FEEDBACK RECEIVED ON EMISSIONS TARGET ENGAGEMENT: 17 JULY – 14 AUGUST 2019

SUBMITTERS WISHING TO BE HEARD							
Sub ID	**First name**	**Last name**	**Name of organisation**	**Do you think we should align with the proposed national target of net zero greenhouse gas emissions by 2050 (that also adopts a separate approach to methane gas) if so, why?**	**Should we take a more ambitious approach? If so, what year should our net zero greenhouse gas emissions target be set and (and why) and how should we consider methane (and why)?**	**Do you support an interim target as a way to encourage early action?**	**Any other comments**
27543	Pam	Richardson	Banks Peninsula Community Board	Please see attached submission.	Please see attached submission.	Yes support interim target	Please see attached submission.

Christchurch City Council
Banks Peninsula Community Board

TO: Christchurch City Council
Email: Katy.McRae@ccc.govt.nz

SUBMISSION ON: Our District's Emissions Target

SUBMISSION BY: Banks Peninsula Community Board

ADDRESS: Lyttelton Service Centre
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DATE: 14 August 2019

The Banks Peninsula Community Board appreciates the opportunity to provide feedback to Christchurch City Council on our district's emission target.

The Board's statutory role is, "to represent, and act as an advocate for, the interests of its community" (Local Government Act 2002, section 52). The Board provides this submission in its capacity as a representative of the communities around Banks Peninsula.

The Board supports our district aligning with the proposed national target of net zero greenhouse gas emissions by 2050 (that also adopts a separate approach to methane gas). We also support the Council adopting an interim target to reduce greenhouse gas emissions by 50% district-wide by 2030 (from our 2016/17 baseline levels). Finally, we support the Council advocating for a reduction in maritime emissions, which can negatively impact our many harbour settlements.

However Banks Peninsula needs support to make these changes. The size and economy of the Peninsula make it challenging for our communities to lower emissions. Motorised vehicles and agriculture are both vital to the sustainability of these communities, but we acknowledge that they also hugely impact the sustainability of our environment. Residents of the Peninsula, like many who live in semi-rural and rural areas, will therefore need help in finding ways to adopt sustainable transport practices, and to develop sustainable agriculture.

For example, the Board would like to see the Council work with landowners interested in planting appropriately sourced indigenous vegetation to offset some of the district's emissions. We also support further funding to fence and plant within sites of ecological significance with the aim of extending and in-filling areas and providing connecting corridors.

The Board would like to speak to its submission.

Yours sincerely,

Pam Richardson

Pam Richardson
Chairperson, Banks Peninsula Community Board

27475	Mike	Mora	Waipuna/Halswell-Hornby-Riccarton Community Board	Generally yes, on the basis that as a city and a country we are all committed to heading in the same direction and acknowledging the government's proposals for the treatment of biogenic methane emissions seem reasonable. The Board's preference is that the intended plans and actions of the Christchurch City Council are in keeping with what central Government does. Such alignment will in the Board's view be more effective in terms of behaviour change locally and nationally. The Board would only support pursuing a lower and earlier target setting if this could be achieved on a rates neutral basis for our ratepayers. Any unsubstantiated costs or consequences for the local government sector, are unacceptable to the Board.	While open minded to the proposition of a more ambitious approach, the Board would only want that to see this happen if parameters such as these were applied: i. Cost neutral, namely, nil increase in rates nor any resulting loss or reduction in Council services (as in a. above) ii. Public passenger transport services and freight. The Board urges that priority be given in collaboration to maximise the existing high level of investment and returns in our region's rail networks. Reintroducing passenger commuter services, with supporting park and ride facilities on peripheral areas of the city, and increasing rail-based freight cartage (including the removal of waste) remain as unfulfilled opportunities to significantly contribute to easing growing congestion and cost pressures on our local and state highway road network. (Ashburton/Amberley/Rangiora/Christchurch). The Board believes that the contribution that these measures would make towards reducing our overall emissions, makes so much sense.	Yes support interim target	In conclusion, the Board has these general comments: • Support for the proposed Climate Change Commission • All policy development to be scientific and evidence based • Maximise the opportunity within the former red zone areas for food production and local supply • Smart Cities: use of real time technology for information gathering, monitoring and display e.g. cycling movements/carbon consumption/savings • Packaging increased national focus and action on efficient carbon zero alternatives • Live local/use local/think local - a suggested message to help drive behaviour change • Self sufficiency: still a viable message • Trees: more plantings on Council-owned land.

27556	KAROLIN	POTTER	SPREYDON CASHMERE COMMUNITY BOARD	Yes. See attached submission.	No. See attached submission.	Yes support interim target	See attached submission.

Spreydon-Cashmere Community Board

Submission on Our District's Emissions Target

1. INTRODUCTION

1.1 The Spreydon-Cashmere Community Board ("the Board") appreciates the opportunity to submit on the proposal for our district's emissions target ("emissions target").

1.2 The Board would like to speak to its submission.

2. SUBMISSION

2.1 The Board is extremely conscious of climate change and the effects that it has and will have in the future.

2.2 The Board applauds the Council's commitment to climate change leadership and recognition of the important role that Christchurch can have in limiting global warming.

2.3 The Board recognises the need for New Zealand to drastically reduce its greenhouse gas emissions and supports the national targets to be put in place for net zero emissions of greenhouse gases by 2050, other than biogenic methane, then remaining at net zero for each subsequent year.

2.4 The Board appreciates the debate on whether the Christchurch District should align with the national Zero Carbon Bill targets, or adopt a more ambitious local approach.

2.5 The Board understands the importance of reducing greenhouse gas emissions as quickly as possible but recognises the need to also manage the speed at which greenhouse gas emissions are reduced to enable time for a just and equitable transition to a low greenhouse gas emissions economy. It is necessary to avoid drastic cuts that will have potentially harmful impacts on the community and the economy. The Board further recognises that not all citizens are equally placed to be able to make and sustain the necessary lifestyle changes to achieve the reductions. For some it will take more time than others.

2.6 The possibility of having a target of net zero emissions of greenhouse gases by 2050 is an interesting one, however, the Board's view is that the unknowns around reductions in methane from our waste management systems, including landfills can be made mean that this is not currently a viable option.

2.7 While being ambitious can be a good thing the Board prefers an approach that gives the greatest chance of Christchurch meeting its target and for this reason supports adoption of national targets to be put in place for net zero emissions of greenhouse gases by 2050, other than biogenic methane, then remaining at net zero for each subsequent year.

2.8 As regards the suggestion of adoption of an interim target the Board agrees that this would preserve focus and maintain momentum of changes necessary to meet the final target. The Board accepts that setting an interim target of reducing greenhouse gas emissions by 50% district-wide by 2030 is appropriate.

3. SUMMARY

The Board **supports** the Council adopting a target for reduction of greenhouse gases that is consistent with the national target for reductions by 2050.

The Board further **supports** the Council adopting an interim target of reducing greenhouse gas emissions by 50% district-wide by 2030.

Karolin Potter,

Chairperson, Spreydon-Cashmere Community Board.

Dated:

27528	Prof Andy	Buchanan	PTL Structural Consultants / University of Canterbury	Yes. However 2030 would be a more aggressive target date. The AECOM report on the 2016/2017 Carbon footprint of Christchurch states that transportation was the highest sector contributing to Christchurch's GHG emissions. However a 2018 report by ThinkStep New Zealand showed that emissions from buildings and infrastructure are greater than had previously been suggested. As buildings become more thermally efficient, less energy is needed for heating and cooling, so we need to focus on the carbon intensive construction processes, such as the manufacturing of concrete and steel, and look at ways to reduce them, principally by substituting with low carbon materials such as timber. The innovative use of mass timber, including glulam, LVL, and cross laminated timber (CLT), creates an excellent opportunity for Christchurch to lead the way in promoting structural timber for residential and commercial, low-rise and high-rise buildings. The Pres-Lam structural timber solution was developed at the University of Canterbury. Structural timber is much lighter than concrete, offering savings in foundations and reduced seismic loads, and far more attractive interiors. All wood products have much lower 'embodied carbon' than steel or concrete, and in addition each cubic metre of timber used in construction stores carbon equivalent to over 900kg of CO2 emissions. The amount of wood in a timber building is between 0.15 and 0.4 m3/m2 of floor area, representing a reduction of 135 to 360kg CO2-e/m2 of floor area. The low figure is for light timber framing and the high figure is for mass timber construction. Last quarter, 146,000m2 of new building was consented in Canterbury: this represents the opportunity for carbon storage equivalent to 80,000-212,000 tonnes of CO2 emissions per year.	Yes. New Zealand should follow Norway, a country of similar size, population and economic development as New Zealand, in having 2030 as the target for zero carbon. Christchurch should be leading the way by setting this target now. I am not competent to talk about methane.	Yes support interim target	An interim target of zero carbon by 2030 is vital if the recent Climate Crisis declaration by the Council is to be recognised. A 'wood first' policy in Christchurch would send a message to property developers and all others in the construction industry, including architects, engineers, other designers, contractors and their clients, making a small but noticeable contribution to reducing the carbon footprint of the city.

				The additional benefit of using wood is the reduced emission of CO2 from manufacturing wood, compared with manufacturing steel or concrete. This roughly doubles the benefit of using wood, so the total carbon reduction opportunity becomes 160,000 to 424,000 tonnes of CO2 emissions per year, with an average of 300,000 tonnes. From the AECOM report, the net emissions offset by land use, land use change and forestry (LULUCF) activities in Christchurch are 362,679 t CO2-e, so this could be about doubled if all new buildings in Christchurch were constructed using timber. Using the figures in the AECOM report, this contribution from timber buildings could double the reported benefit of forestry in offsetting of total Christchurch emissions from 15% to 30% of the total emissions. To encourage a major increase in wood construction, Christchurch City Council should adopt a 'wood first' policy, similar to that adopted by Rotorua Lakes Council in 2015, and international jurisdictions including British Columbia and Tasmania. Such a 'wood first' or 'wood encouragement' policy would require all building designers to show that they have considered wood as an option for their primary structure, and if it is not taken forward, demonstrate valid reasons why.			
27519	Katie	Symons	Structural Engineer at WSP-Opus, Christchurch	Yes. Although the national target is inadequate (see below), it requires backing from regional centres, in order to subsequently push for more ambitious targets. The AECOM report on the 2016/2017 Carbon footprint of Christchurch states that transportation was the highest sector contributing to Christchurch's GHG emissions. The Council is right to continue to prioritise policies that encourage active transport and promote electric cars where motor vehicle transport is required. However a 2018 report by ThinkStep New Zealand showed that emissions from buildings and infrastructure are greater than had previously been suggested. In New Zealand we benefit from having a very low carbon electricity supply	Yes. The young people of Christchurch deserve to have their voice heard and see more immediate action on climate change. The October 2018 IPCC report confirmed the following: â€¢ Human activity is already responsible for 1oC of global warming above pre industrial times, â€¢ We are already committed to further warming, due to the lag between emissions and their effect on climate, most likely about 1.5oC, â€¢ To keep to a 1.5oC increase, CO2 emissions would have to decline by 45% between 2010 and 2030,	Yes support interim target	An interim target of zero carbon by 2030 is vital to engender action today, rather than allowing procrastination. The recent Climate Crisis declaration by the Council should be recognised in strategic and everyday decisions, to demonstrate real meaning. The Council set themselves the target to be carbon neutral by 2030 back in 2017: now in 2019 it is time to raise expectations of other large organisations that are responsible for significant carbon emissions in the city: these include designers, contractors and clients in the construction industry. Please note that although I am an employee of WSP Opus, these are my own personal comments, rather than my employer's.

				thanks to our hydropower resource: we need to focus now on the carbon intensive processes in construction, such as the manufacture of concrete and steel, and look at ways to reduce them: substituting with low carbon materials such as timber is one such method. The use of mass timber, such as glulam and cross laminated timber (CLT), as a structural material for residential and commercial, low and high rise buildings, is an excellent opportunity for Christchurch to lead the way in allowing this construction method to break through to the mainstream. Mass timber differs from traditional timber frame in that the elements are large, solid panels or beams (rather than stick members of timber frame construction), typically manufactured offsite in a factory environment bringing benefits to quality, and engineered in such a way that naturally occurring defects can be compensated for. They result in structural frames lighter than their concrete alternatives, offering further savings in foundations and crucially for seismically active regions, lower lateral loads. Despite the manufacturing processes involved in making these products, they have a lower 'embodied carbon' than steel or concrete, and in addition each cubic metre of timber used in construction sequester or stores over 900kg of CO2 emissions, when sourced from sustainable New Zealand forests. A mass timber building uses between 0.15-0.4m3/m2 of timber, which means emissions of 135-360kgCO2e/m2 of floor area can be stored. In the year to June 2019, ~700,000m2 of new buildings was consented in Christchurch City: this represents the opportunity to sequester 100,000-260,000 tonnes of CO2 emissions. This equates to between 4-10% of the City's annual emissions, not an insignificant amount. Rotorua Lakes Council has implemented a 'wood first' policy since 2015, where all buildings need to show they have considered wood as an option for their primary structure,	â€¢ Existing national climate pledges under the Paris agreement are inadequate, and are in line with a 3oC temperature rise by the end of the century, â€¢ The lower the emissions in 2030, the easier it will be to limit global warming to 1.5oC. Delay in cutting greenhouse gases risks increasing the cost of reductions, locking countries into carbon-emitting infrastructure or stranding high-emission assets, â€¢ The impacts of a 2oC rise (the aspiration of the 2016 Paris agreement) compared to 1.5oC rise are significant: to human populations, economic growth and biodiversity. Norway, a country of similar size, population and economic development as New Zealand have 2030 as their target for zero carbon: there is no reason why New Zealand cannot match that, and regional centres like Christchurch should be leading the way by setting this as their target now.		

				and if it is not taken forward, demonstrate valid reasons why. Christchurch City Council should adopt a similar policy, and proactively enforce it: in doing so not only would it provide a benefit to our net greenhouse gas emissions, but would also provide a valuable market for timber construction products, which are required if national government policies, such as the 'billion trees' programme are going to succeed. The treatment of methane gas is predominantly an issue for the agricultural sector: this submission is primarily concerned with contributions from the construction section, and therefore I make no comment on the approach to methane within the greenhouse gas reduction targets for the city.			

27561	Suky	Thompson	Rod Donald Banks Peninsula Trust			Yes support interim target	Please see attached submission.

Rod Donald banks peninsula trust
te pātaka o rākaihautū

Submission on: CCC Emissions Target Consultation
From: Rod Donald Banks Peninsula Trust

Contact details: Suky Thompson, Trust Manager, manager@roddonaldtrust.co.nz, 03-3047733

Postal address: PO Box 5, Little River, Banks Peninsula 7546

Date: August 14, 2019

The Rod Donald Banks Peninsula Trust is a registered charity and a CCO of the Christchurch City Council.

The Trust has objectives to promote sustainable management and conservation on Banks Peninsula and works on environmental projects that support the reinstatement of native vegetation and enhancement of native biodiversity, generally in conjunction with improved public access on foot and by bike.

The Trust would like to be speak to the Innovation and Sustainable Development Committee in support of its submission.

Submission

The Trust supports:

- The Christchurch City Council declaration of the Climate and Ecological Emergency
- The proposal to set more ambitious emission reduction targets for the Christchurch City Council area than the national targets
- Augmenting reductions through additional carbon sequestration

Our key submission points are to establish clear and ambitious interim targets and then develop implementation plans that financially encourage and support action through information and practical regulation. We suggest that this is achieved through:

1. **Sequestration on a landscape scale through fostering large tracts of naturally regenerating native forest on Banks Peninsula.**
2. **Reduced energy and low carbon transport.**
3. **Encouraging everyday actions that individuals can take to lower their personal carbon footprint and use demand to lower overall emissions.**

Climate and Ecological Emergency

The Trust recognises how serious the problem of human induced climate change is and strongly supports the decision of Christchurch City Council to declare a Climate and Ecological Emergency.

It is now imperative that rapid and effective action is taken to both reduce the emissions from our area and to improve the state of the natural environment to help mitigate and adapt to the emergency. The Trust supports the Government's overall target of net zero by 2050. We recognise that it will not be easy and that all areas of the country and all sectors of the economy need to urgently act to reduce overall emissions.

The Trust submits that climate change mitigation and adaptation implications be considered by the Council in all facets of its own work and steps be taken to halt and reverse ecological decline.

Achieving Reduction targets

The CCC Emissions Target Consultation document provides a useful high-level summary of the current state of Christchurch emissions and the existing amount of sequestration provided via forestry. To assist further work and public understanding, we suggest that the Council publishes supporting information on how the current state of emissions has been assessed and what has been included in the figures.

The Trust supports the interim target for Christchurch to reduce emissions by 50% by 2030. If that can be achieved, the area will be well on its way to reaching the 2050 target.

We believe the upcoming Climate Change Strategy can achieve this overall target through developing and implementing detailed annual action plans with interim targets. We would expect the Council to report annually against these plans and targets enabling the progress toward the goal to be tracked and adjustments made along the way, thus ensuring that our city achieves the 50% reduction by 2030. We recommend that a major review then takes place in the lead up 2030, enabling planning for the remaining 20 years, which will almost inevitably include the harder areas for reduction.

We acknowledge that methane is a difficult area, but suggest that progress needs to be made and dealing with the issue be neither postponed nor ignored. Reducing methane from landfills is clearly within the remit of the Council, and it would be useful to have a breakdown of the percentage of Christchurch methane emissions from agriculture and from landfills and other sources to quantify the level of the problem. We support a 10% methane reduction by 2030, but a more ambitious target for 2050 of at least 50% from agriculture and 90% from other activities – both the Council emissions and other private sources.

Changing individual consumption patterns

We recommend that consumption is added to the list of areas that "need to be re-imagined". We would like to see the Council taking an educational role and, where possible, a regulatory role in promoting changes in consumption patterns.

For example, a low meat and dairy diet is increasingly being suggested as a way for individuals to lower their footprint. If the city population as a whole were to eat a lower footprint diet, that will have flow on effects to agriculture and to methane emissions. Although agriculture is a relatively small part of the direct economy within the City Council's territorial boundary, the city and its people are influencers over what happens in the wider region, and taken as a whole the methane and other agricultural emissions from Canterbury are high. They cannot be ignored, and changing the diet of the human population will in turn lead to necessary agricultural changes.

Travel, the rebuild, food miles and the waste stream are other areas of consumption to add to the list. We would like the Council to foster a city where:

- people use climate friendly methods to travel such as public transport, walking and cycling.
- domestic tourism is encouraged over international travel to reduce air miles, with people recreating in their own backyard – such as beautiful Banks Peninsula
- international tourists are encouraged to make their NZ experience low in carbon emissions by minimising their footprint while here, staying for longer and offsetting their international flights through supporting genuine local sequestration projects
- building materials used are sustainable and low footprint – such as more wood products and much less use of cement/concrete, repurposing the older housing stock rather than enabling urban sprawl and ensuring new houses include sustainability features such as solar panels and space for food gardens
- more food consumed is locally grown, it has a lower carbon footprint and less is wasted
- much less single use packaging is the norm and better separation and recycling of residual waste streams takes place.

The flow through effect of consumer change on production choices should therefore be included as a key method for the Council to effect change. The recent switch from single use plastic bags provides an exemplar for such social change.

Sequester carbon through naturally regenerating native forest on Banks Peninsula

The Consultation document notes that forestry in Christchurch currently only offsets a fraction of the city's emissions. The 100,000ha rural area of Banks Peninsula, much of it hill country that is marginal for farming, affords Christchurch the opportunity to offset emissions and at the same time reverse the Ecological Emergency.

Prior to its settlement by Europeans, Banks Peninsula was predominantly covered in native forest. As a result of timber milling followed by fires to clear land for pasture, this was reduced to 1.2% coverage in fragmented remnants by the 1920s. Since that low point there has been a significant regeneration of native vegetation, seeded from remnant sources and able to take hold in lightly grazed pasture or under nursery crops of gorse and broom. Native forest grows rapidly on Banks Peninsula and natural regeneration is a proven method to establish forest on a landscape scale. It is a much more effective, reliable and ecologically sound way to establish native forest than via planting.

Much of the land on Banks Peninsula is marginal farmland – steep, hard to access and erosion prone. It is therefore not ideal for planting in exotic rotational forestry and the Peninsula has already seen its share of post-harvest erosion problems. Establishing permanent native forest provides a way to sequester carbon, reverse the ecological decline, and protect soil and waterways from erosion.

Planting in natives for permanent forest, while beneficial, would be an unrealistic objective at any landscape scale. Native trees are much more expensive to plant and establish than pines, and there is not the infrastructure to produce large quantities of bare root stock. Natives require protection from hare and deer browse, and labour intensive releasing from weeds for two to three years after planting.

By contrast, the ease with which natural regeneration can be achieved on a landscape scale creates a more realistic opportunity for Banks Peninsula to act as a large carbon sink. This carbon sink could significantly assist the achievement of the net emission targets the City is seeking. The 1,250 hectare Hinewai Reserve in the south-eastern corner of the Peninsula serves as a model demonstrating how rapidly native forest can establish naturally on marginal land provided that grazing stock are excluded, feral herbivores eradicated and some pest and weed control enacted.

Natural regeneration is already happening all over Banks Peninsula, generally due to "benign neglect" engendered by economic conditions rather than the active land management seen at Hinewai. However, this regeneration is not necessarily valued or protected and has come under threat in the past few years as a new farming trend has seen swathes of young regenerating forest aerial sprayed to return the land to improved pasture. This has a doubly negative impact on efforts to reduce emissions as regenerating forest that is about to enter its years of maximum growth and therefore peak carbon sequestration is not only removed, but replaced with methane emitting grazing stock.

The key to establishment of native forest through natural regeneration on a landscape scale lies in finding ways to incentivise land owners to value and actively manage marginal land for regeneration.

The Trust has convened a multi-agency group working with MPI to improve the opportunities for naturally regenerating land to enter the Emissions Trading Scheme (ETS) and earn carbon credits as permanent native forest. However, the current difficulties of entering the scheme combined with a relatively low carbon price mean that the ETS alone does not provide a compelling financial incentive for landowners to change land use from beef and sheep grazing to native forest regeneration.

The Trust therefore submits that **for Christchurch to take advantage of the huge sequestration potential of Banks Peninsula, its Climate Change Strategy will need to find ways to augment the ETS and tip the balance for owners of marginal land on Banks Peninsula into native forest regeneration.**

We suggest that:

- enforcement of existing regulations is important to stem the current trend of spraying off regenerating areas that are already protected
- the Council engages in the land purchase of marginal land to set up model carbon parks
- the Council develops methods to incentivise landowners to change their land management use to foster native regeneration (possibly starting with rates remissions for regenerating land).

Rod Donald Trust as a CCO is positioned to assist with Climate Strategy development and delivery

The Trust has a good understanding of Banks Peninsula, strong local networks, a well established reputation, and the ability to move rapidly when opportunities present. It has nearly 10 years of experience in developing and promoting low carbon sustainable recreation opportunities, supporting land purchase for native forest protection, and working in partnership with a wide range of agencies and private land owners to achieve results in cost effective ways.

As a CCO, the Trust is therefore uniquely placed to assist the Council to develop and deliver its Climate Change Strategy and reduce net emissions through harnessing opportunities on Banks Peninsula including:

- establishing large tracts of ecologically diverse permanent native forest carbon sinks
- low-carbon recreational activities reducing the footprint of both domestic holidays and international visitors
- combining these with a learning environment to further develop environmental and climate awareness, encourage individual behaviour change and grow guardians for the future.

Further Information

For more information about Rod Donald Banks Peninsula Trust:

- www.roddonaldtrust.co.nz
- or watch https://www.youtube.com/watch?v=pAMeS1nQK8Y

For more information about the transformation of marginal land to permanent native forest at Hinewai Reserve please watch the recently released film 'Fools and Dreamers':

- (https://happenfilms.com/fools-and-dreamers)

For a review of the latest IPCC report "Climate Change and Land" advising the halting of forest destruction and enabling restoration of forests:

- https://www.theguardian.com/environment/2019/aug/08/how-climates-impact-on-land-threatens-civilisation-and-how-to-fix-it
- https://www.ipcc.ch/report/srccl/

27206	James and Emma	Dufty	School Strike 4 Climate Christchurch	No.	Yes. At least 2045, preferably 2040 as we believe that 2050 is too late. There does not seem to be as much focus on reducing methane and we would like an increased focus on it including strong targets (i.e. at least the more ambitious end of central government's spectrum)	Yes support interim target	We are encouraging everyone to take time off school and work to continue to take strike action until there is sufficient awareness and action regarding climate change. Our next global strike will be on Friday 27 September. We have not provided any supporting information as we are submitting on behalf of the School Strike 4 Climate team and we will provide any additional comments at the hearing.
27500	Shannon	Gilmore	Generation Zero Christchurch	Generation Zero Christchurch feels the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. We appreciate that the council recognises the importance and time limited nature of this. We are trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. Complementing this approach, the Councils policies should include sufficient flexibility to escalate our ambition on short-lived gases as the moment of global 'peak warming' approaches. An added bonus for the council separating short and long lived gases is the global impact of clarity. NZ played a key role in shaping the bottom-up nature of the Paris Agreement. Christchurch has a part to play here too, by giving NZ a clear example of the most ambitious and impactful way to tackle different greenhouse gases. The Council must determine where coal, oil and gas are being used and determine how, and when, these fuels must be phased out. Generation Zero Christchurch supports the Council having clear, legally-binding targets (2050 target combined with emission	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. We appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. Generation Zero Christchurch suggests the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	Please see attached file. Text regarding this question from attached file: Generation Zero Christchurch supports interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district. Generation Zero Christchurch strongly recommends the council meet its targets by using local emissions reductions only (including from new forest planting). Trading of international credits have proven to be problematic, and they do not have an impact on reducing a cityâ€™s own emissions. If the credits are not valued correctly, their mitigation efforts may also be minimal. Therefore Christchurch as a district needs to work to reduce its own emissions, and the overall greenhouse gas budgets and the target must be met by local reductions Additionally, the Council should not be able to alter emissions budgets in response to 'economic changes' as this undermines their long-term certainty. However, the ability to revise budgets in light of major changes in scientific understanding or international agreements should be permitted. Generation Zero suggests that the Council must take the following factors into consideration when advising on and setting budgets: Scientific knowledge about climate change Technology relevant to climate change Economic circumstances and the likely impact of the decision on the economy and the competitiveness of particular sectors of the economy

				budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			Fiscal circumstances and the likely impact of the decision on taxation, public spending and public borrowing Social circumstances and the likely impact of the decision on fuel/energy poverty Energy policy and the likely impact of the decision on energy supplies and the carbon and energy intensity of the economy We need the Council to consider: A district climate change risk assessment A district adaptation plan Regular review of progress towards implementing the district adaptation plan
27572	Bronwyn	Hayward	University of Canterbury	I think we align in principle but take a stronger approach as below	I think both the city and the council and for that matter my university and other places of learning- schools and ARA/Lincoln could and should be more ambitious . For Christchurch we should bring forward the target year to reach net zero greenhouse gas emissions by 2040. For the City Council itself and education institutions we should aim for 2030	Yes support interim target	In principle yes, but again we could be reducing greenhouse gas emissions by 60% district-wide by 2030 (from our 2016/17 baseline levels It is exciting to see the increase in cycling reported for the city, and the introduction of electric buses- we missed many opportunities to rebuild a more sustainable city for the future after the earthquake- let's not miss the opportunity again
26371	Wayne	Findley		Yes. There's simply no point to swimming against the tide here.	No. There's no way to measure, let alone manage, any of the per-district level emissions, so targets are meaningless, and as a local authority, Council has no way to influence non-Council (e.g. business) activities in any significant way. And there is high dissonance already in many of Council's policies: e.g. encouraging tourism, which is inherently dependent on long-haul air travel which is conveniently omitted from any target; or encouraging travel to events in the Old CBD when	No do not support interim target	Stick to the basics that citizens expect: superb delivery of 3 waters, roads, bridges, refuse collection and disposal, recycling initiatives, parks and reserves. The climate aspects are too diffuse to fit under current competencies, stray far outside ratepayer tolerance, seem prone to empire-building and self-perpetuating bureaucracy, and are not an issue of significance to many: for whom the basics of food, transport, shelter and security - the 4 core human imperatives - are paramount.

					local alternatives would reduce the need to travel at all.		
27586	Rory	O'Connor		Trust it's just' is the important issue. Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: *A significant change in scientific knowledge. *A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). *The district is subject to an extreme natural disaster. *Escalating our ambition on short-lived gases as global 'peak warming'? approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.	The principle with all of this is - act for the poor of the world, and for the future adults and children first, then for ourselves (who benefit by biting the bullet by believing we have done the best, even if we can't fly to Bali or Paris any more). Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. As methane is more impacting than previously thought, and is a high-impact short term gas with short term benefits in reducing output, we need to act more stringently on it than has been thought before - with incentives for the faster-adapting emitters, to move along the knuckle-dragging deniers or more selfish ones. I'm aware it's painful for producers, but the crash and burn will be lesser later for action now. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	Big thanks to the committee for getting this feedback and acting for us all. I want to have faith in you, and this won't be by typical political stonewalling - that's what put us into this tight timeframe when so much was know earlier that, if acted upon then, would have made things so much easier. Act like climate emergency politicos, as nothing less will work. I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.
27582	Alice and Lindsay, Francis and Liz	Main and Shanks, Main and Bertolett		Yes. Reduction in carbon and methane emissions need to be aligned at every level - individual, local body, national and international.	Instead of a more ambitious target we believe the Council needs to set an ambitious interim target of 50% reduction by 2030. The experience in England is that rapid reduction can be achieved chasing "low hanging fruit", that is changes that do not impact on residents' way of life and are financially neutral.	Yes support interim target	There are two global crises - climate disruption and the nature crisis. The draft NZ Biodiversity strategy has set out the loss of plants and animals in Aotearoa. A new revision of the conservation status of New Zealand indigenous vascular plants published by the Department of Conservation in 2018 (de Lange et al) made note of a

					This will give the Council 20 years to achieve the next 50%, which is likely to be the most expensive and disruptive measures. We also wish to see an independent body monitor and report back annually to the Council and residents to keep the programme on track and catch any perverse outcomes from reduction measures.		continuing worrying trend of noticeable deterioration in populations of plants of eastern South Island drylands. It is crucial that the Council does not solve one emergency while making the other worse. In fact, there is the opportunity to improve the rate of decline for Christchurch biodiversity while sequestering carbon. 1. The Council can promote natural regeneration of forest on Banks Peninsula following the successful Hinewai Reserve model. Either incentivizing landowners to fence off bush and a "halo" of gorse or rough pasture for forest expansion or buying marginal farmland for natural regeneration will increase habitat for local plants, birds, lizards and invertebrates while laying down long-term carbon storage in podocarp trees that can live for 600 years. The worst decision would be to opt for "fast forestry" to try to game the carbon accounts by growing conifers, eucalypts and exotic hardwoods. This will reduce habitat for local biodiversity while creating fire-risks. 2. The Peninsula is classified as under-protected, that is the reserves make up less than 20% of the land mass and most reserves are small. Purchase of land for natural regeneration will increase the natural habitat to meet the biological minimum for long-term retention of plants and animals. 3. The Council can lead and promote more sustainable, low-carbon tourism through more e-camper-vans, slow tourism (biking, through-walking), and funding the Banks Peninsula Geopark to create an incentive to holiday close to home and for longer. Walking tracks can be linked through new reserves. 4. Unfortunately many measures to lower carbon in our community will require rates investment. It must be seen as cheaper than fixing up the damage from higher sea levels, storm surges and violet storms. More cycle ways and subsidized bus fares will be needed to reduce the fossil-fuel transportation (with the added bonus of a quieter city and less pollution). 5. Somehow the Council needs to do more to promote smaller, more energy-efficient houses. The urgency of lowering carbon has to signal Council priorities and investment. We need leadership and bold action from the Council.

27587	Thomas	Kulpe		We have a current target, like the unconditional reduction of 5% of the 1990 baseline by 2020, which we will not meet. The current optimistic 2020 projection is based on the carry-over of Kyoto I credits based on hot air ERU. This cooking the books - it is shameful. There is no merit in new targets if we don't analyse why we fail to implement meaningful carbon removal policies. I support net zero by 2050, but that must include agriculture (no methane exceptions) , it must include international air travel by overseas tourists visiting NZ. (CORSIA is a joke!) I don't think it is possible to decouple our economy from fossil fuel. Of course we can use fossil fuel more efficiently but these are low hanging fruit that are currently being harvested and soon the productivity of GHG emissions will not significantly improve any more. The economy will have to shrink between 6% -10% p.a.(based on traditional GDP) and we need massive structural changes (away from beef, dairy, tourism) . If we take net zero by 2050 seriously we will have a hell of a job in front of us and we should count ourselves lucky if we still have the good fortune to enjoy a democratic society with all its achievements like a public health service, public school system etc. GHG emissions are not an accounting problem. The idea of carbon offsets (e.g. planting a billion trees) is not working. Most of NZ was covered in native forest with a huge carbon store in the soil and plant material. Growing back forest on a few percent of the land area will not bring down the GHG concentration of the atmosphere over the next decades; that will take much longer. Faster growing species like pine or eucalyptus erode the soil and carbon sequestration in the soil is poor. I am all for ambitious targets if they are backed up by an implementation plan. I believe we need massive regulatory changes and compliance monitoring. Our political track record of implementing changes for better environmental outcomes is poor (e.g. water quality). I tried to reconcile the emission figures of the Christchurch district with the NZ GHG inventory. I could not find a breakdown of NZ GHG emissions by district. I found GHG emission stats from a few other councils, but this did not allow me to reconcile the 6.6 t CO2-e per person for Christchurch with the national figure of around 18t CO2-e per person. I don't understand why CCC is proposing 2016/17 figures as baseline. The baseline should be 1990 as this would allow comparison with other entities.		
27479	Chris	Doudney		We should reach this target much sooner, because we are in a climate emergency; doing virtually nothing for the next decade will condemn us to a greatly increased risk of totally unknown effects. As a region, we can influence the government and other regions to speed up their responses.	Yes, we should be approaching net zero emissions by 2030	Yes support interim target	This is a climate emergency. We have to act now to curb C02 and equivalent gases release, not in some distant future. This means wholesale action by LOCAL GOVERNMENT to enable action by New Zealanders; a series of subsidies and penalties which forces immediate response from all of us. TheZero Carbon Bill as written does nothing in this direction; it is merely a statement of good intent hoping someone might do something at some time far in the future. Recommendations: The Region to: 1. Impose a carbon tax on all emitters, through such tools as charging for road access on local roads. Use funds resulting to cause, through generous subsidy and buyback of private vehicles, the immediate electrification of regional transport and industry, by 2025, and the virtual cessation of fossil fuel use by 2028. 2. Require, through rating, subsidy, and fining of non-compliant operations, all agriculture to operate on regenerative agriculture principles, thus resulting in massive carbon sequestration in the region's soils without loss of productive output; transition to be completed by 2028. 3. Surcharge the use of of products that detract from the aims of item 2 above, by 2021.

							4. Implement a programme of energy infrastructure projects (eg new wind generators, solar pv generators and battery energy storage facilities to make regional energy use fossil free by 2025; electrify all public transport services and negotiate commuter rail services implementation. Implement and oversee a region-wide network of vehicle charging points for electric vehicles. 5. Subsidise the importation/local construction of electric public transport units: buses, e-bikes, taxis, etc., commencing 2020. 6. Implement urban design actions to enable denser development and improved design to support enhanced environments with no fossil fuel use, commencing 2020. 7. Encourage coastal shipping services as the most economical form of transport for goods transhipment.
27520	Felix	Morgenstern		I absolutely think we should align with the proposed national target of net zero greenhouse gas emissions by 2050. I also think that methane being such a potent greenhouse gas should be given some ambitious targets as well. Global warming is probably the single biggest issue we are faced with at the moment, and how we choose to move forward right now will define whether our climate continues as what we are used to or whether we are left with raging, destructive storms, floods, droughts, heatwaves, wildfires and sea level rise, not to mention all the unforeseen factors that will no doubt come into play. The amount of positive feedback mechanisms that will come into play with even a slight increase of global average temperature and potentially spiral out of control is downright frightening, and something that should be mitigated at all cost. According to the IPCC, warming needs to be kept below 1.5 degrees in order to maintain a stable equilibrium, and that in order for that to happen, emissions need to be halved by 2030 and be net zero by 2050. I believe it is important that Christchurch does its fair share to keep warming under 1.5Â°C and takes responsibility, especially given our relatively high per capita global footprint. I support the Council having clear, legally-	It would be great to take a more ambitious approach and lead the charge on tackling climate change if it's possible, but targets also need to be realistic. I fully support an earlier target than 2030 and 2050, but lack the knowledge to be able to give a meaningful number. Methane, although being 'short-lived', has far more warming potential than CO2, and the warmer the climate becomes, the more methane will also be released from natural sources such as lakes and soils, which is why I believe it should have the same, if not more stringent targets than CO2.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. I support the council's suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2017 baseline levels).

				binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading.			
27521	Julie	Downard		No. 1. Allowing until 2050 before we reach the target of net zero GHG emissions will lead to runaway climate change, mass suffering, mass species extinction, and possible human extinction. The IPCC special report of October 18 gave us just 12 years to reduce our GHG emissions by 45% from 2010 levels, if we are to avoid catastrophic climate destabilisation. That means that by 2030, we must have reduced emissions by 45% from 2010 levels. We have now increased emissions above 2010 levels to the extent that we will now have to reduce emissions by 5% per year in order to meet this target. However, that report did not factor in already locked in global temperature rises due, for example to aerosol pollution, which is currently providing a kind of 'shade' to the heating rays of the sun. Getting rid of aerosol pollution, which will happen automatically as we reduce our GHG emissions, has been calculated to produce a temperature rise of on average 0.5C. The report further did not factor in known feedback loops. Studies have identified dozens of feedback loops, including: - the ice albedo effect (white ice reflects away heat, dark water absorbs heat, so as ice melts there is less and less reflection and more absorption, which leads to the heating becoming exponential rather than linear); - boreal forest dieback (increasing heat increases drought and pest proliferation which kills forests; dead trees then burn, releasing huge amounts of carbon dioxide into the atmosphere Canada's boreal forests have not been a net carbon sequesterer since 2001, and have instead become net emitters. Much of the arctic boreal forest is currently	Yes, CCC should be much more ambitious. The IPCC report talks of a carbon budget. The figures indicate we have just 360GT of carbon dioxide left to emit, if we are to have a 67% chance of limiting the global temp rise to below 1.5C. At our current rate of 42GT per year globally this will run out in just 8.5 years. But we really don't have a carbon budget. We have already reached a carbon dioxide level in the atmosphere of 413 ppm. The safe level was 270 ppm. 350 ppm was the concentration we needed to stay below to avoid 1C of heating. We are now at 1.1C of global heating, and rising fast. Of the five mass extinctions in the geological record, the worst saw the loss of 97% of all life on the planet, due to runaway CO2 emissions. The CO2 levels are similar to those of today. Human extinction is possible. Those are the stakes. When the stakes are high, you don't gamble. You follow the precautionary principle and go all out to avoid the potential consequence. All GHGs must reduce at the same speed to avoid catastrophe. We must reach net zero by 2025, including a 45% reduction in actual emissions from 2010 levels, and we must reach zero emissions by 2030. If the decision is made to set a separate target for methane, then the targets for carbon dioxide and nitrous oxide must be increased accordingly. That would mean an earlier date for reaching net zero, a higher than 45% reduction in actual emissions from 2010 levels, and an earlier date for achieving zero CO2/N2O emissions.	Yes support interim target	I would like to speak to my submission.

				ablaze); - release of methane from permafrost and seafloor methane hydrates (methane is such a potent GHG that this ramps up the speed of heating, again at exponential levels, in turn releasing more methane as the temperature rises). An ice-free arctic alone has been estimated by the world's most eminent scientists to add 50% to global heating. That is not including land-based ice melt, and Antarctic ice melt. The data shows the Arctic will be ice-free by 2024. The report also relies on the future existence of technology which will suck carbon dioxide out of the atmosphere. This is a gamble. The technology doesn't yet work at scale, is inefficient and very expensive. More recent publications have concluded that we don' have 12 years, we have in fact much less. The IPCC's latest report on land use acknowledges that they underestimated the impact global heating would have on food production, for example, and that we are in trouble. For these reasons, setting a net zero goal by 2050 is simply irresponsible. We must reduce our GHG emissions by much more than 5% per year. 2. We must not apply a separate approach for methane. The argument for applying a different target to methane is flawed. While it is true that because of the short lifespan of methane in the atmosphere it only has an effect for 12 years or so, it is so potent that continuing to emit it at current levels could well be the factor that sends some feedback loops across their tipping points. It is essential that we avoid reaching tipping points, and to achieve that we must reduce all GHGs together as fast as possible. All sectors of society will suffer as we reduce, all sectors will have to make changes and sacrifices. The best we can hope for is that we all hurt equally. Protecting one sector at the expense of the wellbeing of the whole			

				community is not only inequitable, but also foolish, as the expense of climate breakdown will be colossal. Should the decision be, however, to set separate targets for methane, then the speed of reduction of carbon dioxide emissions must be even greater, in order to compensate. 3. We must aim not for 'net zero' but for 'zero' GHG emissions. 'Net zero' relies on carbon sequestration to remove the carbon dioxide emitted. Current carbon sequestration occurs by two primary means: absorption by trees, and absorption by marine ecosystems. As discussed above, as the planet heats, forests become net carbon emitters, and no longer sequester. Some of the biggest remaining forests on the planet are now on fire. We simply cannot rely on trees to remove carbon dioxide going forward. Furthermore, as the planet heats, and more CO2 is absorbed into the ocean, the water acidifies, and this, together with pollution run-off from land, is killing the ocean ecosystems. Deadzones in the ocean, where there is nothing still alive, number in the hundreds now, with the largest the size of Israel. When the forests and the oceans can no longer sequester our carbon dioxide, the consequence will be that they no longer produce oxygen. What will we breathe when this happens? We must stop emitting all GHGs and aim for 'zero' emissions. 'Net zero' is not safe. 4. We must have interim targets to keep us on track. A lack of interim targets means that it will be possible to delay meaningful change until just before the target date. We need to work to regular annual reductions, and these annual targets must be clear and legally binding in order that real progress is made. Relying on good-will regarding reducing emissions, is not safe and has not been shown to be effective in the past. Clear targets will provide certainty for businesses			

				and communities and allow each to plan effectively. 5. Being at the forefront of reducing emissions offers opportunities as well as costs. Making an early transition to sustainable sources, in our public transport, and in our energy production will give our city and our businesses an edge on those who transition later.			
27597	John	Gould		Given the urgency of the Climate Change emergency and the growing realization by the population at large that significant action needs to be taken sooner rather than later, and the significant environmental and financial advantages of not delaying actions, I feel it is imperative for CCC to set a District target that is more ambitious target of net zero greenhouse gas emissions by 2040.	The target year should be set at latest 2040. Since more than half of the districts emissions come from transport, there is a much greater opportunity of meeting an earlier net zero greenhouse gas emissions target especially given a number of recent global and local developments eg. globally technological advances in EVs and Ebikes making these more viable and affordable alternatives, and locally the major development of the Christchurch dedicated cycle way infrastructure (13 new routes etc..) along with plans for electric buses etc.. Methane emissions should be included due to the contribution that landfilled waste contributes to these.	Yes support interim target	Given the fact that so much of the districts emissions come from transport, does mean that it should be easier to reach the net zero emission target more easily than for NZ as a whole, especially since many aspects of Christchurch and its surrounds lend themselves to the use of low or zero emission alternative modes of transport. For example: • the existing infrastructure to support light rail (using hydro generated electricity) • a relatively dry climate and flat topography supporting opportunity for more use of bikes and ebikes (as well as walking for shorter journeys) and space to put in more supporting infrastructure • a good existing bus network that could be further improved and extended and made much cheaper (or free) and attractive by including free wifi etc.. • I strongly believe that there is a massive missed opportunity of not making much better use of the grossly under-utilized public transport system in Christchurch and surrounds. CCC and Ecan should enter into urgent discussions as to how the network and indeed the whole transport culture and mind set needs to be transformed. Use of vehicles especially for daily commutes should be strongly dis-incentivized though higher parking fees and fewer car parking facilities, while use of public transport (buses, light rail, ferries etc..) should be highly subsidized or free for users A couple of immediate steps which could be taken include: • letting high school students use the free during the school holidays (when they are running anyway and often near empty in the mornings and afternoons!)

							• introducing a ‘Silver card’ for young people 18-25 offering free public transport at certain times to encourage greater use of public transport (similar to the Gold card which allows the over 65s to travel free on the buses between 9am and 3pm)
27507	Cameron	Bradley		Yes â€“ a long term target will provide certainty for people living and investing in Christchurch that this is the way we are heading so they are able to adjust as well as showing to the rest of the world we are doing our part. These should be legally binding targets with consequences for the city and it’s leaders between now and 2050 if they are not met.	Yes - as a first world country we should be paving the way for the rest of the world who may not have the same resources to put towards this issue. It will also make up for us having had the privilege of polluting the atmosphere for the last several decades. I hope we can achieve net zero long-lived gas emissions by 2040 and net negative long-lived gases by 2050. Long-lived gases should be given more immediate attention as they will impact the world for a longer time to come. This definitely does not mean that short-lived gases should be ignored though, we should be setting equally clear and ambitious, legally binding targets for these also.	Yes support interim target	Definitely, for the same reasons as above.
27444	Nicky	Exton		Yes, I think the Council should definitely align with the proposed nation target of net zero greenhouse gas emissions by 2050. We need to be taking considerable measures to protect the future of our city, country and planet for future generations. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with	Yes, I would strongly recommend that the Council considers a more ambitious approach. We only have a limited amount of time in which to act, and so the more change earlier, the better (so long as the change is done well). I know and care about many of our district's young people and have been a community youth worker in various capacities since 2011. We owe it to our youth and to our children to pass on a healthy world for them to thrive and flourish. The sooner we can make significant changes to our corner of the world, the better! It all adds into the big picture. I suggest that we aim to be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall.	Yes support interim target	I support the Council's proposed interim target of reducing greenhouse gas emissions by 50% district-wide by 2030 (from our 2016/17 baseline levels) in line with the IPCC. I suggest that smaller interim targets be put in place for each incoming council to aim for in order to make sure that goal is actually reached.

				emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. We also need flexibility to adapt to any significant developments in available scientific information or changes in international agreements.	Until we approach peak warming, there is no substitute for long-lived reductions.		
27410	Fliss	Quick			I really believe we should take a more ambitious approach. I'm incredibly concerned about the global lack of movement/progress towards reducing greenhouse emissions. I don't feel qualified to say what I think the targets should be set at, but I'd like to think that we could set an example to the rest of New Zealand, and by extension, the rest of the world.	Yes support interim target	But I'd like to think these interim targets could be more ambitious than the stated 50% by 2030.

27287	Paul	Broady		My submission is the attached document.		Yes support interim target	Attachment

Submission to Christchurch City Council on "Our district's emissions target"

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5 August 2019

"Yes" I would like to speak to the committee about my feedback

Do you think we should align with the proposed national target of net zero greenhouse gas emissions by 2050 (that also adopts a separate approach to methane gas)? If so, why?

The "Zero Carbon Bill" is certainly a good move in the right direction as climate change / global warming is the major issue of our time and of future decades (and centuries?). However, the Bill is not strong enough in several regards although it conforms to some of the guidelines presented in the recent IPCC report (IPCC SR1.5 2018).

We need to have a stronger response. Here are some reasons why.

New Zealand is a major greenhouse gas emitter on a per capita basis. We are about 6th from the top of the list if major oil and gas producers and tiny island states are disregarded. Even including those states we are about 22nd on a list of 183 nations. The global average per capita is about 6.3 tonnes CO_2 equivalents per year. N.Z. per capita is about 17 tonnes per year. A globally equitable solution would have major emitters, such as N.Z., reducing emissions further and quicker than minor emitters.

The IPCC projections provide ambitious pathways to prevent warming greater than +1.5°C by 2100. What is often not explained is their statement that if we follow those pathways then the chances of achieving the target are only 50 to 66%. Therefore, there is a 34 to 50% chance of the +1.5 target being exceeded and then the effects of climate change are likely to be far more damaging. That is not a good chance of success. Would you jump from an aircraft with a parachute that gave you a 50 to 66% chance of hitting the ground gently? Hopefully you wouldn't! So to improve our chances of remaining under +1.5°C we need to be even more ambitious. It is worth a try!

The statements in the IPCC report are also likely to give underestimates of both the difficulties in reducing our emissions and the impacts of climate change. This is because it is a consensus report that can be affected by political influences from national governments.

Should we take a more ambitious approach? If so, what year should our net zero greenhouse gas emissions target be set (and why) and how should we consider methane (and why)?

So, in consideration of the above comments, yes, we should take a more ambitious approach. There are also problems with the focus on "net zero" emissions as the achievement of "absolute zero" emissions would improve our chances of staying below +1.5.

I neither have the ability nor the access to data to rationally calculate an alternative date for zero emissions, net or absolute. Presumably if an earlier date could be achieved then the poor chances of not exceeding +1.5 would be improved somewhat. Politicians worry about the economic and other social impacts of rapid and strong measures to reduce emissions and whether they could keep the support of voters. What a quandary for democracies. However, it seems that public realisation of our increasingly serious situation is increasing rapidly. May be a large majority will soon agree on the necessity of what the IPCC calls the "rapid and far-reaching transitions" needed to the way we live our lives. So, in a spirit of optimism, and trust in an increasing swell of opinion in favour of strong measures, I'd take a stab at a 2040 date for zero.

Net zero

My concerns about "net zero" centre around the claim that newly planted and regenerating areas of forest can be used to "off-set" our current emissions. Yes, forests absorb CO_2 from the atmosphere and store it as plant biomass and in their soils, especially native forests that are allowed to grow to a species rich diversity in their canopy trees plus the underlying trees and shrubs. They can also have great biodiversity conservation values. I am totally in favour of the regeneration of native forests. However, I regard it as ingenuous to claim that they are absorbing our current emissions. What they are doing is putting forest back where it used to be prior to being felled and burned since the arrival of humans and especially Europeans to Aotearoa / N.Z. Forest area before 1000 CE was about 215,000 km^2, by 1840 it was about 148,000 km^2 and is now about 75,000 km^2. Locally most of the Port Hills were formerly covered in forest as was most of Banks Peninsula. Most of the carbon that was locked in the now disappeared forest would have been released into the atmosphere and most of it would still be there. So by growing new forest we are just putting the carbon back into trees that was originally in trees – and we have a very long way to go before we have replaced all that. It is likely not even possible considering the wide areas now devoted to agriculture and urban development.

Biogenic methane

It is being argued that biogenic methane can be treated differently to long-lived greenhouse gases such as CO_2 and nitrous oxide because it has a shorter residency time in the atmosphere. This is true but it also has a much greater warming potential than CO_2, this being about 34 times that of CO_2 over 100 years.

Methane currently contributes over 40% of the warming due to all N.Z. emissions. Therefore if we maintain large numbers of ruminant animals our methane emissions will remain very significant. The short residency time is only useful if we reduce our methane emissions at their source.

The degree of reduction proposed in the Bill, even if reaching the maximum of the range suggested (47% of 2017 emissions by 2050), still leaves us with over 50% of current methane emissions in 2050. This seems to take us into the less ambitious end of the range of reductions that the IPCC suggests are needed by 2050 (Fig. SPM.3a in IPCC SR1.5, 2018). If we did not achieve that level of reduction then it is likely we would not even get into the less ambitious part of their range of reductions. Also, the 10% reduction by 2030 proposed by the Bill does not get us into the range suggested by the IPCC which is about 20 to 60% reduction.

It is worth keeping in mind that recently (2014 – 2017) there has been very strong growth in atmospheric methane (Nisbet and others 2019). The cause is uncertain. May be the atmosphere is less able to remove methane by chemical reactions? May be positive feedbacks involving microbes in soils have kicked in? This is very concerning and emphasises again the need for the precautionary approach in which we vigorously pursue reductions in our own emissions.

My conclusion is that we need to take a much more ambitious path towards greater reductions in methane by 2030 and then again by 2050. Why not 30% by 2030 and 60% by 2050?

Do you support an interim target as a way to encourage early action? **Yes**

New Zealand has already committed to reduce emissions to 30% below 2005 levels by 2030. This includes forestry off-sets. The IPCC state that net CO_2 emissions need to decline by about 45% from 2010 levels by 2030 to avoid greater than +1.5°C. It seems this is a greater reduction than the current N.Z. ambition.

In recent years there has been no decline in N.Z. in either gross or net CO_2 equivalent emissions. Both have remained more or less constant over the period 2002 – 2017 (NZ Greenhouse Gas Inventory 2019) at about 80 and 55 million tonnes respectively.

The greater the delay there is in making reductions the more we open ourselves to the necessity of absorbing huge amounts of CO_2 from the atmosphere between 2050 and 2100 in order to achieve +1.5 or less. Also, the more rapidly reductions would have to be made over a shorter period post-2030 in order to achieve net zero by 2050 in the IPCC scenarios. The technology to perform massive CO_2 absorption does not exist and arguably will not exist at the scale necessary. Also, even the addition of massive reforestation and absorption of CO_2 into soils using improved farming techniques might not be sufficient to achieve the withdrawals that might be necessary. The moral of the story is: apply the precautionary principle, reduce emissions now as rapidly and deeply as we possibly can.

So, I would suggest that we should aim for an absolute reduction in emissions of at least 45% by 2030 and I would support the statement in your document that suggests aiming for 50% district-wide reductions from a 2016-17 baseline..

Any other comments?

It seems odd to me that the per capita emissions of Christchurch (and other NZ cities) are deemed to be so low compared with the national average per capita emissions (about 17 tonnes CO_2-eq). Why are only agricultural activities within the district's boundaries taken into account? The city is hugely dependent on wealth generated by agriculture at the regional and indeed the national scale. Also, the consumption of meat and dairy products by our district's population is mostly supplied by agriculture outside the district's boundaries. There are considerable emissions associated with consumption of those agricultural products. Therefore I think it presents a false impression to say that our annual per capita footprint is 6.6 tonnes when our life-styles are so hugely subsidised by emissions from outside the district.

Another omission in the calculation seems to be the emissions from international aircraft using Christchurch Airport. It is not clear from the AECOM report whether the estimate of air travel

emissions is based just on domestic flights. I am assuming it is as emissions from international air flights are also omitted from national carbon accounting. In my opinion they should be included as they provide significant economic benefit and employment to the city. Surprisingly the AECOM report states that it includes "international shipping" in its estimates of emissions from shipping as a whole but I cannot find an explicit statement of that sort with regards to aviation. Half of the total flight emissions from the overseas origin of an incoming aircraft or to the next destination of an outgoing flight should be added to the city's emissions.

Overall I am greatly heartened to see the City Council setting the stage for the essential changes to our lifestyles that will be necessary to avoid the worst effects of climate change / global warming. Several very strong statements of intention are made in your document. You are committed to being leaders in the issue. You accept that we must rapidly cut our emissions. I hope I can help fulfil those intentions.

On the other side of the coin, I am concerned that you might place too much emphasis on using forestry "offsets" when it is the gross emissions which should be the overwhelming focus.

Thank you for reading my submission.

