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Climate change impacts on NZ renewable electricity generation to 2050

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Overview

1. Background – IPCC and Paris agreement
2. IPCC special report on Global Warming of 1.5°C – published Oct 2018
3. New Zealand and electricity industry implications
4. How is Meridian modelling climate change?

Background



Intergovernmental Panel on Climate Change (IPCC)

- The United Nations body which assesses existing published science on climate change.
- Publishes summary reports of climate science.
- Provides the world with an objective, scientific view of climate change and its political and economic impacts.



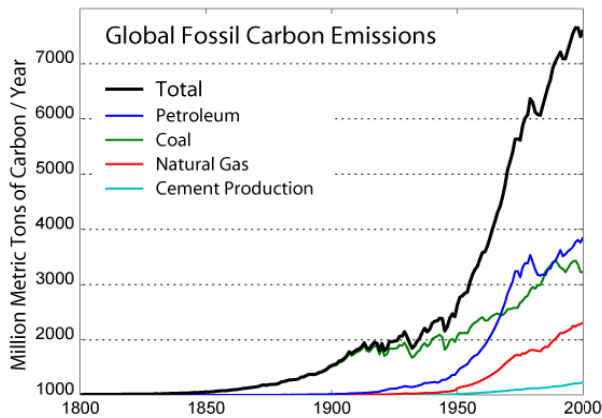
The Paris Agreement

- Drawn up in 2015, it is the most significant climate agreement ever signed.
- 197 parties have signed the agreement – every country in the world (except the Holy See).
- 181 have ratified it, including New Zealand.
- Its long-term goal is to keep the increase in global average temperature to “well below 2°C” above pre-industrial levels; and to
- pursue efforts to limit the increase to 1.5 °C.
- It requires all parties to define their own “nationally determined contributions” to greenhouse gas (GHG) emissions, and to report on these efforts and continue to increase their contributions in the years ahead.

IPCC Special report on Global Warming of 1.5°C – Oct 2018

- considers how to keep the world below 1.5°C temperature increase (above pre-industrial levels)

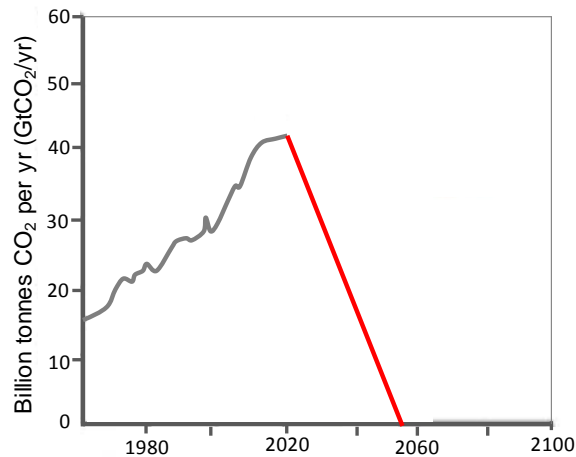
Historical emissions



Source: Marland et al 2003

- Carbon emissions globally have vastly increased over the past two centuries

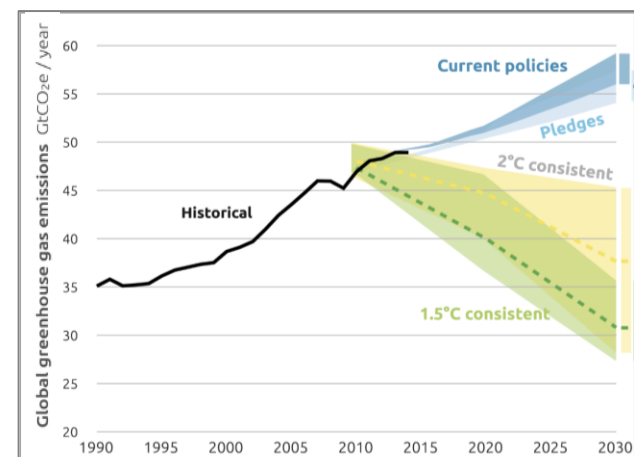
Required emissions trajectory



Source: IPCC

To cap temperature increase at	Anthropogenic CO ₂ emissions must reach nett zero by
1.5°C	2050
2°C	2075

Forecast emissions



Source: climateactiontracker.org

- Current Paris agreement **pledges** would result in a global temperature increase of 3.2 °C by 2100.
- Current government **policies** around the world are projected to result in a 3.4°C increase by 2100.

Source: www.ipcc.ch/sr15/

How can the planet stay below 1.5°C? – four pathways

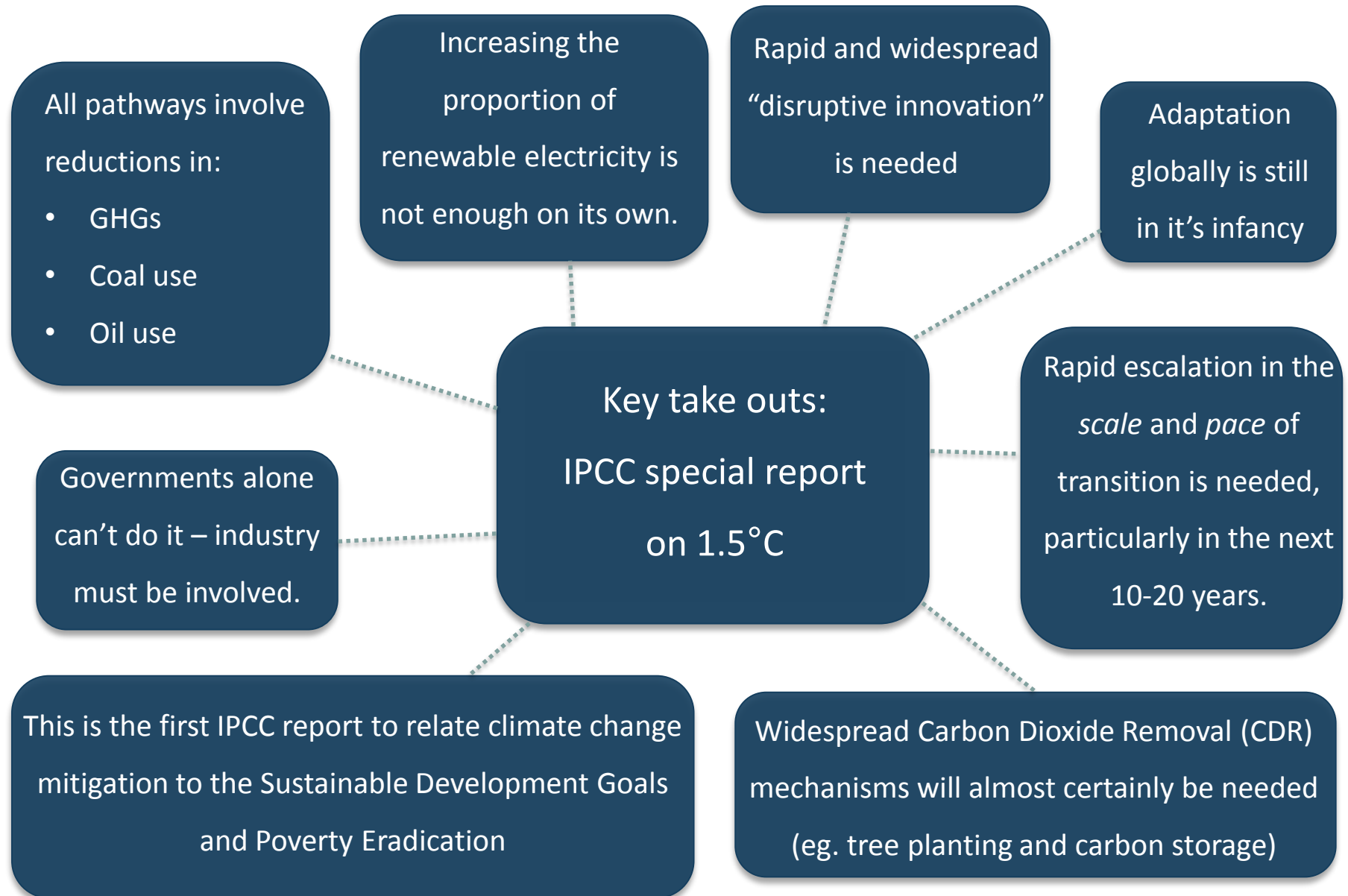
Pathways	GHG emissions	Renewable electricity	Oil Use	Coal Use	Gas use	Energy demand	Nuclear energy	Carbon capture and storage
P1								—
P2								
P3								
P4								

NB: other more minor factors are not included in this table.

