ELECTRICITY AUTHORITY
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Market Development Advisory Group

Wholesale market design with 100% renewable electricity supply

Presentation for NZWEA Conference

24 August 2022

MDAG's task & approach

Task

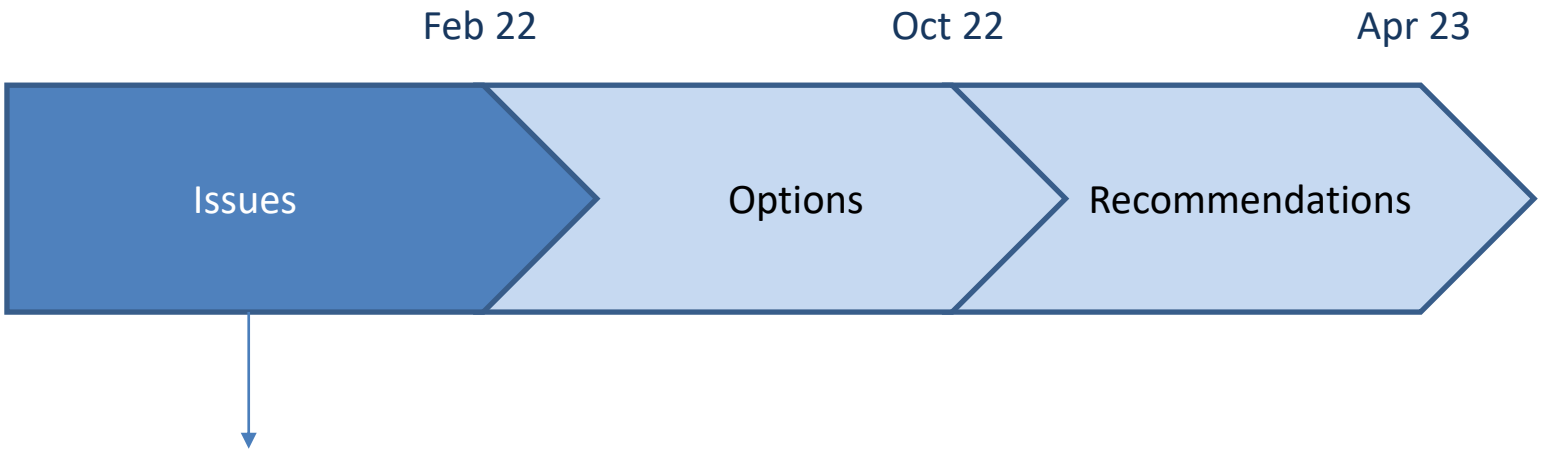
- Electricity Authority asked MDAG:

  What changes should be made to the wholesale electricity market to ensure it is effective with 100% renewable electricity (100%RE) supply.

Approach

- Evidence based - use simulation tool to test assumptions and scenarios (not a forecast)
- Wide engagement
- International insights

