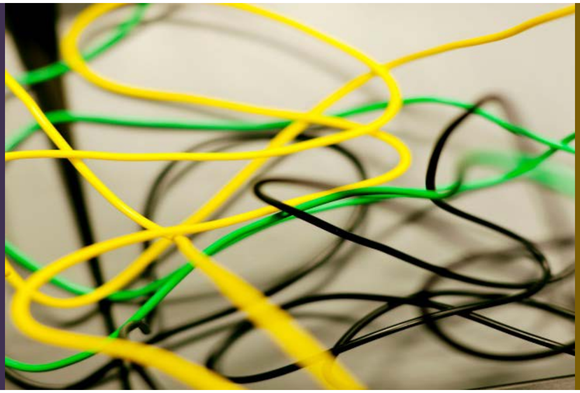
Thoughts on the future

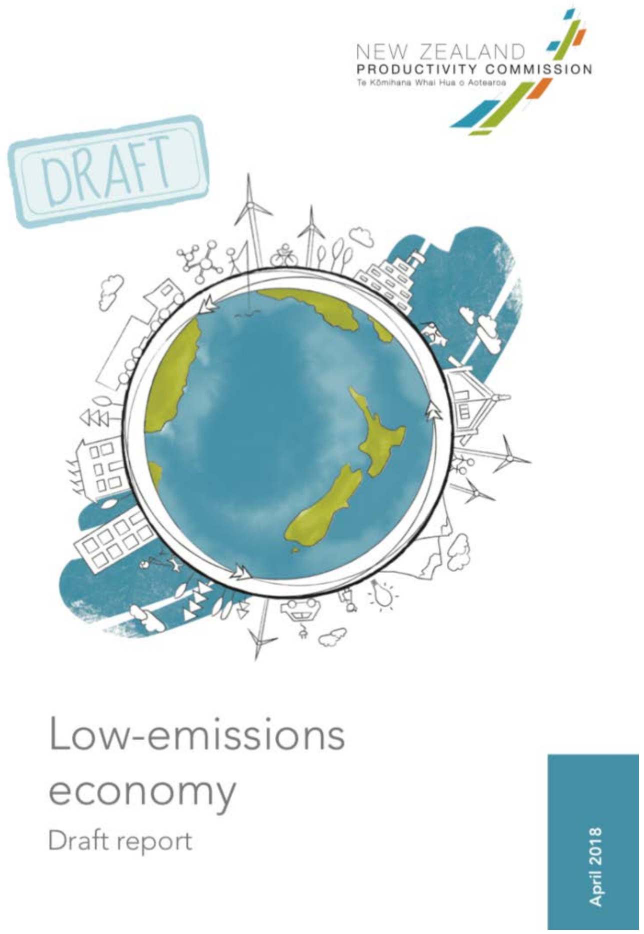
David Reeve

7 May 2019

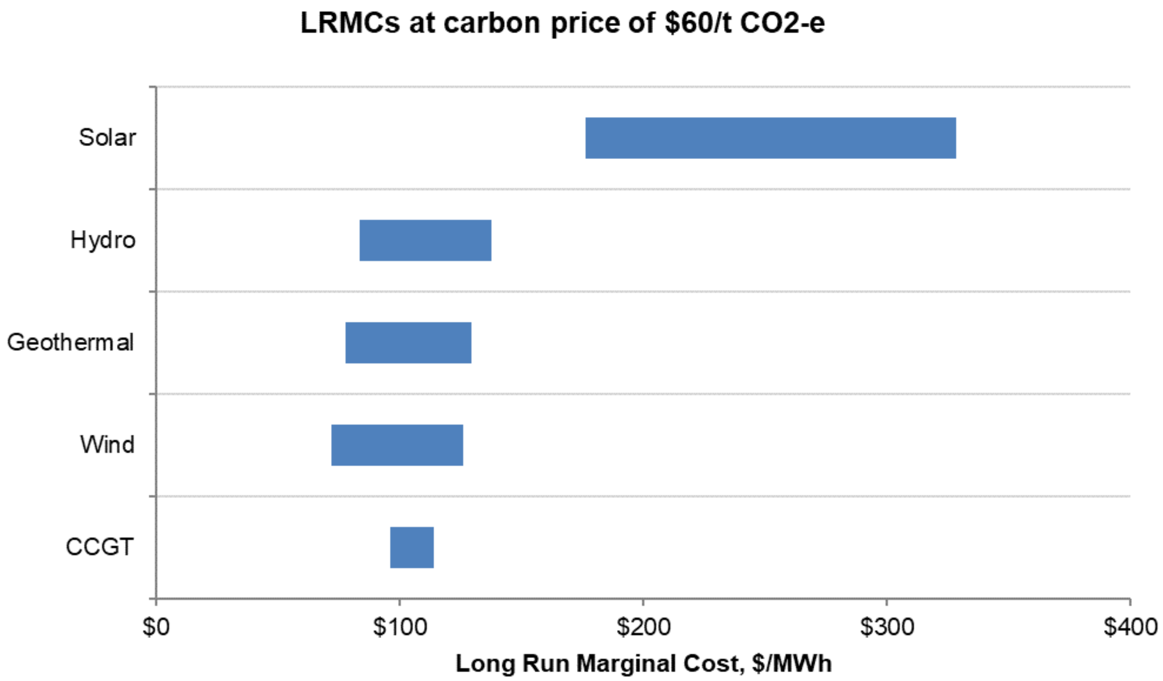


Driver for future – low emissions

Productivity Commission Report – Draft 2018