Key	Increase	Decrease
Small		
Medium		
Large		

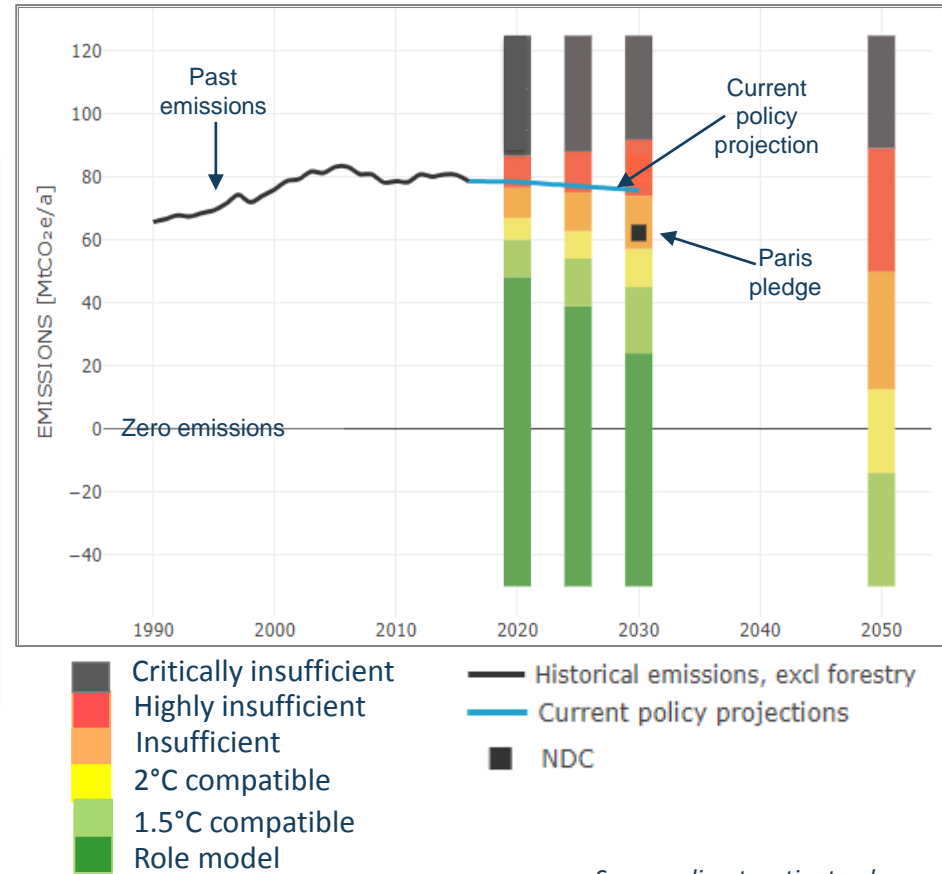
Source: www.ipcc.ch/sr15/

How can we keep the world below 1.5°C temperature increase?

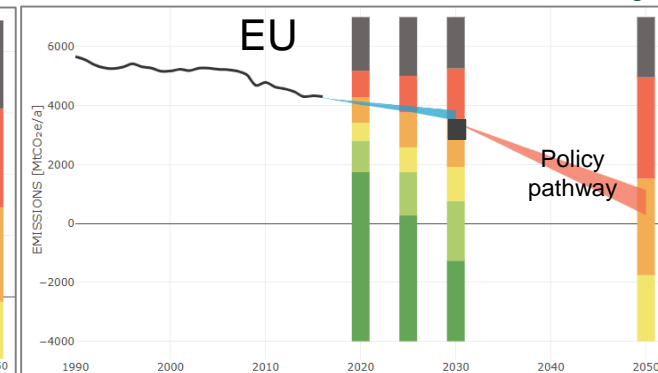
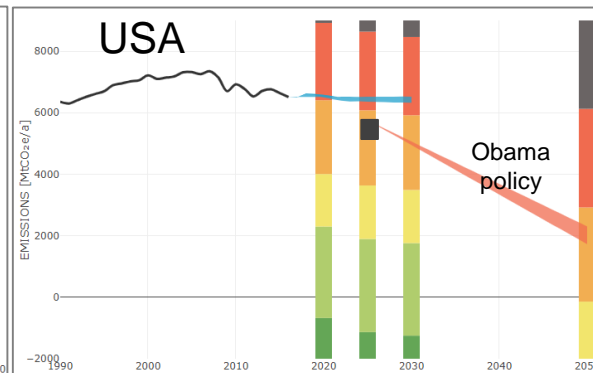
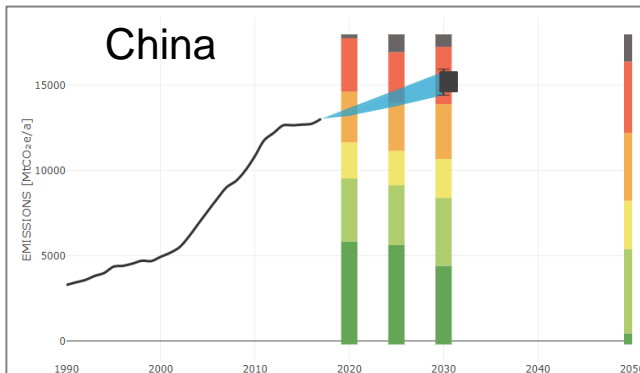


What are NZ's emissions commitments, and how are we doing?

- NZ's Paris Agreement pledge is to reduce GHG emissions to 30% below 2005 levels by 2030 (black square on graph).
- NZ's projected emissions (blue line) are not meeting our Paris commitments.
- Currently emissions are ~15% above 1990 levels.
- Different colours in the chart illustrate NZ's "fair share" of global emissions (per capita). NZ's projected emissions (blue line) are staying in the "highly insufficient" bracket.



Source: climateactiontracker.org



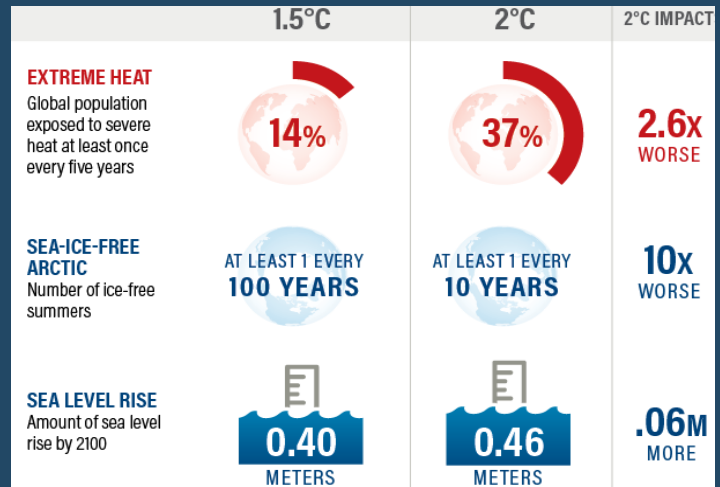
Implications for the NZ electricity industry?

- The world is in agreement on the need for emissions reduction.
- Increasing pressure to decarbonise and reduce emissions is highly likely.
- Wide scale electrification of transport and industry is likely.
- Retirement of coal plant is almost certain.

NZ government has a number of initiatives on this issue

- Zero Carbon Act: expected July 2019. Will commit NZ to nett zero greenhouse gas emissions by 2050.
- Interim Climate Change Committee: set up in 2018 to advise government – report due this week?
- 100% renewable energy by 2035 (in an average hydrological year): government target.
- 1 billion trees by 2028: a major government tree planting initiative is underway.
- Emissions trading scheme: key tool for reducing emissions and meeting our emission reduction targets.
- Powering past coal alliance: NZ signed up & committed to phasing out coal in electricity generation by 2030

1.5°C or 2°C – what's the difference?



Source: wri.org (using IPCC SR1.5 data)

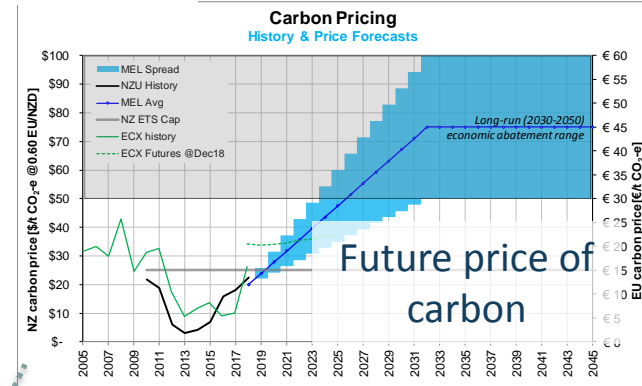
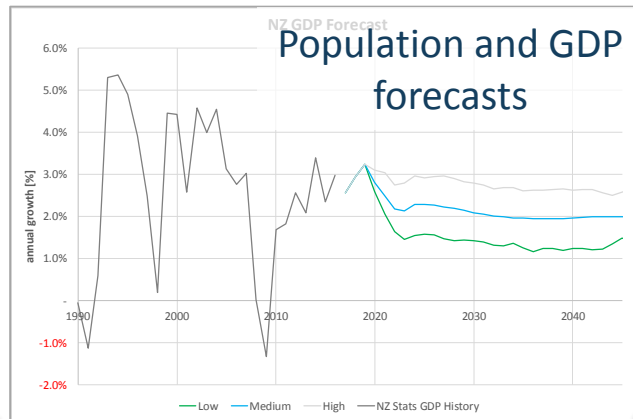
Half a degree makes a big difference to the likely impacts.