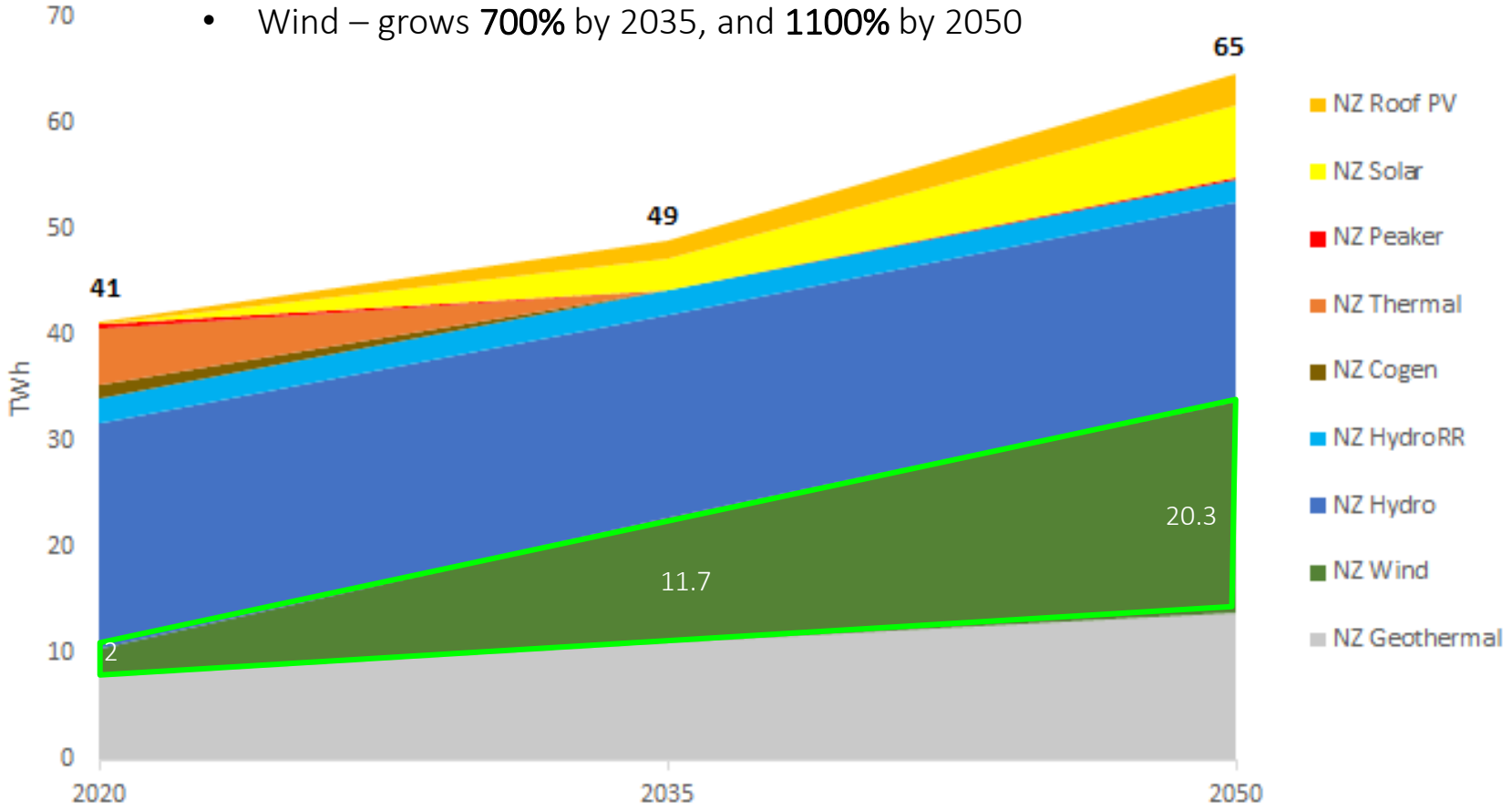
MDAG's task & approach



- An empirical view on how the wholesale market may unfold at a physical and systems level, and then,
- From this evidence, identify the key issues (or challenges) that may need to be addressed.

Growth in capacity

- New capacity ~500-600 MW/yr until 2050
- Compared to <100MW in the past)
- Wind – grows **700%** by 2035, and **1100%** by 2050



