TRANSPOWER

Te Mauri Hiko Monitoring
FY2019 Q2 Review

December 2018

Introduction

- In 2018 Transpower launched Te Mauri Hiko to start a discussion on New Zealand's Energy Future. Taking a scenario-based approach we considered what the future may look like, in the year 2050, as a mechanism to understand the opportunities and discussions stakeholders need to focus on.

- Significant geo-political and technological change are likely to increase future uncertainty, so it is critical we monitor the signs and drivers that underpin our scenarios. This active intelligence gathering will provide insight to help us identify both likely to be realised future scenarios, as well as new and divergent alternative scenarios.

- This new quarterly report is designed to identify, within key drivers of Te Mauri Hiko, those factors that are consistent—or vary—from the expected course of our scenarios. We aim for this to be a discussion and an industry resource like Te Mauri Hiko, so we welcome feedback and suggestions on how to improve our monitoring.

- If you have comments please send them to: TeMauriHiko@transpower.co.nz

Te Mauri Hiko monitoring dashboard

View of our drivers and signs

Key: Consistent | Possible variation | Probable variation

Direction of variation

	Driver	Sign 1	Sign 2	Sign 3
Demand	• Climate Response	Climate change concern	Warming still likely	NZ committed to reduction
	• NZ economic performance	Economic growth ↑	Energy efficiency	Sectoral balance
	• Residential demand	Population growth ↑	Transport sharing	Residential demand
	• Electrification	Light EV adoption	Heavy EV adoption	Process Heat electrification
Supply	• Distributed solar & storage	Residential solar adoption ↓	Commercial solar adoption ↓	Economics of distributed energy
	• Utility generation	Economics favour solar and wind	Renewable generation consented	New generation is renewable ↓
	• Demand management	Battery capacity	Battery technology	Load control tools
	• Dry winter risk	Fossil fuel plant closure ↓	Inter-seasonal demand	Dry year coverage ↓
	• New technology	Unexpected new tech +/- 10%		

Emergent Scenarios

Demand Scenario


Vibrant Haven


NZ Inc


Mobilise

Struggling alone

Supply Scenario


Clean NZ


Peakers permitted


Mass Solar


Big South

Key areas to monitor

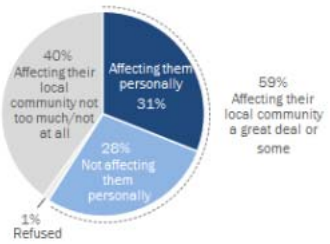
- New Zealand population growth and economic performance may be consistently higher leading to vibrant haven
- Distributed solar uptake may track lower than all supply scenarios
- NZ approach to fossil fuel plant closure could be sooner or permitted to support decarbonisation of other fuel sources

Demand Driver: Climate response driving emission reduction targets

Overall Status: Consistent

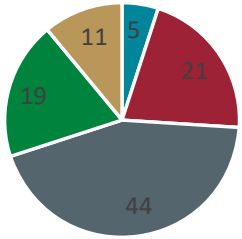
Global concern remains strong

US public concerned about climate change



Source: Survey conducted March 27-April 9, 2018.
"Majorities See Government Efforts to Protect the Environment as Insufficient"
PEW RESEARCH CENTER

EU public level of worry about climate change



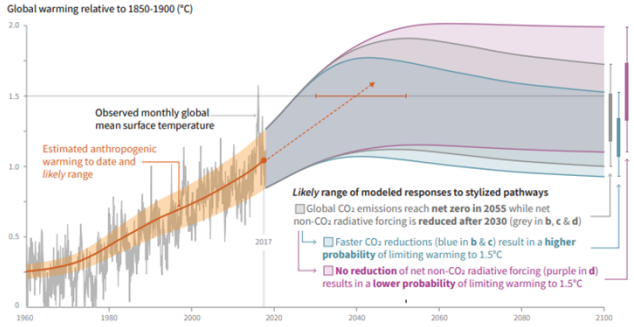
■ Extreme ■ Very ■ Somewhat ■ Not very ■ Not at all

Source: L. Barasi, R Harding and A. Dunatchik 2017.

