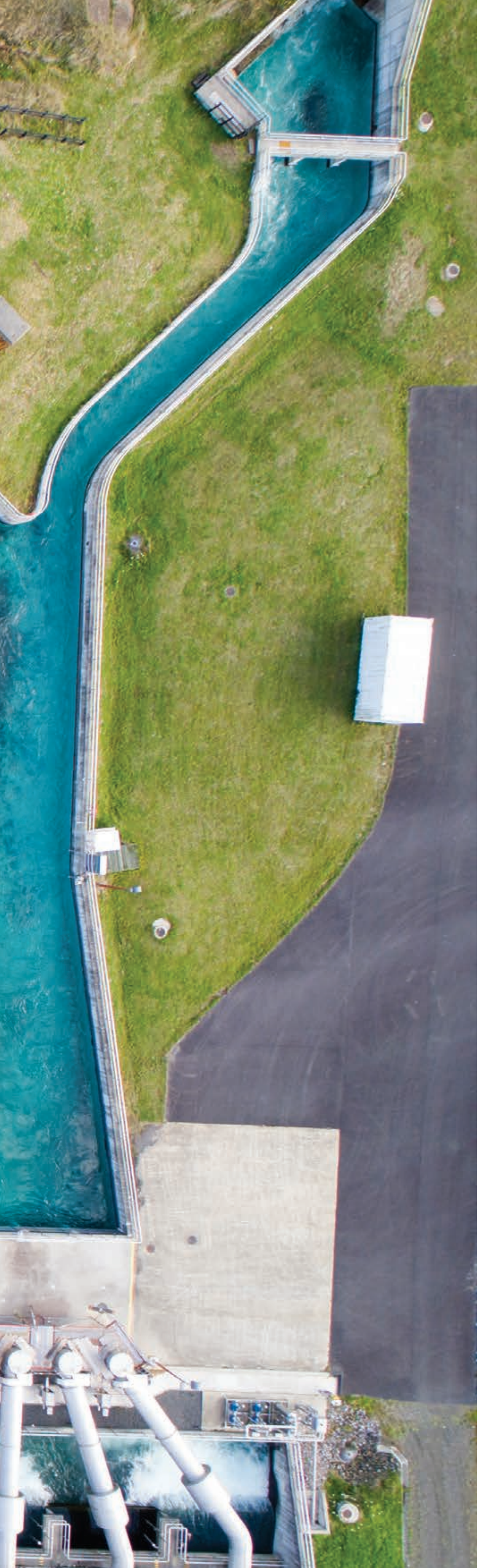
Crafting a path for New Zealand's 100% renewable electricity market

Proposal for industry-wide engagement on the future of New Zealand's thermal assets



Executive summary

An opportunity for Aotearoa to take a leadership position

New Zealand can become the world's first large scale competitive electricity market to reach 100% renewable electricity. Our advantageous starting point, with a highly decarbonised market powered by our enviable geothermal, hydro and wind resources, gives us a clear competitive advantage over the next two decades.

The transition will reduce yearly emissions by ~1.2 Mt CO2-e[1] per annum. For people and communities, a more renewable based energy market would potentially support over 350 new permanent jobs and 7,500 construction jobs over the next 10 years, with a strong concentration in regional New Zealand. For some businesses, decarbonisation will not only reduce costs but also presents an upside opportunity to create differentiation in the market, such as sustainable tourism or carbon-free premium exports like agriculture, dairy or metals. As cross-border carbon taxes start to emerge, low-cost 100% renewable electricity can become a clear competitive advantage for some industries. Looking beyond our shores, new businesses could also be attracted by our clean, reliable, cost competitive electricity, as already demonstrated by the Southern Green Hydrogen project expressions of interest, and the recent data centre announcements by Contact Energy (Lake Parime), Meridian Energy (DataGrid) and Amazon Web Services, which would further support high value jobs.

In a world where green, reliable, firm, cost competitive energy is a scarce resource, Aotearoa's natural endowments have allowed the creation of a highly renewable and cost-efficient electricity market which has strong foundations to execute the last step of the journey to move from 85% to 100%. As an industry, we have the resources, expertise and capabilities to get this transition right, and Kiwis are expecting us to do so.

1 2030 compared to 2022. From CCC decarbonisation modelling, Tiwai stays scenario.

Maintaining the balance to ensure an orderly transition

New Zealand's electricity market is one of only nine countries globally with a 'triple-A' rating in the World Energy Council Energy Trilemma index, demonstrating a world class balance of decarbonisation, security of supply and energy affordability. During the transition, New Zealand will need to pursue two main objectives:

1. **Maintain its world class balance across the trilemma, as more renewables economically replace fossil fuelled generation; and**
2. **Ensure an orderly transition of New Zealand's electricity market to 100% renewable generation.**

1. Maintaining the world class equilibrium across the trilemmaa

- **Decarbonisation** is well on track, with the CCC forecasting 8.5 TWh of additional renewable generation under the 'Tiwai stays' scenario by 2030. The price received by generators is expected to be enough to allow ongoing investment. The main challenge will be to enable a stable and secure regulatory environment for these investments to happen.
- **Security of supply** will be increasingly challenging as new renewables enter the market and utilisation of thermal plants falls. According to CCC modelling, by 2030 New Zealand will need around 4.5TWh of flexible energy (currently supplied by fossil fuelled generation). In addition, 1,300MW to 1,450MW of incremental firm capacity (beyond the 4,600MW provided by renewables, batteries and the HDVC) will be required to cover North Island winter-peak demand (and a 'safety' margin). Low utilisation of thermal plants, which would only operate in peak periods or dry years, could lead to early closure or lack of upstream fuel supply investments, putting security of supply at risk.
- **Energy affordability** for consumers will be the most challenging element to balance. Today, the fixed costs of the thermal assets required to guarantee security of supply are

Exhibit 1: Comparison of pathways for New Zealand's transition

		Capacity market
Maintaining balance in energy system	Decarbonisation	Creates a new revenue source for renewable energy, but this may be minimal for intermittent generation projects
	Security of supply	Ensures sufficient capacity is in the system through capacity payments but does not provide assurance that capacity will actually be available when required
	Energy Affordability	Skews incentives for least cost generation through introduction of new value stream Does not always result in lower wholesale energy prices, due to the introduction of new system costs Does not benefit from operational synergies of existing assets
Orderly transition		Does not directly guarantee the staged and planned shutdown of thermal plants, but it provides long-term transparency through market results
Feasibility		Requires a new market to be introduced and regulated, which typically needs years to find an equilibrium

$100 million to $150 million per annum[2]. With utilisation falling, these plants will require higher prices to recover their fixed costs, leading to increasing volatility in wholesale energy prices. Failing to recover these fixed costs could lead to early closure of some plants, which would further increase volatility and system insecurity.

2. Ensuring an orderly transition

To ensure the best outcome for Aotearoa in the transition to 100% renewable electricity, market signals will need to continue to attract renewables as they do currently, while also incentivising cost effective solutions to guarantee security of supply. Critically, these signals should provide enough certainty to develop and fund alternatives.