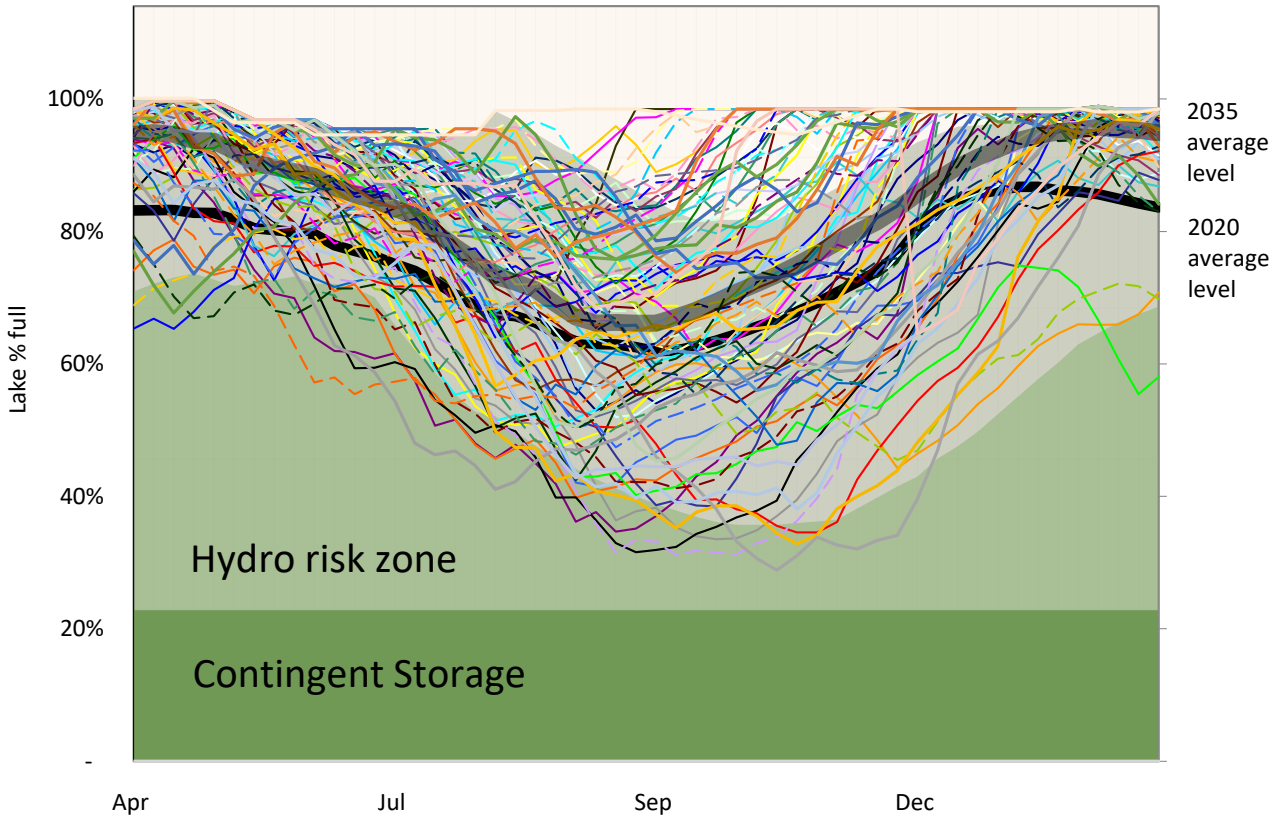
Increase in intermittency

- With most additional capacity coming from wind and solar –
- Intermittency increases from ~6% of total supply now to nearly 50% by 2050.

Hydros become “shock absorbers”

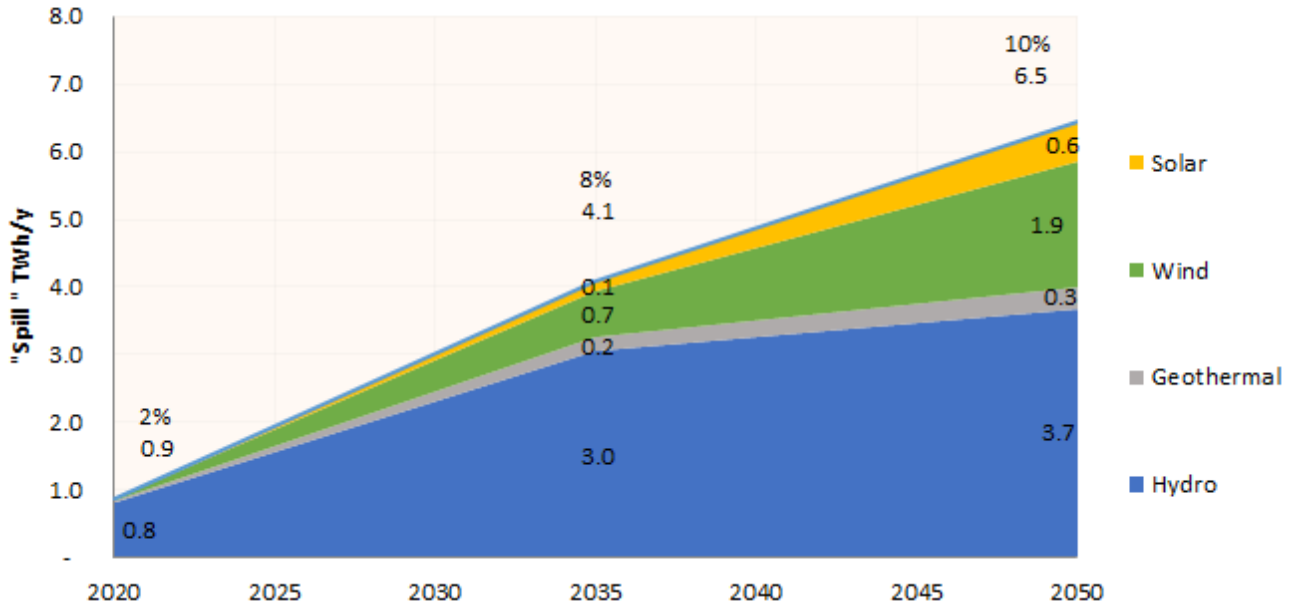
Smoothing out a lot the short-term fluctuations

- Hydro storage levels rise on average
- Storage trajectories largely trace the weather – less scope for short-term hydro management
- Hydro levels also more sensitive to the rates of new investment and demand growth



Increase in “spill”