26951	Ari	Holder-Lunn			I think that 2030 is a good year to aim for. If we leave it to 2050 then it might be too late.	Yes support interim target	Please help with the climate. I'm scared for the future.
26634	William	Stewart		Yes	We should do all we can do. We should be looking at other cities and doing all we can to be at the front of the pack in pushing down emissions. We may be smaller than other cities, but we are nimble. We can inspire others and that is the most important contribution we can have to carbon reduction.	Yes support interim target	
26369	James	Ramsay		Yes absolutely, if not do better. Why? Because it is our responsibility to each other, to leave this city better than we found it. We can reduce our emissions, and we can sequester enough carbon to reach neutrality. These things are possible, and it is our responsibility to do it because we can. Climate change is a global issue, but nothing can get done by a committee of 8 billion, each with their own preconceptions and requirements. Important change must happen at the local level. It starts by choosing our values - as this process will do - it continues, by developing a strong and realistic plan of action (a plan of massive action) - and from this firm foundation it becomes a reality.	Yes. See above. In addition, here is an opportunity for Christchurch to lead. For the last decade almost we have been the beaten and recovering city, doing its best to get back on its feet and stand tall once again. Well, our back is upright once more. It is time for us to square our shoulders. Let's lead the country in becoming the first carbon neutral city. We have the perfect city to maximise public transport and reduce car usage. We have the businesses and universities to develop technologies that can enable us to live complete and unrestricted lives, without taking more than we give back. We have an amazing balance of resources from mountain to sea. It is almost as if this challenge was designed for us - to excel, prove that we have the mana to take care of ourselves, our neighbours, and our tamariki. Let us prove ourselves through this challenge, set our shoulders back, so we can walk forward into the future with our chin held high.	Yes support interim target	53.1% of our emissions come from transportation. 78% of that comes form diesel and petrol vehicles, i.e. personal transportation. Here is an opportunity for us to really cut down. Recent research from the University of Otago [1] showed that "more than half of car trips taken by New Zealanders are less than 5km, while 12 percent are under 1km." I know that I'm guilty of that. On many occasions I have driven to the nearby supermarket because I haven't planned my day right, or driven to the airport instead of catching the bus because I don't know the local routes, or driven to the shops because I can't be bothered. I know I can do better, and I know I am not alone - the study shows that. Here is an obvious problem that has obvious solutions - solutions that we just need to get right. CCC has already done a fantastic job helping with this by dedicating so much money to developing an extensive cycleway. Christchurch is the perfect city for biking, and the new cycleways have delivered on their promises. Anecdotally, many of the people I know now bike to work because it is easier, and enjoyable thanks to these cycleways. This helps with our transportation in regular routines, but what about outside of that. Getting to the airport, or going shopping, or going farther afield? Here there seem to be a few key solutions. Many people think that electric vehicles will be the answer here, but the evidence suggests that they are not as beneficial for the environment as we have been led to believe. Additionally they will bring a wide variety of challenges to our electricity grid to be implemented. See the latest research from University of Canterbury in our hometown [2]. In fact, what has a much bigger impact on reducing carbon emissions is an uptick in public transport use. An increase of 40% use of public transport (even petrol/diesel buses etc.) has a better reduction in carbon emissions than an equivalent increase of electric vehicles. So instead of promoting and subsidising EV's, why don't we promote and subsidise our public transport more? Send every resident in Christchurch a metro card loaded with $30. This takes away the difficulty of getting organised, and the $30 is a small cost to promote people to learn the routes and get used to the system. With bikes, why don't

							we encourage that and keep people safe by having the cops pull over bikers without lights at night - and instead of fining them, give them a set of lights (and maybe charge them the cost of them). Let's continue to enable new and exciting technologies/companies to get involved like our ride-sharing platforms, or lime scooters. Let's be the first city in the world to truly think carefully and intelligently about this problem. Let's take the time to find the highest impact solutions, and have the guts to commit to them. Let's not dilute ourselves to a 1000 small improvements. Let's get 3 big changes in place, and reap the rewards. If one thing has been clear in the last decade of "climate change crises" being announced every second day - people will not change unless it is easy to change. So let's do it. They say that habits work by there being a cue, which triggers the craving, which leads to action, and the action is rewarded. To make a habit stick - you make it obvious (cue), you make it attractive (craving), you make it easy (action), and you make it gratifying (reward). Let's stop pretending like we're saints and be realistic about the way we try to achieve change. First, let us set our values. Let us be clear about why it is important to be carbon neutral. For me, that is more about the local impact. Taking care of the taonga we have received (which for me as originally for Wellington, I greatly appreciate since coming to Christchurch). Improving it where we can, and certainly not leaving it worse than we found it. Clean air. Clear water. Beautiful surroundings. Happy children. I came to this city in 2014 - still in the early days of recovery after the earthquakes. As tragic as they were, this gives us the opportunity to truly make a big difference to our city. To really make it better than we found it. Let us remember our ANZAC spirit of collaboration and brotherhood, and set our sights as a team on what needs to be done. Second, let us be practical about it. Let's not waste exorbitant amounts of money on something that can easily be achieved. Let's minimisise personal transport, let's fund more research into reducing fuel-consumption, let's incentivise each other to do things that make a difference. Perhaps I say this with some bias, as I study towards my PhD which is focused on reducing drag by the careful application of fluid dynamics - but the potential for huge change is real, if we recognise it. Thirdly, let's keep it in our mind. Let's continue to give ourselves cues, by creating the right stories. We've been told the story of EVs is the solution, but it is not. Let's tell the right stories, the positive stories that will promote

							change. That public transport can be good for all, that ride-sharing and lime scooters can be fun and efficient. That this city is beautiful and safe to bike in. Let's find a way to collaborate and get everyone together. Let's write the story we ought to. And finally, let's see it through. If we set a goal, let's stick to it. This is a challenge, perhaps the greatest one this generation will face, but it is not insurmountable. In fact, it is within our grasp. [1] https://www.rnz.co.nz/news/national/394626/switching-short-car-trips-for-walking-and-cycling-has-major-health-gains [2] See attached file: Gallardo, P., Bishop, D., Murray, R., Krumdieck, S. 'New Zealand Transition Engineering Retro-Analysis' (2019), **SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION.**
26362	Lucy	Gray		No. These targets are not amitious enough and do not guarantee our safe futures.	Yes, definitely taking a more ambitious approach. The target should be set at 2040 at the latest and ChCh is in a good position to treat methane in the same way with net zero by 2040. This also places needed impetus for advancement the management of methane released through waste management.	Yes support interim target	I would like to congratulate ccc on the proactive stance being taken on climate action and the commitment to community consultation. It is great to see more ambitious targets being considered. I would also like to see commitment to developing systems to constructively process/recycle soft plastics and create facilities that can process compostable packaging in an environmentally sustainable way.
26314	Alan	Jolliffe		Yes. Why would you do something less than nationally proposed. That is just playing one off against another, It will also be confusing to the public, business and others. I also think that we need to develop techniques and systems to increase the all year round tree and native forest cover, food production locally, in our and neighbouring districts as soon as possible. There are many options to make this happen. Emissions do not know administrative boundaries!	Happy for this to be earlier but there are many factors involved and again could be confusing for everyone. Maybe best option is to get Central Govt to reduce the time period for everyone. Methane. As a district we support the agricultural sector and we need its products (food etc). Therefore our support for reduced methane should be strong. We should not put our heads in the sand and say because our District (CHCH) does not have high Methane emissions we dont care. We need to help find ways to help adjacent districts reduce methane emissions and that will help everyone.	Yes support interim target	I support the interim only if it is less than the Govt target and is achievable and not confusing to people Citizens, Business etc)
27524	Haydn	Barber		No you must include methane gas. Why omit it? Imagine if we omitted CFCs. Boo hoo if gdp goes down a little now, beats going down alot in the future and potentially ruining eco systems in the process.	The target should be the best case scenarios that the ipcc says must be met. Who do we think we are, better than the UN and ipcc, come on, be ambitious.	Yes support interim target	For the price of a shiny new 4 lanes to ashburton, you could probably buy everyone in Christchurch a decent ebike, that would solve the traffic problem and a good portion of the emissions problem.

SUBMITTERS NOT WISHING TO BE HEARD							
Sub ID	**First name**	**Last name**	**Name of organisation**	**Do you think we should align with the proposed national target of net zero greenhouse gas emissions by 2050 (that also adopts a separate approach to methane gas) if so, why?**	**Should we take a more ambitious approach? If so, what year should our net zero greenhouse gas emissions target be set and (and why) and how should we consider methane (and why)?**	**Do you support an interim target as a way to encourage early action?**	**Any other comments**
27638	Rachel	Teen		yes - Because we're a small community of only around 400,000 people - we are agile, adaptable and ready for socio-technical change	Yes more ambitious to 2030 for x amount, 2040 for the rest. Put 'stages' in front of people so they can see & feel progress - break the targets down & make it realistic in people's minds	Yes support interim target	If people can change "overnight" regarding smoking & plastic we can change re: CO2 emissions. Let's be a leader, not a slow, antiquated, combustion engine era follower
27625	Anne	Heins		No, I believe we need to set 2040 as our target		Yes support interim target	Absolutely. The science tells us that we must halve emissions in the next 11 years if we want to have a hope of avoiding runaway climate change. What matters is less about the exact date that we achieve zero emissions, but the total cumulative carbon emissions we emit between now and then. I would go as far as urging 3 year interim targets, to really focus the politicians' minds rather than each Council elected for 3 years being effectively allowed to 'kick the can down the road', which will only make it harder to reach targets in the medium and long term.
27622	Heather	Lunn		Christchurch City Council should meet the net zero greenhouse gas emissions by 2050 quickly through quick fast action so the future of Christchurch will be socially just. The Council has a unique opportunity as our community leaders to show clear direction on this issue. It is important that the community is made aware that life as we know it will change because of climate heating, and it is better to do this before we reach a crisis point. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for business, investors and communities on the direction we are heading.	Yes. We know we have only a short period of time to reduce emissions if we are to stop runaway climate change and the social and political instability that will accompany it. I appreciate that the council recognises that our City's per capita emissions are high and that transport contribute to 53% of these emissions. Given we have a high living standards of living we can adjust to changes. We have access to cycleways, cycles, and a public transport. The bus system runs on time but buses need to be more frequent and affordable. Ecan and CCC need to work together on public transport. As a city we need to be as bold and as ambitious as possible to show other cities what is possible. I suggest the CCC district be net zero long-lived by 2040. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-living gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long lived reductions.	I support interim target across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each {i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.	

				The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: *significant change in scientific knowledge. *significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). *The district is subject to an extreme natural disaster. *Escalating our ambition on short-lived gases as global "peak warming" approaches. The 2050 target should not be altered in response to "economic changes" as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27588	Pip	Newland	Orion	Yes. Orion is a member of the Climate Leaders Coalition and supports the Climate Change Response (Zero Carbon) Amendment Bill. We believe that the district target should align with the national target.	The national target is set after significant data collection, modelling and consultation. On balance, without an equivalent process at a district level, we believe that the district target should align with the national target	Yes support interim target	We support an interim target on emissions reductions, as clear policy direction assists with business planning and certainty. However, there is not enough information available about how the proposed interim district target was produced. We believe it would be appropriate for interim targets to be set after: - the proposed Climate Change Commission has provided its recommendations on emissions budgets and an emissions reduction plan, to ensure district action aligns with national intent, or - additional analysis is made available to show what an appropriate interim target would be in the context of this district, taking account of downstream effects on electricity demand and the associated need for network investment.

27585	Lucian	Nightingale			I am a Christchurch resident and have been all my life and I believe a much more ambitious target should be realized. I attended school through out the early 2000s and am now finishing up at the University of Canterbury. While at primary school I became very concerned about climate change and watched Al Gore's "An Inconvenient Truth". I became very motivated to look in to climate change and its potential impacts, in my years at intermediate school my two science projects were focused on environmentalism. One was a bike trailer to help cut down on car use and the other was a worm farm. However, as the years passed I saw people in authority drag their feet on the issue. Meaningless targets were put in place and my young, idealistic self became disheartened. I am now closer to my mid 20s than I am to my teens, I am much more cynical and frankly I am too busy to really care that much about the environment. Despite this my university lecturer asked our class to make submissions to the CCC on the zero carbon 2050 plan. After frantically reading it this evening (I am making this submission at 11:45pm), I am reminded by the reasons I stopped caring. To think an issue that I believed was the most significant threat to humanity when I was 9 is to be partially fixed when I am in my mid 50s is ridiculous and surreal. The council should harden up and make a radical proposal for change and have the gumption to follow through on it.	No do not support interim target	
27584	Marie	Kennedy		There is likely beneficial consistency and solidarity in alignment with the national target of zero for carbon dioxide and nitrous oxide by 2050, but the national target for methane indicates a lack of sincerity, commitment and determination. Methane is about 28 times more powerful than carbon dioxide at warming the Earth on a 100-year timescale, and more than 80 times more powerful over 20 years. It is the next 20 years that is vital to avoiding warming tripping these near term tipping points leading to exponential warming, such as permafrost melt and ice shelf loss.	We should take a more ambitious approach to the methane target bringing it into line with the national target for carbon dioxide and nitrous oxide. A quick reduction in warming, such as by taking a strong, sacrificial approach to this powerful, short term greenhouse gas (methane) is essential to avoiding uncontrollable, runaway warming such as will result if the permafost or ice shelves melt. If there is a hope for reversing warming it will come from carbon dioxide capture technology, and a radical reduction of methane as the powerful, short term greenhouse gas is essential to buying the time necessary to develop the carbon dioxide capture technology to address carbon dioxide as the longer term issue.	Yes support interim target	These targets - these high level, abstract approaches - are still divorced from individual sacrifice. In wartime emergencies people have proven capacity for great sacrifice, but the response to climate change indicates that everyone thinks someone else should make the sacrifice, such that one doubts whether people have the same fortitude and capacity for self-sacrifice as those earlier generations. Vastly increased meat consumption and portion sizes compared to earlier generations indicates a greed and self-indulgence and inability for self sacrifice such that one has little faith in this generation. Is there is any point setting any target if there is no moral fibre for individual action and sacrifice; targets suggest that society is going to do the work without the individual needing to offer up anything onerous. It's singularly unimpressive when people purport to care for the planet but can't offer to sacrifice the self-indulgence of a single meal of meat, given the environment devastation of intensive farming;

							even if rainforest doesn't need to be cleared in New Zealand to farm cows, it does in other parts of the world, and we can't speak on the world stage if we can't show individual sacrifice. So I would advocate developing models of recognising the reality of climate change through everyday sacrifice around reducing meat consumption as the most tangible, everyday, credible and easy but impressive individual sacrifice with a relationship to reducing methane consumption.
27581	Sylvia	Barnett		I commend the Christchurch City Council for proposing to meet the net zero gas emissions by 2050. It is crucial to participate in the global effort under the Paris Agreement and limit the global average temperature increase to 1.5Â° Celsius above pre-industrial levels.	Russell Norman, Greenpeace Executive Director stated that the Zero Carbon Act had "no teeth" and it is my opinion that opting for a seperate approach to methane, is just that, unambitious. In Simon Upton's Parliamentary Commission Report "Revisiting Stepping Stones", he explains how Methane while still " a potent warming agent" has a shorter residence period in the atmosphere prior to it breaking down into water and carbon dioxide. Upton makes the case that while Methane is still a major issue to be discussed, it is not the gas of prime importance. While Upton's report provides a useful outlook on Methane, I would argue that this is approach may seem optimal at present, for as Upton acknowledges himself, facing the complications of eradicating the gas will be highly problematic for a number or reasons. Nevertheless, it is my advice that as a city, the issue of Methane could be tackled now. I advise that addressing methane as a gas that needs to be eradicated is the optimal position to tackle climate change now if we want to meet the 2050 targets. Furthermore, New Zealand has committed to reducing emissions by 30% by 2030. While any pursued target would be better than a unlikely one, 2030 is only 12 years away and therefore it is my advise that methane needs to decrease to meet this target.	Yes support interim target	
27580	Matt	Stent			Yes, the city of Christchurch should be more ambitious and follow a harsher target especially in the areas of transport and building. Methane should be considered the same if not more severely than other forms of green house gas emission as they can be some of the most harmful in the short term and accelerate the rapidly declining environmental stability.	Yes support interim target	
27578	Jon	Sullivan		I would prefer that Christchurch takes a more ambitious approach. NZ, and the world, needs leadership in this area, and Christchurch could as a much needed	Yes. I agree that it is important for Christchurch to be more ambitious. I also agree that methane should be included with carbon dioxide, as methane is a potent greenhouse gas.	Yes support interim target	

				demonstration to other cities of how best this can be done.	Having said that, it is just as important that we commit to meeting our ambitious goals without unfairly disadvantaging some members of our community, or damaging our environment. For example, the costs of reducing methane should not be placed solely on the shoulders of the rural community. The most disadvantaged should be subsidised by everyone else and we should get through this together. We also shouldn't plant our natural areas with fast growing trees. How we choose to meet our goals will be at least as important as what goals we set. It's hard for me to say which year is the best target without knowing more about how the city aims to meet these goals. We should really be all giving up our cars tomorrow and aiming for net zero emissions by 2020. The threat of climate change is that alarming and urgent. However, I appreciate that the urgency of the threat is still not widely enough understood for that to happen. The council has a role in continuing to spread the message that our status quo must change or we're all going to be in big trouble. Offsetting through native reforestation is relatively easy and would immediately start removing our excess carbon from the atmosphere. The district's biodiversity would also benefit greatly from an increase in area native forests and wetlands. A lot of carbon could be offset by giving sufficient financial incentives for marginal farmland to naturally return to native forest across Banks Peninsula. Hinewai Reserve near Akaroa is a shining example of how this can be done at low cost with no tree planting and minimal weed and pest control. Creating lots of Hinewais across Banks Peninsila would not just offset a large amount of carbon. It would also create a natural legacy that would benefit future generations in many ways, including through many ecosystem services other than carbon sequestration (e.g., erosion control, water treatment, nutrient uptake, pollination). I expect there will be a temptation to instead offset carbon through widespread planting of exotic fast-growing pines and eucalyptus. Private land owners may elect to do this but I am opposed to this being done on public land, and I am opposed to public money subsidising this. Don't break nature trying to fix nature. The council should be thinking of using		

					public land and ratepayer money to achieve broader environmental benefits than just carbon sequestration. Any differences in the rates of carbon uptake by regenerating native forest and an exotic timber plantation can, and should, be made up through other intiatives. Offsetting will only get us so far. We need to be thinking about ambitious changes in behaviour. For example, I could easily see weekly car-free days, e.g., each family not using their car for one day each week. And how about city-wide vegetarian days, e.g., no meat Mondays? Both could start as voluntary events widely promoted and supported by the council. These are just changes, not sacrifices. Busing and biking are fun. Vegetarian food is tasty. The more Christchurch people realise that, the easier it will be meet our ambitious net zero emissions goals. An ambitious goal needs to address the carbon problem head-on by tackling transport. I have been heartened by the recent investment in cycleways, and by the incredible uptake I'm seeing of those cycleways. Really, it's awesome. Two thumbs up, Christchurch! We need to be transitioning to a city with a lot more cycleways and a lot fewer motorways. I worry that the gains made in the centre city through cycleways are being well and truely wiped out by the increasing traffic volumes and journey distances and motorway infrastructure being built for Christchurch's rapidly expanding satellite towns. Christchurch desparately needs to pass "peak car" and start reducing our car dependency. In conclusion, I'd like to see an ambitious target. I would like to see it being backed up by hard decisions and necessary behaviour changes, not just some clever offsetting. This really is an emergency, and the world cannot offset its way out of catastrophic global warming just by planting trees. I'd love to live in a city that is proud to show the world how we can make the hard choices while being a vibrant and creative and economically prosperous place. It is totally possible. We just need to choose to take a new path.		

27575	Angelika	Hofmann		No, the target needs to be brought forward and has to include also Methane Gas as is more potent than CO2. The Focus on all aspects of the City Planning be it transport, housing, business, venues, rubbish and recycling has to be the lowest environmental impact and sustainability .	Yes, target 2030. All sources of methane have to be identified. Any farming should be encouraged to convert to Organic Farm practices which enhance soil fertility and are therefore better CO2 sinks.	No do not support interim target	A target needs to be set and then all measures have to be taken to reach that target.
27569	Max	Sullivan			I think we should take a more ambitious approach and drive cars a lot less as well as all going vegetarian.	Yes support interim target	The world has had major changes in climate since the beggining, but never have these changes happened so rapidly. There is more carbon dioxide in the air now than in the last 800,000 years on record. Our home is getting hotter. And we are the problem. If the human race keeps living the way we do, we are endangering our wildlife, and our future. And although we are the main cause, we are also the main hope. This can be done. But we need to change. And fast. Global warming happens when chemicals called greenhouse gasses, such as carbon dioxide, are put into the atmosphere, making the world hotter. A lot of these greenhouse gasses are being made by us. Things we do every day that seem like nothing are actually causing a big impact. Driving cars, for example. Any engine that runs on petrol or diesel spits out carbon dioxide into the air. There are about 1.2 billion people who drive cars on planet earth. This is a big problem. And cars aren't all. Pretty much anything that uses fossil fuels is playing a big part in heating up the earth. So factories and oil rigs are also causing problems, along with other things like mining. And a major problem which is less well known is eating meat. Meat is having a bigger impact on climate change than cars, planes, and trains combined, for multiple reasons. First of all, it takes a lot of space to raise livestock. Lots of forest ends up being destroyed just to create farmland, just to make a home for our cows and sheep, just so we can eat our meat. And trees are a big help in slowing down climate change. Trees take carbon dioxide and turn it into oxygen, and although they alone will not be enough to end this mess, they are still a key asset. So we need to stop cutting them down to make meat. Secondly, a lot of the animals that we farm burp a chemical called methane, which is also causing climate change. We need to go vegeterian. And this is getting easier. Scientists are working all over the world to create different kinds of 'fake meat.' There are two in stores today called 'beyond meat' and 'Impossible Burger'. For those people who are not willing to give their meat up, there is another option. Scientists are finding ways to help. There is solar power, which powers some houses and cars withs solar power

							using solar panels. And windmills as well as batteries are also sources of electricity. Using this new power they have given us, we can reduce our carbon footprint. And there are a few ideas they have to help stop climate change. The first is refreezing the poles. The idea they are most entheusiastic about is to have seawater pumped through masts on large ships without a crew using very precise nozzles. This would produce salt particles that would go into the clouds making them more reflective and widespread, and this would allow the areas underneath them to cool down. A different approach is carbon capture and storage, or CCS for short. This method involves taking carbon dioxide from the atmosphere and putting it underground. Scientists say that this would be very expensive and if these new methods were to start, they would not be able to end the climate crisis on their own. We still need to change. Climate change is causing major problems all over the world. The sea level rose 20.3 centimetres in the last century. In the past two decades it has rose again at almost double that rate. The temperature of the oceans is also rising. The amount of cyclones and tornadoes among other extreme weather events are increasing. The amount if arctic sea ice and snow cover globaly is decreasing rapidly, endangering our wildlife. And of course, the whole world is getting a lot hotter. This has to stop. Climate change is a huge problem. And it is caused by everything. Cars, trains, buses, planes, meat, mining, and all kinds of factory production. All of these combined are putting us in huge ammount of trouble. Recently Environment Canterbury, or ECAN for short, declared an environmental crisis. If we can't make major changes to our daily living, and fast, then in the future there might not be a life to live, and certaintly not a pleasant one.
27560	Jessica	Halliday		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further	Yes support interim target	

				levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.	reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.		
27559	Douglas	Horrell		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must	Yes support interim target	

				achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.	also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.		
27552	Nilguen	Kulpe		Yes, on a national level but just for our region of Canterbury we should aim at an earlier or interim target as I believe time is precious. We don't have that much time anymore, the sooner we act the better and no matter how much we can appeal to peoples willingness to "do their bit" to reduce their carbon footprint, the council needs clear and manageable strategies in place . Definitely by 2030, better even before that!	Yes, I've answered that above...2030 or beforehand, aiming at 50% reduction of the current emissions. Methane is a growing problem unless the dairy farming industries are much reduced and more people eat less animal products ; educational programmes for farmers to invest in healthy , earth friendly alternatives with financial help by our Government could help to turn the boat (of animal farming) around!	Yes support interim target	I like the idea of getting people together to come up with really tangible and practical ideas of how to combat climate change. Love the edible garden idea in our city center (CHCH), smaller community projects (e.g. Project Lyttelton) and anything that is in the realm of " working together by going something positive " The council could appeal to smaller communities to come up with their dream visions of their place and then support them accordingly (fiance/education/ consultation) I love New Zealand and will always stand for a great future on this amazing planet!

27551	Juliet	Adams		No.	Yes. Any target beyond 2030 will be unreachable because by then the damage caused by emissions will take all our resources in coping with the realities of economic, environmental and social disasters. Methane must be brought into the same time period, to speed our effectiveness in reducing emissions.	Yes support interim target	All citizens and businesses, as well as local bodies, need to become fully committed to modifying their behaviour, starting now, not in 5 or 10 years' time. For example, because Christchurch has more cars per head of population than the NZ average, drivers of cars need to be encouraged to reduce their use, by both carrots and sticks applied by local government. Sticks would be introducing a petrol tax; raising the cost of parking all through the central city. Carrots would be using that income to increase the range and frequency of public transport, helped by the introduction of small buses at times of low use, and greater frequency of regular-sized buses at peak times. IDEAS FOR SUBMISSIONS TO CCC TRANSPORT: Congestion charge, used in London 2003 – daily toll for entering a 22-square kilometre central zone. 200 fixed and mobile cameras read numberplates and check them against payment records. Congestion charge dodgers face fines of up to $390. Buses, cabs, public service vehicles, th e disabled and central zone residents were totally or partially exempt. In a 2003poll, 63% of Londoners said they supported the charge. 50,000 fewer vehicles a day go into the city. Roads are less congested, there are fewer accidents and journey times are faster. The congestion charge revenue paid for fleets of new buses….. https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12252437 new poll, 8 in 10 Kiwis now personally worried over climate change 24.7.19 https://www.stuff.co.nz/business/114464480/nz-businesses-carbon-scorecard-not-the-greatest-as-invite-issued-for-a-tougher-pledge https://www.stuff.co.nz/taranaki-daily-news/news/114469490/green-energy-and-what-they-call-in-parliament-the-law-of-unintended-consequences so everyone needs to reduce demand instead!
27550	Connie	Christense n		No! The national target of net zero greenhouse gas emissions by 2050 is not at all enough to make a big enough positive changes to the devastating impact our harmful consumption and way of life is continuing to inflict on our planet.	Yes! A net zero greenhouse gas emissions target by 2030 in my opinion is critical. It will be a big challenge, but we can absolutely do it if we want to, and New Zealand should stand tall and set a positive example (like we did after the 15 March 2019 shootings) and show the world a shining example to spread hope and inspire others to follow suit.	Yes support interim target	This should be encouraged to give those, who have already done much good work and investment to minimise their environmental impact, a chance to shine and lead the way for those who might be overwhelmed or just a bit slow off the starting blocks ;-) Interim targets should not be used as an excuse for others to not do their bit. There should also be financial benefits for business going above and beyond to reach targets ahead of time.

27547	Leeann	Watson	Canterbury Employers' Chamber of Commerce	This is a submission from the Canterbury Employers' Chamber of Commerce (The Chamber) on the Christchurch City Council emissions target. All commentary and recommendations are based on our observations and expectations, as well as feedback from our business community. COMMENTARY The Council's climate emergency vote has kick-started a very important conversation and brought this issue front-of-mind for many people in Otautahi Christchurch, acknowledging our local role in a key global movement. At The Chamber, we acknowledge that climate change is an issue and agree with the Council's statement that "greenhouse gas emissions are causing unprecedented increases in global temperatures, and we must rapidly cut our emissions to prevent further warming and disruption in the future". From our perspective as an Employers' Chamber and an advocate for local business, our focus is not so much on what the target date will be - although a line in the sand will be crucial in terms of forecasting for businesses - but our focus is more on understanding how it will be implemented. As an Employers' Chamber, we are also very aware that this is a key issue in our operating environment, and it is an issue that can be construed as both an opportunity and a threat to local business - with the spectrum and intensity of impact largely dependent on the actions and steps we take now to address and manage this issue. While inaction and a 'wait and see' approach may have been a somewhat acceptable standpoint previously, we agree that this option has now passed. While we acknowledge the strong leadership and decisive action shown by the Council around this issue, including the recent climate emergency vote, we are only too aware that this is one of myriad issues impacting local business - from local compliance to national regulatory and policy changes, to evolving international trade agreements and volatile global markets. With SMEs making up the majority of businesses in Canterbury, we also need to be careful that we are not adding unnecessary stresses and challenges of owning and managing a business and navigating an already complex operating environment. The Chamber would like to see the following considered and reflected in the district's final climate change strategy, which will be adopted in September 2019. 1. A business-friendly approach As this strategy will have a direct impact on local business, albeit to varying degrees due to a range of contributing factors, we would like to ensure that any approach is business-friendly. Therefore, we would like to see an enabling path, rather than a regulatory path around the roll-out of any targets (or interim targets). An enabling path is based on providing education, incentives and support to help empower business, which we believe is likely to be more easily and quickly adopted - and ultimately more successful in the long run - rather than a regulatory path that has a tendency to inhibit business. A regulatory approach can also be seen by the business community as being too resource heavy, both in terms of human capital and financial resources. We also need to ensure that any legislative framework is aligned with our unique local business environment and circumstances and takes into account our trade dependence and reliance on export competitiveness, as well as the agricultural backbone of our region. We are concerned about what impact a net zero carbon target will have on our largest export industries, and whether it will be possible to pass on any additional costs to consumers if they are to remain competitive in an international marketplace . With any initiatives within the public sector that are financed directly or indirectly through rates, the Council needs to ensure that any decisions are financially prudent. We would like the surety that this target-setting and th.e resulting implementation plan will not significantly cost ratepayers and businesses in increased red tape and compliance costs in the future. There is concern that the more ambitious the emissions target, the greater the costs to firms and households, as outlined in the NZIER's Economic Impact Analysis of 2050 Emissions Targets 1 While the economy will continue to grow, regardless of the specific target, the more ambitious the target, the larger the decrease in economic growth, which will have an impact on communities through potential downturn. 1 https://www. mfe.govt.nz/sites/defa ult/files/media/Clim ate%2 OCha nge/NZ IE R%20report%20- 20Econom ic%20impact%20a nalysis%20of%202050%20e missions%20ta rgets%20-%20FIN AL. pdf We need to be careful that we do everything we can to maintain our vibrant business sector and our environment , and that any approach does not make our region look less business-friendly , potentially causing Canterbury to miss out on new business opportunities, or established businesses to look to relocate elsewhere . 2. Greater engagement and consultation We believe strongly in encouraging robust conversations around areas that will impact our business and wider community. Key to this is to ensure that all ratepayers have an opportunity to be involved regularly

				throughout the process and that the community is kept well-informed of any issues and decisions and the rationale for these. The Council's vote on declaring a climate emergency took much of the business community by surprise, as there was a lack of information leading up to the decision to confirm that it was a well informed, proactive decision that was part of a much larger body of work and regional positioning strategy, and not a knee-jerk reaction to a global movement. Such decision-making made with little or no consultation is not helpful for business confidence and surety and doesn't demonstrate a collective, collaborative approach. We also need to be careful that any of these kinds of statements are meaningful, with tangible actions, to ensure the wider community doesn't treat such declarations with complacency. The Chamber would be able to help Council facilitate a forum with the local business community as part of an open and inclusive engagement strategy. 3. A better understanding of the Council's role in this issue While speed and ambition may achieve results, we need to be mindful that decision-making is measured, robust, sustainable and achievable. The Council has acknowledged in their consultation document the diametric forces of being too drastic and not understanding the risks to the community and economy on the one hand, and the risk of not ta king necessary action quick enough to make a difference on the other - particularly given the largely irreversible nature of this issue. However, one aspect of the Council's communique that is troubling is that if the Council doesn't take action, they "won't be leading on climate action". If the Council wants to adopt a "leading" position on this issue, then we would like to understand exactly what this means. Is this intended to be at a national level or global level? And is there a justifiable business case for them to do so? Taking a leadership role in such a significant issue can be much more demanding on already stretched resources, particularly when there is an urgent need for funding for essential services. There is also a reputational risk for the region if the plan is overly ambitious and not well executed. We would also like to see the Council demonstrate that this leadership position is representative of their constituents' aspirations for the city and its regional identity. If the Council is intent on a leadership role with regards to climate change, then the Council needs to ensure it follows through, and that this results in systemic change and a significant cultural shift for the entire organisation - from senior staff to frontline representatives and including every department. Through leading by example, the Council stands a much greater chance of influencing others across the community to join the action. 4. Adaptation In Canterbury, we are unique in our natural resources and innovative culture, so there is an opportunity for us to look at how we as a region can better utilise and preserve our wider environment. It would perhaps be more meaningful and effective to focus energies on ensuring our local government infrastructure is aligned with the implications of climate change, than prioritising emissions targets. CONCLUSION How the Council rolls out their strategy and implementation plan for the emissions target will be crucial. It is our view that more work needs to be done on the economic impacts of the targets (including any interim targets) and what sort of transitional support would be required to ensure we are not undermining our exporters, our global competitiveness, and our economy. We need to be more aware of the economic consequences of any decision-making and ensure that this is fully communicated to all businesses and members of the wider community that will be impacted. By keeping the local business community informed and engaged, there is an opportunity for the Council to work together with the support of the local business community to make climate change an opportunity for the region, and not a threat. We would be pleased to work directly with the Council to act as a channel for two-way information and engagement, including as a conduit for local businesses to ensure the local business voice is heard and considered, and to support and empower local businesses through any transition. As the home and voice of Canterbury business, The Chamber appreciates the opportunity to work with local government and relevant agencies on key issues that will impact our member and wider business community to ensure that together we can deliver a sustainable and thriving future for our city.

27544	Kay	Robertson			I think we should adopt a more ambitious approach for two reasons: 1) We have less of an issue with agricultural emissions, which may be more problematic to reduce, and 2) The easy remedies will happen first and it will get harder as we go along...so the sooner and faster we make changes, the more likely we are to meet our ultimate targets.	Yes support interim target	**SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION.**
27542	Jan Jakob	Bornheim		At the very minimum, yes.	Yes. Christchurch has a few easy ways of reducing carbon emissions by drastically cutting the contributions of individual motorized transport. I think a 2035 carbon neutral goal is achievable if the favouring of car transport and more incentives for energy-efficient buildings and renovations are provided. I have no opinion on methane, but note that Christchurch is a more urban district than surrounding districts.	Yes support interim target	
27532	Sharyn	Barclay		Submission on wider Christchurch and Banks Peninsula Emissions Targets Firstly, congratulations on your proactive stance with regard to Emission Targets. Those of us in the NGO space lean more and more towards recognition that localisation is the future and support initiatives to 'clean-up our own back-yard'. At the same time, we are aware of your requirement to adhere to legislation which may be at odds with popular community opinion. Councils such as Christchurch have leverage to send a strong message to Central Government that people desire the future to be restorative and regenerative. Councils are less hamstrung by lobbying, big business and partisan political interests than Central Government. Your recent declaration of Climate and Ecological Emergency has strengthened impetus for similar declarations nationwide. Central Government has been shown that this declaration is not just demand from zealots but a mainstream response to heightened climate instability on a global scale. Human society is on the brink of evolutionary change. That change is encompassed by the terms 'justice' and 'kindness'. This was presaged by the recent 'well-being budget' bought in by the current coalition Government (however you judge the effect of this budget to bring about real change). The parameters by which society operates are experiencing tension now that climate injustice necessitates action. The interconnectedness of us and our world has become blaringly obvious. As catastrophic as the consequences of climate disruption has the potential to be, climate injustice has served a purpose by calling out and highlighting other societal, economic and environmental injustices. Human interactions with other aspects of the natural world and within its own populations are in dire need of overhaul so that injustices (including racism, class and age barriers, pay inequity, freshwater mismanagement, ocean exploitation, biodiversity/habitat loss, resource misuse, soil degradation, deforestation, poverty, hunger, fascism and all aspects of human rights - the list goes on and on) can no longer be normalised as the inevitable consequences of existence. Civilisation will not stay civil if these injustices continue to prevail. Climate injustice, where those hardest hit by the changes wrought by greenhouse gas (GHG) emissions are those least responsible for their emission, is precipitating alteration in the very fabric of our existence. Welcoming climate breakdown with open arms and seeing it not as a tragedy but as an opportunity, is appropriate for a responsible elected body such as CCC. A true 'Climate Change Response', as Central Government label their watered-down and laughable Climate Change Response (Zero Carbon) Amendment Bill 2019, has not been seen in the actions of Central Government. CCC, as a responsible (i.e response able) representative entity, is in a position to pave the way with their emissions targets. You wish to set emissions targets bearing in mind potentially harmful impacts on the community and the economy. You state a desire to enable time for a just and equitable transition to a low GHG emissions economy. I put it to you that ACD (Anthropogenic Climate Disruption) is occurring apace and the time you so softly-softly wish to apply to your response, is not available. The conservative 2018 IPCC (Intergovernmental Panel on Climate Change) report estimated 12 years until the catastrophic and irreversible natural world effects of climate breakdown, but change has been modelled as occurring at twice the speed. Those targets determined by Central Government do not protect communities or the economy adequately. Sacrifices and lifestyle changes are necessary now. You say we must â€˜reimagine the way we travel, generate energy, produce food, manage waste, develop agriculture, build infrastructure, and develop our towns and cities, then you say "We can also 'offset'". Unfortunately the recent bill before select committee for national NZ response to Climate Change only proposes the offset part and omits removal proposals in emission budgets, so you are already displaying a desire for a more ambitious approach. You are encouraged to continue to be more ambitious. Please consult experts in those fields responsible for emission release (namely, transport, energy, agriculture, waste, industrial gases and building) with regard to reduction and eventual end. There is a lot of knowledge out there and if you don't ask, you don't get. Section 5W of the Climate Change Response Bill talks about reductions and removals but does not actually give removal strategies. Council can remedy		

				this. Without claiming any expertise; you say agricultural emissions in our district amount to 10.5%. The following paper outlines a destocking program for dairy farms which will have no effect on profit in the short term. The Our Climate Declaration team say Cutting methane now is the fastest action we could take to slow the rate of warming. The cow is the elephant in the room. Targeting methane and nitrous oxide now has more value in terms of reduction. Please stop ignoring this GHG source. Back to CO2 -there is a reason that nature stored fossil fuels underground. They are toxic to life above ground. It is essential that we talk about alternative sources of energy. Renewables (other than hydro) are gaining ascendency commercially and would benefit greatly given public legislative support. The NZ Royal Commission's in-depth study from 2016 showed that New Zealand could produce all its energy from non-fossil fuel sources within 10 years with government support. CCC must get the ball rolling and actively support this transition. Subsidies given to fossil fuel providers and users amount to $20-$80million nationally (depending on how the figure is derived). Identification of business/industry which operates within the Christchurch/Banks Peninsula district where subsidy is given, is a core responsibility of Council. Council is beholden to call out the likes of Mobil and BP as being two companies in the top 10 companies responsible for emissions. Diesel fuel subsidy to the farming community is something under-reported by NZ in general. Your community has the right to this knowledge. What is subsidised in the district? Now to mention the approach to Zero Carbon as has been adopted by the Carbon Change Response (Zero Carbon) Amendment Bill currently before Parliament. Neutralising Carbon is really only 'business as usual' in disguise. Disguise may be the wrong word because 'the Emperor has no clothes' and enforcement is totally lacking. Sure, sequestration of carbon (CO2e) is not intended as the only remedy to GHG reduction but other measures that reduce emissions (such as EV fleets for business, public transport using renewables and incentivising uptake, ride-sharing incentives, the possibility of carless days, general resource efficiencies, red-list building, greater plant-based regenerative agriculture and other less harmful practices.) are not legislatively required. They will hopefully happen by osmosis as societal licence is removed, but are not in place through legislative demand. This does not reflect the urgency of the issue! As First Responders to the Declaration of Climate and Ecological Emergency you are asked to strengthen the true Zero Carbon response. Emissions targets are required which draw a definitive distinction between gross and net CO2e. Specification of net targets alone does not encourage living and working smarter, only living lighter (but still with some harm to the wider environment of which we are a part). Solving any problem with the same mind-set and societal framework within which that problem developed, is widely regarded as folly. Accordingly, it behoves humankind to do no harm to nature within which it is an integral part. You ask in your online form if we should align with the proposed national target of net zero greenhouse gas emissions by 2050 (that also adopts a separate approach to methane gas). Yes, zero emissions is a worthy target but the timeframe requires revision. Between 2025 and 2040, in line with the range of NGO demands, is fitting. The earlier the better. 2030 is a realistic and safer date. In regard to methane (biogenic or from waste/landfill), this requires careful management so that reduction is immediate and any continued emissions (at very low levels) are more than compensated for by offsetting i.e by the tree planting program. Trees used cannot be pine, especially since new research reveals the volatile organic compounds released by pines actually increase the Â½ life of shorter-lived GHGs. Both methane and nitrous oxide are thus at risk of becoming longer-lived GHGs. Nitrous oxide is easy to reduce to zero by banning fertiliser emitting this substance. Overall though, off-setting initiatives are greeted with raised eyebrows because neutral carbon is not zero carbon. The reality of 'just transition' requirement means that some offsetting will be required but that requirement must be at a level where negative emission is in-place. This can be the only acceptable allowance for any continued emission. Thus dairy or any other agriculture that is not plant-based and regenerative must plant trees to render the practice CO2e negative. CCC is required to commit only to resource use which is essential for survival of the population of the Canterbury district. All permits for extraction of any kind are required to be revoked. This includes water extraction and coal mining. This act would show the irrefutable truth of interconnectivity. Alternative economy structures, such as timebanking, could be championed by CCC as could community gardening projects and savings pools. Administrative structure assistance could be offered by CCC to cement these localised alternatives. Where local business is concerned CCC could help, encourage and publicise 'best practice' behaviour to reduce emissions so that 'reinventing the wheel' is minimized. Even a localised currency, perhaps related to the timebanking initiative, is a possibility for CCC to seriously investigate and implement. Emission targets are a critical piece in the whole climate change response game and you have asked re support for an interim target as a way to encourage early action. The Council can seriously use these targets as an indicator of the district's willingness to sacrifice and change their life-styles. The alternative is much worse than the sequelae of the 2010 and 2011 quakes and this must be communicated to naysayers. Please tell the truth -change within the district will follow. Wider Christchurch and Banks Peninsula have shown resilience in the face of natural disaster. With suitable management the district can be called on to show similar resilience in the face of the manmade disaster for which we are all responsible. Interim targets would certainly show the public your commitment and vice versa. By hinging your interim targets on real climate science you can be exponential with targeting, just like changes in the natural world. Please lead by example. Local natural area recovery from the multiple wounds we are inflicting on Mother Earth/Papatuanuku will be fairly rapid (take Hinewai on the peninsula as an example) and can be upheld

				as examples of the veracity and strength of your approach. Make it known that you realise the Emperor-has-no-clothes (in the form of the sadly ineffectual Climate Change Response Bill). Setting real targets for CO2e reduction with practical solutions and enforcement (sadly lacking from the Central Government response), may be a game-changer. Survival is a matter of choice.			
27531	Michael	Brathwaite		I am not convinced that global warming is caused by us. It has happened before and will happen again, kept alive by greedy scientists wanted to keep the gravy train of research grants flowing. Accordingly, any scientist who questions the prevailing "wisdom" is treated as a pariah like the rest of them. Twenty years ago they were studying global cooling. However, if the council is serious about reducing emissions from vehicles, it should stop putting in medium strips and closing street entrances, thereby forcing us to burn more fossil fuels than necessary by forcing us to make unnecessary detours to get where we want to go.	No, I think the whole business is a money-making con by getting countries to pay for unmet goals, and that things like Kyoto are scams.	No do not support interim target	
27530	Sam	MacDonald	Waimāero/Fendalton-Waimairi-Harewood Community Board	The Waimāero/Fendalton-Waimairi-Harewood Community Board (the Board) appreciates the opportunity to provide feedback on Our District's Emissions Targets. The Board supports the Council's development of a climate change strategy that will establish greenhouse gas emissions targets and set a framework for local action on climate change. The Board fully supports the Council being aligned with the proposed national target of net zero greenhouse gas emissions by 2050 and also recommends that the Council follow the advice of the International Panel on Climate Change and set an additional target to reduce greenhouse gas emissions by 50% district-wide by 2030. The Board considers that if these deadlines are not met, irreparable effects of climate change and the negative externalities will occur. Christchurch is a city still rebuilding and the time is right to encourage more environmentally sustainable measures to protect the district we live in and future proof our city while we have the opportunity to do so. These could include sustainable building requirements and the installation of vehicle	As mentioned above, the Board supports the Council being aligned with the proposed national target of net zero greenhouse gas emissions by 2050 and recommends the Council set an interim target to reduce greenhouse gas emissions by 50% district-wide by 2030. The Board considers, however, that while we need to be ambitious in the approach to achieve these targets, we also need to ensure that the approach is sustainable and the process not rushed. It is important that all stakeholders are involved in the debate and decisions on how these targets are achieved. The methane issue is more complex. The Board considers that further research is required to find sustainable initiatives and solutions for recycling. A proactive approach to education and the promotion of successful and innovative ways to reduce our waste need to be promoted, for example Reusing wherever possible. Research into the reduction of Methane gases in the farming industry should be increased, and when finding solutions, those involved in the industry need their livelihoods considered throughout the process.	Yes support interim target	The Board does support an interim target as a way to encourage early action. A focus on 'low-hanging fruit' would enable the 50% reduction by 2030 target to be more readily achieved. This could include: • Establishing a network of vehicle charging ports across the city. • Ensuring an efficient, easily accessible and affordable public transport system. • Supporting initiatives that educate safe cycling practices and cycle routes within schools and establishing facilities, such as the Westburn cycle parks where children can learn to ride, learn road rules in a safe environment. • Providing sufficient cycle and scooter stands that are adequately lit and safely positioned, at all Council facilities that goes beyond, the introduction of vehicle charging. • Supporting and encouraging a reuse culture city-wide. • Investigating ways to acknowledge and recognise people and businesses that are undertaking innovative initiatives to address the challenge e.g. star award certificates that they could have on display in their business etc. The Waimāero/Fendalton-Waimairi-Harewood Community Board is proud to have supported a number of local initiatives which could be replicated in other areas including:

				recharging stations at locations across the city.			• Cotswold School, Bishopdale - Bikes in Schools Project • Cycling Incentive Scheme at Jellie Park Sports and Recreation Centre • The purchase of D-locks to have at Jellie Park for people to borrow
27529	Amanda	Robinson		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				as global ‘peak warming’ approaches. The 2050 target should not be altered in response to ‘economic changes’ as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27525	Tim	Yee		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global ‘peak warming’ approaches. The 2050 target should not be altered in	Yes, as there is a small window of time to reduce emissions, if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now and achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	

				response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27523	Samantha	Weston		No, The proposed target does not call for action soon enough and gives too much time - I believe the community change in NZ will happen too slowly. This is a climate emergency. Methane is still a horrible and damaging greenhouse gas and should have the same reductions imposed.	The sooner we change the better. Christchurch could be a leader in climate change action. I support an interim target to make sure we are on track but 2030 might not be soon enough.	Yes support interim target	
27522	Emma	Booth		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e.	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27518	Serena	Watkin		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include:	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27517	Davena	Watkin		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27516	Cassandra	Spearin	Victoria University of Wellington	No - I think you should do better and aim to meet the target by 2030. 2050 will guarantee our buy-in to a number of catastrophic climate feedback loops, it is in the best interest of every citizen and government department to reduce their greenhouse gases as much as possible, as quickly as possible.	Oh, yes. See above. More ambitious - save more lives and save what semblance of our current lifestyles we have. The longer we wait, the more we sacrifice. Methane should be considered in alignment with it's environmental impacts as assessed by the scientific community - more warming potential but also less environmentally persistent. It should be treated as per scientific recommendations, and methane producers (ie. Canterbury farmers) should be given opportunities to change tactics/retrain/ whatever else, as long as emissions are drastically reduced.	Yes support interim target	Please hurry. Our children are depending on you.
27515	Sacha	Healey		We should AT LEAST align with this, but we desperately need to go further faster. Why? The science is overwhelming.	2030 latest.	Yes support interim target	Here are some ideas - encouraging Canterbury dairy industry to convert to hemp. The land and rainfall are much better suited to hemp, the hemp plant absorbs 4x the carbon of forestry, we can simultaneously reduce Canterbury's methane production and also water and fertiliser use and run-off. As hemp can be used for almost all man-made products including paper, plastic and fuel, it is a sustainable and growing industry that Canterbury would profit from transitioning to now. In terms of reforestation, a massive project reforesting the Port Hills with natives would help clear sediment from Lyttelton Harbour, and could create a fantastic and unique tourist attraction by increasing native biodiversity. This is the tourism of today and the future.

27508	Catherine	Elliot	Lincoln University	Yes, but Christchurch could probably be more progressive than that and reach those targets sooner given our flat topography and Copenhagen conditions for cycling. Actually making bigger adaptations now is key to reaching aims sooner, say by 2040. The carrot needs to be bigger than the stick if the aim is for reaching population change. Mobility is a right, not a privileged so buses should be a free social service and to achieve that, perhaps CCC should control the busses, not ECAN. NZ has the highest car ownership rates in the world. There is no need for most people to own a car if we can manage to reduce the distances to reach important destinations and we can incentivise green modes.	Yes. 2040.I would advise consulting with scientists in this area for determining more ambitious targets. Yes we need to actually use the methane from landfills to be functional insofar as heating pools. The most recent science I could find uses modeling to calculate what some of the changes could be given aims of shifting car trips to bike and walking trips: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0219316 (I have attached the publication for your review) Models which were analysed were for: (a) switching car trips â‰¤1km to walking (b) switching car trips â‰¤1km to walking and those 1-5km to cycling. Changes in vehicular emissions ranged from -5.6ktCO2e/year (UI -7.8 to -3.4) for 25% uptake of scenario (a) to -436ktCO2e/year (UI -607.2 toâ€“ 267.6) for 100% uptake of scenario (b); corresponding to up to 4% of emissions associated with road transport in New Zealand. It is important to consider that reductions in vehicular emissions are compensated by increases in dietary emissions from increased energy expenditure (and therefore assumed increases in food intake) due to increased walking and cycling; for scenario (a) this led to small but insignificant increases in overall emissions. Scenario (b) resulted in significant reductions in emissions, even after allowing for increased emissions from increased dietary intake.	Yes support interim target	Please make change NOW! As a species, humans will not survive the threat of the 6th mass extinction without big, bold change. It is important to remember that whatever changes we make will not be taken up by the entire population, so the bolder, the better. Offering free buses and increasing parking fees and petrol prices, and further extending the 30kph zone will make driving VERY unattractive. At this point, it is seemingly still affordable for most people. Please decentivise driving and incentivise buses, walking and biking with push/pull strategies. http://m.vega.works/wf/click?upn=MfaqEWbky5QIScHuaVakdf6NVtk2eYyMw-2FRZZ3czgoUFcRwjtumVj3sFcIaN2p-2BNBR7d6EeLL30wzTlbbE3aXoiJgDRr7gbF-2BH8oeEgOnmg-3D_ycw659XocAFTxAnEeVuEUphRSriSpfEPTaJyepDsHa1ayGT-2F8OtGUY5J5Vx9OqTpFDkMXtvUzfruBl8j6BdmWDITxNuRwdf8RIqwmL4C4XDShn4WHjTuezyIS45PIohYK4XunNmdK7RYqm5BjaoE3vi1AhuEGon74w7AvQaFmUAqDj7UzMPT5KMyF-2FOWHifjjVC7tDAA7bUuvO4temxVmKx554Luul0opQikSRfBSB4DkWXcs24qbUH9DkyaE6HnSaTDC-2FQBrQf-2Bc-2B-2BSKXBZ5ZXkmO9VIqWS-2BHfrj3MVwZClQ6cupmGBujj5Q3GvjsEPZ6fWb-2BrKE-2ByYWdUEux0HmGZOrpm2PRYM4OLM70jYGgaujot-2F-2BAbKwBSpI-2Bxl0AH3 **SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION**
27498	Zac	Fagg		yes, New Zealand used to be at the forefront of the green movement. its important to protect the earth that gives us so much. Not decimate it for the profit of a few.	we should be as ambitious as possible. last year would have been good, many coutrie around the world have acheived this, why not New Zealand? we are a small and fortunate country with all the capability, yet our representatives are more worried about profits, sadly we cant eat money. with the way the earth is going it should be top priority to protect it. greenhouse gas control is vital for the survival of all ecosytems. New Zealand had a time before cows, and will have a prosperous time after them. the land wasted on cows, creating methane, could be used in many other ways. ideally hemp and other regenerative farming methods.	Yes support interim target	New Zealand used to think outside the norm, first place women could vote, first place nuclear was banned. what happened to our forward thinking ideology???

27497	Antoine	Fitzgerald		Look. I dont know.and will probably never understand why nz doesn't take this more seriously. But I know, we all know how bad thing could get. Nz is a country small enough to make drastic changes to achieve a 100%green economy and future development. We are small enough of a country to get this done seriously by 2030... And set a standard for the rest of the world. Be that country that pioneered change faster than anyone.! Take charge and focus our sovereignty for the land and the people. We could write history and be that change!	I believe there should be a massive carbon tax implied on the industrial economy. This needs to be follows buy nationwide incentives by the government to initiate innovative solutions. And when government funded... it holds shares and get the benefits... get the smart dedicated citizens who wan to help to do the work for you! I also a massive focus on industrial hemp would hugely benefit our economy.	Yes support interim target	Industrial will is obviously the next big technological evolution.. get involved and support the local community making it happen! Its inevitable, so use it!
27496	Siana	Fitzjohn		The Christchurch City Council should definitely align with the proposed national target of net zero emissions by 2050. Climate change is humanity's biggest existential challenge, and while institutional action is coming far too late to avoid catastrophic effects of anthropogenic climate change, further inaction and paralysis would make a dire situation even worse. I support clear, legally binding targets and encourage a more ambitious approach, ie. net zero across all gases by 2050.	Yes. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. The research has been done on the natural limits that we're approaching (or have already surpassed). I do not have the expertise to inform you of how methane should be considered or budgeted; however in the middle of a climate emergency the release of any greenhouse gases are a threat to humanity, and they should be treated as such.	Yes support interim target	While we discuss carbon budgets and crunch numbers it's easy to forget that climate change will lead people to lose their loved ones. Those deep, core, human values should be granted more space in this discussion so that we appreciate how how the stakes are.
27495	Joel	Lawry		No, because we should be leading the charge by committing to a net zero by 2030.	Yes, 2030, ban dairying in canterbury.	Yes support interim target	
27494	Nicholas	Lealand		Yes I agree the CCC should at least meet the proposed target of net zero by 2050. Methane and Nitirus Oxide also need to included in this total as they are substantially more potent greenhouse gases. I think a weighted accounting system should be implemented focusing on the warming effect rather than less relevant factors.	In reality I think the proposed 2050 target is vastly inadequate. I think Christchurch should be striving too substantially beat this target. If we through some miracle got world wide net zero for human co2 emissions tomorrow we would still have substantial increase in the temperature. This is due to run away effects such as melting of ice which keeps temperature down by reflecting sunlight, releasing of methane trapped in permafrost, desertification. If we want to keep the impact (and cost) of climate change to a minimum we need to act both ambitiously and creatively. This change can be perceived as an economic cost certainly, but it can also be regarded as an investment. Early adopting new technology puts us in a powerful position to sell this technology once the market catches up with the need. I would urge you to set a target of net zero 2035. It will require a substantial change in the systems but I think this is very much possible. Particularly with how suitable chch is to cycling. With a backbone of covered cycle-ways, wind farms, solar integration with Canterbury	Yes support interim target	The writing is on the wall, we can embrace it or we can bury our heads. Do we want to be remembered as the country that moved  first and led the world or as the country that was left behind. Yes it will be hard, but it can also be something we are proud of.

					farming practices, EV incentives and with direct carbon capture to produce the fuel needed to run the fleet of legacy vehicles I think this is quite possible. It will also place us at the cutting edge of these technologies so we can then export this skill base world wide to capitalize on this investment.		
27491	Andrew	Snook		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches.	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus I hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. I support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. I feel the council should mirror this with their own targets for the district. We find ourselves in the end of our available window of opportunity for action on climate change. Now, we need leaders and ambition. We can't afford to wait for others to act first anymore, we need to take our opportunity for action now.

