remove emissions

To advise on the level of an emissions budget, we reviewed our prior demonstration pathway and updated this with the latest information and evidence on available emissions reductions and removals. For the fourth emissions budget this means updating our demonstration pathway from *Ināia tonu nei.* Our advice on later emissions budgets will require further updates to our demonstration pathway.

To support our advice on the fourth emissions budget, we conducted research across sectors of the economy, to understand the actions that Aotearoa New Zealand can take to reduce emissions to meet the 2050 target. Our research has built on the existing evidence base developed to support our advice on the first three emissions budgets. This evidence base has been enhanced by feedback through consultation and discussions with stakeholders across a range of sectors and groups.

For each action to reduce emissions, we have considered a range of factors that influence their potential to contribute to emissions reductions. These include:

- the technical potential to adopt the action
- the action's feasibility for deployment in Aotearoa New Zealand
- the costs – and how these are expected to change
- the benefits – both direct and wider co-benefits
- interactions with other actions that could be taken
- broader impacts including consideration of perspectives from mātauranga Māori.

We have considered actions which reduce emissions that involve adopting lower emissions technologies to existing processes. We have also considered actions that involve changes to systems, processes and behaviours. In practice many of the actions we have identified would involve a combination of adopting different technologies and changes to systems, processes or behaviours.

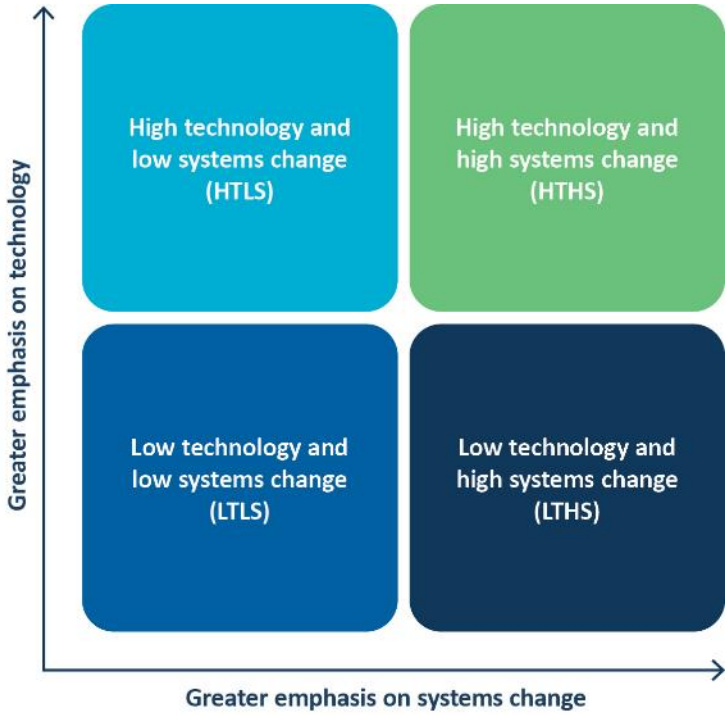
Evidence on actions has been drawn from both domestic and international sources. We have sought to supplement the available evidence by commissioning new research for some actions which we assessed would be important to consider when advising on the fourth emissions budget. These included a review of potential on-farm mitigations for agricultural emissions and mitigations for decarbonising process heat for industry. The reports for these pieces of research are published alongside this draft advice.

Understanding different pathways to 2050 through scenario analysis

Our 2050 scenarios show what is possible to reach the 2050 target

We developed a set of scenarios to demonstrate the range of actions that could be taken to reduce emissions, using dimensions of technology and systems change across sectors of the economy. This analysis focuses on what's possible rather than defining an optimal mix of actions. All of these scenarios were designed to understand different ways in which Aotearoa New Zealand could achieve the 2050 target. **Figure 3.4** shows the structure of our scenarios, and they are explained in more detail below.

Figure 3.4: *Updated scenario structure*



There are two changes to the scenario structure we used for this draft advice compared to the one used in *Ināia tonu nei*. We have changed the horizonal axis to "systems change" instead of "behavioural change". The former is inclusive of the latter. With a view to achieving a low emissions economy, "systems change" also reflects it is possible to fundamentally change the type of good or service produced, or drastically reduce life cycle emissions from traditionally high emitting activities. High systems change also offers significant co-benefits such as cleaner air and water, or better public health outcomes. Examples of high systems change include higher rates of conversion of marginal and erosion prone land to native forests, and higher rates of modal shift to public and active transport.

Low technology and low systems change scenario

This scenario would see Aotearoa New Zealand minimise societal shifts by focusing on emissions reductions for each activity through proven technology options. Key examples of this are relying on electric vehicles to reduce emissions from light vehicle transport and adoption of low methane breeding for ruminant livestock.

High technology and low systems change scenario

This scenario would see Aotearoa New Zealand reduce emissions through adoption of new and emerging technologies while minimising societal shifts. This includes partial conversion of steel production to green hydrogen, and adoption of green anodes for aluminium production. For agriculture this would mean introduction of methane-reducing technologies (modelled as a vaccine) to reduce biogenic methane emissions.

Low technology and high systems change scenario

This scenario would see Aotearoa New Zealand embrace an approach to long-term emissions reductions where societal shifts play a more prominent role in reducing emissions, such as greater use of public and active transport. When compared to the low systems change scenarios, this scenario would also see scaling up of native afforestation on marginal and erosion prone land, further reductions in stocking rates, higher levels of land use change from dairy to horticulture, and further waste avoidance (including waste from food, gardens and paper products).

High technology and high systems change scenario

This scenario draws heavily on new and emerging technologies while targeting systems shifts with significant co-benefits. In this scenario there is a faster reduction in costs for EV batteries, which drives greater adoption of electric vehicles earlier, including trucks, public ferries and small aircraft. This scenario also includes introduction of methane-reducing feed additives for dairy cows and higher diversion of organic waste from landfills to anaerobic digestion (energy recovery).

For examples of high technology and high systems changes by sector, see **Table 3.1**.

Table 3.1: *Examples of high technology and high systems changes by sector*

Sector	High technology change examples	High systems change examples
Transport	Faster adoption of battery electric trucks, faster reduction in EV battery costs, rapid deployment of public charging infrastructure, earlier adoption of electric small aircraft, quicker electrification of public ferries.	Reduction in air travel demand, greater mode shift to active and public transport.
Energy	Faster cost reduction for building new renewable electricity generation, high efficiency recovery boiler for wood/pulp/paper.	Faster fossil gas phase out – by 2045 for process heat and by 2050 for buildings, reduced demand for heating from faster rates of retrofit.
IPPU (industrial processes and product use)	Deployment of green hydrogen steel production, deployment of green anodes for aluminium, faster electrification of compressors in urea production.	Further transition to electric arc furnace for steel production with improved scrap steel collection and recycling, faster phaseout and better recovery of F-gases.
Agriculture	Methane reduction technologies for dairy/sheep/beef, greater ambition for low-methane genetics for sheep, inclusion of genetics for dairy.	Greater reductions in stocking rates, further land-use change to horticulture and forests, further reductions in nitrous oxide use, all urea coated with urease inhibitor.
Waste	Greater organic waste to anaerobic digestion and boiler fuel, increased landfill gas capture efficiency.	Greater composting, greater waste avoidance, increased landfill gas infrastructure.
Forests	No change from LTLS scenario.	Afforestation of sheep and beef land on land use change (LUC) classes 7 and 8, all land classed as LUC 8 and erosion prone LUC 7 retired to natives.

Key insights from our scenarios for all greenhouse gases other than biogenic methane

Scenario results for all greenhouse gases other than biogenic methane are shown in **Figure 3.5**. Under the LTLS scenario gross emissions to 2050 would be higher than in the HTHS scenario. The LTLS scenario would have a net emissions value for all greenhouse gases other than biogenic methane in 2050 of -2 $MtCO_2e$.[xiv] This compares to -20 $MtCO_2e$ for the HTHS scenario.

Lower net emissions in the high systems change scenarios are driven by further effort to reduce emissions alongside greater native afforestation of marginal land to create a longer term, more enduring carbon sink (see **Table 3.2** for a summary of afforestation across our highest and lowest ambition scenarios). While levels of exotic afforestation are similar across pathways, higher levels of native afforestation in the high systems change scenarios will mean less reliance on exotic afforestation to maintain net zero emissions of all greenhouse gases (except biogenic methane) beyond 2050.

Further insights from our scenario analysis are summarised below. Many of these align strongly to our insights in *Ināia tonu nei*.

Electricity generation

Displacing fossil fuels in other sectors (such as transport and industry) with electricity continues to play an essential part of the transition, requiring a major expansion of the electricity system. Wind, geothermal and solar power can meet the expected growth in demand from electrifying transport and heat to 2050 while keeping electricity affordable. Despite this growth, the use of fossil fuels for generating electricity, and therefore emissions from the electricity system, can reduce considerably relative to today.

Road transport

Road transport can be almost completely decarbonised by 2050 by switching to low emissions vehicles alongside increasing uptake of active transport (such as walking and cycling), public transport use, and reducing vehicle travel. Decarbonising transport will require a rapid increase in electric vehicle sales so that nearly all vehicles entering the country are electric by 2035.

Industry and buildings

Low- and medium-temperature heat in industry and buildings can be decarbonised by 2050 by shifting away from coal, diesel and fossil gas to electricity and biomass. This transition will require a steady and sustained effort from now through to 2050.

Energy efficiency and behaviour changes that reduce energy demand will also play an important role in many sectors of the economy. These actions can help to cut emissions sooner and in some hard-to-abate sectors. These actions can also contribute to cost reductions and co-benefits.

[xiv] While the 2050 target requires all greenhouse gas emissions except biogenic methane to be net zero by and beyond 2050, we have worked to ensure the lowest ambition scenario has some contingency in the event international aviation and shipping is included in emissions budgets, or if there are future changes to the 2050 target or the GHG Inventory that make it harder to achieve emissions budgets.

Agriculture emissions

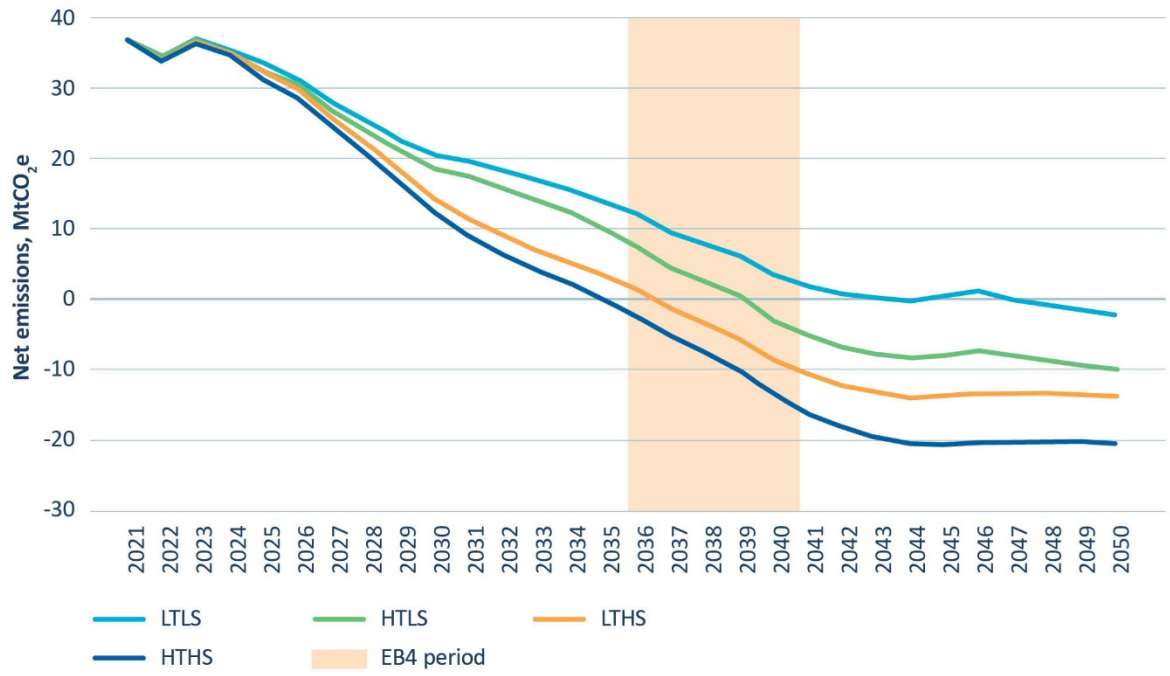
Nitrous oxide emissions from agriculture remain relatively difficult to reduce, but reductions are possible through changes to farm practices including reducing use of nitrogen fertiliser. Nitrification inhibitors are expected to be available to contribute to reducing emissions for the fourth emissions budget period. We have opted to not include them in our scenarios (and EB4 demonstration path) due to their relatively high cost compared to mitigation options for reducing other greenhouse gases. Scenario insights for biogenic methane are covered in the next section.

Forests

Exotic production forests continue to play a role in removing carbon dioxide, particularly until other more enduring sources of removals, such as native forests, can scale up. New native forests can be established on less productive and more erosion-prone land to provide a long-term carbon sink.

The deep reductions in gross emissions in our scenarios mean the 2050 targets could be met with a significantly smaller area of new exotic forests than would occur under current policy settings. We estimate following the reference scenario would result in up to an additional 447,000 hectares of exotic afforestation compared to our 2050 scenarios (for the period 2021-2050) (**Figure 3.5**).

Figure 3.5: *Scenario results for net emissions of all greenhouse gases other than biogenic methane*



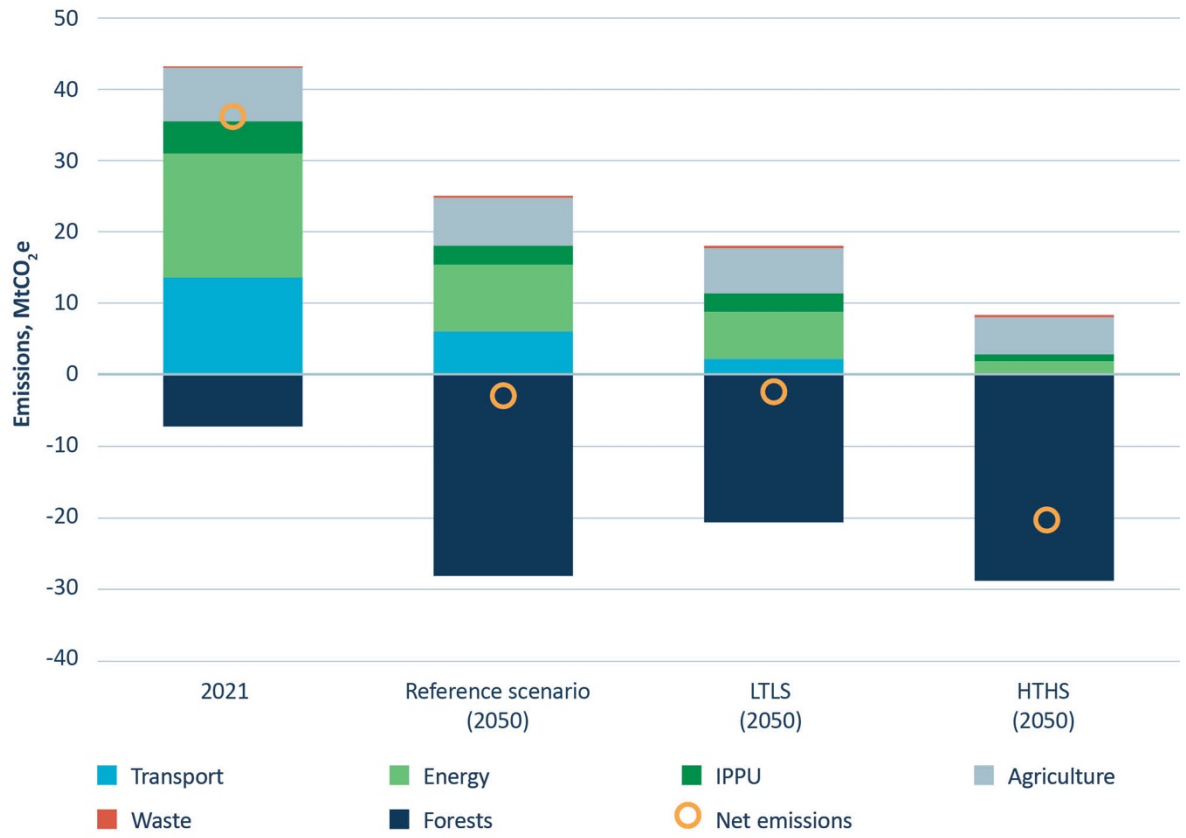
Source: Commission analysis

Table 3.2: Comparing levels of afforestation for highest and lowest ambition scenarios

Scenario	Type of afforestation	Land area afforested from 2021–2050 (in thousands of hectares)
Low technology and low systems change (lowest ambition scenario)	Exotic	742
	Native	452
High technology and high systems change (highest ambition scenario)	Exotic	741
	Native	1,521

Figure 3.6 below shows scenario results in 2050 by sector, for the LTLS, HTHS and reference scenarios, as well as a 2021 baseline comparison. Relative to the reference scenario, the energy and transport sectors would have the largest reductions for the LTLS and HTHS scenarios by 2050. These are 4 $MtCO_2e$ (LTLS) and 6 $MtCO_2e$ (HTHS) for transport, and 3 $MtCO_2e$ (LTLS) and 7 $MtCO_2e$ (HTHS) for energy. Removals by forest are 8 $MtCO_2e$ lower in the LTLS scenario compared to the reference scenario, and slightly higher in the HTHS scenario (by about 1 $MtCO_2e$).

Figure 3.6: Scenario results for all greenhouse gases other than biogenic methane in 2050 by sector



Source: Commission analysis

Key insights from our scenarios for biogenic methane

For biogenic methane, the lowest ambition scenario results in a 24% reduction in emissions in 2050 relative to the 2017 baseline level, compared to a 47% reduction in emissions for the highest ambition scenario. The lowest ambition scenario results in an additional 0.30 $MtCH_4$ of gross emissions (about 8 $MtCO_2e$) compared to the highest ambition scenario. While the reference scenario just meets the 2030 target for biogenic methane, without further abatement it would fall well short of the 2050 target (11 percentage points below the minimum 24% reduction in 2017 levels required). Our scenarios show that, depending on technology and systems change in the next 30 years, it is possible to meet both the less ambitious (24% reduction) and more ambitious (47% reduction) ends. Below are further insights from our scenario analysis.

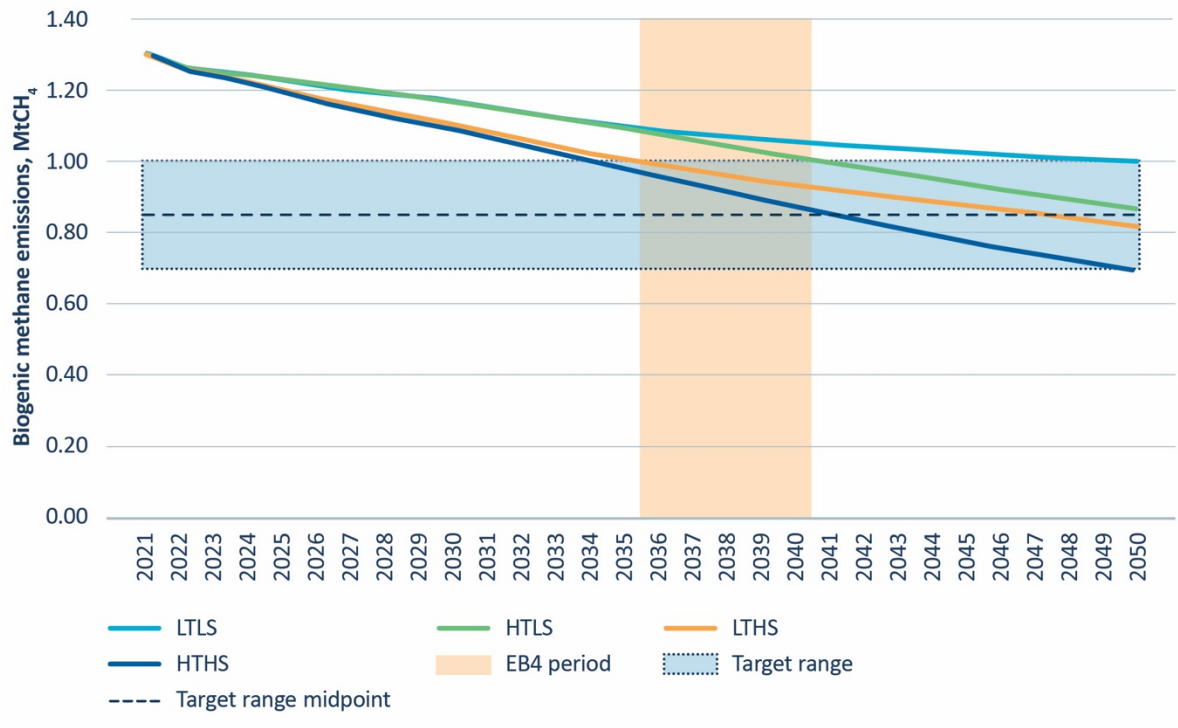
Leaning heavily on current available technologies, combined with projected land use change and reductions in stocking rates, would mean meeting the lower ambition end of the biogenic methane component of the 2050 target (**Figure 3.7**).

New methane-reducing technologies (assumed to be a vaccine and low-methane breeding for dairy cows and cattle) are included in our high technology change scenarios as we have evidence suggesting they may be available. The addition of these technologies, alongside continual improvements to farm management practices, and greater diversion of organic waste from landfills, means reaching the midpoint of the target range is possible. In addition to mitigations detailed above, reaching the high-ambition end of the target range would require:

- the addition of methane-reducing feed alternatives (3-NOP) for dairy cows
- going further to divert organic waste from landfills with greater anaerobic digestion
- greater diversion of waste to boiler fuel
- higher efficiency landfill gas capture.

Without new methane-reducing technologies, meeting the more ambitious end of the 2050 target range would likely require significantly lower agricultural production from livestock and more land-use change away from ruminant livestock.

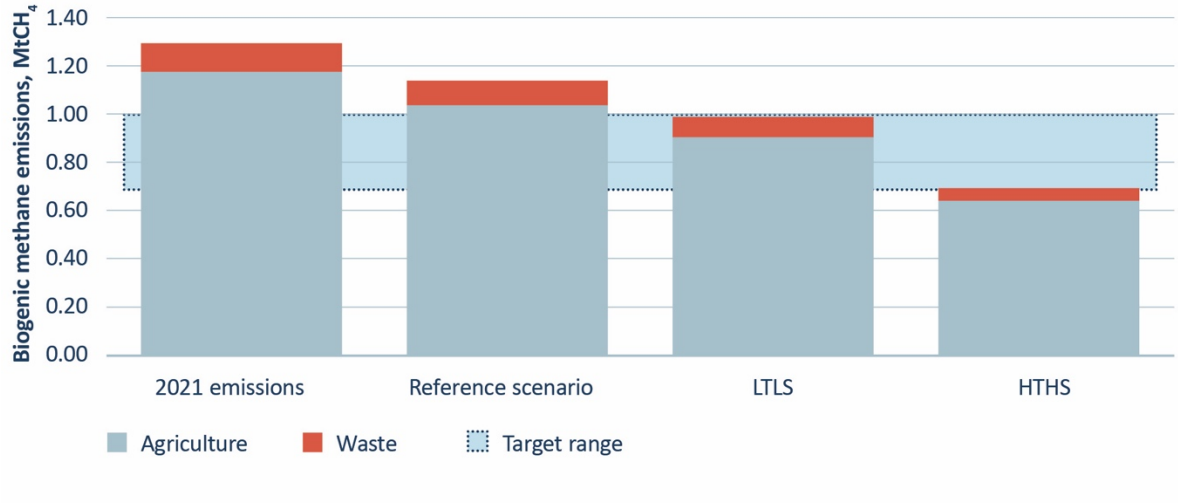
Figure 3.7: *Scenario results for biogenic methane*



Source: Commission analysis

Figure 3.8 below shows biogenic methane emissions in 2050 for the waste and agriculture sectors, for the lowest and highest ambition scenarios with comparison to the reference scenario and a 2021 baseline. In the LTLS scenario, emissions from agriculture are 13% lower, and emissions from waste 12% lower than the reference scenario. In the HTHS scenario emissions from agriculture are 38% lower, and emissions from waste 52% lower than the reference scenario.

Figure 3.8: *Scenario results for biogenic methane in 2050 by sector*



Source: Commission analysis

The EB4 demonstration path

We have used the insights we have drawn from the scenarios to develop the EB4 demonstration path – a pathway for how Aotearoa New Zealand could meet our draft fourth emissions budget. The EB4 path is one set of measures and actions within each sector that would deliver our draft recommended emissions budget.

The remainder of this chapter sets out the emissions outcomes from following this path – along with sensitivity analysis of the EB4 demonstration path. Further details on assumptions and results for each sector are presented in *Chapter 4: Sector contributions to meeting the fourth emissions budget*.

Developing the EB4 demonstration path

To develop the EB4 demonstration path we have considered the speed at which options may feasibly be deployed to reduce emissions. For many actions we have assumed levels of adoption near the midpoint of the assumptions made in the scenarios. However, for some mitigations where there is evidence to support adopting more ambitious uptake, or where the economic costs are judged to be low, our assumptions in the EB4 demonstration path are closer to the high end of what is technically feasible.

We also presented a demonstration path in *Ināia tonu nei* for how the first three emissions budgets could be met. The EB4 demonstration path differs from the previous demonstration path to reflect a number of changes since that advice. These are:

1. updated information and trends (on emissions, potential mitigations/actions to reduce emissions)
2. changes to previous assumptions due to new evidence (since our analysis from *Ināia tonu nei*)
3. improvements to the Greenhouse Gas Inventory[xv]
4. updated government forest projections[xvi]
5. updated actual forest planting.[xvi]

[xv] Updated annually by the Ministry for the Environment

[xvi] Updated annually by the Ministry for Primary Industries

Box 3.2: How we have selected actions in the EB4 demonstration path

Our scenario analysis identified a broad range of possible actions to reduce domestic emissions, including levels of deployment for each scenario. The development of our EB4 demonstration path required applying our judgement – based on the information available to us – to define an optimal mix of actions to reduce emissions for the fourth emissions budget. In doing so we considered matters from sections 5M and 5ZC of the Act, including consideration of actions that are ambitious while also being technically and economically achievable.

Not all possible actions for which there are evidence were included in our scenario analysis or our EB4 demonstration path. This may be due to uncertainty over the development of some technologies, particularly where there are already existing technologies that could reduce emissions, or where evidence suggests high costs of abatement. For example, we have modelled passenger transport transitioning to electric vehicles rather than hydrogen in part due to the technology readiness of EVs, as well as their lower capital cost and higher efficiency compared to hydrogen passenger vehicles. For some technologies we tested the choices of technologies through our scenarios.

Some examples of potential actions that we have chosen not to include in the EB4 demonstration path are detailed below.

Methane inhibitors

A methane inhibitor is a chemical compound that blocks enzymatic pathways for microorganisms in the gut of ruminant livestock, restricting their ability to produce methane.

3-NOP is a methane inhibitor that is expected to be commercially viable prior to the fourth emissions budget period. This inhibitor is a feed additive that is used alongside supplementary feed for dairy cows. As domestic dairy farms are predominantly pasture-based, this inhibitor is expected to be less effective for reducing methane emissions from domestic dairy production. As such we have not included it in our EB4 demonstration path.[xvii]

There is also a slow-release bolus[xviii] methane inhibitor in development that could be better suited to reducing methane emissions from domestic dairy production. Our evidence suggests that these may not be available commercially until 2039, which is towards the end of the budget period. As such we have not included this methane inhibitor in our EB4 demonstration path.[xvii]

Nitrification inhibitors

Nitrification inhibitors are chemical compounds that prevent microorganisms in the soil from producing nitrous oxide (a by-product from the conversion of nitrogen to nitrate).[16]

Our evidence suggests that the nitrification inhibitors are expected to be available commercially as soon as 2025. They are likely to come at a relatively high abatement cost compared to mitigations that reduce emissions for other greenhouse gases. As such we have not included nitrification inhibitors in our EB4 demonstration path.

[xvii] These decisions align with advice that we commissioned from The Agribusiness Group

[xviii] A bolus is a large time-release tablet that stays in the rumen of dairy cows

Hydrogen to decarbonise heavy vehicle transport

Battery electric vehicles and hydrogen fuel cells are two options for reducing emissions for heavy vehicles. Hydrogen fuel cells are expected to have higher range and faster refueling. However, hydrogen fuel cells are an energy-intensive technology and would require a further buildout of electricity networks that would compete with electricity needs from other sectors. Battery electric vehicles are expected to be three times more energy efficient than hydrogen fuel cell vehicles. As such our EB4 demonstration path models battery electric vehicles for heavy transport. However, it could also represent fuel cell trucks powered by green hydrogen fuel cells.

Decarbonising production of methanol

Methanol is a petrochemical feedstock used to produce a wide range of industrial and consumer products, as well as being used as a fuel for shipping. Methanol in New Zealand is produced from fossil gas. Methanol production can be decarbonised by using green hydrogen, in place of fossil gas, combined with a clean source of carbon dioxide. This creates a product called e-methanol. Green hydrogen is produced by electrolysis of water using renewable electricity.[17] This is known to be an energy intensive process.

Replacing fossil gas with biogas is another potential pathway. Biogas is a mixture of methane, carbon dioxide and other gases produced through anaerobic digestion of organic matter.[18] Our assessment of this option is that while existing facilities can produce biogas, this would require volumes of biogas that are unlikely to be achieved domestically. Blending is an option, noting this would only be expected to cover a small portion of the feedstock that current production facilities require, and there will be competition for the usage of biogas for other activities.

Domestic producers of methanol say they are still in early stages of investigating these options to decarbonise methanol production. Given current uncertainty regarding the feasibility of these options, we have chosen not to include these in our EB4 demonstration path.

Carbon capture and storage (CCS) and carbon dioxide removal (CDR) technologies

Our EB4 demonstration path includes CCS for geothermal electricity generation. This involves capturing carbon dioxide from geothermal fluids and reinjecting them back into the geothermal reservoirs (these are avoided emissions).

Other emerging technologies have not been included in our EB4 demonstration path. This is due to their early stages of development and uncertainties over their application in Aotearoa New Zealand, and the expected relatively high cost compared with other removal options (afforestation).

We cover these technologies in greater detail in *Chapter 4*.