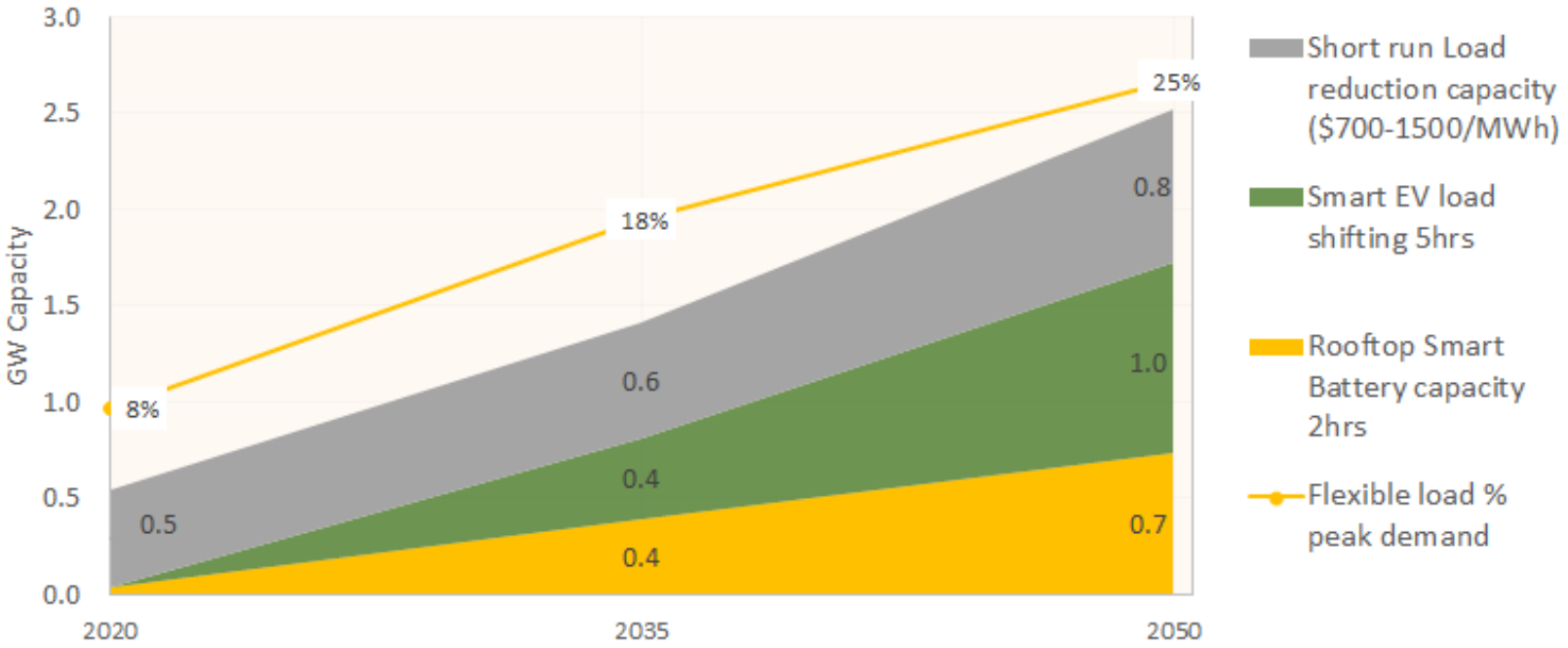
- “Spill” rises from **2%** of total generation in 2020 to **8%** in 2035 and **10%** in 2050
- Spilling water, wind, solar or geothermal
- Economically efficient. (Alternative – less intermittent generation – higher cost)
- For some stakeholders, this will be a major change in mindset.
- Change is really one of degree. Already spill thermal generation and network capacity