				The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27487	Arthur	McGregor		I think we should be more ambitious, but we should definitely not do less that aim to meet the national target!	Yes, I think we should be more ambitious! I think it is totally achievable for us to be net zero across all emissions, including methane, considering that our relative methane emissions are less. I also think we should be aiming to bring forward the target for new zero emissions to at least 2040 if not 2030. As a city, I think it is a win-win to bring forward the targets. Not only do we become a leader in emission reductions with the opportunity to develop new technology but we gain a healthy living environment and a robust future-focused economy. It is absolutely essential that we do our part to reduce our emissions and I really want to see Christchurch leading the charge.	Yes support interim target	We definitely need to set an interim target to ensure that we are on track to meeting our goals.
27481	Alan	Callery			It should be 2030 at the latest. 2050 is nowhere near ambitious enough considering the recent UN report that says we need to reach net zero by 2030 to prevent catastrophic climate change. Currently, we are on track for a 6 degree Celsius global temperature increase. If we reach net zero by 2030 we can reduce that to a 2 degree temperature increase.	Yes support interim target	This is an opportunity for our community to demand ambitious targets, to demand money be spent on incentivising public transport, creating car free days, improving building standards, increasing energy efficiency, educating our neighbours, re-planting native forest, improving recycling facilities in the city anything and everything that will reduce our greenhouse gas emissions and make Christchurch a global example of a sustainable city.
27472	Joss	Doggett		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.	reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.		
27471	Thanh	Ho		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.	peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.		

27470	Patricia	Mackenzie		Yes - NZ has an image of being "pure" but yet we're not taking climate change seriously enough. I think we have some serious buy-in from many, including the farming community. The science shows that the world is not being aggressive enough. Our small population gives us a great opportunity to make some huge changes and be a real example for the world. I don't think this plan is aggressive enough - but it's a start. Chch could do even more which will inspire other cities to jump onboard too.	Yes - Chch should do it by 2040 at the latest. We're a small city and we have a population that will get onboard. It's a small example, but the plastic bag ban was a breeze! We should create a plan for ag, but focus on waste first since ag is more impactful on NZ's overall livelihoods. I'm not an expert, but I've heard that in South Korea, they trap gases from their landfills and convert it into energy which powers their bus system. Might be an option for Chch? There are other ways we can take it up a notch as well. This could be a huge opportunity to put Chch on the map. The earthquake has given us a chance to rebuild, but we aren't thinking BIG enough. Chch is the entry point to many of NZ's most beautiful places. To me, that means we have an amazing opportunity to catch tourists interest by being a 100% renewable city with a huge focus on our "garden city" image. More gardens, more outdoor activities, more areas to play outside, bike lanes and bikes for hire, zero emissions public transport, use of the "sharable city" model, and more. Going green is more than the zero greenhouse gas emissions, it's a mindset change. This could change the game and help Chch connect back to a "community" feel that truly cares about the impact they have on the world around them. Chch could definitely lead the way in this and put ourselves on the map as an amazing place to live, work, and visit!	Yes support interim target	
27466	Sophia	White		I think the council should be more ambitious that the national target. This council has declared a climate change emergency, I would like to see some strong leadership to back up the urgency of this issue.	Yes, I think the council should take a more ambitious approach. In line with the latest IPCC report the year the net zero greenhouse gas emissions target should be set for 2030 latest. Methane is potent greenhouse gas and it should be included with this target. I would like to see a net zero anthropogenic greenhouse gas emission target.	Yes support interim target	I would like to see community boards taking leadership on climate change but they need strong leadership from the council. I think the council is making a start but there is a lot of untapped potential with collaborating with the talented and passionate communities that are working on these issues across the city. Recently I attended a climate change training course in Brisbane during their first climate week. I would like to see our council run a climate week, especially as you have declared a climate change emergency. I would also like to see plans regarding the climate change emergency and how we as a city are to respond. Interim and early action should be part of the climate change emergency response plan.
27462	Adele	Potter		No it is too slow	Yes a much more ambitious target - net zero by 2030 - all agricultural emissions need to be included	Yes support interim target	Reduce by 50% 2025

27461	Ants	Field		No - this is FAR TOO SLOW !!!!!!!!	Yes, we should definitely take a more ambitious approach. We must reduce our emissions as fast as possible. I propose that we should be net zero by 2030. Yes, we must include methane as it is a powerful greenhouse gas. It too should be net zero by 2030.	Yes support interim target	I am proud of the actions that CCC has already taken. It is great to live in a city that has an expanding cycling infrastructure, an electric car hire system and many other wonderful initiatives. Great work has been done and there is lots more to do :)
27457	Ezra	Holder		To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this undermines its long-term certainty. However, the ability to revise the 2050 target in light of	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. I feel the council should mirror this with their own targets for the district.

				major changes in scientific understanding or international agreements should be permitted.			
27455	Madeline	Smith		I believe the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To slow the onset of global warming as well as meeting the Paris Agreement goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global ‘peak warming’ approaches. The 2050 target should not be altered in	Yes. We know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. Yes, I believe that methane should absolutely be at the forefront of all your decision making. 48.1% of New Zealand's emissions come from agriculture, and methane is the largest contributor to New Zealand's national inventory of total GHG emissions, contributing to over a third. Per capita, New Zealand has the largest methane emission rate (0.6 t per person per year) â€” six times the global average. Methane contributes to 45% of warming attributed to human-induced climate change. New Zealand needs to support farmers and agriculturalists in the transition towards alternative farming methods that are less intensive on our lands and resources, all the while producing a lesser quantity of greenhouse gases. To do this we need a government that will support this transition through subsidisation and incentivisation as it sees acceptable. Specifically, in the Canterbury region - Lake Ellesmere is the most nutrient polluted lake in all of NZ, caused by the runoffs from animal agriculture across the entire Canterbury Plain, also from local septic tanks. It is clear in this instance that nitrates must also be monitored and regulated as an emission, for example.	No do not support interim target	New Zealand has a brief opportunity to be at the forefront of climate change mitigation and adaptation, due to our unique agrarian society. The land is our most critical resource - EVERY aspect of life revolves around the earth, the ground below our feet that grows and nourishes the most basic requirements of existence. Our land - NZ's land - has been poisoned, abused and neglected for years now, primarily due to the ignorance of our predecessors. If we do not take swift action, the quality of the soil will reflect in the health of the citizens that inhabit it, in a more visible and aggressive manner. Because it's 2019, and we all know better than that. **SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION.**

				response to ‘economic changes’ as this undermines its long-term certainty.			
27454	Beaulah	Pragg		Yes, Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. We need to do everything in our power to ensure a just transition for those impacted by our emissions reductions, while standing firm in the need to act quickly. To protect ourselves and future generations from the major disruptions of climate change, we need net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global ‘peak warming’ approaches. The 2050 target should not be altered in response to ‘economic changes’ as this undermines its long-term certainty. However,	Yes. We have a small window of time to reduce emissions and to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high. It is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. I feel the council should mirror this with their own targets for the district. As a parent with a young child, I am aware of the fragility of my daughter's future. I will support the council in these efforts and actively encourage those around me to do the same.

				the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27453	Katia	De Lu		At a minimum, I think the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I ask that the council take rapid and ambitious action on reducing emissions so that we can ensure a just and decent future for ourselves and the generations that follow us. As a teaching assistant, I spend my days helping young people learn and grow. I hear about their hopes and dreams for the future, and it breaks my heart to know that they may never have a chance to pursue those dreams, because their future is threatened by climate catastrophe. I understand that change is hard. But I am concerned that too many of our leaders seem to be willing to sacrifice my students' futures because it feels too hard and they'd rather procrastinate and hope that technology saves us later on. When my students decide something is too hard and procrastinate, they suffer the consequences in bad marks. The great injustice of climate change is that when we decide that climate action is too hard, it is future generations - like my students - who will suffer the consequences of our negligence. However, reading the submission documentation for the CCC emissions target gives me hope, because it sounds like the CCC is prepared to step up and show genuine leadership in reducing emissions â€“ acting as role models to take the rapid and ambitious action that everyone must take if we are to prevent the worst effects of climate change. I urge you to live up to those words and show the climate leadership that we so desperately need. Specifically, I ask that the council: • Aim for net zero across all gases by 2050, consistent with meeting the Paris goals.	Yes. We only have a small window of time to reduce emissions if we are to prevent complete climate catastrophe. I appreciate that the council recognises that New Zealand's per capita emissions are unacceptably high. As high emitters with high living standards, it is our responsibility to be as bold and ambitious as possible. We owe it to those in less fortunate parts of the world to show leadership and take responsibility for the damage our lifestyles have caused by making significant and rapid cuts to our emissions. I suggest that the CCC district be: • Net zero all gases by 2050 • Net zero long-lived gases by 2040 at the latest • Net negative long-lived gases by 2050	Yes support interim target	It is particularly important that we make significant reductions in the short to medium term so that we can prevent the worst effects of climate change. We cannot afford to procrastinate. I support interim targets across the district to encourage immediate emissions reductions by business, community, investors, and government. I support the council's suggested interim target to reduce greenhouse gas emissions by 50% district-wide by 2030, in alignment with the IPCC's recommendations. The Government has proposed that three emissions budgets of five years each be in place at any given time. The council should mirror this approach with their own targets for our district. The IPCC tells us that there is still hope, but only if we act now - urgently and ambitiously. We must all pitch in and do our part, and I ask the CCC to show leadership and do the right thing. Please make me proud to be a resident of the CCC district by setting targets for rapid and ambitious emissions reductions. Thank you.

				• Aim for net zero long-lived gases as soon as possible. 2040 is achievable. • Aim for negative long-lived gases by 2050. • Reduce short-lived gases to stable levels, that is, the point at which there is no contribution to global heating. • Commit to clear, legally binding targets, including a 2050 target and emission budgets. • Providing certainty to businesses, investors, and communities around targets is important. For this reason, the targets should not be altered in response to 'economic changes', since this would undermine certainty. However, it is reasonable to change a target or budget in situations such as: • A significant change in scientific knowledge • A significant change in international law • An extreme natural disaster in the district • Increasing the ambition of our targets			

27452	Matthew	Baird		Yes, I believe the CCC should align with the proposed national target at a minimum. I urge the council to make changes that address this issue quickly and as fairly as possible, while keeping awareness that inaction would be unfair to many. I'm pleased that the council appears to be taking this as seriously as is required for us all to have a sustainable future. To be effective, the council must have clear, legally binding targets so that businesses and communities have certainty about what is expected. Specifically, I ask: - aim for net zero across all gasses by 2050 (required for the Paris targets) - aim for net zero long lived gasses as soon as possible (i.e. 2040) - aim for negative long lived gasses by 2050 - reduce short lived gasses to stable levels There may also be cases where the targets should change: - significant changes in scientific knowledge - significant changes in international law (e.g. Paris agreement expands) - the district is subject to an extreme natural disaster - escalating our ambition on short lived gasses as 'peak warming' approaches	Yes, as above I urge the council to be more ambitious than the national targets. The time we have to act is shrinking smaller and smaller. NZ's per capita emissions are uncomfortably high, and I am glad to see the council recognise this. We therefore have a responsibility as high emitters to be as bold and ambitious as possible. I suggest we aim for: - net zero all gasses by 2050 - net zero long lived gasses by 2040 - net negative long lived gasses by 2050 Overall, it is important to focus on reducing emissions as quickly as possible to minimise their effects on our future.	Yes support interim target	I support interim targets as a means to encourage early emission reductions by businesses and communities. I support the council following the IPCC suggested target of 50% reduction by 2030. The council should have 5 year emission budgets to align with the government proposal.
27451	Josiah	Morgan		We should absolutely align with the proposed national target, if not even sooner. By getting ahead of the proposal, the work ahead will involve an easier transition period rather than a rushed period closer to 2050. Emissions are a huge worry.	We should be more ambitious. I do not know enough about the science to offer a genuine preferred date. I have heard some suggest 2040.	Yes support interim target	

27447	John	Lieswyn		This would be the minimum, however I believe that the target should be open to revision as more scientific evidence arises.	I believe that a net negative approach is likely to be required much sooner, and that rather than being viewed as a tax or drag on the economy it should be viewed as an opportunity to improve the way we do things and stimulate new sectors/products/services.	Yes support interim target	I support Council's interim targets, and Council should look at the Government's three emission budgets over five years each as a model.
27445	Matt	Hanson		I think we should aim to exceed the national target and also to include methane within this target	Yes we should take as ambitious of an aproach as possible I do not have the ability to set a date but we should take drastic action in line with the declared climate change emergency. We should consider methane as a greenhouse gas and aim for net zero emissions well before 2050. The only reason to handle methane differently is the challenges in modifying the agricultural sector; however the bulk of the cities emissions do not come from this sector and targeting the methane losses from the waste streams (e.g. landfill gas) is essential and possible with current technology	Yes support interim target	
27437	Nick	Reid		I believe that the Christchurch City Council should align with the national target of net zero greenhouse gas emissions by 2050. Kiaora, my name is Nick Reid and I am a member of Generation Zero. We must play our part as people of Christchurch in the greater bid to end global warning and hinder climate change. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading.	Yes, as we only have a small window of time to reduce emissions if we are to stop climate change. Aotearoa has uncomfortably high emissions per capita, so therefore as a city and a council we very much need to play our part. We need policy to tell industry and households alike that climate change	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. I think a reasonable target is to reduce carbon emissions by 2030 by 50%. The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. I, and Generation Zero feel the council should mirror this with their own targets for the district.
27435	Rose	Bayldon		The Council should absolutely align to the goal of net zero greenhouse gas emissions by 2050. I think it is doable for us to reach net zero long-lived greenhouses gases earlier, with a target of 2050 for all other gases. It is imperative that the council sticks to these targets and does not make alterations in response to economic changes. The only circumstance that this may be changed is in light of new scientific understanding. I am hopeful that the council will stick tho this and act quickly so that we have a fair and equitable future for all. We know that climate change will affect those in poverty the most, so acting now is an important step for creating a just society.	Yes, to stop a snowball effect, I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. It is more important to reduce the long-lived gases first, and then we can focus our energies on short lived gases. As methane is considered a short-lived gas, this gives New Zealand a little more wiggle room as a large portion of our emissions come in the form of methane from the agriculture sector. However, this does not mean that we can ignore methane, targets must be brought in soon so that we can meet goals by 2050.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. To help business owners who may struggle with achieving these goals an interim goal is a good step. I support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 . The Government proposes that three emissions budgets of five years each be in place at any given time. I feel the council should mirror this with their own targets for the district.

				This goal is good as it aligns with the Paris agreement.			
27432	Regan	Stokes		I feel the Christchurch City Council should align with the proposed national target of net zero greenhouse gas emissions by 2050. I am trusting the council to address this issue quickly so the transition may be just, while keeping an awareness that without sufficient, and sufficiently fast, action the future of Christchurch will be an unjust one. To stop global warming and meet the Paris goals, the most ambitious approach is net zero across all gases by 2050, based on a policy framework which achieves (a) net zero long-lived as soon as possible (2040 is achievable); (b) negative long-lived by 2050; and (c) reduces short-lived gases to stable levels (the point at which there is no contribution to global warming). This will balance out to achieve net zero across total gases. I support the Council having clear, legally-binding targets (2050 target combined with emission budgets) as this will provide certainty for businesses, investors and communities on the direction we are heading. The ability for each entity to create its own policy plan to meet these targets provides flexibility to respond to unexpected circumstances, new technology and so on. Certainty is important and there may be situations where it is appropriate to change a target or budget. These situations include: A significant change in scientific knowledge. A significant change in international law (i.e. the Paris Agreement collapses, or the ambition of the Agreement increases). The district is subject to an extreme natural disaster. Escalating our ambition on short-lived gases as global 'peak warming' approaches. The 2050 target should not be altered in response to 'economic changes' as this	Yes, we know we have only a small window of time to reduce emissions if we are to stop runaway climate change. I appreciate that the council recognises that NZ per capita emissions are uncomfortably high, thus we hope the council recognises that it is our responsibility as high emitters with high living standards to be as bold and as ambitious as possible. I suggest the CCC district be net zero long-lived by 2040 and net negative long-lived by 2050. Long-lived reductions must happen now. We must achieve net zero/negative long-lived as soon as possible. This is the most important objective in the short/medium term. Short-lived reductions must also happen now. But once stabilised, further reductions are only impactful from the moment of peak warming onwards. In the short/medium term, aiming to achieve a climate change target by reducing short-lived gases instead of long-lived gases will actually cause more warming overall. Until we approach peak warming, there is no substitute for long-lived reductions.	Yes support interim target	I support interim targets across the district as a means to encourage immediate emissions reductions by business, community, investors and government. We support the councils suggested interim target which aligns with the suggestions by the IPCC to reduce greenhouse gas emissions by 50% district-wide by 2030 (from the 2016/17 baseline levels). The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. We feel the council should mirror this with their own targets for the district.

				undermines its long-term certainty. However, the ability to revise the 2050 target in light of major changes in scientific understanding or international agreements should be permitted.			
27430	Thomas	Young		No, the target dates are not soon enough	Yes, 2025 net zero, with less reliance on offsets	Yes support interim target	
27427	Finnley	Ross		Yes. A city on the steps of the alps with such a large outdoor community is completely effected by a changing climate negatively in many ways.	2025 Net Zero. IPCC the best scientists in the world say we have 12 years to reach net zero, Christchurch should lead the world and achieve this sooner so others follow suit. Methane is a climate change causing gas that is emitted as a result of human consumption it is the same as any others in this regard and should be treated as such. The NZ government and agricultural sector is proud to have no subsidies for agriculture so why should we effectively subsidise now by not including methane.	Yes support interim target	
27423	Susan	Krumdieck	University of Canterbury, Advanced Energy and Material Systems Lab	Yes. It is a bare minimum as far as a target goes.	Yes, but targets don't matter much. The science is already clear, so focus on HOW	Yes support interim target	But I don't really care about targets. I remember back in 2000 Christchurch officially adopting the Kyoto target. Well, that didn't go all that well. A game-changer is needed at this point. Time is up. The UC should be fully engaged with and pushed to the creative outer limits. Let's move beyond targets to HOW to transition. We have a world class engineering school in the city. Ride your bikes out to Ilam and talk to us about Transition Engineering! **SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION.**
27417	Celia	Sheerin		No I think we should adopt a closer target date and include methane in our target.	I would like to see a 2040 target for net zero emissions, including methane. Agricultural emissions account for a huge percentage of NZ's emissions so should not be excluded. If methane is to be treated differently in Chch I would like to see a tighter target than proposed nationally under the Zero Carbon Bill.	Yes support interim target	An interim target (of 2030 if we aim for net zero by 2040) is essential. There should also be annual targets so it is easier to track our progress as a city and inform decision-making. Businesses, schools, households and community groups should be supported with tools to monitor their emissions.
27409	Jacqui	Barnes		No	2030. It is in line with IPCC 1.5 Special Report but recognising that IPCC is extremely conservative and understates the extent of the crisis. We, therefore, need to move quicker than the report suggests. Methane should join CO2 in getting down to net zero as it is more powerful and although it breaks down quicker, it breaks down to CO2	Yes support interim target	

27398	Graham	Townsend		As a bare minimum, yes	Yes - we certainly should try to do so. If we want to avoid dangerous global heating we should aim to be net zero by 2030. arguments that local actions are trivial on the global scale miss the point entirely. We need to show leadership and thus encourage others to follow suit.	Yes support interim target	This is an unprecedented crisis. Business as usual is over. Mitigation will be painful and costly, but essential. We either act, or we watch the economy collapse. http://www.scientificamerican.com/article/climate-science-predictions-prove-too-conservative/ http://advances.sciencemag.org/content/3/1/e1601207 https://www.sciencemag.org/news/2018/11/nations-falling-short-emissions-cuts-set-paris-climate-pact-analysis-finds?utm_campaign=news_weekly_2018-11-30&et_rid=314262142&et_cid=2520633 https://www.pnas.org/content/115/33/8252 https://www.nap.edu/read/18373/chapter/1#xiii https://eos.org/articles/latest-climate-model-points-to-hotter-earth?fbclid=IwAR01yuTg7bGP929IalF1wrEG16t8vJjpJAO8iMpmhd4Q0XLuhcynlwltBBU https://www.bbc.com/news/world-47965284
27392	Nick	Lovett				Yes support interim target	
27383	Tanya	Didham		The government target is at the same time inadequate and unattainable, with the current mind-set anyway. In particular methane gas, while not a big issue in the city, is a huge issue nationally, and should most certainly not be treated with kid gloves. The land and water being used (and abused) by industrial dairy in Canterbury especially, could have far greater value in food production for example, with far less environmental harm. In NZ, any serious emissions target must include methane. Council declared a climate emergency, and it really is - in terms of having enough time to do things differently. Recent research is pointing to a window as small as 18 months to make significant reductions in GHGs. We need to think big. Big perspective and big changes.	Yes, our approach should be ambitious - it must be. If we halve emissions by 2030, we should be able to halve them again by 2035, and be at zero by 2040. In Christchurch City it is chiefly about transport. Nationally we need to put agriculture at the top of the list, but in either case, methane, as a very potent GHG, must be considered in the same way as CO2.	Yes support interim target	An interim target of 50% GHG reduction by 2030 will get us and keep us on the right track. It is a big but reachable goal if we properly tackle transport, agriculture and refuse over the next ten years.
27381	Keri	Hodgman		Yes. We all have an obligation to make the necessary changes to mitigate the impacts of climate change	Yes, we should because I question whether we'll even meet 2050. We should target 2035 as a moderate, pragmatic finalising point.	Yes support interim target	

27376	Karen	Whitla		No time is running out	Yes 2030 to achieve 3/4 and 2035 zero. We haven't got time to play numbers anymore	Yes support interim target	Intern target 3/4 by 2030. I am not going to speak because I have nothing to say other than don't act and we all die of famine, plague, and fire. And I'm not religious
27343	Kerry	Driscoll		As a minimum.	I would like to see a more ambitious approach. Taking up of cleaner transport options, such as electric vehicles, needs to be supported by a reduction in the cost of purchase. Could the Government consider incentives? The retirement of cars that are polluters should be encouraged. Also, we have a lot of land that could be used to plant trees. I am sure the public would be keen to assist. New subdivisions need to be planned around green spaces. Could the RedZone be planted in trees? The use of existing railway lines to carry people from Rolleston and Rangiora? This would also ease congestion.	Yes support interim target	We don't have time to waste.
27327	Matt	Jackson		This should be the bare minimum that is committed to, but in reality it is not nearly a strong enough target for the city, the country or the world. There seems to be general scientific consensus that unless immediate action is taken to drastically reduce emissions over the next 12 years (or sooner) then the 1.5 degree target of the Paris Agreement will not be achieved leading to runaway temperature increases.	Yes as a city we should be leading the way. Net zero emissions by 2030 is in line with the scientific basis for how to limit the effects of climate change to a manageable level. Christchurch is extremely vulnerable to the effects of climate change - sea level rise and coastal erosion in particular but also drought and more intense rainfall. If we do not take action we are responsible for the end product which will mean certain areas of the city will become uninhabitable and vast amounts of money will be required to be reactively spent to 'fix' these problems. Methane should definitely be included - it is far more potent a greenhouse gas in the short term and the short term is where we need to start to limit emissions and prevent catastrophic climate change.	No do not support interim target	Eliminating greenhouse gas emissions needs to be at the heart of every decision that Council makes from now on, otherwise we are condemning future generations to a terrible outlook. We cannot continue to make blithe statements about climate emergencies whilst continuing to bicker amongst ourselves about losing on street car parking in order to facilitate sustainable transport options. Every council capital project should be looking at maximising where trees can be planted - to absorb emissions, improve biodiversity and limit the impacts of climate change that are already guaranteed. How about reforesting all Council reserves in the Port Hills and Banks Peninsula starting today? We need to make big changes to the way we live and we can't keep pretending we can carry on as we have been whilst also becoming a zero emissions city, country and world.
27318	Hugo	Zanker		I believe it is imperative to meet the proposed national target and to exceed that or reach it early if at all possible. It is clear now that we will all need to change how we live in order to overcome this massive challenge and any policies and structures should have a climate change element from here on in.	We should be more ambitious. I would like to see zero greenhouse gas emissions by 2030. This is because there are now strong grounds to believe that 2050 will be far to late to reverse catastrophic climate change.	Yes support interim target	Transport is the biggest greenhouse gas emitter. We must prioritise sustainable transport such as buses, trains and cycling. We can't drive cars for personal use as much any more.

27315	Neil	Thomas		No, I think the target set by the CCC should be more ambitious	Yes, net zero emissions should be targeted by 2030 to have a realistic chance of meeting the international target of restricting warming to less than 2 degrees. We should consider methane in more detail than is currently the case. A local emissions trading scheme for methane should be considered to help nudge the agricultural sector in the right direction. The city should also consider a car free city centre, at least on some days of the week to help encourage people to cycle rather than drive and change attitudes to use of private cars for short journeys within the city.	Yes support interim target	
27303	Vanya	Howel		Yes	Yes	Yes support interim target	
27273	Emily	Toase		Absolutely. Climate change is a huge threat to the economy and communities in NZ and all the cities in NZ need to be working together towards the same targets if we are going to be able to mitigate this threat. NZ is known for its stunning environment, clean air and beautiful scenery and rightly or wrongly, it's assumed that we are leading the way in sustainable living. Christchurch should align with all the other districts in NZ and all work together to ensure that NZ is doing the best we can in reducing our emissions.	Yes. Zero emissions by 2030. We are already seeing the impact of climate change now, so we need to make significant changes if we have a chance of slowing down climate change before its too late. We have a unique opportunity to re-build the city with contemporary design, technology and practices in environmental sustainability. We should take the opportunity to design & build a world leading innovative city which sets the standard for not only NZ, but the world. We should also be working to reduce methane to zero within the same time frame as although it doesn't last as long in the atmosphere, it has 4 times the climate change potential and we need to slow down the changes now. The accumulative effect with carbon within the next 10 years will be damaging enough, not to also aim to reduce it to the zero would be a mistake. Plus, zero emissions will take a change in mindset for a lot of people, in changing their lifestyles to help Chch meet the targets. So it makes sense to make the shift in people's lifestyles all at the same time, rather than confuse people in reducing some emissions but not others, and having to introduce different measures at different times. It also creates the impression that methane is not as significant if we are not as focused on that as carbon, which again, may just cause confusion when trying to communicate changes in practices, services etc.	Yes support interim target	- Keep supporting community gardens, food sharing/swap and edible parks - Advocate for supermarkets on how to reduce their waste. Tonnes of food go to waste each week because of industry legislation on health & hygiene & expiry dates. Can you help super

27228	Paul	O'Connor		Yes, We as a country make up a minute part of the world emissions, and as a result we must protect our economy and infrastructure, by not imposing draconian limits on ourselves. As an insignificant emitter, we need to ensure that we are not sacrificing our economic growth just to feel good. Our contribution will not be recognised by any other country in the world, apart from the green zealots, who constantly spread alarmist misinformation.	No, The targets set are currently over ambitious.	No do not support interim target	All stated above, a recent German study showed that we need to be careful that in the production of Electric Car batteries, more carbon was produced than that emitted by a Mercedes diesel vehicle.
27205	David	Patterson		We can do better. Be bold, be ambitious. We can do this!	Interim targets every 2 years. Net zero target by 2030. We don't have the luxury of waiting for gradual improvements. We HAVE to act now. We need bold leadership and bold decisive action. This is a planetary emergency. Methane is 30 times more potent as a heat-trapping gas, it must be considered with that level of weighting.	Yes support interim target	

27164	Mack	Mack	Sky Dragon Slayers Inc.	NO	NO	No do not support interim target	The Christchurch City Council is well behind the 8 ball. "Climate Change" is a load of bollocks.... the biggest scientific hoax, mistake, scam, in human history... start here... https://thestandard.org.nz/farrar-peddles-climate-change-denial-nonsense/#comment-1520473 Further down in that thread, this comment clarifies the LACK of any "greenhouse effect" in Earth's atmosphere... https://thestandard.org.nz/farrar-peddles-climate-change-denial-nonsense/#comment-1521081 And in this thread, discover that adding more CO2 to the atmosphere, actually has a very slight COOLING effect.. https://thestandard.org.nz/we-need-to-push-back-on-leighton-smith/#comment-1523235 If you happen to follow out my links, don't overlook this comment.... http://www.drroyspencer.com/2013/05/time-for-the-slayers-to-put-up-or-shut-up/#comment-78670 So.... we can all breathe a lot easier now... so this is extremely good news for our children and grandchildren. You people can either see the truth I'm telling you now, or believe in the "climate scientists", who universally say, that without a "greenhouse effect" in the atmosphere, the Earth's average global temperature would be -18 deg C In other words, these brainwashed morons are trying to tell you the ATMOSPHERE is preventing OCEANS from being totally FROZEN SOLID. https://www.climateconversation.org.nz/2019/07/climate-coalition-conversations/#comment-1565266 Hope you can cope with all this. Mack. Sky Dragon Slayer's Chief Public Relations Officer.
27153	Liam	Allan		No, I think we should aim to reduce gas emissions well before 2050.	We (the world) should aim for net zero by 2030, if not earlier, in order to reduce global temperature increases by only 2 degrees as opposed to the 6 degrees that we are currently heading for. Methane as a greenhouse gas is far worse than carbon dioxide comparing molecules to molecules, and we as a country are a great emitter of methane through our larger exports. Methane should therefore certainly be considered, if not at the forefront of our greenhouse gas reduction commitments as a city and a country. The goals need to be achievable, but also need to consider	Yes support interim target	

					the long-term effects of prolonging action (sea level rise, increased flooding and therefore the requirement for better stormwater infrastructure, loss of habitat for native species, quality of life for future generations).		
27152	Kate	Parkinson		This is a weak target. It's nowhere near ambitious enough considering the recent UN report that says we need to reach net zero by 2030 to prevent catastrophic climate change. Currently, we are on track for a 6 degree Celsius global temperature increase.	If we reach net zero by 2030 we can reduce that to a 2 degree temperature increase. Our climate will change, we have to act now to prevent the worst of it!	Yes support interim target	
27148	Oliver	Hunt		No, we should be more ambitious.	Yes, 2030. Methane should be considered as the powerful greenhouse gas that it is. To treat it otherwise and achieve net zero GHG emissions would be fooling ourselves.	Yes support interim target	
27120	Georgina	St. John-Ives		I think we should set an earlier target of net zero greenhouse gas emissions because this time frame is not realistic enough in term of protecting our ability to survive well on earth. Our negative contributions to date towards global warming and climate change will continue to affect future generations, so the earlier we cut emission levels, the better the chance there is for life on this planet to continue. A do or die situation requires fast and drastic action. The change of lifestyle, where we live in accordance to the planet's needs, is most exciting.	Yes net zero greenhouse gas emissions target be set and methane emissions should take more ambitious approach. The net zero greenhouse gas emissions (including methane emissions) target should be set for as early as possible, be it your proposal of 2040 or even earlier, say 2030? (the earliest date you could set based on environmental scientific expert advise- go with that!), because all life being able to survive, through being sustained by environmental well-being, comes before anything else. We are at serious life threatening risk of survival, so we need to act as fast as possible.	Yes support interim target	
27097	Andy	Holder-Lunn		Yes of course. So the planet has a chance of sustaining future generations	Yes. 2030 would be awesome	Yes support interim target	
27082	Edward	Cromwell		I think a more ambitious approach is required.	Yes a more ambitious approach should be taken. Net zero greenhouse gas emissions should be set for 2030 as it is critical that we limit the temperature rise to a maximum of 2 degrees. 2050 is allowing a potential rise of 6 degrees which would have potentially devastating effects. Methane should be considered as it is such a powerful greenhouse gas, regardless of industries it needs to be take into account.	Yes support interim target	

26952	amy	henry		No, I think Christchurch should lead the fight against climate change and develop our own targets as a community. We have shown that we can work together as a community in times of need and in times of trauma. As a city, I think we can and should be more ambitious.	Yes, we should also aim to reduce methane. Within five years.	Yes support interim target	We have the opportunity to lead and build on the community momentum and legacy of the earthquakes. Let us make the canterbury plains, less plain and plant forests let us reinvigorate the banks peninsula and replant the forests that were. We have the opportunity to continue to develop cycleways and should look into light rail to reach wider Canterbury to reduce congestion and carbon emissions.
26940	Cait	Gregory		No. Aligning with the national target of 2050 means this is 31 years from now - I will almost be 60 years old. By this time, I may have children of my own who will be facing the issues surrounding climate change asking me why my generation did not act sooner.	I would encourage a more ambitious target for Christchurch to achieve zero greenhouse gas emissions - we have nothing to lose by being ambitious. If we set the target to at least 2040, I believe it will provide a sense of urgency for the community to make a change. If we could set an example and prove it can be done sooner, it's encouragement for other communities to do the same. People will be more willing to change knowing the 'deadline' is at least 21 years, rather than 31. New Zealanders strictly adapt a "she'll be right" attitude, why would they not think the same about a deadline 31 years away from now? I believe reducing methane should be included in the approach to acting on climate change - whether this be a community wide target which we can aim towards, or simply just more information around ways individuals can reduce their methane contributions. Despite methane being a 'short-lived' gas, it is still a dangerous contribution to our environment. Information is key. I am 27 years old and my friends/family are still learning about what waste goes into which color bin. These things can be so simply resolved through information pamphlets, TV advertisements, presentations. I applaud the Christchurch City app, however not many people know about this tool. Waste is just 9% of our greenhouse gas emissions, but there is so many simple ways we can improve on to reduce this.	Yes support interim target	
26919	Andrew	Mackenzie		Yes. The effort to make these reductions must be spread across all areas in order to make it easier to achieve the target. If it is left to only a few sectors/places to make the reductions then the goal becomes harder	I would like to see it happen earlier than 2050, but I don't really think it is possible to rally the populace of NZ that quickly. It's like turning a battleship. It takes time to build momentum	Yes support interim target	I think we should incorporate more passive/netzero requirements in our building codes in order to make newly built houses and buildings more efficient. We are going through a building boom right now and there is plenty of opportunity to roll something out that can make a difference in the future.

26914	Fredrick	Brown		Yes. Almost all the levers to achieve this are national / international in nature. Council and other local entities have very little ability to influence a different path so could only justify a very small deviation from National policy settings.	No. It would make the city less attractive because it would be less competitive for business operations and investment and more expensive for citizens.	Yes support interim target	I am a Christchurch citizen, currently on sabbatical in the UK.
26881	Rachel	Lockwood		No	Yes, I think we should have a sooner target for net zero, such as 2030	Yes support interim target	
26822	Gary	Freedman		We should be more ambitious. See below	Yes, we should adopt a more ambitious approach. Zero by 2030. We should certainly consider methane. It's a problem that appears to have been sidelined and is significant in New Zealand.	Yes support interim target	Transport seems to be a relatively easy way to tackle GHG emissions. There are technical solutions available now from EVs and we just need policy to encourage these low emission vehicles and to penalize the worst cars. The governments recent freebate announcement is a start, but its very soft compared to most countries. Also most European countries have a date by which combustion engine vehicles can't be purchased. It's 2025 in Norway, 2030 in most others. NZ urgently needs a target like this.
26810	Rosemary	Neave		No, I think we need to be more ambitious. We are not doing enough - all we seem to be do is counting our emissions, not reducing them.	Yes 2030 Yes Methane must be part of the mix	Yes support interim target	
26677	Liam	Speechlay		Yes, but go further. Climate Change is happening and we need to act now.	We should set a more ambitious approach. Net Zero by about 2030. Methane should be a part, however changing peoples transport modes to public transport should be Christchurch's main concern as it is our main polluter.	Yes support interim target	WE NEED TO GET PEOPLE OUT OF CARS AND IN TO BUSES OR TRAINS.
26653	Rhys	Boswell	CIAL	CIAL is fundamentally committed to taking meaningful action to reduce carbon emissions. We have committed to measuring, managing and reducing our organisations carbon footprint since 2007. We are a foundation member of the Climate Change Coalition and we are currently members of the Sustainable Business Council and the Sustainable Business Network. Carbon is one of the three focus areas of our Sustainability Strategy and an integral component of our broader Kaitiaki commitments. CIAL considers that the CCC should align with the proposed national target of net zero by 2050. It will be important for all cities and regions to work to align ambitions with national targets if NZ as a whole hopes to meet our UN commitments around climate change.	CIAL considers that it is important that CCC recognises the significance of the rural sector dominance of the surrounding jurisdictions. The Christchurch economy is inextricably linked to the broader success of all sectors of the Canterbury and wider South Island economy including the agricultural sector. CCC policies around methane should be developed with caution such that there are no unintended consequences for sectors / districts.	Yes support interim target	Policies and targets need to strike the difficult balance between needing to take meaningful action to help arrest the most harmful effects of predicted global warming, whilst not overburdening the ratepayers of Christchurch by creating onerous financial burdens or creating the wrong signals / incentives which might lead to public disengagement or outright opposition.

26645	Daniel	Leadbeater		We should be aligning with this target as a bear minimum. Why not set an more ambitious goal?	Yes, we should take a more ambitious approach. We should have a 10 year plan to make this change. Methane should not be treated any differently. Why do we need a separate carve out? The politics of the issue are separate from the science and it is the science we need to be following. The environment does not care how the emissions are produced, only that they are produced.	No do not support interim target	We are too late for interim targets. We need drastic action now.
26638	Jamee	Elder		Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen.	Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen	Yes support interim target	
26605	Ann	De Schutter		Definitely need to do at least that, if not more. I think we need to get methane gas lower than that sooner though, we need to be acting quicker with reducing our emissions, including methane gas.	Yes, as above, we need to be reducing our emissions from right now, can't we go to 0 emissions by 2030? That's still ages away! For methane I'd suggest using the goal for 2050 for 2030.	Yes support interim target	Only if it is ambitious enough and we are working towards more of a change later on.
26598	adele	geradts		Yes, we should align with the national target global warming /climate change is an urgent issue we all need to be managing better to prevent sea level raises negatively impacting life in Christchurch in the future.	I believe if a more ambitious approach can be taken we should definitely try to reduce emissions as quickly as possible without harmful impacts on the community and the economy. I do believe that the approach to reducing emissions may be too slow over to long a period but as more specialists in climate change and more data is available I would hope the council would adjust for the best outcomes for the city.	Yes support interim target	interim targets are good at keeping us on track to meeting the long term goal and if we can get to zero emissions early that would be better for everyone.
26555	-	-		Yes because our future is at stake.	2030 because that would be much more effective and helpful to the planet if we feel like we need to act faster.	Yes support interim target	Some ideas to help: Plant more trees, plant more flowers, ban the sale of cars that use petrol, advertise catalytic converters and electric cars, ban the importation of any cars that use petrol, make a law where all houses being built need to use renewable energy, only use electric buses, build a solar panel or windmill farm to power the entire city rather than using non renewable energy, Close the roads once a month, Put mini gardens on top of all bus stops like The Netherlands did
26529	John	Riminton		No. See comments below	We should set our zero emissions target, including methane, for 2040. It will enable those whose habits have already been formed to feel that they are doing their bit to help the world.	No do not support interim target	Without a wholly unlikely global clamp down on consumerism, including rejection of the concept of growth, it is almost certainly too late to prevent total economic collapse associated with climate changes. As examples, all international sport from motor racing to tennis, including the 2020 Olympics, should be banned, together with tourism and consumer advertising. This would cause great unemployment and the collapse of the present financial systems. it is safe to predict that this won't happen globally, so creating the environment for catastrophe by 2100.

26494	Braden	Chamberlain		Yes, but more ambitious. As a coastal city (with areas below sea level and/or prone to flooding), Christchurch is positioned to be affected by rising sea levels. As a city that prides itself on it's 'garden city' image, being clean and green is a non negotiable. In addition, the ongoing earthquake rebuild is a unique opportunity to embed net zero emissions in our infrastructure	Yes. 2040 would be an achievable target given the characteristics of the emissions within Christchurch. Aiming for net zero across all types of emissions would be achievable as well.	Yes support interim target	
26452	Stephanie	Poole		Absolutely, we need to tackle climate change head-on to ensure a future for our tamariki. Creating a sustainable future for our planet and our future generations is a necessity - not a choice.	ASAP.	Yes support interim target	
26439	Jack	Young		Yes, this overall goal is based on the best scientific targets available from the IPCC, and is the least we can commit to for our children and our future selves.	Yes, as long as there are practical steps planned to reach the goals. Perhaps 2040 or 2045? Care must be taken from bad examples such as Germany, where well-intentioned but poorly thought-through investment has failed to deliver the promised benefits and has caused negatives such as a huge rise in energy prices. A focus should be put on opportunities with multiple benefits - smarter re-zoning of city areas to encourage modern higher density neighborhoods, to help reduce energy and emissions from building heating, as well as transport (located close to good public transit, not out in Rolleston or other suburbia), and also offer some more affordable options for first homebuyers. These options could also reduce the cost of healthcare from existing cold damp housing (needs to be demolished, but with affordable new options available for tenants/owners). A push for modern public transit, as well as separated bike lanes, could reduce the road toll and associated costs. Huge wins!	Yes support interim target	Be smart, learn from other jurisdictions and countries' programs. Please don't focus on solar and wind, when more cost-effective options exist such as investments/subsidies for building and housing energy efficiency (see Living Building Challenge, or Net Zero buildings). Please don't be weak and avoid difficult decisions - your role is to make those hard decisions which individuals may not want to make due to their short-term focus. This is an opportunity to make Christchurch a much more livable city, with health benefits, a lower cost of living (energy and transport) and reduced local pollution.
26436	Alison	Allsop		Only if you can address the issue with Public Transport only being buses. We need rail considered and fast.	No, people are stressed enough and still getting through EQ issues as well as infrastructure repairs.	No do not support interim target	Please don't let the opportunity to seriously consider rail and be audacious in how you do that. It is not as expensive as previous reports have suggested (follow the money!) and it is insane that the main rail routes head into and out of the city to the areas people are living - North Canty in my part of town. With schools along the way!

26435	Skry	Adamson		No, because it states "net zero emissions of greenhouse gases by 2050, ***other than biogenic methane*** (then remaining at net zero for each subsequent year)" That's a very large percentage to avoid changing, not to mention it's methane - much more damaging than CO2. What we need is to get down to net zero, period - no exceptions, fine print and or clauses for businesses to get out of doing their bit for the environment. If we can't stop farming then we'll need to do something to offset farming and the current proposal ignores doing anything about biogenic methane.	Biogenic methane certainly needs to be sorted out. To target CO2 is to target the public and leave businesses and agriculture to continue to damage the environment without penalty. It leaves the rest of the public paying to clean up after their mess. To offset methane we could levy a tax on the businesses and agricultural sectors most responsible for biogenic methane and use 100% of that money to reforest the landscape. With the Port Hills fire we have an amazing opportunity to plant a natural reserve around a large swathe of Christchurch, which would itself become a tourist opportunity as it grew. We would be making money, doing the right thing and the taxed businesses could easily use it as a way to show they actually give a damn. As for the target year. I think that lets politicians and businesses off the hook. What we need are several staged years so people have to be monitored and (if they haven't achieved goals in that time) fined to help offset the damage they are still causing. Perhaps something like this, assuming we are at 100% CO2 levels now: 2025: Have local laws created and enacted to achieve the following targets. If these have not been achieved then we have a headless chicken as a Council and they can't save their own local area. It's election time every 3 years, so this gives candidates a term to get on the same page and a term to put plans into action. If 2 successive committees can't enact this plan, that will likely become an election issue. 2030: 10% reduction in CO2 2040: 40% reduction in CO2 2045: 70% reduction 2050: 0% net carbon AND biogenic methane	Yes support interim target	It's obvious that this is a huge issue for Canterbury, but I feel that we have little say over biogenic methane output and this is the worst pollution of them all. ECAN is toothless, so can Council really do much to fight the spread of agriculture around the plains? It would be nice to think we could get on-board with Selwyn, Waimak and other Councils to petition ECAN and the government to do it's job and work with the local councils. It would hopefully increase our impact on climate change in the south island and might even gain us a bit of extra cash from the government. They always seem to have a few quid down the back of the sofa for other causes...
26434	Mikayla	Clapson		YES. We are in a time of huge change as a city and now is the easiest time to make such things happen	YES. We are in a time of huge change as a city and now is the easiest time to make such things happen. Scientists are showing that changes need to happen within the next FIVE years to be able to save our planet. Goals 30 years in the future are not helpful.	Yes support interim target	

26433	Andreas	Wesener		I think we would need a more ambitious approach and reduce CO2 emissions quicker.	Yes. Net zero emissions should be reached by 2030.	Yes support interim target	The above goal means we have roughly 10 years to adapt and improve transport and building infrastructures (the worst polluters) and bring down agricultural and waste pollution. Combustion engines should be made illegal or very highly taxed. Petrol has to become far more expensive (taxed). Active modes of transport and public transport (electrified) infrastructure should have top priority over individual car traffic (even electrified). It's an ambitious goal but we're running out of time! The rest could be offset by reforestation. New greenfield development must be stopped.
26432	Sam	Eames		Yes. We have no choice. The time to act is now. The world is falling apart around us and we are not doing enough to save it	Always. We have a unique opportunity to be leaders in city emissions targets. As the city council, YOU have the power to make that happen. Everyone will be affected by inaction with only a potential few affected by action. Our emissions target for net zero should be ambitious (2035). We have the ability to do this (technology, culture shift), we require the councils ability to make it stick	No do not support interim target	Be bold, be courageous. If we don't act in such a way now, there will be no Christchurch left to call home
26430	Mark	Darvill		Yes, I believe that we should align with the proposed national target so that all regions of the country are taking a unified approach to the targets and measurement.	No, I don't believe we should take a more ambitious approach. Christchurch has a number of significant challenges facing it for the next ten to twenty years. These will consume considerable council resources and require behavioural change from the population. Taking a more ambitious approach disrespects the challenges already ahead of us and sets us up to fail those challenges as well as the greenhouse gas targets.	Yes support interim target	I do not favour the calculation of greenhouse gas production on a 'per person' basis as the average flatters those who use excessive amounts and hides their contribution to the total. I would support the development of software tools and guides which allow the calculation of a family production total or a business' production total so that individual (or collective unit) measurement and monitoring can be employed. By the very nature of the maths, a sizeable proportion of the Christchurch population (50%) already use less than the 'average' and whilst they could do better the potential for reduction is greater amongst those that use way more than the average.
26428	Wendi	Stewart		Yes, but I think we can do better and bring it forward. 30 years more damage to the climate is serious.	Yes. 2025. Be ambitious. Consult experts in the field and create a robust plan to fight climate change.	Yes support interim target	
26427	Benjamin	Melese		Yes, as Canterbury is a highly agricultural region. Any commitment Christchurch makes to reducing methane emissions will indirectly harm farmers, and thus the entire Canterbury region		Yes support interim target	Any measures taken need to be balanced against the impacts they will have on society and the economy. For example, central city roads should not be closed to traffic to reduce emissions, instead buses should be subsidised more to entice people to use them
26426	Graeme	Bryant		No. None of the predictions on climate change, global warming, rising sea levels have happened. Why are we doing this exercise when it looks like global temperatures are falling.	The amount of anthropogenic CO2 in our atmosphere is very small. Why are we spending so much money on reducing this when the effect is very small? CO2 is required for plant growth and an increase of CO2 will have a positive effect. Suggestions are that 800 ppm of CO2 is an optimal level.	No do not support interim target	Until we see some actual proof of either global warming or sea level increases, we should not be spending vast amounts of money on something that may never happen?

26421	David	Birch		Yes, as a minimum we should align with the national target, but my preference is that we must exceed the Government's ambitions as Canterbury is probably the worst region in the country for high level emissions.	Definitely, for the reason stated above. Our clean air urban strategy, with respect to emissions from log-burners and industrial stacks, appears to be working reasonably well; but now we must focus on methane emissions from agricultural livestock, particularly from our intensive dairy industry, which are reaching unprecedented levels. Research is well under way into altering the diet of ruminants to reduce the methane production in the gut, and this needs to be well financed and accelerated, but in order to keep this pressure up we need to cut back the target to 2030. The build-up of methane in the atmosphere/stratosphere is particularly difficult to claw back as concentrations increase, so 2050 is far too late.	Yes support interim target	We should be heading for 50% of the target by 2025.
26414	Kate	Spence	Sage & Seed	Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen	Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen	Yes support interim target	
26413	Lucy	Arnold		Yes, as a minimum. Christchurch has huge opportunities to make big changes now.	Yes. The target should be as ambitious as possible â€“ if it is impossible to achieve before 2050, then 2050 should be the target, but if it's at all possible to achieve net zero greenhouse gas emissions earlier than 2050 then we should be aiming for an earlier date. Targets for methane should be more ambitious too, for short term gain as well as longer term impact.	Yes support interim target	
26412	Scott	Butcher		I think that the City Council needs to be far more ambitious in its approach. We simply do not have until 2050 to reduce our emissions to zero. I beleive we should have zero emissions by 2030 at the very latest. Also, with limited farming within CCC boundaries, zero methane by 2030 is also neccessary. This obviously would include methane from landfills	See previous comments.	Yes support interim target	As the CCC passed a resolution recognising both an climate and ecological emergency, then the ecological side of this resolution needs specific attention. In doing so, it will provide solutions to the climate crisis through reconnecting people with nature. Reconnecting people with nature will also help challange unsustainable power and economoic structures which are at the heart of climate change. Many of our ecosystems within Christchurch are under threat, such as coastal salt marsh through sea level rise and forest restoration as summers get dryer and hotter. Therefore we will need to work hard to conceptualise and support an urban ecology that will be resilient in the face of climate change impacts. While we need to build resilience into natural systems, we need to make sure that what we do in supporting urban ecology does not create further risk or generate climate change emissions.
26411	Sophie	Smith		Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen - if we do not act now, we will be reactionary to further disaster, instead of preventing it before it happens.	We are in a time of huge change as a city and now is the easiest time to make such things happen: instead of being more ambitious, we should have targets for every year up to 2050 that will ensure we get to where we need to.	Yes support interim target	

26410	Jason	Pemberton		Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen	Yes. We are in a time of huge change as a city and now is the easiest time to make such things happen	Yes support interim target	
26406	Peter	Ganly		Definitely at least align, I would prefer a more ambitious target	Yes, the targets are laughable in the face of this existential threat. Of course methane should be treated as any other greenhouse gas, the gas may not last long but the warming it brings lasts quite long enough to amplify all the other effects, melt the Asian glaciers faster, melt the ice caps faster etc, and these changes are forever, unlike the life of the gas.	Yes support interim target	There is sustained pessimism everywhere about the existentialist threat of global heating. I am very worried about what sort of life my children and grandchildren and all their coinhabitants of this earth will have. We must get started now and vigorously, in combating global heating. New Zealand is one of the few places in the Southern Hemisphere which will remain habitable under some of the more gloomy scenarios which are forecast to play out over the next century. More sacrifices need to be made now to head towards earlier efforts to control global heating, otherwise it's doomsday. I believe people want to do something positive rather than just listen passively to the pessimistic news.
26402	Susie	Tarnay			Take a more ambitious approach. We have relatively less gas emissions from agricultural compared to transport Council could have an important part to encourage less car usage	Yes support interim target	
26394	Matt	Holdem		No	If you really think you're making a difference then you're an idiot.	No do not support interim target	If you want to drive even more people out of this country then sure tax us even more for living/having a hobby. Will happily take my taxes to Australia where I can enjoy my hobby of cars without being taxed even more. On a side note do you really think the average joe can afford a modern car? Certainty not, which means you are punishing the middle to low class as always.
26386	Claire	Bryant		Yes, to stay in step with a national approach	No, stay with the national approach. Including methane - to enable steady certain adjustment	No do not support interim target	
26384	Charlotte	Bruin		Yes as they have different effects and issues following them. Methane is not as harmful but is also a threat so must be focused on due to its increasing effects while decreasing carbon emissions.	2030, as this will push our economy and set a model for the rest of the world to follow. If we stay with 2050 it will be to late and past going back. I think we should also shine a light on methane and aim to reduce output also but is not as much of a priority as carbon dioxide due to short and long term effects.	Yes support interim target	
26382	Daniel	Williams		I believe that the proposed national targets are a step in the right direction but are not ambitious enough, given the key importance of global warming to planetary health and the future of our community. I have said so in my personal submission to the Zero Carbon Bill.	I understand that and change comes at a cost, and must be planned with fairness in mind. However, climate change is not a new phenomenon, and we have all had plenty of opportunity to understand it and to make personal changes. We have to accept that there is a cost to addressing climate change; more so for those of us who have been ignoring it and profiting from it the most. We can't expect to continue to ignore it at the expense of our children's future. I am happy to leave the technical issues to the experts. I ask our Council to show braveness and leadership on this issue, so that we	Yes support interim target	

					can all be proud to be part of a community that is working towards a better future for our children and young people.		
26380	fay	brorens		A target of 2050 is way to far off. This really is an emergency. If we wait till we feel it (like some counties do now) it will be far too late to act. Methane is a GHG. If it contributes to our carbon footprint then we should do all we can to reduce it. Biodiversity loss and ecosystem loss are all a part of this. Our health depends upon the health of the natural world we are part of.	I think we need to be significantly more ambitious. I think we should borrow to buy electric buses and such to reduce our footprint as fast as possible. I have always advocated care with money and been debt averse but I think we are fighting for our lives. 2028 is a good place to aim to be net zero. We need to do things to sequester carbon too, like planting and re-wilding. Methane is a dangerous hot gas. It has a short life but we should reduce as much as possible because there seems to be huge increase in methane worldwide.	Yes support interim target	good luck, be bold and courageous, think initiative solutions.
26373	Nicholas	Latham			2030 so we as a community can get earlier feedback and lead the way with green technologies. Ignore methane and concentrate on the long term gases	Yes support interim target	
26364	Frances	Willems		Absolutely Yes, because: 1. If what is being presented by the scientists is true, then we don't have much choice. And the scientific evidence is mounting and corroborating on existing evidence. 2. If more countries like the USA behave irresponsibly (i.e. pulling out of the Kioto Protocol), then us other countries will need to work harder to save our planet. 3. It is our duty to our future generations and to other life on our planet.	I would like to say yes to a more ambitious approach, say 2030 as that is what is being suggested in your Emissions-Target Consultation document... a suggestion which I'd hope would be derived from well informed sources. More ambitious also for the reason stated above, that if other countries are not on board we'll need to work harder. The fact that methane remains in our atmosphere for only 12 years was news to me and a relief too. But regardless that it is not as bad for the atmosphere, I still think we need to consider the direct physical impact that agriculture is having on our land and reduce agriculture. With climate change becoming more serious and more droughts on the way, it's not going to be conducive to growing food for the agricultural sector anyway - we should save our land for generating less energy intensive agriculture (i.e. not dairy).	Yes support interim target	
26354	Alicia	Moggre			Yes, come up with a plan for reductions as fast as possible and set a time frame based on the soonest achievable without creating undue hardship to lower income members of the community.	Yes support interim target	

26351	Peter	Murphy		Yes, we need to take this seriously. Rate shouldn't go up, nor should we have to pay for water but the council should encourage people to undertake changes themselves and lead by example. eg Solar PV, Electric Cars/Public Transport, Electric Car Charging, restrictions on farming (more ECan).	Yes, we wouldn't meet the target we set given baby boomer resistance to pay their way, and think it's all so easy, so better we aim for a sooner goal, with a second opportunity to reach the final one	Yes support interim target	Solar PV and Electric Cars/Public Transport are the way forward, lead by example and offer incentives to improve
26350	Josh	Kempthorne		No, I think we a net negative greenhouse gas emissions. We need to reverse our planet's decline. Now I drive to work, but the cities public transport is expensive and more than just inconvenient. My 15min drive is replaced with 60+ in a bus with two busses needed. And despite working at the hospital and living near a major road (Harewood) I still have only 1-2 buses/hour. Compared to living in Edinburgh (compatible population and size) I could reliably get a bus every 10-15min and usually only took two if it was snowing (to avoid a 10min walk). NET ZERO targets mean that people making to changes or actively ignoring the problem, are offset and allowed to continue.	I have no idea what timeframe is realistic... too fast and you fail or it costs to much. To slow, and life as we know it will be unretrievable. But why is Christchurch not considering trams? Electric with wind and sunshine everywhere. Why are we not using a rubbish power plant, like London. So less landfill, and power and minimal emissions and again electricity to support the city's infrastructure. Why does ECAN sell water to oversease buyers and then tell us to conserve? Why will planting trees help when we still support and endorse single occupancy of cars with malls and city centres with abundant cheap carparks? Why are there not subsidies, funded by offending industries, to support households going green with solar power and better stormwater & grey water systems? Christchurch's clean air policy has been a spectacular success. Helped by the quake pushing over a lot of old non compliant chimneys, rather than an active and aggressive process from the council. But my kids now enjoy a night sky I never remember seeing as a kid. The old CCC/ECAN policy of replacement by attrition was always going to be slow and ineffective. Every house should have been visited, and told... "No can't have that fireplace anymore... remove or change" or maybe "No can't sell that house, it's not got compliant heating". CCC/ECAN were lucky the quake accelerated the solution. Yes it will cost, be we can't afford to fail.	Yes support interim target	CCC and ECAN are not all bad. The new stormwater systems that my daughter taught me about are amazing (eg floating gardens/filters) and the new developments with rain gardens etc and the re-engineering of The Avon around the city are spectacular... we just have to keep pushing. Christchurch is the perfect size and location to prove to NZ it's possible.

