Stocktake on the Energy Transition

Aotearoa – New Zealand's view of the present challenges

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APERC Theme for this conference
"Exploring the Potential of Technology to Enable the Energy Transition"

This is a New Zealand view that covers the topics and questions posed

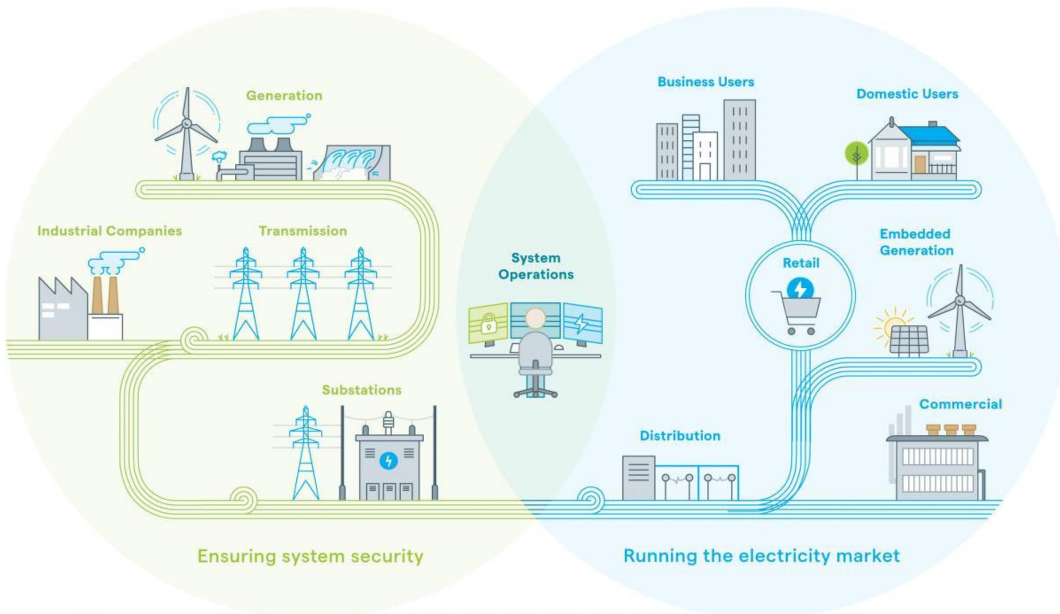
- Context
- Key barriers to the energy transition
- The effect of increased Variable Renewable Energy on electricity affordability and grid stability
- Potential for hydrogen production and Carbon Capture & Storage cost reductions

- References


Context Matters

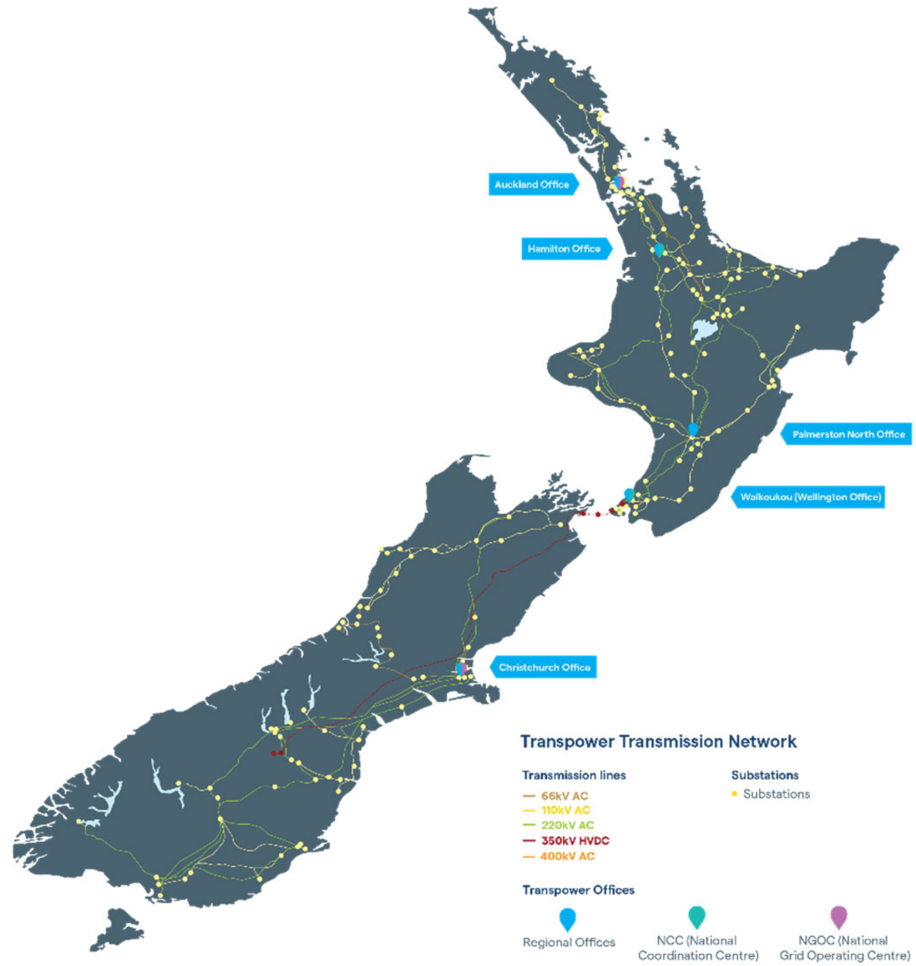
How is Aotearoa's electricity system structured

- New Zealand is horizontally split industry
- Open wholesale generation (12) and retail (45)
- Regulated transmission (1) and distribution (29)
- Energy only market, with realtime dispatch and settlement
- Transpower is a Regulated State owned Enterprise with own Balance sheet and Board
- All Transpower costs recovered from transmission system users
- Shallow connections costs are user paid, deep costs are apportioned across all users