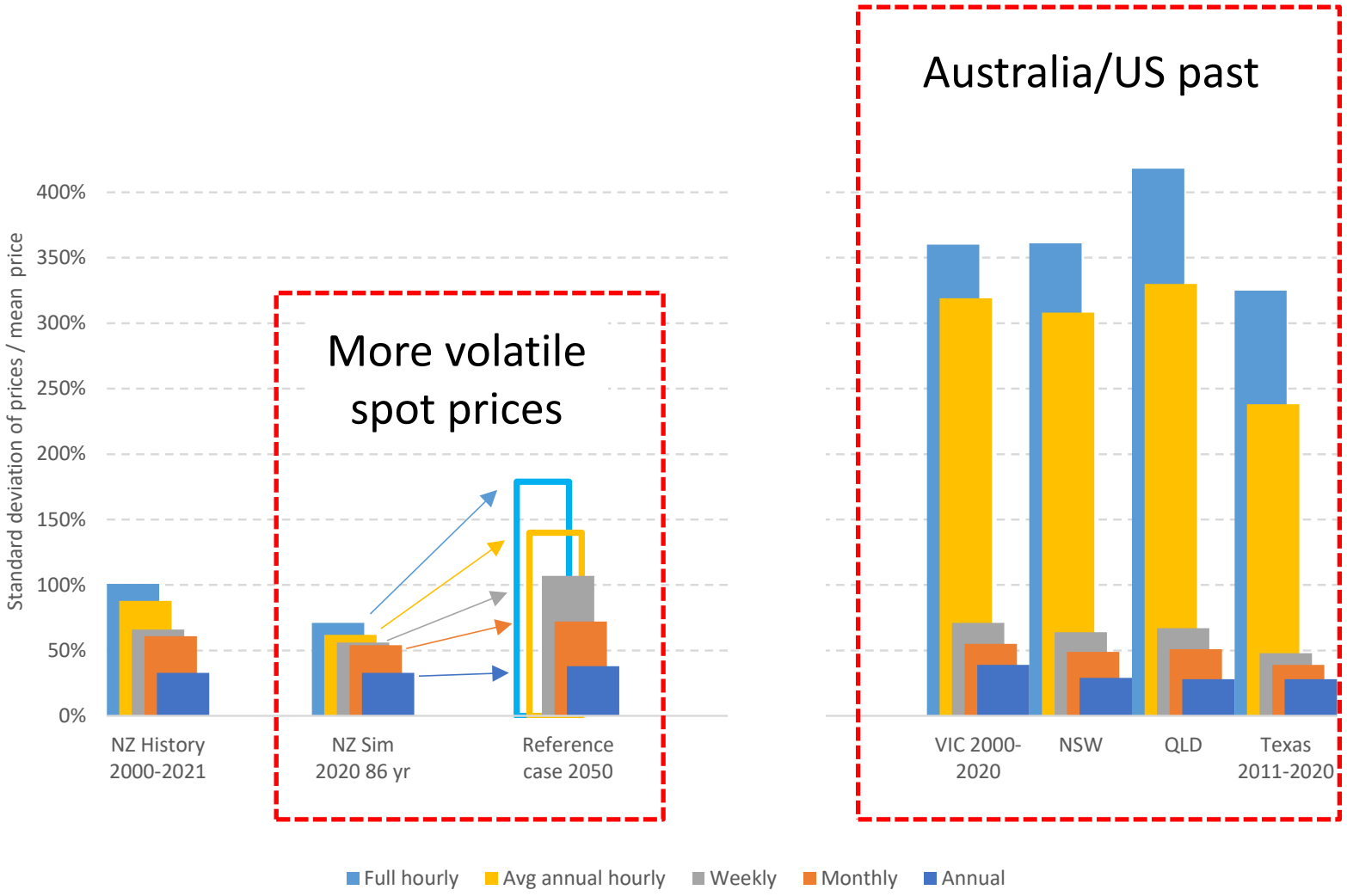
Increased flexible demand sources

- Significant levels of both demand shifting enabled by batteries, and demand which curtails in response to prices.
- In combination, these rise from around **8%** of peak demand in 2020 to around **25%** by 2050.

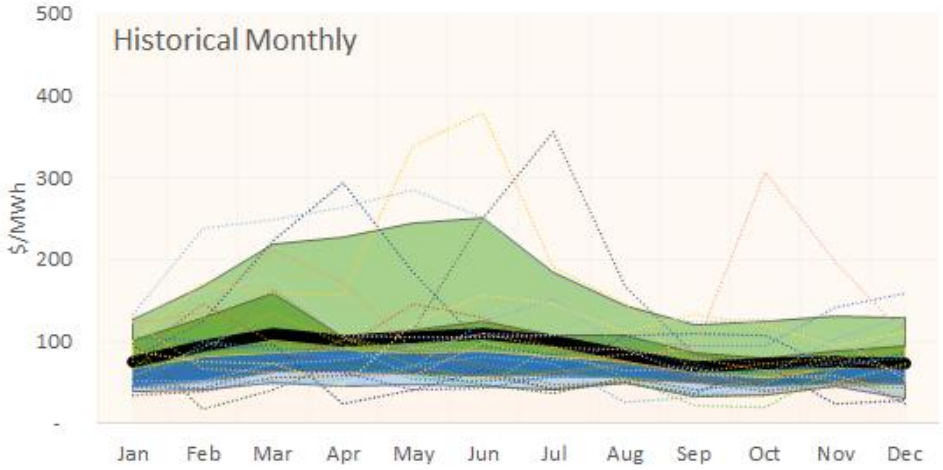
Compared to today this is a very substantial increase. However, technology to enable DSF is improving rapidly, particularly in the areas of batteries and control of devices via the internet. There is also considerable research underway to increase flexibility in certain energy-intensive industries

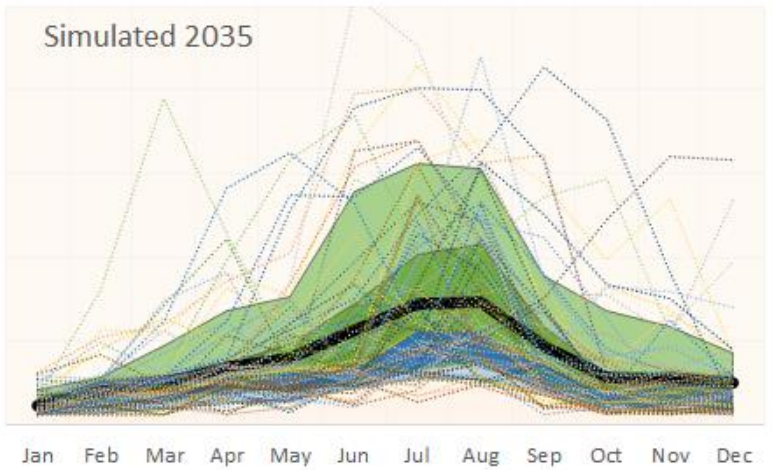


Volatility


Australia/US past
More volatile spot prices
Standard deviation of prices / mean price
400%
350%
300%
250%
200%
150%
100%
50%
0%
NZ History 2000-2021
NZ Sim 2020 86 yr
Reference case 2050
VIC 2000-2020
NSW
QLD
Texas 2011-2020
Full hourly
Avg annual hourly
Weekly
Monthly
Annual