26349	Bruce	Glennie		Greenhouse gases give no more than 10% of global warming with atmospheric water vapor being the major driver of warming at 90% influence. Humans add no more than 4% to the 10% global carbon dioxide emissions giving a human influence of just 0.4 of one percent influence on global warming. Australian Climatologist William Kininmonth stated: "Water vapour is important in regulating the magnititude of the enhanced greenhouse effect in two ways, increased water vapour in the atmosphere has an amplifying effect on the carbon dioxide forcing, and more importantly, increased evaporation constrains the surface temperature rise. It is the evaporation that is dominant because the Earth's surface is more than 70% ocean and much of the remainder is covered by transpiring vegetation. A doubling of CO2 concentration by the end of the century from current levels will cause a moderate global temperature rise not exceeding 1 degree celcius	As humans cannot and do not influence global warming in any measurable way, then there is no benefit in wasting time and resources in trying to stop something over which we have no control. Time will show that anthropogenic global warming claims are the biggest con perpetrated on mankind. It is about big companies making huge money out of trading carbon credits, and climate science harvesting huge amounts of research funds.	No do not support interim target	Read Ian Wisharts book Air Con, and then make a more informed decision
26346	Mark	Penrice		I think that we should align with this policy BUT we should publically state that this is a very low target and that we intend to do more. We should say that the only way to achieve this target is 50% per decade reduction, and a mechanism to reward the cities that are succeeding.	I believe we should be aiming to reduce carbon usage on transport per person by 50% per decade - otherwise the national target can not realistically be achieved. The City should focus efforts on getting people on to motorbikes and bikes (rather than the red herring of 2tonne electric cars for everyone which cant possibly work unless we build nuclear power stations). we could target having a fossil fuel free zone in the central city between 9.30am and 4.30pm by 2025. that way people also benefit from not breathing in poisonous carcinogenic fumes if they go shopping. I think as a society we should include a methane reduction, but I don't think the council is best positioned to resolve this issue.	Yes support interim target	The council are sending a strong pro-car message by; providing electric car charging sites and spaces rather than Ebike and electric motorcycle charging areas, getting staff to use electric cars rather than electric bikes to travel around town, using taxes to subsidise car parking costs, repairing roads without repairing or replacing footpaths (redcliffs/sumner). In addition the council could have provided each household with an ebike + escooter to travel round town for the same value as the car parks built in town in the last 10 years. Planning rules also force car parking on to developers.. even places that sell alcohol need to provide spaces to encourage drink driving. The council is doing an OK job with the cycle ways project, however it appears that the funding still hasn't matched the spending on car parking on public land. Pedestrian areas in town still allow cars to drive on them and there is little/no enforcement of speed restrictions, directional travel, etc. If a small flat town in NZ with a reasonable climate cant achieve these targets then there is no hope.

26339	Gordon	Hammer		Yes we should align with the national target as a minimum. The longer we delay action the more expensive it will be.. Equal approach to methane gas, as the difference in years of reduction is an academic one	2040 as a long term goal. If we split methane gas off from carbon dioxide it will only lead to further subdivisions of gas emissions and academic discussions of the definition of 'greenhouse gas' pollution.	Yes support interim target	
26336	David	Kent		I think that 2050 is too many years away and we need to be more ambitious and try and reach net zero sooner.	Yes, we need to take a more ambitious approach similar to cities like Amsterdam and San Francisco. We need to concentrate on carbon dioxide predominantly but also reduce methane as much as possible. I think that reducing transport emissions is the easiest to do initially with more encouragement of zero and low emission vehicles and penalties and restrictions on high pollution vehicles.	Yes support interim target	We have to be bold and take action to do our bit to save our planet. There are still too many people who either completely deny or remain very skeptical about any action to reduce greenhouse emissions and they stand in the way far too often.
26325	Frances	Nation	Frances Nation	Yes	Yes	Yes support interim target	
26323	Simone	Reddington	The Apothecary	Yes, be like California in the US lead the way and go beyond what's required	Yes 2030 if possible. Aim for higher (lower GHG) so that if we fail we are still on target	Yes support interim target	More public transport is the answer but so is planting trees on every kerb, berm and available green space in chch - we have heaps let's use them.
26312	Tracy	Abbot		Yes, as a bottom line these measures should be met.	Yes, the net emission year should be brought forward - to 2030.	Yes support interim target	
26308	Charlotte	Bebbington		No. The whole country needs to be more responsive. 2050 is complacent. Climate Change is happening faster than we think and in 30 years the damage will be irreversible. Christchurch was the first city to declare a climate emergency and we should be no different in showing our leadership and progressiveness on other areas of climate change too.	Yes, we need to be more ambitious in our approach to climate change. Over half of our emissions come from transport and this is such an easy win by focusing on public transport, cycle infrastructure and electric vehicles. (latter 2 of which are already doing well). Canterbury landscape has changed rapidly in 20 years to accommodate dairy farming. Beyond methane, it has changed the landscape for the worst. In time these changes will attribute to adverse weather patterns, water issues incl. flooding and pollution. These are wider issues that need to be considered as well as reducing methane.	No do not support interim target	People need to act fast. Council & Govt cannot expect residents to do wthe hard yards alone. Change needs to be implemented and acted on from the top.
26307	Steve	Boyd		No, it's too late the goal of net zero greenhouse gas emissions be much more aggressive, 2050 is too late	Yes, 2025 or 2030 - we cannot wait - the risks are unacceptably high	Yes support interim target	

26304	Juliet	Neill		No, more ambition needed.	Given the urgency of the climate situation, and the fact that every day new information is coming to light about how much worse things could be than anticipated, we all need to act much sooner, and the target should be for Christchurch to be carbon neutral by 2030. Methane, though short lived, is up to 60 times more damaging to the environment, and must be considered as well. Of course, after 30 years or so, it breaks down into its components, one of which is CO2, further adding to that which is already in the atmosphere. Christchurch should also aim to become methane neutral by 2030. I imagine this could be a lot easier than it would be for rural districts, as the main urban source of methane pollution would be landfill, as there is little cattle and dairy farming immediately around Christchurch.	Yes support interim target	Keep working on the transport plan, and I wold encourage the Council to seriously think of light commuter rail, preferably electric. While over all congestion has to decrease, encouragement for electric vehicles would be a good plan for emissions reduction, and for some people bicycles are not a feasible form of transport. Buses and bus routes should become the responsibility of the Christchurch City Council, not ECan, and bus fares must be subsidised in order to encourage their use. Perhaps Central Government has a responsibility here.
26303	Andrew	Douglas-Clifford		I think we should do better than the proposed national 2050 target. The speed of the climate crisis necessitates us to move as quickly as possible, and as a city, I think we can move a lot faster than the country as a whole.	Yes, we absolutely should. I would like to see our net-zero greenhouse gas targets to be in the 2030's. Ideally it should be 2030, but no later than 2040. I am unsure about methane, but I think we should also be more ambitious than the national goal here.	Yes support interim target	Since you've now declared a climate emergency, I would like to see prominent and regular communication of milestones and progress that recognise this fact. Actions speak louder than words, swift and decisive actions even more so.
26302	Jonathon	Chambers		No - I think we should take a more ambitious approach.	Yes - we should take a more ambitious approach. I'm not certain what year this should be set at. As early as is practically possible to achieve. Methane should be considered equal (in terms of settings emissions limits) to other greenhouse gases in my opinion. It may dissipate from the atmosphere much more quickly but it is more warming. We need rapid and drastic action to reduce warming to avoid the potential for cascading affects of global temperature rises. The time frame for these reductions is short as outlined in multiple recent scientific reports. Methane is a significant contributor to warming and exists in the atmosphere over exactly the sort of timeframes that are being suggested that we have to act.	Yes support interim target	
26301	Sue	Jarvis			I think that we should aim for net zero by 2030, if we are going to have any chance of keeping the warming under 1.5 then we (and the whole world) have to act as soon as possible. New Zealand has always been seen as a leader - lets continue that. The issue of methane is a tricky one, but I think it should definitely be included, perhaps with sightly different regulations, but again, as soon as possible. There are ways that this can be done while still having animal farming	Yes support interim target	Young people are already passionate about making changes. Let's encourage that and show them we all support them and are willing to make changes. To make this happen positive actions need to be taken, for example to deal with the transport issue - such as free bus trips for school students - even if only in the holidays. Perhaps then they and their families will start using the bus more at other times. Continue to make bike riding safer. Think of other ways to reward behavior change too. Publicise good apples of behaviour change etc

26300	Ivo	De Vocht		No, I think we should be more ambitious as the obstacles we have are readily achievable and we are wealthy enough as a community to make it work.	Yes, I think we should aim for net zero as soon as possible and 20 years is an achievable timeframe that is not too optimistic. Methane emissions should be treated no different to carbon dioxide. It contributes to warming and the lifespan is not relevant. Treating methane differently is just prolonging the isssue that we will eventually have to face; that we have to change the way we eat and produce food	Yes support interim target	I think we need to stage more events to celebrate success in reduction of carbon. If we see our carbon reduction in a positive light it will make the community more likely to act and support further improvement, rather than the current approach which is guilt based
26299	Sabine	Frielink		I think we should speed up the net zero target by as much as we can. Even if we reach it by 2040 research has shown the effects of climate change will have already made irreversible changes to our ecosystems, putting the next generation in danger.	Net zero by 2030 and invest in technologies such as vertical farming, meat grown from cellular growth and plant based milk. Methane problem solved.	Yes support interim target	
26297	Euan	Gutteridge		No - I want to understand what this will mean in terms of living costs. I am concerned that poorer people will not have the ability to make the lifestyle changes required.	No - as above	No do not support interim target	More research required to fully understand implications before further decisions are required
26295	Kristin	Hoskin		The national target is too soft. We can do better and we can do it faster. We need to re earn our currently tarnished reputation as clean and green. And for the sake of our native flora and fauna we need to do it quickly.	Yes we should. 2025 would be reasonable. That is 7 years. Average slaughter age for dairy cows is approx 4 years so this would allow for two generations of farming stock as a transformation period.	Yes support interim target	
26294	George	Sariak		No, I think Christchurch should be ahead of New Zealand and should aim for a more ambitious target. I think because of the rebuild Christchurch should be leading other NZ cities in sustainability commitments. Christchurch is so flat it has the geographic blessing to rival Copenhagen and Amsterdam for cycling however there is a continued emphasis on private vehicle use.	Yes, 2045 should be the target to match city commitments elsewhere in the world such as Edinburgh. Farming in Canterbury is unlikely to stop, methane should be offset through improvements in carbon sequestration (tree planting) as best possible. De-carbonising human activities should lend to allowing some natural processes to emit, however cattle figures must be kept at a suitable limit.	Yes support interim target	Invest more in public transport and cycling. More electric car charging ports in Christchurch. Host car free days through joining the Open Streets initiative. Consider a cheaper weekend cap on Metrobus akin to Sydney's $2.50 cap on Sundays. Make consents subsidised for micro renewables. Ban the highest emitting vehicles from the CBD. Have a low emissions zone in the CBD.
26292	Torfrida	Wainwright		CCC should align with the Zero Carbon Act when it is passed, as long as this Act is very much strengthened from its current form. I attach my submission on this Bill. If the ZCA is passed in a weak form (eg targets set for 2050 rather than 2030), then CCC needs to openly and strongly lobby the government to ensure this is a string Act. The Act provides the basic national framework that will enable local government to act appropriately in the current climate and ecological emergency.	As a lay person I do not know exactly what the targets and deadlines should be, nor the detailed pros and cons of different targets for carbon and methane. However as a citizen I am extremely concerned at the increasing number of scientific reports now stating the extreme depth and urgency of the climate and ecological crisis. Greenhouses gases, including methane, must be reduced as much and as fast as possible. The country (and the council) needs to be on the equivalent of a wartime footing, and make the decisions needed to bring emissions down fast enough to avert catastrophe. You the council have people working for you who can analyse the detail of how this ca/must be done - it does not need to be done for you by the citizens.	Yes support interim target	**SEE ATTACHMENT AT END OF TABLE FOR ADDITIONAL INFORMATION**

					Our house is on fire, we are raising the alarm and asking that you act!		
26290	Bevan	Spooner		No, we need to be more ambitious than that.	2035 - we need faster action Methane is short-living in the atmosphere and takes a lot of carbon out of the atmosphere in it's production (growing the grass). I actually believe carbon neutral farming is a better (and more achievable) goal than just trying to reduce methane emissions	Yes support interim target	Do it!
26289	eric	pawson	university of canterbury	yes, at least	yes, by setting a series of interim targets, every 5 years, with clear strategies to achieve these, based on incentivised management plans negotiated with (for starters) major employers and schools	Yes support interim target	this won't work unless there are clear interim targets and incentivised plans for closing the loop, ie achieving them. We are way past the time for talking and hoping for the best. I'd like to see CCC take the lead on negotiating travel management plans with schools and employers so that as many people as possible have a stake in the achievement of the targets.
26288	Alex	Meredith		We should at least align with this, though as a modern city we should be trying to do more. The why should be obvious, climate change is a big problem!	We should. I am a member of the public jumping in here just representing a point where all the data is not available to me but we should set the most ambitious approach that is practicable. We should definitely be aiming to do better than the country as a whole and because methane is only like 10% of Christchurch emissions it is not unreasonable to include it.	Yes support interim target	
26286	Sue	ALDERMAN		No. Making it a date i. e 2050 is militaristic .	No. It needs to be framed differently than a set date.	No do not support interim target	The Western nations are taking this seriously but the worst world polluter nations are not. Encouraging our population is better than demanding. Also the council needs to be more sensitive to the needs of locals. Stop giving our water to China would be a start. Then there's dairy farm pollution on our back door as well. When the council leafs by example the people may respond as well.
26285	Julia	Allott		No, I think we should be more ambitious.	We should set a net zero target for 2030. Methane should be included but should be able to use offsets to meet the target until 2035. The proposed national target is based on science which indicates that getting to net zero by 2050 may prevent more than 1.5 degrees of heating. The science coming out now indicates that climate heating is moving faster than predicted and so to prevent more than 2 degrees of heating in the hope for a liveable planet we need a much more ambitious approach. Canterbury could lead the way and show others that it can be done. We have a great opportunity to transition our approach to transport and industry (including agricultural) away from the way we have been doing things. If the transition isn't made soon	Yes support interim target	Please make decisions based on science and the long term not on short term monetary gain.

					some industries may be so affected by climate change that they will need huge support at an even higher cost to Government.		
26280	Lucile	Fontaine-Berger		Yes absolutely! It has been a long time coming and was expected for such a long time. I want change for my generation and the next.	Yes absolutely. Why build more car parks in the centre? This makes no sense at all! We need to have a bold move where we force people to ditch their cars. Therefore, we need effective, cheap and reliable public transportation (tramway!), we need more space for bicycles and pedestrians, they don't have enough space and sharing such a small space leads to animosity. Take the example of Utrecht in the Netherlands. Also, instead of building more car parks, we need more local opportunities where people can grow their food, more spaces where people of all ages and origins can live together. Stop massive farming as it is extremely polluting.	No do not support interim target	
26277	Dave	Lane		Aligning with that national target is absolutely necessary, but also no where near sufficient action for our collective community to take. We need to do far more than that to have a meaningful effect on the dire (catastrophic) conditions to which we have all, to varying degrees, contributed.	Yes, we must take a far more ambitious approach. We need to make hard decisions that will cost some people some or all of their livelihoods, because what they're doing on is profiting unsustainably, not bearing the real cost of their actions. People will have to change their behaviour en mass. This needs to be lead by policy and gov't action. Here is an excellent description of the problem and recommendations on how we should act (written by Christine Dann in her submission on the Zero Carbon Bill): https://www.christinedann.org/2019/06/climate-crisis-immediate-response-bill-ideas/ I encourage you all to read and understand it.	Yes support interim target	We need council to define a plan of action, and then ensure that the penalties for not achieving that plan are sufficient that it does not fail as so many half-baked initiatives previously have done.
26322	Mike	Currie		No	We should aim for net zero greenhouse gas emissions including methane of 2030.		

NEW ZEALAND TRANSITION ENGINEERING RETRO-ANALYSIS

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Abstract

To meet New Zealand's emission commitments, the government has prioritized the up-take of Electric Vehicles (EVs), as personal transportation is a large consumer of fossil fuels. Extrapolating figures from official sources (Ministry of Transport and Ministry of Business, Innovation & Employment) we estimate that passenger transportation is responsible for at least 30% of New Zealand's fossil fuel consumption. Given New Zealand has a large share of renewable sources (78%) the simple conclusion is that the uptake of EVs would directly reduce carbon emissions, however the interaction of EVs with the power system is complex and requires a comprehensive approach. Transition Engineering (TE) is an emerging field that addresses sustainability in design and management of engineered systems. Within the context of the TE methodology we investigated the implication of EV targets on the New Zealand Energy System and associated Greenhouse Gas Emissions. We utilized a Retro Analysis approach, using the transport activity and grid composition of 2012, superimposing various policy objectives into that system to understand the costs, benefits, consequences and utility of the policy. An energy system model was developed using the Long-range Energy Alternatives Planning System (LEAP). The model incorporated seasonal availability of power plants along with sector specific energy consumption profiles reported in official datasets. We defined a set of scenarios to examine the impact of different EV targets, charging behavior, modal shift, transport behavior and changes to grid composition. The implications of the intermittent nature of renewable resources were explored along with potential demand additions (EV charging) on the power system.

1 Introduction

A recent report from the Intergovernmental Panel on Climate Change stresses a stronger global response is required to mitigate the effects of Climate Change (Intergovernmental Panel on Climate Change 2018). One mitigation pathway is the electrification of transportation, as transport is a large consumer of non-renewable resources. New Zealand appears well-suited for electric vehicles, with a high share (~78%) of renewable power generation. The New Zealand Government has already announced a set of measures to enhance the uptake of electric vehicles including: exemptions on road user charges, information campaigns, innovation programs and research funding (Ministry of Transport 2018a). The latest "Transport Outlook" report from the Ministry of Transport projects that the ownership costs for electric vehicles (EVs) are to reach cost-parity with internal combustion vehicles by mid-2020s. It is expected that this will then drive EV share to 40% of the vehicle fleet by 2040 (Ministry of Transport 2017b).

New commercially available EVs have a driving range of around 270 kilometers (Nissan 2018), which far exceeds the average distance, 31 kilometers, travelled by individuals in private vehicles daily (Stats NZ Tatauranga Aotearoa 2014). For many New Zealand urban commuters, EV's have become a suitable replacement for Internal Combustion Engine (ICE) vehicles. However, the adoption of a large-scale fleet of EVs should be informed by a robust understanding of the technical challenges, economic and environmental implications. According to a 2018 white paper published by Transpower, in the upcoming years, considering added wind, geothermal, hydro and solar generation and a full removal of gas and coal generation, the biggest challenge to solve will be peak load, particularly in dry years and cold winters (Transpower 2018).

This paper uses a retro-analysis based in 2012, as both transport and energy data were available for this year, to provide insight into the impact of EV's on the NZ power system. A retro-analysis imposes changes, such as policy actions or targets, onto a base-year, with confirmed resources, to investigate the impact of those changes without speculating on future demand or availability. A retro-analysis has previously been used to understand the environmental implications of biofuels in New Zealand (Krumdieck & Page 2013). Within the context of this work, a retro analysis is useful for decoupling the effect of added grid resources from the effects of added EV's and to also present what may occur if proposed added infrastructure is not delivered. The model used accounts for the seasonal variability of renewable resources and charging patterns of the EV's. Two levels of EV

adoption, to match government policy and projections, are investigated: A 64,000 increase in EV's by 2021 and a 40% light fleet replacement by 2040. Official proposed modifications to the grid are also simulated. Combinations of these scenarios are analyzed for their effect on the performance of the grid, including: reserve margin, peak-power requirements, carbon-emissions and generation costs.

2 Background

2.1 Energy and Environmental Planning Tools

Energy-environmental planning models are based on scenario analysis that estimate energy consumption and Greenhouse Gas (GHG) emissions upon projections of socio economic indicators. Common scenarios are based on long-term energy consumption with considerations for environmental aspects, technology substitution, energy carriers substitution, energy efficiency programs and the implementation of Renewable Energy projects. Models that have a strong transportation component also emphasize on the forecast of Vehicle Population, Traffic Volume and Vehicle Kilometers travelled per capita (VKT) (Sadri, Ardehali & Amirnekooei 2014). Several simulation packages are common for this type of analysis and are widely used by researchers, consultancies, and policy makers worldwide. The Long-range Energy Alternatives Planning (LEAP) System is a scenario based modelling software developed by the Stockholm Environment Institute. It relies on a large database of emission factors. The software integrates optimization solvers that can be used to investigate the cost effective addition of different technologies (Stockholm Environment Institute 2017). The Unified System for Regional Electric Power Planning (SUPER) is a modeling tool developed by the Latin American Energy Organization (OLADE). SUPER can model mid to long term expansion of power and transmission capacity of an interconnected system; it can also optimize cost and minimize energy risk (Latin American Energy Organization 2018). EnergyPLAN is a model developed and maintained by the Sustainable Energy Planning Research Group at Aalborg University. EnergyPLAN simulates the operation of national energy systems (EnergyPlan 2018).

Suganthi and Samuel (2012) reviewed several forecasting models that have been used to estimate future energy demand. Models covered in the review cover time series, regression, econometric, decomposition, neural networks, grey box prediction (combination of theoretical structure with coefficients derived from data), input-output and genetic algorithms. The article also describes features from energy planning bottom up models. MARKAL (Market Allocation) is an analytical tool that outlines the supply and demand side from an energy system; the program was originally developed as a least cost linear programming model for the International Energy Agency (IEA) (Suganthi & Samuel 2012). Sadri, Ardehali and Amirnekooei (2014) provide a procedure for energy-environmental planning for transportation, addressing transportation data limitations in developed countries. Iran is used as a case study; Population and Gross Domestic Product (GDP) are forecasted up to 2025 through a Grey model applied over historical data for 1997-2008. An important contribution from their work is that the study uses both LEAP and EnergyPLAN, hence allowing to contrast and highlight the capabilities and limitations of each approach (Sadri, Ardehali & Amirnekooei 2014). LEAP has the capability to contrast the performance of different scenarios whereas Energy PLAN treats every scenario as a new project and comparison needs to be carried out outside of the platform. Emodi et al. (2017) use LEAP to run a long-term (up to 2040) scenario based analysis for Nigeria. The scenarios reflect different levels of policy intervention on energy efficiency and renewable energy application. The article also provides a detailed description of the energy consumption, transport stock turnover, transformation (transmission and distribution), and cost calculations that are carried out within LEAP. One of the biggest challenges for Nigeria will be to enhance the consumer's economic accessibility to cleaner technologies; the study also addresses the need to incorporate the impact of climate change on energy supply and demand forecasts (Emodi et al. 2017). Ostergaard (2015) investigates the range of optimization criteria and performance indicators used in EnergyPLAN models reported on peer reviewed journals. According to the review, Primary Energy Supply (PES), GHG emissions, Economic Costs and Excess power generation are the most employed criteria used for optimization/simulation EnergyPLAN models. The article also

reports on performance indicators for evaluating the impacts of intermittent renewable generation; basically, these are calculated as ratios between marginal changes in optimization criteria (Ostergaard 2015).

2.2 Electric Vehicle Policy

Many countries are promoting policy to increase the uptake of EV's in order to reduce transportation energy, reliance on imported and non-renewable fuels and emissions. Some policy measures directly support the uptake of EV's, including: subsidizing purchase costs, access to bus lanes or high-occupancy lanes and reducing or exempting fees for toll roads and parking. As of 2017, many countries including: Japan, South Korea, Germany, France and the USA have had direct subsidies and tax credits (Nian, M.P & Yuan 2017). Other incentives include research funding or added charging infrastructure.

Norway are the current world leaders in EV adoption with a long history (>25 years) of EV policy. As of 2015, EV's made up 2.7 % of Norway's total vehicle fleet and 17.1% of new passenger vehicle sales (Figenbaum 2017). A main contributor to their uptake is low electricity prices, renewable generation (96% hydro-power) and high oil-prices. Researchers reported that Norway's EV policy only became effective as large vehicle manufacturers entered the EV market and of the incentives price reductions appear to be the most effective measure, as other European markets with price incentives also have higher shares of EV's (Figenbaum 2017).

Several researchers have investigated the impact of EV policy or EV adoption on countries energy systems, emissions and fuel dependence. For the UK, who have banned the sale of conventional ICE vehicles after 2040, Raugei, Hutchinson and Morrey (2018) performed a life cycle analysis of ICE and EV's to analyze the dependence on non-renewable energy. They found the replacement of ICE vehicles with EV's provided significant reductions to the non-renewable Cumulative Energy Demand (nr-CED). If the added load was met with combined cycle gas turbines the nr-CED was reduced by ~32% and by ~70% if met by renewable sources. Brazilian researchers simulated replacing a taxi-fleet in a Brazilian city with EV's and analyzed the carbon emissions (Teixeira & Sodré 2018). Given the carbon-intensity of the grid, large-proportion hydro-power, the transition reduced carbon emissions between 10 to 32 times compared to ICE vehicles. The analysis only included emissions to run the vehicles, not the manufacture, and grid emission factor remained constant, unlikely for large-scale ICE replacement. Researchers from Thailand used a LEAP model to analyze the total effect on GHG of the countries policy target of replacing 1.2 million ICE vehicles with EV (Winyuchakrit, Sukamongkol & Limmeechokchai 2017). They found, given the current grid composition, a high level of non-renewable generation, the GHG emissions would increase 7% and a similar increase was found even when renewable energies made up 20% of generation. The LEAP model did not include the lifecycle (manufacturing) emissions, but did include the impact on the grid with the addition of the EV's. The simulated results for ICE to EV replacement generally appear positive, particularly when just looking at the on-going energy consumption and emissions. The results appear strongly linked to the emission factors for generation and a higher efficiency drive-train. However, the results look less positive, or reverse, when the life-cycle (higher embedded energy in EV's) is taken into account or the impact of the added EV load and time of use on the grid are taken into account. This highlights the need of a LEAP type model as EV's can present a challenging power addition to the grid, which may require higher use of non-renewable energies.

Another driver for the adoption of EV's is the added flexibility of the grid with flexible charging and exporting back to the grid. However, EV's are more constrained than stationary batteries as they must meet transportation needs and do not maintain a connection with the grid. Mills and MacGill (2018) explored the optimization of EV's as a distributed energy resource in a Sydney Australia case-study. They found that universal access to charging infrastructure (chargers at work, schools, shopping malls etc.), required a significant expense, to effectively utilize EV's as a distributed resource for the grid, particularly to balance a mid-day solar-power peak.

3 Methodology

The model reported in this paper follows the hierarchical structure of LEAP. Key Assumptions, Demand, Transformation and Resources are the main modules. All branches and technologies are defined under *Current Accounts.* Scenarios are defined through assumptions on changes of activity, share, population or energy intensity. The sources of information, fundamental assumptions, and scenarios are described in the following sections.

3.1 Model setup and Data

2012 was selected as the base year as sectorial electricity consumption data-sets were available. The demand module was organized into four subfolders for the Transport, Industry, Commercial, and Residential sectors, respectively. The transport module had a higher level of detail as our study particularly focused on the impact of policy on energy consumption and GHG emissions from this sector. The first level of disaggregation considered passenger and freight subfolders. Vehicle Kilometers (VKTs) and vehicle occupancy were used to calculate passenger kilometers (PKMs) that were further allocated to the household light, motorcycle, heavy bus and light commercial sub-categories. VKTs from heavy trucks were excluded from the road passenger category, as they were accounted for in terms of Tonne Kilometers (TKM) within the road freight category. Fuel consumed by Cruise liners and Interislander Ferries were not accounted for within the passenger category. The Freight subfolder is entirely based on transport activity and modal shares (i.e. road, rail and coastal shipping) reported on the National Freight Demand Study (Deloitte et al. 2014). Fuels used within the passenger and freight categories include Diesel, Petrol, Electricity, Residual Fuel Oil and Jet Kerosene. Other fuels like LPG were not included in the analysis, as they are not representative within the New Zealand transport sector (approximately 0.4% share). Data used within the transportation branch along with the corresponding sources are summarized in Table 1.

Description	Sources
VKTs by vehicle and fuel type	Annual vehicle fleet statistics report (Ministry of Transport 2017a)
Vehicle occupancy	Transport Indicators (Ministry of Transport 2018b)
Aircraft PKMs	Air travel statistics and modeling (Cross & Wang 2014)
Rail passenger activity	Transport Indicators (Ministry of Transport 2018b)
Freight activity and modal shares	National Freight Demand Study (Deloitte et al. 2014)
Energy intensities	(Tiwari & Gulati 2013; V. T. T. Technical Research Centre of Finland Ltd 2017)

Table 1 Transport Data and sources

In the Transport Branch, energy intensities were specific to each technology. The definition of Industry, Commercial and Residential sectors followed a different approach. Aggregate energy intensities were defined at the top level of each of these categories. Each category contains a set of fuel branches, and a share was assigned to each one of them. Sectoral Energy Intensities were expressed in terms of energy use per unit of gross product. Data on GDP breakdown by industry for New Zealand was obtained from Figure.NZ (figure.NZ 2016). Sectoral energy use, fuel shares and installed power capacities were obtained from online documentation on energy statistics published by the Ministry of Business, Innovation and Employment (MBIE) (Ministry of Business Innovation and Employment 2015). A novel feature of our model is that it utilizes energy load shapes to derive electricity consumption profiles for different sectors. The profiles employed in the model were taken from an online dataset containing half-hourly readings of electricity consumption for different sectors (Electricity Market Information 2018).

Energy Transmission and distribution, Electricity Generation, Oil Refining, Natural Gas extraction and Oil Extraction define the transformation module. In regards to the Electricity Generation branch, the model incorporates “availability shapes” to describe the fraction of time a plant is available in each of the time slices considered in the analysis. This is also a novel feature of ours and proved to be important in regards to assessing the effect of peak power requirements along with intermittent

renewable generation. These profiles were derived from monthly datasets containing half-hourly readings for different power plants in New Zealand (Electricity Market Information 2018). The information was aggregated into daily time slices as displayed in Figure 1. An additional one hour length slice was added to account for the year's peak event. Remaining data on costs and technical features for electricity generation were obtained from official reports and scientific literature (Dagher & Ruble 2011; Electricity Authority 2014; Kachoee, Salimi & Amidpour 2018; Kale & Pohekar 2014; Ministry of Business Innovation and Employment 2016; Organisation for Economic Co-operation and Development, International Energy Agency & Nuclear Energy Agency 2015; Park, Yun & Jeon 2013). Table 2 provides a summary of data entered in the electricity generation branch. Annual summary statistics from the MBIE website were used to define the losses, historical energy production, exogenous capacity, and availabilities within the Oil Extraction, Natural Gas Extraction, Oil Refining, Transmission and Distribution branches (Ministry of Business Innovation and Employment 2015).

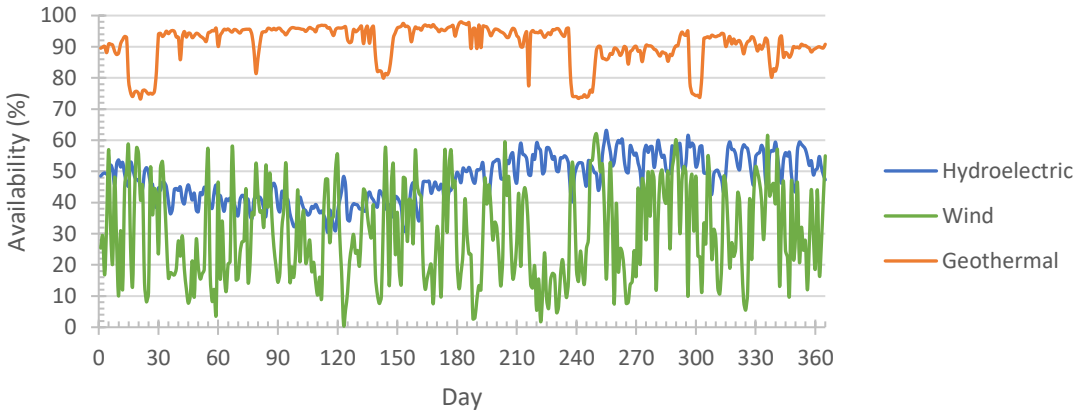

Figure 1 Average Daily Availability of Renewable Generation in 2012

Technology	**Capital cost (NZD/kW)**	**Fixed O&M (NZD/kW)**	**Variable O&M (NZD/MWh)**	**Process efficiency (%)**	**Availability (%)**	**Lifetime (Years)**
Hydroelectric	4395.30	6.73	33.18	100	Variable	50
Onshore Wind	2601.90	54.83	21.30	100	Variable	20
Geothermal	5909.40	102.84	16.63	11.5	Variable	30
Thermal Coal	3924.90	60.92	10.04	38	95	30
Thermal Natural Gas	1177.47	21.14	12.52	35	95	30
Thermal Diesel	970.20	15.29	9.69	40	95	20
Cogeneration NG	1969.80	34.40	10.85	40	95	30
Cogeneration Wood	2822.40	38.15	10.85	24	50	30
Thermal Biogas	6468.00	29.40	76.63	40	50	30
Solar PV	5189.10	68.41	19.45	100	30	30

Table 2 Cost and technical data of electricity generation

3.2 Scenarios

Seven scenarios were simulated to measure the effects of EV uptake and charging strategies, transportation mode shift, transport reduction and grid composition on the performance of the power system, carbon emissions and electricity generation costs, listed in Table 3.

Four scenarios (**EV2, EV40, MT40** & **AC40**) are based on a retro-analysis exploring different levels of EV technology uptake (**EV2 and EV40**), modal shift to bus transportation (**MT40**), and adaptation of transport behavior (**AC40**). The retro approach imposes these changes, with confirmed resources, to investigate their impact without speculating on future demand or availability. The base year was 2012, as it was the most recent year where both transportation and energy datasets were available. Each of these scenarios maintain both light vehicle fleet VKT's at 2012 levels and the grid resources at 2012 composition, including that years' confirmed seasonal availability of renewable technologies (Wind, Geothermal and Hydro), Figure 1. The costs and benefits of EV's will be closely tied by future

grid composition. Consequently, two additional scenarios are simulated (**MR** & **MR-EV40**) which impose the “mixed-renewables scenario” grid composition outlined in the 2016 MBIE report: "Electricity Demand and Generation Scenarios (EDGS)”. According to this plan, it is expected that over 3 GW of installed capacity will be added between 2012 and 2040, as shown in Figure 2.

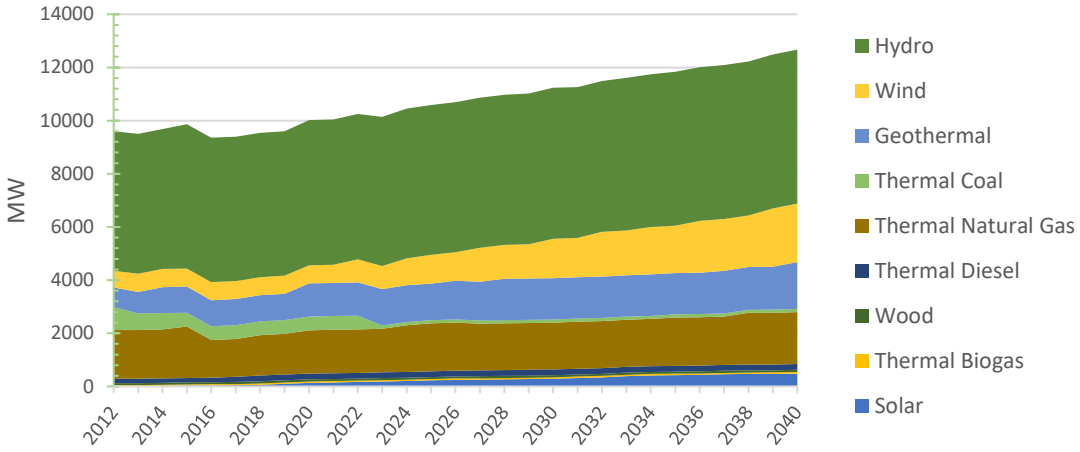

Figure 2 Change in Electricity Capacity, EDGS Mixed Renewables Scenario (Ministry of Business Innovation and Employment 2016)

Two Levels of ICE to EV replacement were considered, 2.3% and 40%, in-line with NZ government targets and projections (**EV2** & **EV40**). The NZ government targets 64,000 additional EV’s by 2021 (2.3% of light vehicle fleet) and the Ministry of transport projects a 40% replacement of ICE vehicles by 2040 (Ministry of Transport 2017b). For analysis, the EV’s are considered to be Nissan Leafs (Nissan 2018). The charging load is calculated given the Nissan leaf’s energy consumption (150 Wh/km), a round trip charging efficiency (ratio of amount of energy put in to amount of energy retrieved from storage) of 80% (Homer Energy 2018), an average daily travelled distance of 33.6 kilometers and an average vehicle occupancy of 1.58 (Ministry of Transport 2018b). As the operation of the power system changes with time, two charging strategies (**8h** & **3h**) are considered. The first charging strategy distributes the charging load of the whole EV fleet over eight off-peak hours (11pm – 7am). The second distributes the charging load over three off-peak hours (11pm-2am). Both scenarios are somewhat optimistic as they do not align with residential or commercial peak power times, however it is likely that many vehicles will be charged overnight so we view this as a reasonable assumption to test the performance of the grid. As faster EV charging becomes available, the aggregate peak load and instantaneous peak loads may increase and could have significant effects on the performance of the power system.

The adoption of EV’s will require significant investments, for both the vehicles and infrastructure. The benefits of EV’s should be put in the context of other means to reduce transportation energy and the associated emissions. To do this a transportation mode shift (**MT40**), a 40% shift of private transportation PKM’s to buses, and transportation reduction (**AC40**), a 40% reduction in PKM’s due to changes in behavior, were simulated. The buses are modelled as ICE vehicles, while electric mass-transit systems could be used the ICE buses are proven technologies with little associated infrastructure costs and serve well to benchmark the benefits of EV’s. Adaptive Capacity is used to justify the transportation demand reduction scenario. It captures the latent potential for the adoption of less energy intense means of transportation by changes in behavior, without changes in infrastructure. It has been proposed as a metric to assess maximum car travel demand reduction without reducing participation in essential activities (Krumdieck 2011). Watcharasukarn, Page and Krumdieck (2012) assessed the current adaptive capacity of commuters using Christchurch as a case of study and they estimated that the passenger activity, associated to car trips from general staff workers, could be reduced by approximately 40%. The respondents in their study reduced their fuel use through changes in destinations (e.g. shopping at local shops), changing transport mode,

chaining trips, and using active means of transport (e.g. walking, cycling) (Watcharasukarn, Page & Krumdieck 2012).

Scenario	Designation	Description	Grid	Vehicles	Charging
Base	BASE	2012 Base year	2012 base	-	-
2.3% EV	EV2-8h	64k EV shift	2012 base	2.3% EV	8 hours
	EV2-3h				3 hours
40% EV	EV40-8h	40% EV shift	2012 base	40% EV	8 hours
	EV40-3h				3 hours
40% MT	MT40	40% PKM shift from ICE vehicles to bus transportation	2012 base	40% PKM shift to MT	-
40% AC	AC40	40% reduction of PKM's due to adaptive capacity	2012 base	40% PKM reduction	-
MR-40% EV	MR-EV40-8h	40% EV shift with grid modified to the 2040 mixed renewable strategy	2040 mixed renewables	40% EV	8 hours
	MR-EV40-3h				3 hours
MR-ICE	MR	Grid modified to the 2040 mixed renewable strategy without added EV's	2040 mixed renewables	-	-

Table 3 Summary of retro-analysis scenarios to be analyzed

4 Results and Discussion

Table 4 provides a summary of the total effect of the different scenarios from the Retro Analysis. Including different EV target levels, charging behaviour, transportation modal shifts, adaptive capacity and electricity generation composition. The next sections provide detailed observations regarding key results.

Scenario Designation	**Reserve Margin (%)**	**Peak Power (MW)**	**% from BASE**	**Energy Demand (PJ)**	**% from BASE**	**GHG Emissions (MT CO_{2e})**	**% from BASE**
BASE	-2.3	6,696	-	540	-	33.02	-
EV2-8h	-2.5	6,710	0.2%	539	-0.3%	32.98	-0.1%
EV2-3h	-2.5	6,710	0.2%	539	-0.3%	32.98	-0.1%
EV40-8h	-7.0	7,030	5.0%	510	-5.6%	31.97	-3.2%
EV40-3h	-13.6	7,573	13.1%	510	-5.6%	31.97	-3.2%
MT40	-2.3	6,696	-	516	-4.5%	31.35	-5.1%
AC40	-2.3	6,696	-	501	-7.4%	30.18	-8.6%
MR-EV40-8h	13.2	7,030	5.0%	510	-5.6%	22.36	-32.3%
MR-EV40-3h	5.1	7,573	13.1%	510	-5.6%	22.36	-32.3%
MR	18.8	6,696	-	540	-	24.73	-25.1%

Table 4 Retro Analysis Results: Reserve Margin, Annual Peak Power Demand, Annual Energy Demand, Annual Direct and Indirect GHG Emissions

4.1 Reserve Margin and Peak Power Requirements

Reserve margin is the excess generation capacity at the peak power demand, and is expressed as a percentage of system capacity. Many scenarios, including the base year (-2.3%), have a negative reserve margin, demonstrating that the power system is already stressed. This is currently dealt with by load shedding, where electricity users agree to shut down operations. The 2021 target, a 2.3% shift to EV's, has minimal impact on the reserve margin (-2.5%, a 0.2% decrease from the baseline). Suggesting this level of EV's will be well tolerated given the current grid resources. The 2040 target,

a 40% shift to EV's, has a significant impact of reserve margin, in the 8 hours charging case it drops the reserve margin to -7%. In addition, the reserve margin is highly sensitive to the charging strategy. Under the critical charging strategy (3 hours), the reserve margin drops to -13.6%. This highlights significant challenge EV charging timing may present to the grid. Further, as capacity is added to the grid, the reserve margin sensitivity increases, with an 8.1% difference in reserve margin between the two charging scenarios (MR-EV40-8h & MR-EV40-3h). This reflects the challenges of a higher share of intermittent generation such as wind power, which increases 142% under the proposed "mixed renewables" grid. With the added generation capacity, a 40% shift to EV's results in a reserve margin or 5.1% for the worst-case scenario, the critical charging strategy. Showing the 40% addition may be well handled with the proposed modifications to the grid. However, the peak loading requires a large addition of capacity to manage, meaning a significant infrastructure cost.

Grid operators and government entities appear to have a high level of confidence on the future prominence of distributed generation, demand response and storage to manage the demand volatility. It has been claimed that smart grid technology encompasses some of these expected advantages. In contrast to existing electrical grids, they are based on a digital structure that enhances the integration of additional renewable capacity, EV's and distributed generation (Bayindir et al. 2016). Nevertheless, at present, smart grids cannot offer this level of flexibility and there are still critical economical and technical barriers to overcome. On the technical side, there are several research challenges implied by the dependence of the intelligent grid on information and communication infrastructure. There are also concerns on the design, deployment and maintenance of smart meters; conduction losses, high temperatures in components, harmonic injections and failure diagnosis. These are key problems in power electronic interfaces (Colak et al. 2016). From a power system perspective, a higher penetration of renewable technologies will imply dealing with a system whose behavior will be quite different from the behavior from current centralized arrangements. Renewable generation technologies lack the ability to deliver the required inertia that is enhanced by rotating masses from synchronous generators, meaning that, it will be challenging for the new system configuration to provide immediate frequency responses to inequalities in the overall power balance (Tielens & Van Hertem 2016). Aside technical issues, the implementation of smart grid technology will need the support of effective economic and regulatory mechanisms to establish the level of grid ownership on a distributed context and control pricing schemes that account for capacity and energy costs (Poudineh & Jamasb 2014). There is an inherent risk in the energy outlook for New Zealand as it heavily leveraged on the success of yet to be proven technologies.

4.2 Energy Demand and GHG Emissions

According to our results, GHG emissions from the energy sector accounted for a total of 33 million tonnes of CO2e in the BASE scenario, which fits the 31.5 million tonnes of CO2e reported under the New Zealand's Greenhouse Gas Inventory (Ministry for the Environment 2018). For total energy demand, there is only a 0.4% relative difference between the BASE scenario and the 542 PJ reported in the National Energy Balances (Ministry of Business Innovation and Employment 2015).

The 40% shift of EV's without modifications to the grid reduces carbon emissions by 3.2%, the charging strategy makes little difference to the emissions. With modifications to the grid (i.e. added renewable generation and partial removal of thermal power plants) this reduction increases to a substantial 32.3% reduction. However, the modifications to the grid alone provide a 25.1% reduction, and so in this best case scenario, the 40% shift to EV's are only responsible for a 7.2% decrease in emissions. This shows that the efficacy of EV's for emission reductions are highly dependent on the added capacity and that modifications to the grid are far more effective at driving down emissions than the significant shift to EV's, a large extend of the reductions coming from the residential and commercial sectors, as shown in Figure 3. Figure 3 also illustrates that the transportation sector remains highly carbon intense even with the addition of EV's. This analysis did not take into account the large embedded energy of EV's and their batteries. The IVL Swedish Environmental Research

Institute has published a report of the greenhouse gas emissions from lithium-ion batteries and found that 150-200 kg Co_{2e} per kWh are required in the current manufacture of these batteries (Romare & Dahllof 2017). For a 40% ICE to EV replacement in New Zealand, considering a 10 year battery replacement and current battery options for the Nissan Leaf, between 0.37 and 0.61 million tonnes of CO_{2e} would be produced in maintaining the batteries for the EV fleet. This is equivalent to 1.1% and 1.8% of total annual emissions, a significant figure compared to the CO2 reductions reported in Table 4. It should be noted that the combination of the grid modification and the shift to EV's (a 32.3% reduction of total emissions from 2012 levels), represents only 7% reduction of energy related emissions from 1990 levels (Ministry for the Environment 2018).

Other strategies considered (MT40 and AC40), reduced emissions 5.1% and 8.6% respectively, without increasing peak demand and requiring intensive modifications to the grid. This highlights that these strategies should not be overlooked as they do not have a strong dependence on the electrical power infrastructure and avoid significant expenses associated with EV's (EV's, batteries and charging infrastructure). For the vehicles alone, assuming the current price of a commercial EV (approximately 25,000 USD) and a discount rate of 5%, the replacement of 40% of the light passenger fleet would represent annual disbursements of 2.7 billion USD from 2012 until 2040.

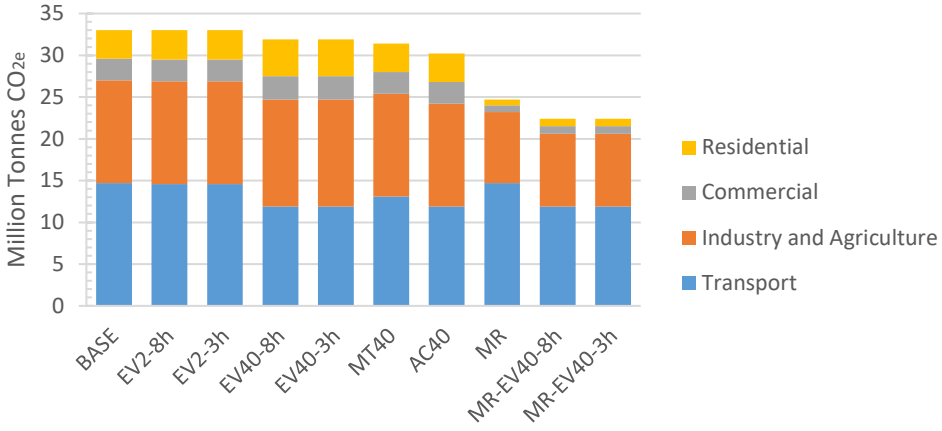

Figure 3 Annual Direct and Indirect GHG Emissions disaggregated by sector

4.3 System Costs

Figure 4 shows the transformation and resource costs. Transformation include maintenance and capital related costs whereas resources include petrol and diesel costs from the transport sector and natural gas to run thermal power plants. Results from different scenarios show an evident tradeoff between capital for investment in renewable energy technologies and fuel required to run thermal power plants. The analysis is based on 2012 fuel costs so the differences will be highly sensitive to future changes in oil price. The costs for the base scenario appear relatively higher to other scenarios. This observation can be interpreted as the cost of not taking future interventions. The MR scenario appears as the most costly given the substantial investment needed for wind generation. There is an observable tradeoff between the costs of building new infrastructure to run EVs with renewable electricity and the costs to keep running cars on oil derivatives. Policy initiatives that account for an optimal balance between technological interventions and commuter behavior are essential, specially when electric public transport may better serve the population.

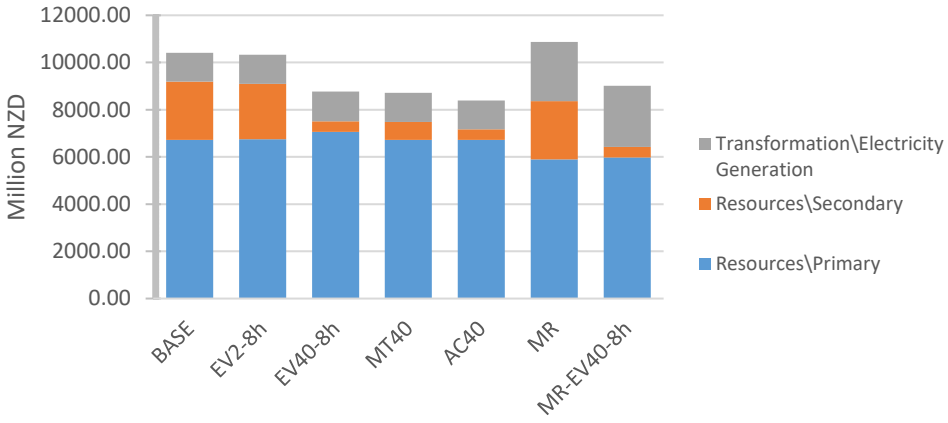

Figure 4 Annual Electricity System costs

5 Conclusions

This model analyzes the impact of EV's and EV policy on New Zealand's power system. The 2021 policy target, a 64,000 vehicle shift to EV's appears to have minimal impact on the power system and should be well tolerated, however it does add a burden to an already stressed power system. A 40% shift to EV's, without modifications to the Grid, significantly increases peak power demand and drives the reserve margin down to between -7% and -13.6%, which may cause significant problems to the functionality of the power-system. The shift also has minimal impact on carbon emissions (-3.2%). With grid modifications, the risk to the power system of the added EV's is reduced (reserve margin >5.1%) and the combination gives a significant reduction of carbon emissions (-32.3% total emissions), although the majority of this reduction comes from added renewable generation capacity. Mass transportation and adaptive capacity are promising pathways that should be explored. They provide significant reductions in carbon emissions (5.1% and 8.6% respectively) without the expenses and technological barriers associated with EV's and added grid capacity.

Currently LEAP lacks storage modeling capabilities, which forced us to disregard the assessment of a decentralized system made up by EV batteries or pumped hydro storage as potential tactics to resolve the intermittency problem. LEAP has the capability to use optimization to calculate a least cost capacity expansion. It was our desire to deliver an optimal expansion plan and contrast it against the one proposed by the MBIE. In our model, the uptake of EV's was reflected by the increase in electricity demand from the residential sector; therefore, we had to define load shapes for each demand device (i.e. fuel technologies within every sector). This feature proved to be a limitation as the software only allows executing optimization given a load shape for the entire system. Additionally, the precision of the results is sensible to the resolution of the time slices. In our case, we were particularly interested in peak power requirements and reserve margin, so we defined an additional time slice to reflect the year's peak hour event. Nevertheless, the calculated emissions might be slightly underestimated for days with high power requirements (i.e. winter days) as the time slices correspond to daily averages of energy demand and power plant availability. Our retrofit approach does not extrapolate future economic activity or population growth. However, this is not a software limitation, and this analysis is possible since additional assumptions can be added to the analysis.

In this paper, we assumed that a power plant's availability was defined by reported historical performance. Nonetheless, it is important to acknowledge that the power dispatched by the system also depends on economic and technical matters. From the perspective of the generators, it would be desirable to dispatch power when the unitary price of energy is higher. Also, power plants may experience temporal pauses due to planned or unplanned maintenance. The real resource availability may be higher than the one used in the model.

Future research should explore the costs associated with added grid and EV charging infrastructure, so the full costs of these policy decisions may be evaluated. There are ongoing efforts to support

electric mass transport systems in New Zealand, for instance, the extension of rail electrification to Pukehoke is considered as a priority investment under the Auckland Transport Alignment Project. Similar initiatives should be investigated to give perspective to the costs of an EV based mass transportation system. Strategies involving multiple pathways (EV's, electric rail etc.) should be combined and analyzed to explore what multi-pronged solutions have the best fit for NZ. One key issue that should be addressed are the risks associated with a large share of highly variable generation (wind), as is proposed. Particularly the capacity to handle over-generation and rapid swings in supply, along with an unknown volatile power demand from EV charging. Additionally, wind generation does not reliably help to mitigate peak power demands.