Who is Transpower NZ

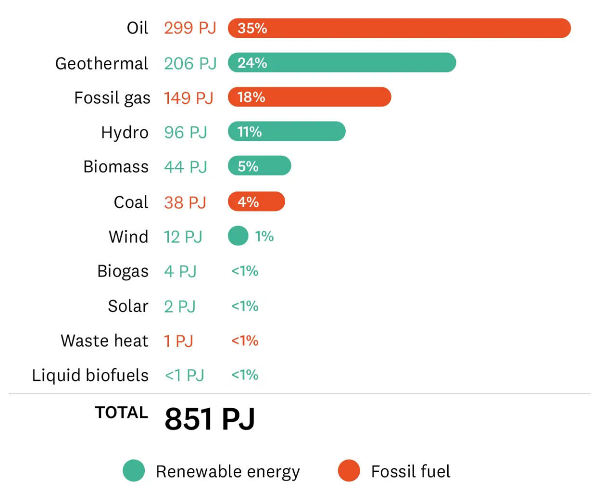
- Owner and operator of New Zealand’s national electricity transmission system
- We provide the infrastructure and market system that connects electricity generators to major electricity users and the distribution network
- Over $5 billion in assets positioned across some 30,000 properties
- 175 substations, 40,000 transmission towers and poles representing more than 11,000 km of lines
- Operate the electricity market system in real time, 5minute dispatch and settlement
- Offices in Wellington, Auckland, Hamilton and Christchurch
- Around 1,100 staff
- All design, construction & maintenance is outsourced



Energy Mix matters

- Aotearoa New Zealand is an island system with no interconnection to other countries, a population of 5.4m people in 2 million households comprising 1.4million stand alone homes
- Renewable electricity approximately 36% of all energy used. Electricity will be 98% renewable by 2030. It was over 96% renewable for four months this summer.
- Installed generation base 11,000MW
- 42TWh, Peak winter demand

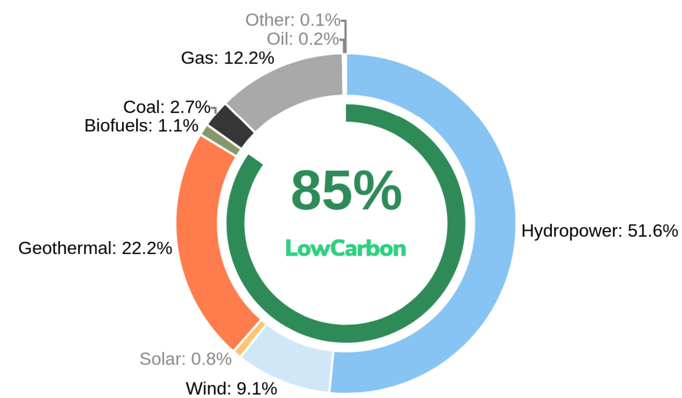
Primary energy supply in New Zealand



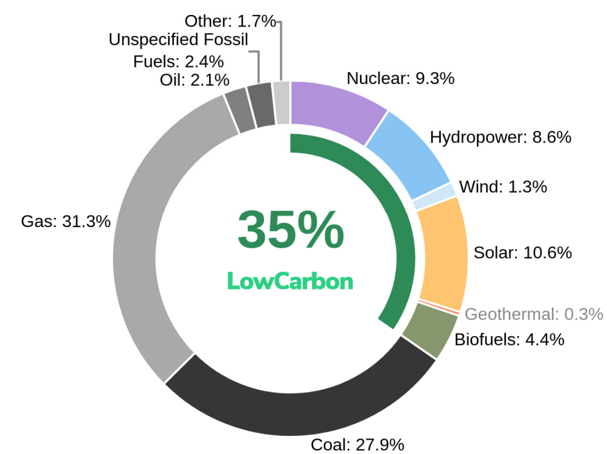
Source: Ministry of Business, Innovation & Employment, 2024 (2023 data)

Electricity generation in

New Zealand in 2025



Japan in 2025



lowcarbonpower.org/r/JP

Our Future Grid Blueprint Te Kanapu

Electrification and decarbonization of the economy, in particular process heat and land transport drives growth under all scenarios