Decisions on decommissioning individual assets need to consider cascading effects for New Zealand. A disorderly exit of thermal assets may put security of supply and jobs at risk – in both the power plants and the upstream fuel supply industry. Equally important, the lack of visibility on the long-term outlook in the sector would delay investments, putting the potential development of new skilled jobs in regional New Zealand at risk.

Three potential pathways to support the transition improving the status-quo

To maintain the energy trilemma balance we have studied three market structures used in international markets: Capacity Markets, Reserve Payments in energy-only markets, and Energy-Only markets supported by risk management products.

In the specific context of New Zealand we have explored which ownership structures could better ensure an orderly transition: Independent ownership, Independent ownership with Government support, and Consolidated ownership. The combination of the market

2 New Zealand dollars unless otherwise stated

Positive contribution | Moderate contribution | Minor contribution

Strategic Reserve

Maintains energy market price signals to attract new renewable projects, with moderate risk of muting scarcity price signals which attract investments in clean flexibility

SO ensures security of supply by directly contracting (reserve payments) with strategic assets

Risk of reserve payments to be extended beyond the actual need of the assets, leading to uneconomical support of stranded assets

May disincentivise the attraction of flexible technologies

Ensures there are no shock thermal exits but SO decisions can change wholesale market price outcomes and investment decisions

No market change required, but it requires change of mandate to SO to be able to source and dispatch capacity, as well as building capabilities

ThermalCo

Maintains energy market price signals to attract new renewable projects in the locations where they are most needed through nodal pricing

Market participants pay for risk management products to ensure their energy needs are covered, incentivising enough capacity online in the system

Market dynamics put downward or upward pressure on risk management product pricing to ensure capacity mix adapts to system needs

Limits impact of volatility to only unhedged market participants

Benefit from operational synergies (e.g. 4.5% fuel savings through dispatch co-optimisation

Allows one entity to plan and stage shutdown of thermal plants, benefiting from synergies and learnings

Gives one point of communication for government and communities

Market and regulation already exists and requires no changes

Requires wide-industry agreement and Commerce Commission approval

structure with their most natural ownership structure led us to define three potential pathways to support New Zealand's transition.

- **Set up a Capacity Market** trading firm capacity to supply peak demand and dry-year demand, in parallel to the existing energy market. All existing and new plants can enter by bidding in reverse auctions to receive a fixed, yearly capacity payment ($/ firm MW) allowing for the recovery of fixed costs;
- **Establish a Strategic Reserve** where Government enters into an agreement with owners of strategic assets to ensure security of supply. These agreements would confirm assets are available to provide firm and flexible capacity in exchange for **reserve payments** to ensure recovery of fixed costs;
- **Establish a ThermalCo** while maintaining the existing energy-only market supported by risk management products. ThermalCo would be an entity that consolidates ownership of and operates all thermal assets. ThermalCo's sale of risk management products would provide sufficient capital to cover fixed costs.

Expected outcomes from the three pathways

Against the dimensions of the trilemma, all three pathways promote decarbonisation of the electricity market and help ensure security of supply. The differences emerged around affordability, achieving an orderly transition, as well as implementation feasibility. Exhibit 2 summarises the comparative merits of each pathway.

ThermalCo: a market-based pathway for Aotearoa

After exploring the three potential pathways to keep the energy trilemma balanced while ensuring an orderly transition for New Zealand's electricity market, we propose the establishment of ThermalCo. ThermalCo will be an entity that owns and operates all existing thermal assets and upstream fuel supply contracts, with the mandate to offer transparent and liquid risk management products, while ensuring an orderly phase out of the thermal capacity when more reliable low emission technologies become economic.

The establishment of ThermalCo will maintain the energy trilemma balance as:

- The offer of risk management products to cover all thermal capacity in an open platform will be a further evolution of the hedging market helping to support **transparency and liquidity** for all market participants to cover dry year and peak demand risk;
- Consolidated ownership of thermal **assets increases the availability of capacity** that could be offered to derivative markets, as outage risks are spread across a larger portfolio;
- Security of supply risks, priced through hedging contracts, will provide the **price signal to incentivise the market-led investments of the lowest costs, reliable technologies** that address these risks. Long-term hedge premiums will support dry-year coverage, while short-term strike prices will provide arbitrage signals for new flexible capacity;
- **Fixed costs recovery through premium** on risk management contracts will **reduce volatility of the spot market** as only variable costs will need to be recovered. Most market participants will likely prefer to cover their risks rather than be exposed to price spikes, providing a more **equitable distribution of fixed costs.**

The establishment of a ThermalCo will ensure an orderly transition of New Zealand's electricity market as:

- Consolidated ownership will provide greater **certainty in the mid- and long-term demand for thermal assets**, allowing for more effective and coordinated planning of the transition of these assets when new technologies can displace them;
- **It maintains a stable regulatory framework** that works well today.

We invite support from stakeholders that want to collaborate and contribute to building a market-led solution for a 100% renewable electricity market in New Zealand that not only achieves environmental targets, but also meets the challenges of security of supply and affordability while ensuring a smooth and orderly transition for all.

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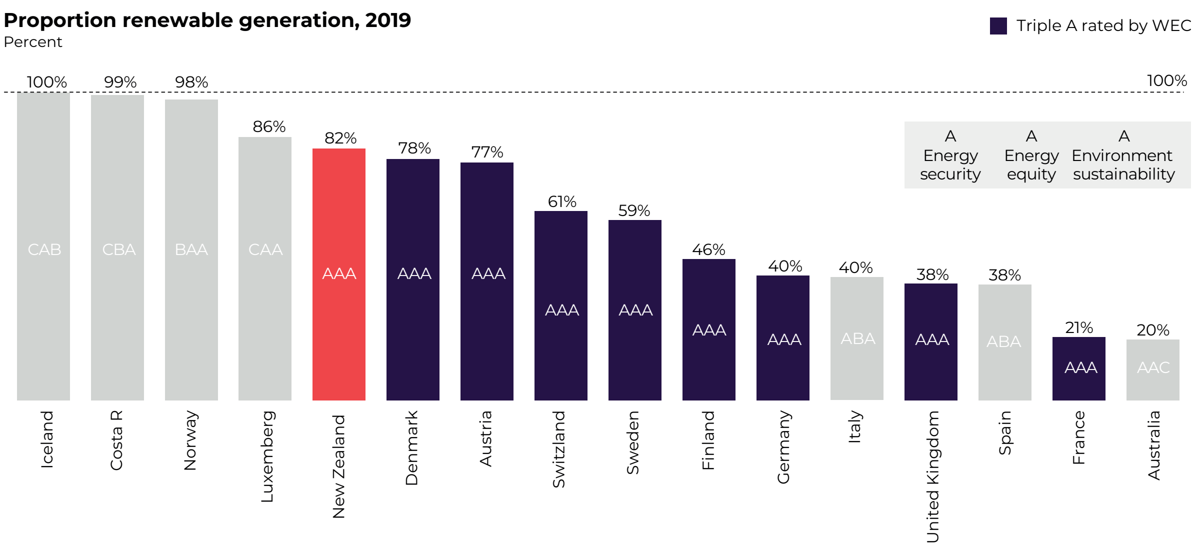
An opportunity for Aotearoa to take a leadership position

Successfully executing on the Government's ambition to achieve 100% renewable electricity presents a unique opportunity for Aotearoa to take a leadership role in the fight against climate change. The reduction in emissions will benefit our people, communities, and businesses.