Results of the EB4 demonstration path

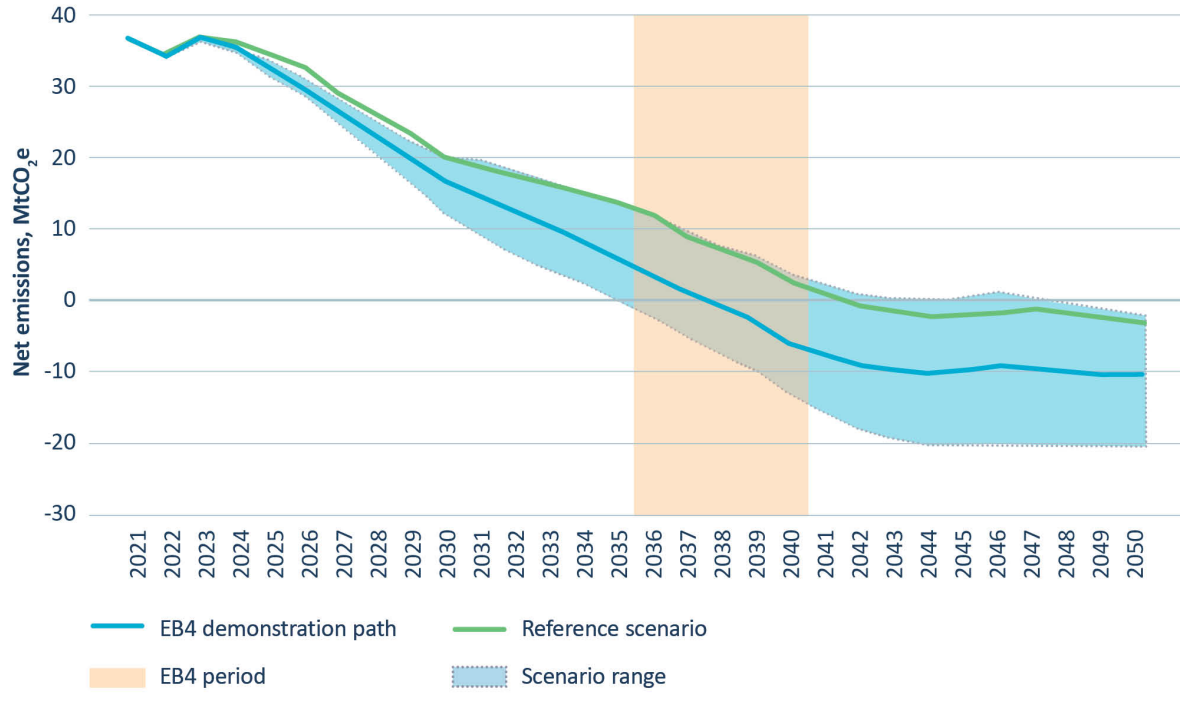
The EB4 demonstration path is shown in **Figure 3.9** and **Figure 3.10** below, alongside the reference scenario. The EB4 demonstration path represents a 32% reduction compared to the level implied from the reference scenario (or 64 $MtCO_2e$ fewer emissions).

Between 2036 and 2040, net emissions of all greenhouse gases other than biogenic methane in the EB4 demonstration path are 41 $MtCO_2e$ lower than the reference scenario. In this same period the EB4 demonstration path has 3 $MtCO_2e$ fewer carbon dioxide removals by forests than the reference scenario (119 vs 122 $MtCO_2e$). Gross emissions reductions are driving the reduction in net emissions of all greenhouse gases other than biogenic methane, with a total reduction of 45 $MtCO_2e$. We estimate that 28 $MtCO_2e$ of these reductions of gross emissions would come from transport, with energy contributing a further 12 $MtCO_2e$.

Emissions of biogenic methane across the fourth emissions budget period are 0.79 $MtCH_4$ lower in the EB4 demonstration path than the reference scenario, or 14% lower emissions. Agriculture emissions are 13% lower in the EB4 demonstration path, compared to 18% lower waste emissions.

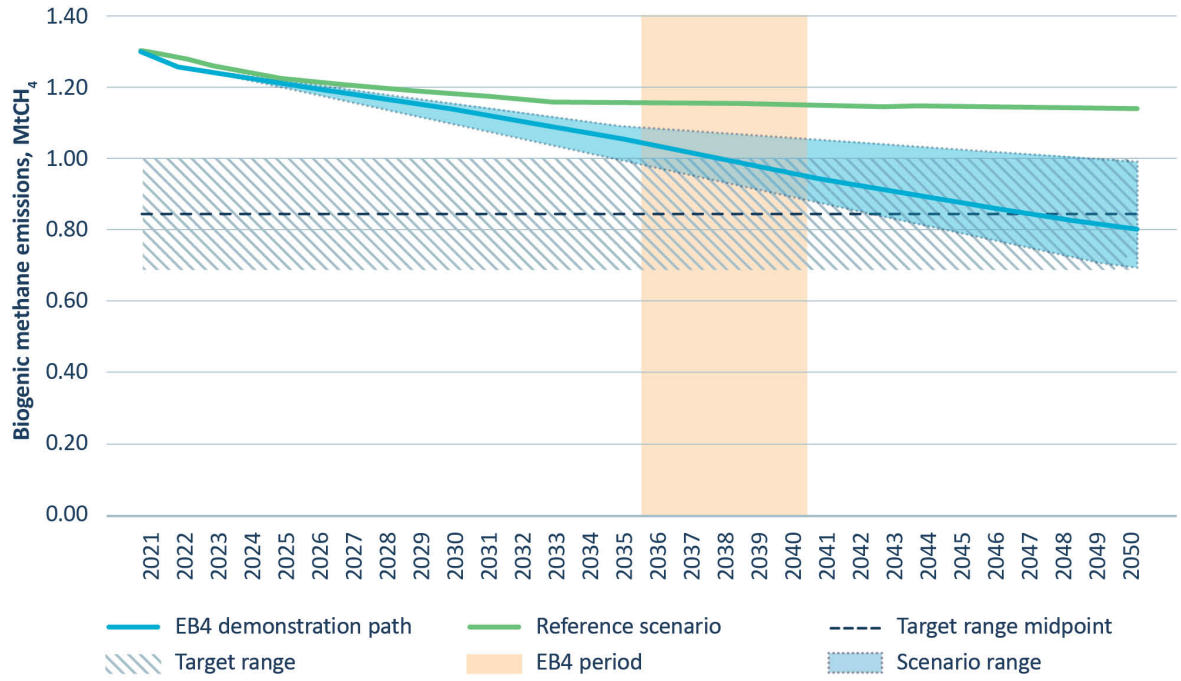
In the EB4 demonstration path net emissions of all greenhouse gases other than biogenic methane reduce by 47 $MtCO_2e$ from 2021–2050. Gross emissions of all greenhouse gases other than biogenic methane reduce by 30 $MtCO_2e$, a reduction of 68%. In this same period biogenic methane emissions reduce by 0.50 $MtCH_4$, a 38% reduction.

Figure 3.9: *The EB4 demonstration path to 2050 for net emissions of all greenhouse gases other than biogenic methane*



Source: Commission analysis

Figure 3.10: *The EB4 demonstration path to 2050 for biogenic methane*



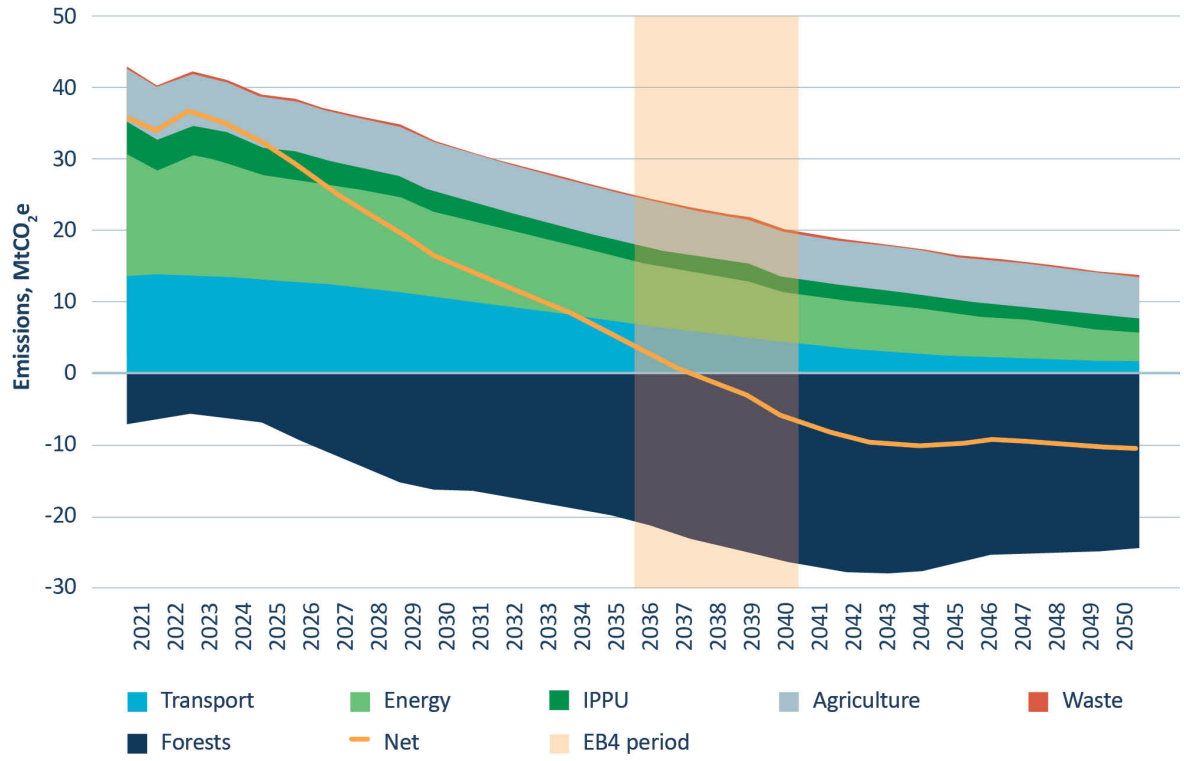
Source: Commission analysis

Summary of sector contributions to the EB4 demonstration path with emissions reductions to 2050

Figure 3.11 below shows emissions of all greenhouse gases other than biogenic methane in the EB4 pathway by sector to 2075. In 2050, gross emissions of all greenhouse gases other than biogenic methane decrease from 44 $MtCO_2e$ to 14 $MtCO_2e$ (relative to a 2021 baseline[xix]). The energy sector has the greatest reductions in emissions in 2050 (13 $MtCO_2e$), closely followed by the transport sector (12 $MtCO_2e$). A full breakdown of emissions reductions by sector to 2050 is in **Figure 3.12**.

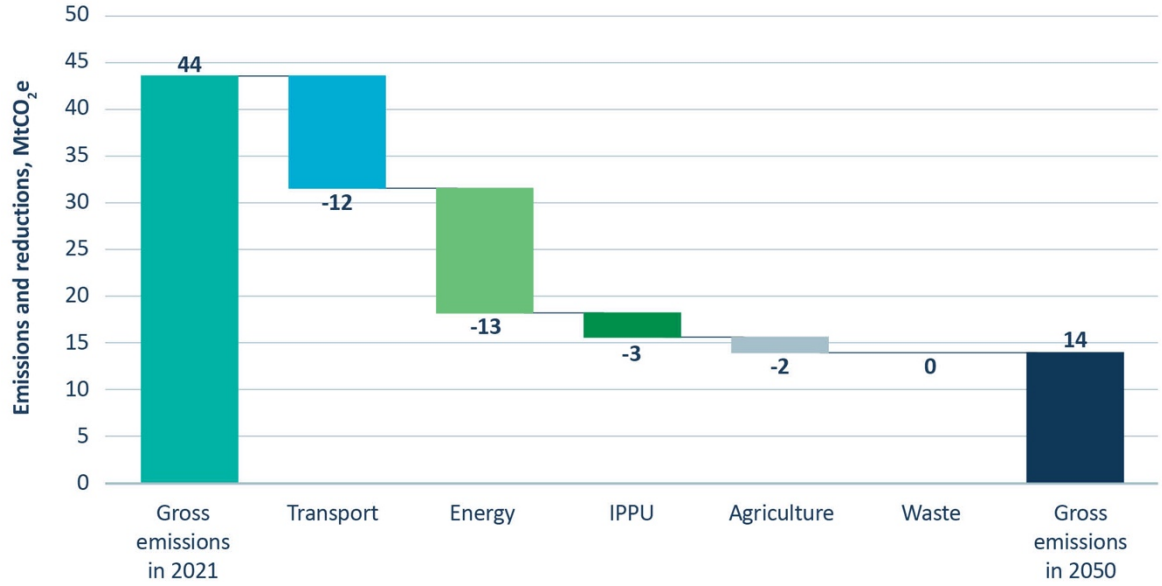
[xix] 2021 was chosen as the baseline as it is the latest available year for actual emissions (in the GHG Inventory).

Figure 3.11: *Emissions of all greenhouse gases other than biogenic methane by sector to 2050*



Source: Commission analysis

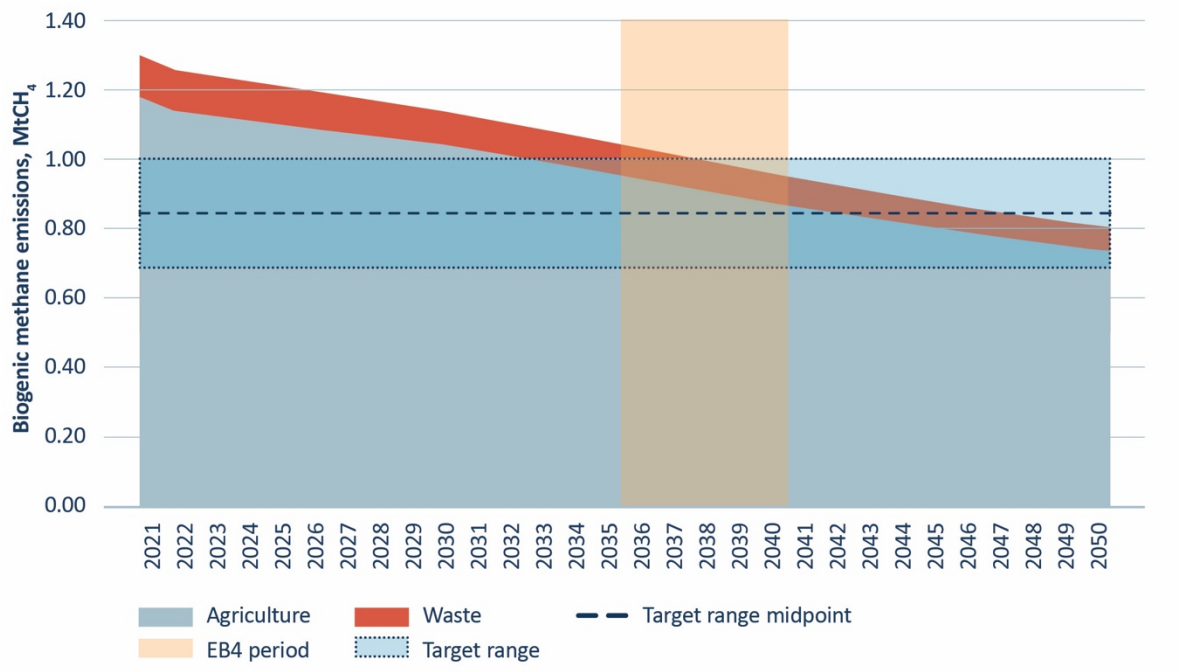
Figure 3.12: *Gross emissions of all greenhouse gases other than biogenic methane in 2021 with reductions by sector by 2050*



Source: Commission analysis

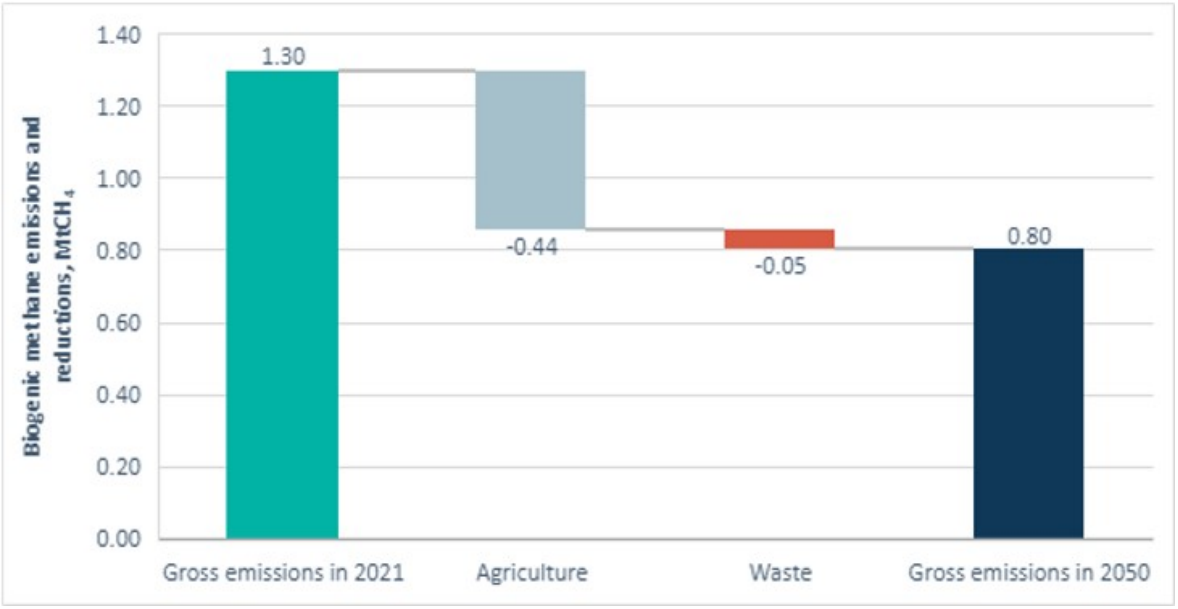
Figure 3.13 shows gross emissions of biogenic methane by sector, which reduce from 1.3 $MtCH_4$ in 2021 to 0.80 $MtCH_4$ in 2050. Between 2021 and 2050 waste sector emissions decrease by 45% (-0.05 $MtCH_4$), compared to a 38% reduction for the agriculture sector (-0.44 $MtCH_4$) (**Figure 3.14**).

Figure 3.13: *Emissions of biogenic methane by sector to 2050*



Source: Commission analysis

Figure 3.14: *Gross emissions of biogenic methane in 2021 with reductions by sector by 2050*



Further information on the assumptions that sit behind these values by sector can be found in *Chapter 4*.

We have undertaken sensitivity analysis to test how key uncertainties could impact the ability to meet our draft fourth emissions budget

This includes risks to meeting our proposed budget level as well as potential opportunities to reduce emissions further than what we have modelled in our EB4 demonstration path. **Figure 3.15** below shows the impact each of these factors has on the fourth emissions budget period. **Box 3.2** shows results of sensitivity analysis from C-PLAN, our Computable General Equilibrium (CGE) model that estimates overall economic impact of our proposed budget.

Stocking rates

We have tested the impact of increasing or decreasing the stocking rate reduction for sheep/dairy cows/cattle compared to the level in our EB4 demonstration path. In this testing we increased and decreased the stocking rate reduction by 25%. The lower stocking rate reduction would increase emissions by about 5 $MtCO_2e$. The higher stocking rate reduction would reduce emissions by a similar level.

Changes in production for large industrial emitters

Future production levels for large industrial emitters are also a key uncertainty which the budget is sensitive to. Our EB4 demonstration path assumes staged closure of methanol production in 2029 and 2039. Full operation of methanol facilities through the fourth emissions budget period would result in an additional 8 $MtCO_2e$ of emissions, equal to 6% of our proposed emissions budget. Full closure prior to 2036 would reduce emissions by nearly 4 $MtCO_2e$.

An unexpected closure of steel production prior to the emissions budget period would reduce emissions by about 3 $MtCO_2e$.

Early closure of the aluminium smelter would reduce emissions by about 4 $MtCO_2e$.

Population and GDP growth

We have tested for population growth and GDP growth that is lower and higher than the Government's projections. For population we have used low (0.3%) and high (1.1%) cases from the Government's 2023 projections. Our EB4 demonstration path uses a value of 0.7%. These values reflect average growth rates from 2022–2040.

For GDP, our EB4 demonstration path assumes an average growth rate of 1.9%. We have used the Government's low case value (1.4%) and high case value (2.4%) for sensitivity analysis.

Given these values, lower population and GDP growth could reduce emissions by up to 1.7 $MtCO_2e$, whereas higher growth could increase emissions by 2.1 $MtCO_2e$.

EV costs

In the EB4 demonstration path, we modelled that light passenger EVs will reach purchase price parity to internal combustion engine (ICE) vehicles in 2032. We also tested the impact of achieving purchase price parity sooner (2028) and later (2035). Achieving purchase price parity sooner would reduce emissions by 1.5 $MtCO_2e$, compared to an additional 1.1 $MtCO_2e$ of emissions for achieving this later.

Oil prices

Our EB4 demonstration path assumes an oil price of $84 USD per barrel in 2023, reducing to $65 from 2030. A higher oil price ($100 USD per barrel from 2025) could reduce emissions by 1.7 $MtCO_2e$, whereas a lower oil price ($40 USD per barrel from 2030) could increase emissions by 1.0 $MtCO_2e$.

Waste diversion rates

Waste diversion redirects organic waste going to municipal landfills to either anaerobic digestion or composting. Reducing waste diversion by 50% would increase emissions by 0.9 $MtCO_2e$. Increasing waste diversion by 50% would lower emissions by 0.9 $MtCO_2e$.

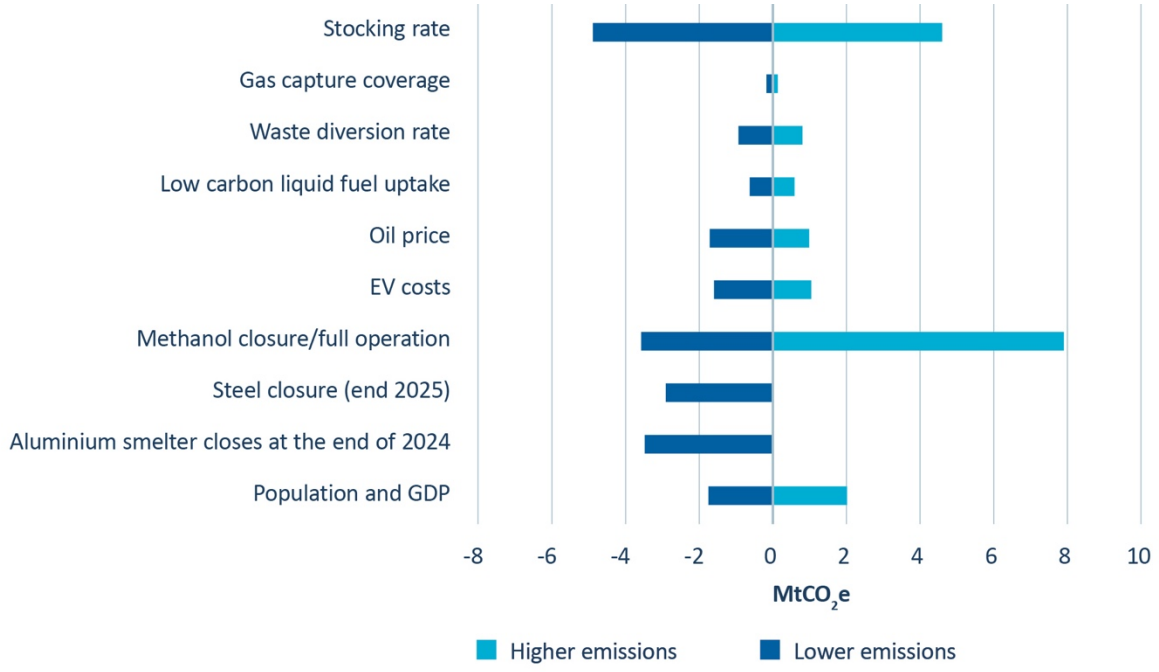
Uptake of low carbon liquid fuels

Low carbon liquid fuels are of non-fossil origin and can replace fuels from fossil sources, for both transport and non-transport energy purposes. Our EB4 demonstration path assumes a 12% blend by 2050. Achieving a 14% blend by 2050 could reduce emissions by 0.6 $MtCO_2e$, versus an additional 0.6 $MtCO_2e$ of emissions for a 10% blend.

Landfill gas capture coverage

Landfill gas capture prevents biogenic methane from being released from decomposing organic material in landfills. Gas captured can be used for other purposes. Higher coverage of landfill gas captured could reduce emissions by 0.1 $MtCO_2e$, and lower coverage could increase emissions by 0.1 $MtCO_2e$.

Figure 3.15: *Sensitivity analysis of budget period emissions to selected factors or events*



Source: Commission analysis

Overall assessment

Changes to stocking rates could have a large impact on meeting the fourth emissions budget. As such the Government will need to carefully consider policies and incentives for managing stocking rates over the fourth emissions budget, and the potential impacts of these on farmers, the wider agriculture sector and communities, and the economy.

Unexpected changes to the production of methanol, aluminium and steel could also have a material impact on the ability to meet our proposed emissions budget. Given these industries' relatively large contribution to overall domestic emissions, the Government will need to plan for the possibility of unexpected changes to production or facility closures through to 2040 (the end of the budget period).

The remaining factors we have tested have a range of impact of less than 2% for the total emissions budget.

Overall, this assessment gives us confidence that the risks posed by these uncertainties are manageable. In addition to targeted policies and incentives, the Government can manage these risks by aiming to outperform the emissions budget in its emissions reduction plan. Our HTHS scenario provides examples of areas where the Government could go further than our EB4 demonstration path. Some key examples include:

- further use of biofuels to decarbonise transport
- higher modal share of public and active transport
- transitioning to 100% steel production by electric arc furnace
- adoption of green anodes for aluminium production
- further land use change from dairy to horticulture
- adoption of methane-reducing feed additives.

Box 3.3: Sensitivity analysis in C-PLAN

We have tested how sensitive the C-PLAN GDP results are to some key uncertainties in the economy. These include the international oil price, international emissions prices, and population and GDP projections (see Figure 3.16).[xx] We have tested the changes to population and GDP growth together as a single sensitivity because the change in projected GDP is partly driven by higher or lower population growth.

When testing these sensitivities, we are looking at how the changes to input assumption(s) affect the estimated impact on GDP of meeting the emissions budgets. This is the difference in GDP between the EB4 demonstration path and the reference scenario.

The level of GDP under the reference scenario is an input assumption, rather than something that is generated by the model. This reference GDP path is held constant across the sensitivity tests – except for in the 'population and GDP' test where we are deliberately testing the effect of lower or higher future growth rates. This method allows us to isolate the change in the impact of meeting our recommended emissions budgets in each sensitivity test.

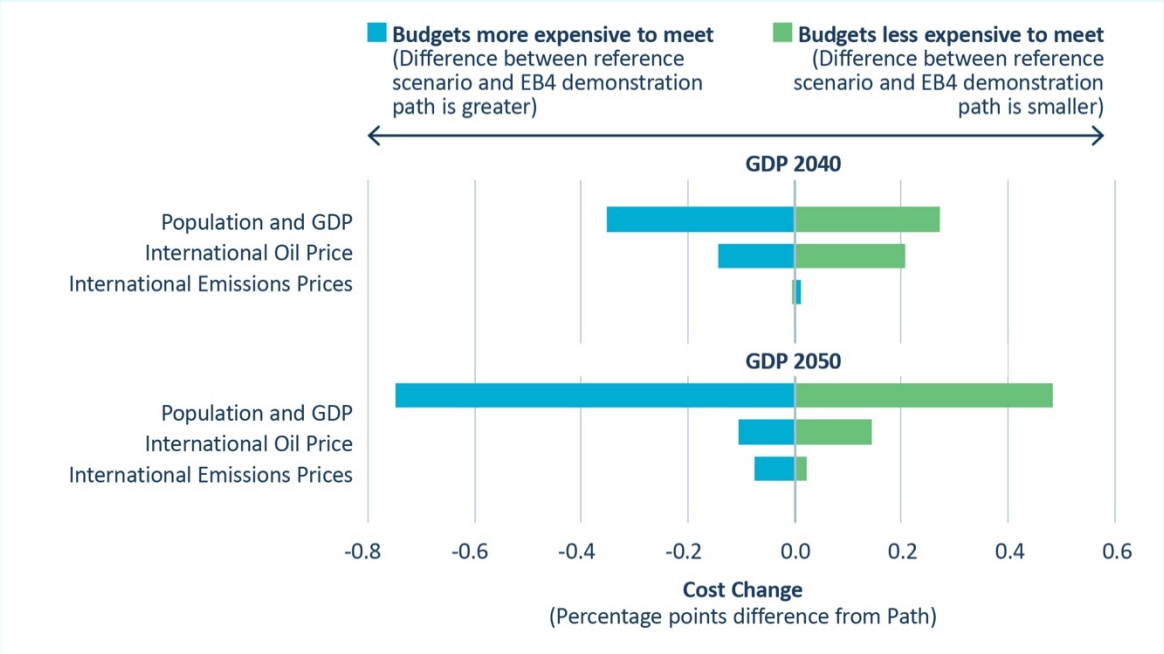
While some of the sensitivity tests do affect the modelled impact on GDP, the effect is generally within about 0.7 percentage points. Population and GDP, when significantly higher or lower than government projections, has the biggest impact on making budgets more or less expensive to meet.

Beyond 2035, GDP is less impacted by changes to international oil prices as the economy is further along in its transition away from fossil fuels.

International emissions prices, doubled and halved in our testing, have a relatively small effect. There are competing effects from higher international emissions prices – for example, our more emissions-intensive exports are relatively cheaper (boosting GDP), but our more emissions-intensive imports (including inputs to manufacturing) are relatively more expensive, reducing GDP. In 2040, these competing effects mean that the middle price is slightly worse in GDP terms than either the higher or lower price sensitivities. However, the effect is so small that, given modelling approximations, it is approximately zero.

[xx] In *Ināia tonu nei* we also tested for potential closing dates for the Methanex methanol plants and the NZAS aluminium smelter. The impact of these factors was small. We expect this will also be case for our draft fourth emissions budget. These factors will likely have similar cost impacts across our EB4 demonstration path and reference scenario.

Figure 3.16: *Impact of selected factors on GDP*



Source: Commission analysis

CHAPTER 4

Sector contributions to meeting the fourth emissions budget

This chapter covers the changes needed in different sectors to achieve the proposed fourth emissions budget.

The role of He Pou a Rangi Climate Change Commission (the Commission) in advising the Government requires us to consider the likely actions to meet the fourth emissions budget and 2050 target. This is important to enable the Government to make decisions on whether the proposed budget is achievable, and plan for the changes that will need to occur across all parts of the economy. It is important that these changes happen at a scale and pace that provides the maximum benefits for the country.

Our draft EB4 demonstration path (see *Chapter 3*) is a tool to illustrate what changes might need to happen and when, based on our analysis. It shows how each of these changes affects Aotearoa New Zealand's emissions reductions.

In the draft EB4 demonstration path, the largest emissions reductions in the fourth emissions budget period come from energy, transport, and agriculture. Achieving these emissions reductions will rely on significant change happening over the first three emissions budget periods. Actions required across the first three budgets build on our previous advice in *Ināia tonu nei* by taking into account the latest information on emissions, trends, and opportunities.

The draft EB4 demonstration path will see some new changes, primarily based on new evidence on adoption of methane-reducing technologies from the 2030s.