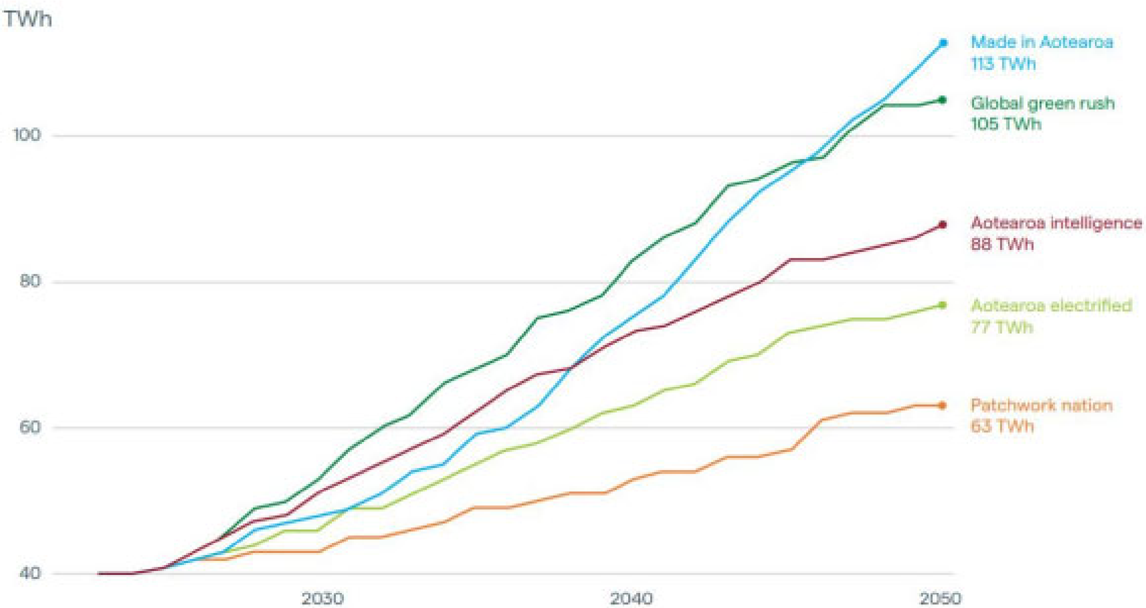
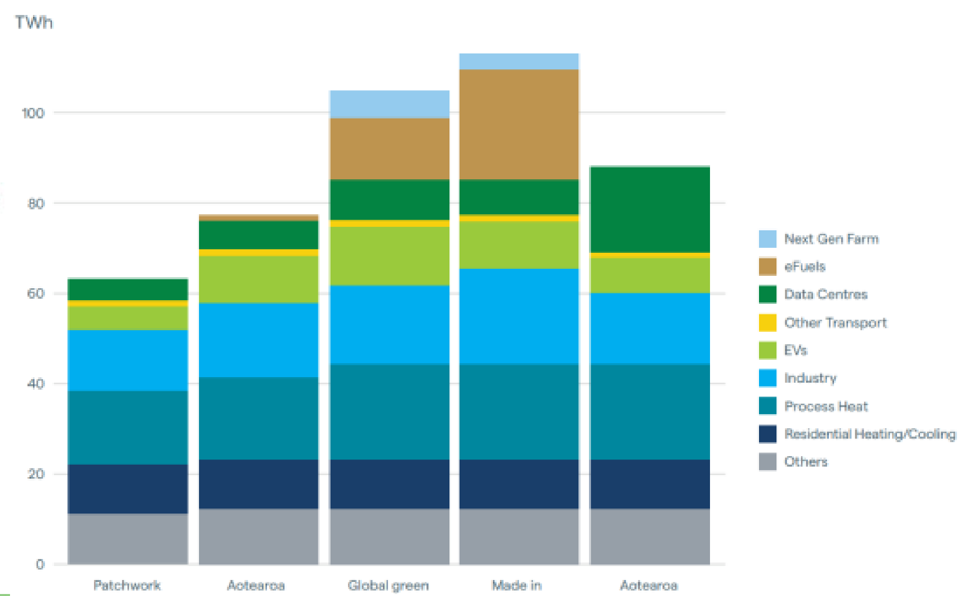


Figure 6: Electricity demand breakdown by driver at 2050



Our Connection Pipeline

An additional 20% of generation is in delivery with 68% of it being renewable intermittent

Future developments consistently above 90%

Key barriers to the energy transition

Challenges & Barriers

Like the 1950s-60-70s will be Consumer lead

Managing the disconnect between consumer pace and infrastructure pace

Regulatory and investment structures of last 20 years not suitable for the next 20

Increasing traditional supply costs further drives consumers to increasing VRE options

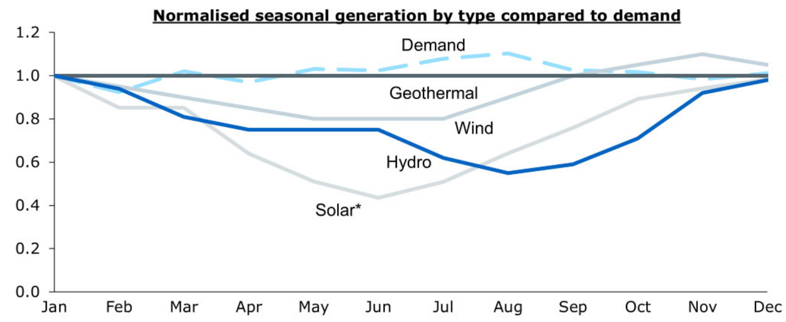
Community acceptance site suitability and routes are a limited resource