Aotearoa's natural endowments have allowed the build of a highly renewable and cost-efficient electricity market over the last century. Between 600mm and 1600mm annual rainfall and combined with a rugged topography create ideal conditions for hydro power generation, while our geothermal resources have seen the development of one of the world's largest geothermal power generation industries. And with most of the country situated in the roaring forties latitudes, New Zealand is also well placed to continue growing competitive wind generation, with intermittency absorbed by hydro reservoirs.

These conditions give Aotearoa a competitive advantage over most developed economies around the world in our drive towards a 100% renewable electricity system. In the World Energy Council's (WEC) Trilemma ratings New Zealand has the highest proportion of renewables of the countries rated 'AAA' (Exhibit 2). The Trilemma measures how a country manages the trade-offs between energy security, energy equity (accessibility and affordability) and environmental sustainability. Most other OECD countries seeking high penetration of renewables will rely mainly on intermittent wind and solar generation, requiring significant investments in expensive storage and flexibility technologies.

Exhibit 2: Global comparison of renewable generation and WEC Energy Trilemma rating



We are well on the way to 100%

Aotearoa has already demonstrated a willingness and ambition to lead the world's decarbonisation efforts. The Climate Change Response Amendment Act 2019[3] saw New Zealand become one the world's first countries with a 2050 carbon neutral legislated objective.

In the electricity sector, the 100% renewable generation by 2030 policy cements this national goal. Practical actions towards these objectives are already underway, including:

- the feasibility study of the New Zealand Battery Project;
- the extensive research and modelling undertaken by He Pou a Rangi, the Climate Change Commission (CCC)[4];
- the Electricity Authority Future security and resilience project; and
- the Ministry of Business Innovation and Environment (MBIE) work to outline economically efficient measures to achieve these goals.

Today, New Zealand is already well on track toward the 100% renewable electricity goal. In the last decade, renewable capacity increased from 6.8GW to 7.4GW, mostly driven by wind additions, increasing the share of renewables in the market from ~75% to the current ~85%. The market has proven highly effective in balancing the energy trilemma with sufficient flexibility to secure supply during dry-year, winter and intra-day peaks.

However, the final steps on the path to 100% renewables will be harder to traverse. With the thermal generation that guarantees the security of supply having an increasingly lower utilisation as renewables replace them over the next 5 to 15 years, the risk of uncoordinated phase outs and volatile prices will increase. These final steps will require us to bring innovative ideas over the next few years to continue to balance the energy trilemma: secure market **decarbonisation** while preserving s**ecurity of supply** at the **lowest possible cost**. The market will need to provide the right signals to ensure an orderly transition where thermal capacity is phased out as new more cost-effective technologies come online. This will likely require investment in diverse generation assets and new technologies, as shown in recent studies in global markets[5].

To do this, New Zealand will need to carefully craft a path for the transition to meet two primary objectives:

1. **Maintain its world class balance across the trilemma, as more renewables economically replace fossil fuelled generation; and**
2. **Ensure an orderly transition of New Zealand's electricity market to 100% renewable generation.**

Choosing the right path and implementing well will not only achieve the underlying value of the transition, but also unlock additional opportunity to Aotearoa.

The opportunity for Aotearoa

Getting the transition right presents a unique opportunity for Aotearoa, benefiting our environment, people, communities, and businesses.

For the environment, yearly thermal generation emissions could be reduced by ~1.2Mt C02-e per annum from 2022 to 2030, in part due to the addition of ~8.5TWh of new renewable electricity (according to the CCC). For people and

3 Climate Change Commission (2019) Climate Change Response Amendment act 2019
4 Climate Change Commission (2021), A low emissions future for Aotearoa
5 McKinsey & Company (2021), Net zero by 2035: A pathway to rapidly decarbonize the US power system

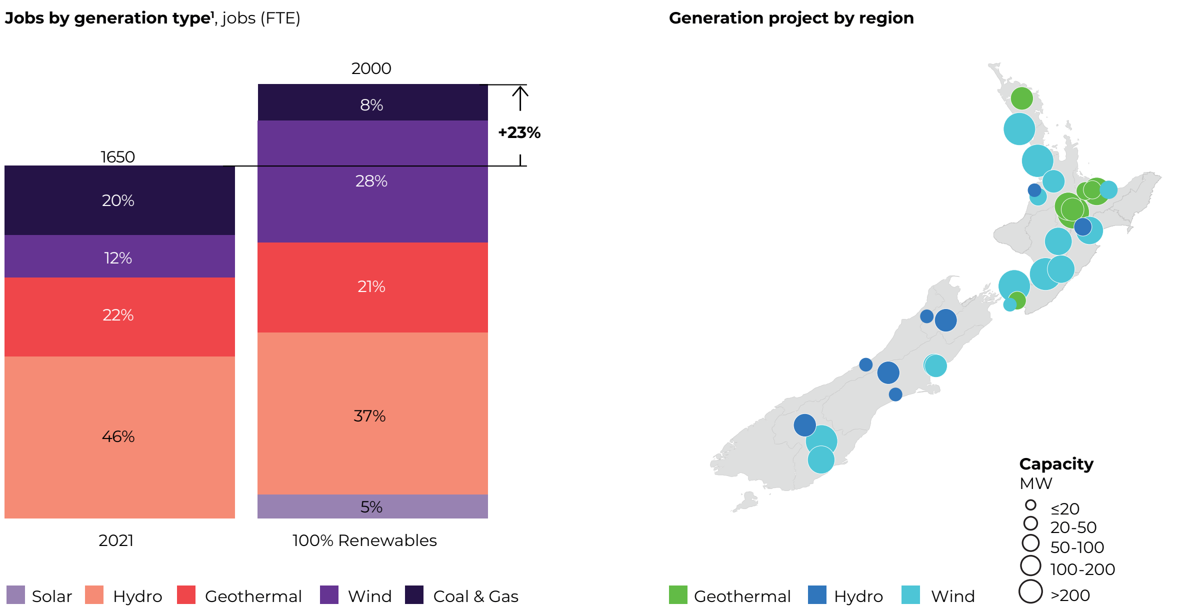
communities, these new renewable electricity projects can potentially support over 350 new permanent jobs and 7,500 construction jobs over the next 10 years, with a strong concentration in regional New Zealand, as shown in Exhibit 3.

New Zealand businesses are now intensifying their efforts to decarbonise their operations, as we are starting to see with dairy processing[6]. For some industries, decarbonisation can go beyond reducing costs (coal boiler electrification for process heat could be cost efficient in the South Island at carbon prices over $60/tonne), to also present an upside opportunity. New Zealand's largest two sources of export are agriculture and tourism. Both could benefit from a 'green premium'[7]. For example, the green premium on dairy products could be worth between 5% and 45%[8,9] of the price paid for certain products. Likewise, New Zealand's world class tourism destination brand would further enhance its sustainability reputation in the bounce back from the Covid-19 pandemic. As cross-border carbon markets emerge over the next decade, today's point of differentiation through a green premium could become a significant competitive advantage for other industries like agriculture, metals or manufacturing.

