



Te Mauri Hiko Monitoring FY2019 Q3 Review



March 2019

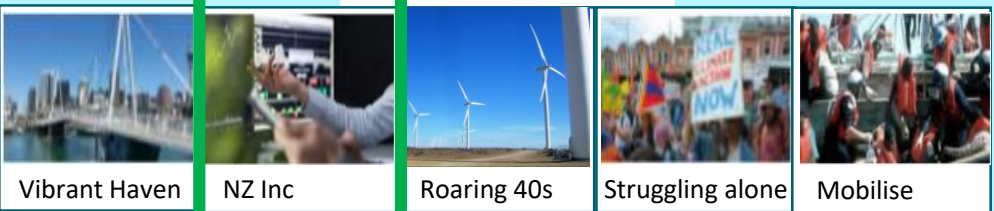
Te Mauri Hiko monitoring dashboard

View of our drivers and signs

Key: Consistent Possible variation Probable variation				
↑ Direction of variation (up indicates more demand or more supply)				
	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



Supply Scenario

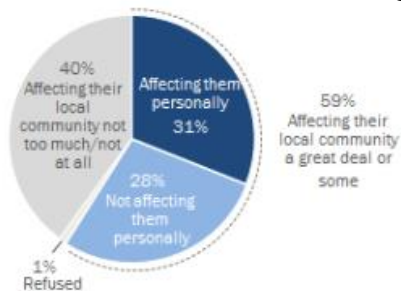


Key areas to monitor

- New Zealand population growth and economic performance still may be consistently higher leading to vibrant haven
- Distributed solar uptake continues to track lower suggesting Roaring 40s
- Energy efficiency effects continuing to be significant
- NZ approach to fossil fuel plant closure could be relaxed to focus on broader decarbonisation goals

Global concern remains strong

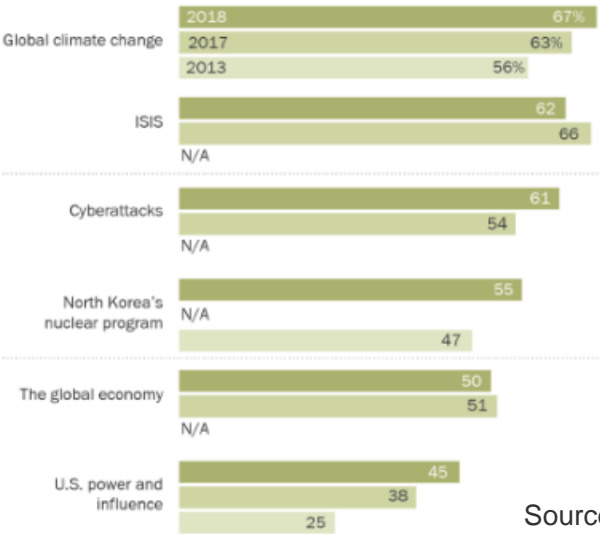
US public concerned about climate change



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

PEW RESEARCH CENTER

Global Climate Change now leading threat

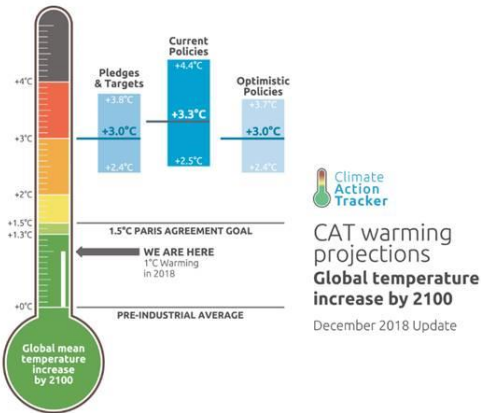


Source: Pew

Updated: May 2018, February 2019

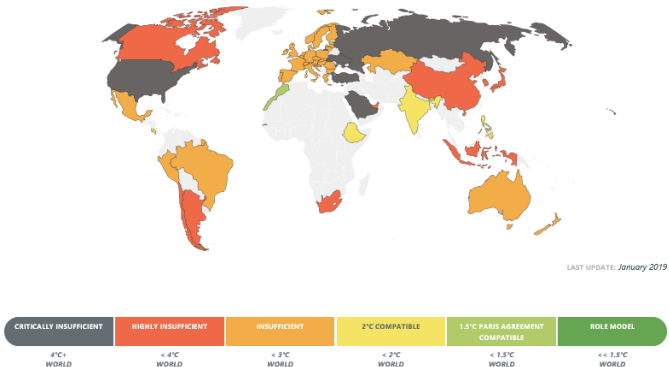
Climate projections continue to show warming

Forecasts show global temperature increases



CAT warming projections
Global temperature increase by 2100
December 2018 Update

Countries not yet doing enough to avert climate



Source: CAT

Updated: January 2019

NZ committed to emissions reduction

Current Targets:

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

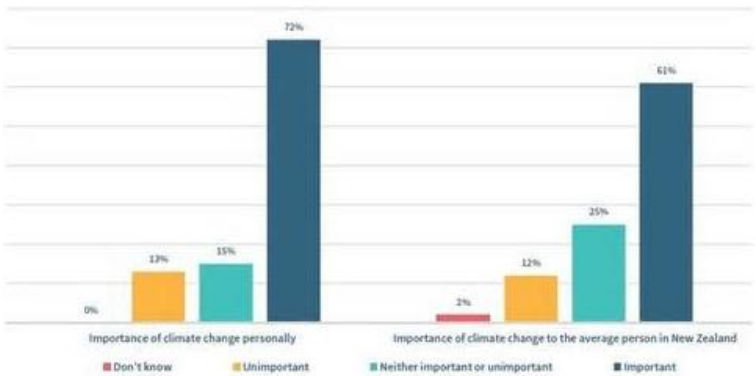
Legal Status:

- Zero carbon bill going to select committee

Progress to target:

- Expecting CCC to produce 5 yearly budgets

NZ public view on importance of climate change



Source: MfE, IAG/Ipsos poll
Will move to tracking carbon budgets when CCC starts

Updated: February 2019

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

Overall Status: Consistent

Continued long-term economic growth

Long-term NZ GDP forecast: GDP forecast will behave in line with Treasury estimates (2.3% p.a. by 2023) with no major structural obstacle observed

June years	2018 Actual	2019 Estimate	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast
Economic						
Real production GDP (annual average % change)	2.7	2.9	3.1	2.7	2.5	2.3
Real GDP per capita (annual average % change)	0.7	1.1	1.5	1.4	1.2	1.2
Unemployment rate (June quarter)	4.4	4.1	3.9	4.0	4.1	4.1
CPI inflation (annual % change, June quarter)	1.5	2.0	2.0	2.0	2.0	2.0
Current account balance (% of GDP)	(3.4)	(3.5)	(3.6)	(3.6)	(3.6)	(3.7)
Fiscal (% of GDP)						
Core Crown tax revenue	27.9	28.1	28.2	28.5	28.8	28.9
Core Crown expenses	28.0	29.5	28.7	28.8	28.4	28.3
Total Crown operating balance before gains and losses	1.9	0.6	1.3	1.5	2.2	2.3
Core Crown residual cash	0.5	(1.7)	(0.8)	(0.3)	0.3	0.8
Net core Crown debt	20.0	20.9	20.7	20.1	19.0	17.4
Net worth attributable to the Crown	45.1	44.5	44.5	45.0	46.3	48.0

Sources: Stats NZ, the Treasury

Economic activity, as measured by gross domestic product (GDP), was up 0.3 percent in the September 2018 quarter. Growth eased after a 1.0 percent increase in the June 2018 quarter. GDP grew 3.0 percent over the year ended September 2018.

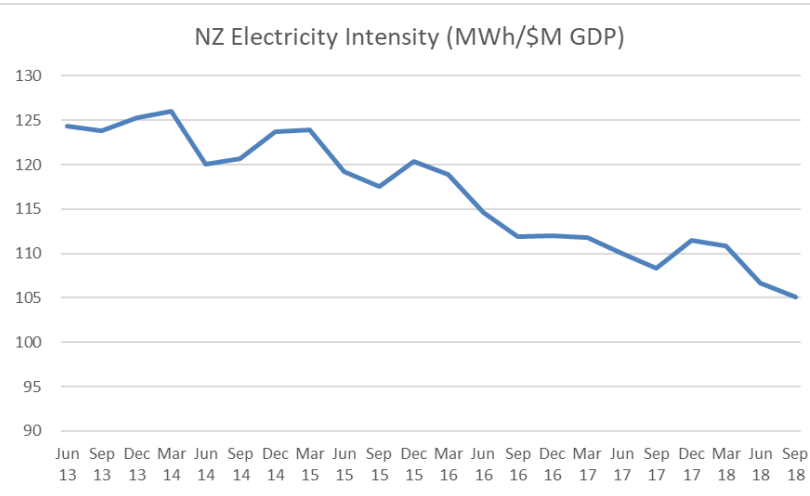
Source: Treasury’s Half Year Economic and Fiscal Update 2018 released 13 Dec 2018

Updated: December 2018

Energy efficiency supports the economy’s electricity intensity slowly reducing

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

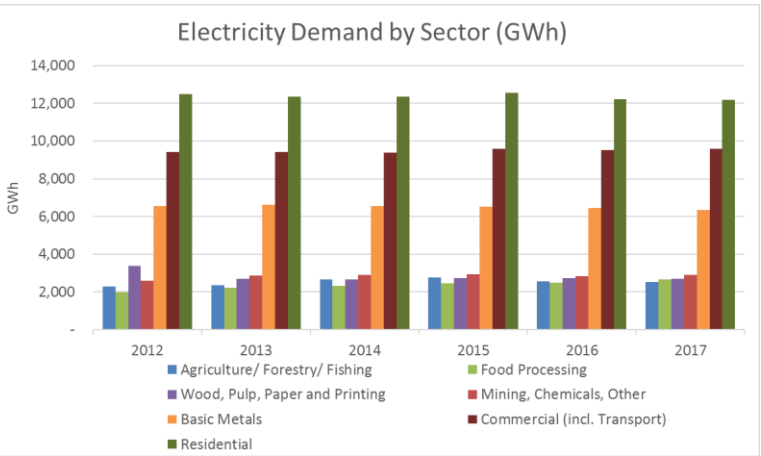
Monitoring to date: September 2018 quarter sees a 3.0% improvement from a year ago.