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Re agriculture, I have read that both Massey Uni and NZ Dairy have done analysis that shows that reducing stocking rates on dairy farms by roughly 30% produces about a 40% reduction in input costs and a 20% increase in profits! I don't understand why more farmers aren't trying this, but according to the RBNZ about 35% of dairy farmers have high levels of debt…perhaps they are so pressured by their banks that they are afraid to try a different farming method. Rather than blaming farmers (who in many cases were encouraged to make these conversion by the previous Government, Fonterra, bankers and salespeople), we will need to support them (financially) in a just transition to lower emissions.

However, in Christchurch transport is our biggest source of emissions. Post-quake, our bus service has been reduced whilst charges have increased (I'm looking at you ECAN). Again, this was the previous Government's doing, but now we have a different Government that presumably will reverse the preference for big roading systems and instead increase support for both public and active transport - so that should help considerably. I would like to see public transport heavily subsidised, coupled with congestion charging to both pay for it and encourage more use of public transport. Improving the uptake of public transport (especially during peak times) benefits both those on the bus and those who stay in their vehicles. I remember hearing that 26% of the benefit of improving public transport goes to those who are still in their own vehicles.

We also need to use the existing rail lines for commuter rail to the ex-burbs that resulted from the post-quake LURP. We also need to consider a light rail down Riccarton Rd and Tuam combined with intensified urban development (see Susan Krumdieck's From the Ground Up proposal).

We need more efficient urban redevelopment, close in, that is based around shared green spaces, low-rise housing (more levels than just row-houses), public/active transport options and shared E-vehicles. I would be interested in living in such a development. I am not interested in these pokie, chopped up sections filled with houses and fences and little community space (other than shopping areas, of course) that the developers favour. It might maximise their profits, but it doesn't create pleasant communities - in my opinion.

Aside from reducing our emissions, addressing these transport issues will help us financially. Everybody driving their cars (because there is no reliable alternative) is extraordinarily expensive. Also, transport fuels are a significant part of our annual import costs and contribute enormously to our trade deficit, adversely affecting NZ's current account. Converting our transport system to a more public/active model will reduce our vulnerability to spikes in global oil prices or a reduction in the value of the NZ dollar, thereby increasing our economic resilience.

Starting in 2020, under the Paris Agreement, we will be required to purchase offsetting carbon credits for our net emissions. In October, 2016, Radio NZ reporter Eric Frykberg covered a conference where Ministry for the Environment climate change director Kay Harrison estimates that the cost of this commitment, for the first 10 years (2020-2030) may be as much as $72 Billion or 30% of annual GDP or 3% of GDP each year. This assumes a price of $50/ton. If international carbon credits are $25/ton, then cost is 'only' $36 Billion.

To put this in perspective, if we assume a population of 4.7 million Kiwis, that equates to between $760 and $1,530 every year for every Kiwi, or about $1,200/ year/Kiwi for a result somewhere in between. How will we afford this?

Frykberg also refers to a report prepared by Infometrics estimating that from 2020, only one fifth of New Zealand's greenhouse gas targets would be met by domestic reductions in emissions and we would have to purchase the rest.

Keith Woodford, a Professor at Lincoln, writing about this, said, “We need to reduce our annual net emissions by about 18 million tonnes” and "by my calculations we need to be planting about 80,000 hectares of new pine forests each year and starting right now". He also said, "If we don’t plant more trees then we either have to kill the cars, kill the cows, or most likely kill both."

So - we better get cracking, we’ve procrastinated and denied for too long and for decades made choices that have taken us down the wrong path. We have wasted trillions in capital investments that were a misallocation of resources. It is time to make the hard choices, to choose a different path. The sooner we do this and the harder we push for these changes, the better off we’ll be.

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PLOS ONE

RESEARCH ARTICLE

Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: A modelling study

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Abstract

Background

Physical inactivity contributes substantively to disease burden, especially in highly car dependent countries such as New Zealand (NZ). We aimed to quantify the future health gain, health-sector cost-savings, and change in greenhouse gas emissions that could be achieved by switching short vehicle trips to walking and cycling in New Zealand.

Methods

We used unit-level survey data to estimate changes in physical activity, distance travelled by mode, and air pollution for: (a) switching car trips under 1km to walking and (b) switching car trips under 5km to a mix of walking and cycling. We modelled uptake levels of 25%, 50%, and 100%, and assumed changes in transport behaviour were permanent. We then used multi-state life table modelling to quantify health impacts as quality adjusted life years (QALYs) gained and changes in health system costs over the rest of the life course of the NZ population alive in 2011 (n = 4.4 million), with 3% discounting.

Findings

The modelled scenarios resulted in health gains between 1.61 (95% uncertainty interval (UI) 1.35 to 1.89) and 25.43 (UI 20.20 to 30.58) QALYs/1000 people, with total QALYs up to 112,020 (UI 88,969 to 134,725) over the remaining lifespan. Healthcare cost savings ranged between NZ$127million (UI $101m to 157m) and NZ$2.1billion (UI $1.6b to 2.6b). Greenhouse gas emissions were reduced by up to 194kgCO_2e/year, though changes in emissions were not significant under the walking scenario.

Conclusions

Substantial health gains and healthcare cost savings could be achieved by switching short car trips to walking and cycling. Implementing infrastructural improvements and

information about the travel survey is available at www.transport.govt.nz/travelsurvey/.

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interventions to encourage walking and cycling is likely to be a cost-effective way to improve population health, and may also reduce greenhouse gas emissions.

Introduction

Transport has a major impact on population health–it directly affects injury rates and air pollution, and indirectly influences physical activity and health impacts arising from climate change. Reducing car use and increasing active transport is expected to improve health at the city-level, nationally, and internationally [1–7].

Setting and population-specific estimates of the impact of transport changes are required to trade-off the positive and negative impacts of increased active transport. For example, there are concerns that increased injury risk or increased air pollution exposure may outweigh the benefits of increased physical activity levels in selected population groups or settings [5].

New Zealand (NZ) is highly car dependent: 79% of all self-reported trips are made by car [8] and car ownership rates are among the highest in the world. Low physical activity is the 4th leading behavioural risk factor in NZ [9], and only half of adults meet the national physical activity recommendations [10]. In addition, 17.3% of gross greenhouse gas emissions in NZ are related to road transport [11].

Internationally, estimates of the health impact of increases in active transport are commonly conducted using comparative risk assessment (CRA) methods [1–4]. However, comparative risk assessment methods do not account for time lags between exposure and disease and long-term changes in survival [12] and this suggests that many studies modelling the health impact of increasing active transport overestimate the benefits.

Previous NZ research based on comparative risk assessment methods strongly suggests that increasing active transport is likely to have positive health impacts and reduce greenhouse gas emissions [4, 7]. However, neither of the previous studies included time lags, estimated the uncertainty around modelled health impacts, nor used a lifetime approach to assess the long-term health impact. These methodological limitations mean it is unclear how the health impact of increasing active transport might compare to addressing other population level risks (e.g. smoking and unhealthy diets). This is particularly problematic from a policy perspective–if the likely impacts of addressing different health risks cannot be compared due to differing methodological approaches then it is difficult to prioritise resource spending appropriately across competing health priorities.

We conducted this study to estimate the health impact, change in health system costs, and greenhouse gas emissions associated with increasing active transport in New Zealand. We use an established multi-state life table modelling approach that has been used to estimate the impact of a wide range of other public health interventions internationally including dietary change, alcohol reduction, and tobacco end game strategies [13–15]. Use of comparable methods facilitates comparison of increasing active transport with interventions addressing other population level risks (e.g. smoking and unhealthy diet).

The aims of this study were: (i) to estimate health impact of switching short trips to walking and cycling; (ii) to estimate change in health system costs associated with modelled changes in transport patterns; (iii) to estimate change in greenhouse gas emissions associated with changes in transport patterns in NZ.

Methods

Overview

We modelled the differences in quality-adjusted life years (QALYs) and healthcare costs of shifts in transport behaviours in NZ. We estimated changes in transport patterns and greenhouse gas emissions using unit-level survey data and then multi-state life table (MSLT) modelling to determine long-term impacts on population health and change in health system costs. The MSLT part of the model used the intervention impacts (change in physical activity, distance travelled, and air pollution) to estimate impact on QALYs and healthcare costs over the remainder of the lifetime of the New Zealand population alive in 2011. Input parameters included risk factor distributions (mode-specific distance travelled, physical activity, and air pollution) and disease data (including incidence, prevalence, and mortality rates, trends, disability weights, and costs). Sources of model inputs are summarised in Table 1, a conceptual framework of the model structure is outlined in Fig 1, and full model details including parameter values are detailed in a Technical Report [16].

Table 1. Description of model inputs.

Input parameter(s)	Detail	Data source
Risk factor		
Physical activity	Minutes per week of moderate and vigorous physical activity (MVPA-METmins/week), weighted by MET value associated with activity. Heterogeneity by age, sex, and ethnicity.	New Zealand Health Survey 2011/12 Compendium of Physical Activities [17]
Distance travelled	Mode-specific total annual distance travelled (for pedestrians, cyclists, motorcyclists, and motor vehicles). Heterogeneity by age, sex, and ethnicity.	New Zealand Household Travel Survey 2003–2014 [18, 19]
Air pollution	Population-weighted annual fine particulate matter exposure (<2.5μm diameter). No heterogeneity.	Brauer et al [20]
Disease and injury parameters		
Disease incidence, prevalence, case-fatality, and mortality rates	Each parameter was first estimated from linked health data, then simultaneously entered into DisMod II (an epidemiological calculator) to ensure coherence. Heterogeneity by age, sex, and ethnicity.	As per Cleghorn et al [21], with model inputs available at [22]
Injury incidence and mortality rates	Derived using GBD data on mode-specific incidence and mortality rates by age and sex, combined with Health Tracker data and NZBDS to estimate rates by ethnicity.	GBD Results Tool [23], NZBDS [24] and Health Tracker
Morbidity rates	In the main lifetable that simulated the QALYs, morbidity for each sex by ethnic by age group in BAU uses the years of life lived with disability (YLD) due to all causes from NZBDS, divided by the number of people in this strata to give a rate. This represents the average 'background' morbidity rate experienced. Disease-specific morbidity (or 'disability') rates are derived similarly, using disease specific YLDs from the NZBDS. Disease specific morbidity rates reflect the average disability experienced by someone with that specific disease. For example, CHD morbidity rate for 55–64 year old non-Māori males was calculated as follows. NZBDS pYLD estimate for 2006 (1,321) was scaled to account for demographic change to estimate pYLD value for 2011 (1,533). The scaled pYLD estimate was divided by the number of prevalent cases estimated from DisModII (17,326), to give a morbidity rate of 0.088.	GBD [25], NZBDS [24], as per methods described in detail in [21] and [26], with model inputs available at [22]
Healthcare costs (2011 NZ$)	The costs used represent excess annual health system costs for cases in first year of diagnosis, last year of life if dying of that disease, and otherwise prevalent years of diagnosis. Heterogeneity by age and sex, but not ethnicity.	As per Kvizhinadze et al [27], available in [16]

GBD: Global Burden of Disease Study

MET: Metabolic equivalent of task

MVPA: Moderate and vigorous physical activity

NZBDS: New Zealand Burden of Disease Study

YLD: Years lived with disability

See Technical Report [16] for further details on parameters, including uncertainty distributions.

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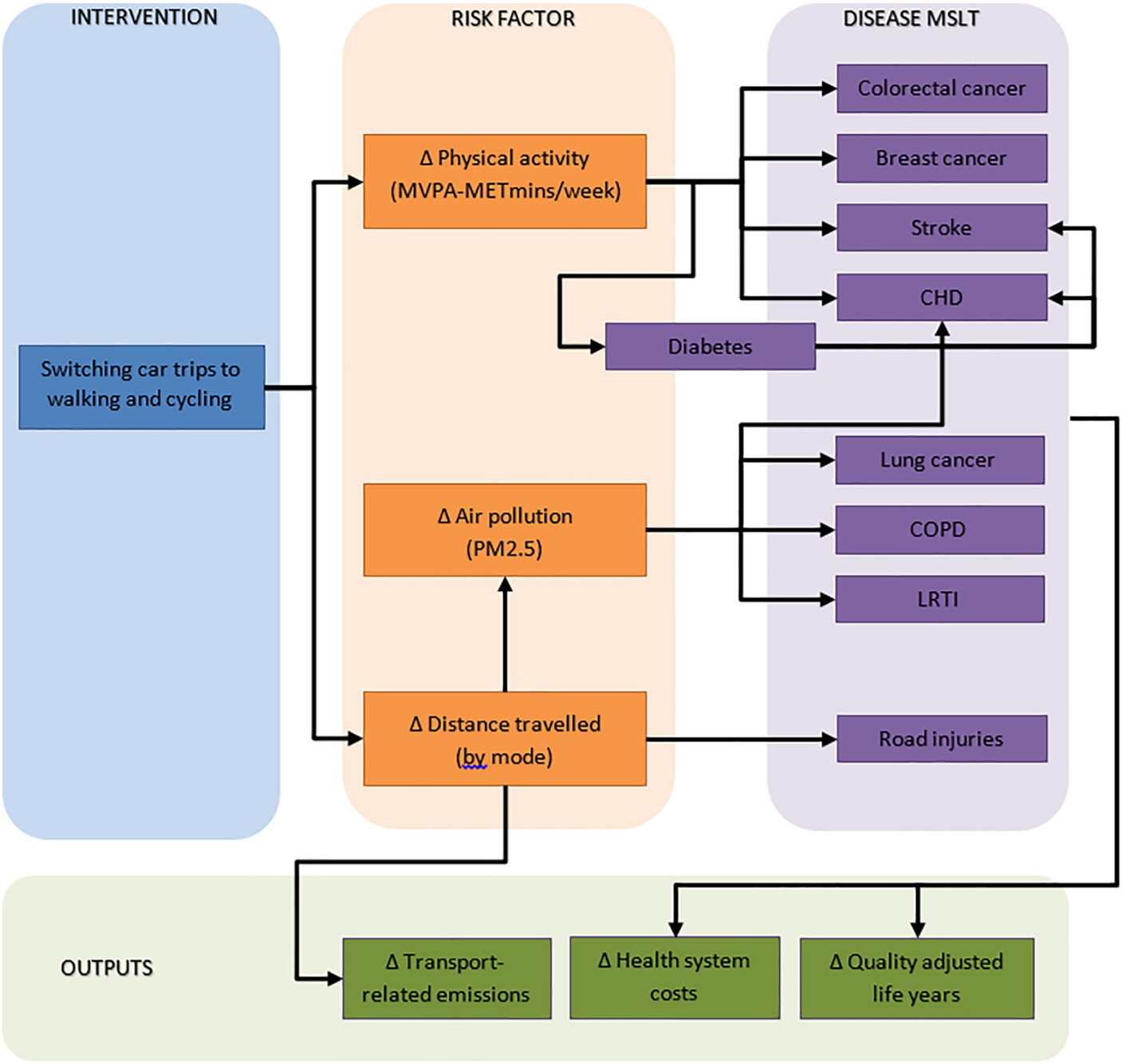

Fig 1. Conceptual framework of the model.

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Intervention scenarios

We modelled the following interventions: (a) switching car trips ≤1km to walking; (b) switching car trips ≤1km to walking and those 1-5km to cycling. In all cases, we switched "there-

and-back" trip pairs for individuals aged 15–79 years. We defined there-and-back trip pairs as two consecutive trips, travelling from a start location to a destination and back, using the same mode. Individuals aged 80+ years were excluded from trip switches due to small numbers participating in active transport and high prevalence of co-morbid conditions that could limit participation at older ages.

The NZ Household Travel Survey dataset was used as the baseline population to estimate changes in travel behaviour under the interventions. An anonymised and de-identified dataset was obtained under a confidentiality deed from the New Zealand Ministry of Transport. For each model run, we sampled there-and-back trips within the dataset to switch from driving (driver or passenger) to walking and/or cycling (random sampling based on scenario percentage uptake), and then calculated person-level changes in physical activity and population-level changes in distance travelled by mode.

Intervention changes in physical activity were calculated by the change in moderate and vigorous physical activity, expressed as a change in MET (metabolic equivalent of task) minutes per week of moderate and vigorous activity (MVPA-METmins/week). A MET is the ratio of work metabolic rate to a standard resting metabolic rate, where one MET is equivalent to sitting quietly [17].

For trips that switched to walking under the intervention scenarios, we assumed that the distance travelled remained constant at a 4.4km/hr walking speed (SD 0.88) [19]. We calculated the duration of the walking trip and multiplied by 3 (SD 0.06, uncorrelated with walking speed) (assigned MET value for walking [17]) to estimate the change in MVPA-METmins. For example, a 0.6km car journey switched to walking would result in a MVPA-METmin increase of 24.5 (0.6 /4.4 * 60 * 3). For trips that switched to cycling, we followed the same process but assumed a speed of 10.5km/hr (average cycling speed of those who reported cycling trips at baseline in the Household Travel Survey (calculated from reported trip distance and duration)) and a 3.5MET values corresponding to cycling at that speed derived from the Compendium of Physical Activities [17]. Trip-level changes in physical activity and mode were aggregated to estimate average population level changes in weekly physical activity and annual mode-specific distance travelled, by age, sex, and ethnicity. Change in air pollution exposure, for the whole population, was calculated from change in distance travelled by motor vehicle.

Intervention impact

The health impacts of modelled interventions were estimated using a proportional multi-state life table model adapted from a model previously developed to evaluate health impacts of changes in diet [21]. We simulated the health impact on the adult NZ population, alive in 2011, out until death (lifetime horizon). The business-as-usual (BAU) scenario reflects continuation of current physical activity levels and transport behaviour, and best future annual percentage change estimates for future trends to 2026 (then held constant) in all-cause mortality and non-communicable disease incidence and case fatality in New Zealand. Intervention scenario changes are assumed to continue for the remainder of the modelled population's lifetime. We applied a 3% discount rate to QALY gains and cost-offsets, in accordance with the Burden of Disease Epidemiology, Equity, and Cost-Effectiveness Protocol and international precedent (e.g. ACE-Prevention in Australia and the recommendations of a US panel of health economists) [26]. Undiscounted results are presented in the Supporting Information.

Intervention effects were captured by combining the differences in risk factor exposure between the BAU and intervention scenarios with relative risks for the association between the risk factor and disease to generate population impact fractions–essentially a percentage change in disease incidence rate. These changes in disease incidence rates flowed through the

proportional life tables to change disease prevalence and then changed disease mortality (as disease case fatality was acting on a different prevalent pool of cases). Disease-specific changes in mortality and morbidity rates were summed up across diseases in each annual cycle for each sex by age by ethnicity (Māori and Non-Māori) cohort, and subtracted or added to the BAU all-cause mortality and morbidity rates in the main lifetable to estimate QALYs gained over the remainder of the cohort's lifespan (or up to age 110 if still alive). Changes in health system costs between BAU and intervention scenarios were also calculated by the changes in the proportion of the population experiencing incidence, prevalence, and death.

Physical activity. To estimate the baseline distribution of physical activity, we converted responses to the New Zealand Physical Activity Questionnaire Short Form in the New Zealand Health Survey to MVPA-METmins/week. Brisk walking was assigned a MET value of 3.0 [17], and moderate and vigorous activities MET values of 4.5 and 6.5 respectively [28]. For example, an individual who reported 30mins of brisk walking per week would have 90MVPA-METminutes/week of physical activity. Observed physical activity levels were smoothed to estimate sub-population physical activity distributions by fitting a lognormal distribution separately by sex, ethnicity (Māori and Non-Māori), and age group.

Road injuries. Changes in road injury under the intervention scenarios were calculated proportionally from changes in distance travelled by pedestrians, cyclists, motorcyclists, and motor vehicles. We then applied mode-specific safety-in-numbers coefficients to changes in distances travelled, in line with established international methods [3, 29].

Air pollution. Intervention changes in air pollution were based on changes in distance travelled by motor vehicles. We used data on the proportion of fine particulate matter attributed to domestic road transport in New Zealand (11%) [30] and assumed that this component of total air pollution would change in proportion to the change in distance travelled. For example, halving distance travelled by motor vehicles would halve the fine particulate matter contributed by domestic road transport.

Healthcare costs

Disease-specific costs were derived according to an established protocol [21, 27]. These were divided into incidence, prevalence, and mortality costs based on the timing of events (first year, subsequent years, last six months of life). Pedestrians, cyclists, motorcyclists, and motor vehicle occupant injuries were costed separately. Finally, costs were scaled to ensure consistency with total healthcare costs in New Zealand, and to avoid double counting costs attributed to individuals who may simultaneously reside in multiple disease states [27]. We present change in health system costs as 2011 NZ$ and also in 2016 US$ (derived using Consumer Price Index (CPI) and Purchasing Power Parity (PPP) adjustments) to aid international comparisons.

Emissions

We multiplied distance travelled for each trip by emissions factors to estimate baseline and intervention annual greenhouse gas emissions. Motor vehicles were assigned emissions factors based on standardised values for New Zealand–with cars assigned an emissions factor of 0.209kgCO_2e/km [31]. The emissions factor is based on the average emissions of the fuel required to travel a kilometre and does not include embodied emissions (i.e. emissions associated with the manufacture of vehicles), nor differences in emissions based on speed or distance travelled (e.g. higher emissions for 'cold start'[32]). We divided the emissions value of car trips by the number of people in the vehicle, assuming the number of people was one (i.e. respondent only) and assigning the full emissions value where the number of people in the car was

not explicitly stated. Pedestrian and cycling trips were assigned emissions of 0.195kgCO_2e/km and 0.094kgCO_2e/km respectively, again reflecting the fuel (in terms of food), required to travel a kilometre. The emissions factors used for pedestrian and cycling trips assumed that energy expenditure was fully compensated with increased energy intake (in line with our assumption of interventions resulting in no change in BMI), and that the emissions profile of the food eaten to compensate had the same emissions footprint as the average New Zealand diet [16, 33].

We report changes in emissions separately for vehicular and dietary emissions to ease comparisons with previous studies that did not include the dietary emissions component. In addition, emissions changes under the intervention scenarios are given for the first year of the intervention only, owing to the incredibly wide uncertainty around future emissions factors given the pace of technological development.

Modelling and analysis

Each scenario was simulated 2,000 times drawing probabilistically from pre-specified uncertainty distributions about each input parameter [16]. First, we ran 2,000 simulations of the individual level trip switches in R. The aggregated results from each simulation for change in physical activity and distance travelled were imported into the MSLT model, built in Excel. A custom-built Visual Basic macro was written to estimate the health impacts and cost offsets of each simulation within the Excel MSLT model, and we calculated the 2.5th and 97.5th percentiles of QALY, emissions, and cost outputs to capture uncertainty.

Scenario analyses

We conducted scenario analyses with one risk factor switched on at a time to examine the proportion of the health gain from different components of the modelled interventions–physical activity only, road injuries only, and air pollution only. We also present results adjusted for ethnic differences in background mortality rates (see [34] for further details).

Results

All scenarios increased the proportion of all trips made by active transport and reduced the proportion of all trips made by motorised vehicles (see Table 2). At baseline, 82% of all trips were made by motor vehicle; 12% of all car trips (as driver or passenger) were under 1km and 44% of car trips were between 1 and 5km. Switching all eligible trips under 1km to walking under scenario (a) reduced the proportion of all trips made by motorized vehicle to 79%. Under full uptake of scenario (b), only 64% of all trips were made by motorized vehicle, and the proportion of all trips made by cycling increased from 1% to 16% of all trips.

Scenario (a) resulted in 23,900 QALYs (UI 20,000 to 28,300; discounted at 3%) gained over the lifetime of the NZ population alive in 2011, and scenario (b) resulted in 112,000 QALYs (UI

Table 2. Percentage of all trips made by different modes under intervention scenarios.

	Baseline	(a) switching car trips ≤1km to walking (100% uptake)	(b) switching car trips ≤1km to walking and those 1-5km to cycling (100% uptake)
Pedestrian	16	19	19
Cyclist	1	1	16
Motorbike	1	1	1
Motor vehicle	82	79	64

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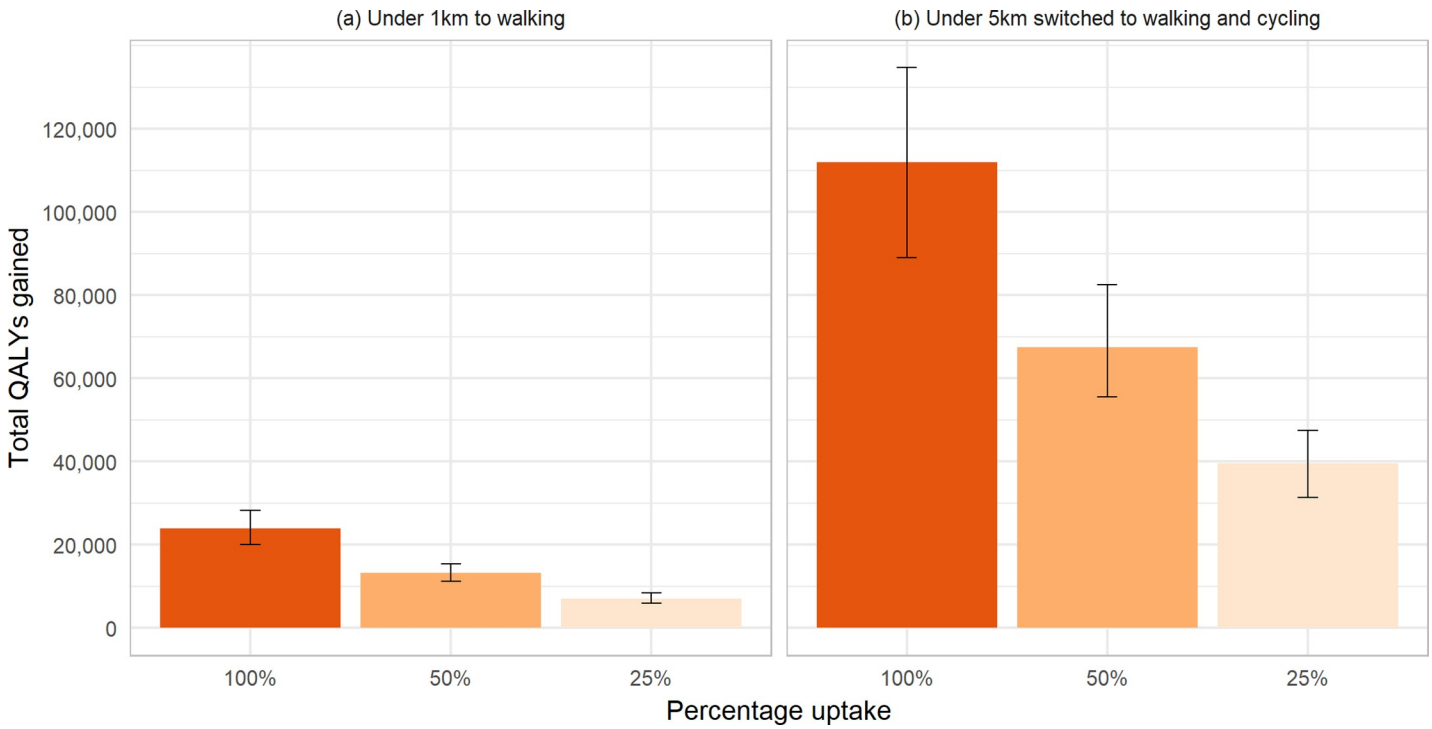

Fig 2. Total QALY gains from modelled interventions.

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89,000 to 134,700) gained under 100% uptake (see Fig 2). This equates to up to 5.42 QALYs per thousand people for scenario (a) and up to 25.43 QALYs per thousand people for scenario (b). S1 and S2 Tables display full details of the QALYs gained and change in health system costs resulting from different levels of uptake of each intervention scenario, with and without discounting. For scenario (a), 25% uptake of trip switched led to 30% of the total health gain that could be achieved if all eligible trip pairs were switched (as the relationship between PA and disease incidence is one of diminishing marginal returns for increasing PA, the percentage of trips switched and percentage of total health gain are not the same); 50% uptake accounted for 55% of the total health gain. On a per capita basis, QALY gains were generally larger in males than females, larger in Māori than Non-Māori, and largest in the 40–59 year old age group (see S3 Table). All scenarios led to reductions in health system costs (see Fig 3). These ranged from cost savings of $127million (NZD in 2011, equivalent to $90million US$ in 2016) for 25% uptake of scenario (a) to $2.1billion (NZD in 2011, $1.5billion in 2016 USD) for full uptake of scenario (b).

By modelling the health impact of each risk factor individually, we were able to determine that the health impacts were primarily driven by increases in physical activity (see Fig 4). All interventions led to an increase in road injuries that offset around 3% of the health gain in scenario (a) and up to 10% of the health gain in scenario (b). Under all intervention scenarios, the contribution of reduced air pollution amounted to under one percent of the QALY gains observed.

Although the intervention took effect immediately, the peak health gains from the modelled interventions were predicted to occur between 2031 and 2040 for the walking scenario and between 2041 and 2050 for the walking and cycling scenario (see Fig 5, and S1 Fig for <100% uptake). In the youngest age group (<40years), health gains were negative in the first ten years of the walking and cycling scenario which reflects the low incidence of non-communicable diseases relative to incidence of road injuries. Although we did not model trip switches in the 80+

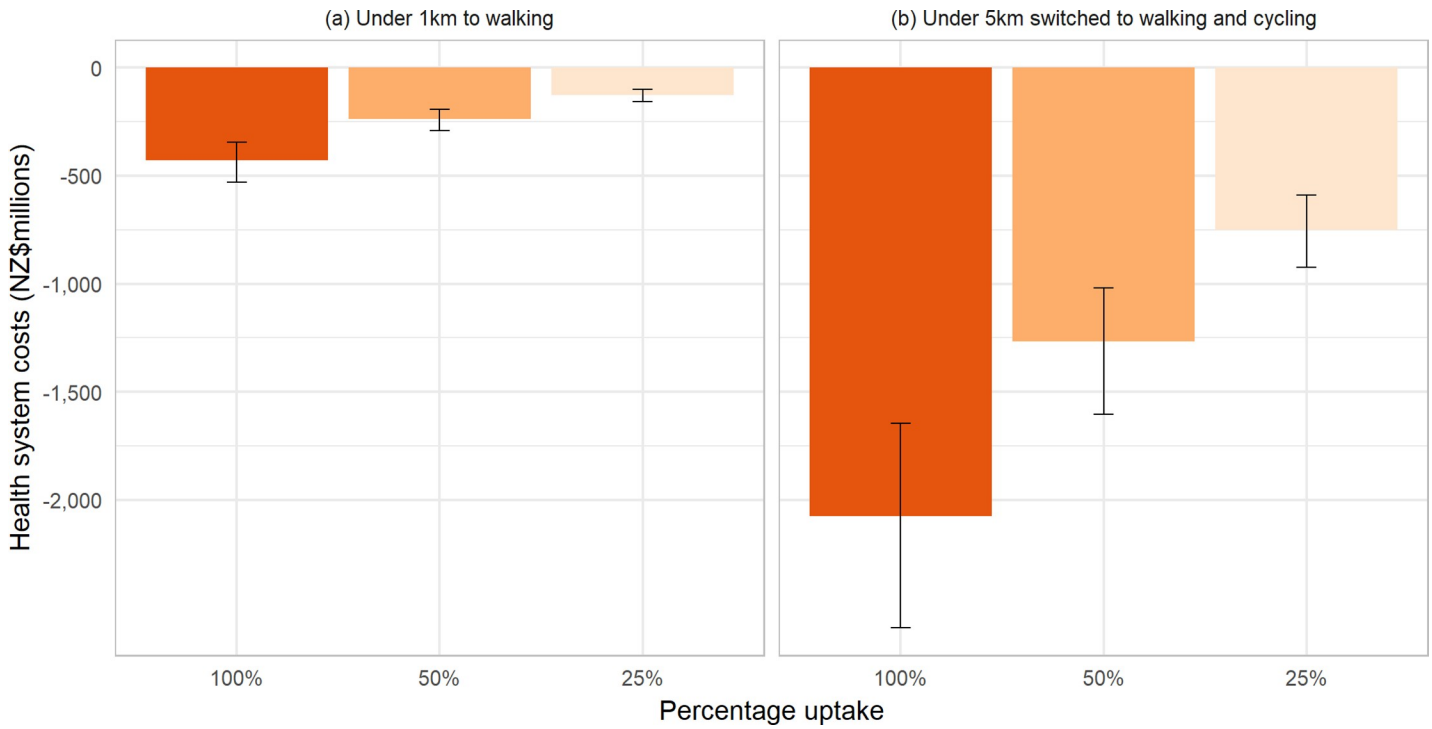

Fig 3. Change in health system costs from modelled interventions.

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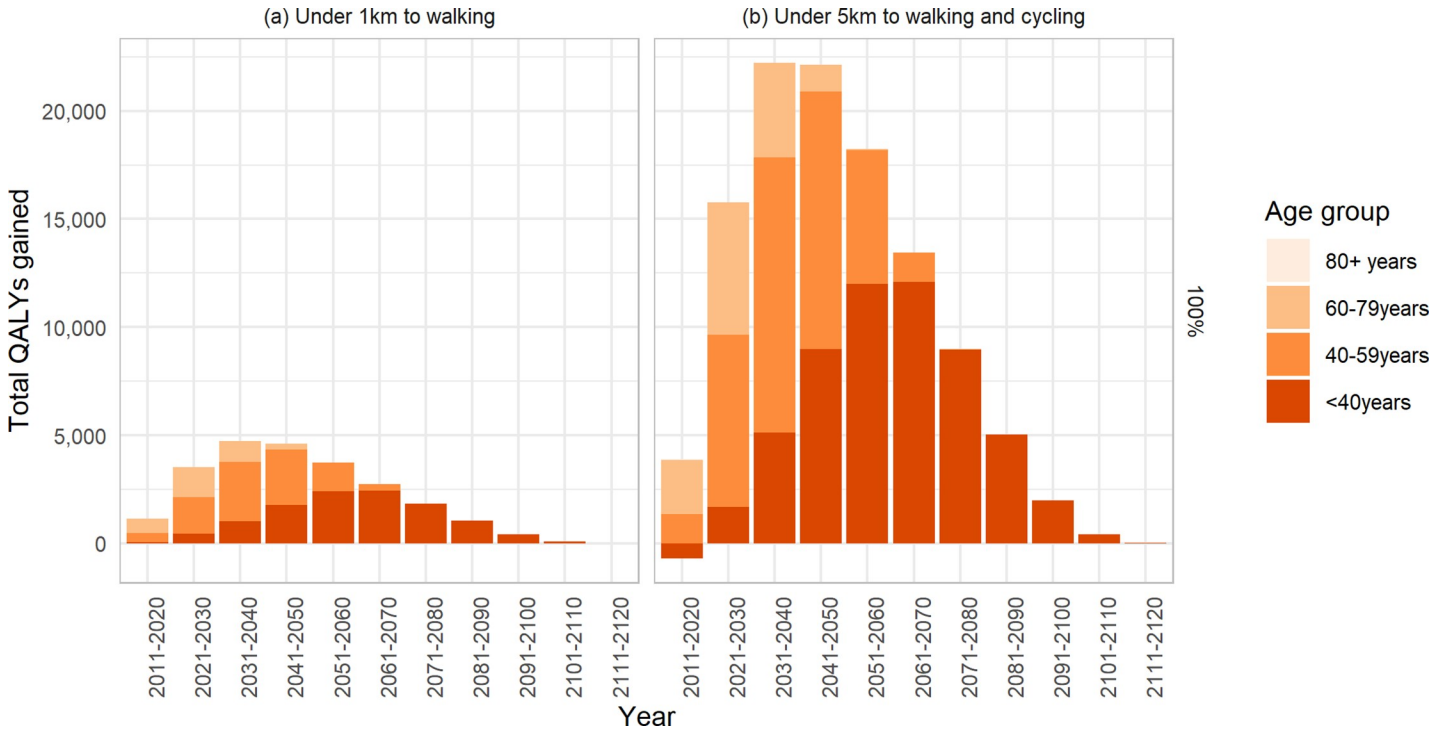

Fig 4. Contribution of risk factors to QALY gains under modelled interventions.

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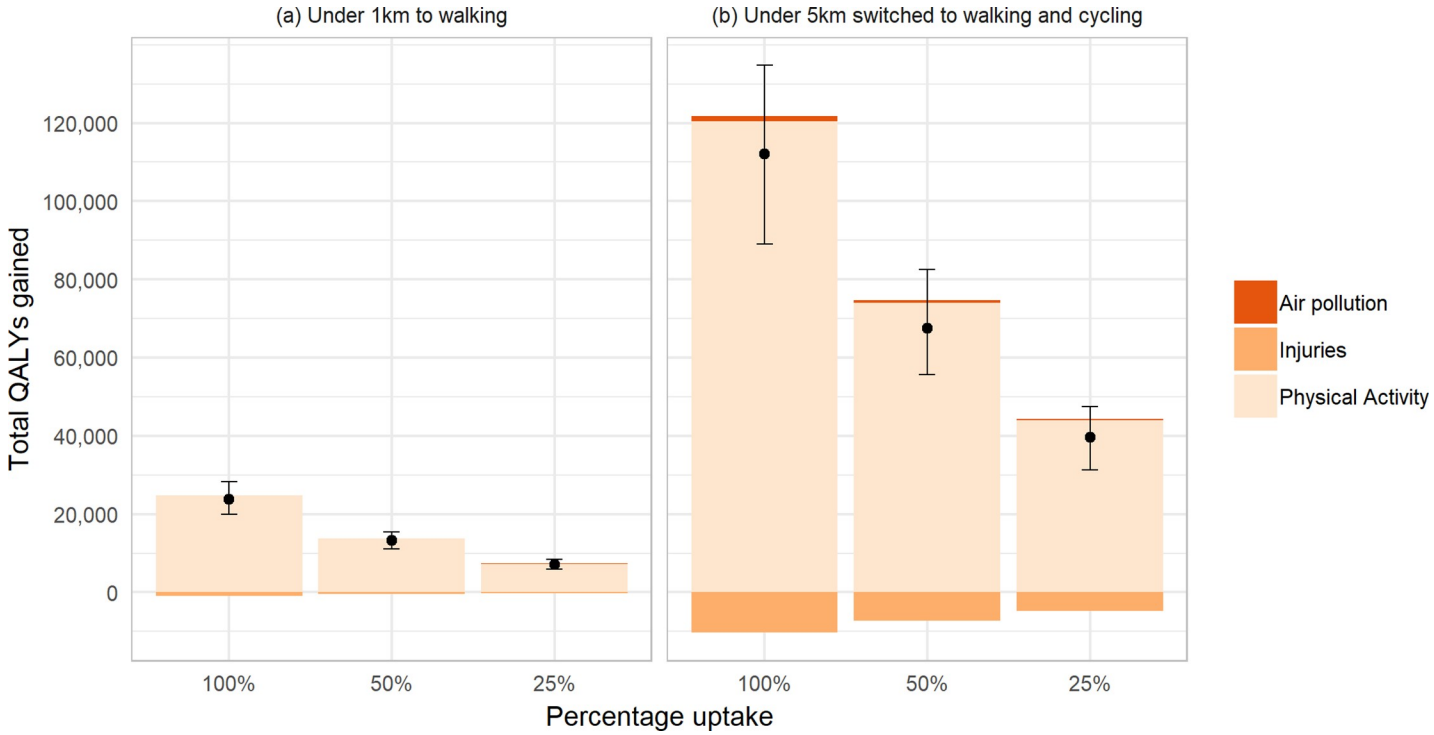

Fig 5. Timing of QALY gains, by age group, under 100% uptake of modelled interventions.

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age group, there were small positive health impacts under both scenarios due to reduced injuries due to the reduction in total distances travelled by motor vehicle.

There were reductions in vehicular emissions under all intervention scenarios, as displayed in Table 3. Changes in vehicular emissions ranged from -5.6ktCO_2e/year (UI -7.8 to -3.4) for 25% uptake of scenario (a) to -436ktCO_2e/year (UI -607.2 to– 267.6) for 100% uptake of scenario (b); corresponding to up to 4% of emissions associated with road transport in New Zealand. Reductions in vehicular emissions were compensated by increases in dietary emissions from increased energy expenditure (and therefore assumed increases in food intake) due to increased walking and cycling; for scenario (a) this led to small but insignificant increases in overall emissions. Scenario (b) resulted in significant reductions in emissions, even after allowing for increased emissions from increased dietary intake.

Discussion

Increasing active transport by switching short trips to a combination of walking and cycling resulted in positive health impacts, substantial savings in healthcare costs, and may also reduce

Table 3. Change in vehicular, dietary, and total greenhouse gas emissions under modelled interventions.

		Change in emissions (ktCO_2e)		
Scenarios	**Percentage uptake**	**Vehicular**	**Dietary**	**Total**
(a) switching car trips ≤1km to walking	100%	-22.5 (-32.0 to -13.5)	24.8 (15.4 to 34.5)	2.4 (-11.1 to 15.3)
	50%	-11.3 (-15.8 to -6.9)	12.4 (7.6 to 17.5)	1.1 (-5.3 to 7.6)
	25%	-5.6 (-7.8 to -3.4)	6.1 (3.7 to 8.5)	0.5 (-2.7 to 3.8)
(b) switching car trips ≤1km to walking and those 1-5km to cycling	100%	-436.4 (-607.2 to -267.6)	241.3 (156.6 to 330.2)	-194.4 (-377.2 to -3.1)
	50%	-218.0 (-302.5 to -136.0)	121.3 (79.0 to 163.8)	-97.5 (-192.5 to -2.7)
	25%	-108.1 (-153.3 to -65.7)	60.3 (39.6 to 81.8)	-47.2 (-96.9 to -1.9)

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greenhouse gas emissions. The majority of the health gains from modelled interventions were due to increases in physical activity as opposed to air pollution. This is the first study that simultaneously quantifies the health impact, health care cost savings, and changes in transport-related greenhouse gas emissions associated with switching short trips to walking and cycling at the national level.

Comparison with previous literature

Our results support the findings of previous literature that show health benefits from increasing active transport. In line with previous research, we find that increases in physical activity account for the majority of health gains for active transport interventions and more than compensate for increases in road injuries [1–3].

Our overall results are similar to those of a recent Australian study estimating the health impacts of increasing active travel in Brisbane using a MSLT modelling approach [6]. The authors estimated per capita gains of around 28.8 health-adjusted life years per thousand (3% discounted) for an intervention that reduced the proportion of trips made by car from 82% to 63%, a similar intervention and result to the full uptake of our combined walking and cycling scenario.

The relative reduction in health gain from increased road injuries as a proportion of the total health gain of interventions that increase physical activity is also similar to previous research. Stevenson et al [35] found reductions in health gains from increased road injury to be up to 7% of total health gains observed across a range of cities worldwide; road injury increases also amount to between 2 and 20% of the total disability adjusted life years gained from interventions to increase walking and cycling in California [1]. These studies demonstrate the need for road safety improvements alongside strategies to increase active transport, to ameliorate real and perceived road safety issues associated with active transport uptake, and to maximise health gains. Strategies to improve road safety are particularly important to ensure positive shorter-term health impacts of increased active transport in younger age groups who experience low non-communicable disease prevalence but high risk of road injury.

The overall greenhouse gas emissions reductions we observe for 100% uptake of the walking and cycling scenario are equivalent to up to 64,000 people flying return between London and Auckland, or up to 1.4% of total emissions from road transport in NZ. The reductions modelled here are smaller than previous estimates as we attribute greenhouse gas emissions factors to walking and cycling (as the current study included estimates of GHG emissions associated with increased food intake), as well as to motorised vehicles. Our emissions factors for walking and cycling are based on the assumption that individuals completely compensate for the increased energy expenditure resulting from walking and cycling, and that the emissions of foods that are compensated is comparable to that of current diets in New Zealand [33]. Meta-analysis of the impact of active transport on BMI shows minimal impact [36], hence we assumed that walkers and cyclers increase food intake directly proportion to changes in energy requirements. However, if energy expenditure was not fully compensated, then the emissions associated with walking and cycling would be lower and there would be additional (likely substantial) health impacts from reduced obesity. In an Australian modelling study which assumed that increased active transport would result in reduced obesity, the change in obesity alone resulted in 80% of the health gains of all risk factor components combined (i.e. obesity, road injury, physical activity, and air pollution combined)[37].

Regarding the GHG emissions, the dietary component of greenhouse gas emissions is amenable to change–dietary greenhouse gas emissions can be reduced by 70–80% by adopting more sustainable diets (e.g. by reducing meat and dairy intake) [38]. This emphasises the need

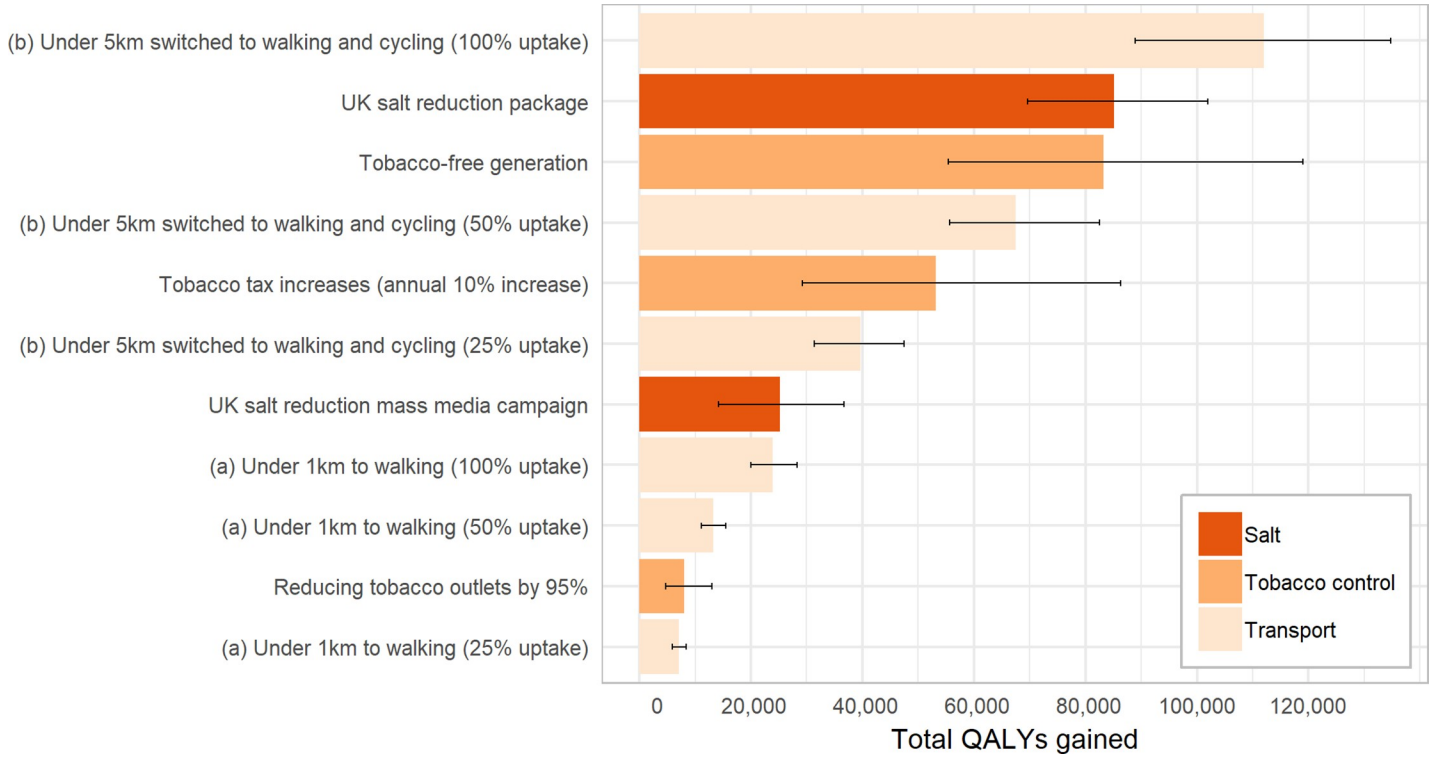

Fig 6. Comparison of active transport scenarios with previously modelled interventions.

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for changes towards sustainable diets regardless of, or in parallel to, increasing transport-related physical activity.

The modelling framework used in this study is comparable to previous work in NZ and this allows us to compare changes in transport interventions against other public health interventions. Fig 6 plots the results of this study against previously modelled interventions for reducing tobacco [15, 39] and reducing salt in New Zealand [40]. The 25% uptake of scenario (a) had similar modelled health gains to reducing tobacco outlets by 95%, and the 100% uptake of scenario (b) had greater health impacts to the modelled health impact of a tobacco-free generation or a UK-style salt reduction campaign. That is, these are substantial health gains.

Strengths and limitations

Our study shows the health impacts associated with switching there-and-back trips to a combination of walking and cycling, which is more plausible than just switching any short trips are made by car due to the need for the car for subsequent trips. We recognise that switching all possible trip pairs (i.e. 100% uptake) is not plausible as some will represent trips made to transport heavy goods (e.g. moving furniture) or trips made by (or with) individuals with limited mobility. However, there may be other trip combinations that are amenable to switching that were not considered as part of this analysis (e.g. A → B → C → A).

We present results for differing levels of intervention uptake and show that there are disproportionate health gains at even low levels of intervention uptake; 25% uptake of trip switches delivers around a third of the total health gain possible from switching all eligible trips. This is due to dose-response relationships between physical activity and cardiovascular diseases demonstrating decreasing marginal returns as physical activity increases [28].

However, this pattern would change if trip switching was clustered within individuals. For example, if trip switches were clustered within individuals with low levels of physical activity then the health gains would be larger.

We were not able to account for patterns of clustering of trips within households. This means that two survey respondents, in the same household, making the same sequence of trips were treated independently in our analysis. This was necessary as we were not able to identify the same trip (in the same vehicle) across multiple survey respondents, and not all people making a trip were captured in the dataset (i.e. not all individuals making a particular trip were survey respondents). This is unlikely to be problematic in the context of the hypothetical scenarios examined in this study, but may be an important consideration for future work examining more targeted behaviour change strategies. For example, for analysis of a family-targeted active transport intervention it would be important to ensure that all family members "switched" at the same time to accurately capture the health impact of the intervention.

The MSLT modelling approach adopted in this study allows us to examine the timing of health gains and account for time lags between changes in transport behaviours and reductions in disease incidence. Traditional CRA approaches overestimate the benefits of physical activity relative to MSLT modelling approaches [12], and therefore it was unclear whether the benefits of increased physical activity would continue to override the negative impacts of increases in injuries. Our study shows that it does–though injury impacts may predominate in the short term in younger age groups.

We lacked data relating transport-related physical activity behaviours to current physical activity levels. We assumed that increases in physical activity under the intervention scenarios were independent of baseline physical activity levels. This may underestimate the health impacts of the modelled interventions if those who make more of their short trips by car have lower physical activity levels, again, due to decreasing marginal returns at high levels of physical activity. We also assumed that increases in transport related physical activity did not displace other physical activity (e.g. recreational physical activity). As current physical activity levels are low, it is unlikely that increases active transport would displace other physical activity but further evidence is needed to establish the extent of substitution under specific policies.

Our estimate of the health impacts related to air pollution are based on vehicle distance travelled. This captures the overall improvement in air quality due to reduced vehicle distance. We do not capture the change in trip-level air pollution exposure for an individual who switches from a car trip (at a rest breathing rate) to an active trip involving a higher breathing rate. The impact of this could be positive (if outdoor air quality is good) or negative (if active trip involves longer exposure to areas with poor air quality due to slower speed). There was insufficient data to determine air pollution exposure at the individual level within the dataset; whilst breathing rates are higher for active modes, the quality of air breathed during the trip could be better or worse. Whilst negative impacts of increased air pollution exposure associated with breathing are unlikely to negate benefits from physical activity [41], examining real-world changes in air pollution exposure from changes in travel mode is needed.

We assumed that switching short trips to active modes would not impact on BMI, in line with findings of a recent review that argued that there were minimal changes in BMI from increases in active transport [36]. Previous modelling studies have assumed BMI reductions based on zero compensation of energy intake [1, 2], and therefore likely overestimate the health impacts of modelled interventions. However, there is emerging evidence from observational studies suggesting that individuals who transition from walking to cycling may have a decrease in BMI [42, 43]. Further research is needed to establish the extent to which additional energy expenditure from increased walking and cycling is compensated by increased food intake. Different interventions may have different BMI impacts (e.g. mass media campaign

encouraging walking for weight loss compared to infrastructure improvements). Further research is also needed to determine the BMI impacts of specific active transport interventions to allow more comprehensive estimates of health and greenhouse gas emission impacts. Interventions that lead to BMI reductions in addition to physical activity level increases could have much larger health gains (and greater reductions in greenhouse gas emissions) than those presented here.

Our emissions assumptions for car journeys do not reflect systematic variation in car emissions such as higher emissions for 'cold starts' nor differences based on engine size. Emissions for short car trips tend to be higher on a per kilometre basis than those of longer trips due to the fuel required to warm the engine, but the magnitude of this impact is likely to be small [32]. There may also be systematic differences in the car types used for shorter trips, but there was insufficient detail on car type at the trip level to include this in our analysis. If the average engine size of cars used for short trips is larger than average then our scenarios may result in even greater reductions in vehicular emissions.

Finally, this study examines the healthcare cost implications associated with increases in active transport. Whilst we do not model intervention costs for our hypothetical intervention scenarios, the healthcare cost savings provide an indication of the cost-effectiveness threshold for interventions to improve walking and cycling. From a health system perspective, an intervention (e.g. a mass media campaign or infrastructure improvements) that results in switching 25% of trips to walking would be cost saving up to an intervention cost of NZ$127million (US $90million) and cost effective (at the $45,000 per QALY threshold) up to around NZ$445million (US$317million). Our estimate of the cost-effectiveness threshold for walking and cycling is considerably higher than the total amount spent on walking and cycling investment by the New Zealand Transport Agency between 2008 and 2017 (~NZ$120million [44]).

This study adds to the growing body of research around the impact of increasing active travel. Increases in active travel could provide a meaningful increase in physical activity at the population level, but may not be enough to address low physical activity levels alone. Interventions to encourage active transport need to address issues around road safety, but recognise that the long-term benefits of increased physical activity far outweigh road injury risks.

Conclusions

Switching short trips to walking and cycling would have positive health impacts, reduce healthcare costs, and may also reduce greenhouse gas emissions. Further research is needed to identify viable strategies to increase uptake of walking and cycling for short trips in highly car dependent societies such as New Zealand.

Supporting information

S1 Table. Table of health gains and healthcare cost savings from modelled interventions (main result).
(DOCX)

S2 Table. Table of health gains and healthcare cost savings from modelled interventions (no discounting).
(DOCX)

S3 Table. Quality adjusted life years gained per 1,000 people by sex, age, and ethnicity.
(DOCX)

S1 Fig. Timing of health gains across modelled interventions.
(DOCX)

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Writing – original draft: Anja Mizdrak.

Writing – review & editing: Anja Mizdrak, Tony Blakely, Christine L. Cleghorn, Linda J. Cobiac.

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INTERGOVERNMENTAL PANEL ON climate change

Climate Change and Land

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Summary for Policymakers

WG I WG II WG III

WMO UNEP

IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems

Summary for Policymakers
Approved Draft

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Introduction

This Special Report on Climate Change and Land[1] responds to the Panel decision in 2016 to prepare three Special Reports[2] during the Sixth Assessment cycle, taking account of proposals from governments and observer organizations[3]. This report addresses greenhouse gas (GHG) fluxes in land-based ecosystems , land use and sustainable land management[4] in relation to climate change adaptation and mitigation, desertification[5], land degradation[6] and food security[7]. This report follows the publication of other recent reports, including the IPCC *Special Report on Global Warming of 1.5°C* (SR15), the thematic assessment of the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) on Land Degradation and Restoration, the IPBES Global Assessment Report on Biodiversity and Ecosystem Services, and the Global Land Outlook of the UN Convention to Combat Desertification (UNCCD). This report provides an updated assessment of the current state of knowledge[8] while striving for coherence and complementarity with other recent reports.