New businesses could also be attracted to our shores, as the Southern Green Hydrogen[10] project expression of interest demonstrates with over 80 responses, including from renowned international companies. Additionally, emerging industries globally are now showing strong interest in New Zealand's clean, reliable power. The data infrastructure industry is a case in point, with examples like our contract with Data Centre company Lake Parime to enter New Zealand, Meridian's partnership with DataGrid to build New Zealand's first hyperscale data centre[11] or the recent Amazon Web Services announcement to open its Aotearoa New Zealand infrastructure region[12].

Exhibit 3: Potential new jobs created in the transition towards a 100% Renewable Market

Employment impacts from shift



1. Does not include construction

Source: Press reports; Employment study: solutions on lack of skilled workers in the geothermal sector & results of the questionnaires; Clean energy at work, Clean Energy Council Report; Internal analysis on Haywood

6 Contact energy (2021), Capital Markets Day 2021
7 McKinsey & Company (2020), The ESG premium: New perspectives on value and performance
8 Wei Yang et. al. (2012), Impact of delivering 'green' dairy products on farm in New Zealand
9 McKinsey & Company (2021), Prioritizing sustainability in the consumer sector
10 Southern Green Hydrogen (2021), Huge Interest in Southland Green Hydrogen Project
11 Meridian (2020), Datagrid and Meridian partner to build NZ's first hyperscale data centre in Invercargill
12 NZ Herald (2021), Amazon says it will spend '$7.5 billion' on giant data centres in Auckland

An industry-wide, market-based pathway towards 100% renewables

At Contact Energy, we believe decarbonisation is both an environmental imperative and a great opportunity for Aotearoa, and this holds strong to our commitment to tiakitanga – to care for New Zealand' tiaki taiao and tiaki tangata. In early 2021, we refreshed our strategy to **lead New Zealand's decarbonisation** through 'Contact26'. In line with this strategy, we are **growing demand** for 100% renewable electricity with projects like Southern Green Hydrogen[13], while **growing renewable development** with the Tauhara power plant, **and decarbonising our portfolio** to contribute to contribute to our 100% renewable target.

This report builds on our portfolio decarbonisation strategic pillar and is the culmination of our research into crafting a path towards New Zealand's 100% renewable electricity market. Our analysis builds on the Climate Change Commission's detailed modelling of New Zealand's decarbonisation scenarios, particularity focusing on the 'Tiwai stays' scenario (see page 15: Research Methodology).

In the report we describe what it will take for New Zealand to get to 100% renewable electricity while achieving the two objectives of keeping the energy trilemma – decarbonisation, security of supply and affordability – in balance, and ensuring an orderly transition of fossil fuelled assets. We examine the challenges the electricity market faces meeting these objectives; specifically, we assess potential market structures to address the challenges and analyse how each would perform against them. Finally, we offer a proposed path forward: the establishment of a ThermalCo – an industry-wide, market-based solution for New Zealand.

This path is not without complexity; we now invite the broader New Zealand energy industry to collaborate in building an industry-wide, market-led solution that will facilitate New Zealand's transition away from fossil fuelled electrictiy generation.

13 Contact and Meridian (2021), The New Zealand hydrogen opportunity

How New Zealand's electricity market covers consumers electricity demand

In New Zealand today multiple technologies compete in a single, energy-only, marginal market, in which the price is set in 30-minute intervals by the most expensive generation plant required to meet consumers' demand in each time slot. Generally, in the course of a year:

- The baseload demand is covered by ~8TWh of geothermal and ~1.2TWh of highly efficient cogeneration power plants;
- When wind blows, it provides ~3TWh of generation;
- The remaining gap to meet the demand is typically covered by stored hydro power and river flows, which provides the bulk of our energy generation through the day, generating between 21 and 27TWh a year depending on rainfall.

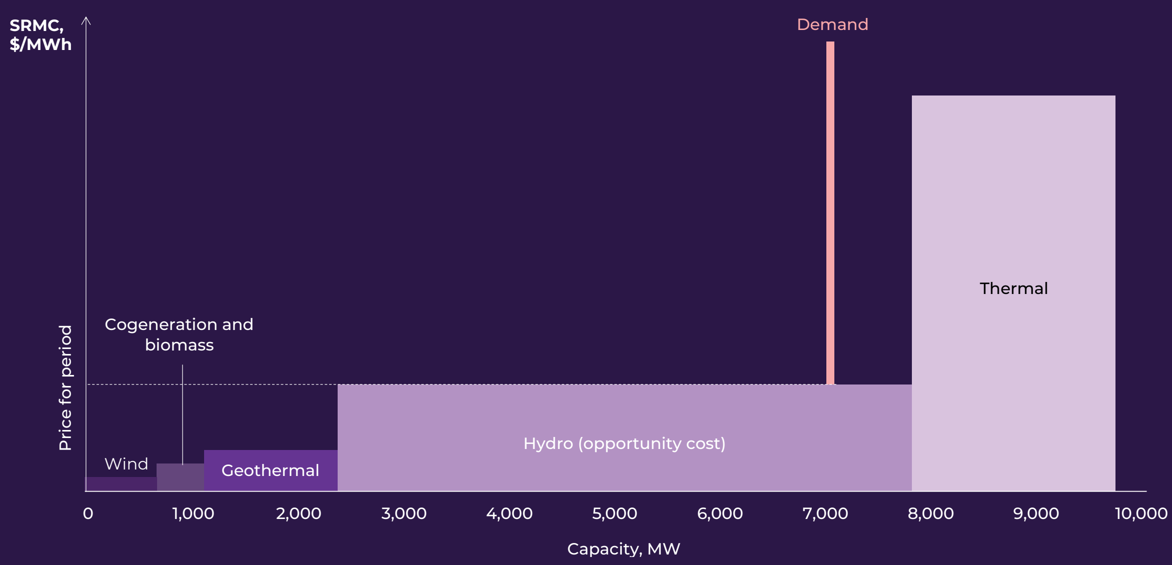
When it is not economic to use hydro, the final gap to meet demand and cover the hydro swing (the difference in generation due to rainfall) is provided by fossil fuelled thermal power plants. This 'thermal gap' (i.e. the share of demand that needs to be covered with thermal generation) in a mean hydro year is currently around 4.5TWh (excluding cogen), but this can fall to ~2TWh in a wet hydro year, and rise to ~8TWh in a dry hydro year.

When the power plants cannot cover the demand, there are 'demand response' mechanisms in place. This is where large scale consumers disconnect part of their loads to maintain system stability.

Different technologies are currently being discussed as potential alternatives to using fossil fuelled generation to cover the 'thermal gap' and winter demand peak in the North Island, including Lake Onslow, a hydrogen fuelled demand response, or the conversion of Huntly to biomass.

Illustrative short run marginal cost (SRMC) supply curve

Short run marginal cost (SRMC) supply curve



Research methodology

In this report, we have based all market modelling on the Climate Change Commission's (CCC) report: 'Ināia tonu nei: a low emissions future for Aotearoa'. This is the Climate Change Commission advice to Government on climate action in Aotearoa and details the paths Aotearoa can take to meet its climate targets. We are using the 'Tiwai-stays' sensitivity as our base case. We have assumed that a closure of the smelter would facilitate an equivalent replacement load.