Updated: December 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

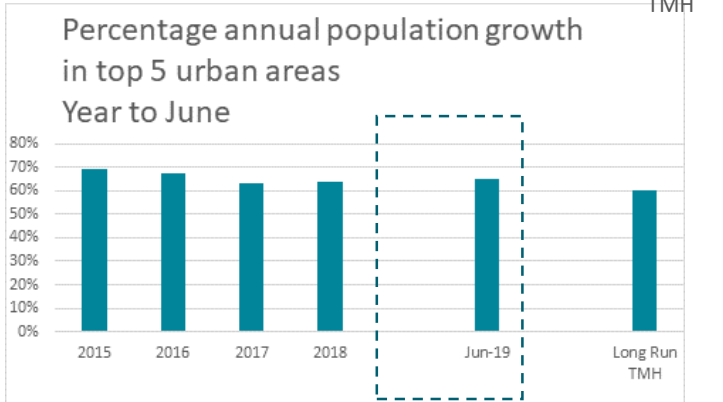
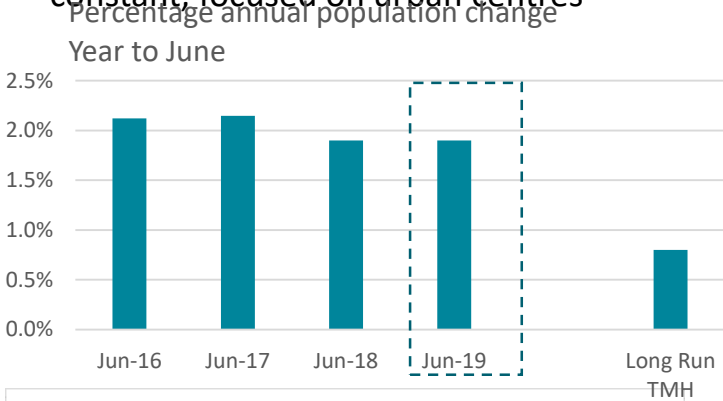
Updated: October 2018

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

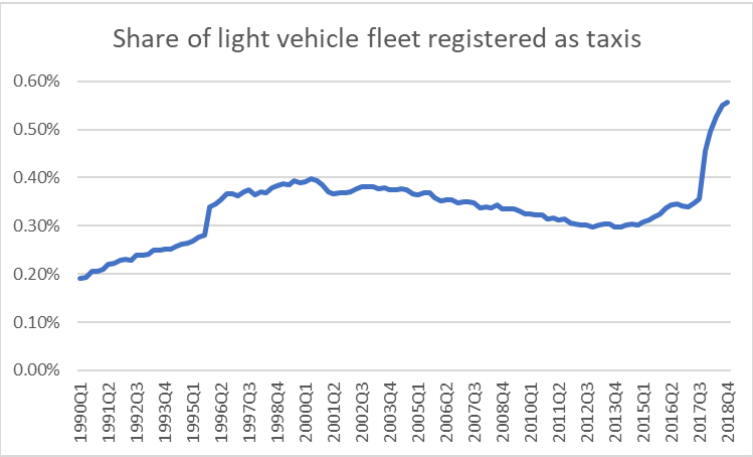


Top 5 areas: Auckland, Hamilton, Tauranga, Wellington, Christchurch
Source: Statistics NZ

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

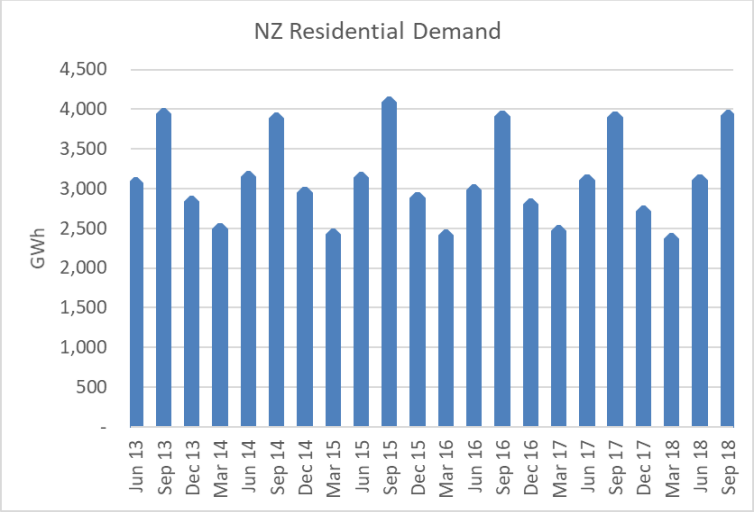
Updated: February 2019

Overall residential demand

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

In the year ended December 2018, the actual number of new dwellings consented was 32,996, up 6.1 percent from the December 2017 year.