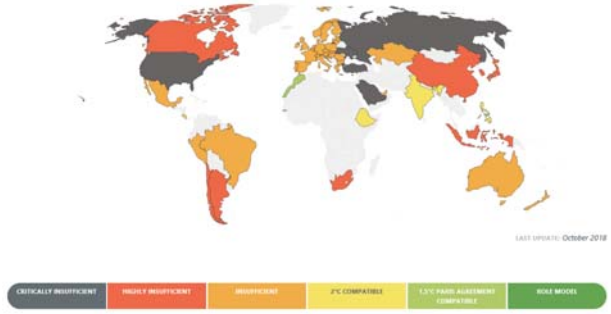
Updated: 2017, May 2018

Climate projections continue to show warming

Forecasts show global temperature increases



Countries not yet doing enough to avert climate change



Source: IPCC, CAT

Updated: October 2018

NZ committed to emissions reduction

New Zealand energy emission reduction targets: New Zealand is on track to meet the Paris Agreement. Reduction targets are strengthened

Current Targets:

- 30% reduction by 2030 (vs 2005)
- 50% reduction by 2050 (vs 1990)

Legal Status:

- Zero carbon bill consultation complete

Progress to target:

- Expecting CCC to produce 5 yearly budgets

Source: MfE
Will move to tracking carbon budgets when CCC starts

Updated: October 2018

Demand Driver: NZ economy continues to become more efficient but underpins sustained demand

Overall Status: Consistent

Continued long-term economic growth

Long-term NZ GDP forecast: GDP forecast will behave in line with what Treasury estimates (2.1% p.a) with no major structural obstacle observed

Table 1 - Summary of the Treasury's Budget Economic and Fiscal Forecasts

June years	2017 Actual	2018 Estimate	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast
Economic						
Real GDP (production basis, annual average % change)	3.3	2.8	3.3	3.4	2.7	2.5
Real GDP per capita (production basis, annual average % change)	1.2	0.7	1.3	1.7	1.3	1.3
Unemployment rate (annual average, %)	5.0	4.5	4.4	4.1	4.1	4.2
CPI inflation (annual average % change)	1.4	1.5	1.4	1.7	1.9	2.0
Current account balance (% of GDP)	-2.7	-2.6	-3.1	-3.0	-3.0	-3.1

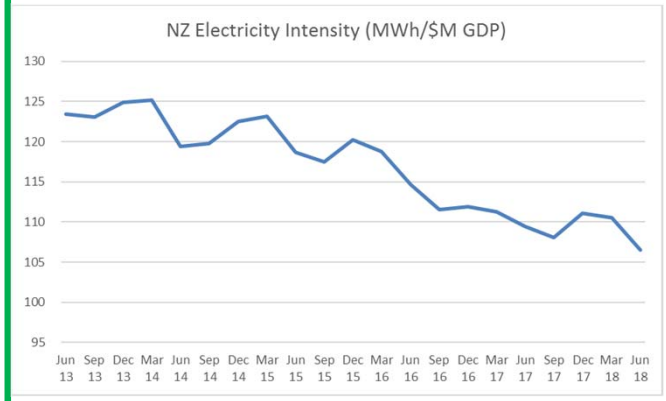
The NZ economy grew 1.0% in the June 2018 quarter, following a rise of 0.5% in the March quarter to bring growth to 2.7% for the year ended June 2018

Source: Treasury's Budget Economic and Fiscal Forecasts

Updated: July 2018

Continuing energy efficiency supports the economy's electricity intensity slowly reducing

Electricity intensity: Electricity intensity will decrease (-1.5% p.a.), driven by buildings and other efficiencies [excluding electrification]

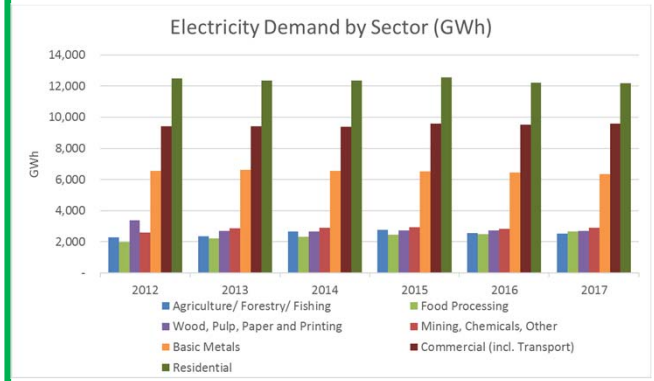


Source: Stats NZ, MBIE

Updated: July 2018

Sectoral outlook shows continuing electricity demand

Primary sector outlook: Primary mobile motive power electrifies strongly towards 2050, Increased robotics & work automation & crop farming increases