Hydro-thermal stochastic optimisation modelling was undertaken by Energylink on behalf of the CCC. We have used the resulting modelling outputs, at a 3-hourly dispatch granularity.

We have overlayed Transpower energy and capacity margin methodology to perform security of supply calculations. LCOEs (Levelised Cost of Energy) from MBIE and CCC have been used as a reference for the potential cost of development of new renewable electricity projects.

Desktop research and internal Contact Energy analytical capabilities have been used to investigate and simulate alternative pathways, in conjunction with the support of local and international consultants.

Maintaining the balance to ensure an orderly transition

In the journey towards 100% renewable electricity, New Zealand will need to maintain its world-class balancing of the energy trilemma: decarbonisation, security of supply, and affordability, while ensuring an orderly transition of New Zealand's electricity market.

New Zealand's 'triple-A' rating in the World Energy Council's Energy Trilemma Index[14] reflects the energy industry's enviable track record of maintaining an environmentally sustainable, reliable, and affordable energy supply. In the last step of our journey towards a 100% renewable electricity market, our industry must continue to get this balance right. Kiwis will expect nothing less as their electricity demand is expected to increase faster than in the last 20 years[15].

The transition towards a renewable electricity market will not be straightforward to navigate. Few countries globally have achieved levels of renewable power close to 100%, and even fewer operating in liberalised energy markets. For New Zealand, the transition approach will need to be tailored to our very specific needs and unique hydrology characteristics and resources, while learning from comparable highly renewable electricity markets as well as other markets under deep renewable transitions (see page 24: Learnings from other markets transitioning to high renewables).

New Zealand's electricity market is currently in good shape with a 1GW capacity margin to cover winter demand and intra-day peaks, and enough flexibility to meet demand in dry years. However, this safety net could be jeopardised by increasing renewables penetration which results in the utilisation of the thermal fleet halving to

14 World Energy Council (2020), Energy Trilemma Index, 2020 Country rankings
15 Climate Change Commission (2021), A low emissions future for Aotearoa

below 20% by 2030 (according to CCC modelling). Lower thermal utilisation makes it more difficult to recover fixed costs in the spot market. This would push asset owners to set higher prices in the few hours they could run the assets, thereby increasing the market volatility, or in the worst case leading to an abrupt decommissioning of thermal assets and putting security of supply at risk.

In the next 10 years, the focus for New Zealand's energy industry must be on keeping the trilemma of decarbonisation, security of supply and affordability balanced as it approaches the 100% renewable electricity mark.

Maintaining the energy trilemma balance

Decarbonisation

Decarbonisation of the power sector is well on track, with ~8.5TWh of new renewables identified that could be economically developed by 2030 if demand conditions allow.

Achieving a 100% renewable electricity market will reduce CO2-e emissions by around 3Mt per year. A first step towards this goal, as outlined by the CCC, would be to achieve ~96% renewable electricity penetration attracting ~8.5TWh of new renewable generation from 2022 to 2030 (in the Tiwai stays scenario). The new generation will most likely come from a mix of geothermal, wind and solar and would reduce yearly emissions by 1.2Mt.

There are a number of factors that need to be considered when making an investment in renewables, including availability of resources, environmental impacts, network access, grid constraints and locational risk. There are diverse renewable electricity resources scattered throughout all New Zealand's regions. The main challenges for renewable electricity projects to come online will be securing resource consent, access to the transmission network, avoiding grid constraints and preventing an overbuild effect that could cannibalise the output of new projects in the short to medium term.

The New Zealand nodal energy market provides the right incentives to overcome these challenges, as prices in nodes where the network is constrained, or there is an overbuild of renewables, will rapidly fall (especially in periods of high renewable generation). This reduces the Generation Weighted Average Price (GWAP) and therefore the attractiveness of new projects.

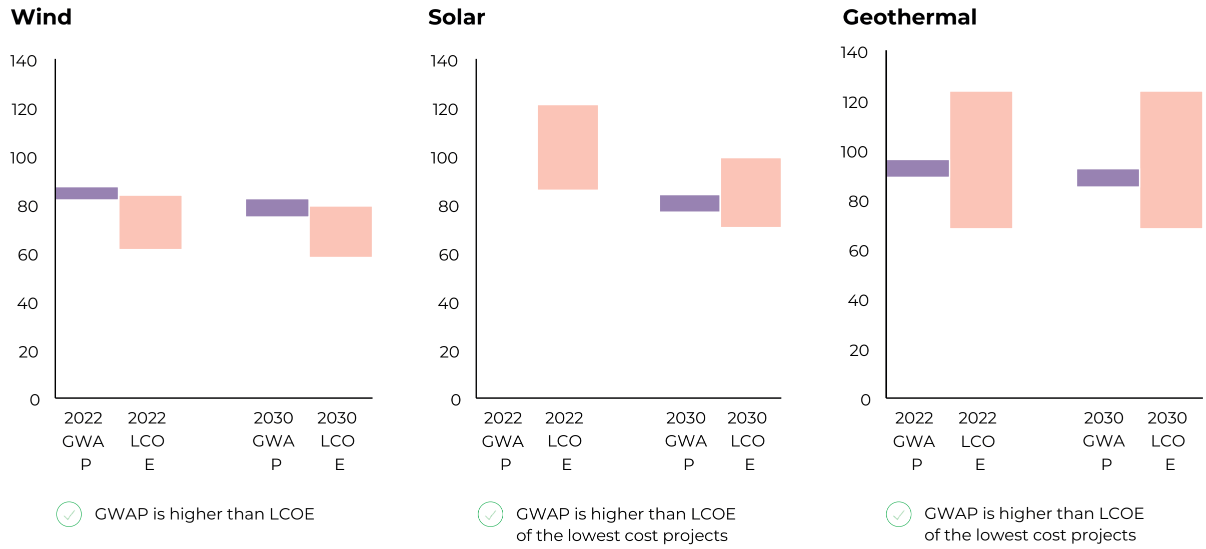
For new renewable electricity projects to enter the market, the expected Generation Weighted Average Price (GWAP) must be equal to or higher than the expected Levelised Cost of Energy (LCOE) of new generation. Expected LCOEs for new renewable generation heavily depend on location and project specific configurations, with the CCC estimates for 2021 ranging from:

- $60-85/MWh for wind (intermittent/unfirmed);
- $70-125/MWh for geothermal (baseload/ firmed); and
- $85-120/MWh for solar (intermittent/unfirmed).

The CCC 'Tiwai stays' scenario is projecting an average wholesale electricity price of

Exhibit 4: Expected Generation Weighted Average Price (GWAP) versus LCOE of new renewable generation

Main investment driver – GWAP vs LCOE for wind, solar and geothermal $/MWh



1. Generation Weighted Average Price
2. Levelised Cost of Energy

$89/MWh[16] from 2022 to 2035 in a mean hydro year. Other market analysts[17] are also projecting long-term average electricity prices above $80/MWh. Expected wholesale energy prices give an indication that renewable projects with lower LCOE are already viable (Exhibit 4); this is supported by projects like Tauhara, Turitea and Harapaki being announced recently.