Decisions required to move to very low emissions



MBIE's analysis was used for cost numbers
Wind and solar costs are potentially lower than this now

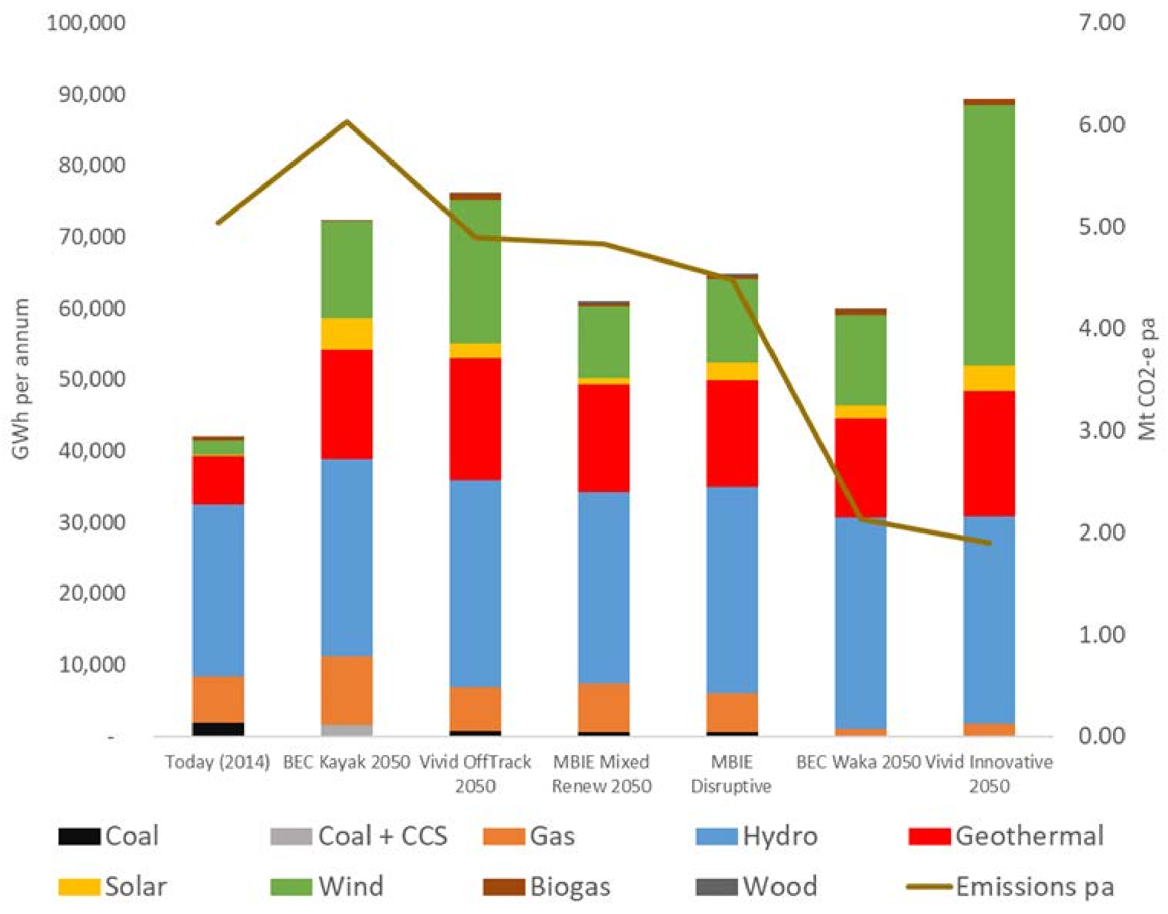
Reducing emissions requires us to:

- **Removing some/all existing thermal**
- **Replacing this, and meeting any demand growth, with low-emissions generation**

What we replace thermal with must do the same roles thermal does currently.

The possibilities open to us will be driven by technology, cost, carbon price and fuel – all highly uncertain over this timeframe.

Scenarios of emissions in 2050



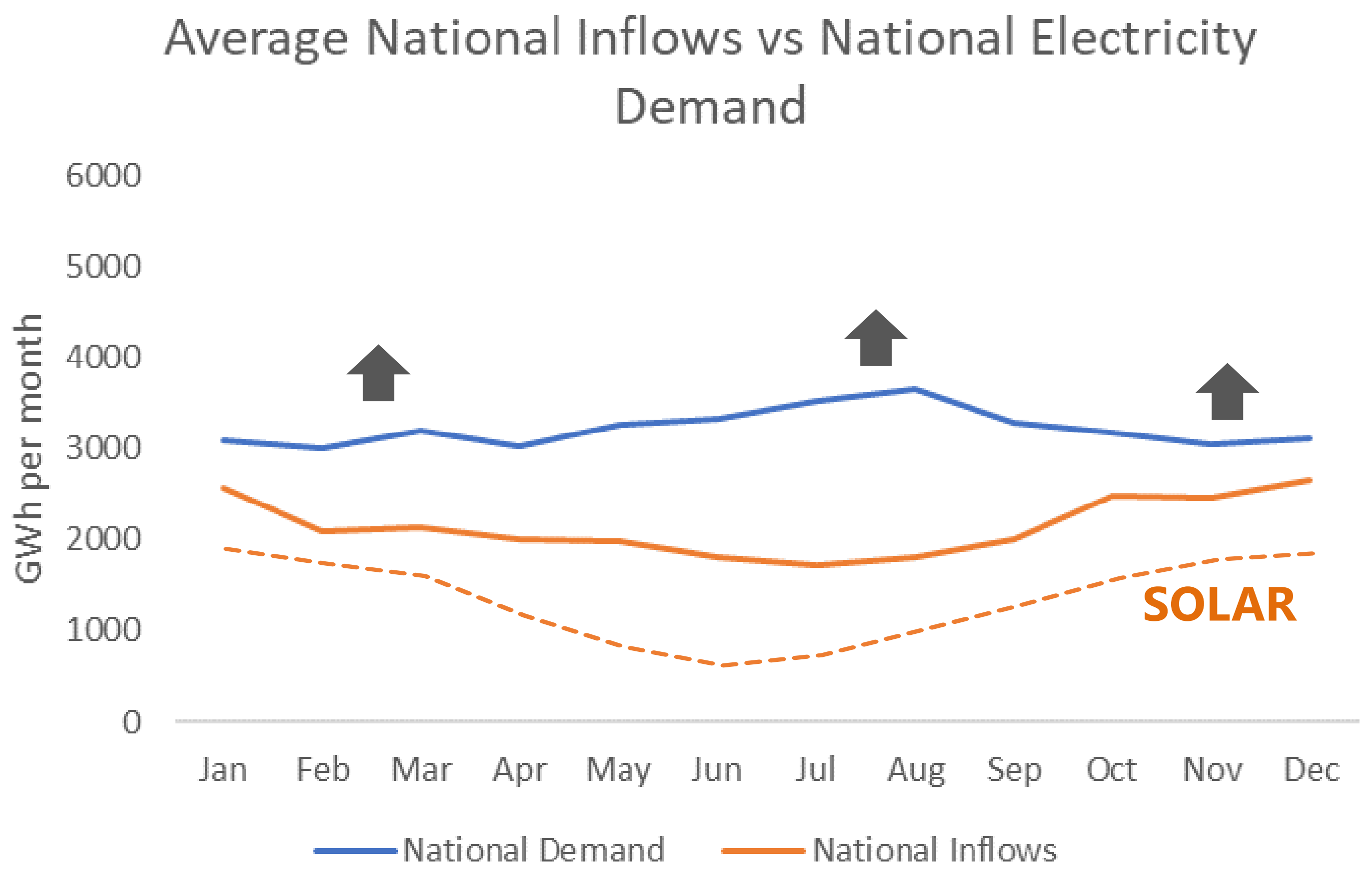
MBIE, BEC, and Vivid scenarios

- **A doubling of geothermal in all scenarios (emissions?)**
- **A variety of solar uptakes (costs?)**
- **Modest investments in hydro**
- **Wind as a the swing fuel…and up to 5,000MW?**

MBIE, BEC resource adequate