This Summary for Policymakers (SPM) is structured in four parts: *A) People, land and climate in a warming world; B) Adaptation and mitigation response options; C) Enabling response options; and D) Action in the near-term.*

Confidence in key findings is indicated using the IPCC calibrated language[9]; the underlying scientific basis of each key finding is indicated by references to the main report.

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[1] The terrestrial portion of the biosphere that comprises the natural resources (soil, near-surface air, vegetation and other biota, and water), the ecological processes, topography, and human settlements and infrastructure that operate within that system.

[2] The three Special reports are: "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."; "Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems"; "The Ocean and Cryosphere in a Changing Climate"

[3] related proposals were: climate change and desertification; desertification with regional aspects; land degradation – an assessment of the interlinkages and integrated strategies for mitigation and adaptation; agriculture, foresty and other landuse; food and agriculture; and food security and climate change.

[4] Sustainable Land Management is defined in this report as "the stewardship and use of land resources, including soils, water, animals and plants, to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions".

[5] Desertification is defined in this report as 'land degradation in arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities'.

[6] Land degradation is defined in this report as 'a negative trend in land condition, caused by direct or indirect human induced processes, including anthropogenic climate change, expressed as long-term reduction and as loss of at least one of the following: biological productivity, ecological integrity, or value to humans'.

[7] Food security is defined in this report as 'a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life'.

[8] The assessment covers literature accepted for publication by 7th April 2019.

[9] Each finding is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, for example, medium

A. People, land and climate in a warming world

A 1. Land provides the principal basis for human livelihoods and well-being including the supply of food, freshwater and multiple other ecosystem services, as well as biodiversity. Human use directly affects more than 70% (*likely* 69-76%) of the global, ice-free land surface (*high confidence*). Land also plays an important role in the climate system. {1.1, 1.2, 2.3, 2.4, Figure SPM.1}

A1.1. People currently use one quarter to one third of land's potential net primary production[10] for food, feed, fibre, timber and energy. Land provides the basis for many other ecosystem functions and services[11], including cultural and regulating services, that are essential for humanity (*high confidence*). In one economic approach, the world's terrestrial ecosystem services have been valued on an annual basis to be approximately equivalent to the annual global Gross Domestic Product[12] (*medium confidence*). {1.1, 1.2, 3.2, 4.1, 5.1, 5.5, Figure SPM.1}

A1.2. Land is both a source and a sink of greenhouse gases (GHGs) and plays a key role in the exchange of energy, water and aerosols between the land surface and atmosphere. Land ecosystems and biodiversity are vulnerable to ongoing climate change and weather and climate extremes, to different extents. Sustainable land management can contribute to reducing the negative impacts of multiple stressors, including climate change, on ecosystems and societies (*high confidence*). {1.1, 1.2, 3.2, 4.1, 5.1, 5.5, Figure SPM.1}

A1.3. Data available since 1961[13] show that global population growth and changes in per capita consumption of food, feed, fibre, timber and energy have caused unprecedented rates of land and freshwater use (*very high confidence*) with agriculture currently accounting for ca. 70% of global fresh-water use (*medium confidence*). Expansion of areas under agriculture and forestry, including commercial production, and enhanced agriculture and forestry productivity have supported consumption and food availability for a growing population *(high confidence).* With

confidence. The following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%, more likely than not >50–100%, more unlikely than likely 0–<50%, extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, for example, very likely. This is consistent with IPCC AR5.

[10] Land's potential net primary production (NPP) is defined in this report as the amount of carbon accumulated through photosynthesis minus the amount lost by plant respiration over a specified time period that would prevail in the absence of land use.

[11] In its conceptual framework, IPBES uses "nature's contribution to people" in which it includes ecosystem goods and services.

[12] i.e. estimated at $75 trillion for 2011, based on US dollars for 2007.

[13] This statement is based on the most comprehensive data from national statistics available within FAOSTAT, which starts in 1961. This does not imply that the changes started in 1961. Land use changes have been taking place from well before the pre-industrial period to the present.

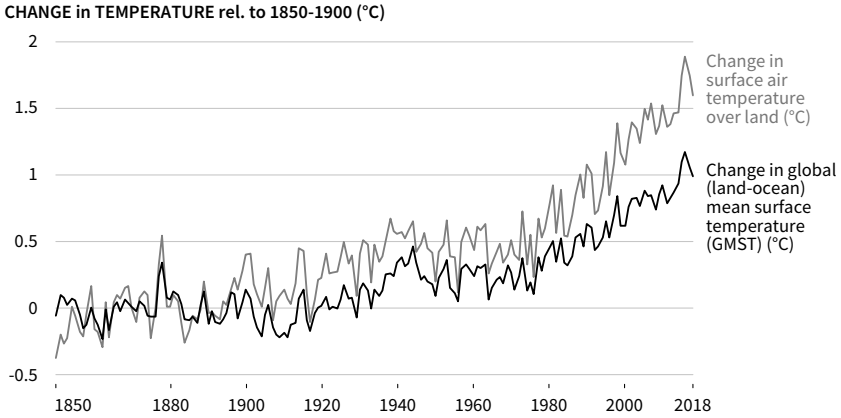
large regional variation, these changes have contributed to increasing net GHG emissions (*very high confidence*), loss of natural ecosystems (e.g. forests, savannahs, natural grasslands and wetlands) and declining biodiversity (*high confidence*). {1.1, 1.3, 5.1, 5.5, Figure SPM.1}

A1.4. Data available since 1961 shows the per capita supply of vegetable oils and meat has more than doubled and the supply of food calories per capita has increased by about one third (*high confidence*). Currently, 25-30% of total food produced is lost or wasted (*medium confidence*). These factors are associated with additional GHG emissions (*high confidence*). Changes in consumption patterns have contributed to about 2 billion adults now being overweight or obese (*high confidence*). An estimated 821 million people are still undernourished (*high confidence*). {1.1, 1.3, 5.1, 5.5, Figure SPM.1}

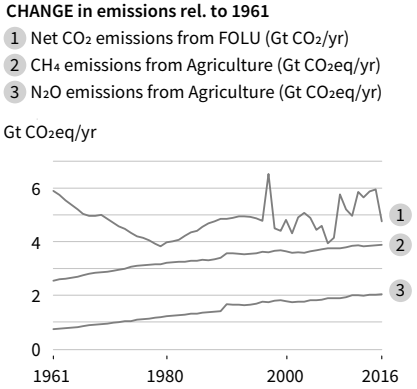
A1.5. About a quarter of the Earth's ice-free land area is subject to human-induced degradation (*medium confidence*). Soil erosion from agricultural fields is estimated to be currently 10 to 20 times (no tillage) to more than 100 times (conventional tillage) higher than the soil formation rate (*medium confidence*). Climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas, drylands and in permafrost areas (*high confidence*). Over the period 1961-2013, the annual area of drylands in drought has increased, on average by slightly more than 1% per year, with large inter-annual variability. In 2015, about 500 (380-620) million people lived within areas which experienced desertification between the 1980s and 2000s. The highest numbers of people affected are in South and East Asia, the circum Sahara region including North Africa, and the Middle East including the Arabian peninsula (*low confidence*). Other dryland regions have also experienced desertification. People living in already degraded or desertified areas are increasingly negatively affected by climate change (*high confidence*). {1.1, 1.2, 3.1, 3.2, 4.1, 4.2, 4.3, Figure SPM.1}

Land use and observed climate change

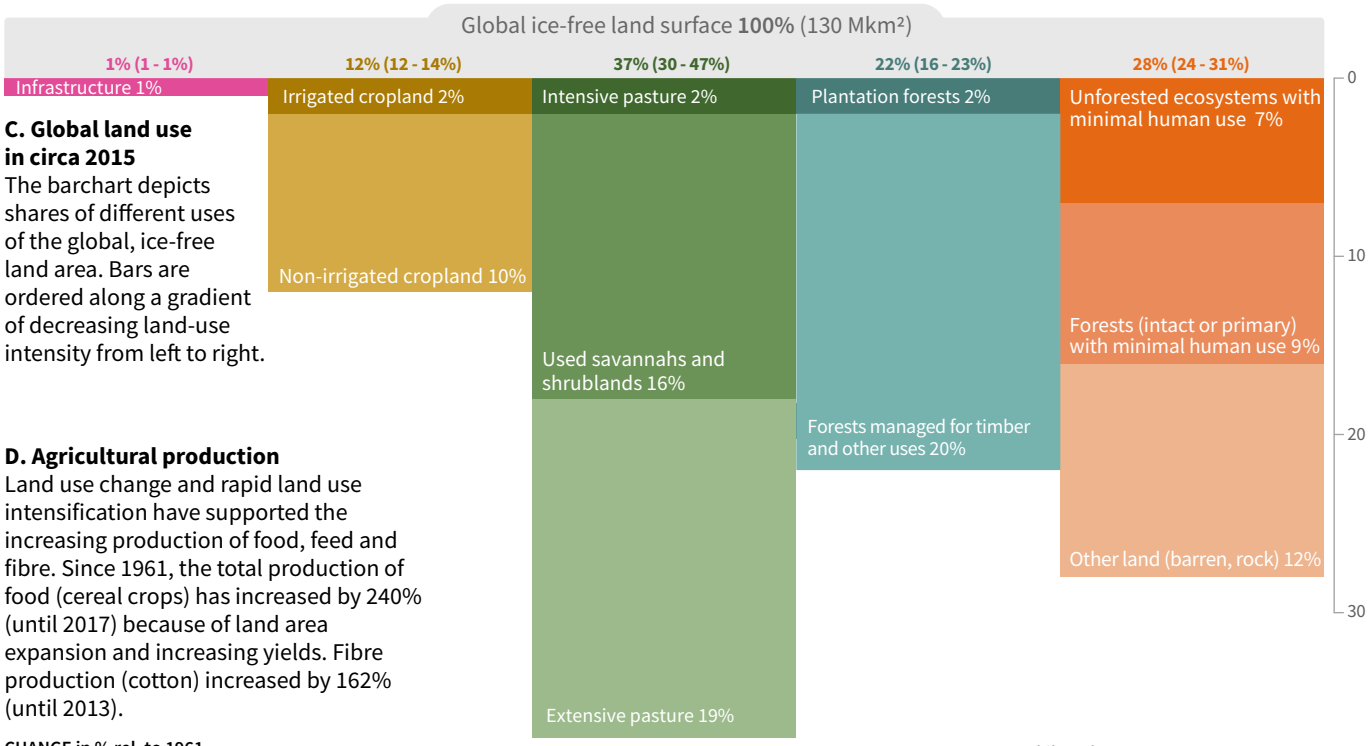
A. Observed temperature change relative to 1850-1900
Since the pre-industrial period (1850-1900) the observed mean land surface air temperature has risen considerably more than the global mean surface (land and ocean) temperature (GMST).



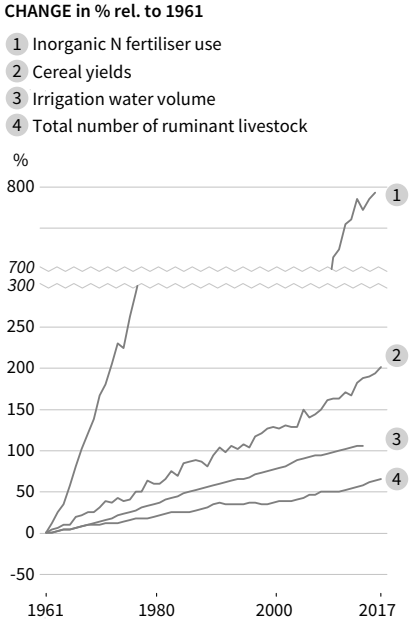
B. GHG emissions
An estimated 23% of total anthropogenic greenhouse gas emissions (2007-2016) derive from Agriculture, Forestry and Other Land Use (AFOLU).



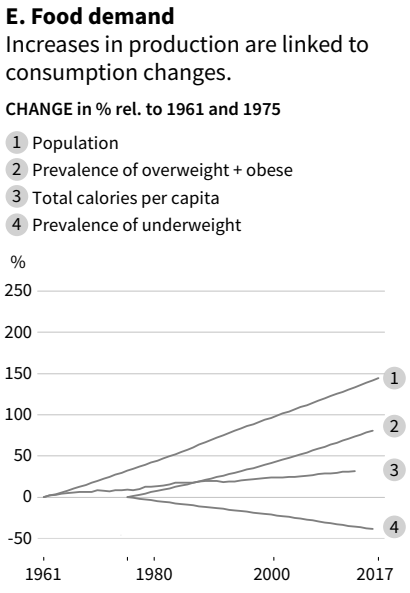
C. Global land use in circa 2015
The barchart depicts shares of different uses of the global, ice-free land area. Bars are ordered along a gradient of decreasing land-use intensity from left to right.



D. Agricultural production
Land use change and rapid land use intensification have supported the increasing production of food, feed and fibre. Since 1961, the total production of food (cereal crops) has increased by 240% (until 2017) because of land area expansion and increasing yields. Fibre production (cotton) increased by 162% (until 2013).



E. Food demand
Increases in production are linked to consumption changes.



F. Desertification and land degradation
Land-use change, land-use intensification and climate change have contributed to desertification and land degradation.

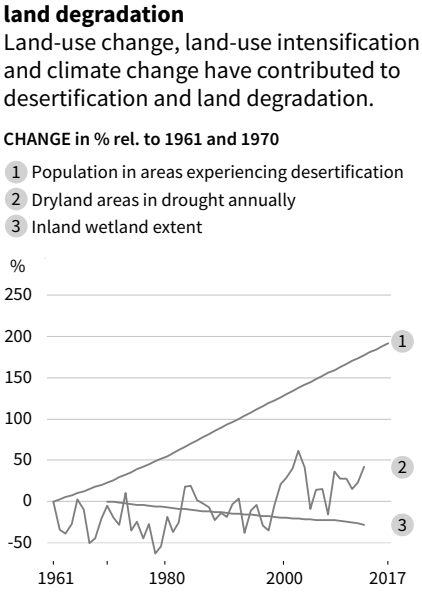


Figure SPM.1: Land use and observed climate change

A representation of the land use and observed climate change covered in this assessment report. Panels A-F show the status and trends in selected land use and climate variables that represent many of the core topics covered in this report. The annual time series in B and D-F are based on the most comprehensive, available data from national statistics, in most cases from FAOSTAT which starts in 1961. Y-axes in panels D-F are expressed relative to the starting year of the time series (rebased to zero). Data sources and notes: **A:** The warming curves are averages of four datasets {2.1; Figure 2.2; Table 2.1} **B:** N_2O and CH_4 from agriculture are from FAOSTAT; Net CO_2 emissions from FOLU using the mean of two bookkeeping models (including emissions from peatland fires since 1997). All values expressed in units of CO_2-eq are based on AR5 100 year Global Warming Potential values without climate-carbon feedbacks (N_2O=265; CH_4=28). {see Table SPM.1, 1.1, 2.3} **C:** Depicts shares of different uses of the global, ice-free land area for approximately the year 2015, ordered along a gradient of decreasing land-use intensity from left to right. Each bar represents a broad land cover category; the numbers on top are the total % of the ice-free area covered, with uncertainty ranges in brackets. Intensive pasture is defined as having a livestock density greater than 100 animals/km². The area of 'forest managed for timber and other uses' was calculated as total forest area minus 'primary/intact' forest area. {1.2, Table 1.1, Figure 1.3} **D:** Note that fertiliser use is shown on a split axis. The large percentage change in fertiliser use reflects the low level of use in 1961 and relates to both increasing fertiliser input per area as well as the expansion of fertilised cropland and grassland to increase food production. {1.1, Figure 1.3} **E:** Overweight population is defined as having a body mass index (BMI) > 25 kg m^{-2}; underweight is defined as BMI < 18.5 kg m^{-2}. {5.1, 5.2} **F:** Dryland areas were estimated using TerraClimate precipitation and potential evapotranspiration (1980-2015) to identify areas where the Aridity Index is below 0.65. Population data are from the HYDE3.2 database. Areas in drought are based on the 12-month accumulation Global Precipitation Climatology Centre Drought Index. The inland wetland extent (including peatlands) is based on aggregated data from more than 2000 time series that report changes in local wetland area over time. {3.1, 4.2, 4.6}

A 2. Since the pre-industrial period, the land surface air temperature has risen nearly twice as much as the global average temperature *(high confidence*). Climate change, including increases in frequency and intensity of extremes, has adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions (*high confidence*). {2.2, 3.2, 4.2, 4.3, 4.4, 5.1, 5.2, Executive Summary Chapter 7, 7.2}

A2.1. Since the pre-industrial period (1850-1900) the observed mean land surface air temperature has risen considerably more than the global mean surface (land and ocean) temperature (GMST) (high confidence). From 1850-1900 to 2006-2015 mean land surface air temperature has increased by 1.53°C (very likely range from 1.38°C to 1.68°C) while GMST increased by 0.87°C (likely range from 0.75°C to 0.99°C). {2.2.1, Figure SPM.1}

A2.2. Warming has resulted in an increased frequency, intensity and duration of heat-related events, including heat waves[14] in most land regions (*high confidence*). Frequency and intensity of droughts has increased in some regions (including the Mediterranean, west Asia, many parts of South America, much of Africa, and north-eastern Asia) (*medium confidence*) and there

[14] A heatwave is defined in this report as 'a period of abnormally hot weather. Heatwaves and warm spells have various and in some cases overlapping definitions'.

has been an increase in the intensity of heavy precipitation events at a global scale (*medium confidence*). {2.2.5, 4.2.3, 5.2}

A2.3. Satellite observations[15] have shown vegetation greening[16] over the last three decades in parts of Asia, Europe, South America, central North America, and southeast Australia. Causes of greening include combinations of an extended growing season, nitrogen deposition, CO_2 fertilisation[17], and land management (*high confidence*). Vegetation browning[18] has been observed in some regions including northern Eurasia, parts of North America, Central Asia and the Congo Basin, largely as a result of water stress (*medium confidence*). Globally, vegetation greening has occurred over a larger area than vegetation browning (*high confidence*). {2.2.3, Box 2.3, 2.2.4, 3.2.1, 3.2.2, 4.3.1, 4.3.2, 4.6.2, 5.2.2}

A2.4. The frequency and intensity of dust storms have increased over the last few decades due to land use and land cover changes and climate-related factors in many dryland areas resulting in increasing negative impacts on human health, in regions such as the Arabian Peninsula and broader Middle East, Central Asia (*high confidence*)[19]. {2.4.1, 3.4.2}

A2.5. In some dryland areas, increased land surface air temperature and evapotranspiration and decreased precipitation amount, in interaction with climate variability and human activities, have contributed to desertification. These areas include Sub-Saharan Africa, parts of East and Central Asia, and Australia. (medium confidence) {2.2, 3.2.2, 4.4.1}

A2.6. Global warming has led to shifts of climate zones in many world regions, including expansion of arid climate zones and contraction of polar climate zones (*high confidence*). As a consequence, many plant and animal species have experienced changes in their ranges, abundances, and shifts in their seasonal activities (*high confidence*). {2.2, 3.2.2, 4.4.1}

A2.7. Climate change can exacerbate land degradation processes (*high confidence*) including through increases in rainfall intensity, flooding, drought frequency and severity, heat stress, dry spells, wind, sea-level rise and wave action, permafrost thaw with outcomes being

[15] The interpretation of satellite observations can be affected by insufficient ground validation and sensor calibration. In addition their spatial resolution can make it difficult to resolve small-scale changes.
[16] Vegetation greening is defined in this report as an increase in photosynthetically active plant biomass which is inferred from satellite observations.
[17] CO2 fertilization is defined in this report as the enhancement of plant growth as a result of increased atmospheric carbon dioxide (CO2) concentration. The magnitude of CO2 fertilization depends on nutrients and water availability.
[18] Vegetation browning is defined in this report as a decrease in photosynthetically active plant biomass which is inferred from satellite observations.
[19] Evidence relative to such trends in dust storms and health impacts in other regions is limited in the literature assessed in this report.

modulated by land management. Ongoing coastal erosion is intensifying and impinging on more regions with sea level rise adding to land use pressure in some regions (*medium confidence*). {4.2.1, 4.2.2, 4.2.3, 4.4.1, 4.4.2, 4.9.6, Table 4.1, 7.2.1, 7.2.2}

A2.8. Climate change has already affected food security due to warming, changing precipitation patterns, and greater frequency of some extreme events (*high confidence*). In many lower-latitude regions, yields of some crops (e.g., maize and wheat) have declined, while in many higher-latitude regions, yields of some crops (e.g., maize, wheat and sugar beets) have increased over recent decades *(high confidence)*. Climate change has resulted in lower animal growth rates and productivity in pastoral systems in Africa (*high confidence)*. There is robust evidence that agricultural pests and diseases have already responded to climate change resulting in both increases and decreases of infestations (*high confidence*). Based on indigenous and local knowledge, climate change is affecting food security in drylands, particularly those in Africa, and high mountain regions of Asia and South America[20]. {5.2.1, 5.2.2, 7.2.2}

A 3. Agriculture, Forestry and Other Land Use (AFOLU) activities accounted for around 13% of CO_2, 44% of methane (CH_4), and 82% of nitrous oxide (N_2O) emissions from human activities globally during 2007-2016, representing 23% (12.0 +/- 3.0 $GtCO_2e\ yr^{-1}$) of total net anthropogenic emissions of GHGs[21] (*medium confidence*). The natural response of land to human-induced environmental change caused a net sink of around 11.2 $GtCO_2\ yr^{-1}$ during 2007-2016 (equivalent to 29% of total CO_2 emissions) (*medium confidence*); the persistence of the sink is uncertain due to climate change (*high confidence*). If emissions associated with pre- and post-production activities in the global food system[22] are included, the emissions are estimated to be 21-37% of total net anthropogenic GHG emissions (*medium confidence*). {2.3, Table 2.2, 5.4}.

A3.1. Land is simultaneously a source and a sink of CO_2 due to both anthropogenic and natural drivers, making it hard to separate anthropogenic from natural fluxes (*very high confidence*). Global models estimate net CO_2 emissions of $5.2 \pm 2.6\ GtCO_2\ yr^{-1}$ (*likely* range) from land use and land-use change during 2007-16. These net emissions are mostly due to deforestation, partly offset by afforestation/reforestation, and emissions and removals by other land use activities

[20] The assessment covered literature whose methodologies included interviews and surveys with indigenous peoples and local communities.

[21] This assessment only includes CO2, CH4 and N2O.

[22] Global food system in this report is defined as 'all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socioeconomic and environmental outcomes at the global level'. These emissions data are not directly comparable to the national inventories prepared according to the 2006 IPCC Guidelines for National Greenhouse Gas.

(*very high confidence*) (Table SPM.1)[23]. There is no clear trend in annual emissions since 1990 (*medium confidence*) (Figure SPM.1). {1.1, 2.3, Table 2.2, Table 2.3}

A3.2. The natural response of land to human-induced environmental changes such as increasing atmospheric CO_2 concentration, nitrogen deposition, and climate change, resulted in global net removals of 11.2 +/– 2.6 Gt CO_2 yr^{-1} (*likely* range) during 2007-2016 (Table SPM.1). The sum of the net removals due to this response and the AFOLU net emissions gives a total net land-atmosphere flux that removed 6.0+/-2.6 $GtCO_2$ yr^{-1} during 2007-2016 (*likely* range). Future net increases in CO_2 emissions from vegetation and soils due to climate change are projected to counteract increased removals due to CO_2 fertilisation and longer growing seasons (*high confidence*). The balance between these processes is a key source of uncertainty for determining the future of the land carbon sink. Projected thawing of permafrost is expected to increase the loss of soil carbon (*high confidence*). During the 21st century, vegetation growth in those areas may compensate in part for this loss (*low confidence*). {Box 2.3, 2.3.1, 2.5.3, 2.7; Table 2.3}

A3.3. Global models and national GHG inventories use different methods to estimate anthropogenic CO_2 emissions and removals for the land sector. Both produce estimates that are in close agreement for land-use change involving forest (e.g., deforestation, afforestation), and differ for managed forest. Global models consider as managed forest those lands that were subject to harvest whereas, consistent with IPCC guidelines, national GHG inventories define managed forest more broadly. On this larger area, inventories can also consider the natural response of land to human-induced environmental changes as anthropogenic, while the global model approach {Table SPM.1} treats this response as part of the non-anthropogenic sink. For illustration, from 2005 to 2014, the sum of the national GHG inventories net emission estimates is 0.1±1.0 $GtCO_2yr^{-1}$, while the mean of two global bookkeeping models is 5.1±2.6 $GtCO_2yr^{-1}$ (*likely* range). Consideration of differences in methods can enhance understanding of land sector net emission estimates and their applications.

[23] The net anthropogenic flux of CO2 from "bookkeeping" or "carbon accounting" models is composed of two opposing gross fluxes: gross emissions (about 20 GtCO2 yr-1) are from deforestation, cultivation of soils, and oxidation of wood products; gross removals (about 14 GtCO2 yr-1) are largely from forest growth following wood harvest and agricultural abandonment (medium confidence).

Table SPM1. Net anthropogenic emissions due to Agriculture, Forestry, and other Land Use (AFOLU) and non-AFOLU (Panel 1) and global food systems (average for 2007-2016)[1] (Panel 2). Positive value represents emissions; negative value represents removals.

		Direct Anthropogenic							
		Net anthropogenic emissions due to Agriculture, Forestry, and Other Land Use (AFOLU)			Non-AFOLU anthropogenic GHG emissions[6]	Total net anthropogenic emissions (AFOLU + non-AFOLU) by gas	AFOLU as a % of total net anthropogenic emissions, by gas	Natural response of land to human-induced environmental change[7]	Net land – atmosphere flux from all lands
Panel 1: Contribution of AFOLU									
		FOLU	Agriculture	Total					
		A	B	C = B + A	D	**E = C + D**	F = (C/E)*100	G	A + G
CO_2[2]									
	Gt CO_2 y^{-1}	5.2 ± 2.6	--[11]	5.2 ± 2.6	33.9 ± 1.8	**39.1 ± 3.2**	~13%	-11.2 ± 2.6	-6.0 ± 2.0
CH_4[3,8]	Mt CH_4 y^{-1}	19 ± 6	142 ± 43	162 ± 48.6	201 ± 100	**363 ± 111**			
	Gt CO_2e y^{-1}	0.5 ± 0.2	4.0 ± 1.2	4.5 ± 1.4	5.6 ± 2.8	**10.1 ± 3.1**	~44%		
N_2O[3,8]	Mt N_2O y^{-1}	0.3 ± 0.1	8 ±2	8.3 ± 2.5	2.0 ± 1.0	**10.4 ± 2.7**			
	Gt CO_2e y^{-1}	0.09 ± 0.03	2.2 ± 0.7	2.3 ± 0.7	0.5 ± 0.3	**2.8 ± 0.7**	~82%		
Total (GHG)	**Gt CO_2e y^{-1}**	**5.8 ± 2.6**	**6.2 ± 1.4**	**12.0 ± 3.0**	**40.0 ± 3.4**	**52.0 ± 4.5**	**~23%**		
Panel 2: Contribution of global food system									
		Land-use change	Agriculture		Non-AFOLU[5] other sectors pre- to post-production	Total global food system emissions			
CO_2[4] Land-use change	Gt CO_2 y^{-1}	4.9 ± 2.5							
CH_4[3,8,9] Agriculture	Gt CO_2e y^{-1}		4.0 ± 1.2						
N_2O[3,8,9] Agriculture	Gt CO_2e y^{-1}		2.2 ± 0.7						
CO_2 other sectors	Gt CO_2 y^{-1}				2.4 – 4.8				
Total (CO2e)[10]	**Gt CO_2e y^{-1}**	**4.9 ± 2.5**	**6.2 ± 1.4**		**2.4 – 4.8**	**10.7 – 19.1**			

Data sources and notes:

[1] Estimates are only given until 2016 as this is the latest date when data are available for all gases.

[2] Net anthropogenic flux of CO_2 due to land cover change such as deforestation and afforestation, and land management including wood harvest and regrowth, as well as peatland burning, based on two bookkeeping models as used in the Global Carbon Budget and for AR5. Agricultural soil carbon stock change under the same land use is not considered in these models. {2.3.1.2.1, Table 2.2, Box 2.2}

[3] Estimates show the mean and assessed uncertainty of two databases, FAOSTAT and USEPA 2012 {2.3; Table 2.2}

[4] Based on FAOSTAT. Categories included in this value are "net forest conversion" (net deforestation), drainage of organic soils (cropland and grassland), biomass burning (humid tropical forests, other forests, organic soils). It excludes "forest land" (forest management plus net forest expansion), which is primarily a sink due to afforestation. Note: total FOLU emissions from FAOSTAT are 2.8 (±1.4) Gt CO_2 yr^{-1} for the period 2007-2016. {Table 2.2, Table 5.4}

[5] CO_2 emissions induced by activities not included in the AFOLU sector, mainly from energy (e.g. grain drying), transport (e.g. international trade), and industry (e.g. synthesis of inorganic fertilizers) part of food systems, including agricultural production activities (e.g. heating in greenhouses), pre-production (e.g. manufacturing of farm inputs) and post-production (e.g. agri-food processing) activities. This estimate is land based and hence excludes emissions from fisheries. It includes emissions from fibre and other non-food agricultural products since these are not separated from food use in data bases. The CO_2 emissions related to food system in other sectors than AFOLU are 6-13% of total anthropogenic CO_2 emissions. These emissions are typically low in smallholder subsistence farming. When added to AFOLU emissions, the estimated share of food systems in global anthropogenic emissions is 21-37%. {5.4.5, Table 5.4}

[6] Total non-AFOLU emissions were calculated as the sum of total CO_2e emissions values for energy, industrial sources, waste and other emissions with data from the Global Carbon Project for CO_2, including international aviation and shipping and from the PRIMAP database for CH_4 and N_2O averaged over 2007-2014 only as that was the period for which data were available {2.3; Table 2.2}.

[7] The natural response of land to human-induced environmental changes is the response of vegetation and soils to environmental changes such as increasing atmospheric CO_2 concentration, nitrogen deposition, and climate change. The estimate shown represents the average from Dynamic Global Vegetation Models {2.3.1.2.4, Box 2.2, Table 2.3}

[8] All values expressed in units of CO_2e are based on AR5 100 year Global Warming Potential (GWP) values without climate-carbon feedbacks (N_2O = 265; CH_4 = 28). Note that the GWP has been used across fossil fuel and biogenic sources of methane. If a higher GWP for fossil fuel CH4 (30 per AR5), then total anthropogenic CH4 emissions expressed in CO2e would be 2% greater.

[9] This estimate is land based and hence excludes emissions from fisheries and emissions from aquaculture (except emissions from feed produced on land and used in aquaculture), and also includes non-food use (e.g. fibre and bioenergy) since these are not separated from food use in databases. It excludes non-CO_2 emissions associated with land use change (FOLU category) since these are from fires in forests and peatlands.

[10] Emissions associated with food loss and waste are included implicitly, since emissions from food system are related to food produced, including food consumed for nutrition and to food loss and waste. The latter is estimated at 8-10% of total anthropogenic emissions in CO2e. {5.5.2.5}

[11] No global data are available for agricultural CO_2 emissions

A3.4. Global AFOLU emissions of methane in the period 2007-2016 were 162 ± 49 Mt CH_4 yr-1 (4.5 ± 1.4 GtCO_2eq yr-1) (*medium confidence*). The globally averaged atmospheric concentration of methane shows a steady increase between the mid-1980s and early 1990s, slower growth thereafter until 1999, a period of no growth between 1999-2006, followed by a resumption of growth in 2007 (*high confidence*). Biogenic sources make up a larger proportion of emissions than they did before 2000 (*high confidence*). Ruminants and the expansion of rice cultivation are important contributors to the rising concentration (*high confidence*). {Table 2.2, 2.3.2, 5.4.2, 5.4.3, Figure SPM.1}.

A3.5. Anthropogenic AFOLU N_2O emissions are rising, and were 8.3 ± 2.5 MtN_2O yr^{-1} (2.3 ± 0.7 $GtCO_2eq$ yr^{-1}) during the period 2007-2016. Anthropogenic N_2O emissions (Figure SPM.1, Table SPM.1) from soils are primarily due to nitrogen application including inefficiencies (over-application or poorly synchronised with crop demand timings) (*high confidence*). Cropland soils emitted around 3 Mt N_2O yr^{-1} (around 795 $MtCO_2$-eq yr^{-1}) during the period 2007-2016 (*medium confidence*). There has been a major growth in emissions from managed pastures due to increased manure deposition (*medium confidence*). Livestock on managed pastures and rangelands accounted for more than one half of total anthropogenic N_2O emissions from agriculture in 2014 (*medium confidence*). {Table 2.1, 2.3.3, 5.4.2, 5.4.3}

A3.6. Total net GHG emissions from agriculture, forestry, and other land use (AFOLU) emissions represent 12.0 +/- 3.0 $GtCO_2eq$ yr^{-1} during 2007-2016. This represents 23% of total net anthropogenic emissions[24] (Table SPM.1). Other approaches, such as global food system, include agricultural emissions and land use change (i.e., deforestation and peatland degradation), as well as outside farm gate emissions from energy, transport and industry sectors for food production. Emissions within farm gate and from agricultural land expansion contributing to the global food system represent 16-27% of total anthropogenic emissions (*medium confidence*). Emissions outside the farm gate represent 5-10% of total anthropogenic emissions (*medium confidence*). Given the diversity of food systems, there are large regional differences in the contributions from different components of the food system (*very high confidence*). Emissions from agricultural production are projected to increase (*high confidence*), driven by population and income growth and changes in consumption patterns (*medium confidence*). {5.5, Table 5.4}

A 4. Changes in land conditions[25], either from land-use or climate change, affect global and regional climate (*high confidence*). At the regional scale, changing land conditions can reduce or accentuate warming and affect the intensity, frequency and duration of extreme events. The magnitude and direction of these changes vary with location and season (*high confidence*). {Executive Summary Chapter 2, 2.3, 2.4, 2.5, 3.3}

A4.1. Since the pre-industrial period, changes in land cover due to human activities have led to both a net release of CO_2 contributing to global warming (*high confidence*), and an increase in global land albedo[26] causing surface cooling (*medium confidence*). Over the historical period, the resulting net effect on globally averaged surface temperature is estimated to be small (*medium confidence*). {2.4, 2.6.1, 2.6.2}

[24] This assessment only includes CO2, CH4 and N2O.
[25] Land conditions encompass changes in land cover (e.g. deforestation, afforestation, urbanisation), in land use (e.g. irrigation), and in land state (e.g. degree of wetness, degree of greening, amount of snow, amount of permafrost)
[26] Land with high albedo reflects more incoming solar radiation than land with low albedo.

A4.2. The likelihood, intensity and duration of many extreme events can be significantly modified by changes in land conditions, including heat related events such as heat waves (*high confidence*) and heavy precipitation events (*medium confidence*). Changes in land conditions can affect temperature and rainfall in regions as far as hundreds of kilometres away (*high confidence*). {2.5.1, 2.5.2, 2.5.4, 3.3; Cross-Chapter Box 4 in Chapter 2}

A4.3. Climate change is projected to alter land conditions with feedbacks on regional climate. In those boreal regions where the treeline migrates northward and/or the growing season lengthens, winter warming will be enhanced due to decreased snow cover and albedo while warming will be reduced during the growing season because of increased evapotranspiration (*high confidence*). In those tropical areas where increased rainfall is projected, increased vegetation growth will reduce regional warming (*medium confidence*). Drier soil conditions resulting from climate change can increase the severity of heat waves, while wetter soil conditions have the opposite effect (*high confidence*). {2.5.2, 2.5.3}

A4.4. Desertification amplifies global warming through the release of CO_2 linked with the decrease in vegetation cover (*high confidence*). This decrease in vegetation cover tends to increase local albedo, leading to surface cooling (*high confidence*). {3.3}

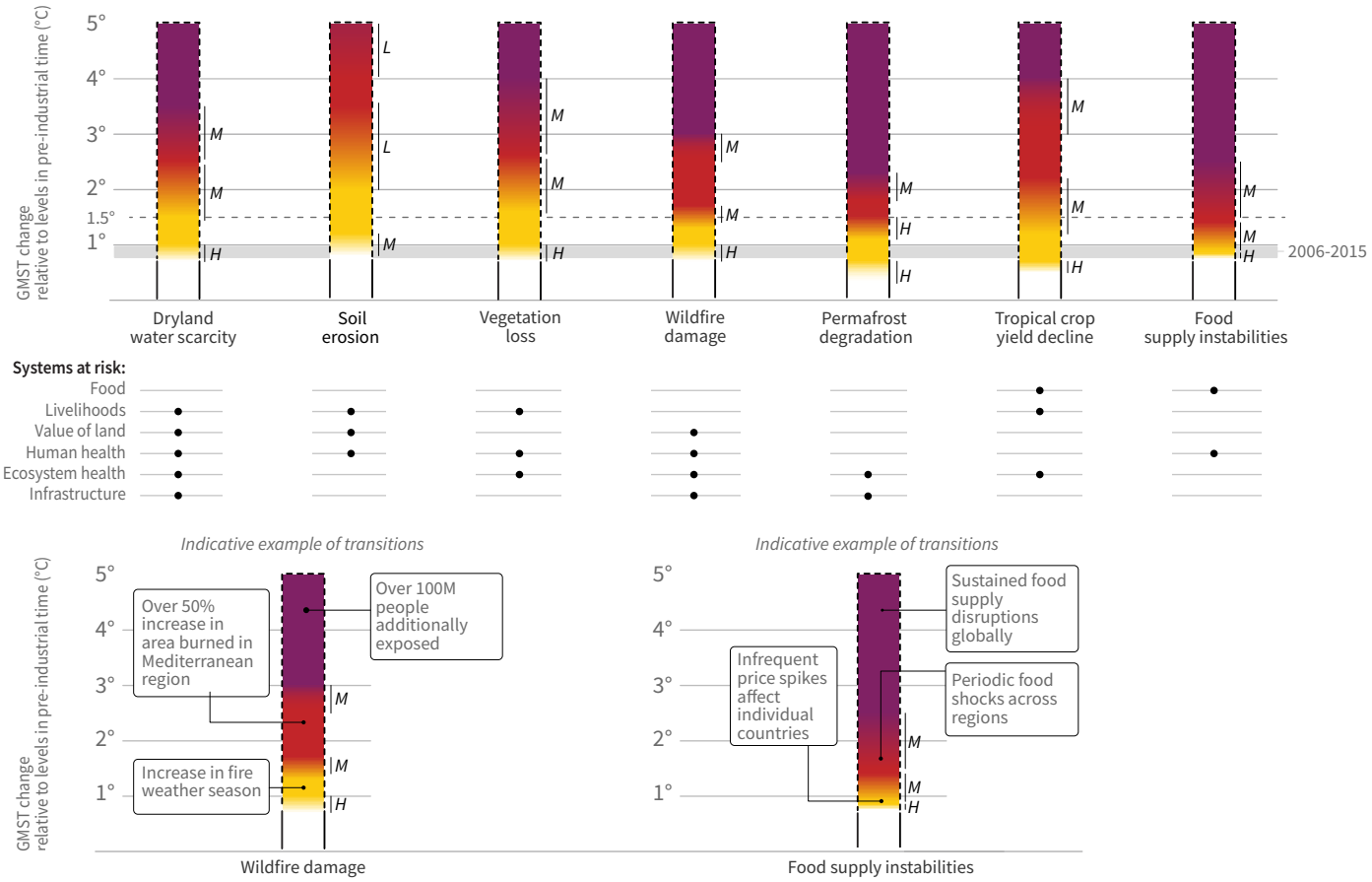
A4.5. Changes in forest cover for example from afforestation, reforestation and deforestation, directly affect regional surface temperature through exchanges of water and energy[27] (*high confidence*). Where forest cover increases in tropical regions cooling results from enhanced evapotranspiration (*high confidence*). Increased evapotranspiration can result in cooler days during the growing season (*high confidence*) and can reduce the amplitude of heat related events (*medium confidence*). In regions with seasonal snow cover, such as boreal and some temperate, increased tree and shrub cover also has a wintertime warming influence due to reduced surface albedo[28] (*high confidence*). {2.3, 2.4.3, 2.5.1, 2.5.2, 2.5.4}

A4.6. Both global warming and urbanisation can enhance warming in cities and their surroundings (heat island effect), especially during heat related events, including heat waves (*high confidence*). Night-time temperatures are more affected by this effect than daytime temperatures (*high confidence*). Increased urbanisation can also intensify extreme rainfall events over the city or downwind of urban areas (*medium confidence*). {2.5.1, 2.5.2, 2.5.3, 4.9.1, Cross-Chapter Box 4 in Chapter 2}

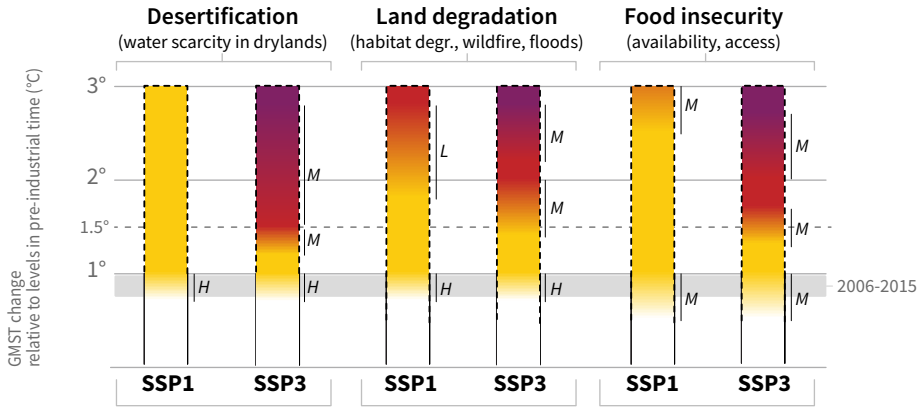
[27] The literature indicates that forest cover changes can also affect climate through changes in emissions of reactive gases and aerosols {2.4, 2.5}.
[28] Emerging literature shows that boreal forest-related aerosols may counteract at least partly the warming effect of surface albedo {2.4.3}.

A. Risks to humans and ecosystems from changes in land-based processes as a result of climate change

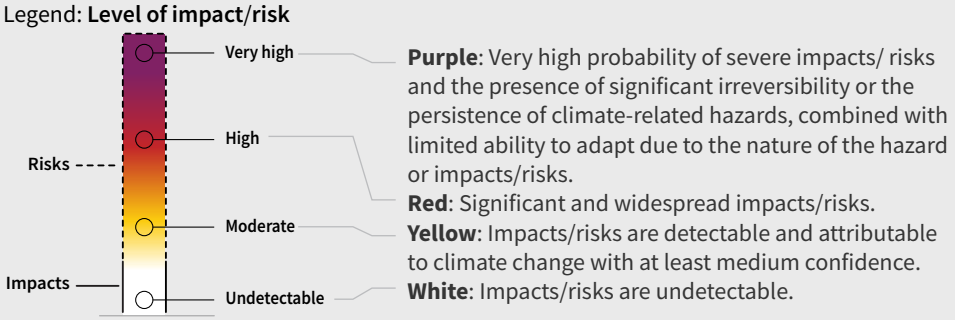
Increases in global mean surface temperature (GMST), relative to pre-industrial levels, affect processes involved in **desertification** (water scarcity), **land degradation** (soil erosion, vegetation loss, wildfire, permafrost thaw) and **food security** (crop yield and food supply instabilities). Changes in these processes drive risks to food systems, livelihoods, infrastructure, the value of land, and human and ecosystem health. Changes in one process (e.g. wildfire or water scarcity) may result in compound risks. Risks are location-specific and differ by region.



B. Different socioeconomic pathways affect levels of climate related risks



Socio-economic choices can reduce or exacerbate climate related risks as well as influence the rate of temperature increase. The **SSP1** pathway illustrates a world with low population growth, high income and reduced inequalities, food produced in low GHG emission systems, effective land use regulation and high adaptive capacity. The **SSP3** pathway has the opposite trends. Risks are lower in SSP1 compared with SSP3 given the same level of GMST increase.



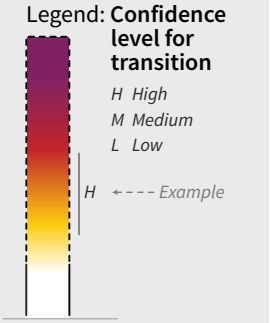


Figure SPM. 2 Risks to land-related human systems and ecosystems from global climate change, socio-economic development and mitigation choices in terrestrial ecosystems.

As in previous IPCC reports the literature was used to make expert judgements to assess the levels of global warming at which levels of risk are undetectable, moderate, high or very high, as described further in Chapter 7 and other parts of the underlying report. The figure indicates assessed risks at approximate warming levels which may be influenced by a variety of factors, including adaptation responses. The assessment considers adaptive capacity consistent with the SSP pathways as described below. **Panel A:** Risks to selected elements of the land system as a function of global mean surface temperature {2.1; Box 2.1; 3.5; 3.7.1.1; 4.4.1.1; 4.4.1.2; 4.4.1.3; 5.2.2; 5.2.3; 5.2.4; 5.2.5; 7.2;7.3, Table SM7.1}. Links to broader systems are illustrative and not intended to be comprehensive. Risk levels are estimated assuming medium exposure and vulnerability driven by moderate trends in socioeconomic conditions broadly consistent with an SSP2 pathway. {Table SM7.4}. **Panel B:** Risks associated with desertification, land degradation and food security due to climate change and patterns of socio-economic development. Increasing risks associated with desertification include population exposed and vulnerable to water scarcity in drylands. Risks related to land degradation include increased habitat degradation, population exposed to wildfire and floods and costs of floods. Risks to food security include availability and access to food, including population at risk of hunger, food price increases and increases in disability adjusted life years attributable due to childhood underweight. Risks are assessed for two contrasted socio-economic pathways (SSP1 and SSP3 {SPM Box 1}) excluding the effects of targeted mitigation policies {3.5; 4.2.1.2; 5.2.2; 5.2.3; 5.2.4; 5.2.5; 6.1.4; 7.2, Table SM7.5}. Risks are not indicated beyond 3°C because SSP1 does not exceed this level of temperature change. **All panels**: As part of the assessment, literature was compiled and data extracted into a summary table. A formal expert elicitation protocol (based on modified-Delphi technique and the Sheffield Elicitation Framework), was followed to identify risk transition thresholds. This included a multi-round elicitation process with two rounds of independent anonymous threshold judgement, and a final consensus discussion. Further information on methods and underlying literature can be found in Chapter 7 Supplementary Material.

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BOX SPM.1: Shared Socioeconomic Pathways (SSPs)

In this report the implications of future socio-economic development on climate change mitigation, adaptation and land-use are explored using shared socio-economic pathways (SSPs). The SSPs span a range of challenges to climate change mitigation and adaptation.

- SSP1 includes a peak and decline in population (~7 billion in 2100), high income and reduced inequalities, effective land-use regulation, less resource intensive consumption, including food produced in low-GHG emission systems and lower food waste, free trade and environmentally-friendly technologies and lifestyles. Relative to other pathways, SSP1 has low challenges to mitigation and low challenges to adaptation (i.e., high adaptive capacity).
- SSP2 includes medium population growth (~9 billion in 2100), medium income; technological progress, production and consumption patterns are a continuation of past trends, and only gradual reduction in inequality occurs. Relative to other pathways, SSP2 has medium challenges to mitigation and medium challenges to adaptation (i.e., medium adaptive capacity).

- SSP3 includes high population (~13 billion in 2100), low income and continued inequalities, material-intensive consumption and production, barriers to trade, and slow rates of technological change. Relative to other pathways, SSP3 has high challenges to mitigation and high challenges to adaptation (i.e., low adaptive capacity).
- SSP4 includes medium population growth (~9 billion in 2100), medium income, but significant inequality within and across regions. Relative to other pathways, SSP4 has low challenges to mitigation, but high challenges to adaptation (i.e., low adaptive capacity).
- SSP5 includes a peak and decline in population (~7 billion in 2100), high income, reduced inequalities, and free trade. This pathway includes resource-intensive production, consumption and lifestyles. Relative to other pathways, SSP5 has high challenges to mitigation, but low challenges to adaptation (i.e., high adaptive capacity).

The SSPs can be combined with Representative Concentration Pathways (RCPs) which imply different levels of mitigation, with implications for adaptation. Therefore, SSPs can be consistent with different levels of global mean surface temperature rise as projected by different SSP-RCP combinations. However, some SSP-RCP combinations are not possible; for instance RCP2.6 and lower levels of future global mean surface temperature rise (e.g., 1.5ºC) are not possible in SSP3 in modelled pathways. {1.2.2, Cross-Chapter Box 1 in Chapter 1, 6.1.4, Cross-Chapter Box 9 in Chapter 6}

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A 5. Climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems (*high confidence*). Increasing impacts on land are projected under all future GHG emission scenarios (*high confidence*). Some regions will face higher risks, while some regions will face risks previously not anticipated (*high confidence*). Cascading risks with impacts on multiple systems and sectors also vary across regions (*high confidence*). {2.2, 3.5, 4.2, 4.4, 4.7, 5.1, 5.2, 5.8, 6.1, 7.2, 7.3, Cross-Chapter Box 9 in Chapter 6, Figure SPM.2}

A5.1. With increasing warming, the frequency, intensity and duration of heat related events including heat waves are projected to continue to increase through the 21st century (*high confidence*). The frequency and intensity of droughts are projected to increase particularly in the Mediterranean region and southern Africa (*medium confidence*). The frequency and intensity of extreme rainfall events are projected to increase in many regions (*high confidence*). {2.2.5, 3.5.1, 4.2.3, 5.2}

A5.2. With increasing warming, climate zones are projected to further shift poleward in the middle and high latitudes (*high confidence*). In high-latitude regions, warming is projected to increase disturbance in boreal forests, including drought, wildfire, and pest outbreaks (*high confidence*). In tropical regions, under medium and high GHG emissions scenarios, warming is projected to result in the emergence of unprecedented[29] climatic conditions by the mid to late 21st century (*medium confidence*). {2.2.4, 2.2.5, 2.5.3, 4.3.2}

A5.3. Current levels of global warming are associated with moderate risks from increased dryland water scarcity, soil erosion, vegetation loss, wildfire damage, permafrost thawing, coastal degradation and tropical crop yield decline (*high confidence*). Risks, including cascading risks, are projected to become increasingly severe with increasing temperatures. At around 1.5°C of global warming the risks from dryland water scarcity, wildfire damage, permafrost degradation and food supply instabilities are projected to be high (*medium confidence*). At around 2°C of global warming the risk from permafrost degradation and food supply instabilities are projected to be very high (*medium confidence*). Additionally, at around 3°C of global warming risk from vegetation loss, wildfire damage, and dryland water scarcity are also projected to be very high (*medium confidence*). Risks from droughts, water stress, heat related events such as heatwaves and habitat degradation simultaneously increase between 1.5°C and 3°C warming (*low confidence*). {Figure SPM.2, 7.2.2, Cross-Chapter Box 9 in Chapter 6, Chapter 7 supplementary material}

A5.4. The stability of food supply[30] is projected to decrease as the magnitude and frequency of extreme weather events that disrupt food chains increases (*high confidence*). Increased atmospheric CO_2 levels can also lower the nutritional quality of crops (*high confidence*). In SSP2, global crop and economic models project a median increase of 7.6% (range of 1 to 23%) in cereal prices in 2050 due to climate change (RCP6.0), leading to higher food prices and increased risk of food insecurity and hunger (*medium confidence*). The most vulnerable people will be more severely affected (*high confidence*). {5.2.3, 5.2.4, 5.2.5, 5.8.1, 7.2.2.2, 7.3.1}

A5.5. In drylands, climate change and desertification are projected to cause reductions in crop and livestock productivity (*high confidence*), modify the plant species mix and reduce biodiversity (*medium confidence*). Under SSP2, the dryland population vulnerable to water stress, drought intensity and habitat degradation is projected to reach 178 million people by 2050 at 1.5°C warming, increasing to 220 million people at 2°C warming, and 277 million people at 3°C warming (*low confidence*). {3.5.1, 3.5.2, 3.7.3}

[29] Unprecedented climatic conditions are defined in this report as not having occurred anywhere during the 20th century. They are characterized by high temperature with strong seasonality and shifts in precipitation. In the literature assessed, the effect of climatic variables other than temperature and precipitation were not considered.

[30] The supply of food is defined in this report as encompassing availability and access (including price). Food supply instability refers to variability that influences food security through reducing access.

A5.6. Asia and Africa[31] are projected to have the highest number of people vulnerable to increased desertification. North America, South America, Mediterranean, southern Africa and central Asia may be increasingly affected by wildfire. The tropics and subtropics are projected to be most vulnerable to crop yield decline. Land degradation resulting from the combination of sea level rise and more intense cyclones is projected to jeopardise lives and livelihoods in cyclone prone areas (*very high confidence*). Within populations, women, the very young, elderly and poor are most at risk (*high confidence*). {3.5.1, 3.5.2, 4.4, Table 4.1, 5.2.2, 7.2.2, Cross-Chapter Box 3 in Chapter 2}

A5.7. Changes in climate can amplify environmentally induced migration both within countries and across borders (*medium confidence*), reflecting multiple drivers of mobility and available adaptation measures (*high confidence*). Extreme weather and climate or slow-onset events may lead to increased displacement, disrupted food chains, threatened livelihoods (*high confidence*), and contribute to exacerbated stresses for conflict (*medium confidence*). {3.4.2, 4.7.3, 5.2.3, 5.2.4, 5.2.5, 5.8.2, 7.2.2, 7.3.1}

A5.8 Unsustainable land management has led to negative economic impacts (*high confidence*). Climate change is projected to exacerbate these negative economic impacts (*high confidence*). {4.3.1, 4.4.1, 4.7, 4.8.5, 4.8.6, 4.9.6, 4.9.7, 4.9.8, 5.2, 5.8.1, 7.3.4, 7.6.1, Cross-Chapter Box 10 in Chapter 7}

A6. The level of risk posed by climate change depends both on the level of warming and on how population, consumption, production, technological development, and land management patterns evolve (*high confidence*). Pathways with higher demand for food, feed, and water, more resource-intensive consumption and production, and more limited technological improvements in agriculture yields result in higher risks from water scarcity in drylands, land degradation, and food insecurity (*high confidence*). {5.1.4, 5.2.3, 6.1.4, 7.2, Cross-Chapter Box 9 in Chapter 6, Figure SPM.2b}

A6.1. Projected increases in population and income, combined with changes in consumption patterns, result in increased demand for food, feed, and water in 2050 in all SSPs (*high confidence*). These changes, combined with land management practices, have implications for land-use change, food insecurity, water scarcity, terrestrial GHG emissions, carbon sequestration potential, and biodiversity (*high confidence*). Development pathways in which incomes increase and the demand for land conversion is reduced, either through reduced

[31] West Africa has a high number of people vulnerable to increased desertification and yield decline. North Africa is vulnerable to water scarcity.

agricultural demand or improved productivity, can lead to reductions in food insecurity (*high confidence*). All assessed future socio-economic pathways result in increases in water demand and water scarcity (*high confidence*). SSPs with greater cropland expansion result in larger declines in biodiversity (*high confidence*). {6.1.4}

A6.2. Risks related to water scarcity in drylands are lower in pathways with low population growth, less increase in water demand, and high adaptive capacity, as in Shared Socio-economic Pathway 1 (SSP1) (See BOX SPM.1). In these scenarios the risk from water scarcity in drylands is moderate even at global warming of 3°C (*low confidence*). By contrast, risks related to water scarcity in drylands are greater for pathways with high population growth, high vulnerability, higher water demand, and low adaptive capacity, such as SSP3. In SSP3 the transition from moderate to high risk occurs between 1.2°C and 1.5°C (*medium confidence*). {7.2, Figure SPM.2b, BOX SPM.1}

A6.3. Risks related to climate change driven land degradation are higher in pathways with a higher population, increased land-use change, low adaptive capacity and other barriers to adaptation (e.g., SSP3). These scenarios result in more people exposed to ecosystem degradation, fire, and coastal flooding (*medium confidence*). For land degradation, the projected transition from moderate to high risk occurs for global warming between 1.8°C and 2.8°C in SSP1 (*low confidence*) and between 1.4°C and 2°C in SSP3 (*medium confidence*). The projected transition from high to very high risk occurs between 2.2°C and 2.8°C for SSP3 (*medium confidence*). {4.4, 7.2, Figure SPM.2b}

A6.4. Risks related to food security are greater in pathways with lower income, increased food demand, increased food prices resulting from competition for land, more limited trade, and other challenges to adaptation (e.g., SSP3) (*high confidence*). For food security, the transition from moderate to high risk occurs for global warming between 2.5°C and 3.5°C in SSP1 (*medium confidence*) and between 1.3°C and 1.7°C in SSP3 (*medium confidence*). The transition from high to very high risk occurs between 2°C and 2.7°C for SSP3 (*medium confidence*). {7.2, Figure SPM.2b}

A6.5 Urban expansion is projected to lead to conversion of cropland leading to losses in food production (*high confidence*). This can result in additional risks to the food system. Strategies for reducing these impacts can include urban and peri-urban food production and management of urban expansion, as well as urban green infrastructure that can reduce climate risks in cities[32] (*high confidence*). {4.9.1, 5.5, 5.6, 6.3, 6.4, 7.5.6} (Figure SPM3)

[32] The land systems considered in this report do not include urban ecosystem dynamics in detail. Urban areas, urban expansion, and other urban processes and their relation to land-related processes are extensive, dynamic, and complex.