Renewable "Dry Winter" cover

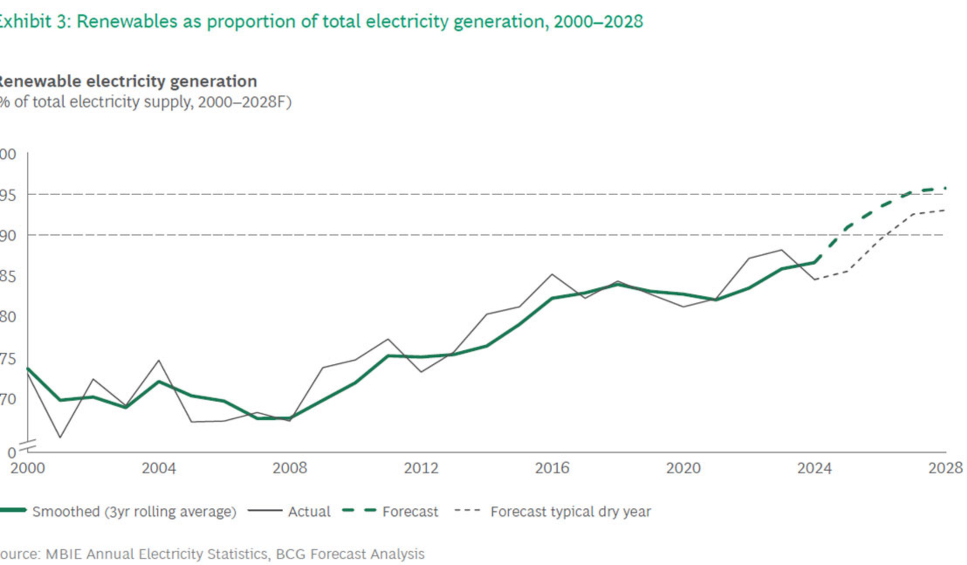
Mitigations

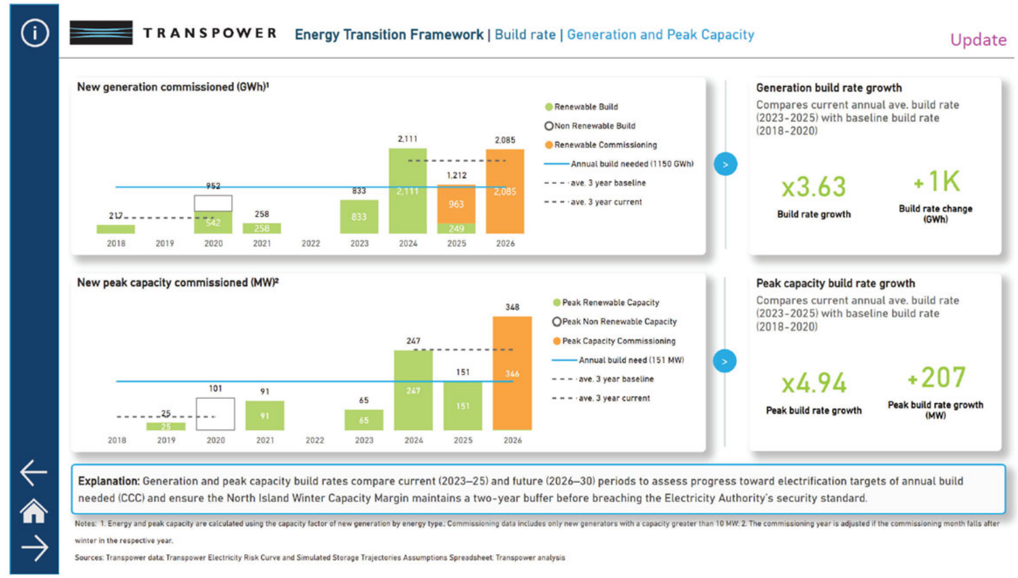
- He Tangata, he tangata, he tangata, involving the consumer, in real conversations
- Identify what consumer really wants or needs and how much can VRE provide for themselves
- Adjust regulation to identify and invest early in low regret high optionality solutions

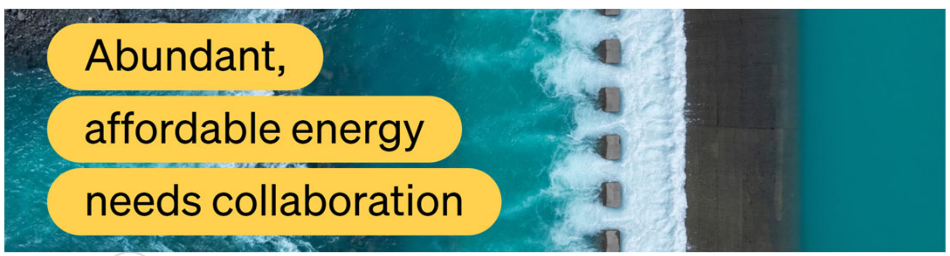
Dry Winter is the 10TWh challenge (2050 Supply mix)

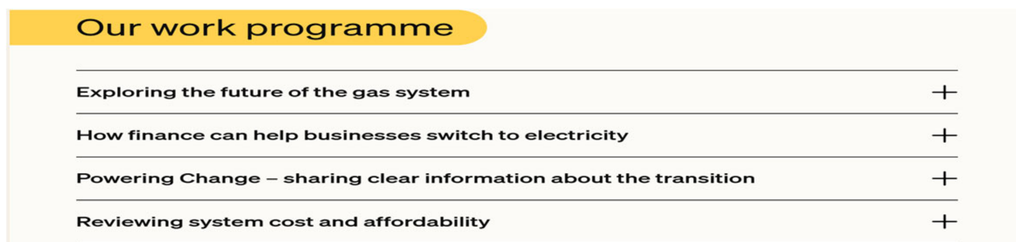


Industry Responding | 98% Renewable electricity by 2030 and pan system collaboration frame (Energy Transition Framework)





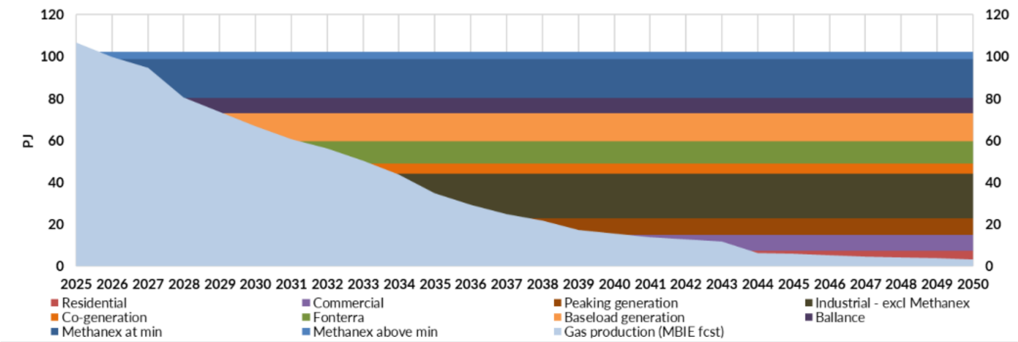




Government Responding | Government to establish a (LNG) import facility to strengthen energy security and support economic growth

- Government LNG infrastructure announcement in February.
- 15 year underwrite for LNG infra investor to firm rapidly declining local production.
- Commitment to be made this year (prior to election).
- Forsyth Barr analysis demonstrates both the need (the supply gap) and the immediate impact on forward electricity prices as the risk of shortage is traded out of the forward price. Forward prices for electricity traded down materially post the announcement.
- Government considering further measures to ensure security of supply is maintained.