More seasonal variation





Conclusion: 100%RE is technically doable

- Our overall conclusion at a *system level* is that shifting to 100%RE appears to be achievable if the right settings are in place.
- NZ well placed compared to many countries:
  - Low cost renewables
  - Sizeable hydro base
  - Nodal spot market
- So let's touch on the issues that may have implications for the wholesale electricity market *design*.

Key issues

- Investment efficiency
- Accurate spot pricing
- Competition, especially in flexibility
- Contracts market
- Demand-side participation
- Real-time coordination

Main prize

- **Investment efficiency is the major prize over the coming 25 years**
  - Large amount of capital and resource use will be channelled into new sources of electricity supply to meet growing electricity demand (on steroids with decarbonisation)
  - We want new supply to come on stream at optimal time, place, size and type
  - This means new supply from sources that are least cost –
    - To the economy
    - To the environment, and therefore
    - For the long term benefit of consumers.

Importance of innovation

- **Any single decision-maker can't see or deploy the full range of optimal solutions**
  - We see a pressing focus around the world on developing ideas and technologies to meet electricity demand without fossil fuels
  - Supply and demand-side options will emerge that are currently not known or currently considered not viable
  - In short, innovation will continue to drive costs and technology is ways that we can't predict

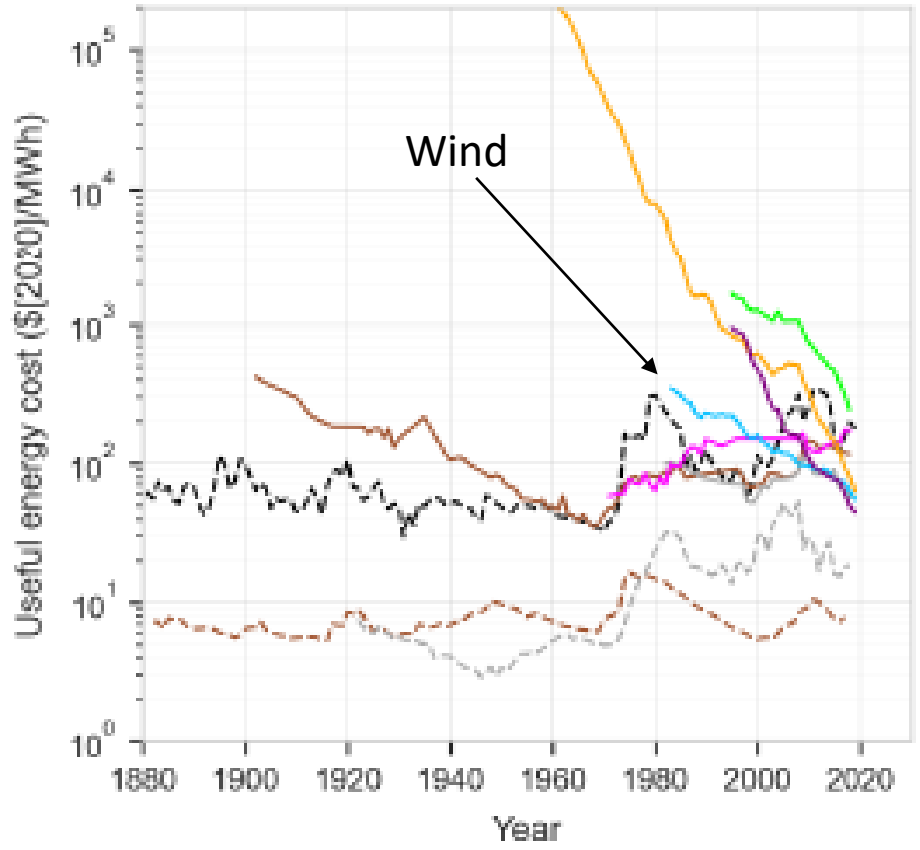
    For example, few people predicted that the cost of solar PV would decrease by more than three orders of magnitude since its first commercial use, while prices for fossil fuels now (ex-carbon), after adjusting for inflation, are very similar to prices 140 years ago with no obvious long range trend