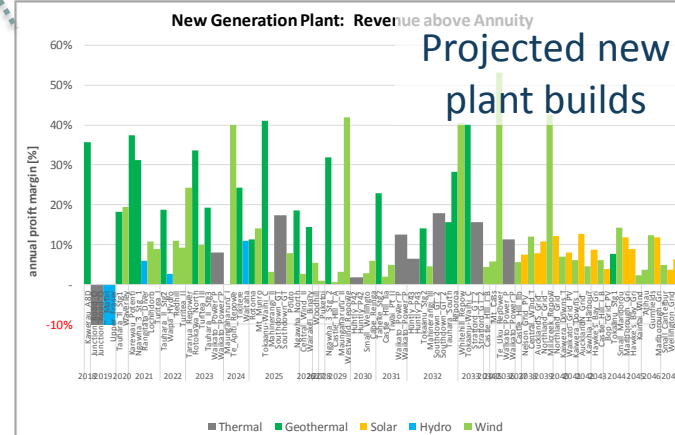
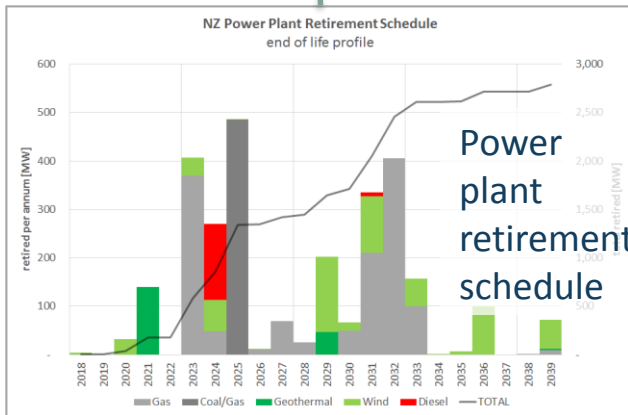
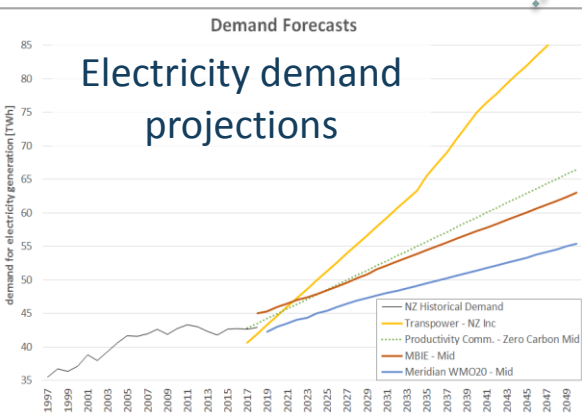
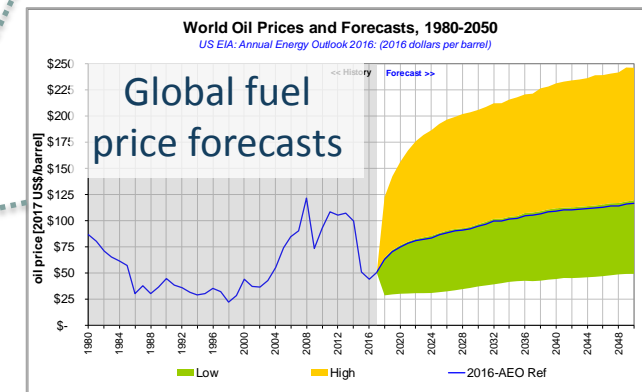
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Meridian Energy 2050 electricity modelling

Modelling the electricity system out to 2050 - LPCon



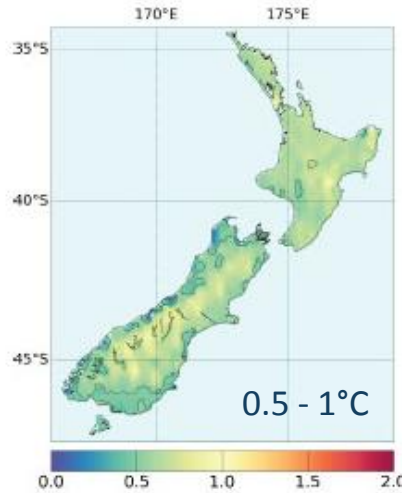
Model inputs



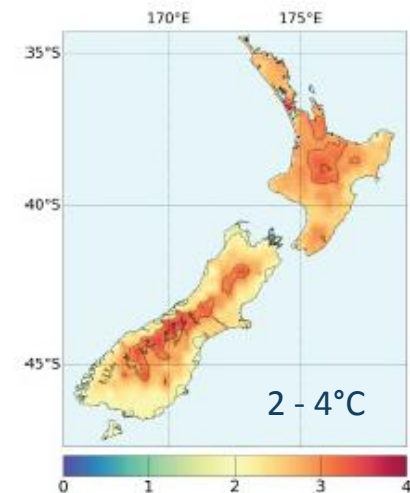
Modelling inputs – future climate - generally

- The following pages examine how the impact of climate change on lake inflows and wind generation is incorporated in the model.
- In a general sense, New Zealand temperatures are expected to get about 0.5 to 1°C warmer by 2050.
- Rainfall is expected to get wetter in the west and south of NZ, and drier in the north and east.