Source: MBIE

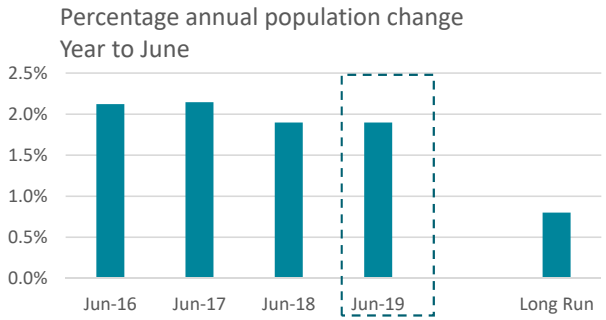
Updated: October 2018

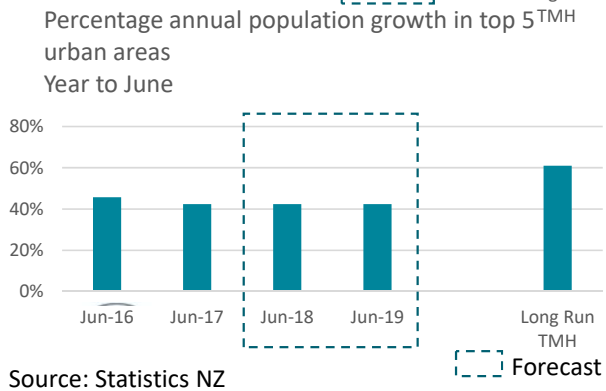
Demand Driver: Residential demand underpinned by population growth

Overall Status: Consistent

Continuing population growth

Population growth and location: Population growth rates will remain constant, focused on urban centres



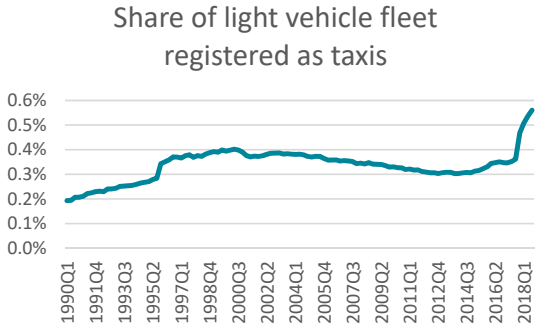


Source: Statistics NZ

Updated: July 2018

Shared versus private vehicle ownership

Shared versus private vehicle ownership: Increasing transport as a service to 50% by 2035 with increased vehicle occupancy

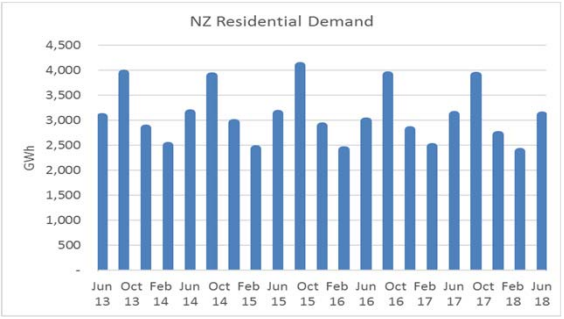


Source: StatsNZ Infoshare: Currently registered vehicles by type

Updated: August 2018

Overall residential demand

Homes become more energy efficient (incl. PV/EV)



Source: MBIE

Updated: October 2018

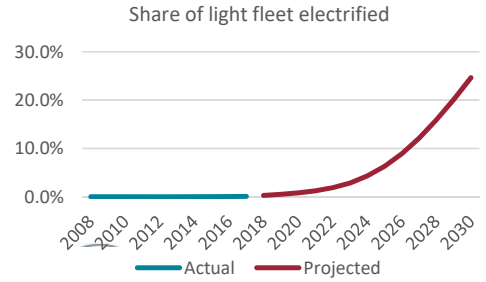
Demand Driver: Significant electrification, driven by transport and process heat

Overall Status: Consistent

Light vehicle fleet is electrified

Percent of light vehicle fleet electrified: EV fleet approaches 2 million cars by 2030
Cost parity of EVs vs ICE reached 2020-2025