The transition towards a 100% renewable electricity market must ensure these pricing signals are maintained and market equilibrium is not lost, to continue to give confidence to investors and see a growing pipeline of new renewable electricity projects.

Regulatory and policy uncertainty is another key risk for a full decarbonisation of the market, increasing the risk premium for investors. In markets such as Germany, Italy and the UK[18] this uncertainty has resulted in the temporary freezing of new investment activity (see page 24: Lessons from other markets transitioning to high renewables).

Security of supply

To maintain security of supply New Zealand needs both energy flexibility to address dry-year risk and firm capacity in the North Island to cover peak demand. This flexibility needs to be backed with a reliable and flexible fuel source until alternative technologies or large-scale demand response become available.

The transition towards a 100% renewable electricity market will require new sources of flexibility to become available to replace the flexibility that thermal currently provides.

Currently ~5TWh of thermal energy (not including cogeneration) is required to meet demand in a mean hydro inflow year (Exhibit 5). According to the Climate Change Commission modelling, in the scenario where the Tiwai smelter stays (or equivalent demand replaces it), further renewable development will reduce the thermal requirement by 2030 to:

- 2TWh in a mean hydro year;
- ~4.5TWh in a dry hydro year;
- ~0.3TWh in a wet hydro year.

16 Real 2021 NZ dollars, referenced off the Haywards Grid Exit Point (GXP).
17 Jarden ~$80/MWh: (2021) *NZ electricity generators: with large decisions ahead, sector still stacks up*; Meridian ~$80/MWh: (2021) *Power without the carbon?*
18 Florian Elgi (2020), Renewable electricity investment risk: An investigation of changes over time and the underlying drivers

In wet years, we should expect there will be excess energy that cannot be stored, resulting in spillage of hydro and wind. This excess of spilled energy results in a decrease in the thermal energy requirements from wet to dry years (i.e. 'hydro swing') from 5.2TWh today to 4.2TWh by 2030, as shown in Exhibit 5.

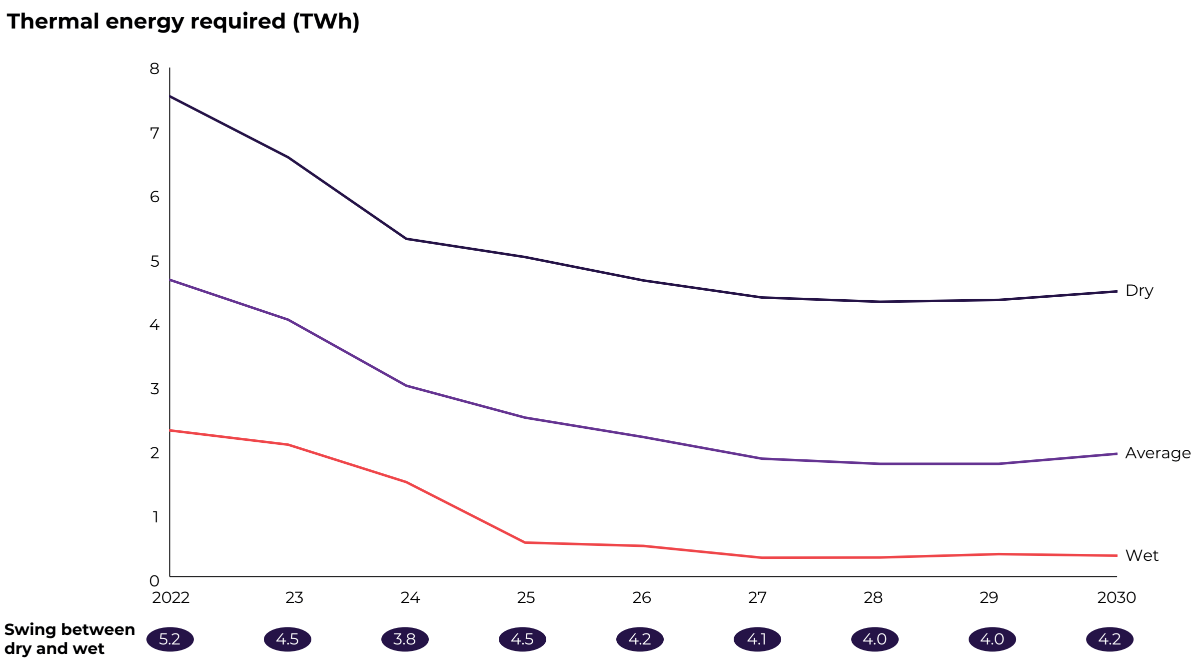
To provide this large swing in energy it is essential there is a reliable and flexible fuel source. Currently this flexibility is provided by the Huntly coal stockpile, coal imports, domestic gas production, the Ahuroa Gas Storage (AGS) facility and industrial demand response. Should coal no longer be a major contributor to this energy swing[19], up to 36PJ of gas will be required to generate the 4.5TWh of electricity during dry years. In a mean hydro year, the gas demand would fall to 14PJ and in a wet year to just 3PJ. The 33PJ of gas flexibility required cannot be met from current fuel storage or contract arrangements, requiring additional flexibility in both domestic gas production and from industrial gas users.

Alternatively, new energy flexibility sources able to store over 4.5TWh of energy could be developed in the transition, such as pumped hydro storage, biomass, biogas, hydrogen, or large-scale industrial demand response.

During winter, the North Island experiences peak electricity demand periods during a few hours in the evenings, when Kiwis get home and turn on heaters and appliances. These periods are especially pronounced in the coldest days of the year. In a 100% renewable electricity market, where wind generation is ~20% of total electricity supply, winter supply could be at risk in the periods when Kiwis need it most.

We have assessed security of supply using Transpower's 'Security of Supply Annual Assessment' methodology and overlaid the CCC modelling assumptions. In 2030, peak North Island demand is expected to be 5,240MW, and in order to cover the safety margin of 630MW to 780MW, around 5,870MW to 6,020MW of firm generation capacity is required. 4,600MW of firm peak capacity could be provided in the North Island by new and existing renewables, cogeneration, batteries and the HDVC interconnector, according to the CCC. This leaves a 1,300-1,430MW gap to be covered with thermal generation or no-carbon alternatives (including more batteries) to stay within security of supply safety limits (Exhibit 6). The CCC modelling assumes 1,150MW of firm thermal capacity is

Exhibit 5: Hydro generation swing



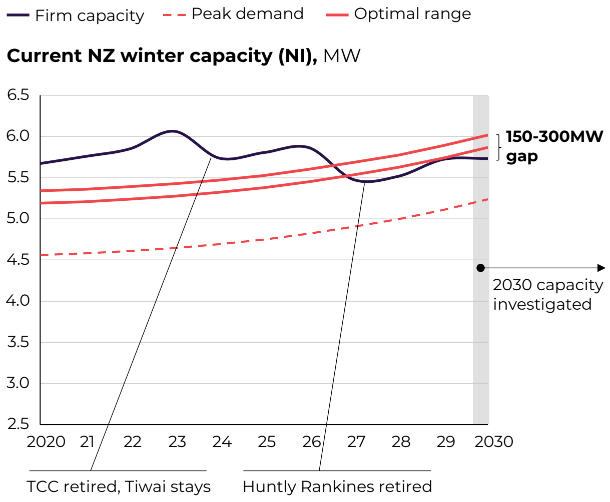
Source: Contact analysis based on CCC data