Gross emissions of long-lived greenhouse gases reduce significantly in the draft EB4 demonstration path, while maintaining current momentum to achieve greater reductions in net emissions through forest removals.

This chapter sets out the changes in our draft EB4 demonstration path out to 2050, focusing on how emissions reductions are achieved in the fourth emissions budget period at a level that meets the proposed budget. More detail on assumptions underpinning our draft EB4 demonstration path can be found in the *Assumptions Log.*

Impacts of the changes in the draft EB4 demonstration path on Aotearoa New Zealand are discussed in detail in *Chapter 5: The impacts of the fourth emissions budget on New Zealanders.*

We are seeking your feedback

In this chapter, we are seeking your feedback on the assumptions we have made in the EB4 demonstration path about each sector. In particular, we want to know:

- Do you agree the changes we assume for each sector are plausible and achievable? If not, why not?
- Do you have any evidence or insights that could contribute to our analysis?

Energy

Energy emissions are emissions that result from burning fuels to produce useful energy (for example, heat). They also include so called fugitive emissions which can occur, for example, in fossil gas production and geothermal electricity generation. They include emissions resulting from electricity generation, heating buildings, and industrial heat. They account for 22% in our current gross emissions profile[xxi]. In our EB4 demonstration path, energy emissions reduce by 59% by 2040 compared to 2021.

The electricity system plays a critical role in supporting other sectors to reduce emissions. To meet the increasing demand for electricity, Aotearoa New Zealand will need to considerably increase its capacity to generate and distribute renewable electricity. Biomass and low carbon liquid fuels would also become important energy sources for process heat and for sectors that are hard to electrify.

Renewable energy would increase substantially to meet demand

In order to support the electrification of key sectors in the economy, our EB4 demonstration path shows electricity demand would increase by 64% from 2022 to 2050 (see **Figure 4.1** below), compared to a 34% increase in the reference scenario.

This demand is primarily driven by electrification of transport and industry. However, we also anticipate new businesses would be attracted to Aotearoa New Zealand due to our low carbon electricity supply. This would put additional demand on our electricity supply. For example, in the EB4 demonstration path we assume new data centres approximately equivalent to 600 MW of new load by 2030, which is based on announcements of data centre development identified by Transpower.[19]

Industry developments, as well as information received through the call for evidence process, suggest that demand-side response can play a key role in helping to reduce peak electricity demand and hence electricity supply costs. This has the potential to save consumers money on bills and minimise the emissions associated with running fossil-fuelled plants to meet demand peaks. As such, the EB4 demonstration path assumes measures such as some industrial manufacturers reducing production at times of high demand, and smart EV charging, are deployed. Improving the way electricity use is managed, along with energy efficiency measures, reduces the overall amount of new capacity needed in the EB4 demonstration path compared to what would be needed without such measures.

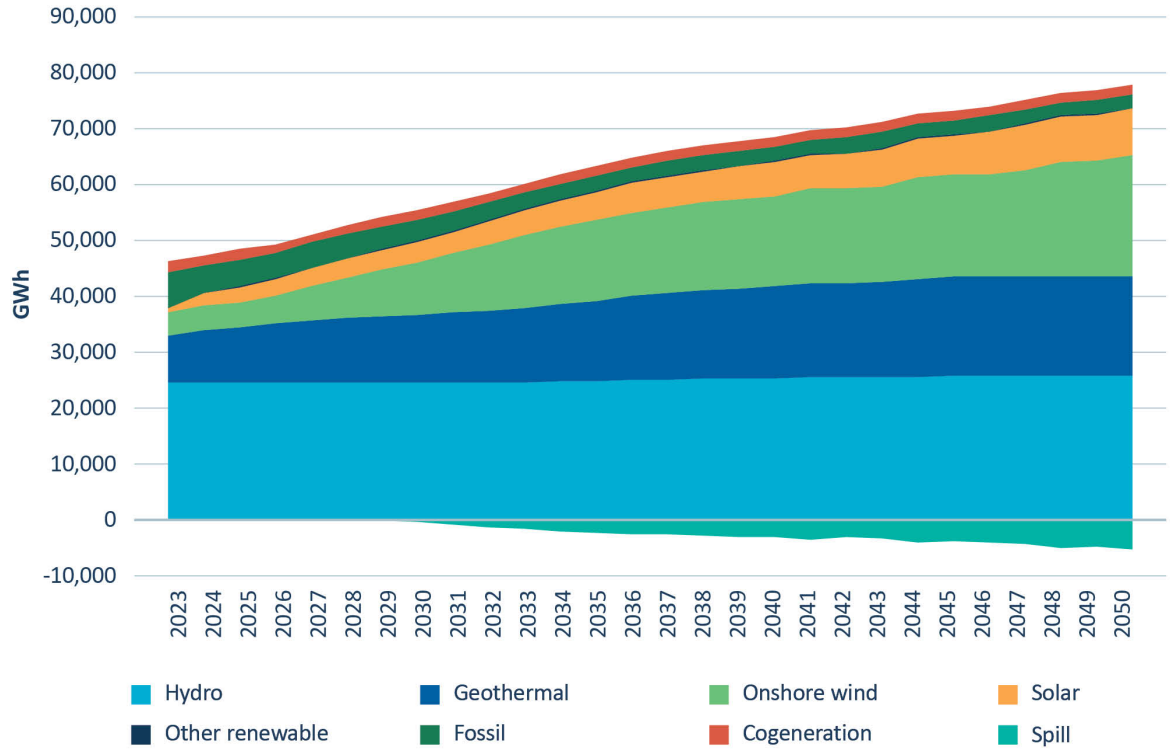
[xxi] Commission analysis using the 2023 GHG Inventory

Meeting this increase in demand would require a step change in new generation capacity being built relative to recent years but is in line with expected growth from other sources. For example, Transpower anticipate a 68% increase in demand by 2050, which would require additional generation capacity of 400–550 MW per year.[20] For scale, the additional capacity needed is equivalent to around two to three large wind farms being completed every year.[xxii]

As shown in **Figure 4.1**, to meet increasing demand for electricity, the EB4 demonstration path would see significant growth in solar, onshore wind, and geothermal generation to 2050, with relatively small increases in hydro generation. The particular generation types are a result of the Emissions in New Zealand model selecting the most economic generation type to build next.[xxiii] This accounts for factors like the cost to build the generation, as well as how often it will actually generate electricity (for example, solar will only generate when it is sunny).

While the model has produced a particular mix of generation types under the EB4 demonstration path, different mixes of renewable technologies could meet the projected increase in demand while achieving similar emissions reductions.

Figure 4.1: *Electricity generation by technology in the EB4 demonstration path*[xxiv]



Source: Commission analysis

[xxii] Although we expect a mixture of renewable generation types, including geothermal and solar.

[xxiii] The model considers a range of renewable generation technologies when it projects what will be built, including hydro, solar, onshore and offshore wind and geothermal.

[xxiv] In the figure "spill" represents an oversupply of electricity from renewable technologies generating electricity at times it is not needed.

Role of fossil fuels in providing a secure electricity supply would decline

Currently Aotearoa New Zealand's highly renewable electricity system relies on fossil fuel plants to provide electricity in situations where alternative options are not available (for example, when lakes are low or in times of high demand). There are also some fossil fuel plants that provide stable electricity generation, which can run most of the time.

Owing to the success of the Ngāwhā Geothermal Power Station in fully capturing emissions through gas capture and reinjection (see **Box 4.1**), we have allowed for geothermal to play a significant role in the EB4 demonstration path. Unlike wind and solar, which can vary due to weather, geothermal plants provide a stable form of electricity supply.

Furthermore, as costs to build renewable plants decline and rising carbon prices make it more expensive to run fossil power plants, it would become increasingly cost effective to replace the role of the fossil gas plants in providing reliable additional supply when needed, with an oversupply of renewable energy. However, we do see small amounts of fossil gas electricity continuing to play a supporting role in ensuring the security of supply through to 2050.

Box 4.1: Carbon capture and storage

We have considered the potential role for both Carbon Capture and Storage (CCS), and Carbon Dioxide Removals[xxv] in the EB4 demonstration path.

There have been recent successful trials at three geothermal fields (Ngāwhā, Te Huka and Ngātamariki), of CCS of CO_2 from geothermal fluids back into the geothermal reservoir. These trials, alongside stakeholder intentions to roll out this technology more widely, give us high confidence that geothermal capture of fugitive emissions can contribute to emissions reductions for the fourth emissions budget.

While there is potential in Aotearoa New Zealand for CCS and CDR to be applied in other contexts, we have not included it as an action in the EB4 demonstration path at this time. This is due to a number of factors including:

- the early stage of development of the technologies and their application in Aotearoa New Zealand
- the expected relatively high cost of these technologies compared with the other main removal option to reduce net emissions (afforestation)
- the availability of other technologies and actions which can reduce gross emission from most activities**.**

Due to these factors – except for geothermal electricity and afforestation – we do not consider that CCS and CDR would be required to achieve the proposed fourth emissions budget. This does not preclude the Government choosing to develop and apply these technologies to help achieve and maintain net zero emissions for greenhouse gases other than biogenic methane after 2050, if it believes there are benefits from doing so.

The Commission could also reconsider the role of CCS and CDR in achieving and maintaining net zero emissions for greenhouse gases other than biogenic methane if the evidence on the potential, costs and suitability of the technology in Aotearoa New Zealand changes.

[xxv] CCS is a process in which a relatively pure stream of CO_2 from industrial and energy-related sources is separated (captured) at or near a point source, conditioned, compressed, and transported to a permanent storage location for long-term isolation from the atmosphere. Permanent storage is generally geological (underground geologic formations, rocks, minerals).

CDR are deliberate human activities that draw physical quantities of CO_2 from the atmosphere, and durably store it in geological, terrestrial, or ocean reservoirs. There are two broad removal methods, biological and engineered geochemical/chemical. Engineered technologies, many of which are not yet mature, proven, or economically scalable, include direct air carbon capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS), the latter of which is CCS technology applied to a bioenergy facility.

There is large potential to improve the energy efficiency of buildings

For existing buildings, renovations offer an opportunity to replace fossil fuel heating systems and make large improvements in energy efficiency through improved insulation or more efficient forms of heating (such as heat pumps). New commercial and public buildings can be built to higher standards with new technologies to monitor and control energy use.

In the EB4 demonstration path, we have assumed that the energy efficiency of buildings would improve over time, reducing the demand for heating by 19% for residential buildings and 43% in commercial buildings by 2050, relative to 2019 levels. These are based on underlying assumptions on rates of energy efficiency improvements and rates of retrofit, which are consistent with those used in *Ināia tonu nei*.

We also assume coal would be phased out in residential buildings by 2032 and commercial buildings by 2037.[xxvi] Fossil gas would be phased out in all buildings by 2050. This would allow for smarter management of limited gas reserves in the transition, and our analysis suggests it is already economic in many cases for households to switch to electric. We have reviewed evidence on the potential for biogas integration,[xxvii] including material received through the call for evidence process, and have chosen not to include this in our pathway: it is not clear that a sufficient quantity of biogas will be available at a price point that would make it competitive with electricity as a decarbonisation solution.

Biomass and low carbon liquid fuels are important for sectors that are hard to electrify

The use of biomass, biofuels and other low carbon liquid fuels would be important for reducing emissions in some sectors, in addition to using electricity. For instance, solid biomass fuel is a key low-carbon option for process heat. Given the higher cost, in the EB4 demonstration path we assume the main long-term role of low carbon liquid fuels would be for sectors that are hard to electrify, such as some industry, long-haul aviation and shipping.

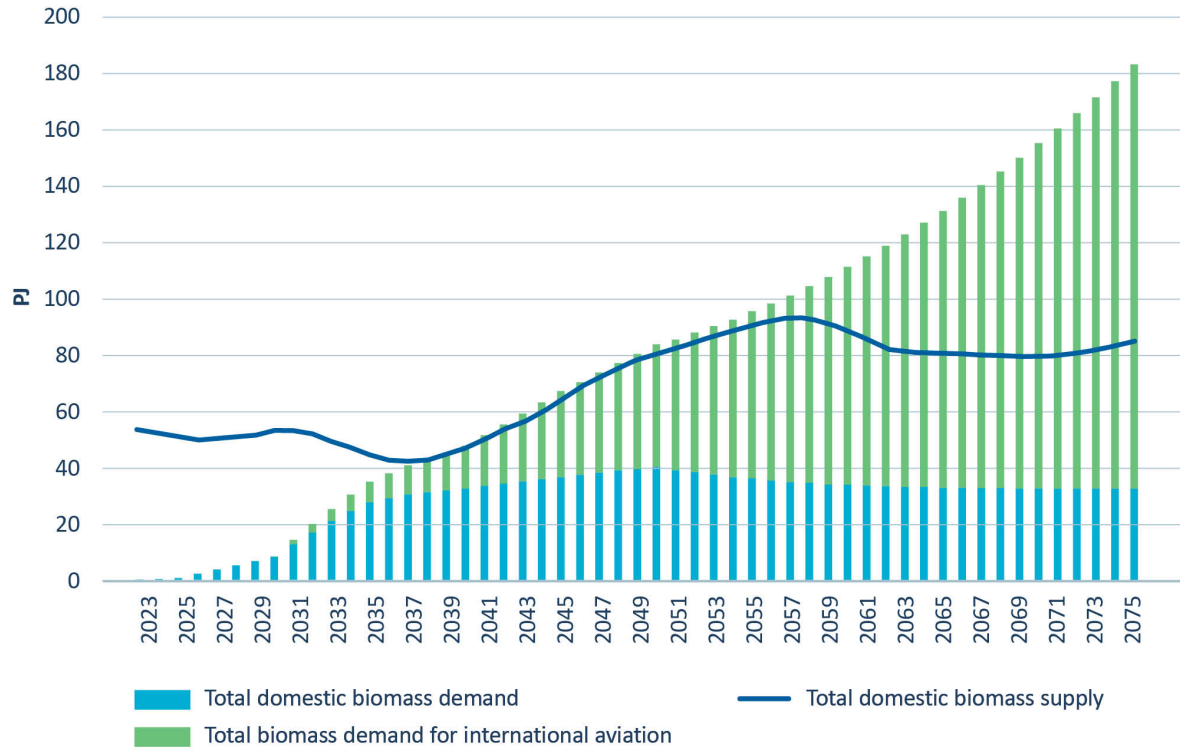
Ensuring there is sufficient availability of these fuels would be important to meet demand. In Aotearoa New Zealand, the main source of biomass is from exotic forestry. In the EB4 demonstration path we assume biomass supply is met through wood waste or residues from forest harvest as well as pulp logs. While the emissions from international aviation are not included in Aotearoa New Zealand's emissions (or the EB4 demonstration path), the use of low carbon liquid fuels in the sector would place a competing demand on biomass.

Our analysis in **Figure 4.2** shows that domestic biomass supply would be able to meet both uses until around 2050. In addition to biomass-derived liquid fuels, there are also other options that could help meet low carbon liquid fuel demand, such as the domestic production of synthetic fuels, or importing from international markets. It is also possible that low carbon liquid fuel demand may decrease due to the progression of alternative technologies.

[xxvi] This is based on analysis of past data of coal use in commercial buildings.

[xxvii] Biogas integration in this case refers to the blending of biomethane into existing fossil gas pipelines. This means gas consumers would be burning a mixture of fossil gas and biomethane. As biomethane is chemically identical to fossil gas, consumers would not notice anything different about their gas supply and existing appliances could continue to be used unmodified.

Figure 4.2: *Biomass supply and demand under the EB4 demonstration path*

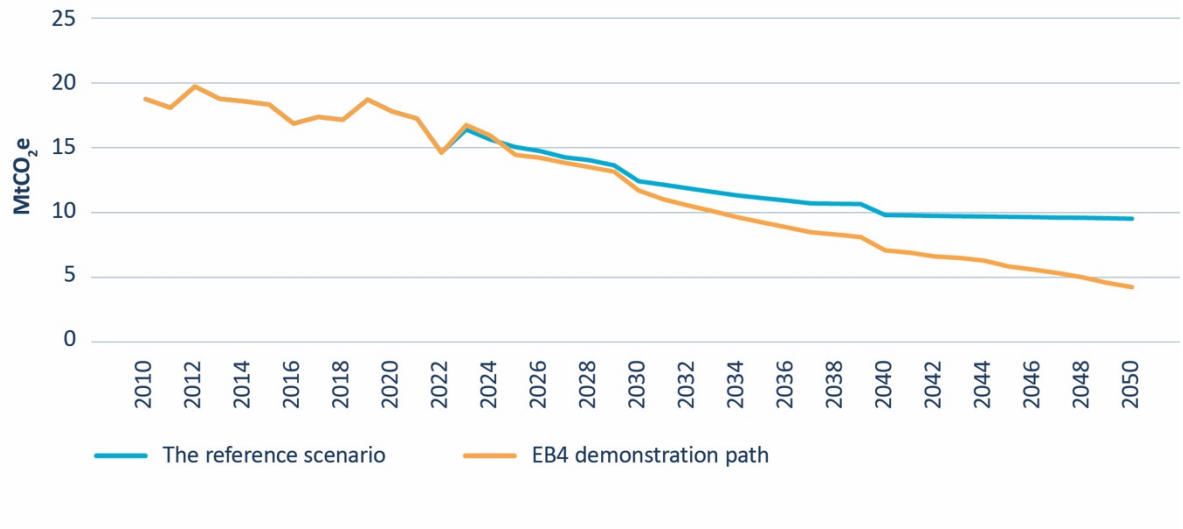


Source: Commission analysis

Increased renewable energy and phase out of fossil fuels would reduce emissions rapidly

Figure 4.3 shows that actions to reduce the role of fossil fuels and improve efficiency in the EB4 demonstration path would lead to relatively steady declines in energy emissions (excluding emissions from transport) through to 2050, compared to actions in the reference scenario. The step change reductions in 2030 and 2040 are a result of the assumed staged closure of methanol production in those years.
The steady declines are driven by phase outs of fossil fuels, replaced by renewable energy sources, across several sectors including electricity generation, industrial process heat, residential and commercial space, and water heating.

Figure 4.3: *Emissions from energy (excluding transport) in the EB4 demonstration path and the reference scenario*



Fossil fuels would be phased out in industrial process heat by 2050

Process heat is energy used primarily for industrial processes and manufacturing. There are proven options for decarbonising low- and medium-temperature process heat in industry. These include switching fuel use from coal and fossil gas to biomass and electricity.

The EB4 demonstration path, and all of our scenarios, align with the Government's policy to phase out coal in low- to medium-temperature industrial process heat by 2037.[21] This would see a steady, but reasonably rapid, rate of conversion to be on track to eliminate coal use for food processing before 2037. This change would be the equivalent of converting one to two very large dairy processing plants away from coal each year or converting a larger number of smaller plants.

We assume fossil gas would be phased out in the EB4 demonstration path by 2050. This assumption is based on our assessment of balancing ambition with what could reasonably be achieved. Modelling undertaken for us by DETA found that it would be possible to decarbonise process heat by 2050, however it would require concerted efforts to grow and upskill the workforce to ensure there are sufficient skilled workers to deliver the decarbonisation projects.[xxviii]

Along with boiler conversion, the EB4 demonstration path assumes significant improvements in energy efficiency across the food processing sector, averaging around 1.1–1.3% per year.

Based on publicly available information[22] and stakeholder engagement, we now also assume that the level of coal substitution for biomass and tyre-derived fuel in cement production can increase to 100% from the current level of 50%. We assume this occurs by 2035.

For some industrial activities that are hard to decarbonise, such as high temperature furnace heat, our EB4 demonstration path assumes liquefied petroleum gas would replace fossil gas until gas can be fully phased out. This is because as fossil gas phases down, it is likely to become less viable to maintain fossil gas transmission and distribution infrastructure as there will be too few consumers to generate the revenue required.

[xxviii] More information on modelling undertaken by DETA for this report can be found in the *Technical Annex.*

Industrial processes and product use

In addition to industrial energy emissions that are discussed in the section above, there are also some industries in Aotearoa New Zealand that emit greenhouse gases as a result of the underlying processes themselves. Industrial process and product use (IPPU) emissions capture these emissions as well as emissions from product use – mainly refrigerants.

Emissions from industrial processes and product use currently make up about 6% of Aotearoa New Zealand's gross emissions profile.[xxix] In our EB4 demonstration path, IPPU emissions reduce by 53% by 2040 compared to 2021. To reduce emissions from IPPU in the EB4 path, Aotearoa New Zealand will need to reduce emissions from large industrial processes such as steel or aluminium production, as well as phase down fluorinated gas emissions.

Higher emitting industry would transition to low emissions alternatives

Demand for coal, oil, and fossil gas is expected to reduce under the EB4 demonstration path as industry, business and households are assumed to switch to lower emissions energy sources. Our EB4 demonstration path would see fossil gas demand in Aotearoa New Zealand reduce by about 65% between 2022 and 2040, compared to 50% under the reference scenario. This therefore results in a decrease in fossil fuel production.

Recent developments in technologies mean we are assuming industries are likely to be able to go further in reducing emissions in the EB4 demonstration path, than we previously projected in *Ināia tonu nei.* For example, as per recent announcements regarding NZ Steel's electric arc furnace project,[23] we now assume 75% of steel production can be coal-free by 2032.[xxx]

For industries where greenhouse gases are a by-product of the production process, emissions can be hard to avoid. In *Ināia tonu nei* we had assumed that the NZAS aluminium smelter would close in 2024. However, the plant now sees a path to staying open (as opposed to production moving overseas). We now assume it would stay open until at least 2050, as there is no clear evidence to suggest it would close at any particular date. We also assume methanol production (through the Methanex plants) would undergo a staged closure – with one of its two remaining plants closing down in 2029 and the second in 2039. This is based on publicly available information on Methanex's fossil gas supply contracts.

[xxix] Commission analysis using the 2023 GHG Inventory

[xxx] In 2023, the Government announced it would partner with the Glenbrook steel mill to install an electric arc furnace. This investment would approximately halve emissions from steel production and displace about 50% of its coal use. The agreement contains incentive payments if NZ Steel installs the electric arc furnace by 2027 and if it can achieve greater levels of emissions reductions by 2030.

F-gases reduce in line with international commitments

Fluorinated gases, particularly hydrofluorocarbons (HFCs), are greenhouse gases that are primarily used as refrigerants in fridges, freezers, and air conditioning systems.

The EB4 demonstration path assumes greenhouse gas emissions from HFCs reduce by 53% by 2035 and 64% by 2040 relative to 2021, in line with the actions Aotearoa New Zealand takes under the Kigali Amendment to the Montreal Protocol, as well as other policy measures. This assumption is considerably more ambitious than *Ināia tonu nei* where we assumed HFC emissions would reduce 32% by 2035 relative to 2019.

Our assumptions for the EB4 demonstration path are directly based on projections from the Ministry for the Environment[xxxi] around what can be achieved with current policy including:

- reducing the import of HFCs contained within products
- reducing the leakage of HFCs in equipment
- increasing end-of-life recovery of products that contain these gases.

Mobile machinery and off-road vehicle emissions

These include emissions from vehicles used in forestry, construction, mining and agriculture, as well as fishing vessels and recreational watercraft. These types of machinery are more difficult to electrify, so the transition will likely take longer.

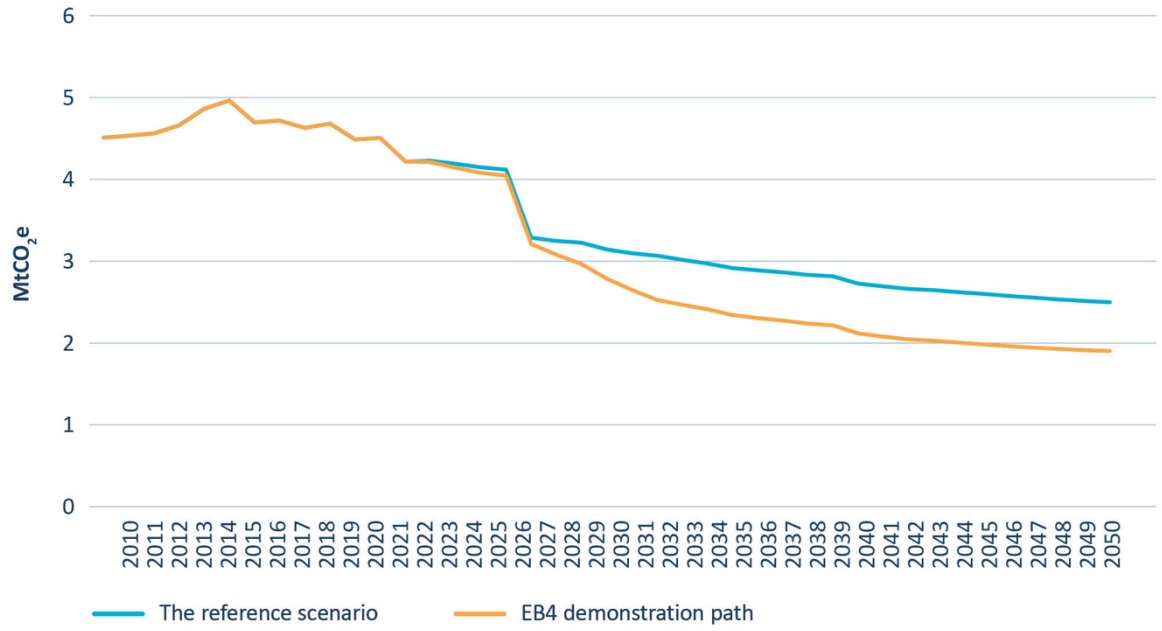
In *Ināia tonu nei*, we assumed that electrifying off-road vehicles would happen at the same rate as heavy on-road transport. But while we are starting to see electric trucks on the road, EV uptake off-road is very limited. We now assume the uptake of electric vehicles off-road would lag on road heavy vehicles by five years, and low carbon liquid fuels would play an important role. Challenges for electrifying off road vehicles include the scale of the market (i.e. fewer numbers of large machinery), access to charging structure, EV capability, and cost.

Industrial process and product use emissions would reduce as fossil fuels are phased out

As shown in **Figure 4.4**, the actions in the EB4 demonstration path would result in emissions from industry reducing significantly from 2023 through to 2050. We would see a steep decline in 2027 for both the EB4 demonstration path and the reference scenario due to 50% of steel production switching to electric arc furnace-based production. There would be further declines in the EB4 demonstration path emissions from 2027 onwards as the proportion of steel produced using the electric arc furnace process increases to 75%. The phasedown of hydrofluorocarbons (HFCs) also leads to a decreasing trend in emissions.

[xxxi] The Ministry for the Environment projections include high, low and mid levels of emissions reductions from HFCs based on current policy. We used the low emissions projections.

Figure 4.4: *IPPU emissions in the EB4 demonstration path and the reference scenario*



Transport

Emissions from transport currently make up 17% of Aotearoa New Zealand's gross emissions profile.[xxxii] In our EB4 demonstration path, these emissions would reduce by 68% by 2040 compared to 2021.

Moving to electric vehicles plays a large role in reducing emissions as well as more use of public transport, walking and cycling. By 2040, we anticipate more than 85% of the light vehicle fleet[xxxiii] (cars, utes/vans, and motorcycles) would be electric and all new and used vehicles entering Aotearoa New Zealand electric. Low carbon liquid fuels would play an important role for transport that is hard to electrify such as air travel and heavy off-road vehicles.

More people would be walking, cycling and using public transport

We assume the total distance travelled via walking, cycling, and public transport would have grown to 15% of all passenger kilometres travelled by 2040. This compares to 5% in the most recent Household Travel Survey. This assumes that public transport in major centres like Auckland and Wellington will achieve a 20% share of passenger kilometres travelled by 2040. This will require substantial investment in public transport infrastructure, and cycling and walking infrastructure.

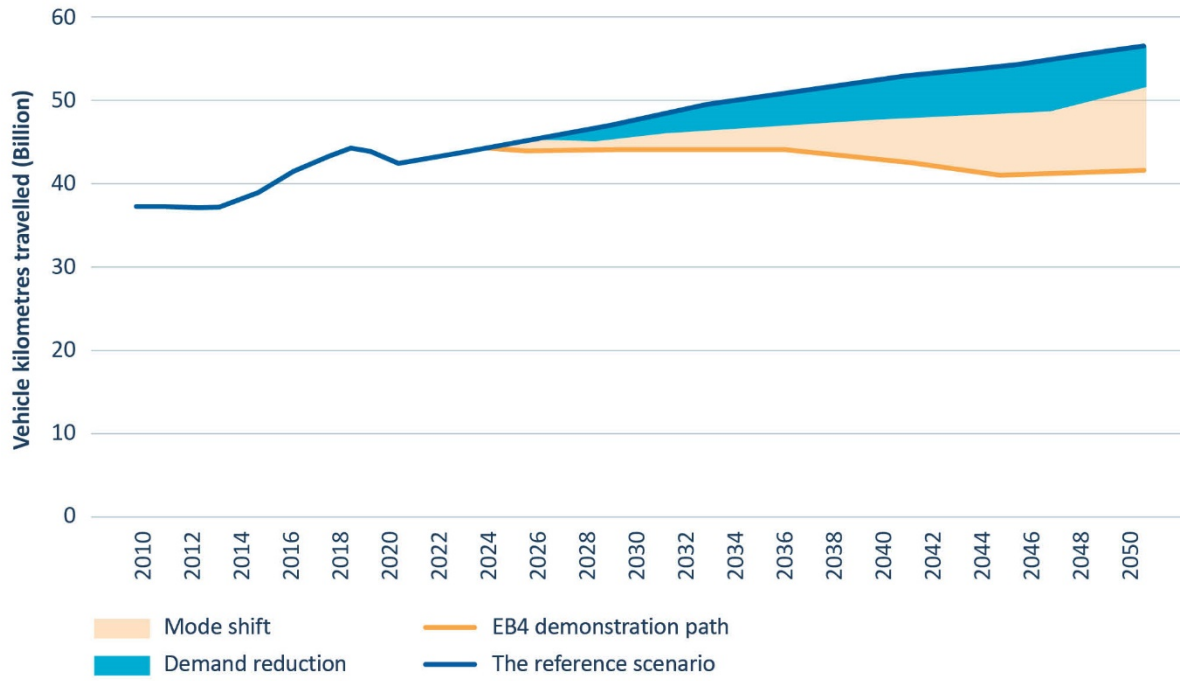
This increase in mode shift and some reduced demand for travel (for example due to more working from ho me and more dense urban form) would reduce the overall distances travelled by vehicles by 18% in 2040, co mpared to the reference scenario (see **Figure 4.5**).

[xxxii] Commission analysis using the 2023 GHG Inventory.

[xxxiii] Light vehicles are those under 3.5 gross tonnes and heavy vehicles are those over 3.5 gross tonnes.

As well as supporting emissions reduction, this change comes with co-benefits to health, congestion, and road safety (see *Chapter 5: Impacts of the fourth emissions budget on New Zealanders*) and reduces the path's dependency on electrification alone.