Most significant differences in emissions driven by thermal decommissioning

The ongoing importance of storage and fuel flexibility



Variability in inflows over the year, and between years will always need storage and flexible fuel.

The way in which demand grows may help reduce the seasonal shifting required.

It's not obvious how batteries play a role.

Solar exacerbates the issue

Deeper cuts (towards 100% renewable)

Energy Policy 60 (2013) 324–333

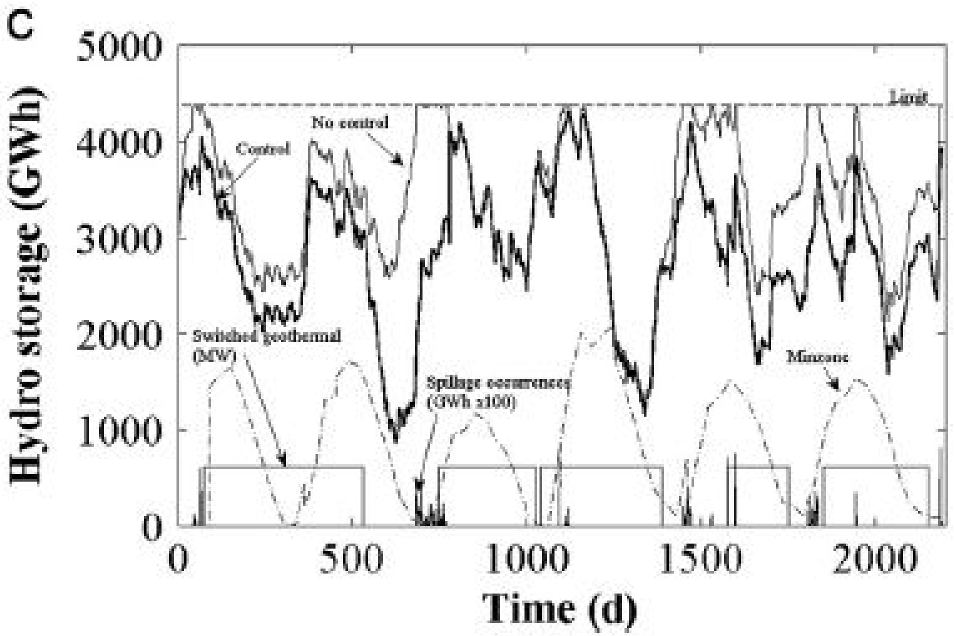
Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Security of supply, energy spillage control and peaking options within a 100% renewable electricity system for New Zealand

I.G. Mason [a,*], S.C. Page [c], A.G. Williamson [b]