Figure 13. Forecast gas supply vs estimated 2025 gas demand. The top of the demand stack is the demand most likely to exit first

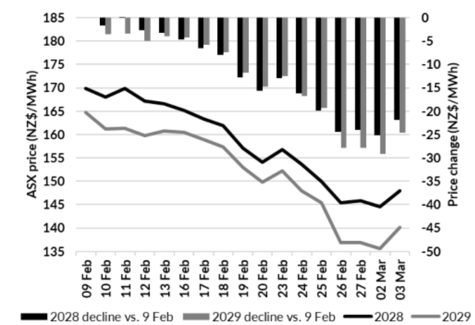


Source: MBIE, Forsyth Barr analysis

Figure 16. Rolling five-day average OTA prices have declined sharply since mid-February

Source: EMI, Forsyth Barr analysis

Figure 17. The reduction in ASX futures prices equates to~-NZ$25/MWh



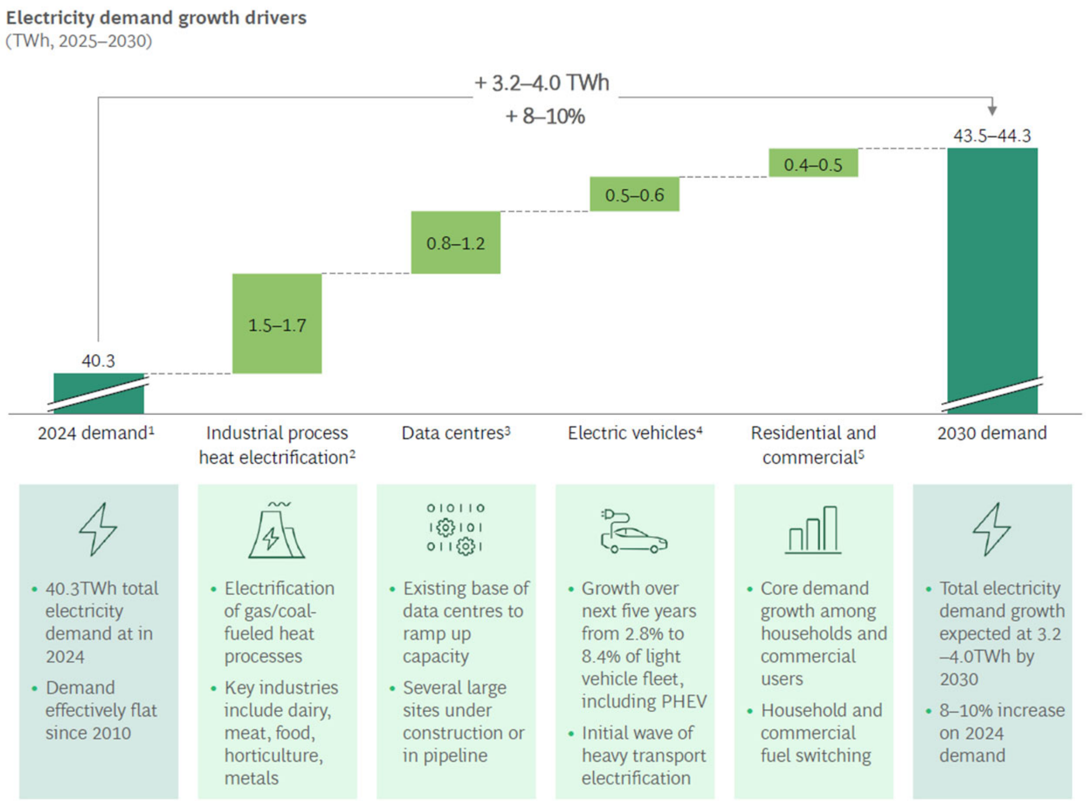
Source: EMI, Forsyth Barr analysis

Transition Underway | While all transitions are messy NZ has many advantages and the big rocks are clear

- NZ attractive investment destination:
  - Transition will be largely private capital funded
  - High degree of political alignment on the substance
  - Stable political environment and strong institutions
  - Abundance of renewable energy

- The transition big rocks are clear:
  - Build renewables
  - Develop flex
  - Batteries for daily firming
  - Coal and gas (LNG) for seasonal for a period
  - Some anticipatory infra build

- Industry focussed on getting on with it



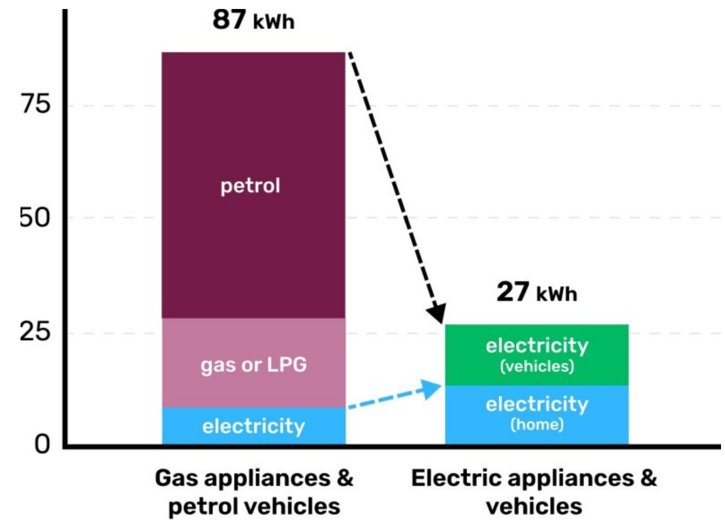
Effects of increased VRE on electricity affordability and grid stability