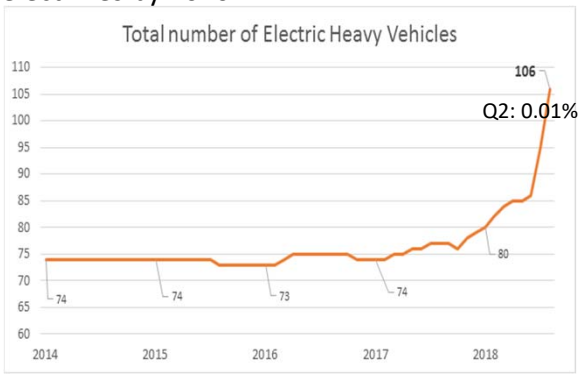
Source: transport.govt.nz



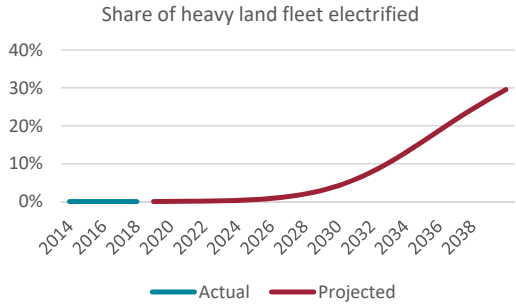
Updated: August 2018

Heavy vehicle fleet electrified more slowly

Percent of medium and heavy vehicle fleet electrified: 30% of heavy land transport electrifies by 2040



Source: transport.govt.nz

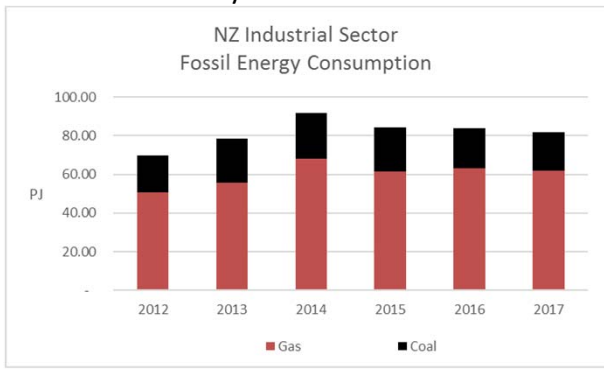


Updated: August 2018

Process heat electrification

Percent of major industrials with plans to electrify heat:

- 100% of coal used for process heat is electrified 2050
- 50% of oil used for process heat is electrified 2050
- 40% of gas used for process heat is electrified by 2050



Source: MBIE

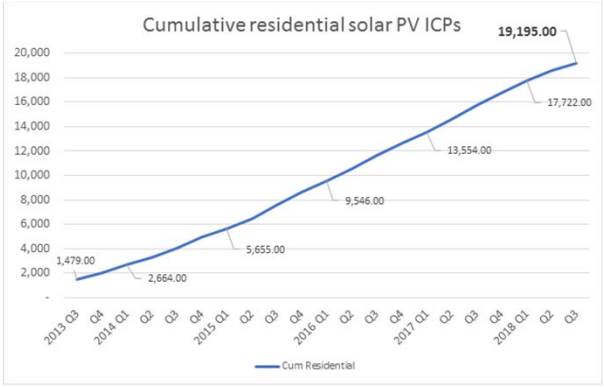
Updated: Dec 2017

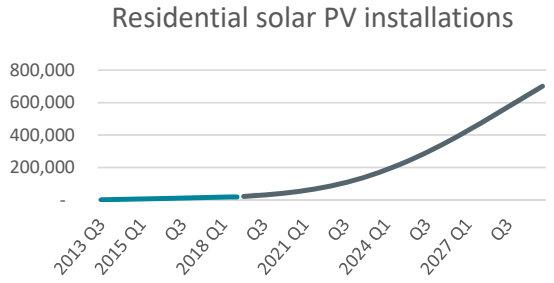
Supply Driver: Residential and commercial solar and storage grows substantially