B. Adaptation and mitigation response options

B 1. Many land-related responses that contribute to climate change adaptation and mitigation can also combat desertification and land degradation and enhance food security. The potential for land-related responses and the relative emphasis on adaptation and mitigation is context specific, including the adaptive capacities of communities and regions. While land-related response options can make important contributions to adaptation and mitigation, there are some barriers to adaptation and limits to their contribution to global mitigation. (*very high confidence*) {2.6, 4.8, 5.6, 6.1, 6.3, 6.4, Figure SPM.3}

B1.1. Some land-related actions are already being taken that contribute to climate change adaptation, mitigation and sustainable development. The response options were assessed across adaptation, mitigation, combating desertification and land degradation, food security and sustainable development, and a select set of options deliver across all of these challenges. These options include, but are not limited to, sustainable food production, improved and sustainable forest management, soil organic carbon management, ecosystem conservation and land restoration, reduced deforestation and degradation, and reduced food loss and waste (*high confidence*). These response options require integration of biophysical, socioeconomic and other enabling factors. {6.3, 6.4.5; Cross-Chapter Box 10 in Chapter 7}

B1.2. While some response options have immediate impact, others take decades to deliver measurable results. Examples of response options with immediate impacts include the conservation of high-carbon ecosystems such as peatlands, wetlands, rangelands, mangroves and forests. Examples that provide multiple ecosystem services and functions, but take more time to deliver, include afforestation and reforestation as well as the restoration of high-carbon ecosystems, agroforestry, and the reclamation of degraded soils (*high confidence*). {6.4.5; Cross-Chapter Box 10 in Chapter 7}

B1.3. The successful implementation of response options depends on consideration of local environmental and socio-economic conditions. Some options such as soil carbon management are potentially applicable across a broad range of land use types, whereas the efficacy of land management practices relating to organic soils, peatlands and wetlands, and those linked to freshwater resources, depends on specific agro-ecological conditions (*high confidence*). Given

Several issues addressed in this report such as population, growth, incomes, food production and consumption, food security, and diets have close relationships with these urban processes. Urban areas are also the setting of many processes related to land-use change dynamics, including loss of ecosystem functions and services, that can lead to increased disaster risk. Some specific urban issues are assessed in this report.

the site-specific nature of climate change impacts on food system components and wide variations in agroecosystems, adaptation and mitigation options and their barriers are linked to environmental and cultural context at regional and local levels *(high confidence).* Achieving land degradation neutrality depends on the integration of multiple responses across local, regional and national scales, multiple sectors including agriculture, pasture, forest and water (*high confidence*). {4.8, 6.2, 6.3, 6.4.4}

B1.4. Land based options that deliver carbon sequestration in soil or vegetation, such as afforestation, reforestation, agroforestry, soil carbon management on mineral soils, or carbon storage in harvested wood products do not continue to sequester carbon indefinitely (*high confidence*). Peatlands, however, can continue to sequester carbon for centuries (*high confidence*). When vegetation matures or when vegetation and soil carbon reservoirs reach saturation, the annual removal of CO_2 from the atmosphere declines towards zero, while carbon stocks can be maintained (*high confidence*). However, accumulated carbon in vegetation and soils is at risk from future loss (or sink reversal) triggered by disturbances such as flood, drought, fire, or pest outbreaks, or future poor management (*high confidence*). {6.4.1}

B 2. Most of the response options assessed contribute positively to sustainable development and other societal goals (*high confidence*). Many response options can be applied without competing for land and have the potential to provide multiple co-benefits (*high confidence*). A further set of response options has the potential to reduce demand for land, thereby enhancing the potential for other response options to deliver across each of climate change adaptation and mitigation, combating desertification and land degradation, and enhancing food security (*high confidence*). {4.8, 6.2, 6.3.6, 6.4.3; Figure SPM.3}

B2.1. A number of land management options, such as improved management of cropland and grazing lands, improved and sustainable forest management, and increased soil organic carbon content, do not require land use change and do not create demand for more land conversion (*high confidence*). Further, a number of response options such as increased food productivity, dietary choices and food losses and waste reduction, can reduce demand for land conversion, thereby potentially freeing land and creating opportunities for enhanced implementation of other response options (*high confidence*). Response options that reduce competition for land are possible and are applicable at different scales, from farm to regional (*high confidence*). {4.8, 6.3.6, 6.4; Figure SPM.3}

B2.2. A wide range of adaptation and mitigation responses, e.g. preserving and restoring natural ecosystems such as peatland, coastal lands and forests, biodiversity conservation, reducing competition for land, fire management, soil management, and most risk management options (e.g. use of local seeds, disaster risk management, risk sharing instruments) have the potential to make

positive contributions to sustainable development, enhancement of ecosystem functions and services and other societal goals (*medium confidence*). Ecosystem-based adaptation can, in some contexts, promote nature conservation while alleviating poverty and even provide co-benefits by removing greenhouse gases and protecting livelihoods (e.g. mangroves) (*medium confidence*). {6.4.3, 7.4.6.2}

B2.3. Most of the land management-based response options that do not increase competition for land, and almost all options based on value chain management (e.g. dietary choices, reduced post-harvest losses, reduced food waste) and risk management, can contribute to eradicating poverty and eliminating hunger while promoting good health and wellbeing, clean water and sanitation, climate action, and life on land (*medium confidence*). {6.4.3}

B 3. Although most response options can be applied without competing for available land, some can increase demand for land conversion (*high confidence*). At the deployment scale of several $GtCO_2yr^{-1}$, this increased demand for land conversion could lead to adverse side effects for adaptation, desertification, land degradation and food security (*high confidence*). If applied on a limited share of total land and integrated into sustainably managed landscapes, there will be fewer adverse side-effects and some positive co-benefits can be realised (*high confidence*). {4.5, 6.2, 6.4; Cross-Chapter Box 7 in Chapter 6; Figure SPM.3}

B3.1. If applied at scales necessary to remove CO_2 from the atmosphere at the level of several $GtCO_2yr^{-1}$, afforestation, reforestation and the use of land to provide feedstock for bioenergy with or without carbon capture and storage, or for biochar, could greatly increase demand for land conversion (*high confidence*). Integration into sustainably managed landscapes at appropriate scale can ameliorate adverse impacts (*medium confidence*). Reduced grassland conversion to croplands, restoration and reduced conversion of peatlands, and restoration and reduced conversion of coastal wetlands affect smaller land areas globally, and the impacts on land use change of these options are smaller or more variable (*high confidence*). {Cross-Chapter Box 7 in Chapter 6; 6.4; Figure SPM.3}

B3.2. While land can make a valuable contribution to climate change mitigation, there are limits to the deployment of land-based mitigation measures such as bioenergy crops or afforestation. Widespread use at the scale of several millions of km^2 globally could increase risks for desertification, land degradation, food security and sustainable development (*medium confidence*). Applied on a limited share of total land, land-based mitigation measures that displace other land uses have fewer adverse side-effects and can have positive co-benefits for adaptation, desertification, land degradation or food security. (*high confidence*) {4.2, 4.5, 6.4; Cross-Chapter Box 7 in Chapter 6, Figure SPM3}

B3.3 The production and use of biomass for bioenergy can have co-benefits, adverse side effects, and risks for land degradation, food insecurity, GHG emissions and other environmental and sustainable development goals (*high confidence*). These impacts are context specific and depend on the scale of deployment, initial land use, land type, bioenergy feedstock, initial carbon stocks, climatic region and management regime, and other land-demanding response options can have a similar range of consequences (*high confidence*). The use of residues and organic waste as bioenergy feedstock can mitigate land use change pressures associated with bioenergy deployment, but residues are limited and the removal of residues that would otherwise be left on the soil could lead to soil degradation (*high confidence*). {2.6.1.5; Cross-Chapter Box 7 in Chapter 6; Figure SPM3}

B3.4. For projected socioeconomic pathways with low population, effective land-use regulation, food produced in low-GHG emission systems and lower food loss and waste (SSP1), the transition from low to moderate risk to food security, land degradation and water scarcity in dry lands occur between 1 and 4 million km^2 of bioenergy or BECCS (*medium confidence*). By contrast, in pathways with high population, low income and slow rates of technological change (SSP3), the transition from low to moderate risk occurs between 0.1 and 1 million km^2 (*medium confidence*). {6.4; Cross-Chapter Box 7 in Chapter 6; Table SM7.6; Box SPM1}

B 4. Many activities for combating desertification can contribute to climate change adaptation with mitigation co-benefits, as well as to halting biodiversity loss with sustainable development co-benefits to society (*high confidence*). Avoiding, reducing and reversing desertification would enhance soil fertility, increase carbon storage in soils and biomass, while benefitting agricultural productivity and food security (*high confidence*). Preventing desertification is preferable to attempting to restore degraded land due to the potential for residual risks and maladaptive outcomes (*high confidence*). {3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.7.1, 3.7.2}

B4.1. Solutions that help adapt to and mitigate climate change while contributing to combating desertification are site and regionally specific and include *inter alia*: water harvesting and micro-irrigation, restoring degraded lands using drought-resilient ecologically appropriate plants; agroforestry and other agroecological and ecosystem-based adaptation practices (*high confidence*). {3.3, 3.6.1, 3.7.2, 3.7.5, 5.2, 5.6}

B4.2. Reducing dust and sand storms and sand dune movement can lessen the negative effects of wind erosion and improve air quality and health (*high confidence*). Depending on water availability and soil conditions, afforestation, tree planting and ecosystem restoration programs,

which aim for the creation of windbreaks in the form of "green walls", and "green dams" using native and other climate resilient tree species with low water needs, can reduce sand storms, avert wind erosion, and contribute to carbon sinks, while improving micro-climates, soil nutrients and water retention (*high confidence*). {3.3, 3.6.1, 3.7.2, 3.7.5}

B4.3. Measures to combat desertification can promote soil carbon sequestration (*high confidence*). Natural vegetation restoration and tree planting on degraded land enriches, in the long term, carbon in the topsoil and subsoil (*medium confidence*). Modelled rates of carbon sequestration following the adoption of conservation agriculture practices in drylands depend on local conditions (*medium confidence*). If soil carbon is lost, it may take a prolonged period of time for carbon stocks to recover. {3.1.4, 3.3, 3.6.1, 3.6.3, 3.7.1, 3.7.2}

B4.4 Eradicating poverty and ensuring food security can benefit from applying measures promoting land degradation neutrality (including avoiding, reducing and reversing land degradation) in rangelands, croplands and forests, which contribute to combating desertification, while mitigating and adapting to climate change within the framework of sustainable development. Such measures include avoiding deforestation and locally suitable practices including management of rangeland and forest fires (*high confidence*). {3.4.2, 3.6.1, 3.6.2, 3.6.3, 4.8.5}.

B4.5 Currently there is a lack of knowledge of adaptation limits and potential maladaptation to combined effects of climate change and desertification. In the absence of new or enhanced adaptation options, the potential for residual risks and maladaptive outcomes is high (*high confidence*). Even when solutions are available, social, economic and institutional constraints could pose barriers to their implementation (*medium confidence*). Some adaptation options can become maladaptive due to their environmental impacts, such as irrigation causing soil salinisation or over extraction leading to ground-water depletion (*medium confidence*). Extreme forms of desertification can lead to the complete loss of land productivity, limiting adaptation options or reaching the limits to adaptation (*high confidence*). {Executive Summary Chapter 3, 3.6.4, 3.7.5, 7.4.9}

B4.6. Developing, enabling and promoting access to cleaner energy sources and technologies can contribute to adaptation and mitigating climate change and combating desertification and forest degradation through decreasing the use of traditional biomass for energy while increasing the diversity of energy supply (*medium confidence*). This can have socioeconomic and health benefits, especially for women and children. (*high confidence*). The efficiency of wind and solar energy infrastructures is recognized; the efficiency can be affected in some regions by dust and sand storms (*high confidence*). {3.5.3, 3.5.4, 4.4.4, 7.5.2, Cross-Chapter Box 12 in Chapter 7}

B 5. Sustainable land management[33], including sustainable forest management[34], can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation (*very high confidence*). It can also contribute to mitigation and adaptation (*high confidence*). Reducing and reversing land degradation, at scales from individual farms to entire watersheds, can provide cost effective, immediate, and long-term benefits to communities and support several Sustainable Development Goals (SDGs) with co-benefits for adaptation (*very high confidence*) and mitigation (*high confidence*). Even with implementation of sustainable land management, limits to adaptation can be exceeded in some situations (*medium confidence*). {1.3.2, 4.1.5, 4.8, Table 4.2}

B5.1. Land degradation in agriculture systems can be addressed through sustainable land management, with an ecological and socioeconomic focus, with co-benefits for climate change adaptation. Management options that reduce vulnerability to soil erosion and nutrient loss include growing green manure crops and cover crops, crop residue retention, reduced/zero tillage, and maintenance of ground cover through improved grazing management (*very high confidence*). {4.8}

B5.2. The following options also have mitigation co-benefits. Farming systems such as agroforestry, perennial pasture phases and use of perennial grains, can substantially reduce erosion and nutrient leaching while building soil carbon (*high confidence*). The global sequestration potential of cover crops would be about 0.44 +/- 0.11 $GtCO_2$ yr^{-1} if applied to 25% of global cropland (*high confidence*). The application of certain biochars can sequester carbon (*high confidence*), and improve soil conditions in some soil types/climates (*medium confidence*). {4.8.1.1, 4.8.1.3, 4.9.2, 4.9.5, 5.5.1, 5.5.4; Cross-Chapter Box 6 in Chapter 5}

B5.3. Reducing deforestation and forest degradation lowers GHG emissions (*high confidence*), with an estimated technical mitigation potential of 0.4–5.8 $GtCO_2$ yr^{-1}. By providing long-term livelihoods for communities, sustainable forest management can reduce the extent of

[33] Sustainable land management is defined in this report as the stewardship and use of land resources, including soils, water, animals and plants, to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. Examples of options include inter alia agroecology (including agroforestry), conservation agriculture and forestry practices, crop and forest species diversity, appropriate crop and forest rotations, organic farming, integrated pest management, the conservation of pollinators, rain water harvesting, range and pasture management, and precision agriculture systems.

[34] Sustainable forest management is defined in this report as the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality, and their potential to fulfill now and in the future, relevant ecological, economic and social functions at local, national and global levels and that does not cause damage to other ecosystems.

forest conversion to non-forest uses (e.g., cropland or settlements) (*high confidence*). Sustainable forest management aimed at providing timber, fibre, biomass, non-timber resources and other ecosystem functions and services, can lower GHG emissions and can contribute to adaptation. (*high confidence*). {2.6.1.2, 4.1.5, 4.3.2, 4.5.3, 4.8.1.3, 4.8.3, 4.8.4}

B5.4. Sustainable forest management can maintain or enhance forest carbon stocks, and can maintain forest carbon sinks, including by transferring carbon to wood products, thus addressing the issue of sink saturation (*high confidence*). Where wood carbon is transferred to harvested wood products, these can store carbon over the long-term and can substitute for emissions-intensive materials reducing emissions in other sectors (*high confidence*). Where biomass is used for energy, e.g., as a mitigation strategy, the carbon is released back into the atmosphere more quickly (*high confidence*). {2.6.1, 2.7, 4.1.5, 4.8.4, 6.4.1, Figure SPM.3, Cross-Chapter Box 7 in Chapter 6}

B5.5. Climate change can lead to land degradation, even with the implementation of measures intended to avoid, reduce or reverse land degradation (*high confidence*). Such limits to adaptation are dynamic, site specific and are determined through the interaction of biophysical changes with social and institutional conditions (*very high confidence*). In some situations, exceeding the limits of adaptation can trigger escalating losses or result inundesirable transformational changes (*medium confidence)*, such as forced migration (*low confidence*), conflicts (*low confidence*) or poverty (*medium confidence*). Examples of climate change induced land degradation that may exceed limits to adaptation include coastal erosion exacerbated by sea level rise where land disappears (*high confidence*), thawing of permafrost affecting infrastructure and livelihoods (*medium confidence*), and extreme soil erosion causing loss of productive capacity (*medium confidence*). {4.7, 4.8.5, 4.8.6, 4.9.6, 4.9.7, 4.9.8}

B 6. Response options throughout the food system, from production to consumption, including food loss and waste, can be deployed and scaled up to advance adaptation and mitigation (*high confidence*). The total technical mitigation potential from crop and livestock activities, and agroforestry is estimated as 2.3-9.6 $GtCO_2e.yr^{-1}$ by 2050 (*medium confidence)*. The total technical mitigation potential of dietary changes is estimated as 0.7-8 $GtCO_2e.yr-1$ by 2050 (*medium confidence*). {5.3, 5.5, 5.6}

B6.1. Practices that contribute to climate change adaptation and mitigation in cropland include increasing soil organic matter, erosion control, improved fertiliser management, improved crop management, for example, paddy rice management, and use ofvarieties and genetic improvements for heat and drought tolerance. For livestock, options include better grazing land management, improved manure management, higher-quality feed, and use of breeds and genetic improvement. Different farming and pastoral systems can achieve reductions in the emissions

intensity of livestock products. Depending on the farming and pastoral systems and level of development, reductions in the emissions intensity of livestock products may lead to absolute reductions in GHG emissions (*medium confidence*). Many livestock related options can enhance the adaptive capacity of rural communities, in particular, of smallholders and pastoralists. Significant synergies exist between adaptation and mitigation, for example through sustainable land management approaches (*high confidence*). {4.8, 5.3.3, 5.5.1, 5.6}

B6.2. Diversification in the food system (e.g., implementation of integrated production systems, broad-based genetic resources, and diets) can reduce risks from climate change (*medium confidence*). Balanced diets, featuring plant-based foods, such as those based on coarse grains, legumes, fruits and vegetables, nuts and seeds, and animal-sourced food produced in resilient, sustainable and low-GHG emission systems, present major opportunities for adaptation and mitigation while generating significant co-benefits in terms of human health (*high confidence*). By 2050, dietary changes could free several Mkm^2 (*medium confidence*) of land and provide a technical mitigation potential of 0.7 to 8.0 $GtCO_2e\ yr^{-1}$, relative to business as usual projections (*high confidence*). Transitions towards low-GHG emission diets may be influenced by local production practices, technical and financial barriers and associated livelihoods and cultural habits (*high confidence*). {5.3, 5.5.2, 5.5, 5.6}

B6.3. Reduction of food loss and waste can lower GHG emissions and contribute to adaptation through reduction in the land area needed for food production (*medium confidence*). During 2010-2016, global food loss and waste contributed 8-10% of total anthropogenic GHG emissions (*medium confidence*). Currently, 25-30% of total food produced is lost or wasted (*medium confidence*). Technical options such as improved harvesting techniques, on-farm storage, infrastructure, transport, packaging, retail and education can reduce food loss and waste across the supply chain. Causes of food loss and waste differ substantially between developed and developing countries, as well as between regions (*medium confidence*). {5.5.2} By 2050, reduced food loss and waste can free several Mkm^2 of land (*low confidence).* {6.3.6}

B 7. Future land use depends, in part, on the desired climate outcome and the portfolio of response options deployed (*high confidence*). All assessed modelled pathways that limit warming to 1.5ºC or well below 2°C require land-based mitigation and land-use change, with most including different combinations of reforestation, afforestation, reduced deforestation, and bioenergy (*high confidence*). A small number of modelled pathways achieve 1.5ºC with reduced land conversion (*high confidence*) and, thus, reduced consequences for desertification, land degradation, and food security (*medium confidence*). {2.6, 6.4, 7.4, 7.6; Cross-Chapter Box 9 in Chapter 6; Figure SPM.4}

B7.1. Modelled pathways limiting global warming to 1.5ºC[35] include more land-based mitigation than higher warming level pathways (*high confidence*), but the impacts of climate change on land systems in these pathways are less severe (*medium confidence*). {2.6, 6.4, 7.4, Cross-Chapter Box 9 in Chapter 6, Figure SPM.2, Figure SPM.4}

B7.2. Modelled pathways limiting global warming to 1.5°C and 2ºC project a 2 million km^2 reduction to a 12 million km^2 increase in forest area in 2050 relative to 2010 (*medium confidence*). 3ºC pathways project lower forest areas, ranging from a 4 million km^2 reduction to a 6 million km^2 increase (*medium confidence*). {2.5, 6.3, 7.3, 7.5; Cross-Chapter Box 9 in Chapter 6; Figure SPM.3, Figure SPM.4}

B7.3. The land area needed for bioenergy in modelled pathways varies significantly depending on the socioeconomic pathway, the warming level, and the feedstock and production system used (*high confidence*). Modelled pathways limiting global warming to 1.5°C use up to 7 million km^2 for bioenergy in 2050; bioenergy land area is smaller in 2°C (0.4 to 5 million km^2) and 3°C pathways (0.1 to 3 million km^2) (*medium confidence*). Pathways with large levels of land conversion may imply adverse side-effects impacting water scarcity, biodiversity, land degradation, desertification, and food security, if not adequately and carefully managed, whereas best practice implementation at appropriate scales can have co-benefits, such as management of dryland salinity, enhanced biocontrol and biodiversity and enhancing soil carbon sequestration (*high confidence*). {2.6, 6.1, 6.4, 7.2; Cross-Chapter Box 7 in Chapter 6, Figure SPM.3}

B7.4. Most mitigation pathways include substantial deployment of bioenergy technologies. A small number of modelled pathways limit warming to 1.5ºC with reduced dependence on bioenergy and BECCS (land area below <1 million km^2 in 2050) and other carbon dioxide removal (CDR) options (*high confidence*). These pathways have even more reliance on rapid and far-reaching transitions in energy, land, urban systems and infrastructure, and on behavioural and lifestyle changes compared to other 1.5°C pathways. {2.6.2, 5.5.1, 6.4, Cross-Chapter Box 7 in Chapter 6

B7.5. These modelled pathways do not consider the effects of climate change on land or CO_2 fertilisation. In addition, these pathways include only a subset of the response options assessed in this report (*high confidence*); the inclusion of additional response options in models could reduce the projected need for bioenergy or CDR that increases the demand for land. {6.4.4, Cross-Chapter Box 9 in Chapter 6}

[35] In this report references to pathways limiting global warming to a particular level are based on a 66% probability of staying below that temperature level in 2100 using the MAGICC model.

Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security

Panel A shows response options that can be implemented without or with limited competition for land, including some that have the potential to reduce the demand for land. Co-benefits and adverse side effects are shown quantitatively based on the high end of the range of potentials assessed. Magnitudes of contributions are categorised using thresholds for positive or negative impacts. Letters within the cells indicate confidence in the magnitude of the impact relative to the thresholds used (see legend). Confidence in the direction of change is generally higher.

	Response options based on land management	Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Agriculture	Increased food productivity	L	M	L	M	H	—
	Agro-forestry	M	M	M	M	L	●
	Improved cropland management	M	L	L	L	L	●●
	Improved livestock management	M	L	L	L	L	●●●
	Agricultural diversification	L	L	L	M	L	●
	Improved grazing land management	M	L	L	L	L	—
	Integrated water management	L	L	L	L	L	●●
	Reduced grassland conversion to cropland	L	—	L	L	- L	●
Forests	Forest management	M	L	L	L	L	●●
	Reduced deforestation and forest degradation	H	L	L	L	L	●●
Soils	Increased soil organic carbon content	H	L	M	M	L	●●
	Reduced soil erosion	↔ L	L	M	M	L	●●
	Reduced soil salinization	—	L	L	L	L	●●
	Reduced soil compaction	—	L	—	L	L	●
Other ecosystems	Fire management	M	M	M	M	L	●
	Reduced landslides and natural hazards	L	L	L	L	L	—
	Reduced pollution including acidification	↔ M	M	L	L	L	—
	Restoration & reduced conversion of coastal wetlands	M	L	M	M	↔ L	—
	Restoration & reduced conversion of peatlands	M	—	na	M	- L	●
	Response options based on value chain management						
Demand	Reduced post-harvest losses	H	M	L	L	H	—
	Dietary change	H	—	L	H	H	—
	Reduced food waste (consumer or retailer)	H	—	L	M	M	—
Supply	Sustainable sourcing	—	L	—	L	L	—
	Improved food processing and retailing	L	L	—	—	L	—
	Improved energy use in food systems	L	L	—	—	L	—
	Response options based on risk management						
Risk	Livelihood diversification	—	L	—	L	L	—
	Management of urban sprawl	—	L	L	M	L	—
	Risk sharing instruments	↔ L	L	—	↔ L	L	●●

Options shown are those for which data are available to assess global potential for three or more land challenges.
The magnitudes are assessed independently for each option and are not additive.

Key for criteria used to define magnitude of impact of each integrated response option

		Mitigation *Gt CO_2-eq yr^{-1}*	Adaptation *Million people*	Desertification *Million km^2*	Land Degradation *Million km^2*	Food Security *Million people*
Positive	Large	More than 3	Positive for more than 25	Positive for more than 3	Positive for more than 3	Positive for more than 100
	Moderate	0.3 to 3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	Small	Less than 0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
	Negligible	No effect	No effect	No effect	No effect	No effect
Negative	Small	Less than -0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
	Moderate	-0.3 to -3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	Large	More than -3	Negative for more than 25	Negative for more than 3	Negative for more than 3	Negative for more than 100

↔ **Variable**: Can be positive or negative — no data — na not applicable

Confidence level

Indicates confidence in the estimate of magnitude category.

H High confidence
M Medium confidence
L Low confidence

Cost range

See technical caption for cost ranges in US$ tCO_2e^{-1} or US$ ha^{-1}.

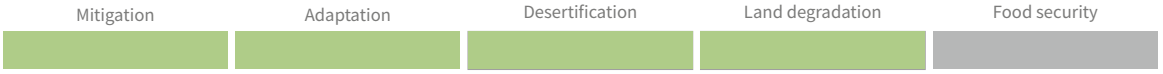
●●● High cost
●● Medium cost
● Low cost
— no data

Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security

Panel B shows response options that rely on additional land-use change and could have implications across three or more land challenges under different implementation contexts. For each option, the first row (high level implementation) shows a quantitative assessment (as in Panel A) of implications for global implementation at scales delivering CO_2 removals of more than 3 $GtCO_2\ yr^{-1}$ using the magnitude thresholds shown in Panel A. The red hatched cells indicate an increasing pressure but unquantified impact. For each option, the second row (best practice implementation) shows qualitative estimates of impact if implemented using best practices in appropriately managed landscape systems that allow for efficient and sustainable resource use and supported by appropriate governance mechanisms. In these qualitative assessments, green indicates a positive impact, grey indicates a neutral interaction.

Bioenergy and BECCS

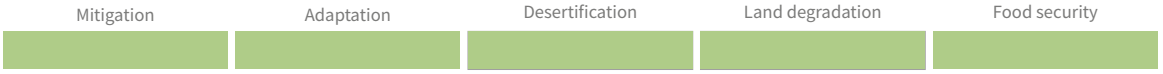
High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts, assuming carbon dioxide removal by BECCS at a scale of 11.3 $GtCO_2\ yr^{-1}$ in 2050, and noting that bioenergy without CCS can also achieve emissions reductions of up to several $GtCO_2\ yr^{-1}$ when it is a low carbon energy source {2.7.1.5; 6.4.1.1.5}. Studies linking bioenergy to food security estimate an increase in the population at risk of hunger to up to 150 million people at this level of implementation {6.4.5.1.5}. The red hatched cells for desertification and land degradation indicate that while up to 15 million km_2 of additional land is required in 2100 in 2°C scenarios which will increase pressure for desertification and land degradation, the actual area affected by this additional pressure is not easily quantified {6.4.3.1.5; 6.4.4.1.5}.



Best practice: The sign and magnitude of the effects of bioenergy and BECCS depends on the scale of deployment, the type of bioenergy feedstock, which other response options are included, and where bioenergy is grown (including prior land use and indirect land use change emissions). For example, limiting bioenergy production to marginal lands or abandoned cropland would have negligible effects on biodiversity, food security, and potentially co-benefits for land degradation; however, the benefits for mitigation could also be smaller. {Table 6.58}

Reforestation and forest restoration

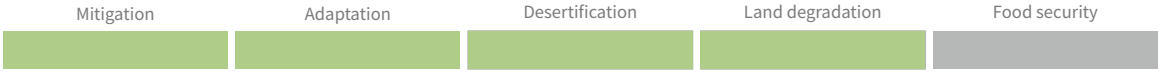
High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of reforestation and forest restoration (partly overlapping with afforestation) at a scale of 10.1 $GtCO_2\ yr^{-1}$ removal {6.4.1.1.2}. Large-scale afforestation could cause increases in food prices of 80% by 2050, and more general mitigation measures in the AFOLU sector can translate into a rise in undernourishment of 80–300 million people; the impact of reforestation is lower {6.4.5.1.2}.



Best practice: There are co-benefits of reforestation and forest restoration in previously forested areas, assuming small scale deployment using native species and involving local stakeholders to provide a safety net for food security. Examples of sustainable implementation include, but are not limited to, reducing illegal logging and halting illegal forest loss in protected areas, reforesting and restoring forests in degraded and desertified lands {Box6.1C; Table 6.6}.

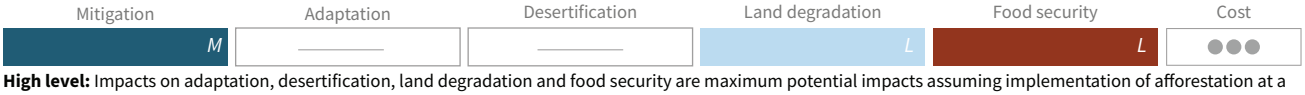
Afforestation

High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of afforestation (partly overlapping with reforestation and forest restoration) at a scale of 8.9 $GtCO_2\ yr^{-1}$ removal {6.4.1.1.2}. Large-scale afforestation could cause increases in food prices of 80% by 2050, and more general mitigation measures in the AFOLU sector can translate into a rise in undernourishment of 80–300 million people {6.4.5.1.2}.

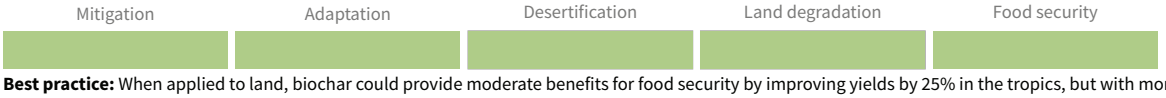


Best practice: Afforestation is used to prevent desertification and to tackle land degradation. Forested land also offers benefits in terms of food supply, especially when forest is established on degraded land, mangroves, and other land that cannot be used for agriculture. For example, food from forests represents a safety-net during times of food and income insecurity {6.4.5.1.2}.

Biochar addition to soil



High level: Impacts on adaptation, desertification, land degradation and food security are maximum potential impacts assuming implementation of afforestation at a scale of 6.6 $GtCO_2\ yr^{-1}$ removal {6.4.1.1.3}. Dedicated energy crops required for feedstock production could occupy 0.4–2.6 Mkm^2 of land, equivalent to around 20% of the global cropland area, which could potentially have a large effect on food security for up to 100 million people {6.4.5.1.3}.



Best practice: When applied to land, biochar could provide moderate benefits for food security by improving yields by 25% in the tropics, but with more limited impacts in temperate regions, or through improved water holding capacity and nutrient use efficiency. Abandoned cropland could be used to supply biomass for biochar, thus avoiding competition with food production; 5-9 Mkm^2 of land is estimated to be available for biomass production without compromising food security and biodiversity, considering marginal and degraded land and land released by pasture intensification {6.4.5.1.3}.

Figure SPM.3 Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security.

This Figure is based on an aggregation of information from studies with a wide variety of assumptions about how response options are implemented and the contexts in which they occur. Response options implemented differently at local to global scales could lead to different outcomes. **Magnitude of potential:** For panel A, magnitudes are for the technical potential of response options globally. For each land challenge, magnitudes are set relative to a marker level as follows. For mitigation, potentials are set relative to the approximate potentials for the response options with the largest individual impacts (~3 $GtCO_2$-eq yr^{-1}). The threshold for the "large" magnitude category is set at this level. For adaptation, magnitudes are set relative to the 100 million lives estimated to be affected by climate change and a carbon-based economy between 2010 and 2030. The threshold for the "large" magnitude category represents 25% of this total. For desertification and land degradation, magnitudes are set relative to the lower end of current estimates of degraded land, 10-60 million km^2. The threshold for the "large" magnitude category represents 30% of the lower estimate. For food security, magnitudes are set relative to the approximately 800 million people who are currently undernourished. The threshold for the "large" magnitude category represents 12.5% of this total. For panel B, for the first row (high level implementation) for each response option, the magnitude and thresholds are as defined for panel A. In the second row (best practice implementation) for each response option, the qualitative assessments that are green denote potential positive impacts, and those shown in grey indicate neutral interactions. Increased food production is assumed to be achieved through sustainable intensification rather than through injudicious application of additional external inputs such as agrochemicals. **Levels of confidence:** Confidence in the magnitude category (high, medium or low) into which each option falls for mitigation, adaptation, combating desertification and land degradation, and enhancing food security. *High confidence* means that there is a high level of agreement and evidence in the literature to support the categorisation as high, medium or low magnitude. *Low confidence* denotes that the categorisation of magnitude is based on few studies. *Medium confidence* reflects medium evidence and agreement in the magnitude of response. **Cost ranges:** Cost estimates are based on aggregation of often regional studies and vary in the components of costs that are included. In panel B, cost estimates are not provided for best practice implementation. One coin indicates low cost (<USD10 tCO_2-eq^{-1} or <USD20 ha^{-1}), two coins indicate medium cost (USD10-USD100 tCO_2-eq^{-1} or USD20-USD200 ha^{-1}), and three coins indicate high cost (>USD100 tCO_2-eq^{-1} or USD200 ha^{-1}). Thresholds in USD ha^{-1} are chosen to be comparable, but precise conversions will depend on the response option. **Supporting evidence:** Supporting evidence for the magnitude of the quantitative potential for land management-based response options can be found as follows: for mitigation tables 6.13 to 6.20, with further evidence in Section 2.7.1; for adaptation tables 6.21 to 6.28; for combating desertification tables 6.29 to 6.36, with further evidence in Chapter 3; for combating degradation tables 6.37 to 6.44, with further evidence in Chapter 4; for enhancing food security tables 6.45 to 6.52, with further evidence in Chapter 5. Other synergies and trade-offs not shown here are discussed in Chapter 6. Additional supporting evidence for the qualitative assessments in the second row for each option in panel B can be found in the tables 6.6, 6.55, 6.56 and 6.58, section 6.3.5.1.3, and Box 6.1c.

C. Enabling response options

C 1. Appropriate design of policies, institutions and governance systems at all scales can contribute to land-related adaptation and mitigation while facilitating the pursuit of climate-adaptive development pathways (*high confidence*). Mutually supportive climate and land policies have the potential to save resources, amplify social resilience, support ecological restoration, and foster engagement and collaboration between multiple stakeholders (*high confidence*). {Figure SPM.1, Figure SPM.2, Figure SPM.3; 3.6.2, 3.6.3, 4.8, 4.9.4, 5.7, 6.3, 6.4, 7.2.2, 7.3, 7.4, 7.4.7, 7.4.8, 7.5, 7.5.5, 7.5.6, 7.6.6; Cross-Chapter Box 10 in Chapter 7}

C1.1. Land-use zoning, spatial planning, integrated landscape planning, regulations, incentives (such as payment for ecosystem services), and voluntary or persuasive instruments (such as environmental farm planning, standards and certification for sustainable production, use of scientific, local and indigenous knowledge and collective action), can achieve positive adaptation and mitigation outcomes (*medium confidence*). They can also contribute revenue and provide incentive to rehabilitate degraded lands and adapt to and mitigate climate change in certain contexts (*medium confidence*). Policies promoting the target of land degradation neutrality can also support food security, human wellbeing and climate change adaptation and mitigation (*high confidence*). {Figure SPM.2; 3.4.2, 4.1.6, 4.7, 4.8.5, 5.1.2, 5.7.3, 7.3, 7.4.6, 7.4.7, 7.5}

C1.2. Insecure land tenure affects the ability of people, communities and organisations to make changes to land that can advance adaptation and mitigation (*medium confidence*). Limited recognition of customary access to land and ownership of land can result in increased vulnerability and decreased adaptive capacity (*medium confidence*). Land policies (including recognition of customary tenure, community mapping, redistribution, decentralisation, co-management, regulation of rental markets) can provide both security and flexibility response to climate change (*medium confidence*). {3.6.1, 3.6.2, 5.3, 7.2.4, 7.6.4, Cross-Chapter Box 6 in Chapter 5}

C1.3. Achieving land degradation neutrality will involve a balance of measures that avoid and reduce land degradation, through adoption of sustainable land management, and measures to reverse degradation through rehabilitation and restoration of degraded land. Many interventions to achieve land degradation neutrality commonly also deliver climate change adaptation and mitigation benefits. The pursuit of land degradation neutrality provides impetus to address land degradation and climate change simultaneously (*high confidence*). {4.5.3, 4.8.5, 4.8.7, 7.4.5}

C1.4. Due to the complexity of challenges and the diversity of actors involved in addressing land challenges, a mix of policies, rather than single policy approaches, can deliver improved results in addressing the complex challenges of sustainable land management and climate change (*high confidence*). Policy mixes can strongly reduce the vulnerability and exposure of human and natural systems to climate change (*high confidence*). Elements of such policy mixes may include weather and health insurance, social protection and adaptive safety nets, contingent finance and reserve funds, universal access to early warning systems combined with effective contingency plans (*high confidence*). {1.2, 4.8, 4.9.2, 5.3.2, 5.6, 5.6.6, 5.7.2, 7.3.2, 7.4, 7.4.2, 7.4.6, 7.4.7, 7.4.8, 7.5.5, 7.5.6, 7.6.4, Figure SPM.4}

C2. Policies that operate across the food system, including those that reduce food loss and waste and influence dietary choices, enable more sustainable land-use management, enhanced food security and low emissions trajectories (*high confidence*). Such policies can contribute to climate change adaptation and mitigation, reduce land degradation, desertification and poverty as well as improve public health (*high confidence*). The adoption of sustainable land management and poverty eradication can be enabled by improving access to markets, securing land tenure, factoring environmental costs into food, making payments for ecosystem services, and enhancing local and community collective action *(high confidence)*. {1.1.2, 1.2.1, 3.6.3, 4.7.1, 4.7.2, 4.8, 5.5, 6.4, 7.4.6, 7.6.5}

C2.1. Policies that enable and incentivise sustainable land management for climate change adaptation and mitigation include improved access to markets for inputs, outputs and financial services, empowering women and indigenous peoples, enhancing local and community collective action, reforming subsidies and promoting an enabling trade system (*high confidence*). Land restoration and rehabilitation efforts can be more effective when policies support local management of natural resources, while strengthening cooperation between actors and institutions, including at the international level. {3.6.3, 4.1.6, 4.5.4, 4.8.2, 4.8.4, 5.7, 7.2}

C2.2. Reflecting the environmental costs of land-degrading agricultural practices can incentivise more sustainable land management *(high confidence)*. Barriers to the reflection of environmental costs arise from technical difficulties in estimating these costs and those embodied in foods. {3.6.3, 5.5.1, 5.5.2, 5.6.6, 5.7, 7.4.4, Cross-Chapter Box 10 in Chapter 7}

C2.3. Adaptation and enhanced resilience to extreme events impacting food systems can be facilitated by comprehensive risk management, including risk sharing and transfer mechanisms *(high confidence)*. Agricultural diversification, expansion of market access, and preparation for increasing supply chain disruption can support the scaling up of adaptation in food systems (*high confidence)*. {5.3.2, 5.3.3, 5.3.5}

C2.4. Public health policies to improve nutrition, such as increasing the diversity of food sources in public procurement, health insurance, financial incentives, and awareness-raising campaigns, can potentially influence food demand, reduce healthcare costs, contribute to lower GHG emissions and enhance adaptive capacity *(high confidence)*. Influencing demand for food, through promoting diets based on public health guidelines, can enable more sustainable land management and contribute to achieving multiple SDGs *(high confidence)*. {3.4.2, 4.7.2, 5.1, 5.7, 6.3, 6.4}

C 3. Acknowledging co-benefits and trade-offs when designing land and food policies can overcome barriers to implementation (*medium confidence*). Strengthened multilevel, hybrid and cross-sectoral governance, as well as policies developed and adopted in an iterative, coherent, adaptive and flexible manner can maximise co-benefits and minimise trade-offs, given that land management decisions are made from farm level to national scales, and both climate and land policies often range across multiple sectors, departments and agencies (*high confidence*). {Figure SPM.3; 4.8.5, 4.9, 5.6, 6.4, 7.3, 7.4.6, 7.4.8, 7.4.9, 7.5.6, 7.6.2}

C3.1. Addressing desertification, land degradation, and food security in an integrated, coordinated and coherent manner can assist climate resilient development and provides numerous potential co-benefits (*high confidence*). {3.7.5, 4.8, 5.6, 5.7, 6.4, 7.2.2, 7.3.1, 7.3.4, 7.4.7, 7.4.8, 7.5.6, 7.5.5}

C3.2. Technological, biophysical, socio-economic, financial and cultural barriers can limit the adoption of many land-based response options, as can uncertainty about benefits (*high confidence*). Many sustainable land management practices are not widely adopted due to insecure land tenure, lack of access to resources and agricultural advisory services, insufficient and unequal private and public incentives, and lack of knowledge and practical experience (*high confidence*). Public discourse, carefully designed policy interventions, incorporating social learning and market changes can together help reduce barriers to implementation (*medium confidence*). {3.6.1, 3.6.2, 5.3.5, 5.5.2, 5.6, 6.2, 6.4, 7.4, 7.5, 7.6}

C3.3. The land and food sectors face particular challenges of institutional fragmentation and often suffer from a lack of engagement between stakeholders at different scales and narrowly focused policy objectives (*medium confidence*). Coordination with other sectors, such as public health, transportation, environment, water, energy and infrastructure, can increase co-benefits, such as risk reduction and improved health (*medium confidence*). {5.6.3, 5.7, 6.2, 6.4.4, 7.1, 7.3, 7.4.8, 7.6.2, 7.6.3}

C3.4. Some response options and policies may result in trade-offs, including social impacts, ecosystem functions and services damage, water depletion, or high costs, that cannot be well-managed, even with institutional best practices (*medium confidence*). Addressing such trade-offs helps avoid maladaptation (*medium confidence).* Anticipation and evaluation of potential trade-offs and knowledge gaps supports evidence-based policymaking to weigh the costs and benefits of specific responses for different stakeholders (*medium confidence*). Successful management of trade-offs often includes maximising stakeholder input with structured feedback processes, particularly in community-based models, use of innovative fora like facilitated dialogues or spatially explicit mapping, and iterative adaptive management that allows for continuous readjustments in policy as new evidence comes to light (*medium confidence*). {5.3.5, 6.4.2, 6.4.4, 6.4.5, 7.5.6; Cross-Chapter Box 13 in Chapter 7}

C 4. The effectiveness of decision-making and governance is enhanced by the involvement of local stakeholders (particularly those most vulnerable to climate change including indigenous peoples and local communities, women, and the poor and marginalised) in the selection, evaluation, implementation and monitoring of policy instruments for land-based climate change adaptation and mitigation (*high confidence*). Integration across sectors and scales increases the chance of maximising co-benefits and minimising trade-offs (*medium confidence*). {1.4, 3.1, 3.6, 3.7, 4.8, 4.9, 5.1.3, Box 5.1, 7.4, 7.6}

C4.1. Successful implementation of sustainable land management practices requires accounting for local environmental and socio-economic conditions (*very high confidence*). Sustainable land management in the context of climate change is typically advanced by involving all relevant stakeholders in identifying land-use pressures and impacts (such as biodiversity decline, soil loss, over-extraction of groundwater, habitat loss, land-use change in agriculture, food production and forestry) as well as preventing, reducing and restoring degraded land (*medium confidence*). {1.4.1, 4.1.6, 4.8.7, 5.2.5, 7.2.4, 7.6.2, 7.6.4}

C4.2. Inclusiveness in the measurement, reporting and verification of the performance of policy instruments can support sustainable land management (*medium confidence*). Involving stakeholders in the selection of indicators, collection of climate data, land modelling and land-use planning, mediates and facilitates integrated landscape planning and choice of policy (*medium confidence*). {3.7.5, 5.7.4, 7.4.1, 7.4.4, 7.5.3, 7.5.4, 7.5.5, 7.6.4, 7.6.6}

C4.3. Agricultural practices that include indigenous and local knowledge can contribute to overcoming the combined challenges of climate change, food security, biodiversity conservation, and combating desertification and land degradation (*high confidence*). Coordinated action across a range of actors including businesses, producers, consumers, land managers and policymakers in partnership with indigenous peoples and local communities enable conditions for

the adoption of response options (*high confidence*) {3.1.3, 3.6.1, 3.6.2, 4.8.2, 5.5.1, 5.6.4, 5.7.1, 5.7.4, 6.2, 7.3, 7.4.6, 7.6.4}

C4.4. Empowering women can bring synergies and co-benefits to household food security and sustainable land management (*high confidence*). Due to women's disproportionate vulnerability to climate change impacts, their inclusion in land management and tenure is constrained. Policies that can address land rights and barriers to women's participation in sustainable land management include financial transfers to women under the auspices of anti-poverty programmes, spending on health, education, training and capacity building for women, subsidised credit and program dissemination through existing women's community-based organisations (*medium confidence*). {1.4.1, 4.8.2, 5.1.3, Box 5.1, Cross-Chapter Box 11 in Chapter 7}.

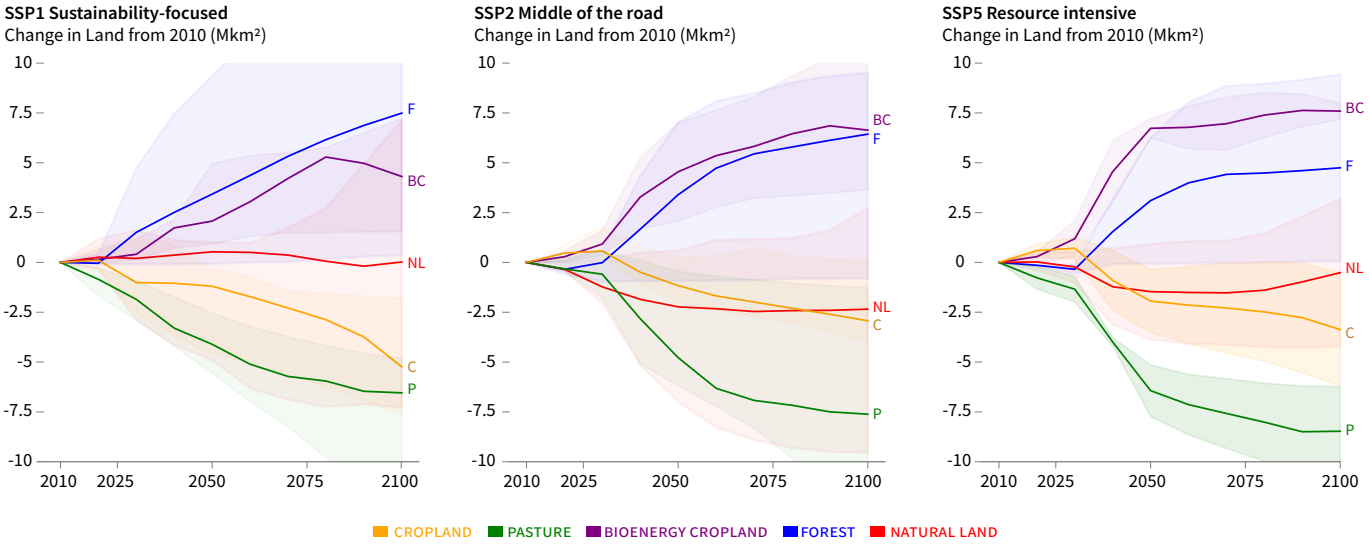
A. Pathways linking socioeconomic development, mitigation responses and land

Socioeconomic development and land management influence the evolution of the land system including the relative amount of land allocated to **CROPLAND**, **PASTURE**, **BIOENERGY CROPLAND**, **FOREST**, and **NATURAL LAND**. The lines show the median across Integrated Assessment Models (IAMs) for three alternative shared socioeconomic pathways (**SSP1**, **SSP2** and **SSP5** at **RCP1.9**); shaded areas show the range across models. Note that pathways illustrate the effects of climate change mitigation but not those of climate change impacts or adaptation.

A. Sustainability-focused (SSP1)
Sustainability in land management, agricultural intensification, production and consumption patterns result in reduced need for agricultural land, despite increases in per capita food consumption. This land can instead be used for reforestation, afforestation, and bioenergy.

B. Middle of the road (SSP2)
Societal as well as technological development follows historical patterns. Increased demand for land mitigation options such as bioenergy, reduced deforestation or afforestation decreases availability of agricultural land for food, feed and fibre.

C. Resource intensive (SSP5)
Resource-intensive production and consumption patterns, results in high baseline emissions. Mitigation focuses on technological solutions including substantial bioenergy and BECCS . Intensification and competing land uses contribute to declines in agricultural land.