No observed definitive growth trend in residential electricity demand as yet.



Source: MBIE, Stats NZ

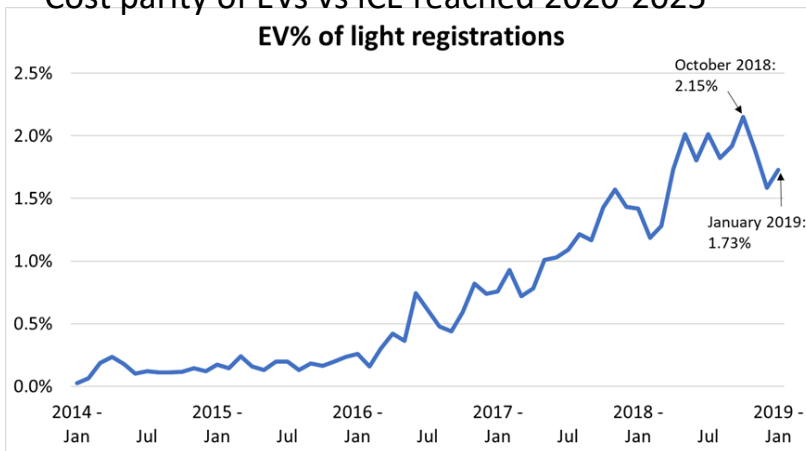
Updated: February 2019

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

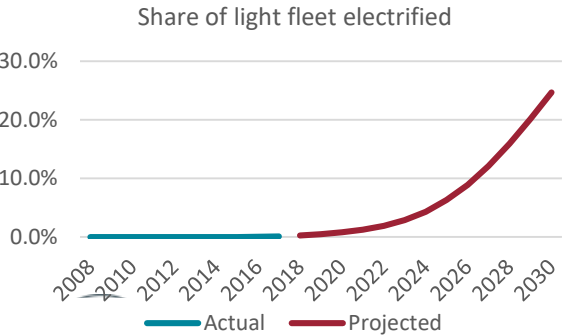
Overall Status: Consistent

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



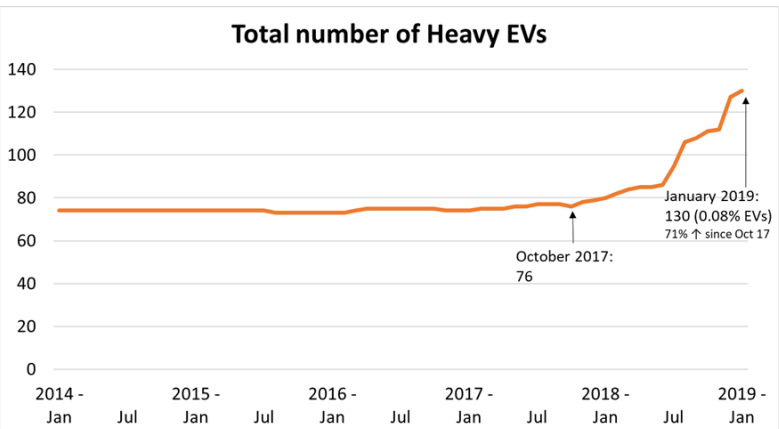
Source: transport.govt.nz



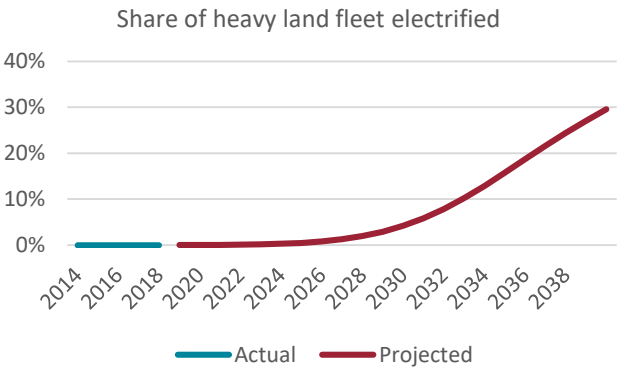
Updated: January 2019

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