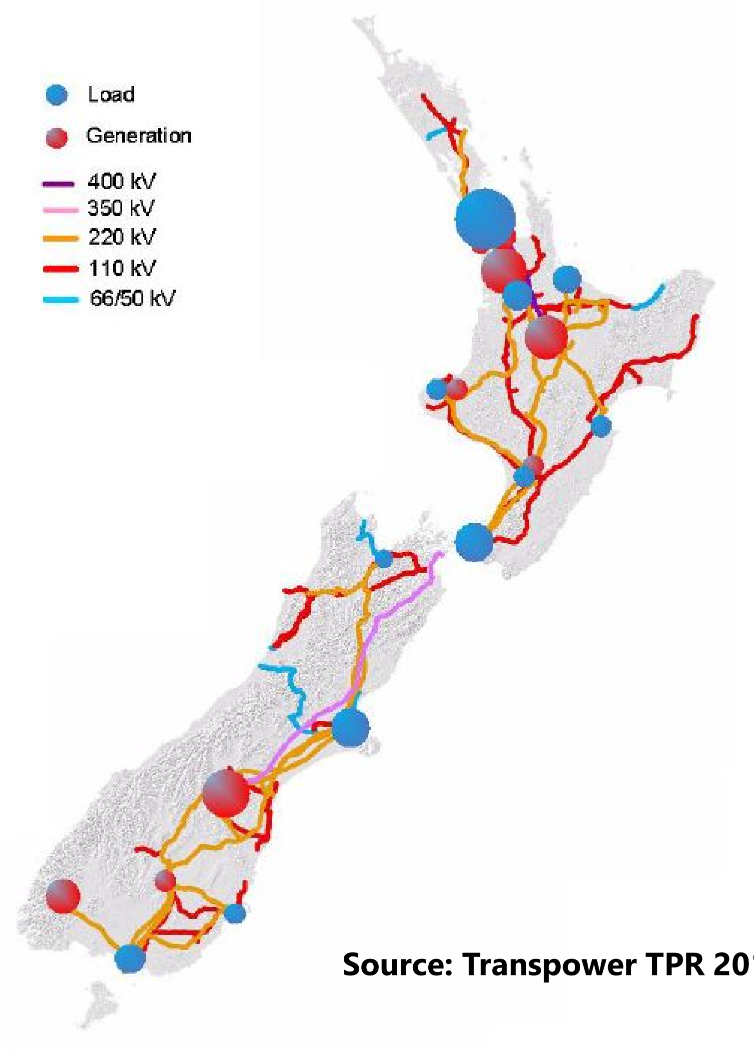


Based on the <u>mature technologies we use today</u>, we think minimum emissions of around 1Mt is possible, but only by using partially loaded geothermal for hydro firming (Mason *et al*).

But by 2050, anything is possible:

- Zero-emission geothermal systems?
- Biomass-fuelled peakers?
- Hydrogen storage?
- Pumped storage?
- [Industrial] Demand response?
- Carbon capture and storage?
- ….Overbuild?

Implications: Transmission and Ancillary Services



Source: Transpower TPR 2015

Transpower's current grid plans for next 10-15 years robust to most of the scenarios.

But prospect of Vivid/Waka wind takeup, if concentrated, raises prospect of HVDC re-think to enable volatile power transfer in normal and dry years.

Low levels of spinning plant in Auckland raises voltage questions.

High renewables (esp solar and wind) creates need for synthetic inertia, as well as different ramping needs to manage frequency – new AS products needed?

Power electronics: where the revolution begins

Distribution penetration can lead to utility scale problems. It's not all a future technology problem. The future is now.

- D-fig wind generators – Dr Jekyll and Mr Hyde
- Solar invertors – 94MW – Dr Jekyll and Mr Hyde
- Battery rectifier/invertors – Dr Jekyll and Mr Hyde
- EV chargers - ?
- DC – DC convertors ?
- Increasingly in the excitation systems of generating units – Dr Jekyll
- Motor speed controllers - ?
- Brushless motors - ?

Power electronics: Mr Hyde and Doctor Jekyll

Mr Hyde

- Concern that invertors are being installed that don't meet basic standards
- Don't follow voltage
- Don't follow frequency
- Generate harmonic distortion
- Don't provide inertia

Regulation
vs
Incentive
vs
Combination?

Dr Jekyll

- Can clean up power supplies
- Can support voltage
- With battery can support frequency
- Can clean up harmonics
- With battery can synthesise inertia

David Reeve
dreeve@thinkSapere.com
021 597 860

independence, integrity and objectivity