Figure 4.5: *Comparison of vehicle kilometres travelled from the EB4 demonstration path and reference scenario*



Source: Commission analysis

All light vehicles entering the fleet would be electric by 2040

Electrification is central to transport decarbonisation in our EB4 demonstration path. By 2040, we assume all light vehicles, both new and used, and almost all trucks entering the fleet would be zero emissions battery EVs. This results in almost 80% of light travel vehicle travel being done in an EV by 2040.

The switch to EVs in our light vehicle fleet has been happening faster than we expected in *Ināia tonu ne*i. Between 2020 and 2023, registration share of EVs rose from 5% to 14%. This could be attributed to Government policy (the Clean Car Discount) which was in place for the same period.

While the cost of purchasing an EV is currently higher than petrol or diesel vehicles, recent trends in battery prices have been showing these costs are coming down. By 2040, we expect the cost of purchasing a new battery EV to be 15% lower than a new petrol vehicle.

Almost all new trucks would be electric by 2040, with some mode shift from road to rail and coastal shipping

In contrast with the light fleet, the switch to electrics in heavy vehicles has been slower than projected in *Ināia tonu nei.*[xxxiv] We expect it would take longer for capital costs to be similar to petrol and diesel vehicles compared to light vehicles – but total cost of ownership for heavy vehicles would be lower in the early 2030s due to lower operational costs.[xxxv]

In addition to switching to heavy electric vehicles, we also assume shifts to lower emissions modes like rail and coastal shipping at the same levels we assumed in *Ināia tonu nei.* This would lower the vehicle kilometres travelled (VKT) of heavy vehicles by 10% by 2040 compared to the reference scenario.

Aviation would decarbonise by switching to electric and utilising low carbon fuels

Although air travel faces more challenges for reducing emissions than land transport due to limited potential for electrification, there are some emerging opportunities. In the EB4 demonstration path, we assume battery electric aircraft are gradually deployed for (short haul) regional flights[xxxvi] – which account for around 40% of Aotearoa New Zealand's domestic air travel. In the EB4 demonstration path we assume 13% of regional trips (5% of total travel) would be electrified by 2040 by battery-electric aircraft.[xxxvii] For inter-regional jet aircraft, the use of low carbon liquid fuels and improving efficiency are the main mechanisms for reducing emissions. Use of low carbon liquid fuels grows, gradually reaching 7% by 2040, and 15% by 2050.

We assumed a slower rate of efficiency improvement and electrification than in *Ināia tonu nei.* This was based on improved modelling showing the challenges the sector faces and our assessment of new evidence.[24,25] As a result, emissions from the EB4 demonstration path for aviation are 22% higher by 2040 than in *Ināia tonu nei.*

[xxxiv] For new heavy trucks, only 500 heavy EVs are registered within the motor vehicle fleet in 2023. Many of these are electric buses with only a few heavy trucks. *Ināia tonu nei* had 700 electric heavy vehicles in the fleet in 2023.

[xxxv] This is for an 'average' truck, but each vehicle's operating environment will determine where the crossover point is.

[xxxvi] Flights using smaller turboprop aircraft like the ATR72, Q300 and Cessna Caravan.

[xxxvii] This could also be achieved with hydrogen aircraft or a larger share of plug-in hybrid aircraft.

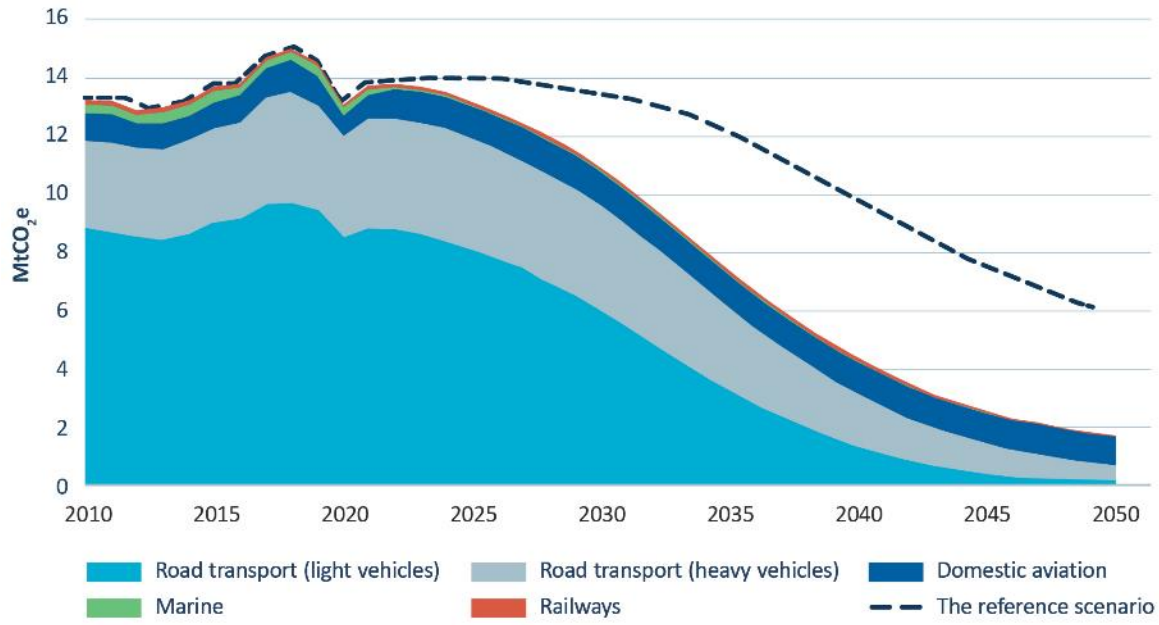
Emissions from transport would reduce dramatically

Emissions from light vehicles, which currently make up 64% of total transport emissions, fall steeply from 2021 to 2040 (8.9 $MtCO_2e$ in 2021 to 1.3 $MtCO_2e$ in 2040). This is due to vehicle distance travelled reducing through greater use of public transport, walking and cycling more, alongside switching to electric vehicles.

Other parts of the transport system are slower to decarbonise. Heavy vehicle emissions are reduced by half (from 3.8 $MtCO_2e$ in 2021 to 1.8 $MtCO_2e$ in 2040) from actions including mode shift to rail and coastal shipping and electrification.

Driven by growing demand, the aviation sector emissions will grow slightly between 2021 and 2040 (0.8 $MtCO_2e$ in 2021 to 1.1 $MtCO_2e$ in 2040). By 2040, aviation is 25% of the remaining transport emissions.

Figure 4.6: *Transport emissions in the EB4 demonstration path and reference scenario*[xxxviii]



Source: Commission analysis

[xxxviii] In the reference scenario, marine emissions fall dramatically in 2022, reducing to one quarter of previous levels. We chose to follow this trend in our scenarios and paths because it is in both the reference and published energy statistics. We chose to retain the same activity projections for the sector in line with the assumption made with other sectors. See Technical Annex for further detail.

Agriculture

Agriculture emissions currently make up 51% of Aotearoa New Zealand's gross emissions profile.[xxxix] In our EB4 demonstration path, these emissions would be reduced by 24% by 2040 compared to 2021. This is primarily due to changes in farming practices and uptake of methane reduction technologies.

Changes in farming practices would reduce emissions

The work of the Biological Emissions Reference Group (BERG), the New Zealand Agricultural Greenhouse Gas Research Centre, and others, has identified that changes in farm management practices, such as reducing stocking rates and fertiliser on most farms[xl] can reduce emissions while improving animal performance (productivity).[26]

In the EB4 demonstration path, we assume that farmers reduce stocking rates by 23% for dairy and 12% for sheep and beef farms by 2050, compared to 2021.

Figure 4.7 shows that it is possible to reduce methane emissions from the dairy sector by lowering stocking rates while maintaining relatively stable production levels of milk solids. This is due to improvements in on-farm efficiency. However, this means that production and revenue would not grow as projected under the reference scenario.

We estimate that by maintaining recent trends in land use change and reductions in stock numbers for the sheep and beef sector, meat production would reduce by 17% in the EB4 demonstration path in 2050 (relative to 2023 levels). This is similar to what we would expect under the reference scenario and is shown in **Figure 4.8**.

Figure 4.7: *Stock numbers, production and methane emissions for dairy in the EB4 demonstration path and the reference scenario (TRS) relative to 2023 dairy values*

[xxxix] Commission analysis using latest values (2021) from the 2023 GHG Inventory.

[xl] Farms that are already operating at close to optimal efficiency may not be able to reduce emissions without reducing profitability, but many farms are expected to be able to reduce emissions while maintaining or increasing profitability.

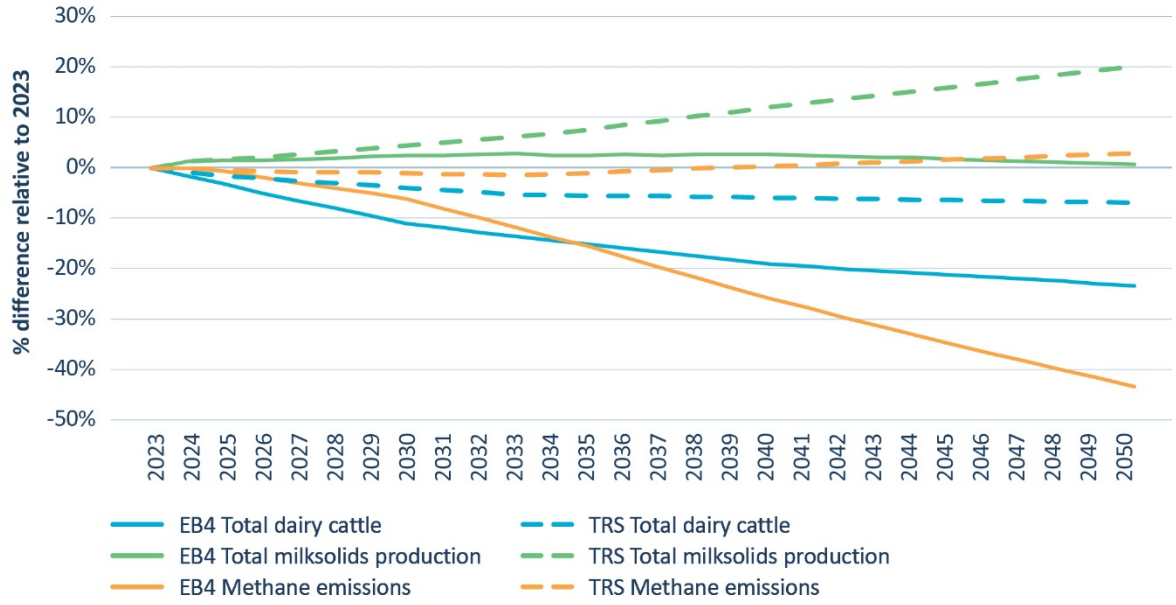
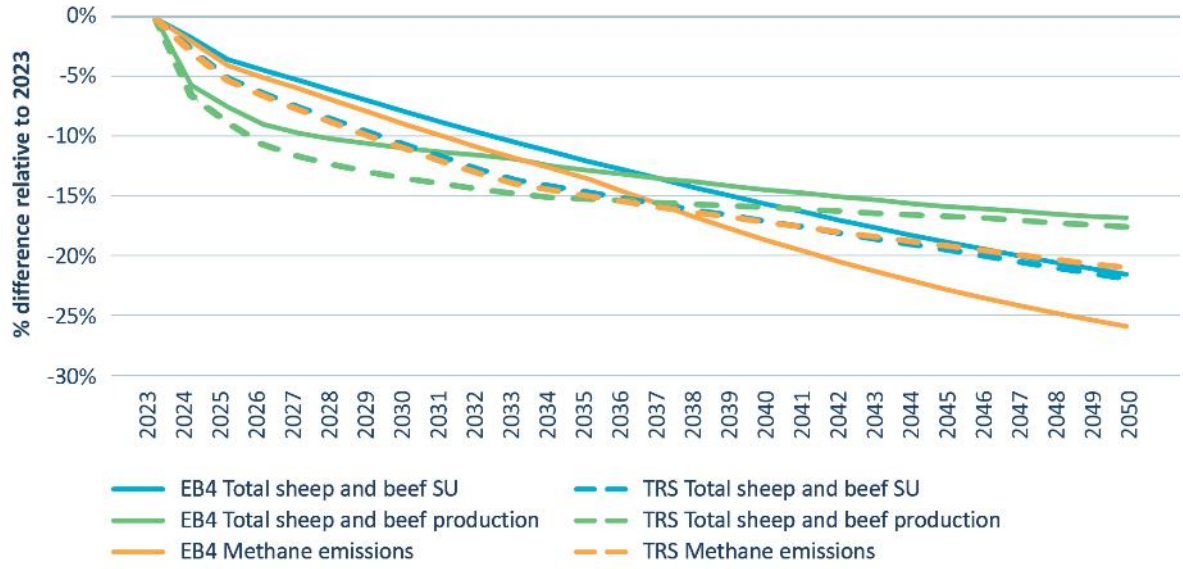


Figure 4.8: *Stock numbers, production and methane emissions for sheep and beef in the EB4 demonstration path and the reference path relative to 2023 sheep and beef values*



Developing technologies offer more potential to reduce emissions

The biggest driver of changes in agricultural emissions in our EB4 demonstration path compared to *Ināia tonu nei* is due to new research around when new and emerging methane reduction technologies are likely to be adopted.[xli]

[xli] Our assumptions for the EB4 demonstration path are based on a report by The Agribusiness Group that reviewed the latest evidence on agricultural technologies. We have published this report as part of the supporting information and data that accompanies this draft advice.

In our EB4 demonstration path, we assume that urease inhibitor, farm effluent treatment, and low methane producing sheep genetics are introduced. These technologies are already available and being adopted to different extents. We now also expect the ability to genetically select for low-emitting dairy cattle before 2030.[27]

For other technologies, the future is more uncertain. There is much research being done on methane-reducing technologies, including methane vaccines and methane inhibitors. While there are methane inhibitors available overseas, they are currently not suitable for Aotearoa New Zealand's pasture-based agriculture. Methane vaccines are also not currently available – research suggests that a vaccine could be available for dairy and sheep and beef by 2035.

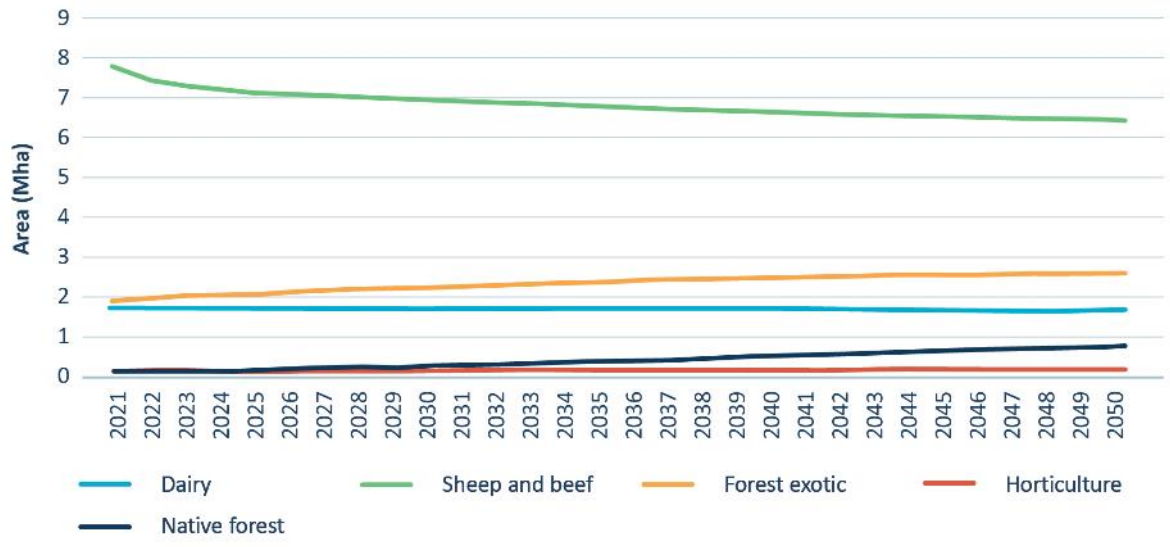
To account for this uncertainty in the EB4 demonstration path, we assume generally that some methane-reducing technologies would be taken up but do not specify the technology. In total we expect methane-reducing technologies would reduce emissions by 1.05 $MtCO_2e$ in the fourth emissions budget period.

Unlike *Ināia tonu nei,* we are not assuming nitrification inhibitors would be taken up as the costs are high compared to the other technologies (around \$1,700 per tCO_2e compared to options such as selecting for low methane animals that could cost at \$34 per tCO_2e).[xlii]

Converting land to lower emissions uses

In the EB4 demonstration path, we assume some land is converted to uses that have lower emissions. We assume land currently used for dairy is converted to horticulture at a rate of 1,103 ha per year (compared to actual rates of dairy land being reduced on average by 1,138 ha per year from 2017–2022). We assume 17% of land used for sheep and beef is converted to native and exotic forestry by 2050, relative to 2021 (similar to current trends). This is shown in **Figure 4.9**.

Figure 4.9: *Summary of projected land use from 2021 to 2050 in the EB4 demonstration path (projections begin in 2022)*



Source: Commission analysis

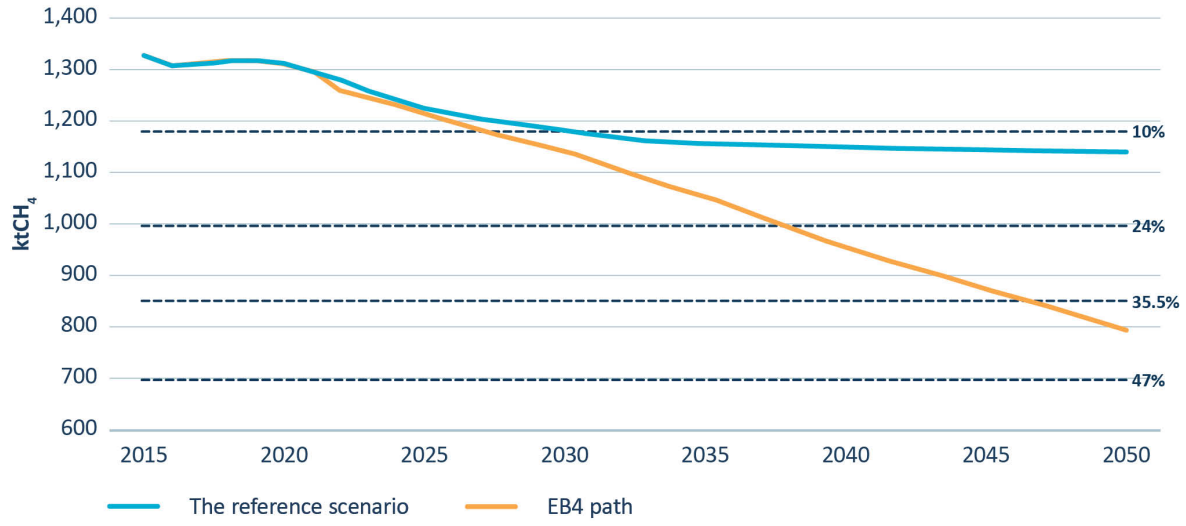
[xlii] In *Ināia tonu nei,* we assumed nitrification inhibitors would be used after 2035.

Impact on emissions

More technology being available in the EB4 demonstration path, alongside improved practices, would mean emissions could reduce considerably to meet the fourth emissions budget. Recent changes in land use and smaller dairy herds means emissions from this sector are starting at a lower point since *Ināia tonu nei*. Our analysis shows it is possible to achieve a 39% reduction of biogenic methane relative to 2017 levels (about the midpoint of the biogenic methane target range) by 2050 (**Figure 4.10**).

This compares to *Ināia tonu nei* where our analysis suggested Aotearoa New Zealand could only reach the less ambitious end of the target range – based primarily on implementing practices that are already available. This reflected the technology and systems we expected would be available for the first three emissions budgets. With an additional five years until the fourth emissions budget and the developments in relation to methane-reducing technologies discussed above, we have taken the view that these technologies will be available in the fourth budget period.

Figure 4.10: *Reduction of biogenic methane from agriculture and waste in our EB4 demonstration path in relation to the 2050 target*



Source: Commission analysis

Forests

Aotearoa New Zealand's forests play an important role in our transition, acting as removals for carbon in our atmosphere. Aotearoa New Zealand has choices in how much it uses these removals to sequester carbon versus how much focus in on reducing emissions.

More land converting to exotic forestry in recent years means overall less exotic forestry is needed in our EB4 demonstration path to 2050 to reach the same overall amount of exotic forestry that we modelled in *Ināia tonu nei*. Our EB4 demonstration path would see a much higher level of native planting, compared to current rates, to provide a long-term carbon sink.

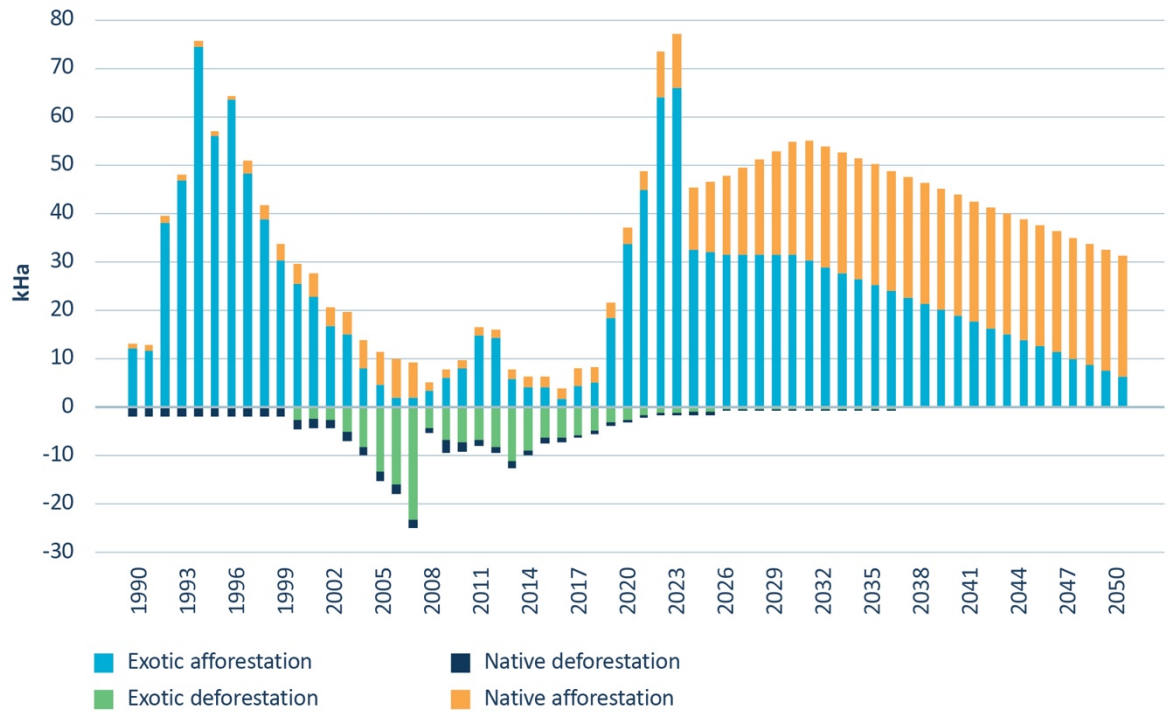
There is less reliance on exotic forestry in the EB4 demonstration path

The EB4 demonstration path reduces reliance on exotic forestry and prioritises native forests to provide long-term carbon removals. We analysed a large increase in new native forests on marginal and erosion-prone land through planting and letting land revert to natives.

The overall amount of exotic forestry in our EB4 demonstration path would be similar to what we modelled in *Ināia tonu nei*. However, as actual planting rates of exotic forestry in 2020–2022 were much higher than projected in *Ināia tonu nei,* less new exotic forestry would be needed through 2050 to reach the same overall levels. Consistent with what we heard from submitters through feedback on the New Zealand Emissions Trading Scheme settings consultation, we do not assume that afforestation rates will remain at high levels beyond 2023 (see **Figure 4.11** below).

In the EB4 demonstration path, the amount of permanent deforestation (i.e. land-use change) is also lower than the reference scenario.

Figure 4.11: *Exotic and native afforestation, and deforestation, in the EB4 path*



Source: Commission analysis

Volume of wood products would decline after 2040

Over the fourth emissions budget period (2036–40), we expect the volume of wood products harvested in the EB4 demonstration path to match the level in the reference case until the early 2040s (**Figure 4.12**). This is due to the same amount of planting activities until 2023, assuming exotic forests follow 28-year harvesting cycles.

From 2042, fewer harvested wood products are produced relative to the reference scenario to 2050. In 2050, there is 2.3 million cubic metres fewer harvested wood products (total recoverable volume) in the EB4 demonstration path. This difference is due to the lower level of plantings, and consequent fewer harvested wood products, from 2024 onwards.

Figure 4.12: *Volume of harvested wood products in the EB4 demonstration path and reference scenario*

Source: Commission analysis

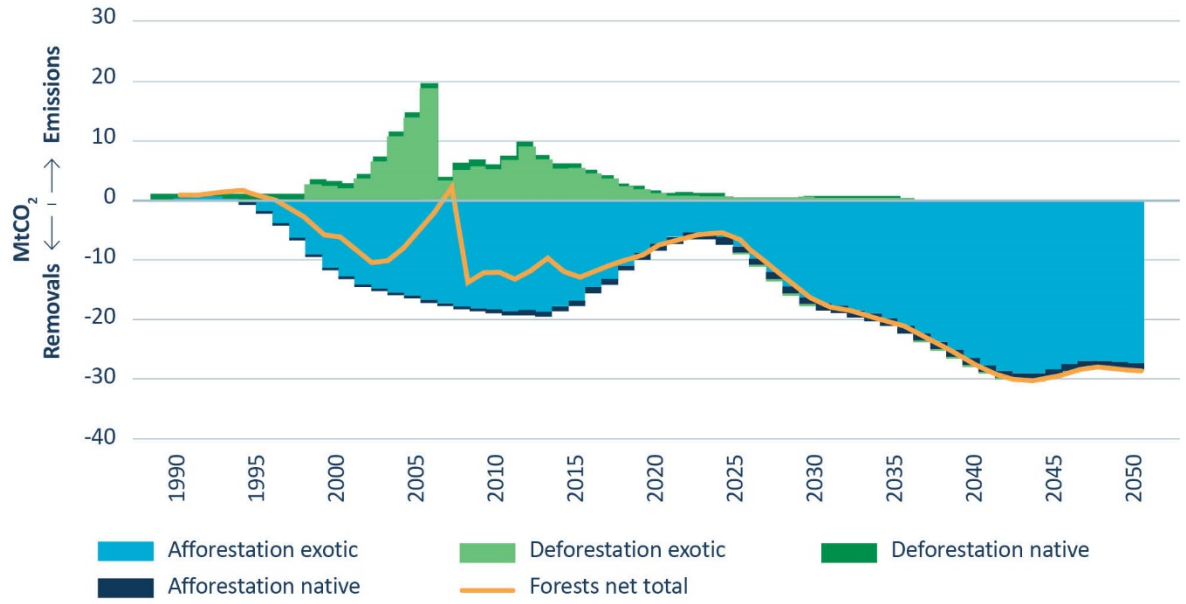
More native forest would grow a long term carbon sink

Figure 4.13 shows that carbon dioxide removals from exotic forests mainly comprise all carbon dioxide removals in the EB4 demonstration path until 2050 but native forests play a role over the longer term.

While exotic forests can sequester carbon quickly,[xliii] removals from native forests happen over a longer time. Native forests generally store more carbon per hectare over a longer period so can provide an enduring carbon sink for Aotearoa New Zealand for tens to hundreds of years. However, some native forests have slower growth rates than radiata pine, and therefore remove carbon dioxide at a slower rate.

Overall, exotic forests remove 104 $MtCO_2e$ and native forests remove 14 $MtCO_2e$[xliv] over the EB4 period.

Figure 4.13: *Carbon dioxide emissions and removals by exotic and native forests in the EB4 path*



Source: Commission analysis

[xliii] One hectare of radiata pine could sequester carbon dioxide at an average rate of about 34 tCO_2 each year, over the approximately 28 years of a standard rotation – although the rate of growth is likely high in early years (it slows with age).

[xliv] The accumulation of carbon dioxide sequestration in native forests may be a conservative estimate, as the model's carbon table for native forests is limited. Likely, higher rates of carbon accumulation may occur in some types of planted tall native forests, which may be reflected in future models when data becomes available.

Waste

Emissions from waste account for 4% of Aotearoa New Zealand's current gross emissions profile.[xlv] Under our EB4 demonstration path, these emissions would be reduced by 29% by 2040 compared to 2021.

Reusing and recovering waste materials is a key part of moving to a more circular and lower emissions economy. The EB4 demonstration path would see a reduced amount of waste generated and a focus on reducing the amount of organic waste (such as food, wood and paper) going to landfill.

We can go further on organic waste

Organic waste is the largest source of emissions in the waste sector as it produces methane when it breaks down in landfill.

Overall, our EB4 demonstration path assumes the amount of organic waste going to landfill will approximately halve by 2050. This would mean much less organic waste going to landfill than we anticipated in *Ināia tonu nei* (where we assumed 34% less by 2050). Our assessment that there are more abatement options for this sector builds on planned and potential policies in the sector, as outlined in our *Advice on the direction of policy for the Government's second emissions reduction plan*[xlvi] and *Aotearoa New Zealand's Waste Strategy*.[28] We estimate we could:

- double the amount of wood being diverted from landfill to other uses (for example through product stewardship schemes)[xlvii]
- divert 80% of food and 95% of garden waste to composting or anaerobic digestion by 2050.

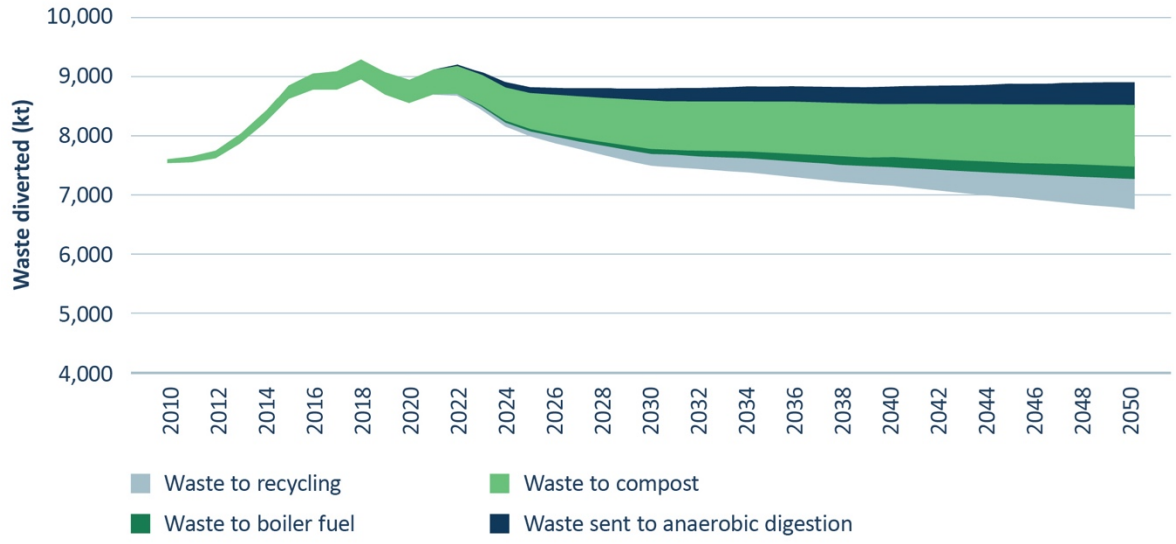
As shown in **Figure 4.14** a large portion of waste diverted would go to compost (light green) or anaerobic digestion facilities (dark blue).