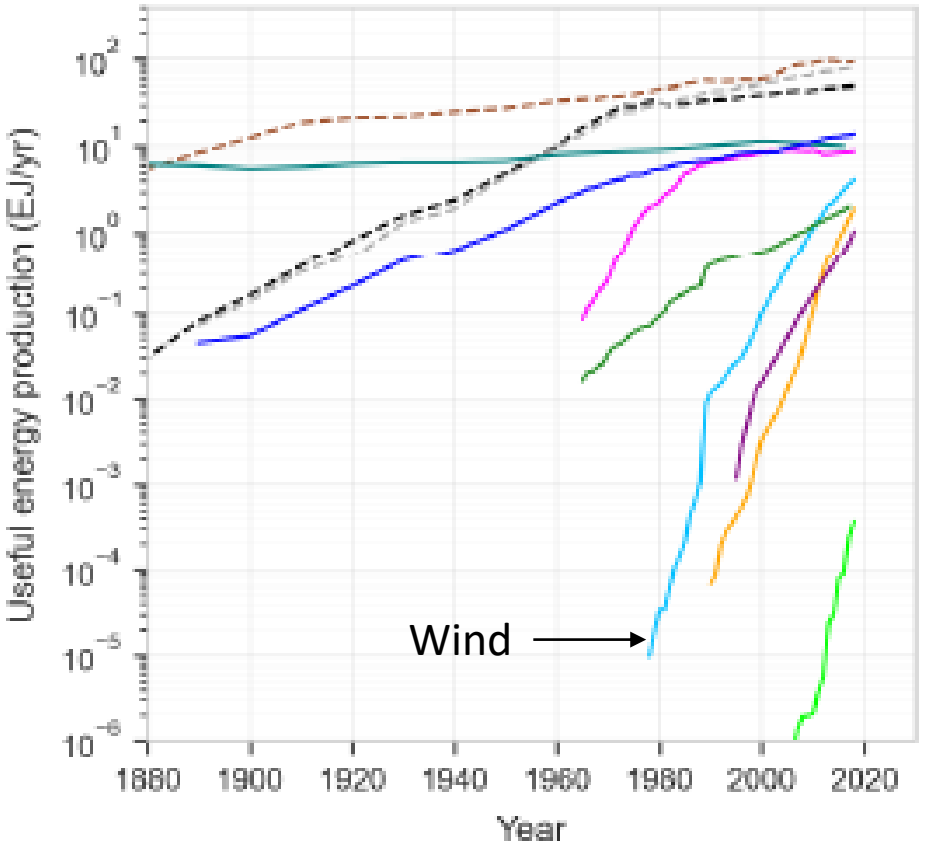
  - So, there is a very high value on a regulatory framework that fosters and enables better supply and demand options to come into the market, displacing less competitive alternatives

Renewables cost trends

Cost of wind generation dropped **70% in the last decade**

[Source: https://ourworldindata.org/cheap-renewables-growth]





Oil
Coal
Gas
Coal electricity
Gas electricity
Traditional biomass
Nuclear electricity
Hydropower
Biopower
Wind electricity
Solar PV electricity
Batteries (lifetime-adjusted)
P2X fuel from solar and wind (modelled)

Source: Oxford Martin School – "Empirically grounded technology forecasts and the energy transition" - Sept 14th, 2021 INET Oxford Working Paper No. 2021-01

Spot market – foundational role

Investment efficiency is **anchored by a well-functioning spot market** in which prices reflect the cost of consuming/producing an extra unit of electricity – including opportunity and scarcity costs

↓

Spots prices then drive risk management by wholesale buyers and sellers – hedging, demand-side response, and (over time) investment

↓

Competition drives diversity in risk management with better solutions displacing less efficient solutions – which lowers costs over time to the economy, environment and consumers

Confidence in spot price

Confidence in spot prices –
Accurately signalling the **marginal cost** (value) of supplying an extra unit to meet demand, including very high prices that properly reflect scarcity

- Confidence in **sufficiency of competition**
- **Availability of 'tools'** (demand-side and contracts) to manage spot price risks and **understanding of risks** and need for each participant to manage properly
- Confidence in **market and governance processes**

Volatility is not a 'bad'

- Rather, it is a "good" where it signals real changes in the value of supply and demand –needs to be fully signalled without smearing or camouflage
- This pricing information drives risk management by wholesale buyers and sellers, which feeds into longer term contracts, which in turn drives innovation and investment for the long term-benefit of consumers
- In New Zealand, this was a foundational design idea was brought into focus by the Prime Ministerial Review into the 1992 electricity shortage, chaired by Rt Hon Sir Ronald Davidson*

Volatility is caused by several factors – relatively inelastic demand; our long, stringy transmission network; highly changeable weather; large variations in hydro inflows; and step-changes in the cost of supply (across hydro, wind, geothermal, gas, coal and diesel)

Those step changes in cost of supply are likely to become greater with 100%RE, resulting in greater volatility, as outlined earlier

* Then Chief Justice, with Ron Carter, Chair of Beca Carter, and Murray Gough, CEO of the NZ Dairy Board – see Electricity Shortage Review Committee, The Electricity Shortage 1992 (December 1992).