19 The CCC assumes the Rankine units are closed in 2026

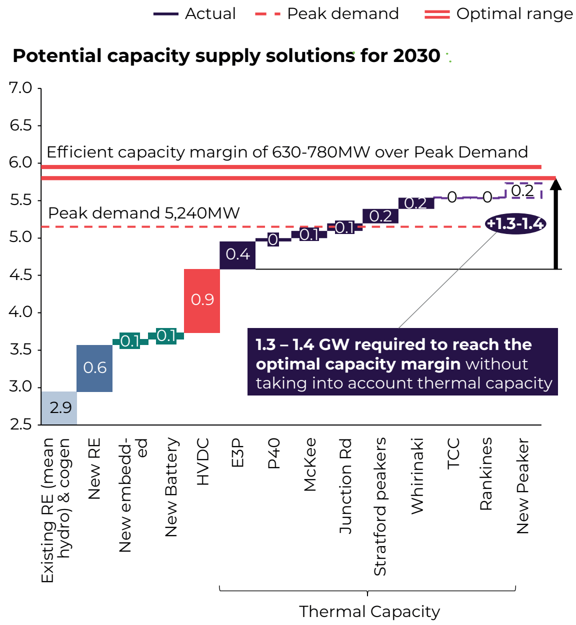
Exhibit 6: Capacity margin evolution

Winter capacity margin in CCC Demonstration

Current NZ winter capacity (NI), MW



Potential capacity supply solutions for 2030



Source: CCC Modelling

available in 2030, which falls short of Transpower's safety limits.

To maintain the security of supply in the transition towards a 100% renewable electricity market, New Zealand must ensure enough flexible fuel is available in the system to meet the dry-year risks, while enough capacity remains online to cover winter peak demand periods. This would require thermal operators to continue to maintain plants for long periods of time while they are not generating electricity. A predictable and stable revenue stream for thermal operators would enable them to cover the ongoing maintenance costs over these periods when they are not earning revenue in the wholesale spot market.

Affordability

Competitive market pressure will be necessary to achieve decarbonisation and security of supply at the lowest cost for customers

The current wholesale market does provide the right price signals to attract new renewable electricity projects and investment that outcompete more expensive thermal generation.

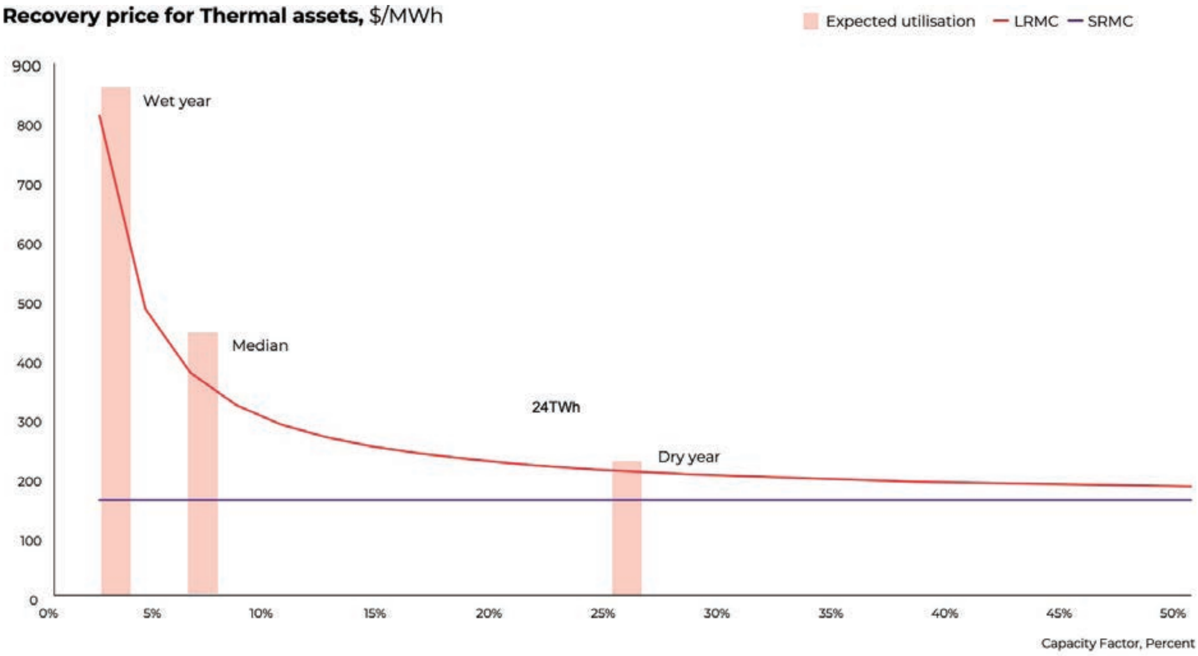
If demand growth outpaces supply growth then prices rise, which sends a signal to increase investment (and prices fall if supply growth outpaces demand).

However, New Zealand will also have to keep thermal capacity online until other flexible generation sources are available to ensure security of supply. Today, the 1,900MW of thermal capacity available (excluding cogen) requires $100 million to $150 million of spending to cover fixed costs[20,21,22,23] every year to keep operating, which represent $2-3/MWh for the entire market. Fixed costs are recovered during the hours when they operate, but this will become increasingly challenging as more renewable generation enters the market and drives prices down. The Climate Change Commission projects utilisation of gas peaking plants dropping <15% most years (Exhibit 7), requiring higher prices (above >$400/MWh in median years) to cover their fixed costs.

The challenge of recovering these costs over fewer and fewer periods will lead to increasing price volatility in the wholesale spot market. The impact of this is an less stable environment

20 Jarden (2021), *NZ electricity generators: with large decisions ahead, sector still stacks up*
21 WSP on behalf of MBIE (2020), 2020 Thermal Generation Stack Update Report
22 Contact Energy (2021), 2021 Full Year Results
23 Genesis (2021), Annual Report 2020-2021

Exhibit 7: Long-run marginal cost of gas peakers under different utilisations



Source: Contact analysis

for all stakeholders that may increase prices for consumers:

- **Thermal asset owners** would be facing higher carbon prices and the prospect of not recovering fixed costs in some years (when rainfall is above mean). There may also be higher operational risk of their assets, given the greater impact of unplanned outages on the decreasing hours of utilisation. The increased risks will likely result in an increase in risk premiums that would be reflected in the derivative markets, raising cost for consumers.