[xlv] Commission analysis using the 2023 GHG Inventory

[xlvi] For example, recommendation for regulated product stewardship for construction wood/waste and planned Government policy, regarding the circular economy, behaviour change and policy intervention to reduce food and garden waste to landfill.

[xlvii] Product stewardship is where producers, brand owners, importers, retailers, or consumers participate in an accredited product stewardship scheme which reduces the harm caused by products at end-of-life and supports the recovery of raw materials that are normally lost when these products become waste.

Figure 4.14: *Amount of waste (kt) diverted in the EB4 demonstration path*



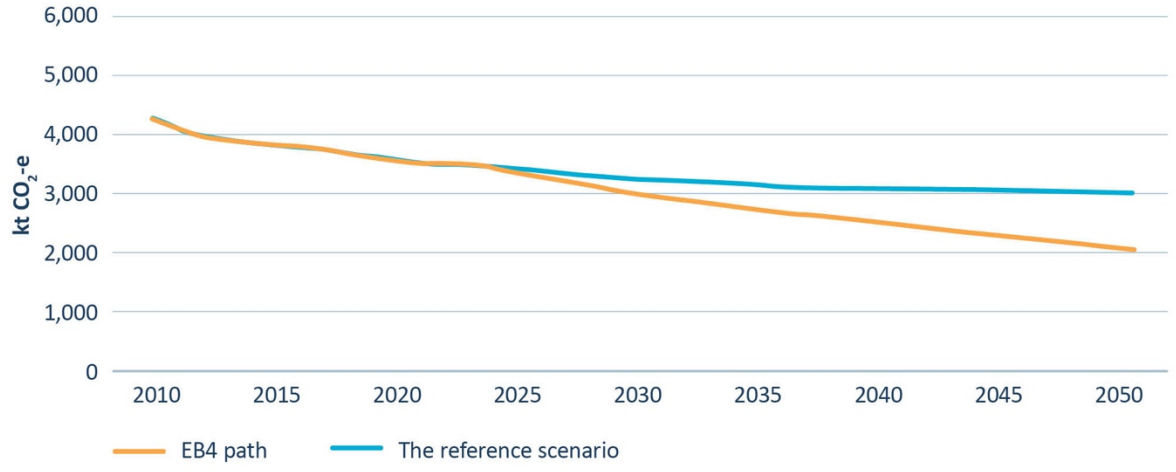
Source: Commission analysis

However, we have lowered our ambition for reducing other waste types including bulk waste, nappies, and sludge in response to stakeholder feedback.[xlviii]

Impact on emissions

As shown in **Figure 4.15**, for the fourth emissions budget period, we anticipate total emissions from waste would be 2.7 $MtCO_2e$ less than we otherwise would expect (in the reference scenario).

Figure 4.15: *Emissions from waste in the EB4 demonstration path compared to reference scenario*



Source: Commission analysis

[xlviii] This feedback included submissions on our *Advice on the direction of policy for the Government's second emissions reduction plan*, regarding what is possible for the waste sector to achieve within current policy direction to target organics.

CHAPTER 5

The impacts of meeting the fourth emissions budget on New Zealanders

This chapter sets out what the changes to achieve the proposed fourth emissions budget might mean for people, in terms of opportunities and challenges across the country.

The role of He Pou a Rangi Climate Change Commission (the Commission) in advising the Government requires us to consider the implications of decisions about emissions reduction for the country as a whole. This is fundamental for informing key judgements we need to make in preparing advice on the fourth emissions budget, and will be important for the Government to consider when making final decisions.

The impacts of meeting an emissions budget cover all the changes that can be expected, both positive and negative, from the actions required to achieve the new level of emissions reductions. We take into account the opportunities and risks that are likely, and the way these might vary in size and timing depending on the choices made about how the emissions are reduced.

The wide range of matters we consider includes social, cultural, environmental and ecological circumstances, including differences between sectors and regions. We consider the Crown–Māori relationship, te ao Māori, and specific effects on iwi/Māori. The Climate Change Response Act 2002 (the Act) also requires consideration of the distribution of impacts across regions and communities, and from generation to generation.

The first section sets out how we make this assessment of changes that might be felt in a future period, and how they are measured. This builds on the approach the Commission used to assess the potential impacts of meeting the first three emissions budgets and the 2050 target as part of *Ināia tonu nei*, when we provided advice on the level of the first three emissions budgets.

The following sections step through different potential impacts of the EB4 demonstration path set out in Chapters 2–4. Understanding the likely opportunities and challenges enables us to understand how New Zealanders will be affected by the fourth emissions budget, and if the impacts on the economy, businesses, households and whānau, regions and communities, iwi/Māori, and the environment can be managed in an equitable way.

We are seeking your feedback

In this chapter, we are seeking your feedback on our assessment of the impacts. In particular, we want to know:

- Do you agree with our assessment of the impacts?
- Are there other impacts the Commission should consider, or give more prominence to?
- Are there other specific effects on iwi/Māori we should be considering? Are there other matters about the Crown–Māori relationship, or for te ao Māori, that we should be considering?

How we assessed the possible impacts

The range of matters that need to be considered is broad. We look at the effects across Aotearoa New Zealand's wider economy, society and environment, and consider the Crown–Māori relationship, te ao Māori and the specific effects for iwi/Māori. This is required in the Act, as shown in *Chapter 1: Introduction*, under *Matters we considered in developing this advice*.

Assessing the consequences of choices for a future period is challenging, even as an idea. We have followed the process set out in our earlier work on the first three emissions budgets, as set out in *Ināia tonu nei*.

The first step is to identify what actions would be needed to achieve the proposed greenhouse gas emissions reductions, in this case for the fourth emissions budget for 2036–2040. This is what is covered in the 'EB4 demonstration path' as shown in *Chapter 3***.** The focus is on the difference between 'what would be happening already' and 'what would need to change to achieve further reductions'.

Our analysis uses the modelling explained earlier (see also *Chapter 2: The proposed level of the fourth emissions budget*). We compare what needs to happen for our draft EB4 demonstration path, with what is already expected to happen, as shown in our 'reference scenario' (based on government agency projections from policies as of 1 July 2023). For example, when we look at the savings from electric vehicles, we estimate this by looking at only the number of electric vehicles added in the EB4 demonstration path, beyond the number already included in the reference scenario.

Comparison with the reference scenario allows us to isolate the specific actions needed to reduce greenhouse gas emissions as set in the EB4 demonstration path. That lets us assess the likely nature and size of the impacts of meeting the fourth emissions budget.

Our assessment assumes that the EB4 demonstration path is followed. Delays in acting to achieve the emissions reductions needed to meet the emissions budget could intensify negative impacts and delay the availability of opportunities presented by the transition to lower emissions. The greater level of negative impacts is expected because delayed action can require abrupt changes to meet the budgeted reductions, and abrupt changes have greater overall impacts.

The choice of actions taken to meet the fourth emissions budget will determine the impacts and how they are distributed across groups

The specific actions taken to achieve the fourth emissions budget, and the policies introduced to encourage them, will determine the size and speed of changes needed. These choices also affect how any changes will be experienced differently in different regions, groups of people or economic sectors – we talk about 'distribution of impacts'. While the policy decisions are a future task (we will provide advice on those options for an emissions reduction plan, which the Government considers when it prepares its draft and final plans), considering the effects of potential actions when setting the fourth emissions budget level allows the Government to make decisions on whether the effects can be managed, and what supporting policies may be needed. We took the size, speed and distribution of impacts into account in the judgements that underlie our proposed fourth emissions budget; the Act also requires these effects to be considered by the Government when making final decisions.

A number of factors (see **Box 5.1**), some outside government control, will determine how changes actually occur to meet the fourth emissions budget, and therefore how different sectors, regions and communities will be affected.

Box 5.1: Key factors that will affect how people and communities are impacted

Setting the level of an emissions budget does not on its own have direct impacts on people. It is the choices made to achieve the budget that will determine the impacts that the budget creates. Some of these choices are made by the Government, others by individuals, businesses, industries or even the international community. Factors that may affect how the change is experienced by people include:

- **policies and signals** – the overall mix of policies (including through emissions pricing) as well as individual policy design, and other signals from the Government
- **Government choices** – the choices the Government makes about whether and how to support vulnerable groups
- **technology** – the development, pace, availability and cost of technology
- **behaviour change** – the willingness and extent of behaviour change across individuals, groups or businesses, and society
- **investment** – the extent and pace of public and private investment in enabling businesses and communities to take action
- **international context** – the influence of international policy on Aotearoa New Zealand's products, international regulation, or external shocks such as COVID-19
- **climate adaptation** – the effects of a changing climate on people and the choices around climate adaptation.

Economic impacts of meeting the fourth emissions budget

Overall assessment of the economic impacts

How the economy will change and grow between now and 2050 will depend on a huge range of factors, of which action to address climate change is just one. Our judgement, based on the evidence we have gathered and the results of our modelling, is that the expected economic effects of meeting the fourth emissions budget in the way we have demonstrated should not be a barrier to Aotearoa New Zealand acting to reduce its greenhouse gas emissions.

We are confident that if the country took the actions in the EB4 demonstration path the overall effect would be economic and social gains. This depends on making changes that reduce gross emissions, and can unlock co-benefits.

As above, we recognise that estimating changes 15 or more years into the future is difficult, and there are a range of factors that can influence how that change occurs, including successive governments' choices about policies (see **Box 5.1**).

We draw on a range of perspectives to understand the potential changes

To understand the potential impacts of the fourth emissions budget we have used a range of models and approaches to make our assessment. Individually each perspective has limitations, but by combining perspectives we are able to arrive at a more comprehensive assessment of the changes involved in following the EB4 demonstration path. Our conclusions about the economic impacts are based on considering the results of these different perspectives together.

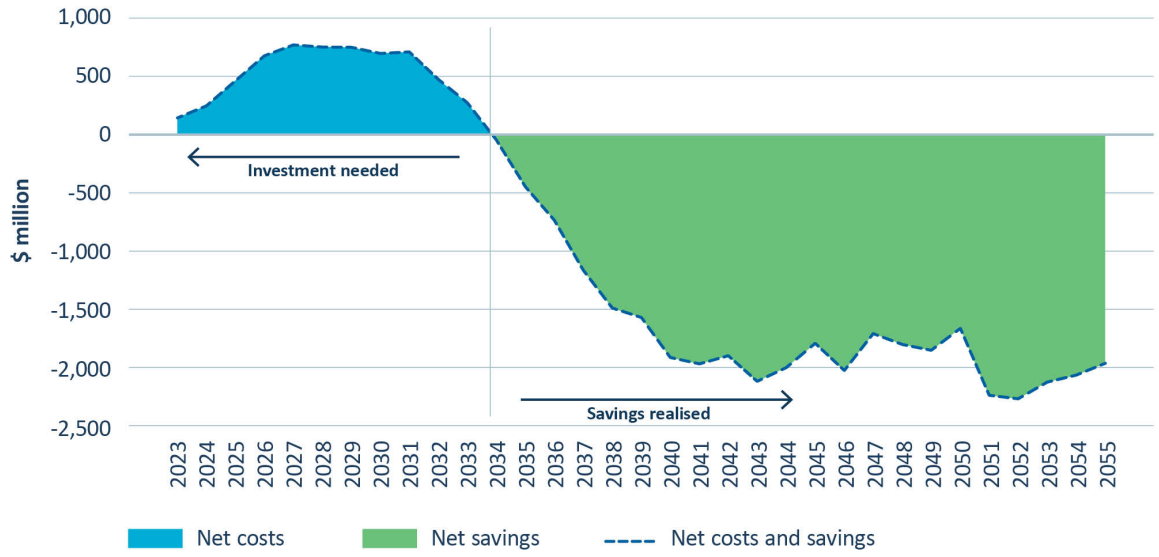
Investment in climate action will lead to large direct cost savings

We have looked at the changes in **direct financial costs** under the EB4 demonstration path relative to the reference scenario. This reflects the expected changes in investment and operating costs for technologies in key emitting sectors, including transport, energy, industry and agriculture. We have used the Energy and Emissions in New Zealand (ENZ) model to make this assessment. This analysis provides a perspective on the overall change in costs to households and businesses from adopting certain emissions reduction actions.

The ENZ model shows that, for many of the actions in the EB4 demonstration path, investments made in low emissions technologies will more than pay for themselves in the long term through fuel savings and lower maintenance costs.

Figure 5.1 shows changes in financial investments and savings from following the EB4 demonstration path. The increase in investment in the short term would lead to a payoff beyond 2034 from reduced costs of operation. Savings would come from improved efficiency, lower energy costs and lower maintenance costs of lower emissions technologies. This is expected to save Aotearoa New Zealand almost $2 billion on average each year by the fourth emissions budget period.

Figure 5.1: *Projected annual change in investment and savings from fuel switching across domestic road and air transport, buildings and process heat sectors in the EB4 demonstration path compared to the reference scenario*[xlix]



Source: Commission analysis

The economy will continue to grow through the transition

We have also considered the **indirect economic effects** of following the EB4 demonstration path. This perspective helps us to see the big-picture effect of our proposals on the economy as well as how things shift between sectors within the economy.

We have used a Computable General Equibrium (CGE) model C-PLAN, developed for the Commission, to assess how the EB4 demonstration path might alter the projected growth of the overall economy, measured using gross domestic product (GDP)[l].

[xlix] This cost analysis includes estimates of future spending on electricity distribution networks. Recently electricity distribution businesses released updated forecasts of investment which were significantly higher than previously forecast. This information will be taken into account when updating this analysis for our final advice and could result in changes to the estimated costs of electricity supply.

[l] Gross domestic product (GDP) is a measure of the size of a country's economy. While this is often interpreted as a measure of wellbeing or economic welfare, there are limits to what is included in GDP. For example, GDP does not factor in changes in the state of the environment, or changes in the quality of life from improvements to health. It is possible that some actions in the EB4 demonstration path (such as increasing walking and cycling) could increase wellbeing, but decrease GDP.

The model suggests that following the EB4 demonstration path would mean the level of GDP in 2050 would be 1.6% lower than if Aotearoa New Zealand follows the reference scenario[li]. For the fourth emissions budget period the difference in GDP between the EB4 demonstration path and the reference scenario is a reduction in the level of GDP of on average 0.5%, or around $2 billion (2023 prices). Action to reduce emissions will be one of many factors that determine the trajectory of economic growth, and this result does not incorporate the effect of a changing climate on growth, or benefits from actions to reduce emissions outside the market, such as improvements in human health.

There are specific limitations of C-PLAN that should also be considered:

- Like many CGE models, the model assumes that businesses and households are able to adjust perfectly in response to the changes happening in the EB4 demonstration path. In reality, financial or technological constraints may mean that this is not possible.
- The model includes the main emissions reduction actions from the EB4 demonstration path, but it has not been possible to represent all of them. As a result C-PLAN reduces output in some sectors to meet the imposed emissions constraint, where in reality we expect there to be ways to reduce emissions in these sectors. This limitation is expected to overestimate the size of the expected change in GDP.
- C-PLAN looks only at market transactions, and does not account for the non-market changes that climate actions can drive – including changes in ecosystem services, human health, or cultural values.
- C-PLAN does not consider the expected effects of the physical impacts of climate change (such as droughts, floods, forest fires, changing weather patterns) on economic output. Experience from recent extreme weather events suggests the impact of these events could be substantial. While recovery from these events could boost economic activity in the short term, it diverts resources from other productive uses.

Box 5.2: Other approaches to estimating the wider economic effects of climate action

Other jurisdictions have modelled the impacts of emissions reductions using non-CGE models. These models assume that the economy can have unused capacity and the additional investment in decarbonisation can provide a stimulus that boosts total economic output. International studies using these macro-econometric models suggest that GDP could be boosted through climate action.[lii]

OECD modelling from 2017 found that implementing a mix of economic and climate policy reforms could result in GDP 2.8% higher on average across G20 countries, compared to continuing existing policies.[29] Modelling for the UK Climate Change Committee using a macro-econometric model also found that increased investment, stimulating activity and employment, along with increased savings (or reduced operating costs) would lead to a potential boost to GDP of around 2% by 2035.[30]

[li] In *Ināia tonu nei* we assessed that the impact of meeting the 2050 target would be a reduction in GDP of 1.2% against the reference scenario at the time. The change in estimate should be considered in the context of the great uncertainty inherent in predicting the level of GDP over 25 years.

[lii] For more information see https://www.climatecommission.govt.nz/public/Evidence-21/Evidence-CH-15-How-we-earn-our-way-in-the-world.pdf pg.14-17.

There are wider economic benefits of the actions in the draft EB4 demonstration path

As discussed above, many of the wider effects of actions that reduce greenhouse gas emissions are not accounted for when assessing potential changes in GDP. Many actions to reduce emissions can have indirect 'co-benefits' – such as improving human health, supporting biodiversity, or improving other environmental systems. For some of the co-benefits we have been able to quantify the expected impacts. Many others are described qualitatively.

For this draft advice, we have used the Government's recently published guidance[31] to quantify the benefits from improved air quality from following our proposed EB4 demonstration path. Air pollution has significant impacts on human health, contributes to reduced quality-of-life and lost productivity through increased hospitalisations, childhood asthma, restricted activity days, and premature mortality.

We have estimated that the reduction in transport fossil fuel demand under the draft EB4 demonstration path would lead to improvements in air quality valued at on average $2.7 billion a year over the fourth emissions budget compared to the reference scenario.

There are other co-benefits from the draft EB4 demonstration path, but we have not been able to quantify the value of these for this draft advice. These include:

- better health from homes that are more energy efficient and warmer, as well as from people walking and cycling more
- improved biodiversity and resilience to the physical effects of climate change (such as flooding and land erosion in high rainfall events), through much larger planting of native forests
- improved soil and water quality from changes to farm management such as managing supplementary feed, and adjusting stocking rates and fertiliser use.

According to the Intergovernmental Panel on Climate Change, the potential for 'synergies' or benefits across other goals, including health and equity, is greater than the potential for negative impacts or trade-offs.[32]

The size of these co-benefits would depend on the specific actions taken to achieve the fourth emissions budget, including policy choices by the Government. For example, actions that focus on improving walking and cycling can bring much larger benefits than those focused on electric vehicles alone.[33]

While it is not possible to estimate a monetary value for some of the benefits, **Table 5.1** provides an indication of scale of some of these co-benefits.

Table 5.1: *Non-quantified co-benefits of the EB4 demonstration path*

Benefit	Action in the EB4 demonstration path	Potential scale of benefit
Energy efficiency	Improved insulation and heating – increases energy efficiency and reduces exposure to mould and allergens, as well as the risk of respiratory issues and lung cancer. In the EB4 demonstration path, we have assumed that the energy efficiency of new and existing buildings would improve over time (reducing the demand for heating by 19% for residential buildings).	Health benefits from EECA's Warmer Kiwi Homes has been found to generate at least $4.36 in benefits for every $1 of government investment.[34] In 2017, damp or mouldy housing in New Zealand was estimated to lead to 6,276 hospitalisations, representing a cost of $36 million.[35] Greater energy efficiency can also save costs to households.
More active transport	Access to active types of transport such as walking and cycling can also improve individuals' health, including mental health. These gains can particularly benefit certain groups or communities.	Healthcare cost savings from switching 50% of short vehicle trips to walking and cycling have been estimated to be $2.1 billion (across the lifetime of the New Zealand population alive in 2011).[36]
Improved biodiversity and resilience to climate change	For the fourth emissions budget we see native planting playing an important role, particularly on marginal or highly erodible land – reducing emissions while improving biodiversity and resilience to climate change.	The cost of landslides following Cyclone Gabrielle was conservatively estimated at $1.5 billion so the scale of these benefits should not be underestimated.[37] Facilitating planting on agricultural land to support more diverse or 'mosaic' landscapes can provide greater biodiversity, and more diverse income, as well as improve soil and water quality.
Soil and water quality	Changes in stocking rates, nitrogen fertiliser use, pasture management, and supplementary feed in the EB4 demonstration path would bring co-benefits for water and soil quality.	Management practices already in commercial use could potentially improve the efficiency of nitrogen use on farms. This could, in turn, potentially reduce nitrogen leaching by more than 30% and greenhouse gas emissions by more than 15%.[38]

There is a risk to export markets if Aotearoa New Zealand does not act

We have also considered what the potential implications for Aotearoa New Zealand's economy could be if it does not respond to climate change by acting to reduce greenhouse gas emissions, or if that action is considered by others to be inadequate. The major source of Aotearoa New Zealand's export earnings comes from agricultural and primary products, including meat, wool, milk and wood. Changes in consumer preferences or market access arrangements for these products could significantly affect the ablity or value of these exports.

We have observed a trend towards greater transparency around emissions reporting for companies, and some jurisdictions are increasingly implementing or exploring policy that would seek to restrict market access for products which do not meet emissions standards. If Aotearoa New Zealand fails to act to reduce emissions there is a risk that access to some markets could be restricted. While it is not possible to quantify this risk, we expect that the actions included in the proposed EB4 demonstration path would decrease the likelihood that other countries would act to restrict market access for Aotearoa New Zealand's primary products. We also consider that these actions would put exporters in a stronger position to demonstrate value from providing lower emissions products to consumers.

Impact on public spending and borrowing will depend on policy

The proposed fourth emissions budget is also expected to affect central government taxation and spending. For example, accelerating the transition to EVs under the draft EB4 demonstration path is expected to result in a change from revenue collection from fuel excise duties towards road user charges. Other sources of central government revenue are expected to be affected, including Waste Levy funding.

The impacts on public spending will also be determined by the mix of policies that future governments choose to implement to achieve emissions budgets. These are choices for the government of the day.

Our analysis has not identified any concerns about the potential impacts of emissions budgets on taxation, public spending or borrowing, that are not most appropriately addressed by the government of the day. We assess the expected changes to taxation and public spending as manageable, but the Government will need to plan for these.

Considering specific effects for iwi/Māori

The Commission's role in advising the Government requires us to consider the implications of decisions about Aotearoa New Zealand's climate response, including for the Crown–Māori relationship, te ao Māori and the specific effects for iwi/Māori (see *Chapter 1*).

This section presents our understanding of likely effects for iwi/Māori of following the draft EB4 demonstration path. This is based on earlier engagement and consultations, and on research. We look forward to increasing our understanding of potential opportunities and challenges for iwi/Māori through feedback on this draft advice, recognising the potential benefits presented by the transition to a lower emissions economy and the accompanying need to increase resilience to the impacts of climate change.

Through engagement, previous consultations, and Maui.Tech case studies we have heard about iwi/Māori climate leadership, expressed through intergenerational taiao strategies and grounded in tikanga and mātauranga Māori. A key element for Aotearoa New Zealand to meet the fourth emissions budget is engagement with iwi/Māori to enable continued climate leadership. Our analysis and engagement with communities shows this will support faster emissions reduction and help achieve an equitable transition for the benefit of all New Zealanders – as set out in our December 2023 advice to the Government on its next emissions reduction plan.[39]

Māori have important roles to play in communities: as partners of the Crown; leaders of their iwi, hapū; kaitiaki of their whenua; landowners and business owners. With an asset base estimated to be worth $70 billion and a projected growth rate of 5% per annum,[40] the potential economic opportunities for iwi/Māori to support the transition are also considerable.

Much of the Māori economy is based directly off the land. The sheep and beef industry makes up 51% of emissions for the Māori economy compared to 30% for the whole of the economy. The Māori economy is also proportionately more involved in dairy, construction, forestry, fishing, education, and transport.[41] Māori also have considerable interests in the tourism and leisure sectors.

We understand that te ao Māori places te taiao (natural environment) and mokopuna (future generations) at the heart of decision-making. Our Māui.Tech case study work also highlighted how tikanga and mātauranga Māori inform business models, pathways for land-use change, and other social and cultural initiatives that reduce emissions.[42] In 2021, Stats NZ found that 70% of Māori authorities, including 75% of those in the primary industries, were very aware of the potential impacts of climate change, compared with 39% of all New Zealand businesses.[43]

Opportunities and risks for the Māori economy in the transition

The strong land base of iwi/Māori provides opportunities to accelerate environmental management practices based on te ao Māori, but it also exposes the Māori economy to greater risk and may reduce revenue for iwi/Māori in the fourth emissions budget period. An indication of this exposure is provided by these statistics: while contributing 6.4% of the country's GDP in 2018, the Māori economy was responsible for 11.2% of Aotearoa New Zealand's emissions, due largely to strong interests in sheep and beef.[41]

Research on the emissions profile of the Māori economy found the following key areas of risk:[44]

- As Māori collectives are heavily invested in agriculture and forestry, any increasing costs or impacts on this sector may negatively impact Māori whānau
- Land use characteristics of Māori freehold land mean that these landowners may have more limited options and face challenges in terms of land use change (see **Box 5.3**)
- A large proportion of forested Māori freehold land was planted before 1990, rendering this land ineligible for earning emissions trading units – but still liable to pay carbon credits if deforested
- Māori are disproportionately in lower paid jobs, which are more exposed to shocks in the economy
- Māori SMEs make up almost all of the Māori asset base for transport, construction, and manufacturing – that may require significant capital expenditure to transition (which may be a barrier).

Through engagement and previous consultations, we have heard from some iwi/Māori representatives that the unique standing of Māori as tangata whenua with whakapapa to te taiao means that climate change presents a unique wellbeing risk for Māori, as harm to the environment can be thought of as desecrating an ancestor.

We have also heard that that an equitable transition for Māori needs to be Māori-led, and that any transition decisions should involve Māori in a meaningful way and at a local level. In our advice to the Government on its next emissions reduction plan in 2023 we also demonstrated that investing directly in iwi/Māori and designing policies in partnership, at all levels of decision-making, was essential to managing the impacts on iwi/Māori.

Choices made about actions to meet the fourth emissions budget also present opportunities and risks for the Crown–Māori relationship. An effective relationship between iwi/Māori and the Crown and private entities is more likely to lead to effective and durable emissions reductions, avoiding unnecessary delays and costs.

Box 5.3: Complexities of Māori freehold land

Iwi/Māori have a unique relationship with their whenua, it is an integral part of who they are and how they connect to each other, to their tūpuna and to the broader ecosystem. From 1840 many Māori were dispossessed of their whenua by the government, largely through acquisition and raupatu (confiscation).

There are now some common characteristics of Māori land that mean a high proportion of Māori land area is restricted or of limited use including:

- Much of Māori land is made up of land titles that are small in area (around 40% of Māori land is less than a hectare)
- Much is on steeper or highly erodible land – around double that of non-Māori
- More than 50% have no management structure in place
- 1.4m ha is fragmented in small parcels of land with many registered owners (approximately 27,000 titles).

Often, forestry operations on land held by Māori collectives are typically subject to long-term agreements, sometimes up to 99 years or a defined number of rotations. As these agreements end, many Māori landowners are taking on management responsibilities for their forests and making decisions for their whenua, including whether it is commercially viable to plant permanent forests.

Different policy settings – such as those under Te Ture Whenua Māori Act – have an impact on what Māori collective owners of land can do with their land, which in turn may have wider implications under Te Tiriti o Waitangi/The Treaty of Waitangi.

The iwi/Māori workforce is changing

Historically, a higher proportion of Māori have been in lower paid jobs or in industries that are particularly vulnerable to changes in technology and economic cycles (for example manufacturing, wholesale, retail, trade, and construction).

In more recent years, Māori employment has been diversifying and moving more into higher skilled jobs.[liii] Since 2013 there has been large growth of Māori employees in administrative, support, retail, accommodation and food services, and construction and manufacturing. There have also been increases in health, education, and public administration (reflecting government spending drivers). The proportion of Māori employed in the professional, scientific, and technical services sector is also above the economy-wide average.[45]

With a younger Māori demographic compared to the rest of the population, there is an opportunity to build on these trends and support rangatahi to develop appropriate skills for the transition to a low emissions economy grounded in te ao Māori.

There is care needed to manage workforces through transition, to avoid disproportionate effects on particular groups. Māori employees have historically fared poorly in transitions, being more likely to be made redundant during recessions or have found it harder to find re-employment. This has also been evident after sudden adjustments such as the Christchurch earthquakes, when Māori generally fared less well than Pākehā workers.[46]

Regions and communities

Changes for the agricultural and land sectors

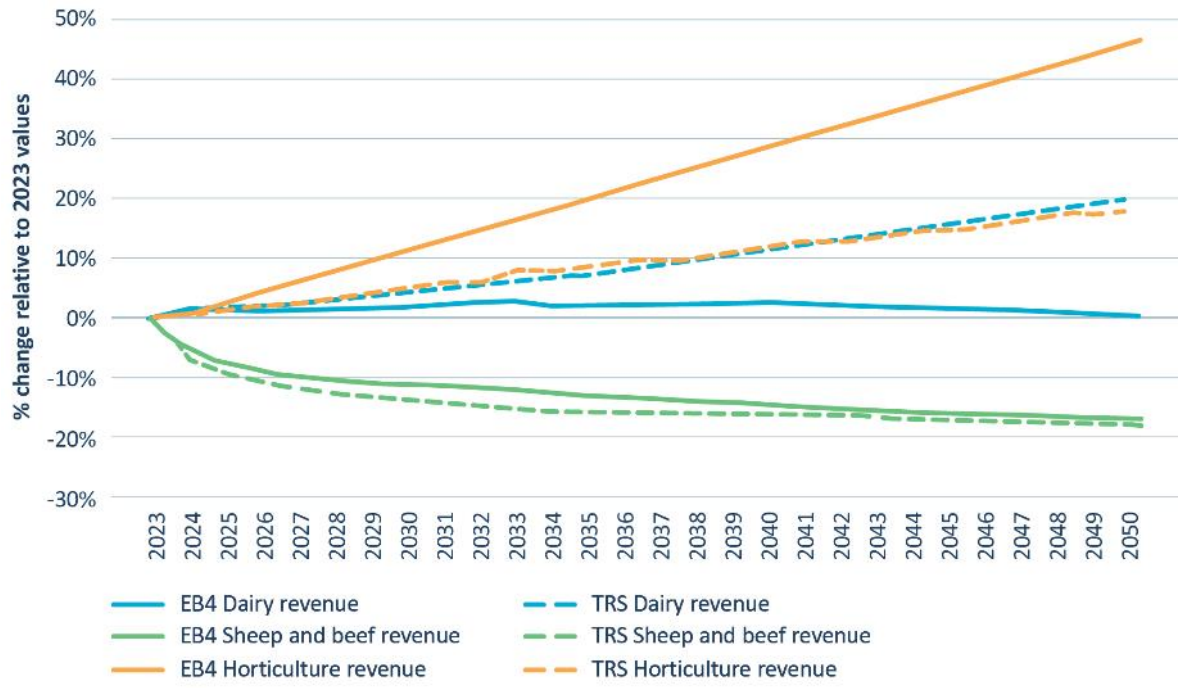
There have been substantial changes in how land is used over the last 30 years, along with significant changes in farming practice and performance. Understanding the scale of the impacts on agriculture for the fourth emissions budget should also be considered in light of the potential changes required to respond to changing consumer preferences in a lower emissions world, and the challenges of dealing with the physical impacts of climate change.