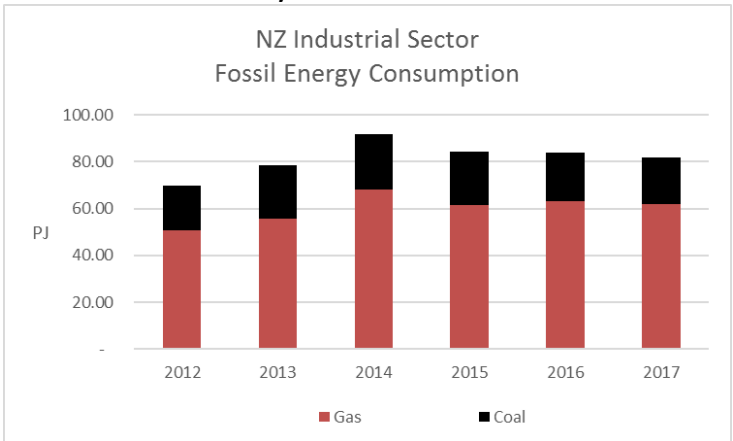


Updated: January 2019

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

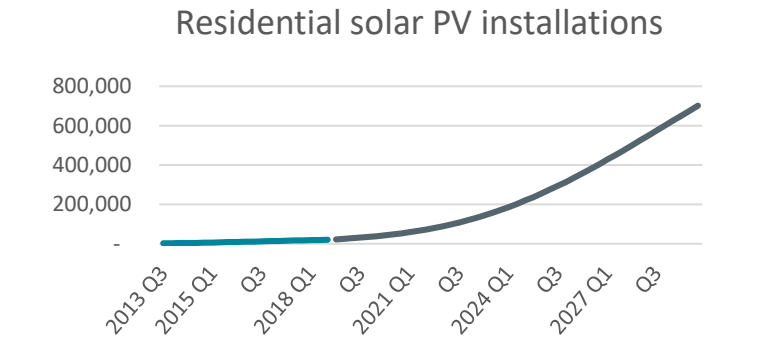
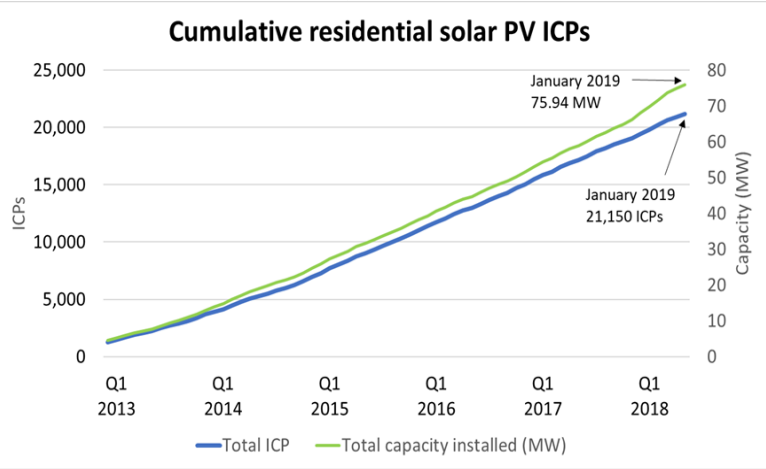
Updated: Dec 2017

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

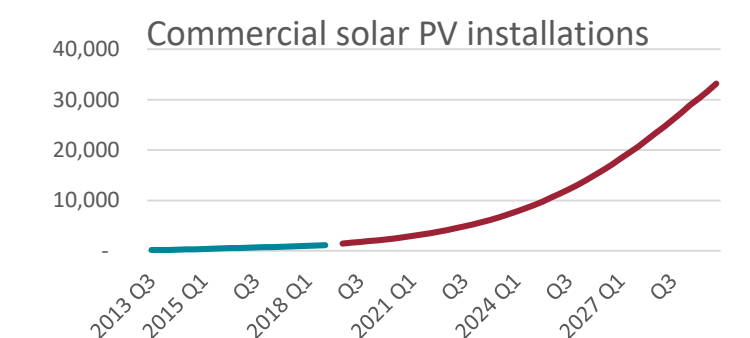
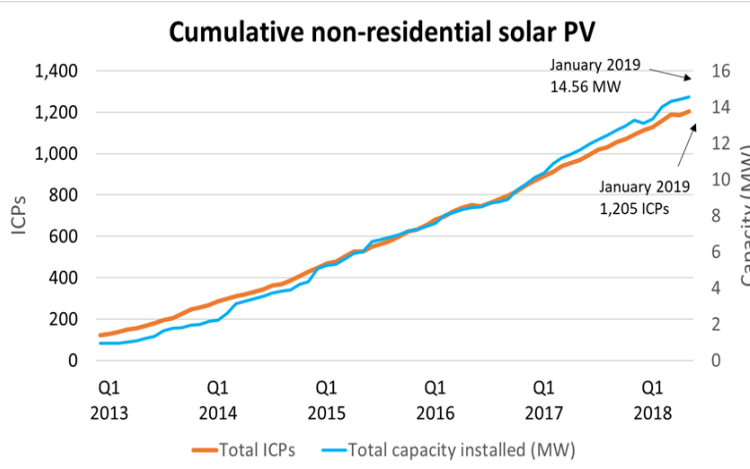


Source: emi.ea.govt.nz

Updated: February 2019

Amount of commercial solar growth

Amount of commercial solar: 30,000 businesses with solar PV by 2030 All NZ, solar>10kW : 307 ICPs



