

100% Renewable Electricity Market Design

Mercury Presentation to MDAG

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PATHWAY TO 100% MATTERS

- > How the market will operate under 100% renewable generation will be influenced by the path taken over the transition.
- > There are range of scenarios including:
 - Timing of NZAS exit;
 - Construction and location of large-scale, long duration storage (such as Lake Onslow);
 - Penetration of DER (distributed generation and battery storage);
 - Extent of grid-scale renewable build;
 - Maturity and development of the contracts market;
 - Extent of flexible demand-side participation in the market; and
 - Phase out of thermal generation and pace of such.
- > Question – is there a role for MDAG to consider scenario analysis on the various transition pathways to help inform industry debate on the impacts?



PRINCIPLES OF EFFICIENT MARKET DESIGN

1. Capital and operational costs are transparent and reflected in market prices which provide efficient signals for investment, retirement and consumption decisions.
 - MDAG Theme: *Promote Efficient Investment / Discover prices and provide signals*
2. Efficient dispatch of fuel to balance supply and demand over short term (e.g. minimising renewable spill) – least cost capacity to meet demand (merit order dispatch)
 - MDAG Theme: *Promote Efficient Dispatch*
3. Ensure adequate resources available over longer time periods (e.g. between seasons) to deliver energy requirements.
 - MDAG Theme: *Ensure the lights stay on / Discover prices and provide signals*



1. CAPITAL AND OPERATIONAL COSTS ARE TRANSPARENT - MARKET PRICES WHICH PROVIDE EFFICIENT SIGNALS FOR INVESTMENT, RETIREMENT AND CONSUMPTION DECISIONS.

Current

- > Move to market was to deliver more efficient price signals / security given historic cross-subsidies / shortages.
- > Spot market prices inform futures prices (includes risk premia for both capacity and energy uncertainty)
- > Thermal plays role of generator of last resort / provides certainty demand can be met
- > Futures curve provides a price path against which to assess the viability of future generation investment
- > Contract market developing (e.g. PPAs for new wind development)

Future 100%

- > How will existing strong linkages evolve between spot and futures when 100% renewable market?
- > How is scarcity signalled when generator of last resort is uncertain? Is it scarcity pricing, demand-side bids, storage, green fuels replacing existing fossil fuel in generation?
- > How are long term PPAs structured given the potential uncertainty around the future price path and firming?
- > Potential for “missing money” problem to intensify due to higher spot volatility?
- > Need for continued transparency in costs / merit order approach for generation and storage options¹.



2. EFFICIENT DISPATCH OF FUEL TO BALANCE SUPPLY AND DEMAND OVER SHORT TERM

Current

- > Hydro generation offers are set by the opportunity cost of water reflecting the risk of scarcity from running out of water or risk of spilling.
- > Ancillary services are procured to manage common quality on the power system.
- > Current unit commitment challenges for inflexible plant under EOM - if price signals aren't timely/high enough, capacity may not be available when needed.

Future 100%

- > How will we compensate short-term firm capacity to be available?
- > Other markets address this via day ahead, operating reserve and/or capacity markets to manage demand peaks and short-term capacity challenges, but performance mixed.
- > Need for greater clarity and forecasting for increasingly intermittent generation and participation / transparency from the demand-side (needs to be firm – role for rules, similar to generation?).
- > Will ancillary service markets remain suitable as we transition into a market with increasing intermittent renewable penetration?



3. ENSURE ADEQUATE RESOURCES AVAILABLE OVER LONGER TIME PERIODS

Current

- > Currently intra-year resource adequacy is managed through hydro operators setting water values in relation to thermal fuel to rationally dispatch hydro storage.
- > Parties most at risk of low hydro inflows are incentivised to contract with firm generation providers to manage risk. Bilateral contracting has supported dry year energy security, e.g., Genesis swaptions.
- > Market has delivered strong performance since inception with no energy-driven shortages (e.g., need for official conservation campaigns avoided).

Future 100%

- > What will the impact of greater intermittent and less baseload generation mean for flexible hydro storage? Flexible hydro storage will increasingly be needed to provide capacity (as well as energy).
- > Absent coal stockpiles and gas storage how will deep energy storage be provided?
- > How do we send signals to ensure the most efficient / least cost mix of energy storage options are delivered over the long term in a similar way the market has delivered merit order generation investment?