Consumer economic impacts

Consumer electricity spend may rise but total energy spend will fall

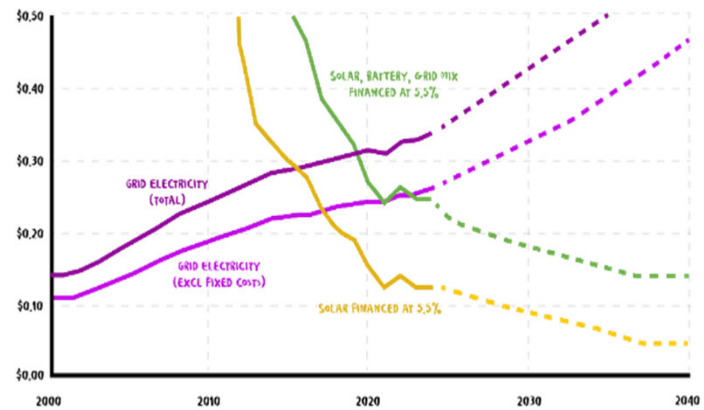
Electricity costs will rise until marginal generation displaced

Security of domestic supply will be more highly valued



Mitigations

- Greater deployment of distributed BESS to reduce generator –ve price periods/spilled energy also increases reserves and reduces need for Grid build



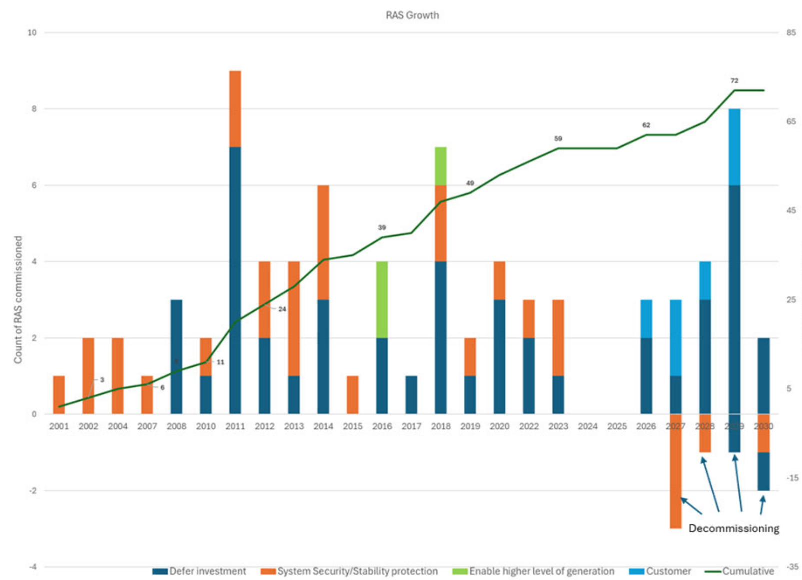
VRE System impacts

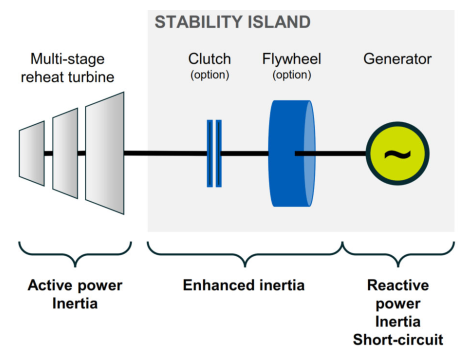
Its becoming more complicated and variable

Increasing asynchronous non-linear intermittent generation increases variability of power flows, peak constraints and harmonic production while reducing system strength

Mitigations

- Deployment of Remedial Action Schemes in both SCADA and Protection (SPS) systems
- Move from Fixed to Variable circuit ratings
- Increasing circuit ratings with HTLS conductors and reconductoring
- Harmonic monitoring and allocation process
- Change in hydro dispatch to greater flexing
- Creating value with integrated system solutions to solve more than one problem
- Improved and greater forecasting





Grid stability and system limits

Greater dynamic power flows and system movements

System Frequency

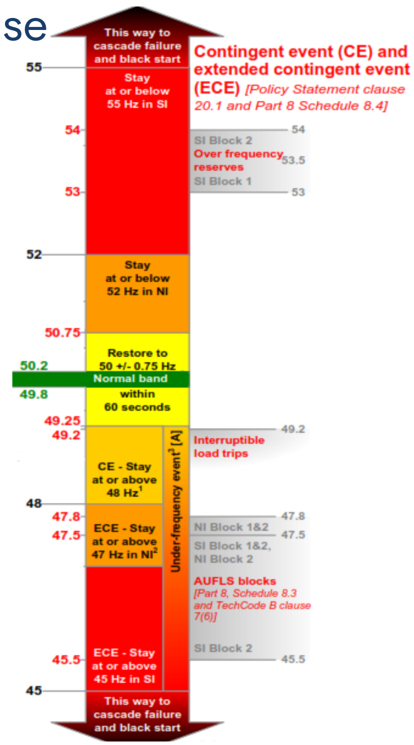
- Accepting wider more dynamic range
- Developing protection & control response