Projected annual temperature changes by 2090

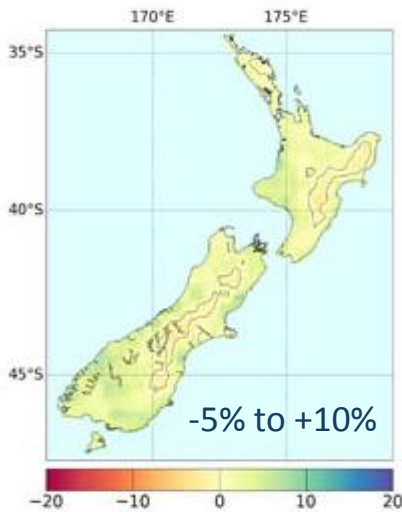


Low emissions

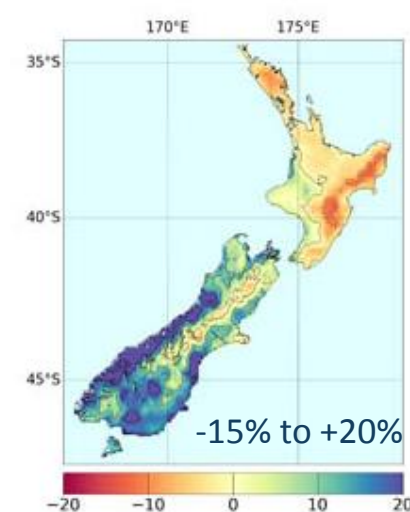


High emissions

Projected annual rainfall changes by 2090



Low emissions

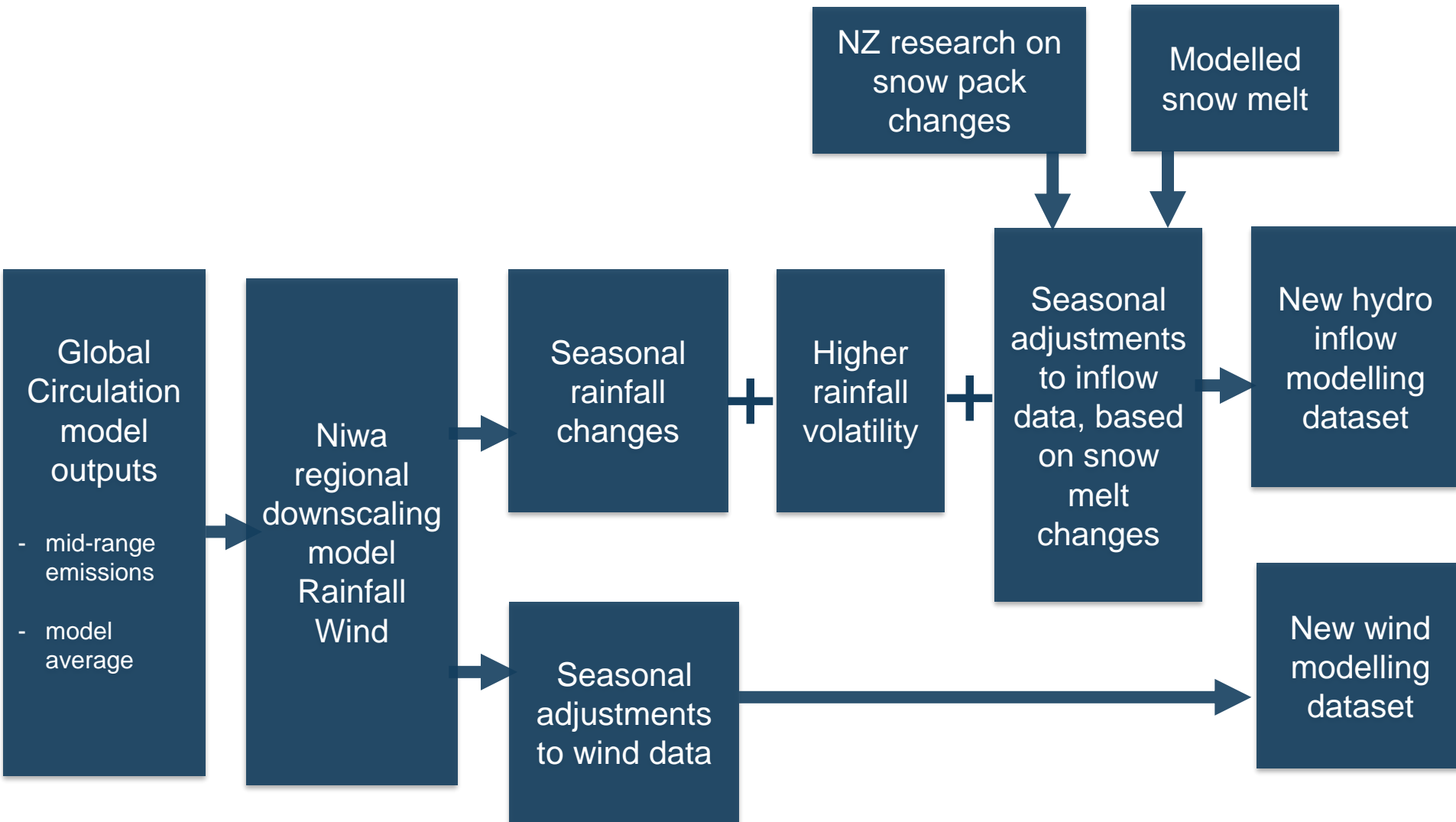


High emissions

Source: MfE 2018

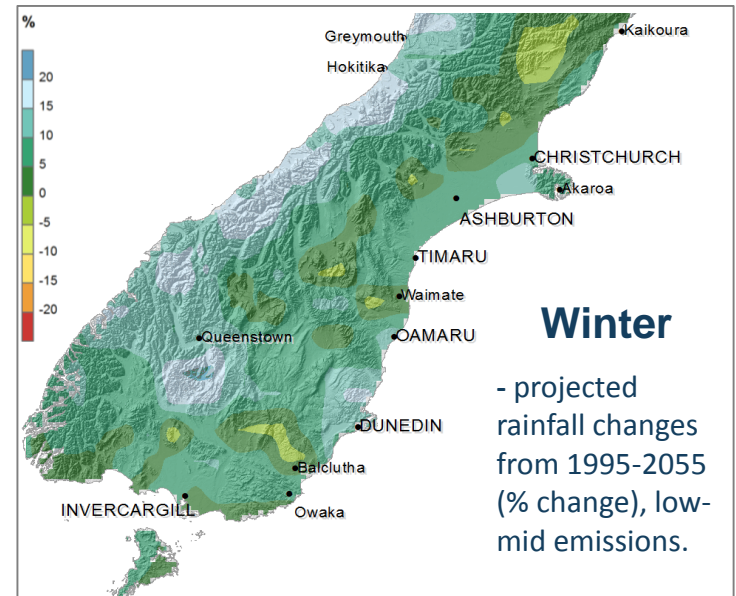
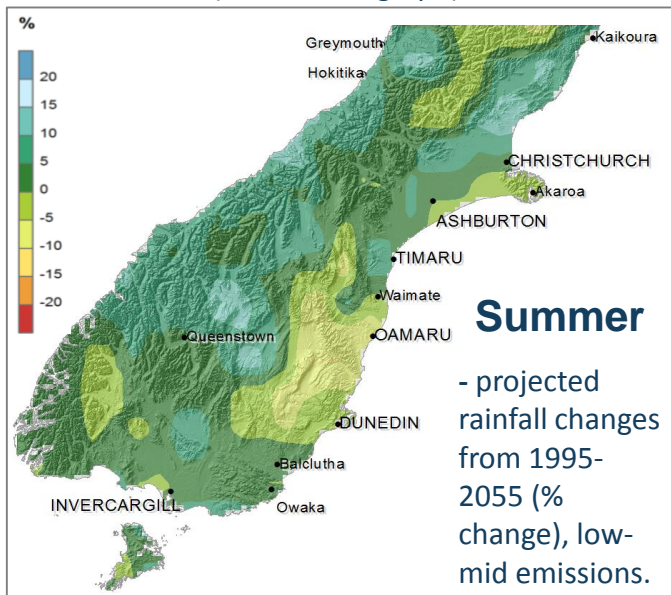
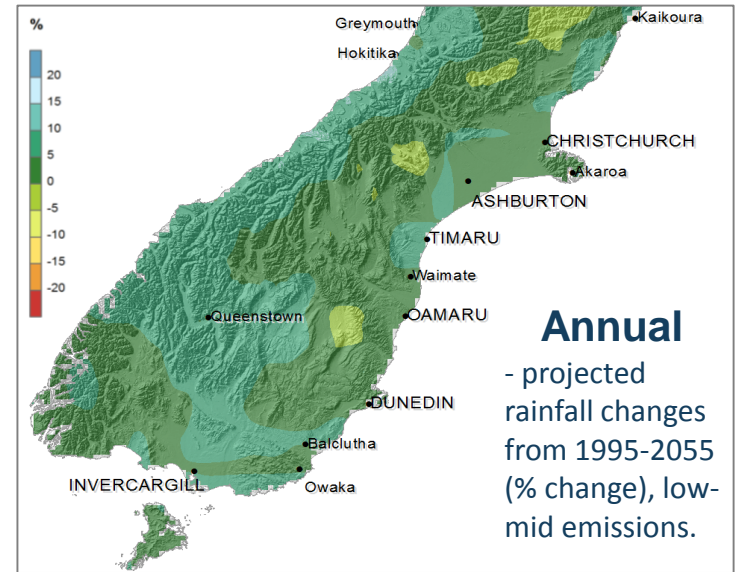
Modelled future hydro lake inflows and wind generation

- Methodology used to modify our model inflow & wind inputs



Projected changes to rainfall by 2050

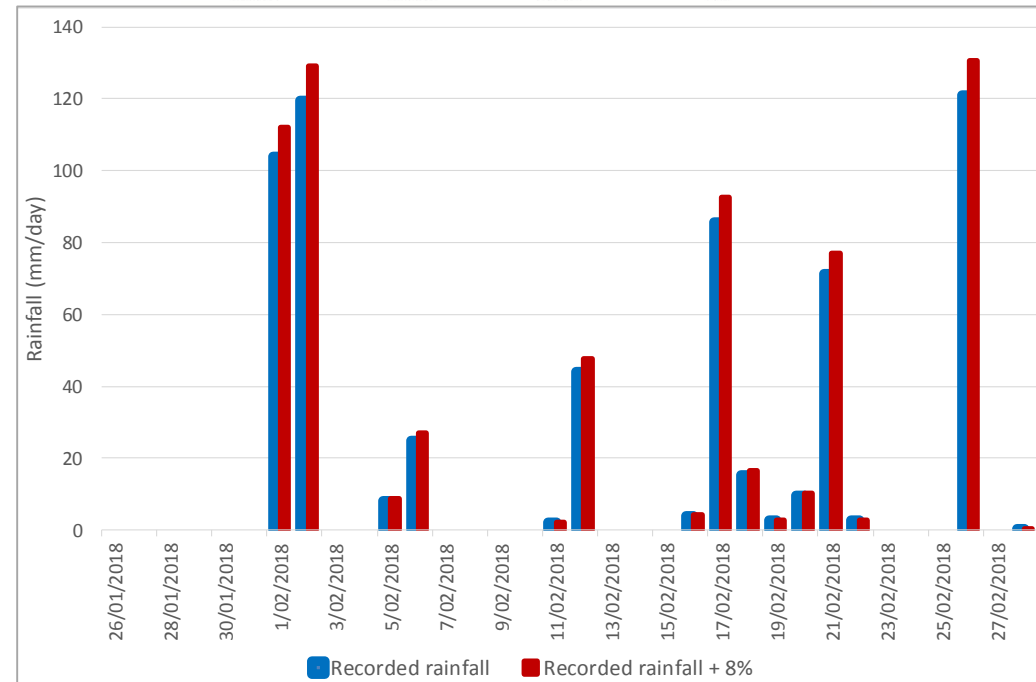
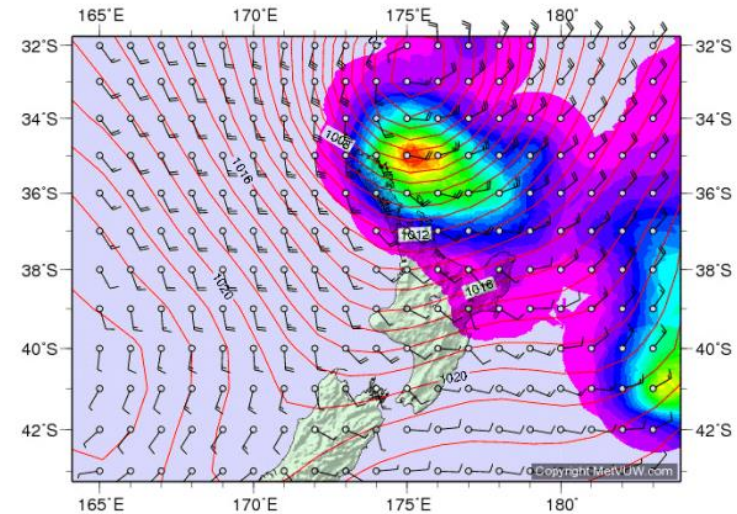
- Annually, Waitaki catchment rainfall is forecast to get 0-10% wetter by mid-century, compared to 1995 levels (see map at right).
- In addition to this, rainfall is projected to change seasonally as well.
- Waitaki rainfall is expected to get
 - wetter in all seasons,
 - particularly in winter (bottom right graph), where it is expected to be 10-15% wetter by mid-century.
 - 0-10% wetter in summer under low-mid emissions (bottom left graph).



Source: ofcnz.niwa.co.nz

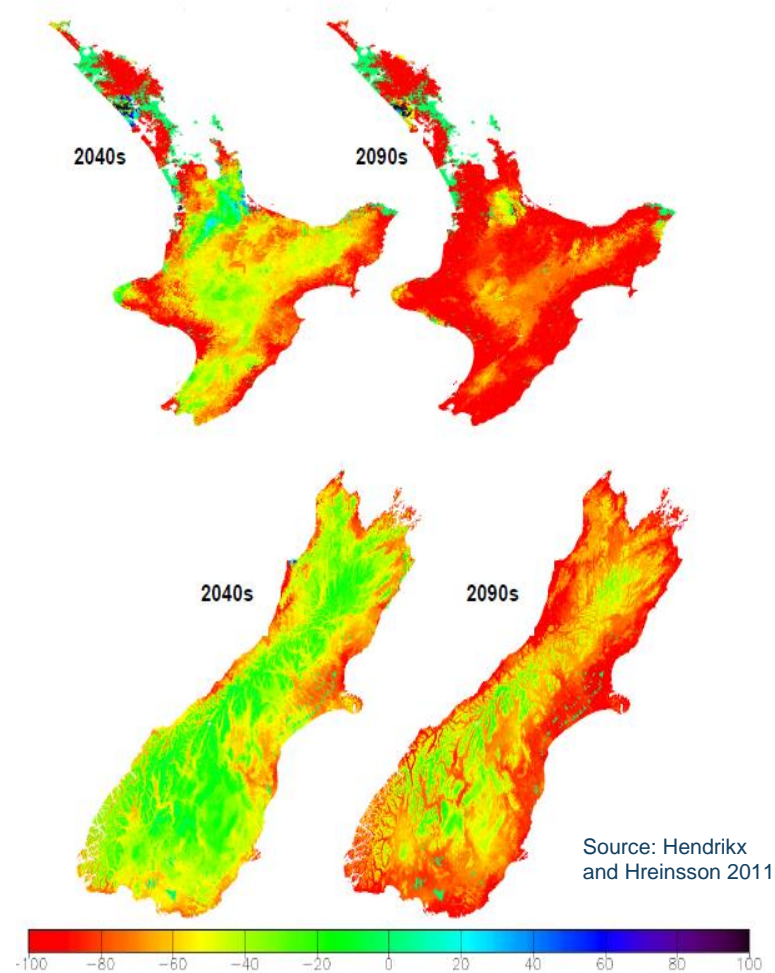
Projected changes to rainfall volatility by 2050

- An increase of 1°C of a parcel of air results in an 8% increase in moisture carrying ability of that air.
- Increased wind speeds (projected in coming decades) will enhance orographic uplift in the South Island in particular, enhancing both precipitation amounts and spillover over the Southern Alps and into the Waitaki, Clutha, and Manapouri catchments.
- For our modelling purposes, it is therefore estimated that each rain event will be 8% wetter by 2050.
- An example of this is shown in the below right graph, for Hermitage (Mt Cook) rainfall for February 2018, both recorded (blue) and simulated 2050 rainfall (red).