Overall Status: Possible variation ↓

Amount of residential solar growth

Amount of residential solar: 650 thousand houses with solar PV by 2030





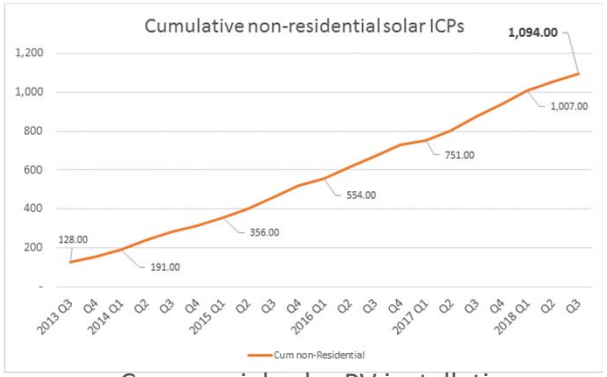
Source: emi.govt.nz

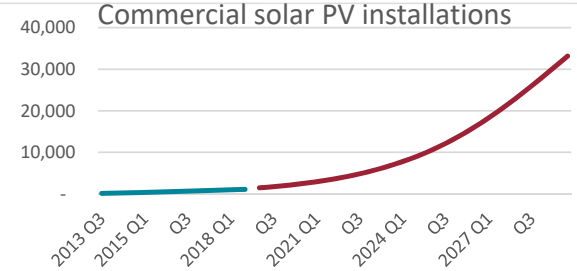
Updated: August 2018

Amount of commercial solar growth

Amount of commercial solar: 30 thousand businesses with solar PV by 2030

All NZ, solar>10kW : 307 ICPs



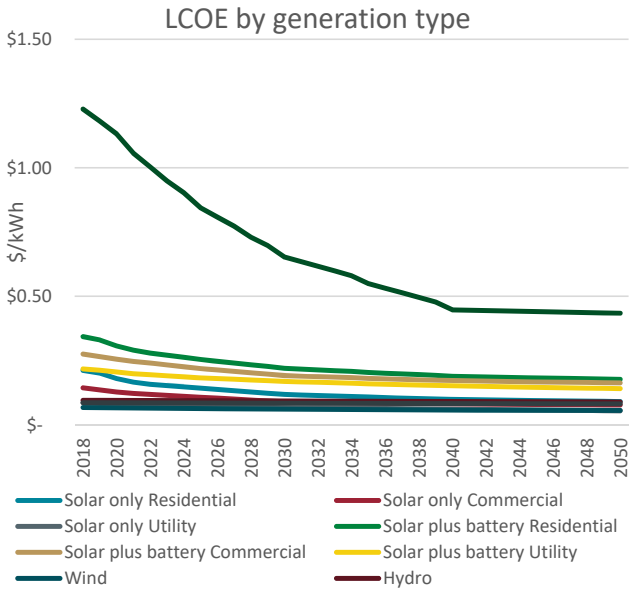


Source: emi.govt.nz

Updated: August 2018

Solar economics support uptake to complement grid

Long run price forecasts of solar/battery versus electricity price



Source: NREL

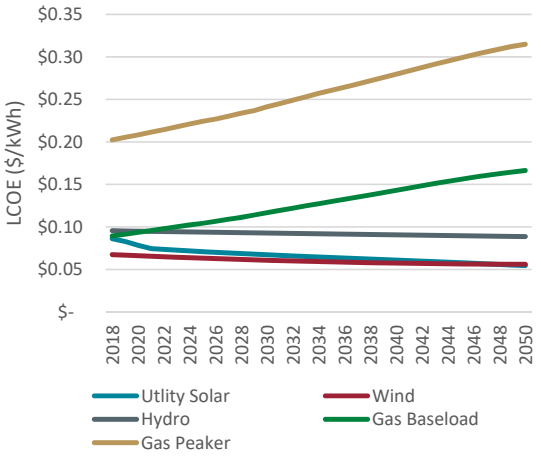
Updated: September

Supply Driver: Utility energy growth mostly through solar and wind

Overall Status: Consistent

Solar and Wind becoming lowest cost utility additions

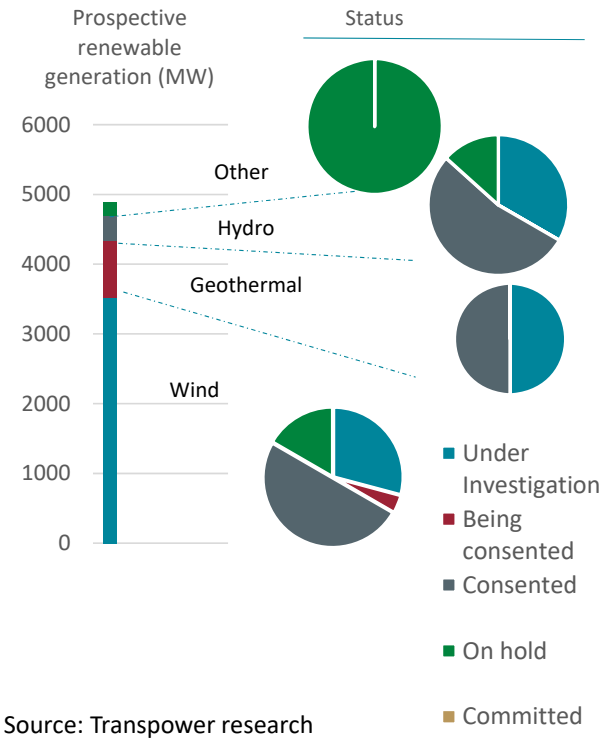
Long run LCOE forecasts by generation type: Solar and wind keep falling to become the preferred option



Source: NREL

Updated: October 2018

New renewable generation schemes can be progressed