> 51.2 Hz over-frequency events managed by tripping certain generators

50.2 Hz to 49.8 Hz is the normal band

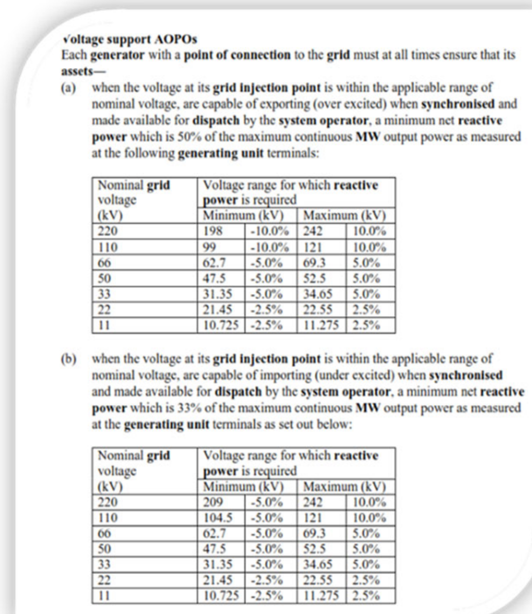
> 48 Hz CE under-frequency events managed by FIR and SIR

< 48 Hz ECE under-frequency events can trip AUFLS blocks



System Voltage Limits

- Increasing range +/- 5-6-10%



Voltage support AOPOs

Each **generator** with a **point of connection** to the **grid** must at all times ensure that its **assets**—

(a) when the voltage at its **grid injection point** is within the applicable range of nominal voltage, are capable of exporting (over excited) when **synchronised** and made available for **dispatch** by the **system operator**, a minimum net **reactive power** which is 50% of the maximum continuous **MW** output power as measured at the following **generating unit** terminals:

Nominal **grid** voltage (kV)	Voltage range for which **reactive power** is required			
	Minimum (kV)		Maximum (kV)	
220	198	-10.0%	242	10.0%
110	99	-10.0%	121	10.0%
66	62.7	-5.0%	69.3	5.0%
50	47.5	-5.0%	52.5	5.0%
33	31.35	-5.0%	34.65	5.0%
22	21.45	-2.5%	22.55	2.5%
11	10.725	-2.5%	11.275	2.5%

(b) when the voltage at its **grid injection point** is within the applicable range of nominal voltage, are capable of importing (under excited) when **synchronised** and made available for **dispatch** by the **system operator**, a minimum net **reactive power** which is 33% of the maximum continuous **MW** output power as measured at the **generating unit** terminals as set out below:

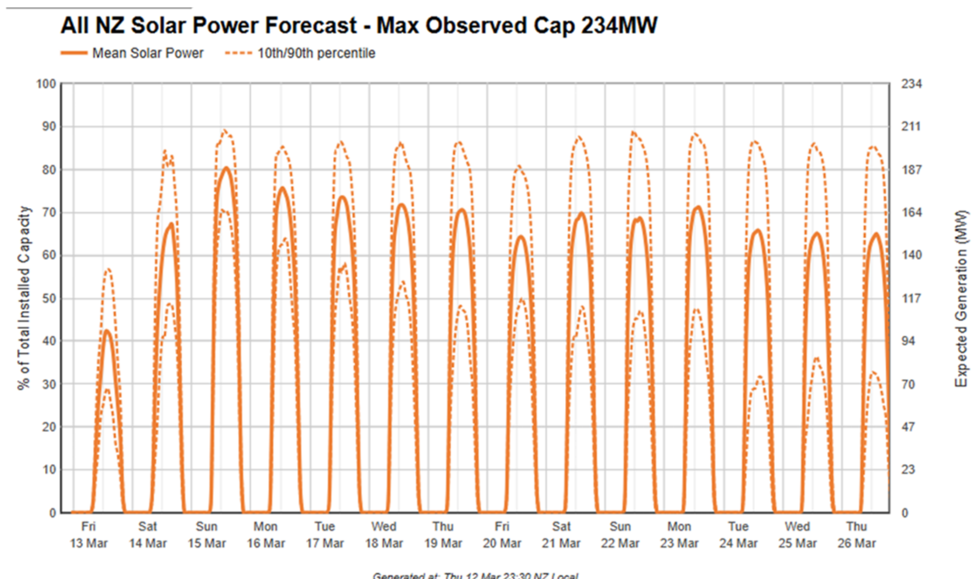
Nominal **grid** voltage (kV)	Voltage range for which **reactive power** is required			
	Minimum (kV)		Maximum (kV)	
220	209	-5.0%	242	10.0%
110	104.5	-5.0%	121	10.0%
66	62.7	-5.0%	69.3	5.0%
50	47.5	-5.0%	52.5	5.0%
33	31.35	-5.0%	34.65	5.0%
22	21.45	-2.5%	22.55	2.5%
11	10.725	-2.5%	11.275	2.5%

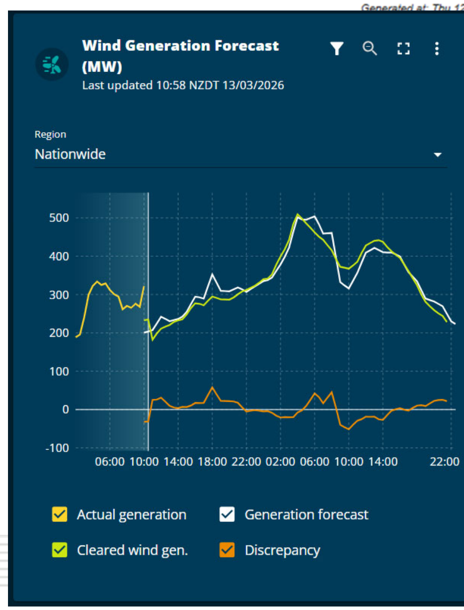
VRE System Impacts

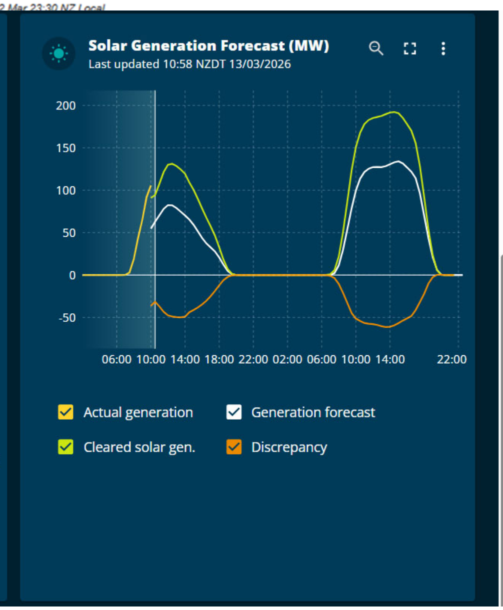
Greater dynamic power flows and system movements