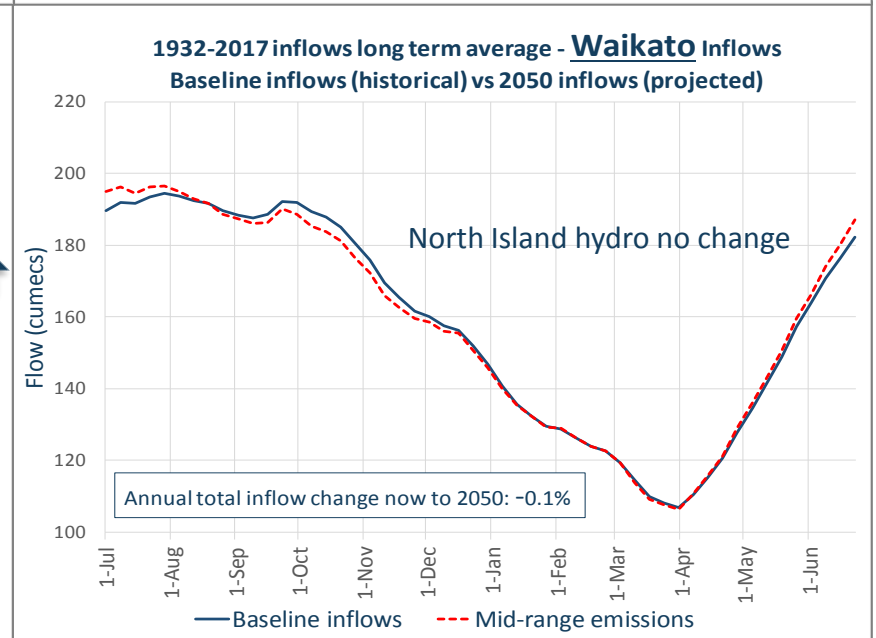
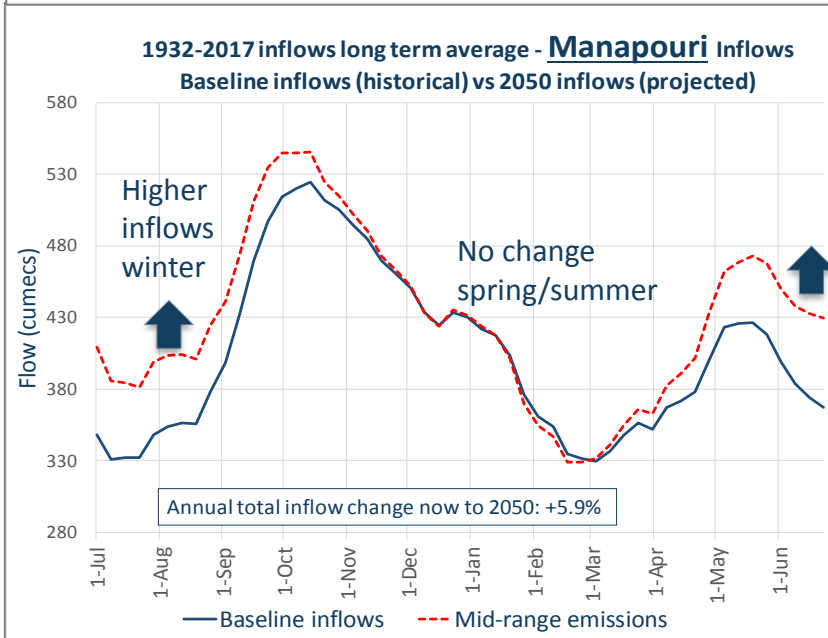
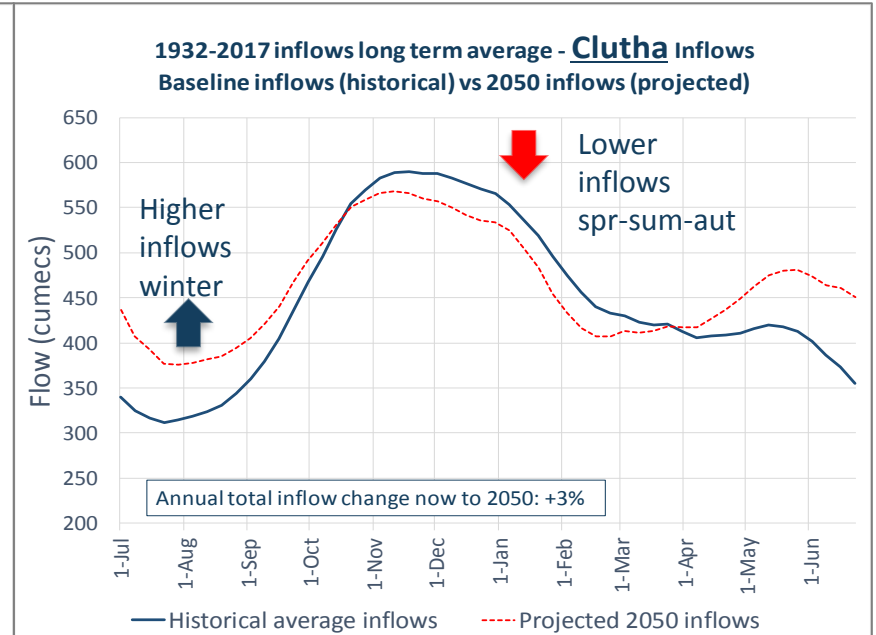
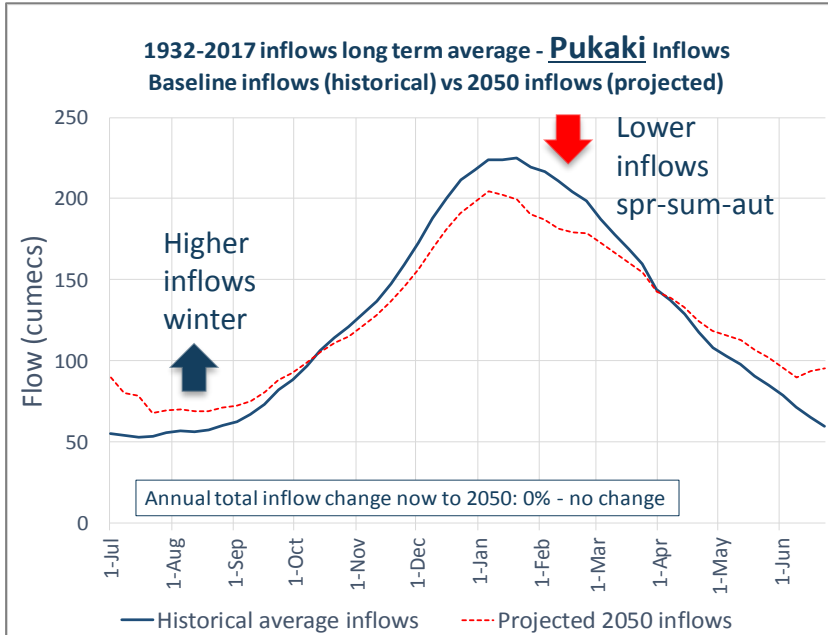
Projected changes to snow melt by 2050

- The Waitaki catchment receives half its summer inflows (or 22% of its annual inflows) from snowmelt (McKerchar 1998, Kerr 2013).
- The Clutha catchment 16% of its annual inflows from snow melt, and the Waiau 8%.
- Mid-century snowpack in NZ is expected to be ~20% smaller than today under a middle of the road emissions scenario (Hendrikx and Hreinsson (2011)).
- Melting glacier ice has been found to make up ~6% of Waitaki inflows. Glacial ice contribution to Waitaki inflows is likely to be reasonably consistent over the next 50 years, so has therefore not been adapted for in this study.