Sufficiency of competition

- Under 100%RE:
  - Likely increase in competition for short term supply – from EV, solar and grid scale batteries and demand-side flex
  - Likely decrease in competition (or increase market power) for medium term flexible supply
- In short, our analysis indicates larger flexible generators *may* have greater means to raise volatility of volatility, and *would likely* have stronger incentives to do so than in the past
- Evaluating a spectrum of remedial measures – conduct rules and structural options.

Availability of tools for buyers and sellers to manage spot price risks

- Contracts:
  - Simulations to test impact on incentives from different contracting arrangements
  - Analysing barriers to uptake
  - Evaluating options, which include:
    - Improved disclosure (anonymised) of contract offers and bids contract data)
    - Improved choice of contract products (e.g. caps)
    - Expanded market making obligations – to increase liquidity and range of risk coverage for contract buyers

Availability of tools for buyers and sellers to manage spot price risks

- Demand-side:
  - Simulations to test when its is profitable to use DSF
  - Developing 4 or 5 case studies to illustrate economic cost-benefit of DSF potential – for independent retailer, for gen-tailer, for large industrial (longer term), and large industrial (short term)
  - Analysing barriers to uptake
  - Evaluating options, including 'nega-watt' schemes (Aus and FERC)

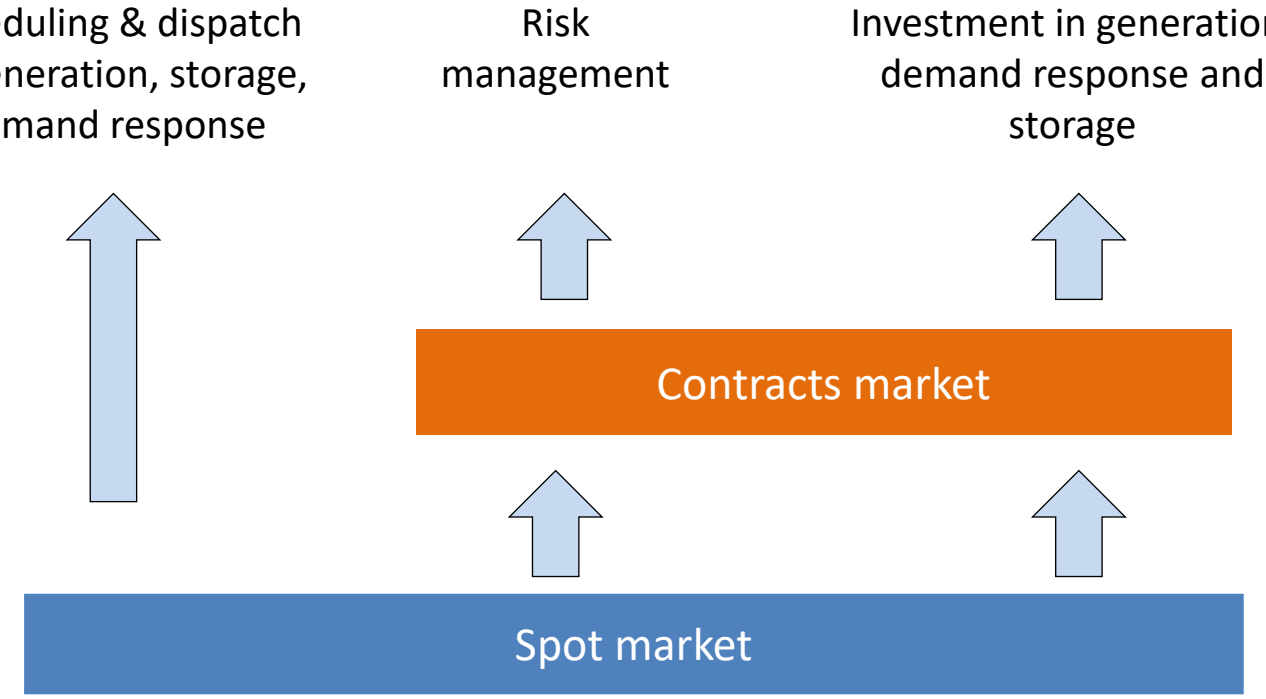
Confidence in market and governance processes

- Strengthening government and public insight:
  - **Quarterly or half-yearly outlook report** – what to expect in range of prices (reflecting seasonal weather forecast and other key factors) and new investment in the pipeline
  - **Quarterly briefings** to officials and Ministers on the quarterly market outlook and other supervision processes in place – with these briefings happening even when things are unexceptional
  - Structured and regular **'warrant of fitness'** reports on the spot, contract and ancillary services markets
  - A structured **programme of education** for officials (and interested Ministers) across relevant departments on how electricity pricing works and government's role – recognising that personnel are constantly changing

Key issues and linkages

Types of decision:

Aspect of wholesale electricity market:



Thank you

Link to MDAG's Stage 1 report – https://www.ea.govt.nz/development/work-programme/pricing-cost-allocation/100/consultations/#c19134