Under the EB4 demonstration path, the value of dairy output is expected to be maintained while the sector reduces emissions. As shown in **Figure 5.2**, improved practices in the dairy sector would mean that milk solid production and revenue can be maintained at around today's levels out to 2040, despite the EB4 demonstration path including land use change from dairy to horticulture of 32,000 hectares by 2050. However, compared with the reference scenario (which would not meet the biogenic methane component of the 2050 target) revenue from the dairy sector would not increase relative to today.

Current and recent historical trends are expected to continue with output from sheep and beef in the EB4 demonstration path projected to continue to decline by 17% by 2050 relative to 2023 levels. In comparison, revenue from horticulture is projected to increase (see **Figure 5.2**) due to greater land use change from dairy.

[liii] Māori in high-skill jobs increased from 47,500 to nearly 87,200 between 2006 and 2018, an 83% increase. [https://www.mbie.govt.nz/dmsdocument/17448-maori-economy-emissions-profile]

Figure 5.2: *Comparison of revenue changes for sheep and beef, dairy, and horticulture to the reference scenario (TRS) relative to 2023*



For both dairy, and sheep and beef, adopting improved farming practices and new technologies would allow emissions to be reduced by changing practices to focus on farming fewer, more productive animals. Adopting new methane-reducing technologies, as assumed in the EB4 demonstration path, is expected to come at a cost. This cost should be considered in the context of the potential consumer shifts which could increase demand for products that can demonstrate a lower emissions footprint. Maintaining access to markets may also rely on Aotearoa New Zealand's farmers being able to demonstrate they are taking actions to address greenhouse gas emissions. We also note that without new technologies, reducing agricultural production and more land-use change would be required to reach the fourth emissions budget.

There is an opportunity to add value to the land sector

With the large size of Aotearoa New Zealand's land sector there are also opportunities to build on the traditional farming sectors, with a lower carbon, more 'circular' bioeconomy.[liv] Research suggests there will be opportunities to grow the bioeconomy, [47] including through:

- substituting fuel and fossil-fuel based plastics
- establishing new bioproduct and fibre-based exports
- adding value to forests and establishing new manufacturing processes
- creating several hundred jobs in the regions.

For example, waste wood from exotic forestry can provide a source of biomass for low carbon liquid fuels, replacing fossil fuels for transport or other energy. Native forests also create opportunities for jobs in honey, recreation and ecotourism, and forest-based pharmaceuticals.

[liv] Bioeconomy describes the parts of the economy that use renewable biological resources to produce food, products and energy. A more 'circular' bioeconomy can use waste biomass, or renewable resources, from forestry, fisheries, and agriculture as raw materials to produce other products. 'Waste' from one process becomes feedstock for another.

Incentives to reduce emissions will affect rural communities through land use change

Given the large contribution of the land sector to Aotearoa New Zealand's emissions profile, incentives to reduce emissions will continue to affect how land is used and how it will change over time.

Over recent years, the relative profitability of forestry compared to extensively farmed sheep and beef has led to changes in land use. The EB4 demonstration path assumes less exotic forestry is needed compared to the reference scenario, but forestry will continue to play an important role. Like recent trends, exotic and native forests are likely to be established on parts of sheep and beef land, particularly areas with low economic viability (for example erodible areas).

The impact of this land use change on communities is difficult to predict and likely to affect different communities in different ways. Wholescale conversion of sheep and beef farmland to forestry would affect communities in the immediate area. More land converting from dairy to horticulture would also affect the nature of work in different regions , as horticulture requires more seasonal workers. More permanent or native afforestation may also generate fewer jobs than exotic production forestry, particularly if the land is left to revert rather than being planted.

Some changes in land use could in turn impact the population of rural communities and reduce expenditure in other businesses that rely on these sectors. Land-use change could also disproportionately impact iwi/Māori given Māori are more invested in land activities and a higher proportion live in rural areas.

Less reliance on exotic forestry to offset emissions will be important to reduce these impacts. Capacity-building and advisory services for landowners focused on integrating trees or forestry onto farms rather than wholesale land-use change could also limit the impacts of afforestation.

Changes in the expected patterns of employment

Our analysis in *Ināia tonu nei* estimated that most regions would experience more jobs (rather than fewer), except for Taranaki and the West Coast (due to jobs in the oil, fossil gas, and mining sectors in these two regions). Since *Ināia tonu nei*, interest in offshore renewables and hydrogen in Taranaki has grown significantly, which may offset job losses from oil and fossil gas, should these industries develop.

For the fourth emission budget, employment is likely to face similar trends as outlined in *Ināia tonu nei*, as the path results in broadly the same pattern of changes across sectors. The high-level trends in employment expected for the fourth emissions budget are shown in **Box 5.4**.

Changing employment would affect some groups more than others

For the most part, the changes in the patterns of employment that are predicted are expected to be gradual. There will be more opportunities for workers to naturally transition out of sectors through normal turn-over or retirement than if there are expected to be abrupt changes in a sector. For instance, some sectors may be able to adjust over time by reducing the number of new workers being hired rather than workers losing their jobs. Younger workers can be expected to factor the long-term prospects of a sector into their career choices.

There are also significant shifts in the patterns of employment expected between sectors over the next 15 years, as some sectors grow and others contract. These changes are expected for a number of reasons not connected to climate action.

Box 5.4: How employment in different sectors may be affected

In the EB4 demonstration path, we expect the following trends in the pattern of employment occur:

- Fewer jobs in coal mining, oil and fossil gas and the services that support them , particularly affecting Taranaki and the West Cost where most of these jobs are located.
- More jobs in renewable electricity – workers will be needed quickly as capacity grows and transmission and distribution infrastructure improves.
- Fewer motor mechanics will be needed as people shift to more active and public transport, and transition to electric vehicles that require less maintenance.
- More jobs in energy efficiency, for example research by BERL and the Green Building Council found that moving to building low emissions buildings only from 2025 onwards could support an additional 46,000 FTE between 2025 and 2050, as well as contributing an additional $147 billion to GDP.[48]
- More jobs in the waste sector – estimates indicate 2–4 jobs could be created in resource recovery for every job in landfilling.[46]
- Changing jobs in the agriculture sector.
- New jobs in agriculture advising farmers how to improve farm management practices as well as more research and development into new methane-reducing technologies.
- Fewer jobs in sheep and beef as more land-use change away from sheep and beef occurs.
- More jobs in horticulture requiring higher numbers of workers, as horticulture is generally more labour intensive, but seasonal.
- Similar number of jobs in food processing – the number of jobs in meat and milk processing would be unlikely to change significantly if recommended emissions budgets are met.
- More jobs in forestry including native forests where there may be new opportunities for jobs in honey, recreation and ecotourism, and forest-based pharmaceuticals.
- More jobs in bioeconomy, for example new jobs in recovering forest and wood waste, or wood and biofuel processing.
- Job uncertainty in carbon intensive industries that are unable to reduce emissions or fully decarbonise effectively, for example in steel, aluminium, cement, methanol, and fertiliser/lime industries.
- Potential for new jobs in alternative fuels or other new sectors depending on how they emerge.

Analysis by the Commission for *Ināia tonu nei* also found that there would be more impacts on some groups of workers than others. Specifically:

- As Māori tend to be employed more in higher emissions industries, like sheep and beef, and lower-skilled jobs, Māori may be more exposed to workforce changes.
- Pacific people currently experience higher unemployment and earn less, but our analysis estimated they could experience more job gains.
- Young people are likely to see net job gain as a result of recommended emissions budgets, where those workers over the age of 45 would be more affected by job loss.
- Men may be more affected by the transition than women. This is because the industries that are most affected by the transition tend to employ more men. However, there has been evidence historically that women are more negatively affected during economic change.
- Any changes to jobs could have disproportionate impacts on disabled people. This is because disabled people are more likely to face poor employment outcomes, as they are less likely to be in work or education, and are more likely to be unemployed, underutilised, and earn less than people who don't have a disability.

A recent study commissioned by the Ministry for Business, Innovation and Employment (MBIE) looked at the impacts of economic transitions on firms, workers and regions.[49] The findings of this report demonstrated the importance of a transition that both targets those who bear the greatest costs or are least able to respond by themselves. Comparing the three case studies of climate change, technology change, and the 1980s reforms, the study found that:

- the impacts of past transitions have not fallen equitably across the population, and the costs of adjusting can fall heavily on groups such as Māori businesses and employees, small businesses in exposed industries, and regions of Aotearoa New Zealand with 'tight' labour markets
- economic transitions can drive economic displacement, change the mix of skills in demand, increase costs of operating for firms and affect household wellbeing.

Improving skills will be important to reduce employment impacts

While there is evidence from international studies that emissions-reducing sectors tend to create more job opportunities than are lost in fossil fuel sectors[50], differences in type of work and skills can mean that work from one sector is not easily transferrable to another.

In its report *Technological Change and the Future of Work*,[51] the New Zealand Productivity Commission highlighted that Aotearoa New Zealand generally has a flexible labour market that has historically adapted well to economic change. Good flexibility, however, requires workforce training, as well as support for individuals and communities. For example, to build new renewable energy and improve transmission over the coming decades, Transpower estimates that thousands more highly skilled workers will be needed in the electricity sector by 2035 to meet increasing electricity demand.[52] Many of these jobs will be outside the main centres, particularly in building new generation and distribution lines. Many of the workers in the oil and fossil gas sector are highly skilled – engineering, earth sciences, surveying and logistics.

The workforce changes in higher emitting sectors are expected to occur gradually, as some workers will continue to be needed to manage, safely decommission, and phase out existing infrastructure. Additional workforce in the renewable energy sector is likely to be needed in the short term, which may pose some constraints to this sector.

The Commission's *Advice on the direction of policy for the Government's second emissions reduction plan* outlined the importance of making the education system more flexible to enable mid-career professionals to re-train and address barriers that restrict some New Zealanders from accessing education, including iwi/Māori, Pacific people, and low-income groups.

Households and whānau

Changes to meet the fourth emissions budget across the economy will have flow-on effects to households. Exactly how changes will be felt for households can be challenging to predict.

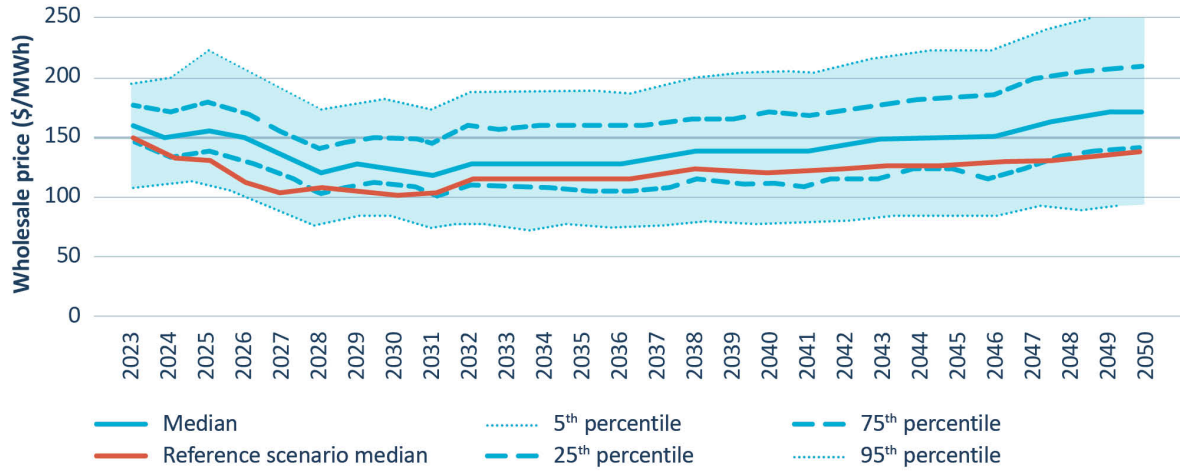
Electricity bills are unlikely to significantly change due to meeting the fourth emissions budget

Analysis by the Commission suggests that actions to meet proposed emissions budgets are unlikely to significantly increase overall household electricity bills.

Under the reference scenario we expect electricity prices to increase as the costs of building new generation increase. As indicated in **Figure 5.3** modelling suggests that by taking action to meet our proposed emissions budget, wholesale electricity prices are likely to be slightly higher than in the reference scenario.[lv] However, wholesale prices are only one component of a household's electricity bill, with costs of transmission and distribution needing to be considered.

Additionally, the modelling shows that wholesale prices continue to remain highly sensitive to the inflow levels into hydro lakes. This is illustrated by the wide price range shown between the percentiles on the graph.

Figure 5.3: *Wholesale price range under the EB4 demonstration path with median price under the reference scenario overlaid*



Source: EnergyLink modelling

[lv] We commissioned modelling work by EnergyLink to estimate the wholesale electricity price – the price at which retailers buy the electricity. Wholesale prices change depending on changes in supply, demand, or environmental factors such as river levels for hydro generation. When electricity retailers determine how to pass costs on to households they often do this in a way that removes the day-to-day, month-to-month, and year-to-year variability of wholesale prices. This modelling assumes a continuation of the current market structure for pricing.

For both the EB4 demonstration path and the reference scenario wholesale prices are higher in the near term, reflecting 2022/23 market conditions of tight levels of energy supply, compared to demand. Over the next few years, the modelling shows that replacing fossil gas generation with lower cost wind, solar, and geothermal is expected to reduce the average wholesale price. Beyond the late 2020s, as electricity demand continues to rise, more new renewables are expected to be built. Since the most attractive projects are built first, further addition of generation gradually becomes more expensive, which may place slight upward pressure on wholesale prices.

Household bills could also be significantly impacted by the investment costs to upgrade transmission and distribution infrastructure, to allow for increasing demand. The level of costs and how these costs are passed on to households will depend on how companies fund such upgrades, as well as government regulation around electricity pricing.[lvi] Under the EB4 demonstration path there is greater use of demand side response, where some electricity demand (mainly from industrial consumers) can be switched off when prices increase. This can reduce the need to build additional generation and network capacity to meet peaks in demand, which contributes to lower costs of electricity under the EB4 demonstration path relative to the reference scenario.

The costs of the gas network will be shared across a smaller number of customers

Households that use fossil gas for heating and cooking are likely to see an increase in their fossil gas bills. As households switch away from fossil gas the cost of maintaining the gas distribution network will need to be recovered from a smaller number of customers. For those households that continue to use fossil gas, the average bill in 2040 is expected to increase by up to $580 a year under the EB4 demonstration path, compared to the reference scenario. It is difficult to predict exactly what will happen, as the speed at which households switch away from fossil gas will affect the prices for those who remain, and therefore their incentive to switch too.

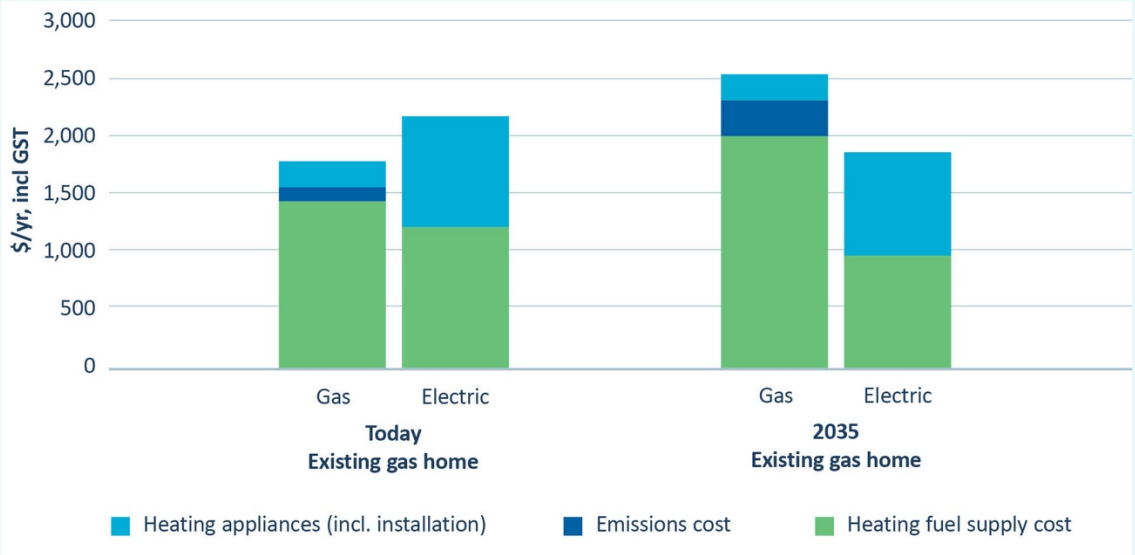
Higher fossil gas prices may mean that, over time, many households would benefit from replacing fossil gas appliances with electric ones. Replacing appliances at the end of their life, and discouraging new fossil gas appliances from being installed, would help to reduce the cost of this change for households. Other costs associated with this change include removing fossil gas piping into homes, additional wiring, changes to electricity meter boards, and the associated building work.

[lvi] How consumers will be affected by this investment for the next five years is an area currently being considereded by the Commerce Commission Commerce Commission – Commission focussed on ensuring consumers benefit from large-scale investment in electricity lines (comcom.govt.nz)

Box 5.5: Impact on household space and water heating costs of switching away from fossil gas to electricity

Figure 5.4 shows the costs of space and water heating for an existing home today and in 2035, for a household continuing to use fossil gas, or choosing to switch to electricity.[lvii] Currently, households already using fossil gas would increase overall costs by switching to electricity for space and water heating. Although switching would reduce the fuel costs a household faces, it would increase overall costs as there are costs to buying a heat pump and removing the fossil gas appliance that need to be factored in. However, by 2035 the higher price of fossil gas is expected to make switching to electricity for space and water heating save households around $670/year (after factoring in the costs of buying a heat pump and removing fossil gas appliances).

Figure 5.4: *Potential impact on household energy bills of switching from gas to electricity for space and water heating*



Source: Commission Analysis

Notes: In this chart, the 'Heating appliances' component includes operational and maintenance costs associated with running heating appliances, as well as capital costs incurred when replacing appliances. The capital component includes 'make-good costs', such as building work for retrofit situations. The 'heating appliances' component is annualised over the lifetime of the appliance. 'Emissions cost' refers to the proportion of the fuel supply cost incurred due to the presence of emissions pricing. 'Heating fuel supply cost' refers to the proportion of a fossil gas or electricity bill which is incurred due to the use of energy for heating.

[lvii] Our analysis for new homes shows that it is already cheaper for households to install heat pumps for space and water heating than to install and use fossil gas. By 2035, the difference is even greater with a home that installs fossil gas paying an additional $1,880/year compared with one that installs a heat pump.

Petrol and diesel prices are similar to the reference scenario

Improving fuel efficiency, a shift to EVs and more public transport, walking, and cycling are all important in reducing emissions from transport. Commission modelling indicates that petrol prices could increase by up to 40 cents per litre in 2040 compared with today, due to higher emissions prices and the use of low carbon liquid fuels under the EB4 demonstration path. This is similar to the increase in petrol price assumed in the reference scenario.

The average household using petrol or diesel vehicles may expect to see transport fuel costs increase over time, but overall costs for transport will depend on the distance travelled and the efficiency of the vehicle. Shifting some trips to walking, cycling, or public transport could offset some of the increased transport fuel costs. 'Active transport' like walking and cycling brings further benefits to health and wellbeing through greater fitness, reducing risk of cardiovascular disease, cancer, and mortality. Higher petrol and diesel prices are also expected to encourage households to purchase more efficient vehicles.

For those able, taking up lower carbon technology can lower costs and bring wider benefits

Households that can improve the energy efficiency of their homes, such as by installing insulation or double glazing, will benefit from lower electricity bills and warmer, drier homes.

Efficiency improvements can also reduce electricity use at peak times, in the mornings, evenings, and in winter. Reduced demand at peak times helps the entire electricity system as there is less need to build additional generation and upgrade electricity lines, reducing costs for all households.

Electricity bills are expected to increase if a household purchases an EV, but the additional cost would be more than offset by savings in petrol and diesel.

As costs come down, owning an electric vehicle (EV) is also expected to save households money, through lower initial purchase and maintenance costs. Commission analysis found that households that replace their internal combustion engine vehicle (ICE) with an EV could save more than $2300 a year by 2040 in purchase and running costs, in part due to the purchase price of EVs being 15% lower than an ICE vehicle.

Meeting the fourth emissions budget has the potential to increase access to transport through greater choices for public transport, safer walking and cycling, and more car sharing or leasing as opposed to car ownership. Public transport can improve access to job and education opportunities for individuals who do not own private vehicles, enhancing economic opportunities for a broader segment of the population.

Some households or whānau will be more affected than others

The people who most need efficiency and cost saving measures are the most at risk of being the last to receive such benefits given technologies can be difficult to afford or access in different areas. Government support targeted to those people who are most challenged to make changes will be important to manage impacts.

A recent report by the Energy Hardship Panel found that 110,000 households in Aotearoa New Zealand could not afford to keep their homes adequately warm in 2022. In 2017, damp or mouldy housing was estimated to have led to 6,276 hospitalisations, representing a cost of $36 million.[53]

The report also shows Māori, Pacific peoples, renters, and low-income households were far more likely to experience energy hardship. These groups are more likely to live in older, poorly insulated homes, where cost savings due to improved energy efficiency would make the biggest difference.

Current transport systems that are reliant on ICE vehicles can lead to health inequities. Generally, less socially advantaged groups are less able to afford converting to EVs and may also experience disproportionate harm from noise exposure, air pollution, physical inactivity, injury and climate change.[54]

Other barriers or impacts for some households, whānau or communities include:

- Lower income households may be more exposed to higher emission prices as they tend to spend a larger share of their disposable income on food and fuel.
- Renters may be disproportionately affected as landlords do not have the same incentive to install energy efficient appliances or measures as they would not benefit from the savings in running costs.
- Switching to EVs may also be challenging for those who cannot charge an EV at home, for example people living in apartments.
- Women are less likely to cycle due to safety concerns.[55]
- Smaller remote communities may be exposed to higher electricity prices, which can vary as much as 40% between regions.[56]
- Smaller remote communities may also have less access to public transport, and be more reliant on fossil fuels.

Policy that targets most affected households bring the greatest benefits

Targeted climate policy provides an opportunity to address inequality and bring a greater scale of benefits such as warm and healthy homes, or cost savings for those that most need it, alongside reducing emissions.

A recent study found that reducing transport emissions may help reduce health inequities between Māori and non-Māori if policies are implemented equitably, particularly where greater walking and cycling is involved. When assessing the health benefits of actions on transport for our technology and behaviour change scenarios in *Ināia tonu nei* – this study found that health gains for Māori were 20-30% larger than for non-Māori.[57]

An equitable transition

The changing climate will exacerbate impacts on vulnerable sectors and communities

As the climate continues to change, adapting to climate change will take more and more attention – influencing the choices made and the availability of emissions reductions funding.

Many sectors and communities that are most vulnerable to climate change are also those that may be most affected by emissions reductions, such as agriculture, forestry, fisheries, tourism, and energy and transport networks. There may be less availability of water for irrigation or feed for stock, for example, placing further pressure on the land sector and reducing land-use choices in certain areas. More exotic forestry may also increase the vulnerability of regions to climate events, as was the case with Cyclone Gabrielle.

Critical infrastructure, including built assets, stormwater and wastewater, transport links (for example, roads, railways, airports) and electricity (transmission lines, structures, sites), is also at risk of severe weather events – with potentially high emissions rebuilds.

The impacts of a changing climate are likely to have a disproportionate impact on iwi/Māori due to:

- increased risk of displacement from tūrangawaewae vulnerable to climate change, with many marae and papakāinga located coastally
- the high proportion of business interests in the primary sector
- potentially restricted access to taonga species that are vulnerable to impacts
- disrupted transfer of customary practices and mātauranga Māori to future generations.[58]

Young people will be more exposed to the effects of climate change in their lifetime. Delaying action on climate change has the potential to have a greater impact on younger people as it will mean higher costs later.

Acting to reduce emissions and adapting to climate change will be crucial together, to ensure one goal does not undermine the other and that inequities are not exacerbated.

Government policy will be crucial to addressing inequities

By clearly signalling its transition plans, the Government can help to provide certainty and time for sectors and communities to plan and change. Policies, investment, and support targeted at those who will face the most costs will also be important for managing impacts. Failing to address fairness and equity could risk a backlash against climate action generally, and particularly from those who will lose the most.[59]

As shown in this chapter, iwi/Māori may potentially be more affected by the fourth emissions budget. Investing directly in iwi/Māori and working in partnership is not only important to address these inequities and uphold Te Tiriti, but also for accelerating emissions reductions for the benefit of all New Zealanders. Supporting communities and enabling young people to participate in the transition to a low emissions future can positively impact mental health through an increased sense of control, hopefulness, and resilience.

Meeting the fourth emissions budget can be economically affordable and socially acceptable if it is well-paced, planned together with communities, and well-signalled, and society will benefit from associated improvements to health and wellbeing. Balancing the pace of change will be important to ensure inequities are not created or exacerbated in the short term, while also ensuring the costs don't fall inequitably to future generations. Our draft advice on the fourth emissions budget seeks to find this balance.

CHAPTER 6

Proposed changes to the first, second, and third emissions budgets

We propose adjustments to the first, second and third emissions budgets due to changes in how New Zealand's Greenhouse Gas Inventory calculates and reports emissions, and the impact of higher rates of forestry planting than projected.

As part of its decisions on setting the fourth emissions budget, the Government has the option of revising the set emissions budgets to ensure they remain both ambitious and technically and economically achievable.

Under the Climate Change Response Act 2002 (the Act[60]), as part of our advice to the Government on the setting of the fourth emissions budget, we may also provide advice on whether any revisions should be made to the first (2022–2025), second (2026-2030), and third (2031-3035) emissions budgets.

Reviewing set emissions budgets every five years helps ensure that we are flexible to changing circumstance and that they remain ambitious and technically and economically achievable over time.

We may only advise a change to emissions budgets if we find evidence that specific circumstances have changed since the budgets were originally set. There are two categories of change we are required to consider in this analysis:

- **methodological change**: the New Zealand Greenhouse Gas Inventory (GHG Inventory) releases its reports annually. With each new release, the inventory may make adjustments to the way it calculates and reports Aotearoa New Zealand's greenhouse gas emissions. Whenever there are changes to the inventory's methodology or underlying data, these adjustments are applied retrospectively to all previous reports, as well as the most recent release. These adjustments can change Aotearoa New Zealand's reported level of emissions, and therefore have direct implications for whether current and future emissions budgets can be met.
- **significant change**: emissions budgets are set based on specific considerations in the Act, including domestic and international scientific advice, the likely impact of actions taken to meet the budget, the distribution of those impacts across regions, communities, and generations, and economic circumstances. Over time, these conditions may undergo significant change, which can impact what is achievable in an emissions budget period.

It is the Minister's decision whether to revise an emissions budget. For the current emissions budget period, the Minister must not revise the emissions budget, under s5ZE of the Act, unless the circumstances are exceptional.

Our analysis has shown that methodological changes have occurred since the budgets were originally set and propose that methodological changes are incorporated into revisions for all budgets and for all budget periods. We have assessed that the impacts of higher rates of recent forestry planting are a significant change in the second and third emissions budget.

This chapter provides our draft advice on revisions to the first, second, and third emissions budgets. It outlines the factors we have considered in our analysis, including the impact of the methodological and significant changes we have identified in our work.

We are seeking your feedback

In this chapter, we are seeking your feedback on our approach and assessment on revisions to the first three emissions budgets. In particular, we want to know:

- Do you agree with the Commission's approach to assessing changes to emissions budgets which have already been set? If not, why not?
- Do you agree that all set budgets should be revised to account for methodological changes?
- Do you agree with the Commission's assessment of the significant changes that have occurred? If not, why not?

Methodological change

Changes to how emissions budgets are calculated mean emissions budgets need to change

Why account for methodological changes?

Methodological consistency is important. Our models, utilising the data provided by the GHG Inventory, are used to inform projections of future emission pathways and emissions budgets. Methodological updates to the inventory can lead to an increase or decrease in emission levels, without any changes in mitigation actions. In some cases, these changes may look like large emissions reductions or increases, but these changes represent a change in how the emissions are measured, not the real-world increase or decrease in emissions.

The ability under the Act to review and, if appropriate, revise set emissions budgets because of methodological change means that progress can be more accurately monitored, and ambition on emissions reduction can be maintained over time. If set emissions budgets could not be revised, changes to the inventory methodology could lead to unexpected windfall gains or losses for a budget period. A notable example of a methodological change was the reallocation of liquid fuel emissions from road transport to recreational marine usage in the residential energy sector. The impact of this change on the first emissions budget was a decrease of approximately 4 $MtCO_2e$ in the transport sector, which was partially offset by an increase in emissions in the residential energy sector.

How we have assessed the impacts of methodological changes on set emissions budgets

For this draft advice, we looked at methodological changes that occurred since the first, second, and third emissions budgets were set by the Government in 2022 including the latest inventory update in 2023.[61] For the final advice, we will need to reflect any methodological changes in the 2024 update which will be published in April 2024.