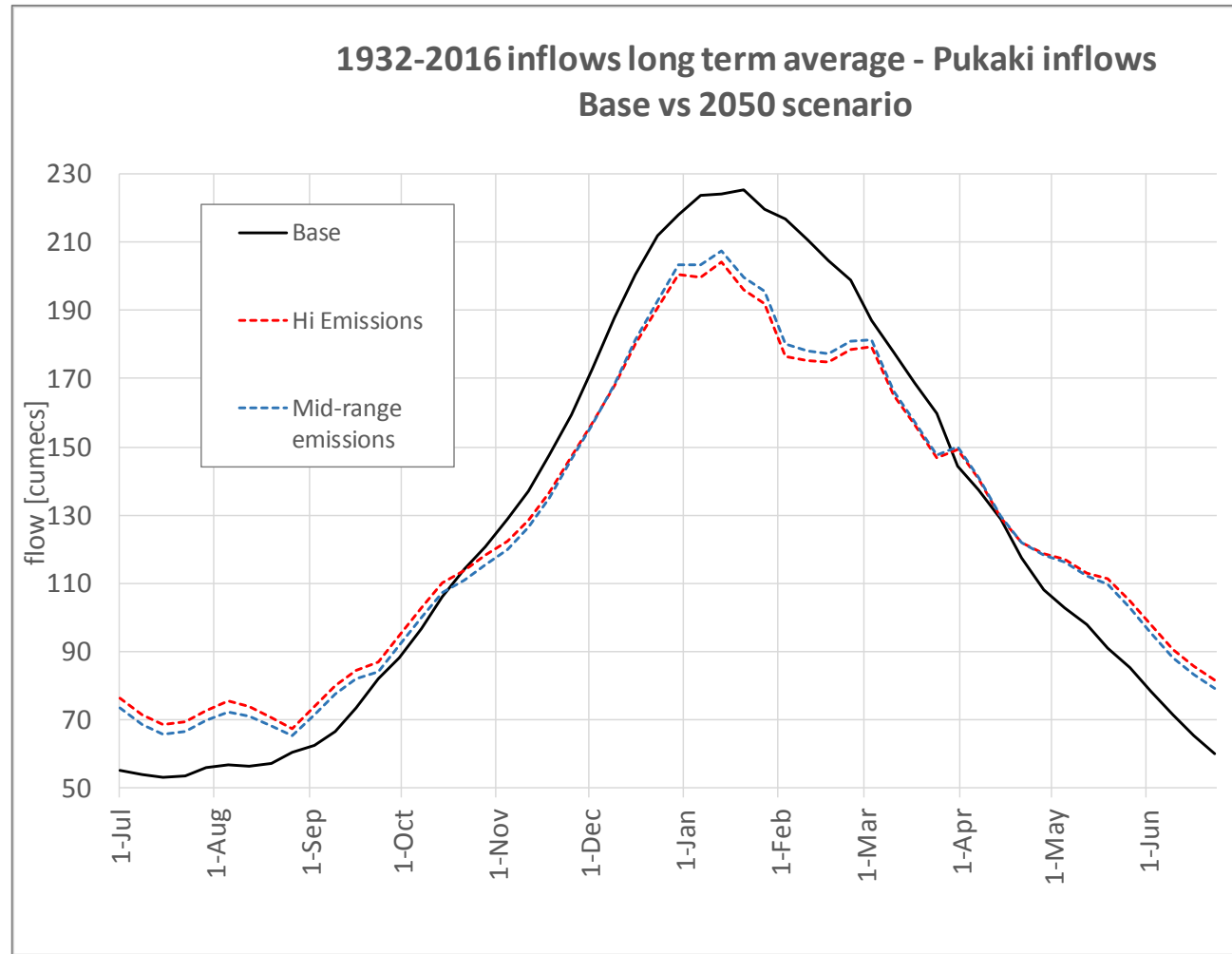
Percentage difference in mean maximum snow accumulation in each year for 2040s and 2090s using the 12-model average A1B scenario as input, when compared to the current.

Modelled changes to inflows by 2050



Modelled changes to inflows under a high emissions scenario

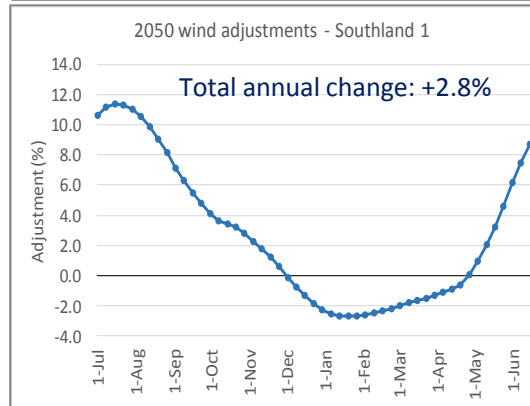
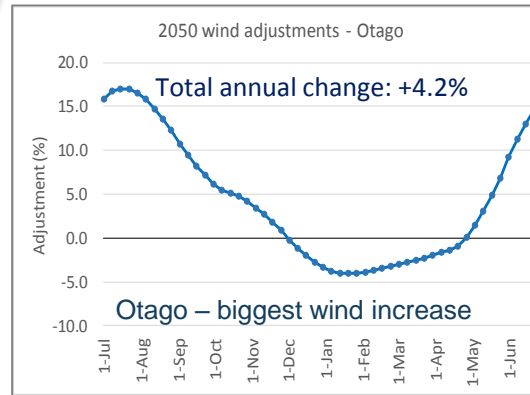
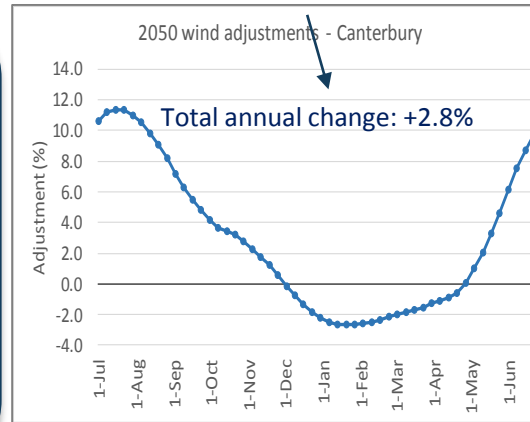
- Changes under a high emissions scenario (as compared to a middle of the road emissions scenario) were examined.
- Due to the relatively short time frame (2050), the impact on inflows between the two scenarios were not significant.



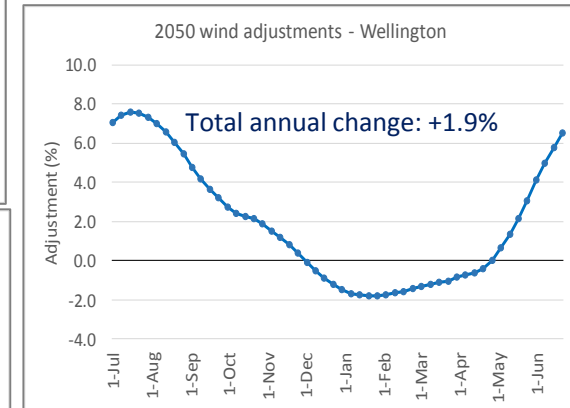
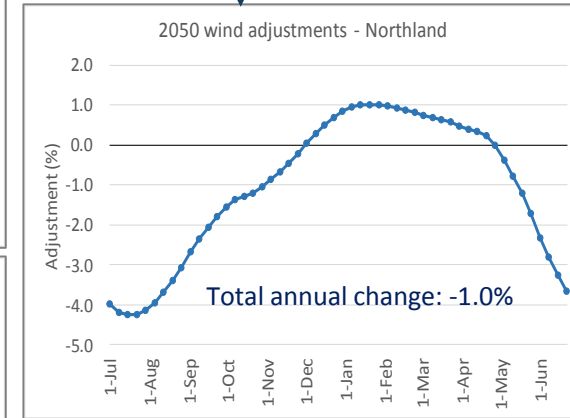
Projected changes to wind speeds

- The South Island is expected to get windier in most regions.
- The North Island is expected to be:
 - slightly windier in the lower half
 - less windy in the upper half.
- The biggest change is expected to be in Otago, where a 4.2% increase in annual total wind is expected by 2050.