Source: emi.ea.govt.nz

Updated: February 2019

Solar economics support uptake to complement grid

Long run price forecasts of solar/battery versus electricity price

LCOE by generation type

Year	Solar only Residential	Solar only Commercial	Solar only Utility	Solar plus battery Residential	Solar plus battery Commercial	Solar plus battery Utility	Wind	Hydro
2018	~0.35	~0.30	~0.25	~0.40	~0.35	~0.30	~0.15	~0.10
2020	~0.30	~0.25	~0.20	~0.35	~0.30	~0.25	~0.15	~0.10
2022	~0.25	~0.20	~0.15	~0.30	~0.25	~0.20	~0.15	~0.10
2024	~0.20	~0.15	~0.10	~0.25	~0.20	~0.15	~0.15	~0.10
2026	~0.15	~0.10	~0.05	~0.20	~0.15	~0.10	~0.15	~0.10
2028	~0.10	~0.05	~0.05	~0.15	~0.10	~0.05	~0.15	~0.10
2030	~0.05	~0.05	~0.05	~0.10	~0.05	~0.05	~0.15	~0.10
2032	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2034	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2036	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2038	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2040	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2042	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2044	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2046	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2048	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10
2050	~0.05	~0.05	~0.05	~0.05	~0.05	~0.05	~0.15	~0.10

Source: NREL

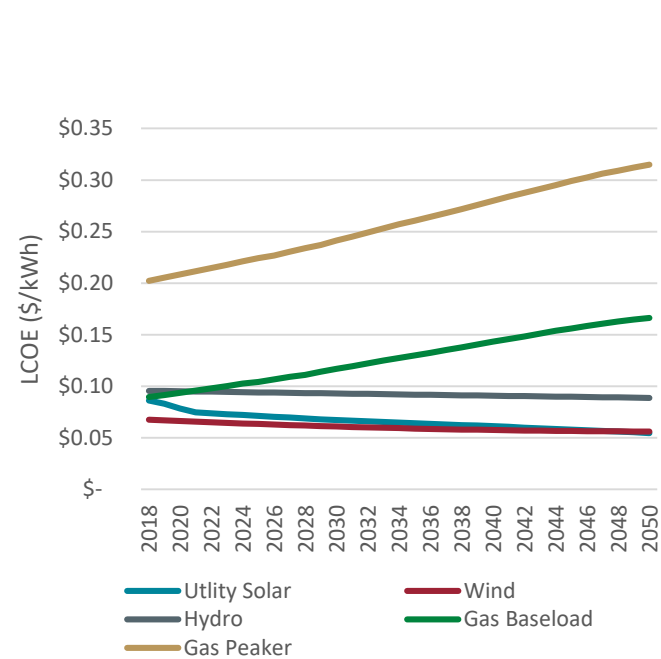
Updated: September 2018

Supply Driver: Utility energy growth mostly through solar and wind

Overall Status: Consistent

Solar and Wind becoming lowest cost utility additions

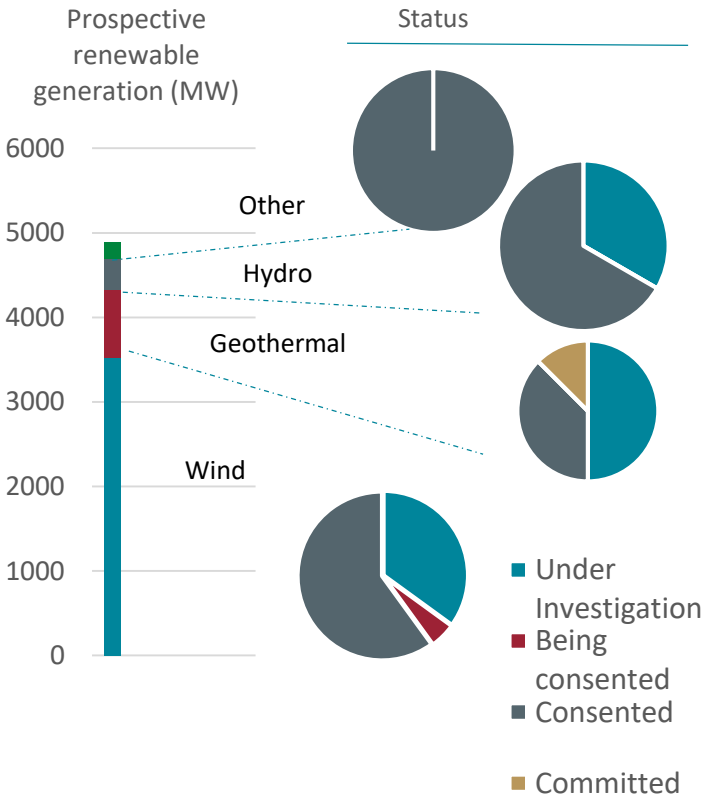
Long run LCOE forecasts by generation type: Solar and wind keep falling to become the preferred option



Source: NREL

Updated: October 2018

New renewable generation schemes can be progressed



Source: Transpower research

Updated: January 2019

New generation is renewable

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

Project	Type	Capacity	Status
Junction Rd	Gas (non-renewable)	100MW	Construction
Ngawha 3	Geothermal	28MW	Construction
Turitea	Wind	119MW	Committed