Source: Transpower research

Updated: October 2018

New generation is renewable

New generation which are committed to are renewable (committed to means that full construction has commenced)

Project	Type	Status
Junction Rd	Gas (non-renewable)	Construction

* Ngawha not yet confirmed committed

Source: Transpower research

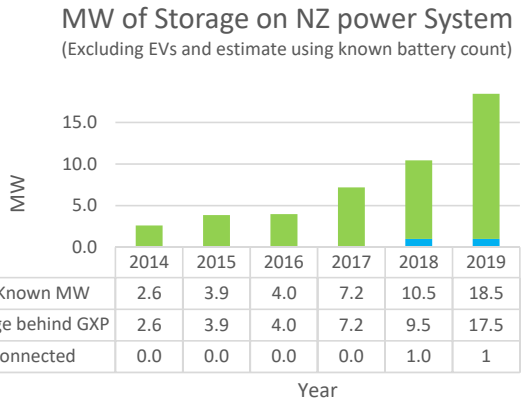
Updated: October 2018

Supply Driver: Batteries and DER will play a large role in meeting the daily winter peak

Overall Status: Consistent

Sufficient battery capacity is added

Combined residential/commercial/utility batteries



	2014	2015	2016	2017	2018	2019
Total Known MW	2.6	3.9	4.0	7.2	10.5	18.5
Storage behind GXP	2.6	3.9	4.0	7.2	9.5	17.5
Grid Connected	0.0	0.0	0.0	0.0	1.0	1

- Vector committed to install further 8 MW post 2018
- Te Mauri Hiko base case – 700MW in 2030

Source: Commerce Commission

Updated: October 2018

Known storage technologies continue to be preferred

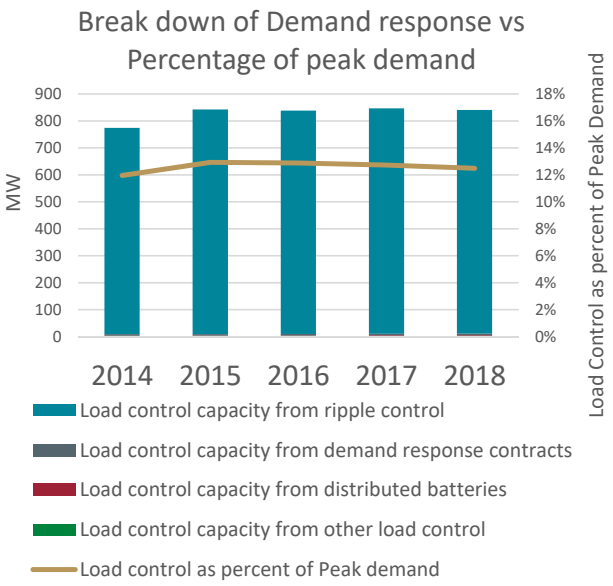
Adoption of storage technologies: Li-ion remains the preferred choice