B. Land use and land cover change in the SSPs

	Quantitative indicators for the SSPs	Count of models included*	Change in Natural Land from 2010 Mkm²	Change in Bioenergy Cropland from 2010 Mkm²	Change in Cropland from 2010 Mkm²	Change in Forest from 2010 Mkm²	Change in Pasture from 2010 Mkm²
SSP1	**RCP1.9** in 2050	5/5	0.5 (-4.9, 1)	2.1 (0.9, 5)	-1.2 (-4.6, -0.3)	3.4 (-0.1, 9.4)	-4.1 (-5.6, -2.5)
	↳ 2100		0 (-7.3, 7.1)	4.3 (1.5, 7.2)	-5.2 (-7.6, -1.8)	7.5 (0.4, 15.8)	-6.5 (-12.2, -4.8)
	RCP2.6 in 2050	5/5	-0.9 (-2.2, 1.5)	1.3 (0.4, 1.9)	-1 (-4.7, 1)	2.6 (-0.1, 8.4)	-3 (-4, -2.4)
	↳ 2100		0.2 (-3.5, 1.1)	5.1 (1.6, 6.3)	-3.2 (-7.7, -1.8)	6.6 (-0.1, 10.5)	-5.5 (-9.9, -4.2)
	RCP4.5 in 2050	5/5	0.5 (-1, 1.7)	0.8 (0.5, 1.3)	0.1 (-3.2, 1.5)	0.6 (-0.7, 4.2)	-2.4 (-3.3, -0.9)
	↳ 2100		1.8 (-1.7, 6)	1.9 (1.4, 3.7)	-2.3 (-6.4, -1.6)	3.9 (0.2, 8.8)	-4.6 (-7.3, -2.7)
	Baseline in 2050	5/5	0.3 (-1.1, 1.8)	0.5 (0.2, 1.4)	0.2 (-1.6, 1.9)	-0.1 (-0.8, 1.1)	-1.5 (-2.9, -0.2)
	↳ 2100		3.3 (-0.3, 5.9)	1.8 (1.4, 2.4)	-1.5 (-5.7, -0.9)	0.9 (0.3, 3)	-2.1 (-7, 0)
SSP2	**RCP1.9** in 2050	4/5	-2.2 (-7, 0.6)	4.5 (2.1, 7)	-1.2 (-2, 0.3)	3.4 (-0.9, 7)	-4.8 (-6.2, -0.4)
	↳ 2100		-2.3 (-9.6, 2.7)	6.6 (3.6, 11)	-2.9 (-4, 0.1)	6.4 (-0.8, 9.5)	-7.6 (-11.7, -1.3)
	RCP2.6 in 2050	5/5	-3.2 (-4.2, 0.1)	2.2 (1.7, 4.7)	0.6 (-1.9, 1.9)	1.6 (-0.9, 4.2)	-1.4 (-3.7, 0.4)
	↳ 2100		-5.2 (-7.2, 0.5)	6.9 (2.3, 10.8)	-1.4 (-4, 0.8)	5.6 (-0.9, 5.9)	-7.2 (-8, 0.5)
	RCP4.5 in 2050	5/5	-2.2 (-2.2, 0.7)	1.5 (0.1, 2.1)	1.2 (-0.9, 2.7)	-0.9 (-2.5, 2.9)	-0.1 (-2.5, 1.6)
	↳ 2100		-3.4 (-4.7, 1.5)	4.1 (0.4, 6.3)	0.7 (-2.6, 3.1)	-0.5 (-3.1, 5.9)	-2.8 (-5.3, 1.9)
	Baseline in 2050	5/5	-1.5 (-2.6, -0.2)	0.7 (0, 1.5)	1.3 (1, 2.7)	-1.3 (-2.5, -0.4)	-0.1 (-1.2, 1.6)
	↳ 2100		-2.1 (-5.9, 0.3)	1.2 (0.1, 2.4)	1.9 (0.8, 2.8)	-1.3 (-2.7, -0.2)	-0.2 (-1.9, 2.1)
SSP3	**RCP1.9** in 2050	Infeasible in all assessed models		-	-	-	-
	↳ 2100			-	-	-	-
	RCP2.6 in 2050	Infeasible in all assessed models		-	-	-	-
	↳ 2100			-	-	-	-
	RCP4.5 in 2050	3/3	-3.4 (-4.4, -2)	1.3 (1.3, 2)	2.3 (1.2, 3)	-2.4 (-4, -1)	2.1 (-0.1, 3.8)
	↳ 2100		-6.2 (-6.8, -5.4)	4.6 (1.5, 7.1)	3.4 (1.9, 4.5)	-3.1 (-5.5, -0.3)	2 (-2.5, 4.4)
	Baseline in 2050	4/4	-3 (-4.6, -1.7)	1 (0.2, 1.5)	2.5 (1.5, 3)	-2.5 (-4, -1.5)	2.4 (0.6, 3.8)
	↳ 2100		-5 (-7.1, -4.2)	1.1 (0.9, 2.5)	5.1 (3.8, 6.1)	-5.3 (-6, -2.6)	3.4 (0.9, 6.4)
SSP4	**RCP1.9** in 2050	Infeasible in all assessed models**		-	-	-	-
	↳ 2100			-	-	-	-
	RCP2.6 in 2050	3/3	-4.5 (-6, -2.1)	3.3 (1.5, 4.5)	0.5 (-0.1, 0.9)	0.7 (-0.3, 2.2)	-0.6 (-0.7, 0.1)
	↳ 2100		-5.8 (-10.2, -4.7)	2.5 (2.3, 15.2)	-0.8 (-0.8, 1.8)	1.4 (-1.7, 4.1)	-1.2 (-2.5, -0.2)
	RCP4.5 in 2050	3/3	-2.7 (-4.4, -0.4)	1.7 (1, 1.9)	1.1 (-0.1, 1.7)	-1.8 (-2.3, 2.1)	0.8 (-0.5, 1.5)
	↳ 2100		-2.8 (-7.8, -2)	2.7 (2.3, 4.7)	1.1 (0.2, 1.2)	-0.7 (-2.6, 1)	1.4 (-1, 1.8)
	Baseline in 2050	3/3	-2.8 (-2.9, -0.2)	1.1 (0.7, 2)	1.1 (0.7, 1.8)	-1.8 (-2.3, -1)	1.5 (-0.5, 2.1)
	↳ 2100		-2.4 (-5, -1)	1.7 (1.4, 2.6)	1.2 (1.2, 1.9)	-2.4 (-2.5, -2)	1.3 (-1, 4.4)
SSP5	**RCP1.9** in 2050	2/4	-1.5 (-3.9, 0.9)	6.7 (6.2, 7.2)	-1.9 (-3.5, -0.4)	3.1 (-0.1, 6.3)	-6.4 (-7.7, -5.1)
	↳ 2100		-0.5 (-4.2, 3.2)	7.6 (7.2, 8)	-3.4 (-6.2, -0.5)	4.7 (0.1, 9.4)	-8.5 (-10.7, -6.2)
	RCP2.6 in 2050	4/4	-3.4 (-6.9, 0.3)	4.8 (3.8, 5.1)	-2.1 (-4, 1)	3.9 (-0.1, 6.7)	-4.4 (-5, 0.2)
	↳ 2100		-4.3 (-8.4, 0.5)	9.1 (7.7, 9.2)	-3.3 (-6.5, -0.5)	3.9 (-0.1, 9.3)	-6.3 (-9.1, -1.4)
	RCP4.5 in 2050	4/4	-2.5 (-3.7, 0.2)	1.7 (0.6, 2.9)	0.6 (-3.3, 1.9)	-0.1 (-1.7, 6)	-1.2 (-2.6, 2.3)
	↳ 2100		-4.1 (-4.6, 0.7)	4.8 (2, 8)	-1 (-5.5, 1)	-0.2 (-1.4, 9.1)	-3 (-5.2, 2.1)
	Baseline in 2050	4/4	-0.6 (-3.8, 0.4)	0.8 (0, 2.1)	1.5 (-0.7, 3.3)	-1.9 (-3.4, 0.5)	-0.1 (-1.5, 2.9)
	↳ 2100		-0.2 (-2.4, 1.8)	1 (0.2, 2.3)	1 (-2, 2.5)	-2.1 (-3.4, 1.1)	-0.4 (-2.4, 2.8)

** Count of models included / Count of models attempted. One model did not provide land data and is excluded from all entries.*

*** One model could reach RCP1.9 with SSP4, but did not provide land data*

Figure SPM.4 Pathways linking socioeconomic development, mitigation responses and land

Future scenarios provide a framework for understanding the implications of mitigation and socioeconomics on land. The Shared Socioeconomic Pathways (SSPs) span a range of different socioeconomic assumptions (Box SPM.1). They are combined with Representative Concentration Pathways (RCPs)[36]which imply different levels of mitigation. The changes in cropland, pasture, bioenergy cropland, forest, and natural land from 2010 are shown. For this figure: Cropland includes all land in food, feed, and fodder crops, as well as other arable land (cultivated area). This category includes 1st generation non-forest bioenergy crops (e.g. corn for ethanol, sugar cane for ethanol, soybeans for biodiesel), but excludes 2nd generation bioenergy crops. Pasture includes categories of pasture land, not only high quality rangeland, and is based on FAO definition of "permanent meadows and pastures". Bioenergy cropland includes land dedicated to 2nd generation energy crops (e.g., switchgrass, miscanthus, fast-growing wood species). Forest includes managed and unmanaged forest. Natural land includes other grassland, savannah, and shrubland. **Panel A:** This panel shows integrated assessment model (IAM)[37] results for SSP1, SSP2 and SSP5 at RCP1.9[38]. For each pathway, the shaded areas show the range across all IAMs; the line indicates the median across models. For RCP1.9, SSP1, SSP2 and SSP5 include results from five, four and two IAMs respectively. **Panel B**: Land use and land cover change are indicated for various SSP-RCP combinations, showing multi-model median and range (min, max). {Box SPM.1, 1.3.2, Cross-Chapter Box 1 in Chapter 1, 2.7.2, Cross-Chapter Box 9 in Chapter 6, 6.1, 6.4.4, 7.4.2, 7.4.4, 7.4.5, 7.4.6, 7.4.7, 7.4.8, 7.5.3, 7.5.6; Cross-Chapter Box 9 in Chapter 6}

D. Action in the near-term

D 1. Actions can be taken in the near-term, based on existing knowledge, to address desertification, land degradation and food security while supporting longer-term responses that enable adaptation and mitigation to climate change. These include actions to build individual and institutional capacity, accelerate knowledge transfer, enhance technology transfer and deployment, enable financial mechanisms, implement early warning systems, undertake risk management and address gaps in implementation and upscaling (*high confidence*). {3.6.1, 3.6.2, 3.7.2, 4.8, 5.3.3, 5.5, 5.6.4, 5.7, 6.2, 6.4, 7.3, 7.4.9, 7.6; Cross-Chapter Box 10 in Chapter 7}

D1.1. Near-term capacity-building, technology transfer and deployment, and enabling financial mechanisms can strengthen adaptation and mitigation in the land sector. Knowledge and technology transfer can help enhance the sustainable use of natural resources for food security under a changing climate (*medium confidence*). Raising awareness, capacity building and education about sustainable land management practices, agricultural extension and advisory

[36] Representative Concentration Pathways (RCPs) are scenarios that include timeseries of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover".

[37] Integrated Assessment Models (IAMs) integrate knowledge from two or more domains into a single framework. In this figure, IAMs are used to assess linkages between economic, social and technological development and the evolution of the climate system.

[38] The RCP1.9 pathways assessed in this report have a 66% chance of limiting warming to 1.5C in 2100, but some of these pathways overshoot 1.5C of warming during the 21st century by >0.1C.

services, and expansion of access to agricultural services to producers and land users can effectively address land degradation (*medium confidence*). {3.1, 5.7.4, 7.2, 7.3.4, 7.5.4}

D1.2. Measuring and monitoring land use change including land degradation and desertification is supported by the expanded use of new information and communication technologies (cellphone based applications, cloud-based services, ground sensors, drone imagery), use of climate services, and remotely sensed land and climate information on land resources (*medium confidence*). Early warning systems for extreme weather and climate events are critical for protecting lives and property and enhancing disaster risk reduction and management (*high confidence*). Seasonal forecasts and early warning systems are critical for food security (famine) and biodiversity monitoring including pests and diseases and adaptive climate risk management (*high confidence*). There are high returns on investments in human and institutional capacities. These investments include access to observation and early warning systems, and other services derived from in-situ hydro-meteorological and remote sensing-based monitoring systems and data, field observation, inventory and survey, and expanded use of digital technologies (*high confidence*). {1.2, 3.6.2, 4.2.2, 4.2.4, 5.3.1, 5.3.6, 6.4, 7.3.4, 7.4.3, 7.5.4, 7.5.5, 7.6.4; Cross-Chapter Box 5 in Chapter 3}

D1.3. Framing land management in terms of risk management, specific to land, can play an important role in adaptation through landscape approaches, biological control of outbreaks of pests and diseases, and improving risk sharing and transfer mechanisms (*high confidence*). Providing information on climate-related risk can improve the capacity of land managers and enable timely decision making (*high confidence*). {5.3.2, 5.3.5, 5.6.2, 5.6.3; Cross-Chapter Box 6 in Chapter 5; 5.6.5, 5.7.1, 5.7.2, 7.2.4}

D1.4. Sustainable land management can be improved by increasing the availability and accessibility of data and information relating to the effectiveness, co-benefits and risks of emerging response options and increasing the efficiency of land use (*high confidence*). Some response options (e.g., improved soil carbon management) have been implemented only at small-scale demonstration facilities and knowledge, financial, and institutional gaps and challenges exist with upscaling and the widespread deployment of these options (*medium confidence*). {4.8, 5.5.1, 5.5.2, 5.6.1, 5.6.5, 5.7.5, 6.2, 6.4,}

D 2. Near-term action to address climate change adaptation and mitigation, desertification, land degradation and food security can bring social, ecological, economic and development co-benefits (*high confidence*). Co-benefits can contribute to poverty eradication and more resilient livelihoods for those who are vulnerable (*high confidence*). {3.4.2, 5.7, 7.5}

D2.1. Near-term actions to promote sustainable land management will help reduce land and food-related vulnerabilities, and can create more resilient livelihoods, reduce land degradation and desertification, and loss of biodiversity (*high confidence*). There are synergies between

sustainable land management, poverty eradication efforts, access to market, non-market mechanisms and the elimination of low-productivity practices. Maximising these synergies can lead to adaptation, mitigation, and development co-benefits through preserving ecosystem functions and services (*medium confidence*). {3.4.2, 3.6.3, Table 4.2, 4.7, 4.9, 4.10, 5.6, 5.7, 7.3, 7.4, 7.5, 7.6; Cross-Chapter Box 12 in Chapter 7}

D2.2. Investments in land restoration can result in global benefits and in drylands can have benefit-cost ratios of between three and six in terms of the estimated economic value of restored ecosystem services (*medium confidence*). Many sustainable land management technologies and practices are profitable within three to 10 years (*medium confidence*). While they can require upfront investment, actions to ensure sustainable land management can improve crop yields and the economic value of pasture. Land restoration and rehabilitation measures improve livelihood systems and provide both short-term positive economic returns and longer-term benefits in terms of climate change adaptation and mitigation, biodiversity and enhanced ecosystem functions and services (*high confidence*). {3.6.1, 3.6.3, 4.8.1, 7.2.4, 7.2.3, 7.3.1, 7.4.6, Cross-Chapter Box 10 in Chapter 7}

D2.3. Upfront investments in sustainable land management practices and technologies can range from about USD 20 ha^{-1} to USD 5000 ha^{-1}, with a median estimated to be around USD 500 ha^{-1}. Government support and improved access to credit can help overcome barriers to adoption, especially those faced by poor smallholder farmers (*high confidence*). Near-term change to balanced diets (see B6.2) can reduce the pressure on land and provide significant health co-benefits through improving nutrition (*medium confidence)*. {3.6.3, 4.8, 5.3, 5.5, 5.6, 5.7, 6.4, 7.4.7, 7.5.5; Cross-Chapter Box 9 in Chapter 6}

D 3. Rapid reductions in anthropogenic GHG emissions across all sectors following ambitious mitigation pathways reduce negative impacts of climate change on land ecosystems and food systems (*medium confidence*). Delaying climate mitigation and adaptation responses across sectors would lead to increasingly negative impacts on land and reduce the prospect of sustainable development (*medium confidence*). {Box SPM.1, Figure SPM.2, 2.5, 2.7, 5.2, 6.2, 6.4, 7.2, 7.3.1, 7.4.7, 7.4.8, 7.5.6; Cross-Chapter Box 9 in Chapter 6, Cross-Chapter Box 10 in Chapter 7}

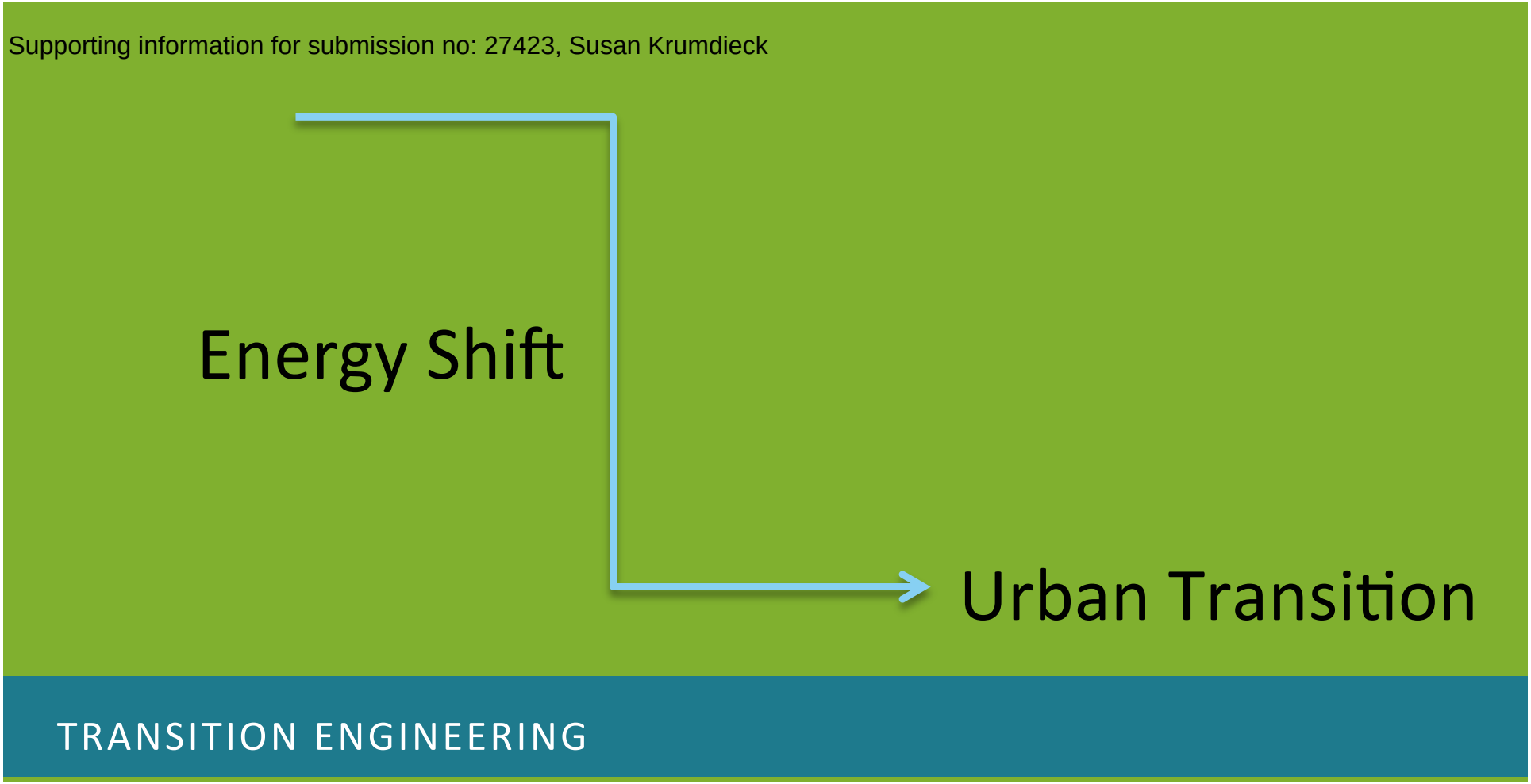
D3.1. Delayed action across sectors leads to an increasing need for widespread deployment of land-based adaptation and mitigation options and can result in a decreasing potential for the array of these options in most regions of the world and limit their current and future effectiveness (*high confidence*). Acting now may avert or reduce risks and losses, and generate benefits to society (*medium confidence*). Prompt action on climate mitigation and

adaptation aligned with sustainable land management and sustainable development depending on the region could reduce the risk to millions of people from climate extremes, desertification, land degradation and food and livelihood insecurity (*high confidence*). {1.3.5, 3.4.2, 3.5.2, 4.1.6, 4.7.1, 4.7.2, 5.2.3, 5.3.1, 6.3, 6.5, 7.3.1}

D3.2. In future scenarios, deferral of GHG emissions reductions implies trade-offs leading to significantly higher costs and risks associated with rising temperatures (*medium confidence*). The potential for some response options, such as increasing soil organic carbon, decreases as climate change intensifies, as soils have reduced capacity to act as sinks for carbon sequestration at higher temperatures (*high confidence*). Delays in avoiding or reducing land degradation and promoting positive ecosystem restoration risk long-term impacts including rapid declines in productivity of agriculture and rangelands, permafrost degradation and difficulties in peatland rewetting (*medium confidence*). {1.3.1, 3.6.2, 4.8, 4.9, 4.9.1, 5.5.2, 6.3, 6.4, 7.2, 7.3; Cross-Chapter Box 10 in Chapter 7}

D3.3. Deferral of GHG emissions reductions from all sectors implies trade-offs including irreversible loss in land ecosystem functions and services required for food, health, habitable settlements and production, leading to increasingly significant economic impacts on many countries in many regions of the world (*high confidence*). Delaying action as is assumed in high emissions scenarios could result in some irreversible impacts on some ecosystems, which in the longer-term has the potential to lead to substantial additional GHG emissions from ecosystems that would accelerate global warming (*medium confidence*). {1.3.1, 2.5.3, 2.7, 3.6.2, 4.9, 4.10.1, 5.4.2.4, 6.3, 6.4, 7.2, 7.3; Cross-Chapter Box 9 in Chapter 6, Cross-Chapter Box 10 in Chapter 7}

Supporting information for submission no: 27423, Susan Krumdieck



TRANSITION ENGINEERING

Proposal: This document sets out the process for Transition Engineering consultation with a city. The process involves one kick-off workshop, one context project, two data analysis and modelling projects, three workshops and a presentation of the shift projects and transition plans to the city council and stakeholders.

Key Elements:

- **Knowledge Base, Shared Understanding of the Situation, Stakeholder Values and Vision**
- **Scenarios, Economics and Management Explorations and Base Data**
- **Brainstorming and Innovation**
- **Design Thinking and Development of Shift Projects**

Background: Energy Shift Projects

An energy shift project is a specific investment in a change that releases value in the business or organization by re-developing energy consuming plant or operations in a way that achieves a new normal of lower exposure to energy risks. Energy shift projects usually involve innovations in technology, services, IT or operations. Each energy shift project is developed through an InTIME review and discovery brainstorming process with the organization.

Energy Audit and Data Collection

The first stage is an energy audit of the business operations, built environment and equipment. The history of the organization and the exposure to energy risks are reviewed with managers. Operations are reviewed with employees. Historical and cultural attitudes and events are investigated. Data management systems are interrogated and improved. The data is organized and analysed and a predictive model developed.

InTIME Brainstorm and Innovation

A series of creative brainstorming workshops are carried out with the organization using the base data from the audit, and scenarios. The workshops are aimed at illuminating the organization's core values, and exploring the risks of the forward operating environment and to develop technically viable visions of the successful position in the long-term future. The workshops continue until at least one shift project brief has been produced, including the trigger for initiation, how the organization will change to achieve the shift, the plan for integrated learning and improvement in the project, and a road map for how the shift project, when successful will lead to transition in the organization, including the analysis of the competitive position and risk environment. The workshops create a culture of play and risk-taking, and are guided by professional InTIME navigators and Transition Engineers.

Global Association for Transition Engineering

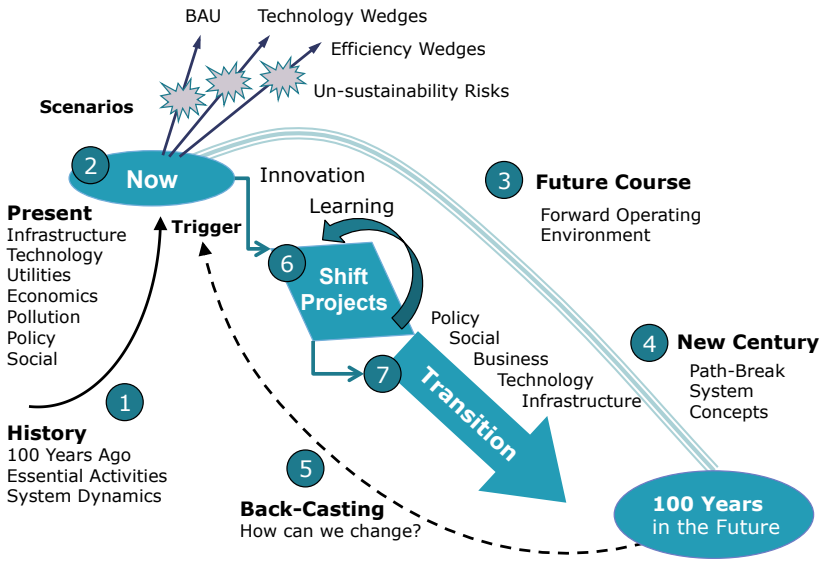
The emerging field of Transition Engineering is stepping into the space pioneered by sustainability and energy management. GATE was formed in 2017 recognising that a direct and practical approach to change was required in order to go beyond the intentions of carbon reduction and sustainability and to deliver specific shift projects. Shift projects are specific to a company or organization, achieve objectives of carbon or energy transition, and return benefits and value on the investment in the shift project.

Another key part of the energy transition engineering work is the innovation of products and operations and the management of risk by establishing a competitive position.

GATE

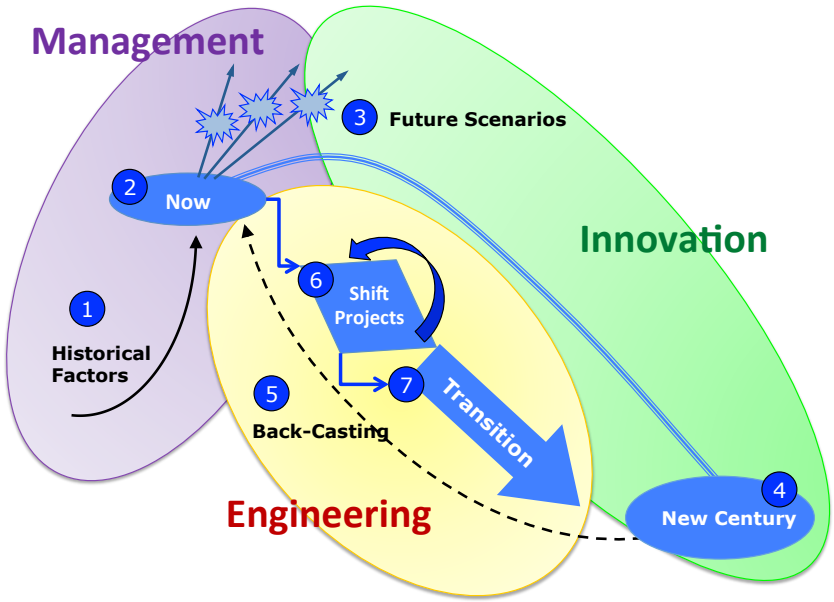
Interdisciplinary Transition Innovation, Management & Engineering

InTIME Methodology and Analysis Tools



Background: InTIME Approach

Interdisciplinary Transition Innovation, Management and Engineering



We have a situation that we will change. If we think we have solutions, then are we sure of the problems?

Management

Most of our management practice and understanding is based on experience. Most of what we have to manage is what already exists. Thus, digging in the history of our situation is vital to understanding our confirmation bias and our expectations.

Collecting and analysing the data about the current situation is unambiguously necessary. But we also want to understand the current player positions and stakeholder values.

We don't know how to think about the future, but the energy and resource scenario is a tool that will let us quantify unsustainability.

Innovation

When you feel stuck, and none of the possible decisions lead to the outcome that aligns with your vision… you need to path break. We need to stretch outside of what we know about our current situation and what we expect – to explore the world populated by people we know, doing the same things we do, in the same place, but with a different history than us.

The innovation phase is a group brainstorm, but also an engineering project in the art of the possible.

Engineering

Back casting is the strategic analysis of what we we learned when we cut our ties with our expectations and found the future we want to send our kids off to. We will have a whole range of ideas, but the strategic analysis will help us to explore and find the opportunities.

The results will be built in to specific shift projects. Each shift project is not an end point, it is a starting point for learning and building adaptive capacity. It is also the lens through which we will view the transition of our city with much more clarity and purpose.

Workshop 1: Change of Perspective

The first step is to map out the city employees who have responsibilities in different aspects of the city sustainability, planning, infrastructure, asset management and operations. Most of the knowledge base for the city is already there, and all of the knowledge about the history and current issues and trends for future scenarios can be brought together in a interdisciplinary exploration workshop to help them find ways to discuss and share information and ideas with each other. This is an interesting project in itself. I have done workshops with Traffic+Transport+Urban Planning+Economics+Land Use Development people in a city, and it is a bit like an intervention with a fractured family! But the outcome is new shared values realization and shared communication linkages. They don't have to learn everything the other groups know, but they need to understand how they are connected to the whole system, and develop a language of shared vision that helps them all navigate the transition work. So the first workshop is where the people working for the city and region explain to me (and thus to each other) what the history and context are from their particular perspective, how they manage things in their area and what the economics are. Then we move on to scenarios and identifying and characterizing the timelines for unsustainability risks. The main outcome for this first piece of work is There are homework projects to do after the Workshop 1 in preparation for Workshop 2.

Imagine you've just been time-transported onto the deck of the Titanic, after it left port. You have 24 hours. You have some important information.

What is the situation? Is it the same for the other 2000 people on board? What could change the situation?

What are the problems? Do other people on board have the same problems? You have key information, is that the same thing as having solutions?

Kick-off Seminar: Identify our Monkey Traps

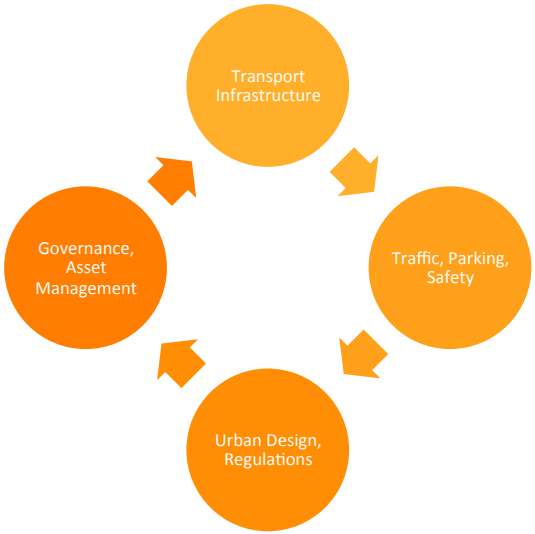
Park and Unpack Wicked Problems

Cities are stuck with their past and their current issues. Investors and councils have some hugely expensive and important decisions to make, and are often paralyzed by the need to make the "perfect decision" for all the stakeholders. The sustainable city vision looms over discussions about big investments in unsustainable infrastructure, and unsustainable urban form. The city declares that it will achieve carbon neutrality by 2040, but opens up a new expressway out to a new suburb. The city runs, but it doesn't work. The city dreams of the future, and is stuck in the reality of the way things are today.

Holding up examples of things other cities have done seems ineffectual. Each city has a different history, urban form, and issues of supply chains, economic connections and natural hazards. The biggest wicked problem is the car, but there are many more: water, education, waste, health, security, finances.

Future Vision

City and Regional Council Responsibilities



Workshop 2: Management

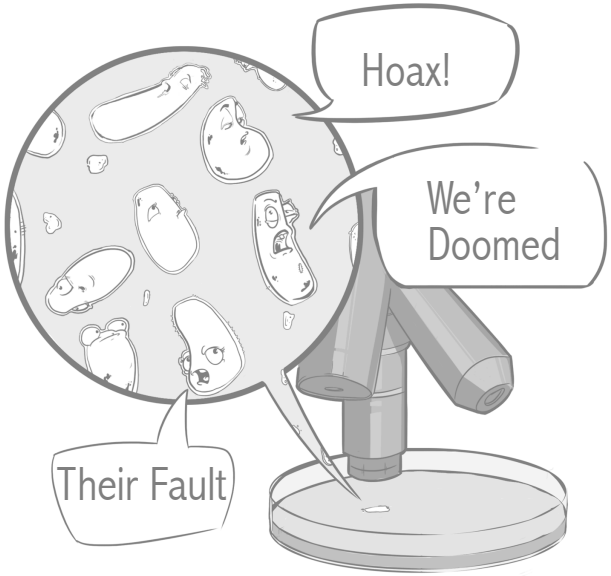
The first step is to map out the city employees who have responsibilities in different aspects of the city sustainability, planning, infrastructure, asset management and operations. Most of the knowledge base for the city is already there, and all of the knowledge about the history and current issues and trends for future scenarios can be brought together in a interdisciplinary exploration workshop to help them find ways to discuss and share information and ideas with each other. This is an interesting project in itself. I have done workshops with Traffic+Transport+Urban Planning+Economics+Land Use Development people in a city, and it is a bit like an intervention with a fractured family! But the outcome is new shared values realization and shared communication linkages. They don't have to learn everything the other groups know, but they need to understand how they are connected to the whole system, and develop a language of shared vision that helps them all navigate the transition work. So the first workshop is where the people working for the city and region explain to me (and thus to each other) what the history and context are from their particular perspective, how they manage things in their area and what the economics are. Then we move on to scenarios and identifying and characterizing the timelines for unsustainability risks. The main outcome for this first piece of work is There are homework projects to do after the Workshop 2 in preparation for Workshop 3.

People who know the city, its history and wicked problems − Take off their Blindfolds

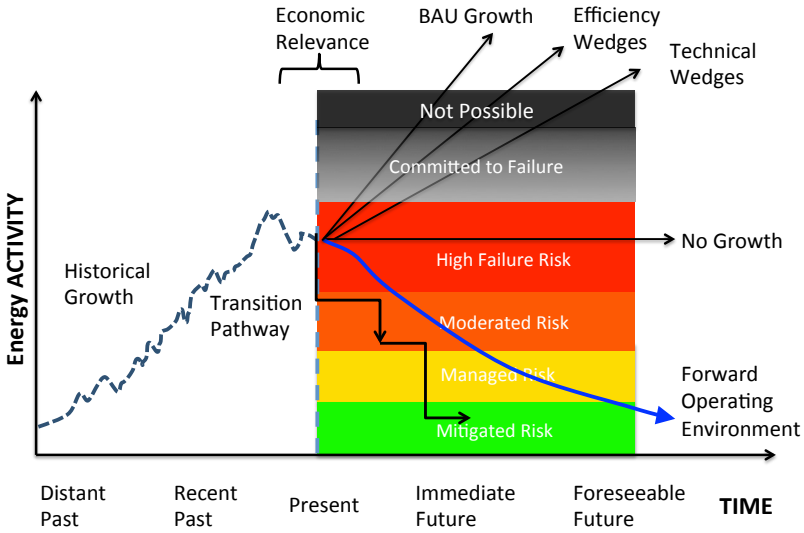
Study 1: Scenarios

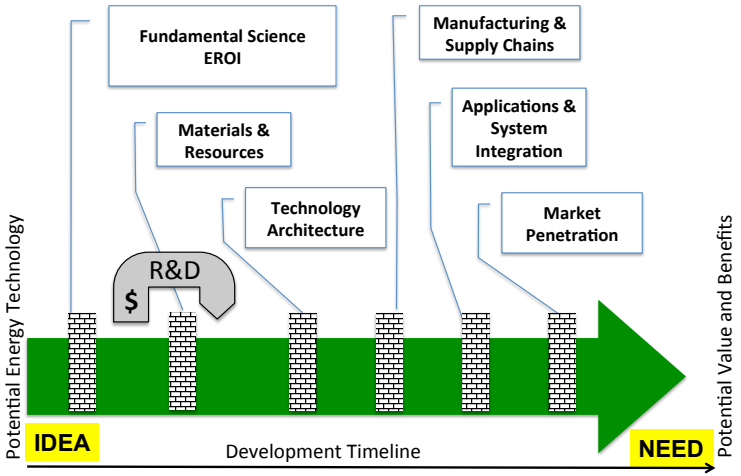
Scenarios are a well known and poorly done. The Transition Scenarios are quantitative exploration of trends, with assessment of risks. Everyone in risk management knows that participation and communication with stakeholders is essential and difficult. Willful blindness and confirmation bias are subconscious coping mechanisms that all people have, and that need careful navigation.

This project will be done with the Transition Engineers and stakeholders, using data from existing sources and simple models of linear progression, exponential growth, boom and bust or logistic saturation – depending on the if-then scenario. The future scenarios might be met with a psychological response similar to greif, because they rarely align with expectations. Don't worry. The Transition Engineers are equipped to communicate what is possible and probable to the stakeholders with skillful bedside manner, and to help them "park and pack" their unmet expectations.



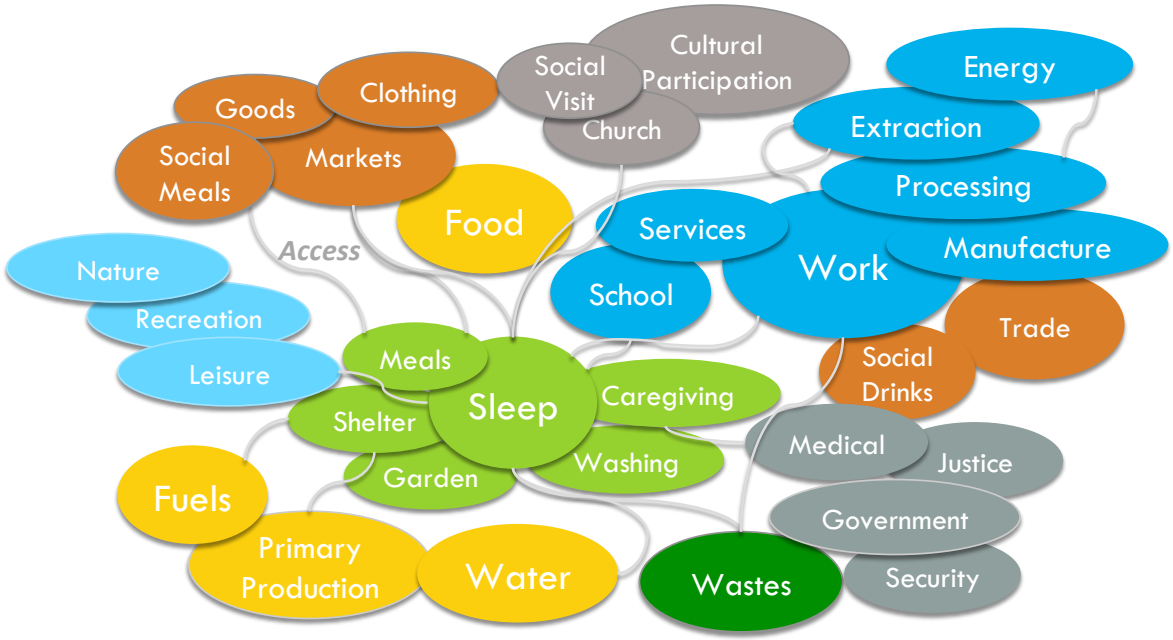
The first step in the art of the possible is the quantification of the impossible and improbable





Workshop 3: Innovation

This workshop is a path-break brainstorm and it starts by breaking down the pre-conceptions that participants have, learning how to identify wicked problems, and how to overcome their own emotional response by "parking and unpacking" the issues. Hopefully, the teams will have brought the wicked problems from their homework between the workshops. The rest of the workshop involves the creative work of path-breaking and going 100 years in the future to visit the City. It is a group exercise because they have to learn how to train their minds to let go of the present and they need to learn how to help each other feel free to explore this future. Again, there would be homework for the next week. The homework involves "seeing" the city differently when they go out and about. It involves seeing past today and accepting that every year over the next 100 years the people of the city will keep their values and their identities and the really essential things that make life good and the necessary things that make the city special, and that they will adapt to all of the changes in technology, energy, convenience, etc.



Human Ecology

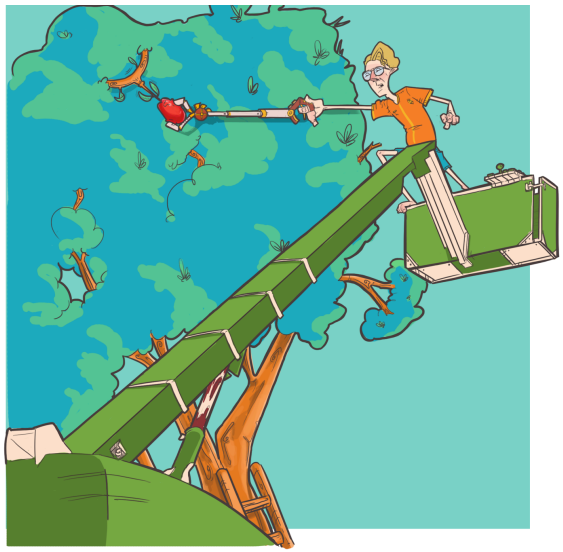
Value Recognition

- Essential to Wellbeing
- Necessary for Culture
- Important for Maintenance
- Useful for Productivity
- Convenient for Lifestyle
- Optional for Leisure

Workshop 4: Engineering Shift Projects

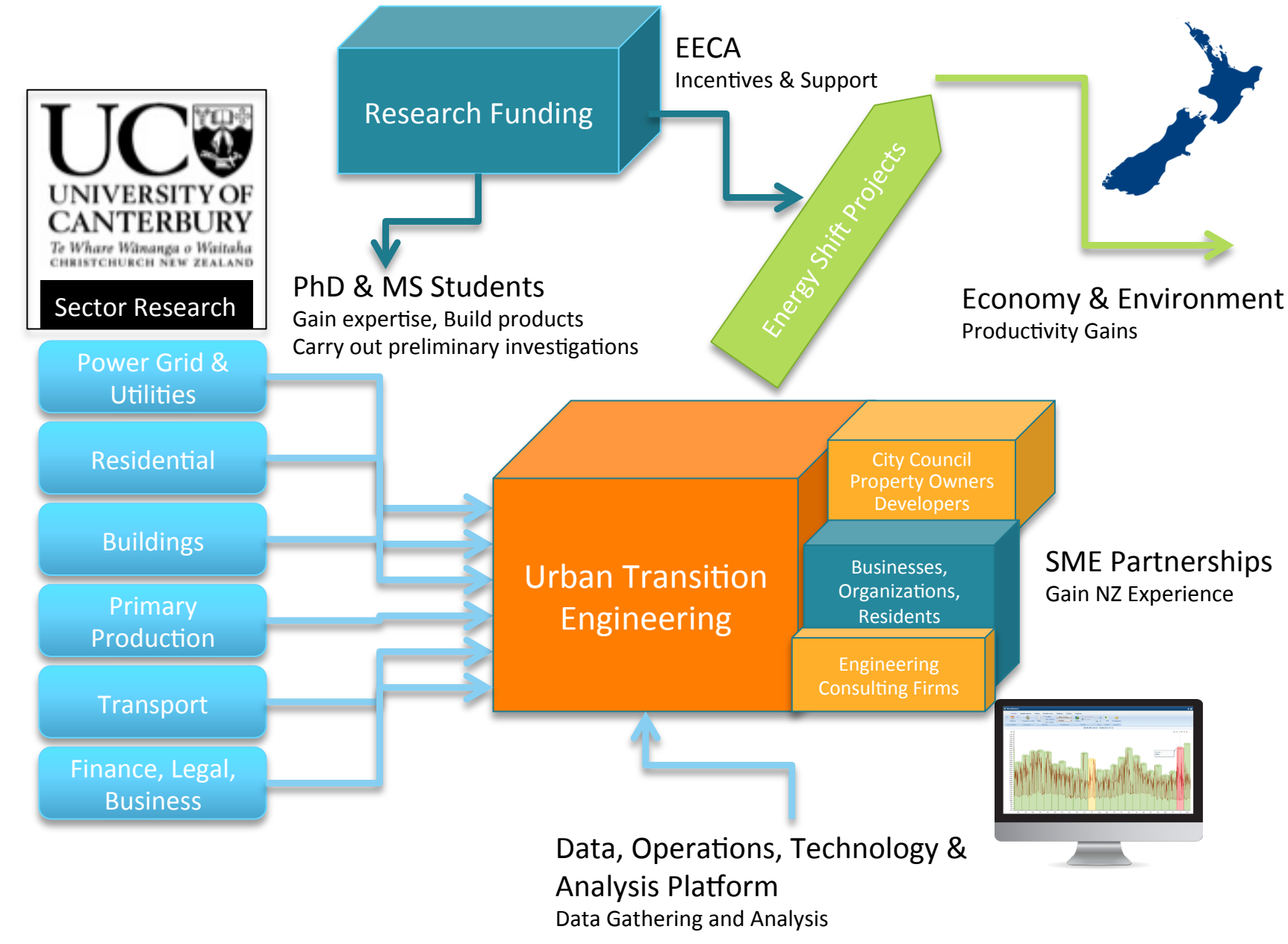
Ideation takes the empathic visions from the innovation phase and clusters them into themes. These themes may not be the same departments that we are used to working in. This workshop is where we take everything we have learned and work through our new perspective on the past, the current wicked problems and the future. We will use processes from Design Thinking and discover the group adaptability, resourcefulness, and learning by doing as alternatives to the prescriptive thinking about "how to implement solutions". We aren't going to look for general sustainable solutions because there aren't any. Rather, we are going to brainstorm projects that we could start right now, that we don't know how they would work out, and we might not even know what technology could be used, but we will define our project ideas according to the changes they would make in our situation. We also have to discuss how we would learn from the project, and how we would measure whether it was causing a transition in the situation.

Workshop 4 is done as a group to build the culture of the new perspective. This workshop will involve quite a bit of chaos, because we cannot afford to let our old expectations creep back in. Then we spend the rest of the workshop developing project briefs for the shift projects. It wouldn't be surprising if the first shift projects are measuring and monitoring innovations. This is how I got into he research projects that I have done on cities. It is true that you have to measure and monitor or you can't decide on changes and you can't learn from your mistakes. And that brings us back to the question of if you want to propose that the outcome of the InTIME workshops are joint action research projects with the city, which you suspect will also be developments of new IT or technologies or data-mining and modeling projects.



Then we will ask what we have to change in our selves, in our approach, in what we are going to try, and what we are willing to learn. Yes, we have a situation. Can we change the situation? How does each shift project idea affect the various stakeholders?

The Business Concept



URBAN TRANSITION ENGINEERING

The Transition Project

Policy and Communities

Science and Engineering

Commerce, Law and Arts

Discovering Disruptive Ideas

New Zealand, like the rest of the world, is at a transition point in history. Tomorrow will largely be like today, our activities and culture will carry on next year in much the same way as this year. However, we know that the path we are travelling has changed direction. To a large extent, the challenges of realizing the opportunities that are possible along the transition pathway have been left to the next generation. The Transition Project is a unique opportunity to utilize the free-thinking energy and research of today's brightest young scholars, working with companies, communities and councils, to discover the opportunities for New Zealand that can be found in the transition from unsustainable pathways.

What is New about the Transition Project?

Carbon emissions must be dramatically reduced, but we rely on fossil fuel. Every ton of emissions reduction represents a change in an existing system. The new idea is to "flip the perspective" and energy down-shift unsustainable activities in profitable and beneficial ways. The new idea is to move beyond targets and to develop and carry out viable transition projects with New Zealand companies, communities and organizations.

How do we get started?

Establishment and facilitation activities:

1. Establish the Transition Project working group, appoint a board, set terms of reference, create industry partnerships, award fellowships.
2. Establish the Transition Project facilities and supervision team at Canterbury University and the collaborations with other universities, organizations and companies.

Budget

- $1.8 million over 5 years for program establishment, administration
- $3.8 million for the facility building (a model for regenerative urban construction and building industry transition)
- $3.75 million in merit fellowships for the 50 participants
- $3.5 million for Forgiveness of 50 student loans

Transition Pathway

Fifty of New Zealand's most talented young thinkers and creators join together for a 4-year intensive project of discovery, innovation and change.

The Transition Institute

A national board of eminent New Zealanders oversee establishment.

Top Honours graduates in Engineering, Policy, Law, Science, Sociology, Marketing and Business are selected for PhD programs

50 participants based on the national competition and the range of disciplines.

Participants are housed, work, study, and most importantly, brainstorm and create together for the course of 4-5 years

Participants work widely with people from all walks of life, and study the technologies, ideas and experiences from around the world.

Real Climate Action for NZ

Participants earn a PhD in their respective fields, and take positions in the projects they created.

Participants, upon completion of their PhD receive forgiveness of the total sum of their student loan.

Imagine that 50 of New Zealand's top Honours graduates from different disciplines focused their research efforts and built their expertise in the work of energy transition. Imagine if they worked directly with energy companies and New Zealand's vital industries on real down-shift projects. Imagine they worked with farmers, economists, government, communities and conservationists. Imagine that the country and the world could follow their disruptive discoveries and the progress of their down-shift projects to overcome some of our most complex problems. You can probably imagine that right now, we could find 50 brilliant and creative young people to try out this bold new idea. Can you imagine what is stopping them?

Four years of accumulated student debt should not be the barrier to discovery.

The Transition Project Facility – Ilam Crossing

The first project will be the design and building of a new kind of urban re-development. An old "student slum" area near the Ilam campus of Canterbury University will be transformed into a sustainable university village with shops, apartments and working facilities for the project partners. This first project is called *From the Ground Up*, and will produce a template for overcoming the urban planning, transport, housing and construction issues that are dragging down our urban life and generating unwanted traffic congestion and emissions. In year 2 of the project students will start moving into the facility and work on inventing the new kind of property laws and real-value financial instruments.

Tertiary Education Partners

Canterbury (Engineering, History), Auckland (Psychology, Marketing, Business), Victoria (Law, Architecture, Arts), Lincoln (Agriculture), Otago (Health, Sociology), Waikato (Economics), Massey (Primary Industries), ARA (Media, Construction, Trades)

Industry Partners

Z Energy, Fulton Hogan, Fonterra, BP, Mainfreight, KiwiRail, Golden Circle, Air New Zealand, Kiwibank, Fischer & Paykel, Tait Electronics, Meridian Energy, Contact Energy, Fletcher Building, OPUS Engineering, Jacobs, Alstom

Councils and NGO's in Partnership

Christchurch City Council, Ruapehu District Council, Dunedin City Council, Southland, GenZero, Wise Response

Professor Susan Krumdieck

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Co-Founder, Global Association for Transition Engineering. GATE

Submission on the Zero Carbon Bill

Torfrida Qainwright, Otautahi/Christchurch

Submission number: 26292

Preamble - personal background

I am a 68 year old pakeha woman living in Christchurch.

I spent my working life as a policy analyst/planner in the public health system – summarizing research into reports to enable clinicians and managers to make rational and inclusive funding decisions. So while I don't have expertise in the science of climate change or its mitigation, I know how to evaluate the credibility of research and its sources. My scientist friends have for decades shared with me the information coming through on the climate and ecological crisis. I have shared their anger, grief and despair over the lack of action on this from government or business over the past decades.

I have been an active member of 350chch and other climate organisations since 2009. I've organised rallies, written submissions, engaged in street theatre, vigils, blockades and more. In all that time Aotearoa's greenhouse gas emissions have risen steadily, our biodiversity, land and water quality have declined steadily. I am a gardener and a beekeeper. I've lived long enough to witness first hand the disappearance of the insects, plants and birdlife.

I invite you to watch this 11 minute animated video (1) summarising the science of the tipping points towards climate catastrophe. This video was made in 2008. In 2018 a slew of reports from IPCC, United Nations, World Wildlife Fund and other reputable bodies showed that nothing had happened in the intervening ten years to slow our relentless progress towards catastrophe.

I am now an active supporter/organiser within Extinction Rebellion. This movement demands of our elected leaders that they tell the truth about the crisis, that they declare an emergency and act on this crisis, and that they listen to the people, not just the vested interests wanting to continue business as usual;

Along with the hundreds of ordinary New Zealanders that have flocked to this movement over the last 6 months, I am fully prepared to be arrested, go to prison and to be continually and non-violently disruptive to 'business as usual' until those in power take the situation seriously.

I also treasure the rule of law and the democratic process that you and we are engaged in here. This is a crucial piece of legislation if we are to tackle the climate crisis. As it stands now, it is far too weak to do what is needed to swing this crisis around – the targets are too weak, the timeline is not urgent enough, the Act has no guaranteed priority over other legislation (such as the Resource Management Act).

I hope you as Members of Parliament have the good sense to see how you are holding a tool in your hands that is essential for getting us through the hard times that are coming. If you fumble it, close your eyes to what is happening to the world, and play safe, you will be answerable not to future generations (we will indeed be lucky to have any) but to the children living now who know full well what they are up against and who need and are demanding your leadership.

Comments on the Zero Carbon Bill

1. Purpose of the Bill

I support the Bill's purpose to provide a mechanism to enable New Zealand to contribute to limiting the global average temperature increase to 1.5ºC above pre-industrial levels.

However I believe the Purpose is too vague and propose that the wording be considerably strengthened on two counts. I propose that:

a) **The Purpose must reflect the acute urgency** of the climate and ecological crisis, and the depth of transformative change needed, so that this is clearly conveyed to the public.

Last year, the ntergovernmental Panel on Climate Change's (IPCC) *Special Report on 1.5ºC* outlined the disastrous impacts of allowing global warming to exceed 1.5ºC and urged immediate action.

Since then numerous scientists have commented (2) that the IPCC report is overly optimistic and that the situation is even more urgent, because:

- IPCC did not factor in known feedback loops likely to create sudden tipping points towards markedly higher global temperatures. These include warmer oceans due to loss of summer ice over the Arctic, methane released as permafrost and sea-beds heat up, and the likely transition of the Amazon and Asian rainforests from carbon sinks to carbon emitters.
- IPCC assumes the rapid and widespread use of carbon capture and storage technologies that have not been proven effective at scale.

The science shows that we are in a serious climate and ecological crisis that requires urgent, decisive action by the government to mobilize the whole of society round this emergency.

b) **The Purpose must make clear that this Act has priority** over other legislation and regulations. (see section 6 below).

2. Targets – date and level

The Bill requires net emissions of greenhouse gases other than biogenic methane to be zero by 2050, and gross emissions of biogenic methane to be 10% less than 2017 levels by 2030 and 25-47% less by 2050.

The IPCC *Special Report* suggests that to have a 50% chance of staying within the 1.5C warming cap (with little or no overshoot) will require global CO2 emissions to fall by about 45% compared to 2010 levels by 2030. A 50% chance of avoiding more than 1.5C warming involves a very high risk of failing!

The Bill does not mention this point or commit to a reduction of this magnitude by 2030.

The urgency and gravity of the climate and ecological crisis requires New Zealand to adopts more ambitious targets. The longer we delay making the changes needed, the harder it will be to keep within the targets.

The current target for carbon neutrality should aim for 2030. If we don't achieve this by then, the science is telling us that any targets we set for 2050 will be too late anyway.

I propose that

a) Targets be set for 2030, not 2050
b) Gross emissions of greenhouse gases other than biogenic methane are zero by 2030
c) Gross emissions of biogenic methane are 30% below 2017 levels by 2030

3. Methane targets

A 2019 report (3) as shown dramatic rises in atmospheric methane over recent years that threaten to derail plans to hold global temperatures to 2C. This increase is mostly due to animal farming.

Biogenic methane accounts for nearly half of New Zealand's greenhouse gas emissions. To reduce these by just 10% over 11 years is extremely un-ambitious. It reflects the vested interests of the major stakeholders and their assumption that we can continue 'business as usual', and does not reflect the interests of the New Zealand population or address the reality of the current crisis.

It has been argued (4) for some years that less intensive dairy stocking (with concomitant drops in urea, nitrate fertiliser, irrigation and bought-in stock food) would not only reduce methane and improve water and land quality, it would also be more profitable for most farmers. It is also readily achievable.

I propose that:

a) A target for gross emissions of biogenic methane of 30% fewer emissions than in 2017 by 2030

4. New Zealand's contribution to global efforts to reduce emissions

Given NZ's large historic (i.e. cumulative) emissions to date, our current high per capita emissions and relatively high GDP per capita, there is a very strong case in terms of social and climate justice for New Zealand to commit to a faster reduction in long-lived GHG gases than the global average (i.e. of 45%).

a) I propose that the Bill include this intent and reflect that in the targets and target deadlines.

5. Offsets - net versus gross emission targets

"Net zero" is the point where New Zealand's gross carbon emissions are balanced out by counteracting factors such as trees that soak up carbon. Currently 'net zero' could be achieved through forestry offsets and international credits.

I propose that

a) **Forestry offsets are restricted**: The Bill does not restrict forestry offsets. Overly relying on trees to offset our ongoing emissions is risky and inappropriate because trees can be lost to fire, pests and climate impacts. We support tree planting, especially natives. But they are a poor substitute for actually stopping carbon emissions. The Bill must be strengthened by adding a gross emissions target, or a forestry offset cap. to limit our risky reliance on trees.

b) **International credits are prohibited**: The Bill says targets must be met "as far as possible" domestically. This commitment is vague and unhelpful. Prohibiting the use of international credits will promote long-term certainty and accountability. It will also drive domestic action and innovation from local communities and businesses, rather than allowing us to pay other countries to do our work for us

c) **international aviation and shipping are included**: The Bill currently does not include New Zealand's share of international aviation and shipping emissions. These must be included in the Bill, as is the case under the UK Climate Change Act.

6. Enforcement

The recommendations of the Climate Commission are not binding on the government. There is no provision for a judicial review if government ministries or local bodies do not meet the targets that government sets, or if policies or practices are inconsistent with the targets of the Zero Carbon Act.

We are in a climate and ecological crisis! This is a time for emergency measures! This Act, once passed, *must* have priority over other legislation, particularly the current Resource Management Act. It should no longer be possible to approve coal mining or coal-fired boiler resource consents under the RMA, just because that Act does not include a clause permitting climate change impacts as a justification for non-approval.

I propose that:

a) **The Purpose of the Bill is rewritten** to make it clear that this Act has priority over all other legislation and regulations, as befits an over-arching piece of legislation dealing with a national emergency.

b) **Legally binding targets**: If the government fails to meet a target, section 5ZJ of the Bill says a court may only issue a declaration of breach. No other remedy is permitted. Section 5ZJ must be removed to allow the court to take other steps.

c) **Long-term planning**: Emission budgets must be set 10 years in advance (for example, the budget for 2036-2040 must be set before 2026). However, the Bill does not set clear timeframes for the government to make policy plans to meet future budgets. This fails to promote transparency or long-term certainty. The Bill should set a strict time frame for the government to prepare and publish its policy plans, at least 5 years before the budget period begins.

d) **Comprehensive policy making**: Our climate strategy must encompass all sectors and drive coordinated decision-making across government. Section 5ZK of the Bill says that government bodies may choose to take the Bill's targets and budgets into account when developing policy and making decisions. Section 5ZK should be changed so that government bodies must take targets and budgets into account.

Notes NB these sources also exist as hyperlinks in the text

1. Link to 11 min. animated video on climate tipping points: https://vimeo.com/1709110
2. Breakthrough website – reports on climate science. https://www.breakthroughonline.org.au/publications
3. Guardian article on global methane levels https://www.theguardian.com/environment/2019/feb/17/methane-levels-sharp-rise-threaten-paris-climate-agreement
4. Peter Fraser on Fonterra - https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=12238017