* Ngawha not yet confirmed committed
Source: Transpower research

Updated: March 2019

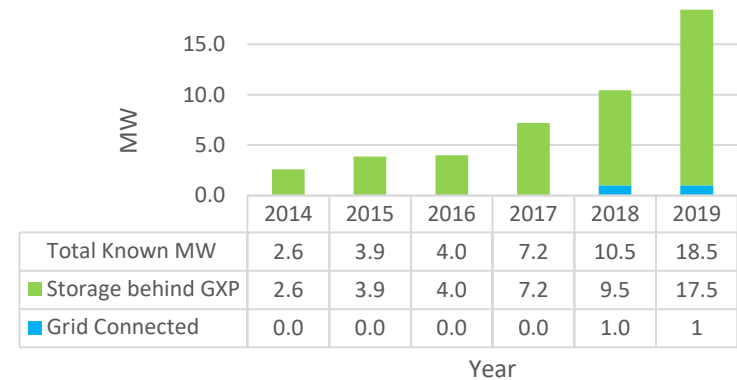
Supply Driver: Batteries and DER will play a large role in meeting the daily winter peak

Overall Status: **Consistent**

Sufficient battery capacity is added

Combined residential/commercial/utility batteries

MW of Storage on NZ power System
(Excluding EVs and estimate using known battery count)



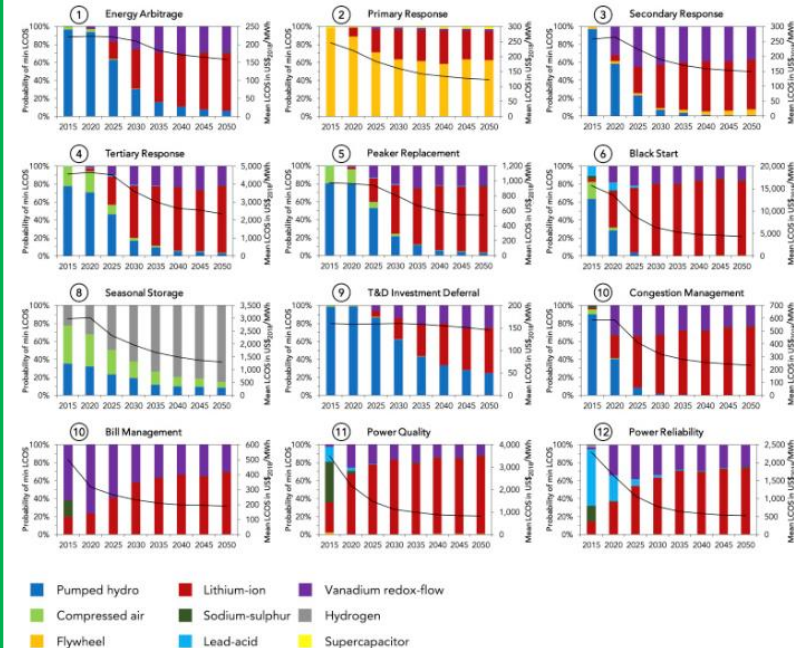
- Vector committed to install further 8 MW post 2018
- Te Mauri Hiko base case – 700MW in 2030

Source: Commerce Commission

Updated: October 2018

Known storage technologies continue to be preferred

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

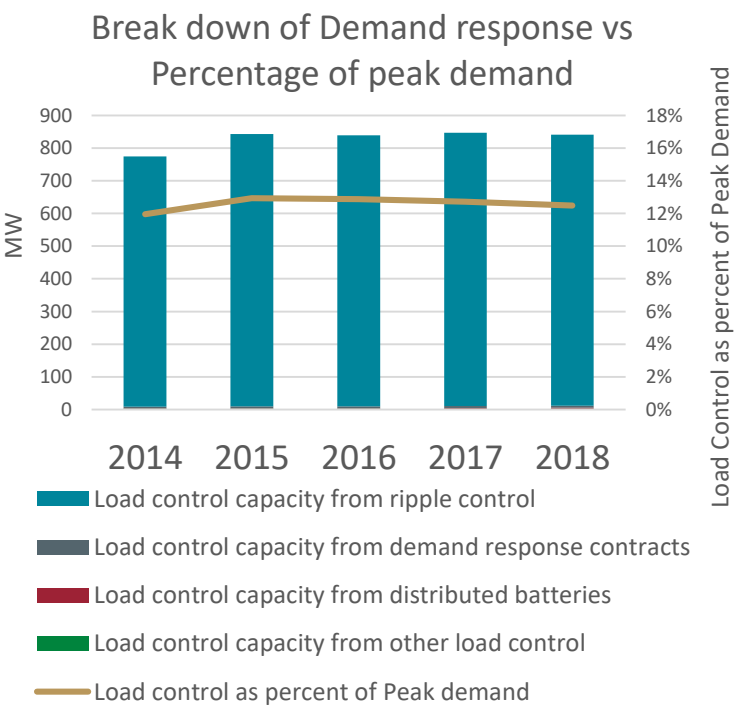


<https://www.sciencedirect.com/science/article/pii/S254243511830583X?via%3Dihub>

Updated: January 2019

Load control / response grows to play a bigger role

Demand response as a percentage of peak:



Source: Commerce Commission

Updated: October 2018

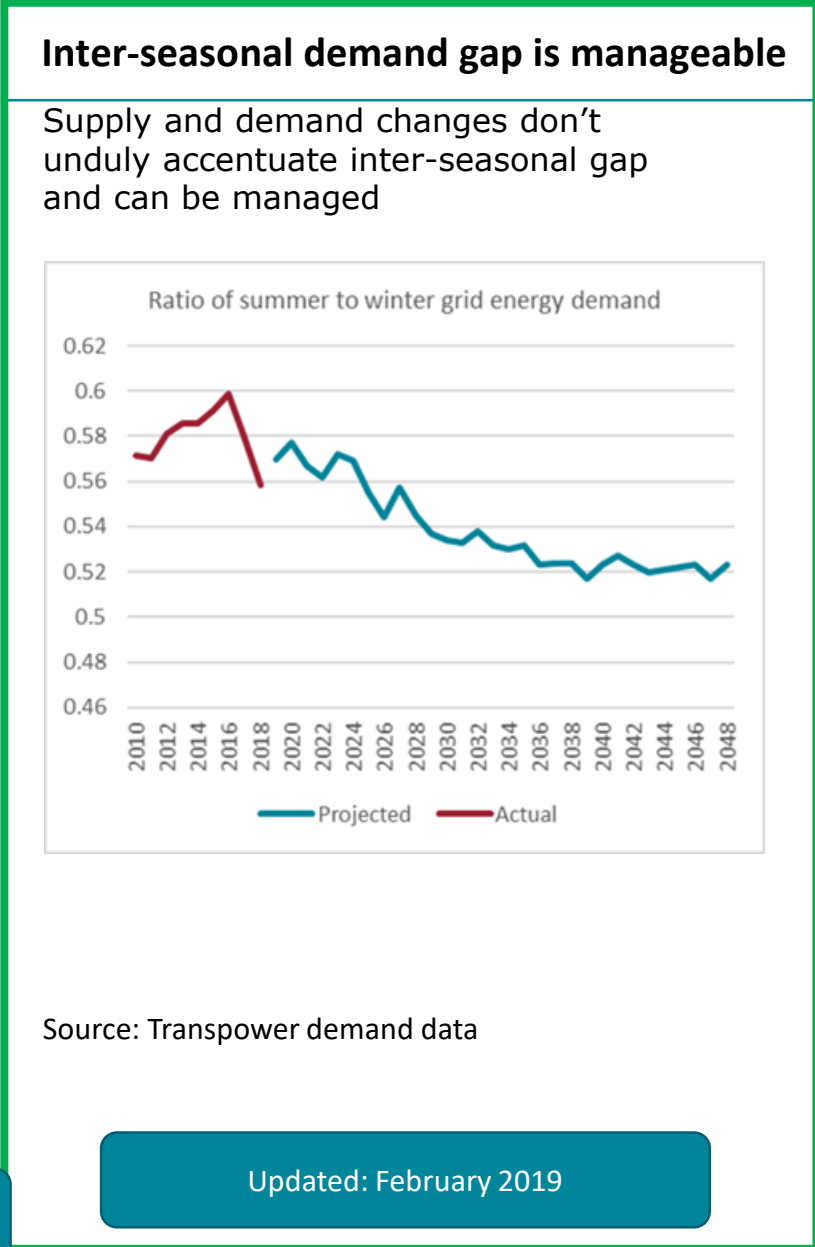
↓ Closure of fossil fuel plants as modelled

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 Discussion of shift in use
Huntly U6	2004	48 Gas	No announced plans
Stratford CC	1998	385 Gas	...it's very unclear as to whether a further extension of its life will be viable.... we have to make the decision is probably ... late 2020.
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 permitted at Huntly
NB: Also gas co-gen at Glenbrook, Hawera, Te Kapa, Kawerau, Kiriitihi, Kapuni

Updated: February 2019



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	<ul style="list-style-type: none">New battery technology could enable super-low cost, long term storage that is very reliable	<ul style="list-style-type: none">Potential to provide security of supply so less need for overbuild for domestic consumptionAbility to shift energy between seasons flattening demand	<ul style="list-style-type: none">Possible
Widespread use of hydrogen for energy storage	<ul style="list-style-type: none">Hydrogen energy storage could enable heavy transport and create new export marketEconomics appear to be challenging	<ul style="list-style-type: none">Export of hydrogen increases demandHeavy transport based on hydrogen moves or increases demand	<ul style="list-style-type: none">Possible
Acceleration of energy efficiency	<ul style="list-style-type: none">Step change in energy efficiency improvements from big changes in homes, heating and lighting	<ul style="list-style-type: none">Existing demand reduces as energy efficiency more than offsets population and economic growth.EV and process heat still to be layered in	<ul style="list-style-type: none">Possible

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