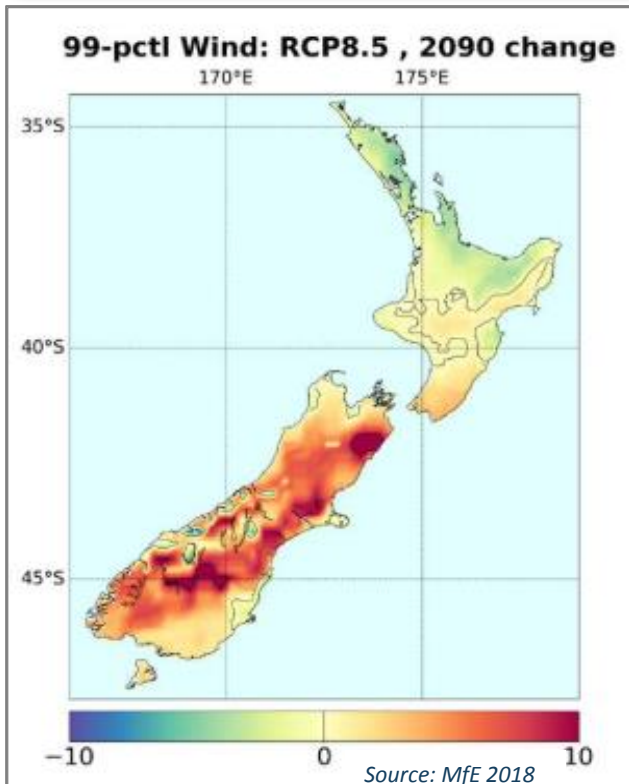
South Island – 2 to 5% windier



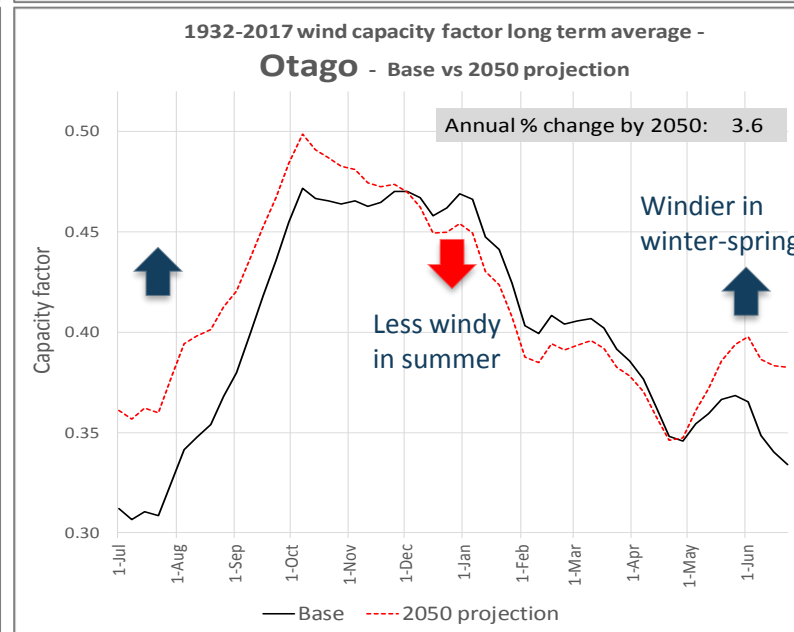
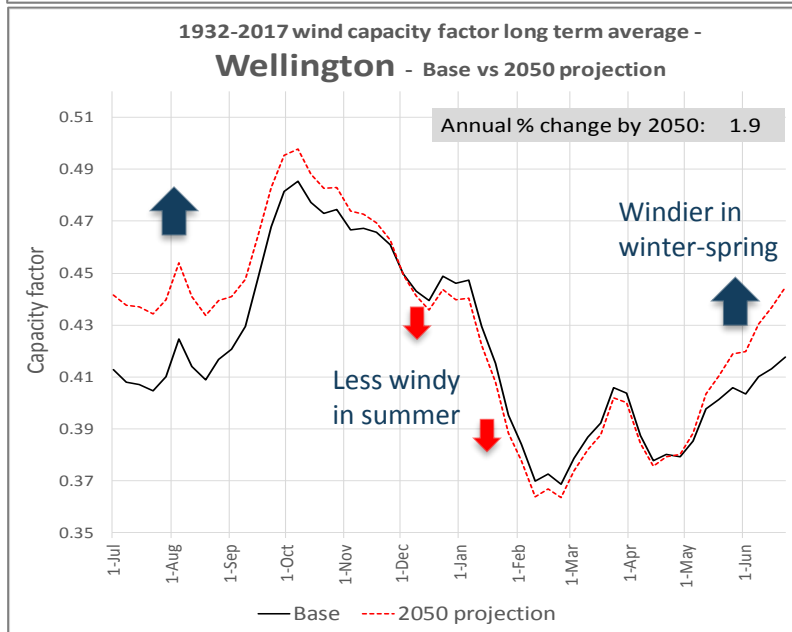
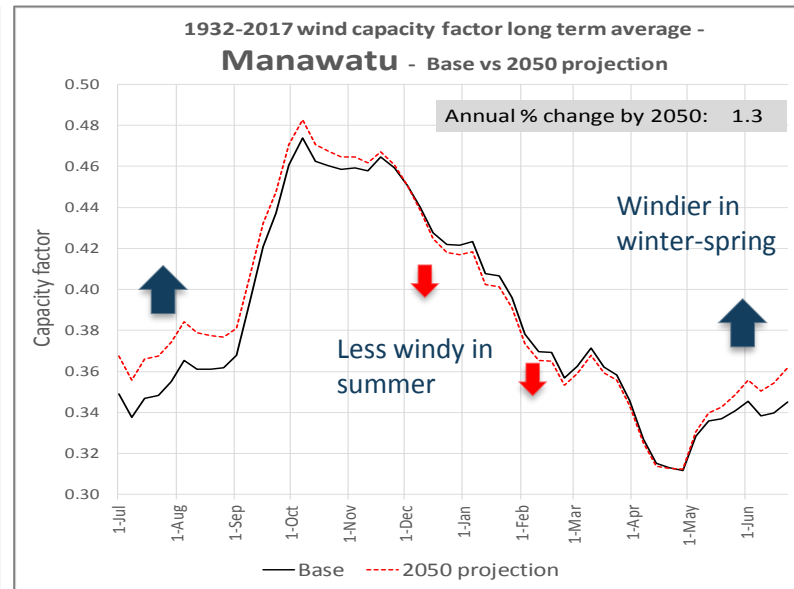
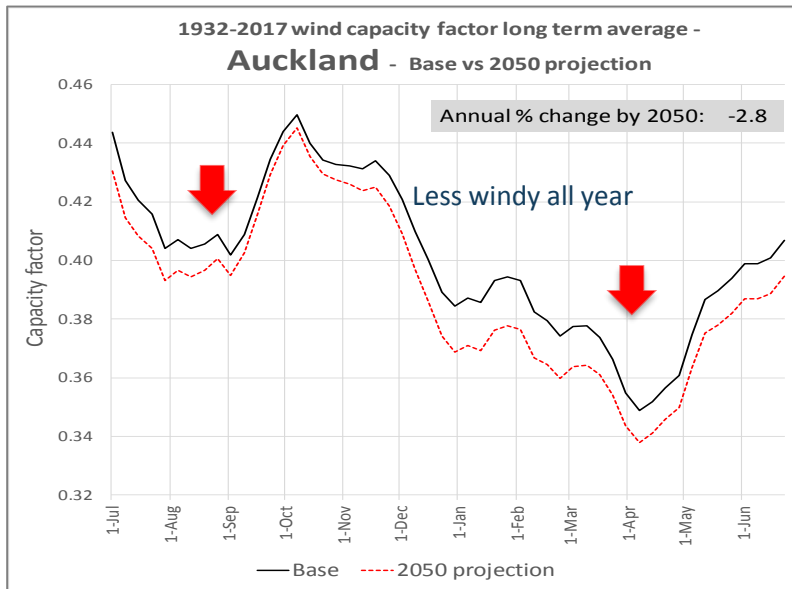
Northland – less windy overall



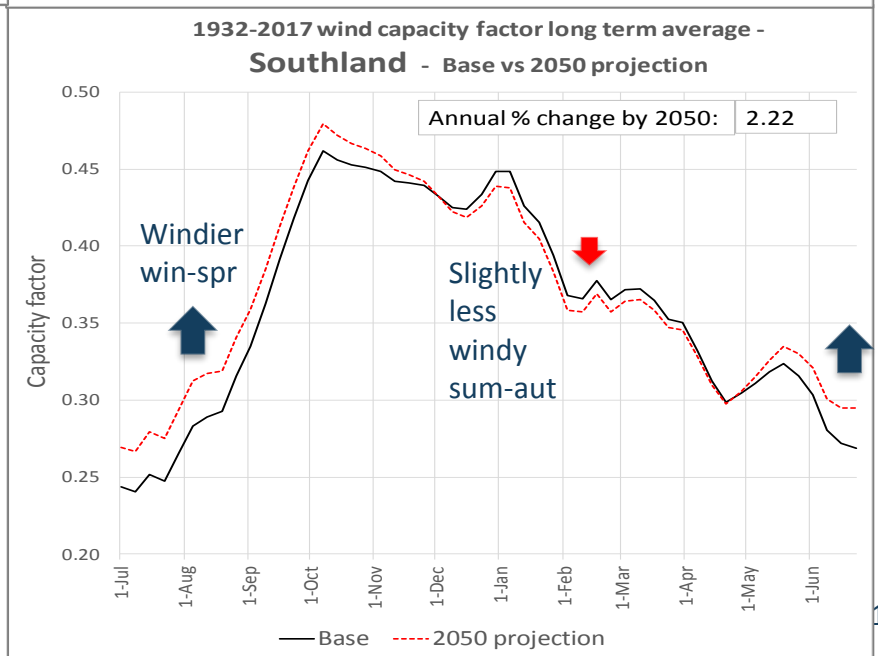
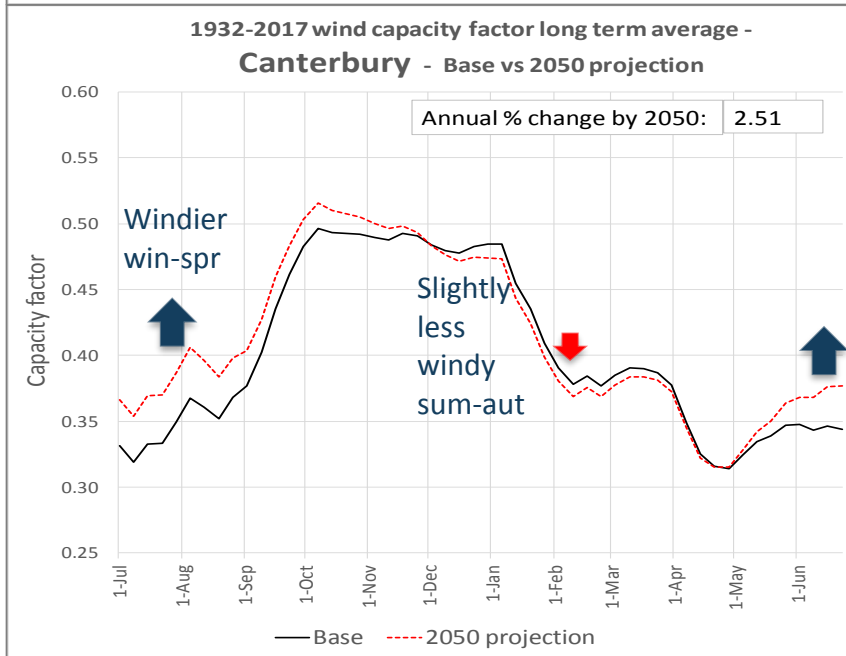
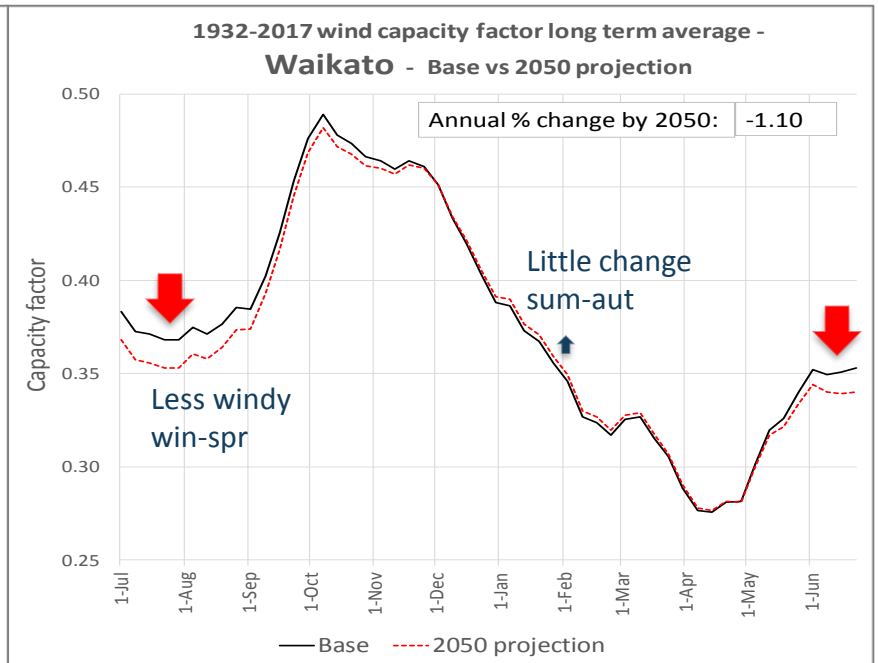
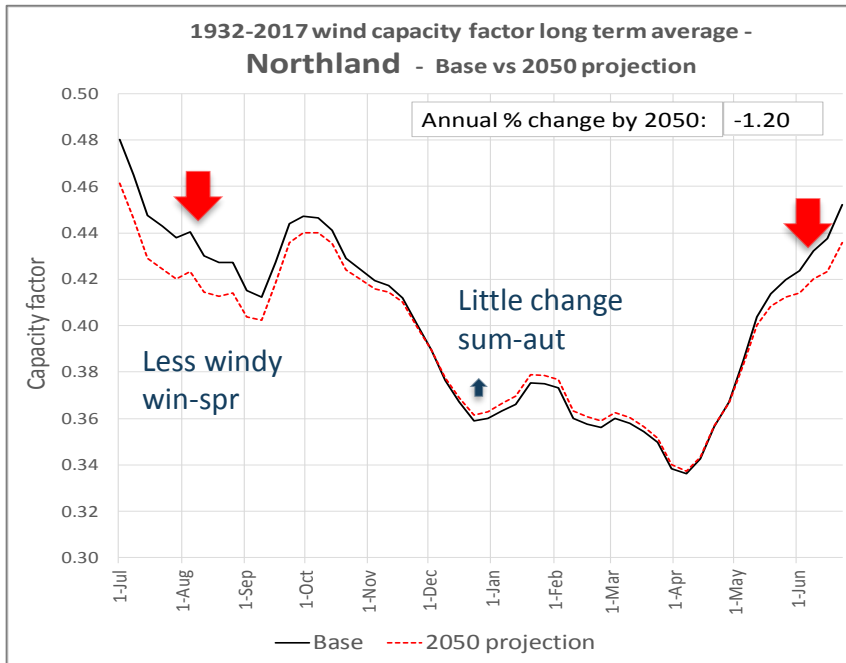
Wellington – slightly windier overall