Appendix: Materials shared with NZ Battery Project

GREAT SOLUTIONS ARE DELIVERABLE, RESILIENT, PROVIDE OPTIONALITY AND EFFICIENT

Requirement	Description
Storage capacity	Provides the storage capacity that will be needed to manage the dry year risk, matched to the timing of the dry year risk growth, and fossil-thermal retirements.
Social license & political risk	Delivery will not be blocked by a change of government/policy or push-back from powerful interests.
Low delivery risk	Solution(s) are technically & practically feasible, noting environmental, supply chain, engineering, geotech constraints, etc.
Resilient	Resilient to events which may disrupt the operation of the solution(s).
Emissions	Allows retirement of fossil fuelled generation in the context of a net zero carbon economy and energy system by 2050.
Option value	Solution(s) do not prevent future investment in better solution(s) and/or create a high risk of stranded assets.
Cost	Solution(s) deployed are cost-effective in terms of levelised cost of storage/cost of carbon abatement relative to alternatives and capital deployed through time.
Benefits	Recognises the potential for large benefits from solutions that deliver more than just a battery; e.g. a battery solution is embedded in a hydrogen economy.
Effective signals	Avoids an electricity market that would discourage generation investment and disrupt electrification of the economy. Transpower estimates ~20-30 TWh of new generation build by 2050, requiring a major investment commitment. 2.7 TWh recently committed for Turitea, Harapaki & Tauhara projects represents ~\$1.5bn.

> Tensions between competing requirements need to be managed within the context of a pathway to net zero carbon energy by 2050, rather than a narrow focus on 100% renewable electricity by 2030.



SHORTLIST INCLUDES DEMAND-SIDE OPTIONS, MULTIPLE HYDRO SOLUTIONS, HYDROGEN, AND OTHERS

Option	Description
Demand-side	Energy efficiency, small scale demand response, large scale demand response (e.g., in conjunction with hydrogen.)
Hydro	Extend existing lake ranges or build new dams to increase existing catchment hydro storage.
Thermals	Keep thermals running on fossil fuel in the near term, then retire them or convert to run on biogas, biomass or green hydrogen. Alternatively, continue to burn fossil fuels and abate through CCS or offset.
Onslow	Options may range from 3 to 12 TWh.
Other hydro	Other smaller, geographically diverse hydro schemes.
Renewable overbuild	Overbuild/early-build solar, geothermal, wind to supply energy year round.
Hydrogen	Build large-scale renewable generation to produce hydrogen for domestic use and/or export. Either store hydrogen and convert back to electricity through combustion or fuel cell or divert energy from electrolyser to provide for dry year energy requirement.
Liquid or compressed air storage	Convert underground caverns into compressed air storage facilities with turbines to generate energy when needed. Co-location with existing heat sources and cold recycling are required for liquid air to achieve efficiencies up to and beyond 50%.
Longlist	Interconnection with Australia, large scale demand response, emerging battery tech, seasonal hot rock, mechanical storage, grid scale lithium-ion batteries, nuclear(!).



EXAMPLE STACK SOLUTION CAN MEET MUCH OF ENERGY REQUIREMENT AT LOW COST AND SIGNIFICANT RISK DIVERSIFICATION

Solution	Description	Contribution to dry year (GWh)	Cost	Cumulative (GWh)
Energy efficiency ¹	LED lighting (2,000 GWh impact)	1,200	\$15-50/MWh	1,200
	Heat pump hot water (1,000 GWh impact)	500		1,700
	Heat pump space heat (1,800 GWh impact)	1,800		3,500
Extending existing lakes	Extending the operating ranges of Pukaki and other hydro lakes	1,000	Low ²	4,500
Thermal plant	Continue to operate thermal plant on natural gas and/or convert to green fuels such as biogas, hydrogen, etc.	5,000 – 10,000	Fixed costs: ~\$35-\$100/kW p.a. SRMC: \$70/MWh - \$200/MWh (depending on gas, carbon price) ³	9,500
Renewable overbuild	“Overbuild” solar, geothermal, wind to supply energy year round.	1,000 –	Levelised costs ~\$60-\$90/MWh, depending on firming.	10,500
Distributed hydro	Enhanced and new hydro (2,000 – 5,000 GWh)	2,000	Unknown	12,500
			Unknown	
Hydrogen	Large electrolyser which exports 80% hydrogen and stores 20% chemically or underground (e.g., Ahuroa.) In dry year generates from stores and/or turns off electrolyser for demand response. 570 MW off for one year = 5,000 GWh.	5,000	Unknown	17,500