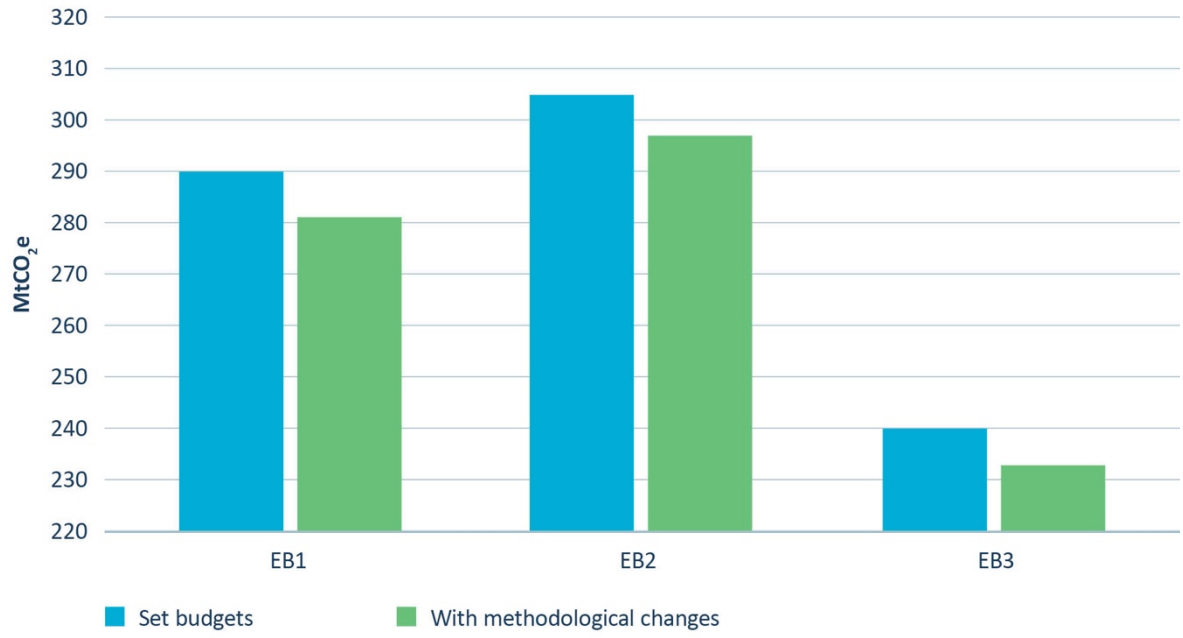
To determine the impact of methodological changes on emissions budgets, we have taken data from the 2023 inventory update for the period between 1990 and 2019, and compared this with our previous modelling on emissions budgets we did for *Ināia tonu nei*[62] covering the same period. This was so we could isolate the impacts due to methodological changes from other changes such as more recent data or updated emissions projections. This allowed us to see what the emissions budgets would have been at the point in time when the set budgets were established, if the updated inventory methodologies had been used.

There is a *de facto*, minimum threshold that applies since emissions budgets are reported to the nearest 1 $MtCO_2e$ across a budget period. Changes that in aggregate come to less than ± 0.5 $MtCO_2e$ across a budget period would not result in us recommending a change to the emissions budgets.

What our modelling shows

Our analysis shows that the methodological changes to the inventory since 2022 would have had an impact on the level of the emissions budgets. If updated methodologies had been used at the time of setting the first three emissions budgets, all three budgets would have been set at lower levels. The impact of the methodological changes on the set budgets is shown below in **Figure 6.1**.

Figure 6.1: *Emissions budget changes due to methodological improvements to the GHG Inventory ($MtCO_2e$)*



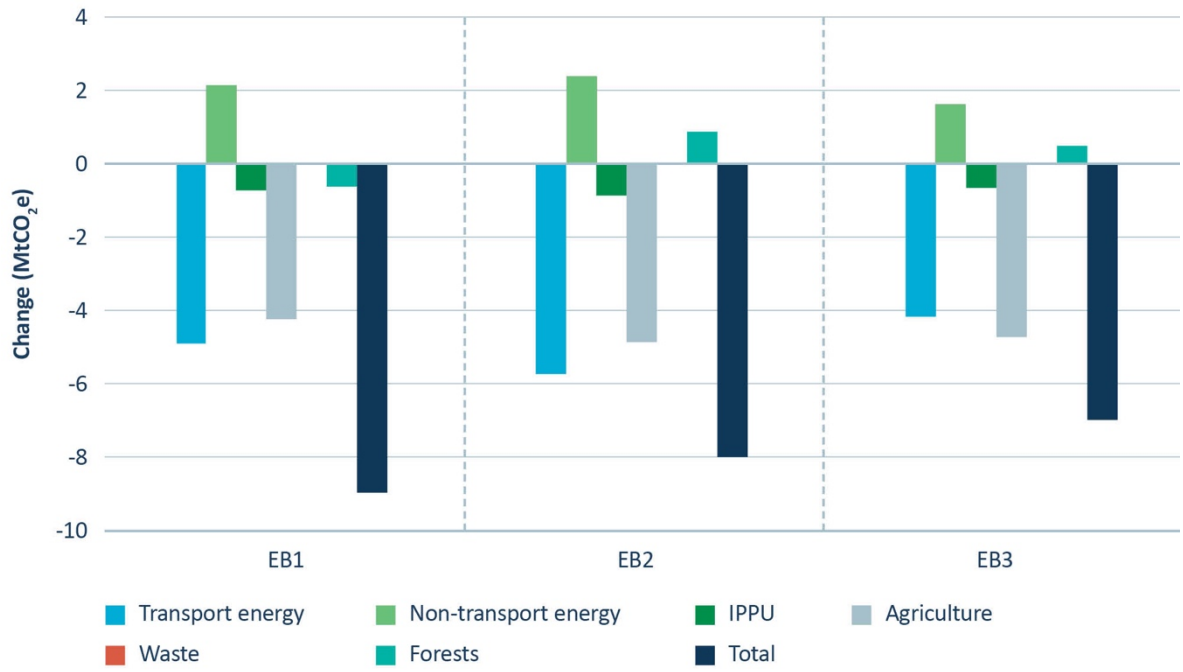
Source: Commission analysis

Some of the methodological changes that had the most impact on this overall change were:

- A proportion of emissions from petrol and diesel in the transport category were reallocated to the residential sector (categorised as non-transport energy), which includes fuel used around the home and fuel used for recreational activities like boating.
- In non-transport energy, there was the additional allocation from the transport sector (as outlined above) and the energy content of coal (gross calorific value) was updated.
- In the industrial processes and product use (IPPU) category there was a re-estimation of stocks of hydrofluorocarbons (HFCs) held by importers and users.
- In the agricultural category non-pasture feed was added into the inventory, there was a revision to the fraction of nitrogen applied to agricultural land that is lost through leaching, and changes were made to the accounting method for agricultural lime.
- Within forestry there were multiple method changes to increase accuracy of planted forest estimates, and improvements to harvest/deforestation data and carbon yields.

Figure 6.2 below summarises the impact of methodological changes by sector across the first three emissions budget periods, with the total rounded to the nearest whole $MtCO_2e$.

Figure 6.2: *Impact on emissions budgets by sector of methodological improvements to the GHG Inventory*



Source: Commission analysis

Significant change

A significant change is one that is notable, important, and consequential

Considerations when assessing if a change is significant

Emissions budgets are set, based on specific considerations in the Act. Over time, these considerations may undergo significant change, which can impact the achievability of emissions budgets, as well as the actions to reduce emissions in Aotearoa New Zealand.

The Commission may recommend that set budgets be revised if there has been one or more significant changes that have affected those considerations on which the emissions budget was based (see **Box 6.1**).

In order to determine whether a change is significant, we need to define the term significant. For this draft advice, significant is defined as something that is notable, important and consequential.[63]

Box 6.1: List of considerations that are potentially significant

When considering significant changes, the Commission must have regard to changes that have occurred in the considerations used for setting the emissions budgets. These considerations include:

- key opportunities for emissions reductions and removals
- the principal risks and uncertainties
- projections in the emission and removal of greenhouse gases
- domestic and international scientific advice
- existing technology and anticipated technological developments
- what is technically and economically achievable
- impact of actions to achieve budgets and the 2050 target
- distribution of impacts for regions, communities and between generations
- economic circumstances
- the impact of land use change on communities
- results of public consultation
- responses to climate change taken by other signatories to the Paris Agreement
- Aotearoa New Zealand's relevant obligations under international agreements.

For significant changes we have applied the minimum threshold differently for the current emissions budget (2022–2025) compared to future budgets. This was due to the proximity to the end of the budget period, and the nature of a significant change compared to a methodological change.

Under the Act, the Minister of Climate Change must only revise the current budget if the circumstances are exceptional.[64] This does not preclude the Commission from recommending a significant change to the current budget, as the decision on whether it is exceptional is for the Minister of Climate Change to make.

We have developed a framework for assessing significant change

This framework is designed to meet our statutory requirements when evaluating significant changes.

Using a framework ensures that we are systematically and consistently assessing whether changes are significant, and that the approach is transparent. We are only assessing changes that:

- were not known when the budget was originally set
- are not due to a methodological improvement, since this is addressed separately
- are not due to a change to the 2050 target, since this, in its own right, would induce revisions of emissions budgets to be made
- affect one or more of the matters listed in the Act (see **Box 6.1**).

There are potentially many changes that occur over time. For changes that meet the criteria above, the significant change framework can be applied. The framework consists of two steps:

1. Test of significance – an assessment against criteria that provides more detail to our definition of significance (i.e. notable, important and consequential) (**Table 6.1**).
2. Recommendation on budget changes – an assessment of the cumulative impacts of significant changes and our recommendations based on consistency with the purpose of the Act.

The criteria in **Table 6.1** are applied to an identified change. One or more of the criteria should be met for the change to be considered significant. Some of the considerations in the Act may require modelling to evaluate whether impacts have changed.

Table 6.1: *Criteria used for testing whether a change should be considered significant*

Criteria applied	Reasoning
Material impact: How does the change affect the level of emissions reductions possible?	To be notable the change should be large enough to materially impact the level of an emissions budget.
Permanence: Is the impact of the change permanent, or could it be reversed?	The change should likely be permanent for the period of the set emissions budgets and the impact of the change should propagate through multiple budget periods. Some change may simply bring an existing action to reduce emissions forward in time to an earlier budget period. However, this is unlikely to represent a change in the emissions budgets as it represents an alternative path which government may take, but which has already been factored in.
Likelihood: What is the likelihood that the impact on budgets will be realised?	Changes have an impact on budgets occurring several years into the future. There may be uncertainties as to the magnitude of the impact and the timescale over which an action to reduce emissions might be implemented. If the assumption on which the change is based is uncertain this could influence the likelihood of it occurring.
Reason for change: Has the change altered the assessment of what is feasible in the budget period?	The change should impact the feasibility of what is achievable in the budget period to be considered significant. For example, an alternative technology may be a circumstance that has changed, but if we have already considered its effects, it just represents an alternative path that government may take and is not a significant change.

The second step in the framework is to evaluate how the application of the criteria affects the emissions budgets. A recommendation to change an emissions budget is based on the cumulative impact of all the significant changes. This means that even if two significant changes were identified, if they were opposite and equal in magnitude, they would cancel each other out, and there would be no need to change the emissions budget. As well as assessing the cumulative impacts of changes, this step also considers the purpose of emissions budgets under the Act. Emissions budgets are required to provide a means to meet the 2050 target and contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C. Under the Act, emissions budgets should also provide predictability for those affected.

The framework is discussed in more detail in the *Technical Annex*.

Box 6.2: Equal consideration regarding the direction of change

Recommendations on changes to emissions budgets will depend on the cumulative impacts of the significant changes identified. The significant change may have the effect of loosening or tightening those budgets, whilst any budget changes should remain consistent with the purpose of emissions budgets under the Act. The purpose of budgets includes:

1. to continue providing a path to meeting the 2050 target
2. contributing to the global effort under the Paris Agreement to limit global average temperature increase to 1.5°C
3. providing predictability for those affected, including households, business and investors.

The purpose of the emissions budgets can be achieved regardless of whether the change increases or decreases emissions. A stable emissions budget would be favoured if we follow the principle of predictability, or one with a limited number of changes.

If a change occurred which results in an increase in an emissions budget we may still consider it aligned with meeting the 2050 target, as long as later budgets remain on track. To align with the purpose of the Act to maintain the global effort required to limit temperature rise to 1.5°C, an increase in an emissions budget may need a steeper correction in a later budget, so that cumulative emissions remain unchanged.

Finally, a change that tightens an emissions budget may also be consistent with the purpose of the budgets. It would represent a path aligned with meeting the 2050 target as well as contributing to the global effort limiting temperature rise to 1.5°C.

In meeting the purpose of the Act, an emissions budget may equally be revised up as down as a result of a significant change.

Our analysis suggests higher afforestation rates are the only significant change

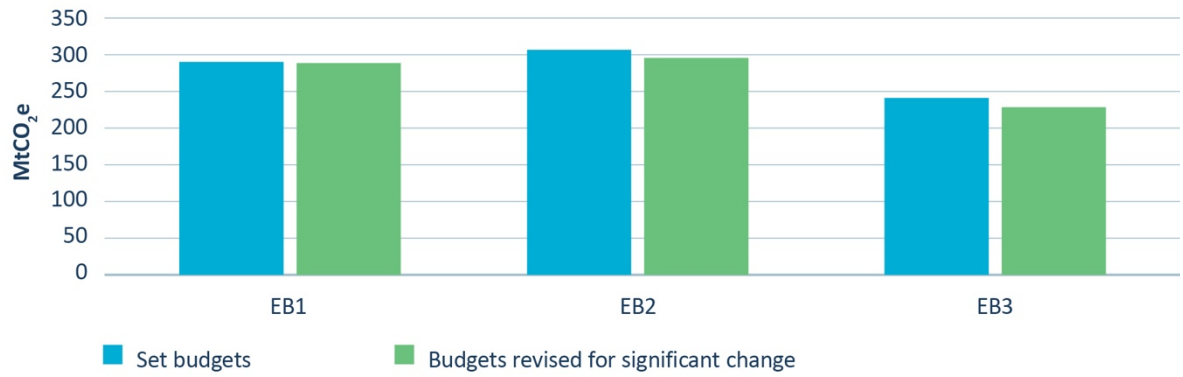
Afforestation rates of exotic forests, which have occurred in the last 3 years, are substantially higher than were predicted when the first three emissions budgets were set. The government projections for afforestation through to 2050 have also changed considerably. The projected afforestation for 2024 to 2050 remains highly uncertain, so this is not considered within our assessment. However, the actual higher afforestation rates observed from 2020 to 2022 (and anticipated for 2023) are accounted for. Our assessment assumes the same ultimate level of afforestation occurs by 2050 as modelled for the set budgets. This means that the change we assessed is the impact of the afforestation occurring earlier.

Our assessment of significance was based on the criteria from **Table 6.1**.

1. **Material impact** – The change is material for the second and third emissions budgets. For the first emissions budget we did not consider the estimated change of 1 $MtCO_2e$ to be material. The difference between what was projected for afforestation in the set budgets and afforestation observed (2020, 2021, 2022) and anticipated (2023) results in substantial changes of -11 $MtCO_2e$ in the second emissions budget, and -12 $MtCO_2e$ in the third emissions budget.
2. **Likelihood** – The higher afforestation that has occurred, and the impact of this, will see ongoing additional removals of carbon through to 2050. Although the projected afforestation rate is uncertain, the actual afforestation to have occurred is highly likely to achieve sustained removals of CO_2.
3. **Permanence** – There is a high degree of confidence that this change is permanent for the duration of the emissions budgets through to 2050. The impacts of this change are unlikely to be reversed in this time through deforestation.
4. **Reason for change** – The higher rate of afforestation changes the balance between net and gross emissions reductions. If the first three emissions budgets can be met without reducing gross emissions, then subsequent emissions budgets will, at worst, be unachievable and, at best, only achieved through higher-cost action later. The level of ambition on gross emissions reductions should be maintained along with the actions necessary to ensure future budgets can be met. What we now consider feasible is greater overall reductions occurring in the second and third emissions budgets. Earlier planting has an enduring impact on emissions reductions.

The impact of the modelled exotic afforestation on emissions budgets is shown in **Figure 6.3.** The figure shows the extent of the reduction in emissions budgets, being more pronounced in the second and third emissions budgets.

Figure 6.3: *Impact on emissions budgets of higher afforestation levels*



Source: Commission analysis

We considered a range of other changes in our analysis that were not assessed to be significant

We evaluated a number of changes using the above framework. No other change was deemed to be significant at this time, and an explanation for this is provided in **Table 6.2**. Further details are available in the *Technical Annex*.

Table 6.2: *Changes evaluated for significance using the framework*

Changes evaluated but not deemed to be significant		
Change item		**Justification**
Transport	**EV uptake rate higher than predicted**	From 2021, a suite of policies were introduced to incentivise the uptake of low emissions vehicles. This policy response was intended to achieve an action assumed in the budgets, and therefore hasn't changed our assessment of what was feasible. Uptake projections are inherently uncertain, and the rates could be different in the second and third emissions budgets. Changes to government policy may alter the projection of EV uptake in the future.
	Change in vehicle kilometres travelled (VKT) projections	VKT forms the basis of emissions estimates in the ENZ model which is used to derive the level of emissions budgets. Light vehicle VKT is now estimated to be lower than that projected under *Ināia tonu nei* through to the third emissions budget. For heavy vehicles the VKT projections have increased but have a smaller total VKT than light vehicles. These projections linked to demand can be harder to accurately predict than single discrete events, such as an industrial process change. This makes it an uncertain change that may not be permanent, and therefore was determined to not represent a significant change.
	Biofuels mandate	Biofuels are part of the *Ināia tonu nei* demonstration path and government emissions reduction plan and are a realistic action to reduce emissions for hard to abate sectors such as heavy freight and aviation. The biofuels mandate is a specific policy used to incentivise uptake. Although this policy has been discontinued it does not mean alternative mechanisms will not emerge, or that alternative paths cannot be identified.

Changes evaluated but not deemed to be significant		
Change item		**Justification**
Energy and industry	**NZ Steel Electric Arc Furnace (EAF) funded**	The EAF is a change in technology that will reduce carbon emissions that was not considered in *Ināia tonu nei*. The EAF is considered one of the main initiatives for the Government to meet its second and third emissions budget targets. It is a policy response to the emissions budgets being in place. The EAF is not representative of a new technological breakthrough for the industry but represents a different path for decarbonisation that the Government could take.
	Fonterra receiving GIDI funding to reduce process heat	This initiative is a policy response by the Government as a means to achieve budget reductions. Although this particular initiative was not modelled in *Ināia tonu nei*, the move away from coal for process heat was considered at the time (albeit at a later date). Our understanding of what is feasible is unchanged, and it should not represent a significant change.
	Heat pumps that can deliver heat >100°C	This is an emerging technology which has continued to develop since *Ināia tonu nei* was published. It is likely to be an option for electrification of process heat within the second emissions budget period. The GIDI funding recently awarded to Fonterra to reduce coal use in process heat, in part, addresses the same emissions source. This represents an alternative decarbonisation path the Government could take. There is not sufficient justification to represent a significant change.
Agriculture	**Methane Inhibitor 3-NOP**	The likelihood that a methane inhibitor will be available in Aotearoa New Zealand by the second emissions budget period (2025–2030) has increased since the set budgets. However, there is no change yet to the knowledge of how effectively they could reduce emissions, barriers that may exist, or the costs to implement across Aotearoa New Zealand. The uncertainties remain too large to recommend this as a significant change.
	Implication of land use changes on communities	Since *Ināia tonu nei* was published the rate of afforestation has increased faster than was predicted. How this progresses in the next few years could dictate the impacts on communities. There is a limited body of literature addressing the potential social impacts of future land use changes[65,66], and were available at the time the budgets were set. No further climate policies have been announced or introduced that are likely to significantly influence land use change and impact rural communities.

Collective impacts of changes on the first three emissions budgets

Our analysis in this draft advice has shown methodological and significant changes to the first three emissions budgets have occurred. The impact across the three emissions budget periods is illustrated in **Table 6.3**. Under the Act we are required to provide emissions budget recommendations that include all greenhouse gases expressed as a net quantity of CO_2e.

Table 6.3: *Impact of methodological and significant changes on set budgets*

	Emissions Budget 1 (2022–2025)	Emissions Budget 2 (2026–2030)	Emissions Budget 3 (2031–2035)
Set budgets (Total net emissions)	290 $MtCO_2e$	305 $MtCO_2e$	240 $MtCO_2e$
Difference due to methodological changes	-9 $MtCO_2e$	-8 $MtCO_2e$	-7 $MtCO_2e$
Difference due to significant changes	0 $MtCO_2e$	-11 $MtCO_2e$	-12 $MtCO_2e$
Recommended budgets (Total net emissions)	281 $MtCO_2e$	286 $MtCO_2e$	221 $MtCO_2e$
Annual average	70.3 $MtCO_2e$/yr	57.2 $MtCO_2e$/yr	44.2 $MtCO_2e$/yr

Source: Commission analysis

Proposed recommendation

Proposed Recommendation 5 – Revisions to the set emissions budgets

We propose that the Government revise the first, second and third emissions budgets as outlined in the table* below:

	Emissions Budget 1 (2022–2025)	**Emissions Budget 2 (2026–2030)**	**Emissions Budget 3 (2031–2035)**
Notified budgets (total net emissions)	290 $MtCO_2e$	305 $MtCO_2e$	240 $MtCO_2e$
Difference due to methodological changes	-9 $MtCO_2e$	-8 $MtCO_2e$	-7 $MtCO_2e$
Difference due to significant changes	0 $MtCO_2e$	-11 $MtCO_2e$	-12 $MtCO_2e$
Recommended budgets (total net emissions)	281 $MtCO_2e$	286 $MtCO_2e$	221 $MtCO_2e$
Annual average	70.3 $MtCO_2e$/yr	57.2 $MtCO_2e$/yr	44.2 $MtCO_2e$/yr

*All values listed in $MtCO_2e$ are calculated using the IPCC AR5 GWP_{100} values.

CHAPTER 7

Measuring progress towards emissions budgets and the 2050 target

The methods used to calculate and report the amount of greenhouse gases emitted or removed from the atmosphere over time towards the targets are a critical component of effective climate policy.

Emissions accounting rules are the rules that govern how greenhouse gas emissions are measured and calculated in Aotearoa New Zealand. They are important for informing climate policy and monitoring and reporting progress against emissions budgets and the 2050 target.

Under the Climate Change Response Act 2002 (the Act), any time He Pou a Rangi Climate Change Commission (the Commission) provides advice on emissions budgets, we must also advise on the rules that will be used to measure progress towards meeting those budgets and the 2050 target.

We first advised on these rules in our 2021 report *Ināia tonu nei*, in which we provided advice to the Government on the setting of the first three emissions budgets. When the Government set the first three emissions budgets in May 2022, it adopted emissions accounting rules largely in line with our advice.

Now, as we prepare to provide the Government with advice on the fourth emissions budget, we have the opportunity to review the rules and consider whether they remain fit-for-purpose.

Our initial analysis suggests there have not been sufficient changes since the Government adopted these rules to warrant a review. We are proposing that the current rules, which utilise production accounting with a modified activity-based framework for land emissions, are still the most appropriate of the available options for measuring emissions reductions.

However, there remain areas where the Government has yet to clarify how its rules will work, including particulars of rules applying to forestry and rules for new sources and sinks. The operation of these rules could materially affect the ambition of future budgets.

This chapter provides our draft advice and proposed recommendations for how the Government can set additional rules to better manage the levels of carbon dioxide removals by forests included in emissions budgets, as well as account for other additional sources of carbon dioxide removals.

We are seeking your feedback

In this chapter, we are seeking your feedback on our draft advice on accounting rules. In particular, we want to know:

- Do you agree with our assessment that the Government should continue with the existing accounting approach? If not, why not, and what accounting approach should be used instead?
- Is there any additional evidence that would support reviewing the existing approach?
- Do you agree with our assessment of what the Government should be considering when it sets a reference level for forest management?
- Do you agree with our assessment of what the Government should be considering as it develops accounting methodologies for inclusion of additional sources and sinks in budgets and target accounting?

Greenhouse gas emissions accounting

Robust and accurate emissions accounting is essential for:

- setting emissions budgets and target components
- monitoring and evaluating progress towards meeting budgets and target components
- judging compliance at the end of a budget period.

In our previous advice we introduced six principles for what emissions accounting should do. These principles are based on the requirements of Article 4.13 of the Paris Agreement that in accounting for emissions parties shall "… promote environmental integrity, transparency, accuracy, completeness, comparability and consistency, and ensure the avoidance of double counting…". We said that emissions accounting should:

- seek to cover all material human caused emissions sources and sinks
- be grounded in robust science and evidence
- send a clear signal for climate action
- be accurate and reduce uncertainty as far as practicable
- be transparent, practical, and acceptable
- be consistent and maintain the integrity of the 2050 target.

A key purpose of the emissions reduction targets that countries set themselves is to drive actions to reduce human impacts on the climate. The accounting methods for these targets need to deliver useful data to inform emissions reduction efforts and influence which reduction activities are prioritised. This link to policy and to driving behaviour change is why emissions accounting for targets may differ from the methods used for reporting emissions in national greenhouse gas inventories.

Accounting approaches and methodologies should have room for continuous improvement toward more robust measuring and reporting of emissions. Changes in methodologies should not be a mechanism to achieve targets more quickly.

Roles and responsibilities

The Commission is required to advise on the rules that will apply to measure progress towards emissions budgets and the 2050 target, as part of its five-yearly advice on emissions budgets.[67] The Government must then set the accounting rules as part of setting each emissions budget.

The Commission has a role to monitor the Government's progress in delivering its emissions reduction plans and in reaching the emission budgets. The Commission reports on progress annually from 2024 and these monitoring reports must use the rules adopted by the Government when the emission budgets were set.

Changing the accounting rules can change the ambition of the target

The ambition of a target or budget depends both on its level and on the rules used to measure progress towards it. If there are significant accounting changes that depart from those that were used to set the emissions budget, that could have the effect of changing the ambition of the budget – making it either easier or harder to achieve. This is why methodological consistency is important between setting budgets and meeting them.

Ensuring methodological consistency is one of the requirements of the Paris rulebook for meeting Nationally Determined Contributions (NDCs).[68] Similarly the Act requires that the Commission monitor progress towards emission budgets using the rules adopted when the budgets were set.[69]

Any changes to accounting rules should only be retrospectively applied to ensure consistent methods are used to both set and meet an emissions budget.

Our previous advice

We provided comprehensive advice on accounting in *Ināia tonu nei*

In the Commission's first advice, *Ināia tonu nei*, we applied the accounting principles above to assess the main choices for emissions accounting, and made recommendations for how the Government should proceed on several accounting issues:

- Whether to use production- or consumption-based emission estimates.
- How to account for emissions from the land sector.
- Voluntary offsetting.
- Methodological inventory updates.

In *Ināia tonu nei,* we identified two options for approaches to accounting for emissions: production and consumption approaches. The production approach records emissions at the point where human activity causes their release to the atmosphere. It includes all emissions occurring within a territorial boundary. The consumption approach focuses instead on the use of goods and services and the emissions embodied in the entire supply chain required to produce the good or service – no matter where that emission occurred.[70]

We recommended that the Government calculate and report emissions on a production basis rather than a consumption basis. This was because consumption-based emissions estimates for Aotearoa New Zealand were (and remain today) at the early stages of development, making them unsuitable as a basis for measuring progress against budgets and the 2050 target. In contrast, production-based estimates of emissions have been produced annually for more than 25 years and have improved in their rigour and completeness over that time. However, we recommended the Government continue to produce and improve consumption-based estimates as a complementary tool.

Methodologies to estimate emissions are based on guidance developed by the IPCC. For the energy, agriculture, industry, and waste sectors there is largely one set of agreed methodologies on how emissions are to be estimated via the IPCC 2006 guidelines. Accounting for emissions and removals from the land sector[lviii] is more complex, and there is a wider set of choices of methodologies available. A large amount of land in Aotearoa New Zealand is used for forestry so the rules for measuring and accounting for its impact can have a large effect on total emissions. This is why much of our advice focuses on how to account for land sector emissions and removals.

For land emissions, we recommended the Government use a modified activity-based approach for accounting, rather than a land-based approach. An activity-based approach accounts for particular activities – in this case afforestation, reforestation, and deforestation – in order to filter out the effect of land-use decisions made before the base year. This approach was adopted by the international community for the Kyoto Protocol. The methodology has been modified (via the averaging approach) to better focus on the component of forestry removals that are additional and permanent.

We found that this approach would best focus on the impacts of decisions made now and into the future, rather than rewarding or penalising decisions made in the past. We also noted it would align with the approach being used for Aotearoa New Zealand's NDC under the Paris Agreement.

Our recommendations were that the Government calculate and report Aotearoa New Zealand's emissions by:

- using a 1990 base year and 'averaging' for post-1989 forests, aligning emissions budget accounting with the approach for the NDC
- including the land areas and uses corresponding to afforestation, reforestation, and deforestation, as confirmed for the first NDC
- excluding forest management, despite its inclusion in NDC accounting. This was because the Government had not yet set the reference level, so we had not been able to assess how it manages the inherent challenges and uncertainties
- including harvested wood products (HWPs) from post-1989 forest carbon stocks, but not from pre-1990 forests, as they are a forest management activity which we recommended was excluded
- including a natural disturbances provision to allow for managing the risks of extreme natural events that could radically affect land emissions and removals, and aligning it with the first NDC and the 2013 IPCC Kyoto Protocol Supplement.

[lviii] The "land sector" here predominantly refers to forestry but also includes other non-agriculture land-cover such as wetlands or scrubland.

We also recommended the Government undertake further work to improve emissions estimates and broaden the options available for emissions accounting in the future by:

- continuing to produce annual reports on national consumption estimates
- developing appropriate methods to reflect changes in carbon dioxide stored in above ground biomass and harvested wood products due to increased use of biomass for energy
- developing methods for tracking emissions and removals by sources and sinks not yet included in the country's domestic or international target accounting, with prioritisation given to development of methods to account for carbon in organic soils (such as peat) and biomass (such as small lots of trees and regenerating vegetation)
- examining the feasibility of using the land-based approach in accounting for targets and emissions budgets for sources and sinks other than production forests, while also managing the uncertainty and emissions fluctuations from the harvest cycles of production forests
- developing sound and transparent practices for accounting for domestic voluntary mitigation and offsetting claims, in relation to the New Zealand Emissions Trading Scheme (NZ ETS), emissions budgets, and NDC.

The Government set the first rules for emissions accounting in 2022

When the Government set the first, second, and third emissions budgets in May 2022, it put in place its approach to measuring progress towards meeting those budgets and the 2050 target, largely in line with our advice.

The current rules use:

- production-based accounting, calculated and reported annually by the National Greenhouse Gas Inventory (GHG Inventory)
- a modified activity-based approach for accounting for land emissions in line with accounting for Aotearoa New Zealand's NDC.

However, the Government's rules diverged from our advice in two areas.

Excluding forest management from accounting

In *Ināia tonu nei*, we advised that forest management be excluded from accounting. The Government decided it will include forest management activities in accounting towards budgets and the 2050 target.

The Government is developing a reference level for accounting for pre-1990 forests under forest management and had previously been expected to complete this work by the end of 2023. This would have enabled emissions from pre-1990 forest management activities to be included in the rules for the first emissions budget, in line with accounting for Aotearoa New Zealand's first NDC.

However, this is now scheduled to be completed and published in the Government's Biennial Transparency Report, due at the end of 2024.

Including a natural disturbances provision within accounting

The Government disagreed with our advice regarding including natural disturbances within accounting; instead, the Government said it would reconsider this issue when accounting for pre-1990 forest management.

The primary reason cited by the Government for its decision was the lack of evidence that would enable this provision to be implemented. In particular, it reported there was little, if any, evidence for assessing the background level of natural disturbance occurring in a newly established forest, to which modified activity-based accounting is being applied.

However, the Government did see the natural disturbance provision as relevant for existing pre-1990 forests, where there is evidence for calculating the background level of natural disturbance, against which the provision to exclude emissions from natural disturbances can then be applied.