Modelled changes to wind farm capacity factor

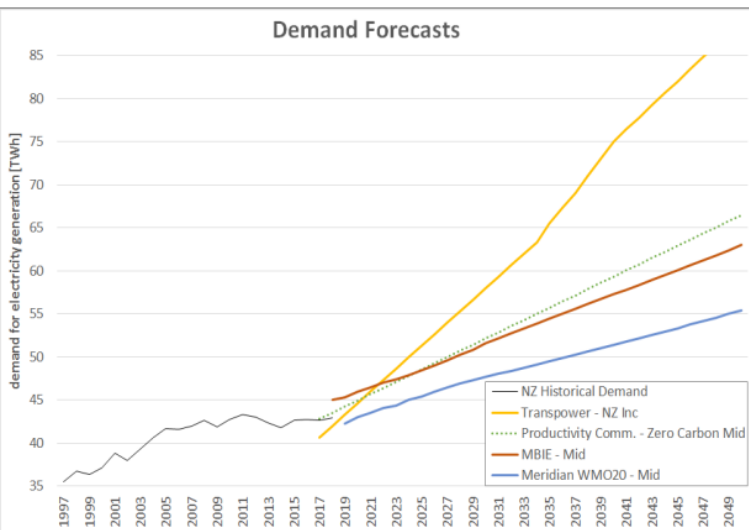


Modelled changes to wind farm capacity factor (continued)

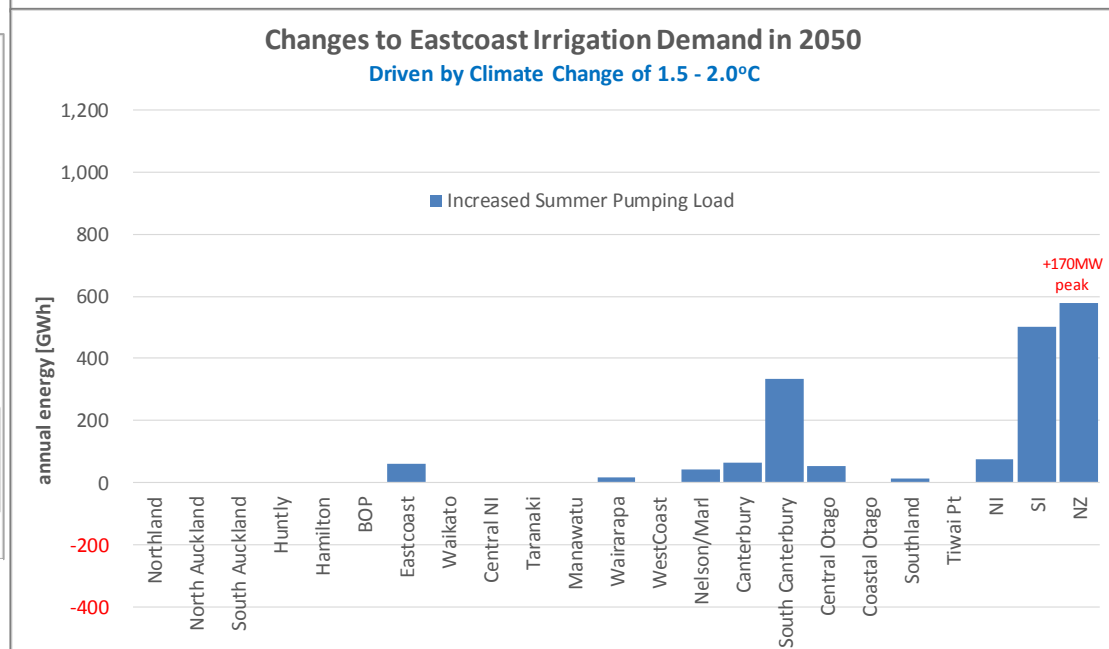
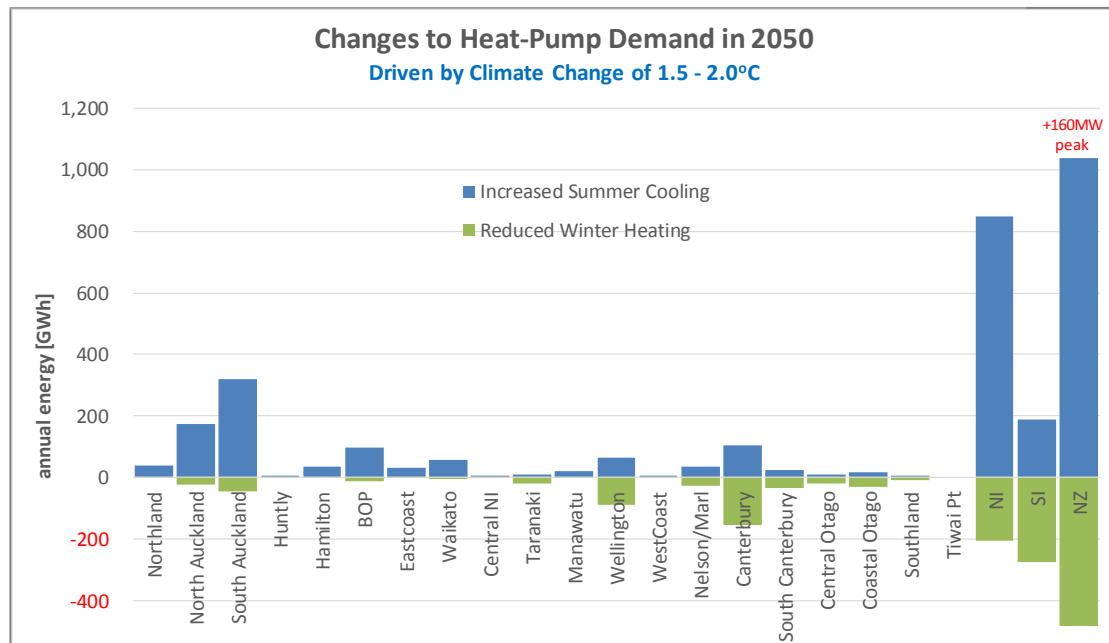


Projected changes to electricity demand by 2050

- Increased demand is expected as electrification of transport and industry occurs.
- Higher temperatures across the year are expected to increase electricity demand from both summer cooling and winter heating.
- We expect to see increased irrigation load as climate changes strengthen, especially on the East Coast of NZ.



Source: Meridian Energy



References

- Hendrikx, J. and Hreinsson, E.O. 2011: The potential impact of climate change on seasonal snow in New Zealand: Part II-industry vulnerability and future snowmaking potential. *Theoretical and Applied Climatology* 110(4).
- Kerr, T. 2013: The contribution of snow melt to the rivers of the South Island, New Zealand. *Journal of Hydrology (NZ)* 52 (2): 61-82.
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- Ministry for the Environment 2018. *Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment, 2nd Edition*. Wellington: Ministry for the Environment.