Storage tech options	Current status	Estimated cost (US$/kWh)
Lithium ion batteries	In use	<100
Redox flow batteries	In use	<100
Zinc-hybrid batteries	Field studies	
Glass batteries	Prototype	
Lithium air batteries	Research	
Potassium ion batteries	Research	
Sodium ion batteries	Research	
Super iron battery	Research	
Ice storage air conditioning	In use	
Molten salt thermal storage	In use	
Molten silicon storage	Research	
Compressed air	In use	
Hot rocks	Pilot	
Pumped hydro	In use	
Cryogenic energy storage	Pilot	
Flywheel energy storage	In use	
District heating	In use	

Updated: October 2018

Load control / response grows to play a bigger role

Demand response as a percentage of peak:



Source: Commerce Commission

Updated: October 2018

Supply Driver: Winter and peak supply needs are met, even in a dry year

Overall Status: Possible variation ↓

Closure of fossil fuel plants as modelled

NZ strategy / policy for dry winter risk: Closure of all fossil fuel peakers between now and 2040

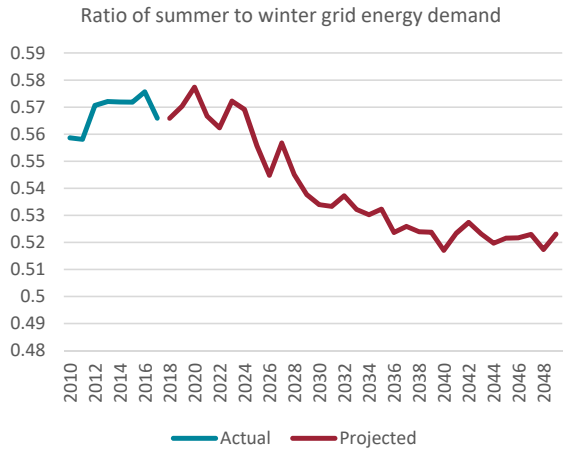
Plant	Commission	Capacity (MW)	Time horizon
Huntly Rankines	1982	750* Coal/ Gas	Commitment to no coal after 2025 in normal year or at all from 2030
Huntly U5	2007	400 Gas	Major upgrade to continue beyond ~2022
Huntly U6	2004	48 Gas	No announced plans
Stratford CC	1998	385 Gas	New blades needed in 2022
Stratford Peaker	2011	200 Gas	No announced plans
Whirinaki	2004	155 Diesel	No announced plans
McKee Peaker	2013	100 Gas	No announced plans

* One 250MW unit already permanently closed
NB: Also gas co-gen at Glenbrook, Hawera, Te Rapa, Kawerau, Kinleith, Kapuni
Source: Press, Annual report

Updated: October 2018

Inter-seasonal demand gap is manageable

Supply and demand changes don't unduly accentuate inter-seasonal gap and can be managed



Source: Transpower demand data

Updated: August 2018

Dry year coverage is available

Security of supply even in a 1 in 10 dry year

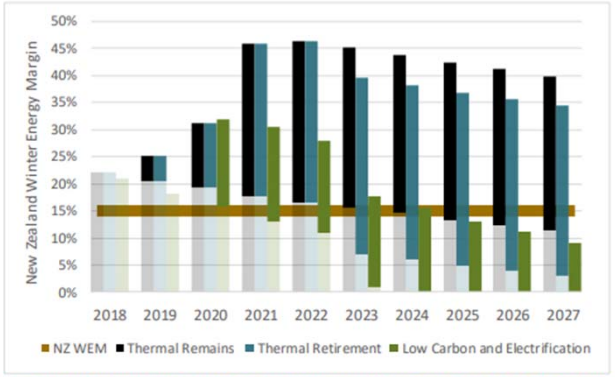


Figure 1: NZ-WEM with existing (including committed) generation and consented but on hold generation

Source: Transpower Security of Supply Assessment 2018

Updated: February 2018

Driver: Other technology significantly different from Te Mauri Hiko

Overall Status: Consistent

New Technology	Description of change	Potential impact	Likelihood
Low cost long storage batteries	• New battery technology could enable super-low cost, long term storage that is very reliable	• Potential to provide security of supply so less need for overbuild for domestic consumption • Ability to shift energy between seasons flattening demand	• Possible
Widespread use of hydrogen for energy storage	• Hydrogen energy storage could enable heavy transport and create new export market	• Export of hydrogen increases demand • Heavy transport based on hydrogen moves or increases demand	• Possible

* Also monitoring Blockchain, international grid and carbon sequestration but seen as low likelihood of unexpected disruption at this time