Mitigations Continued

- Improving immediate and longer term forecasting capability
- Geographical distribution reduces variability exposure
- Increasing 2-4 day energy storage minimises "Dunkelflauter" effect







Potential of hydrogen and CCS and cost reduction

Hydrogen Applications & Challenges

Applications

New Zealand application will be niche

- Energy Carrier & Feedstock
- Long distance transport, road, marine & aviation
- Sustainable Aviation Fuel, Methanol, Ammonia

Challenges

- Requires renewable energy production to produce
- Round Trip Efficiency & resulting cost disadvantage compared to direct use of electricity
- Price/Performance cost reductions of competing technology solutions, eg heavy road transport BEV
- Much larger infrastructure deployment required than BEV

CCS Applications & Challenges

Applications

New Zealand application very limited

- New Zealand drivers different, most greenhouse gas (GHG) emissions from sectors where CCUS is not viable, such as agriculture (40 Mt CO2 a year) and transport (17 Mt CO2 a year)
- Potential deployment sectors include energy (22 Mt CO2 a year), industrial (5 Mt CO2 a year) and waste (3 Mt CO2 a year), approximately 36% of NZ gross emissions

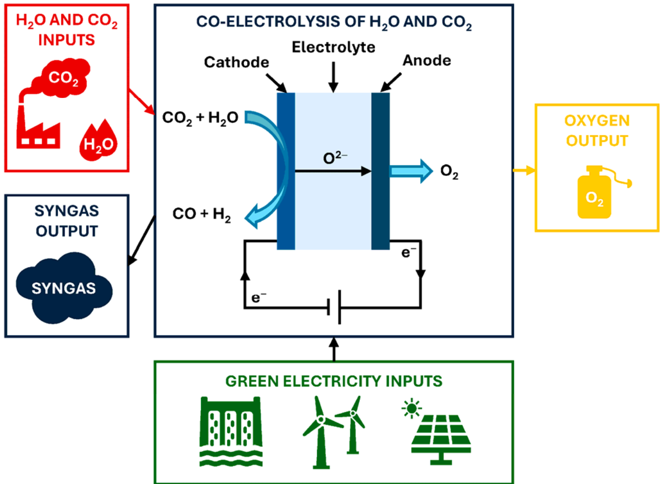
Challenges

- Cost compared to reducing primary emissions or biologic processes
- Energy required to process and compress is diverted renewable energy opportunity
- Suitable geologically stable structures limited in NZ
- Longterm fiscal liability

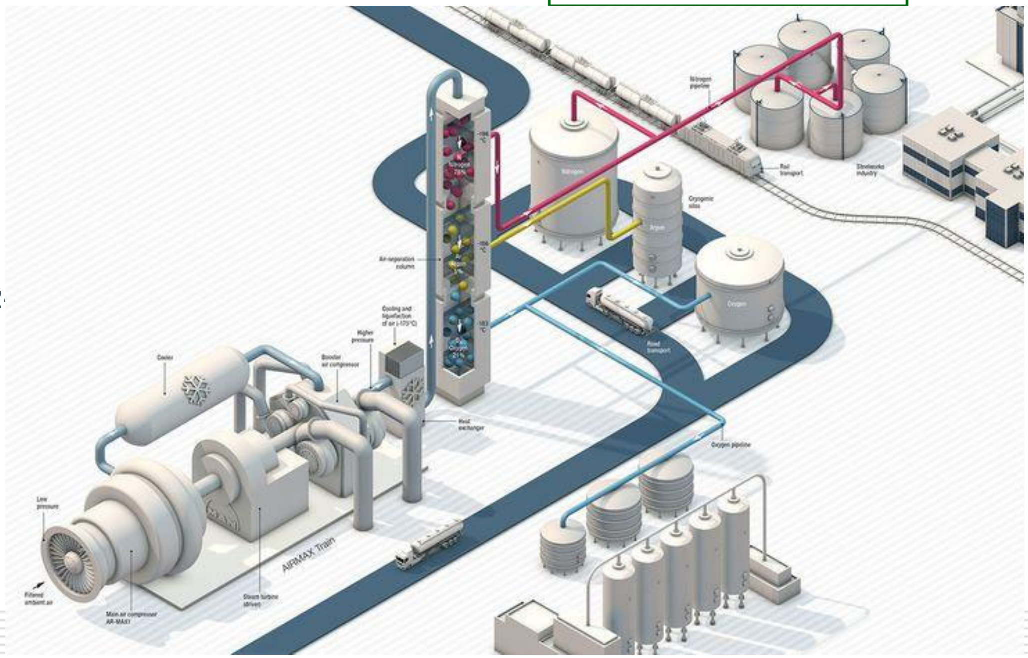
Potential for more integrated solutions to reduce costs

Stacking value streams of new plant, eg

- co-electrolyisis of seawater for desalination, O_2 production and syngas output



- Cryogenic Air Separation/LAES O_2, CO_2, N_2, production, inertia, and energy storage



Thank you

TRANSPOWER.CO.NZ

Reference

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- Government releases how it intends to regulate carbon storage | Ministry for the Environment
- Carbon Dioxide Removal and Usage
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