The Government has begun work to include additional sources and sinks in its accounting against targets

Since the first emissions reduction plan, the Government has made high-level announcements

In *Ināia tonu nei*, we advised that the Government needed to do further work to develop methods for tracking emissions and removals by sources and sinks not yet included in the country's domestic or international target accounting. We recommended the Government prioritise the development of methods to account for carbon in organic soils (such as peat) and biomass (such as small lots of trees and regenerating vegetation).

In July 2023, the Government announced the development of a Carbon Removals Strategy, intended to be included in the second emissions reduction plan. The strategy is expected to consider how a broader portfolio of carbon dioxide removal activities can be used to meet emissions budgets and the NDC under the Paris Agreement.

In July 2023, the Minister of Climate Change sought agreement through Cabinet to bring further advice on potential methodology options and timing options for including additional sources and sinks in NDC accounting back to Cabinet by mid-2024.

We cannot assess impacts on budgets and the 2050 target at this time

In *Ināia tonu nei,* we advised that expanding target accounting beyond the scope used to set existing targets would be cause for a review of the 2050 target to ensure its integrity. This is important to prevent undermining the ambition of Aotearoa New Zealand's climate commitments. This is something we said was most appropriately considered in 2024 when reviewing the 2050 target. We also said at this time there would be opportunity to review existing budgets as part of our advice on the fourth emissions budget.

The Government has not made enough progress for us to do this. While high-level announcements have been made, significant technical work would need to happen for these additional sources and sinks to be included in budgets and target accounting. To date, we have not seen evidence of this work and cannot comment on the process or integrity of analysis.

The next formal opportunity for us to consider whether budgets need to be revised will be in 2028/2029 when we give advice on the fifth emissions budget. There could also be an opportunity to do a further review of the 2050 target if the Minister of Climate Change requests it.

If the Government includes any additional sources and sinks into budgets and target accounting before that time, we will be able to pick this up as part of our annual monitoring function. Identifying changes to accounting will allow us to understand the impact of additional sources and sinks on meeting emissions budgets. If additional sinks are included, we advise that the Government consider these sinks as additional to the emissions budget rather than as a way to make meeting the emissions budget easier.

Our approach for this draft advice

Our proposed recommendations in this draft advice build on our previous advice

In preparing advice on the fourth emissions budget, we have looked at whether the Government has updated any of its approaches to accounting since the Government set budgets and rules to measure progress.

We have found that the Government has not made sufficient progress to warrant a review of the existing rules to ensure they are fit for purpose. We are proposing in this draft advice the Government continue to use production accounting with a modified activity-based approach for accounting for land emissions. *Ināia tonu nei* describes our assessment of the available options and our rationale for supporting these approaches.

Our previous recommendations to Government to undertake further work to improve emissions estimates and broaden the options available for emissions accounting in the future are still relevant.

Since this work was evidenced thoroughly in *Ināia tonu nei,* these proposed recommendations are not revisited further in this draft advice. The proposed recommendations in this draft advice are intended to build on our previous advice.

This draft advice focuses on setting expectations for further work

Since the Government is currently developing a reference level for forest management and progressing work on expanding accounting to additional sources and sinks, our further advice focuses on setting expectations for what we expect to see as this work progresses.

We have used the accounting principles we developed for *Ināia tonu nei* as a basis for how the Government should be considering accounting issues and challenges when making further decisions on these areas. The following sections outline these issues.

Should the Government consult on or publish any new material between now and the end of public consultation, we will be able to reassess our recommendations.

Forest management

Forest management activities will be counted towards budgets and the 2050 target

Forest management is included in the approach to NDC accounting. The Government is currently developing a reference level for forest management for the NDC period 2020–2030. This will also be used for budgets and targets accounting.

Box 7.1 Setting a reference level for forest management

As stated in *Ināia tonu nei* forest management is the part of the NDC accounting system where the impact on carbon stocks of management practices affecting pre-1990 forests is counted.

It involves setting a reference level based on a future projection of what emissions and removals in pre-1990 forests would be with no change in management. By tracking progress against this reference level, we can potentially measure and monitor the impacts of changes in management practices on a long-term basis.

Theoretically, this approach can be used to recognise the effect of human interventions that increase carbon stocks in pre-1900 forests, such as extending harvest lengths in production forests or undertaking pest control. In practice this is difficult to implement, given the measurement and monitoring systems that are used to estimate national scale land emissions.

Using counterfactual projections in this way has inherent accuracy and uncertainty challenges, with high risks of both under- and over-estimation. Foresters have choices about how and when to harvest and replant their forests. It can be difficult to discern actual changes to management practices from forecasting errors.

Recent history shows there are challenges to this approach

Under previous Kyoto Protocol Rules (prior to the Paris agreement and establishment of NDCs) it was mandatory for countries to include forest management in accounting. In Aotearoa New Zealand's reporting against the 2020 emissions reduction target (covering the 2013–2020 period), the GHG inventory showed a significant amount of removals from forest management providing a net removal of 123 $MtCO_2e$ towards meeting Aotearoa New Zealand's 2020 target.

The net removal appears to have been the result of lower harvesting rates of pre-1990 production forest than projected when the reference level was set. Issues with accuracy of estimates for intended harvesting rates of pre-1990 forests are largely due to the skewed profile of the country's forests driving variable harvest rates, as well as inconsistency of different forest statistics. This means that the removals accounted for may not actually be 'additional' to what was planned. Delayed (rather than avoided) harvesting would just result in these emissions occurring further down the track.

The implications of this on Aotearoa New Zealand's target were limited due to Kyoto Protocol rules setting a limit to the amount forest management contributions can count towards the target, resulting in only 18.7 $MtCO_2e$ contributing to meeting the target. The Government has not yet indicated whether it intends to put limits in place for the current NDC.

While changes in forest management of production forests were recorded, there were no changes recorded from changes in forest management of Aotearoa New Zealand's 7.7 Mha of pre-1990 native forests. This is because Aotearoa New Zealand's native forests are generally not harvested, and effects from activities – such as pest control – are challenging to accurately attribute with current monitoring techniques. Detailed research could help overcome these barriers, but with present methods, thousands of forest monitoring plots would be required (at significant cost) to provide accurate enough information for accounting purposes.[71]

Land area under forest management will increase over time

The averaging approach replaces the stock change approach to accounting for carbon dioxide removals from forestry. Under the averaging approach, an additionality test applies to the specific removals in each newly planted forest. Only removals from around the first 20 years of growth (up to the forest's long term average carbon stock) are considered additional and count towards targets. After that time, the forest transitions to the forest management category and normal growth and harvest changes are no longer included in accounting emissions so long as the land remains in forestry. Sometimes the forest will store more carbon dioxide than has been credited, and sometimes it will store less depending on where it is in a planting and harvesting cycle, but these fluctuations should average out over the long term.

This approach means that the distinction is no longer pre-1990 forest land versus post-89 forest land. It is newly planted forest land versus land under forest management. As more and more post-89 forest ages, it will transition into the forest management category. This means that any errors in forecasting emissions and removals from land under forest management will affect larger and larger areas of land over time and have correspondingly bigger impacts on the emissions budgets and the 2050 target. This is another reason to be cautious about crediting forest management under emissions budgets using counterfactural projections.

Methodologies will need to be improved

If the Government is going to include forest management activities in budgets and 2050 target accounting, it will need to improve its methodologies to better align with the principles the Commission has set out to guide accounting and ensure integrity of Aotearoa New Zealand's climate ambition.

The Government will need to consider how they will develop an appropriate evidence base to measure and monitor forest management activities. This should include a plan for how they will improve estimates around intended pre-1990 production forest harvesting.

Adopting strong criteria around additionality and permanence will be important to ensure removals can be considered genuine (see below section for more detail on recommended criteria for carbon removals).

As Aotearoa New Zealand's history with Kyoto Protocol accounting shows, the inclusion of forest management creates risks of generating credits or debits that are not the result of genuine management practice change affecting long term emissions trajectories.

The Government should consider immediate needs for managing the inherent accuracy and uncertainty risks of including forest management as part of a wider plan for how it will manage risks across all carbon dioxide removal activities. This is discussed in more detail in below section.

Expanding accounting to include additional sources and sinks

There are significant sources of land emissions and removals not yet accounted for

In *Ināia tonu nei*, the Commission provided advice about investigating the options for a wider portfolio of carbon dioxide removal activities. Inclusion of these activities is in line with our principle that accounting should aim to cover all material human-caused emissions sources and sinks.

The most significant sources of land emissions and removals not yet part of accounting are emissions from organic soils (mostly drained wetlands) and removals from vegetation biomass (mostly improved pasture and small lots of trees) on grasslands.

Criteria should underpin removals to ensure integrity

We think it is important that new sources of removals are not used to weaken emissions budgets and the 2050 target. In our advice to the Government on the direction of policy for the second emissions reduction plan, we recommended that the Government adopts the principles of additionality and permanence (durability) and includes them as criteria for any recognised removal activities, along with other key characteristics including removal capacity, measurability, cost, and acceptability. Additionality, permanence and measurability are key criteria for the environmental integrity of removals.[72] Removal capacity, cost and acceptability are important for the wider impacts of removals and their role in Aotearoa New Zealand's transition to a low emissions economy. We have provided further detail on these criteria below.

Additionality

As defined in our advice to the Government regarding its second emissions reduction plan, additionality is the concept that an activity only contributes to carbon dioxide removal if it is extra to the status quo or business as usual. This was the reason for the setting of baseline years for carbon storage in forests in Aotearoa New Zealand at the 1989/1990 boundary. The adoption of averaging has superseded the 1989/1990 boundary by applying a stricter additionality test for new forestry.

When defining additionality for additional sources and sinks, the Government will need to consider what the appropriate baseline year should be for these new sources and sinks. To reduce complications and ensure consistency, this baseline year should be the same across all non-forest land uses.

Strict additionality tests will be needed to ensure any removals considered are a result of genuine management practice and not a way to gain removal credits that do not reflect genuine additional removals. These tests should consider whether the emissions reductions or removals that occur from an activity have happened as a result of policy that has been implemented for climate change. These tests may be different across activities depending on the baseline year.

Permanence (durability)

As defined in our advice to the Government regarding its second emissions reduction plan, permanence indicates how long carbon dioxide is expected to be stored; it is also referred to as the durability of carbon dioxide removal. Carbon capture through land and coastal vegetation, soils, and sediment has storage timescales of decades to centuries. Processes involving marine sediments have timelines of centuries to millennia, and engineering processes involving geological formations and minerals even longer.

As these emissions sources and removals are subject to changes in management practices and changing climate impacts, there is a risk of reversal. The Government should consider how they may enforce permanence of removals related to change in management activities.

Other key characteristics that should be part of criteria

Alongside permanence and additionality, other criteria that should be included are:

- **removal capacity** – this is the measure of how many emissions can be sequestered by the carbon sink
- **measurability** – this refers to the level of confidence in the ability to measure removals and storage including whether established methods exist, and how well demonstrated they are to date
- **cost** – this refers to the costs associated with developing evidence bases and ongoing monitoring and reporting of emissions associated with each activity
- **acceptability** – this relates to the social licence and international acceptability of activities. Nature-based carbon dioxide removals should also go hand in hand with ecological restoration and attending to the biodiversity crisis.

Long-term planning and commitment will be needed

It is important that the Government sends long-term signals. Inclusion of these activities in accounting will require long-term time commitment and resources to ensure there are appropriate evidence bases and long-term monitoring and evaluation assessments. This will need to be planned for and funded.

Evidence bases of emissions and removals associated with different sources and sinks, and changes in management practices are still being built. This makes accurately estimating the potential and enduring contribution from non-forest land uses to emission targets challenging. The emissions and removals from these sources/sinks are also different from site to site and project to project, so it can be difficult at a national scale to attribute change in management practices to 'real world' emissions.

The Government should develop a phased approach over the long term to allow time for developing and improving data sets and setting up long-term monitoring and evaluation across different sources, sinks, and changes in management practices. Some sources and sinks will be more important to prioritise, due to their emissions intensity and/or removal capacity (for example, peat and small stands of trees/regenerating vegetation). Prioritisation for removals should be guided by the criteria set out above, and in line with the accounting principles. This should then inform which policies are needed to incentivise them.

Risks and uncertainties will need to be managed

As with forest management, inclusion of these sources, sinks, and activities creates risks of generating credits or debits that are not the result of genuine management practice change. Both under and over-estimates will affect long term emissions trajectories. It could also potentially be used to strategically generate removal credits that do not reflect genuine additional removals, especially if policies are being developed to incentivise them.

The Government will need to plan for how they are going to manage these uncertainties. This plan should:

- include considerations on limits and constraints on the amount of removals that can be used to account towards the budgets and 2050 target consistent with Aotearoa New Zealand's climate ambition
- cover both forest and non-forest land uses (recognising there may be more immediate needs for managing risks associated with forest management)
- be consistent with wider work the Government should do on clearly communicating the role of removals from forestry out to 2050, as advised in *2023 Advice on the direction of policy for the Government's second emissions reduction plan.*

Proposed recommendation

Proposed Recommendation 6 – Rules to measure progress

We propose that as the Government considers whether to include any new sources of emissions or carbon dioxide removals in its accounting for emissions budgets, it:

- adopts the principles of additionality and permanence (durability) and include them as criteria for any recognised removal activities, along with other key characteristics including removal capacity, measurability, cost, and acceptability
- develops and implements a long-term plan for measuring and monitoring additional sources, sinks, and changes in management activities, including how the plan will be funded
- develops and implements a plan for how the Government will manage accuracy and uncertainty risks, limiting the risk that over or under-estimation will impact long-term emissions trajectories and associated emissions reduction efforts.

References

[1] He Pou a Rangi Climate Change Commission (2021). *Ināia tonu nei: a low emissions future for Aotearoa.* http://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa.pdf

[2] Ministry for the Environment Manatū Mō Te Taiao, 'New Zealand's Greenhouse Gas Inventory' (2021), <https://environment.govt.nz/facts-and-science/climate-change/measuring-greenhouse-gas-emissions/about-new-zealands-greenhouse-gas-inventory/#about-the-inventory> [accessed 11 March 2024].

[3] International Panel on Climate Change. (2014). *Fifth Assessment Report*. https://www.ipcc.ch/assessment-report/ar5/

[4] Ministry for the Environment. (2024). *Emissions budgets and the emissions reduction plan*. https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/emissions-reductions/emissions-budgets-and-the-emissions-reduction-plan/

[5] Ministry for the Environment. (2023). *New Zealand's Greenhouse Gas Inventory 1990–2021*. https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2021/

[6] Ministry for Primary Industries. (2023). *Afforestation and Deforestatoin Intentions Survey 2022*. https://www.mpi.govt.nz/dmsdocument/57130-Afforestation-and-Deforestation-Intentions-Survey-2022

[7] Ministry for the Environment. (2023). *New Zealand's Greenhouse Gas Inventory 1990–2021*. Wellington: Ministry for the Environment. https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2021/

[8] Kuschel et al. (2022). *Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1 – Finding and implications*. Report prepared by G Kuschel, J Metcalfe, S Sridhar, P Davy, K Hastings, K Mason, T Denne, J Berentson-Shaw, S Bell, S Hales, J Atkinson and A Woodward for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency. https://environment.govt.nz/publications/health-and-air-pollution-in-new-zealand-2016-findings-and-implications/

[9] Energy Hardship Expert Panel. (2023). *Te Kore, Te Pō, Te Ao Mārama Energy Hardship: The challenges and a way forward Energy Hardship Expert Panel Report to the Minister* (OIA release). Request for Te Kore, Te Pō, Te Ao Mārama | Energy Hardship: The challenges and a way forward (mbie.govt.nz) [Accessed 23 January 2024]

[10] BERL (2022). *Transitioning to net zero emission houses and offices.* https://www.berl.co.nz/our-mahi/transitioning-near-zero-emission-houses-and-offices. [Accessed 23 January 2024]

[11] Etkins, P., Ishwaran, M., Newton-Smith, R., et al. (2019). *Report to the Committee on Climate Change of the Advisory Group on costs and benefits of net zero*. p.32-33. Advisory-Group-on-Costs-and-Benefits-of-Net-Zero.pdf (theccc.org.uk)

[12] Climate Change Commission. (2023). *2023 Advice on the direction of policy for the Government's second emissions reduction plan*. https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/advice-for-preparation-of-emissions-reduction-plans/2023-advice-to-inform-the-strategic-direction-of-the-governments-second-emissions-reduction-plan-april-2023/

[13] Etkins, P., Ishwaran, M., Newton-Smith, R., et al. (2019). *Report to the Committee on Climate Change of the Advisory Group on costs and benefits of net zero*. p.32-33. Advisory-Group-on-Costs-and-Benefits-of-Net-Zero.pdf (theccc.org.uk)

[14] Ministry for the Environment Manatū Mō Te Taiao, *New Zealand's Greenhouse Gas Inventory 1990–2021*, ME 1750 (Wellington: Ministry for the Environment Manatū Mō Te Taiao, 2023) <https://environment.govt.nz/assets/publications/climate-change/New-Zealands-Greenhouse-Gas-Inventory-1990-2021-Chapters-1-15.pdf> [accessed 11 March 2024] (p. xxvii)

[15] Stats New Zealand. (2023). *Greenhouse gas emissions by region (industry and household): Year ended 2022*. https://www.stats.govt.nz/information-releases/greenhouse-gas-emissions-by-region-industry-andhousehold-year-ended-2022/. [accessed 11 March 2024]

[16] New Zealand Agriculture Greenhouse Gas Research Centre. Nitrification inhibitors. in: *Nitrous Oxide research programme*. https://www.nzagrc.org.nz/domestic/nitrous-oxide-research-programme/nitrification-inhibitors/

[17] Energy Efficiency & Conservation Authority. Green hydrogen. In: *Insights. Energy's role in climate change. Renewable energy.* https://www.eeca.govt.nz/insights/energys-role-in-climate-change/renewable-energy/hydrogen/

[18] International Energy Agency. (2020). An introduction to biogas and biomethane. In: *Outlook for biogas and biomethane.* https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/an-introduction-to-biogas-and-biomethane

[19] Transpower. (2023). *Monitoring Report October 2023*. Whakamana I Te Mauri Hiko. https://static.transpower.co.nz/public/uncontrolled_docs/Monitoring%20Report%20-%20October%202023%20FINAL%20V.pdf?VersionId=_VjodWjAGDptG7uSbL1y62JeBUwgy.y7.

[20] Transpower. (2020). *Whakamana I Te Mauri Hiko: Empowering our Energy Future*. https://static.transpower.co.nz/public/publications/resources/TP%20Whakamana%20i%20Te%20Mauri%20Hiko.pdf?VersionId=FljQmfxCk6MZ9mIvpNws63xFEBXwhX7f [accessed 2 Febuary 2024].

[21] National policy statement for greenhouse gas emissions from industrial process heat | Ministry for the Environment

[22] Golden Bay submission to Climate Change Response (Late Payment Penalties and Industrial Allocation) Amendment Bill dated April 6 2023

[23] NZ Government. (2023, 21 May). *NZ's biggest ever emissions reduction project unveiled.* https://www.beehive.govt.nz/release/nz%E2%80%99s-biggest-ever-emissions-reduction-project-unveiled.

[24] Mukhopadhaya, J. & Graver, B. (2022). *Performance analysis of regional electric aircraft*. The International Council on Clean Transportation. https://theicct.org/wp-content/uploads/2022/07/global-aviation-performance-analysis-regional-electric-aircraft-jul22-1.pdf-1.pdf [accessed 16 February 2024].

[25] Ara Ake. (2024). *Transitioning to Low-Emissions Domestic Aviation in New-Zealand A Detailed Technical Options Analysis.* https://www.araake.co.nz/assets/Transitioning-to-low-emissions-domestic-aviation-in-New-Zealand_A-detailed-technical-options-analysis.pdf [accessed 16 February 2024].

[26] BERG. 2018. Report of the Biological Emissions Reference Group (BERG) www.mpi.govt.nz/dmsdocument/32125/direct

[27] The AgriBusiness Group, Journeaux Economics. 2023. Report on agricultural Greenhouse Gas mitigation technologies. https://www.climatecommission.govt.nz/public/Uploads/EB4/supporting-docs/Report-on-agricultural-mitigation-technologies-Final.pdf

[28] Ministry for the Environment. (2024). *Aotearoa New Zealand Waste Strategy*. https://environment.govt.nz/what-government-is-doing/areas-of-work/waste/aotearoa-new-zealand-waste-strategy/

[29] OECD. (2017a). Investing in Climate, Investing in Growth. OECD Publishing. https://www.oecd-ilibrary.org/economics/investing-in-climate-investing-in-growth_9789264273528-en;jsessionid=k89-blaFGI3sMPQOJdZk3JzMxyKoQEULHQVKyib_.ip-10-240-5-48 [Accessed 23 January 2024]

[30] Committiee on Climate Change, United Kingdown. (2020). *The Sixth Carbon Budget – The UK's path to Net Zero*. The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (theccc.org.uk) [accessed 23rd January 2024]

[31] Waka Kotahi, (2023): Cost Benefit Manual (2023) https://www.nzta.govt.nz/assets/resources/monetised-benefits-and-costs-manual/Monetised-benefits-and-costs-manual.pdf.

[32] Intergovernmental Panel on Climate Change (IPCC). (2018): Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24. https://doi.org/10.1017/9781009157940.001. [Accessed 1 Febuary 2024, pg.19]

[33] Shaw C, Mizdrak A, Gage R, McLeod M, Jones R, Woodward A, et al. (2024) Policy approaches to decarbonising the transport sector in Aotearoa/NZ: Equity, health and health system impacts. medRxiv. 2024:2024.01.29.24301894.

[34] Fyfe, C. Grimes, A. Minehan, S. Taptiklis, P. 2022. Evaluation of the Warmer Kiwis Homes Programme: Full Report including Cost Benefit Analysis. Motu Working Paper 22-14. Wellington: Motu

[35] Energy Hardship Expert Panel. 2023. *Te Kore, Te Pō, Te Ao Mārama Energy Hardship: The challenges and a way forward Energy Hardship Expert Panel Report to the Minister* (OIA release). Request for Te Kore, Te Pō, Te Ao Mārama | Energy Hardship: The challenges and a way forward (mbie.govt.nz) [Accessed 23 January 2024]

[36] Mizdrak A, Blakely T, Cleghorn CL, Cobiac LJ. (2024) Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: A modelling study. PLoS ONE. 2019;14(7):e0219316. https://doi.org/10.1371/journal.pone.0219316

[37] Manaaki Whenua Landcare Research. 2023. *Rapid assessment of Land Damage – Cyclone Gabrielle.* Prepared for the Ministry for the Environment. https://environment.govt.nz/assets/Rapid-assessment-of-land-damage-Cyclone-Gabrielle-Manaaki-Whenua-Landcare-Research-report.pdf [Accessed 26 January 2024]

[38] Anastasiadis S, Kerr S. 2013. Mitigation and Heterogeneity in Management Practices on New Zealand Dairy Farms. Motu Working Paper. Wellington: Motu.

[39] He Pou a Rangi Climate Change Commission. (2023). 2023 Advice on the direction of policy for the Government's second emissions reduction plan. https://climatecommission.govt.nz/public/Advice-togovt-docs/ERP2/final-erp2/ERP2-Final-Advice-forweb.pdf

[40] Te Puni Kōkiri. (2023). *Long-term insights briefing*. https://www.tpk.govt.nz/en/o-matou-mohiotanga/crownmaori-relations/longterm-insights-briefing-2023.

[41] BERL. (2021). Māori economy emissions profile – Climate change mitigation impact on the Māori economy. https://www.mbie.govt.nz/dmsdocument/17448-maori-economy-emissions-profile.

[42] Maui.Tech. (2023). "*Whakatū*", Maui.Tech case study interviews with Whakatū representatives, filmed between October-November 2021, video #14 of 14, at 1:35, accessed 27/09/2023 https://vimeo.com/845690241/16a3bd4197?share=copy.

[43] Stats NZ. (2021). Tatauranga umanga Māori – Statistics on Māori businesses. https://www.stats.govt.nz/information-releases/tatauranga-umanga-maori-statistics-on-maori-businesses-2021-english.

[44] Ibid

[45] The Reserve Bank of New Zealand & BERL. (2018). *Te Ōhanga Māori – The Māori Economy 2018*. https://www.rbnz.govt.nz/-/media/project/sites/rbnz/files/research/te-ohanga-maori-report-2018.pdf> [accessed Febuary 2024] (p. 15).

[46] Ministry of Business Innovation and Employment. (2021). *The emissions exposure of workers, firms and regions. https://www.mbie.govt.nz/dmsdocument/13781-the-emissions-exposure-of-workers-firms-and-regions.* https://www.mbie.govt.nz/dmsdocument/13781-the-emissions-exposure-of-workers-firms-and-regionsAccessed 23 January 2024.

[47] New Zealand Forest Research Institute Limited (SCION). (2020). *Strategy to 2030*. Rotorua. https://www.scionresearch.com/about-us/about-scion/strategy-to-2030.

[48] BERL. (2022). *Transitioning to net zero emission houses and offices.* https://www.berl.co.nz/our-mahi/transitioning-near-zero-emission-houses-and-offices. Accessed 23 January 2024.

[49] Ministry of Business Innovation and employment. *Impacts of Economic Transitions on Firms, Workers, Regions and Households*. https://www.mbie.govt.nz/dmsdocument/25537-impacts-of-economic-transitions-on-firms-workers-regions-and-households.

[50] Raul Alfaro-Pelico et al. (2023). Realizing the Green Jobs Promise: The Benefits of a Regenerative Approach. *Rocky Mountain Institute.* https://rmi.org/insight/realizing-the-green-jobs-promise/. Accessed 23 January 2024.

[51] Productivity Commission. (2020). *Technological change and the future of work: Final report*. https://www.productivity.govt.nz/inquiries/technology-and-the-future-of-work/

[52] Transpower. (2020). *Whakamana I Te Mauri Hiko: Empowering our Energy Future*. https://static.transpower.co.nz/public/publications/resources/TP%20Whakamana%20i%20Te%20Mauri%20Hiko.pdf?VersionId=FljQmfxCk6MZ9mIvpNws63xFEBXwhX7f.Accessed 2 Febuary 2024.

[53] Request for Te Kore, Te Pō, Te Ao Mārama | Energy Hardship: The challenges and a way forward (mbie.govt.nz)

[54] Shaw C, Mizdrak A, Gage R, McLeod M, Jones R, Woodward A, et al. *Policy approaches to decarbonising the transport sector in Aotearoa/NZ: Equity, health and health system impacts*. medRxiv. 2024:2024.01.29.24301894.

[55] New Zealand Transport Agency. (2022). Understanding attitude and perceptions of cycling & walking. https://www.nzta.govt.nz/assets/resources/understanding-attitudes-and-perceptions-of-cycling-and-walking/Waka-Kotahi-Attitudes-to-cycling-and-walking-final-report-2022.pdf

[56] Ministry of Business Innovation and Employment. (2023). *Quarterly Survey of Domestic Electricity Prices.* https://www.mbie.govt.nz/assets/quarterly-survey-of-domestic-electricity-prices-15-may-2023.pdf

[57] Ibid.

[58] Ministry for the Environment. (2023). *Our atmosphere and climate 2023. https://environment.govt.nz/publications/our-atmosphere-and-climate-2023/* . Accessed 23 January 2024.

[59] Roy, J., P. Tschakert, H. Waisman, S. et al. (2018). Sustainable Development, Poverty Eradication and Reducing Inequalities. *In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Cambridge. University Press, Cambridge, UK and New York, NY, USA, pp. 445-538. https://doi.org/10.1017/9781009157940.007.

[60] Climate Change Response Act 2002, Section 5ZE Climate Change Response Act 2002 No 40 (as at 01 January 2024), Public Act – New Zealand Legislation [accessed 02 2024].

[61] Ministry for the Environment. 2023. Planned methodological improvements for Aotearoa New Zealand's Greenhouse Gas Inventory 1990–2021. Wellington: Ministry for the Environment. Planned methodological improvements for Aotearoa New Zealand's Greenhouse Gas Inventory 1990–2021 | Ministry for the Environment

[62] He Pou a Rangi Climate Change Commission, *Ināia tonu nei: a low emissions future for Aotearoa* (Wellington: He Pou a Rangi Climate Change Commission, 2021) http://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa.pdf [accessed 12 2023].

[63] Oxford English Dictionary (2023, March) www.oed.com/search/dictionary/?scope=Entries&q=significant

[64] Climate Change Response Act 2002, Section 5ZE(6) Climate Change Response Act 2002 No 40 (as at 01 January 2024), Public Act – New Zealand Legislation [accessed 02 2024].

[65] Motu. (2019). Potential Social Impacts of Land-use Changes, 2020-2050 – Report to the Interim Climate Change Committee. https://www.mcguinnessinstitute.org/wp-content/uploads/2022/02/FINAL-Motu-Potential-Social-Impacts-of-Land-use-Changes-2020-2050-Report-to-the-Interim-Climate-Change-Committee-Motu.pdf

[66] Dorner, Z., Djanibekov, U., Soliman, T., Stroombergen, A., Kerr, S., Fleming, D., Cortes-Acosta, S., Greenhalgh, S. (2018). Land-use Change as a Mitigation Option for Climate Change – Report to the Biological Emissions Reference Group (Project No. 18398). https://www.motu.nz/assets/Documents/our-work/environment-and-agriculture/agricultural-economics/agricultural-greenhouse-gas-emissions/Land-use-change-as-a-mitigation-option-BERG-report.pdf

[67] Climate Change Response Act 2002, Section 5ZA(1)(b)

[68] United Nations Framework Convention on Climate Change Secretariat. *Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018. Decision 4/CMA.1 Further guidance in relation to the mitigation section of Decision 1/CP.21*, Clause 13. https://unfccc.int/sites/default/files/resource/cma2018_3_add1_advance.pdf

[69] Climate Change Response Act 2002, Section 5ZJ(2)

[70] Stats NZ, 2020. Approaches to measuring New Zealand's greenhouse gas emissions. https://www.stats.govt.nz/methods/approaches-to-measuring-new-zealands-greenhouse-gas-emissions/

[71] He Pou a Rangi Climate Change Commission, *Ināia Tonu Nei: A Low Emissions Future for Aotearoa 2021 Supporting Evidence Part 1: Our place in the world* (Wellington: He Pou a Rangi Climate Change Commission, 2021) *https://www.climatecommission.govt.nz/public/Evidence-21/Evidence-CH-03-how-to-measure-progress.pdf* [accessed 29 December, 2023] (p. 24)

[72] Axelsson, K., Wagner, A., Johnstone, I., Allen, M., Caldecott, B., Eyre, N., Fankhauser, S., Hale, T., Hepburn, C., Hickey, C., Khosla, R., Lezak, S., Mitchell-Larson, E., Malhi, Y., Seddon, N., Smith, A. and Smith, S.M. *Oxford Principles for Net Zero Aligned Carbon Offsetting (revised 2024).* (Oxford: Smith School of Enterprise and the Environment, University of Oxford, 2024) https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf [accessed 7 March 2024] (p.14)

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