- A very volatile market creates an unstable environment for **renewable electricity investors** – who in general seek predictable, stable cash-flows in markets with regulatory stability. Exposing New Zealand's energy market to high volatility and potential risk of regulatory intervention could see renewable investments slow down. New renewable projects are often underwritten with Power Purchase Agreements (PPAs) which provide a stable cashflow for the generation output, however greater regulatory intervention risks may limit buyers' appetites to enter into long term, fixed price agreements. Furthermore, in markets with high volatility and uncertainty the risk premium on any hedge products would rise, increasing the cost to consumers. Sustained high volatility can be a market signal for the investment of flexible 'green' energy solutions, however these can take years to design, fund, and build with consumers and retailers incurring high costs in the interim.

- Volatility and exposure to sustained periods of high wholesale prices would also increase pressure on **energy purchasers and retailers**, who may not have the ability to rapidly pass-through market changes to customers as a mechanism to keep their books balanced. Retailers would also price the risk derived from volatility into their tariffs, which may result in higher costs for consumers. At the extreme, this could lead to a similar situation where small retailers that could not adequately cover their market risk exposure due to an extreme and sustained price increase, like seen in Australia or the United Kingdom.

No-carbon alternatives to thermal generation are emerging as technology evolves. Over recent months, we have seen different analyses and proposals from Concept Consulting, Genesis, Meridian and MBIE focusing on which technologies could best substitute the current thermal asset base. The portfolio of solutions that could be applicable in New Zealand are aggregated in Exhibit 8. While today maintaining the existing fleet seems to be the most affordable option, batteries, green fuels in existing plants, large-scale demand response (e.g. in hydrogen) or

Exhibit 8: Potential decarbonisation solutions

Technology	Description	Pros	Cons
Fossil Gas Peaker	Retain a small amount of gas-fired peaker generation in the North Island in combination with other sources of flexibility e.g. batteries, DSR1	Low fixed costs Located in North Island matching demand	Carbon emissions
Green Peaker	Convert gas-fired peakers to run on biofuel	Scalable as per demand Neutral carbon emissions	High fuel costs
Coal reserve	Retain the coal-fired Huntly station, but only run when lakes are low	Located in North Island matching demand	Carbon emissions Not as flexible as other technology
Renewable electricity overbuild	Size renewable electricity capacity to have just enough in periods of scarcity and spillage in periods of high renewable electricity output	Larger share of firm capacity provided by renewable electricity	Spillage increases consumer prices (needs to be partially paid back to asset owners)
Hydrogen / Aluminium flex	Set up a large scale demand response from a hydrogen production facility or the Tiwai aluminium smelter, e.g. curtail plant demand based on opportunity cost between electricity and commodity price	Low capital cost Large scale resource Good fit with renewable electricity	Located in South Island
Pumped hydro	Build a pumped hydro storage facility in the South Island that pumps water up to the reservoir at times of renewable electricity excess	Large scale resource Good fit with renewable electricity	High capital costs and low efficiency Located in South Island Long development times
Green Rankines	Run the existing 500MW Rankine cycle plant (units 1,2,4) on biodiesel, biomass, or green hydrogen fuel	Scalable to demand Neutral carbon emissions Existing generators	High fuel costs

pumped hydro appear likely to be the key potential competitive candidates by the end of the decade and possibly sooner.

New Zealand must ensure volatility and market uncertainty is properly managed during the transition. This will maintain the market signals needed to attract the most efficient investments in technologies to cover both bulk energy supply, dry-year and winter peak demand. Providing greater certainty and equitably sharing the fixed costs required to ensure security of supply would be the most effective way to keep energy affordable for consumers, while attracting new technology investments in a timely manner will reduce overall system costs.

Ensuring an orderly transition for New Zealand

An orderly transition for New Zealand's electricity market avoids the cascading impacts that uncoordinated decisions on assets can have on security of supply, affordability, jobs and investments.

New Zealand's transition to 100% renewable electricity is going to be one of the first in the world, especially amongst liberalised electricity markets. Market signals will need to continue to attract renewables as they have to date, while also incentivising cost effective solutions to guarantee security of supply. These signals should herald a smooth transition of assets, providing enough certainty to find alternatives, and should evolve together with the market requirements and technology improvements to ensure an approach that benefits all of Aotearoa.

With thermal asset utilisation under pressure, there is a growing risk in decommissioning decisions being taken by individual asset owners who do not want to carry the risk of increasingly uncertain cost recovery. Uncoordinated decommissioning would have cascading effects for New Zealand:

- There may not be sufficient time to create robust **transition plans for the people, regions and communities** that depend on these assets – resulting in a **lack of readiness of alternative technologies** to mitigate the energy security risk; and/or inadequate planning and development of new opportunities, for example jobs in new industries or in the construction phase of alternative energy solutions;
- **Price volatility would be exacerbated**, Whilst this would send a signal to increase investment in alternative technologies, a 'disorderly' transition would see market risk premiums increase as a result of the price volatility, which could make energy less affordable during the transition;
- **Security of supply** may be compromised, or may be provided by more costly alternatives to thermal (until alternative technologies are developed and the market finds its long-term equilibrium);
- The **upstream fuel supply would suffer** from **lack of demand certainty**, potentially leading to delays in investments required to guarantee a secure fuel supply.

We believe the current market structure will provide the price signals to incentivise the new investment required, however the sort of outcomes we might see from a disorderly transition may tempt regulators to intervene. Any intervention that blunts pricing signals will have a cascading effect on investment decisions, creating even more pressure on regulators.

Conversely, providing transparency and visibility through a more coordinated decommissioning plan will alleviate most of these challenges, making the transition smoother. Risks will be lower for thermal asset owners which will help to keep volatility within acceptable levels that will still attract the required investments. Transition plans for the people and communities will be made and coordinated with the development of alternative economic activity in the regions, and there will be certainty for the upstream fuel supply industry.

Learnings from other markets in the transition towards high renewables

***New Zealand is not alone in managing the complex set of trade-offs required to transition to a renewable electricity market.* Governments across the world are taking action and pushing legislation to address the transition issues, such as the implementation of Capacity Markets or Reserve Services offered by the System Operator (SO). Understanding the impact of different pathways taken by other countries and taking key learnings from each international experience can help New Zealand get the transition right.**

Capacity Market in the United Kingdom got off to a bumpy start: low prices and 1 year suspension due to legal challenges

In the UK capacity was expected to drop significantly due to the closure of several firm capacity power plants. In 2014, the government approved the implementation of a technology-neutral Capacity Market, with the official delivery start in 2018 and the objective to maintain the UK capacity margin within a safety range.

However, by the end of 2018, the Capacity Market was suspended by European Court of Justice after a legal challenge alleging it discriminated against demand response. As a consequence, £1.1 billion of contracts awarded in 2014 with expected delivery between October 2018 and September 2019 were at risk.

A review from the Institute of Energy Economics and Financial Analysis calculated the scheme had cost ~NZ$7.4 billion, with 83% of the funds going to operators of existing power plants, and only 3.5% awarded to operators to build new generation.

There are three key learnings for New Zealand:

- A capacity market takes time to implement and deliver impact (4+ years to reverse capacity margin downward trend in the UK), making it less suitable as a transitional measure.
- It does not ensure regulatory certainty as it is exposed to constant scrutiny of the regulator to ensure fair competition among technologies, putting investments at risk if suspended
- It limits the intake of new capacity in the market if clearing prices are not sufficiently high (a significant share of capacity awarded in the UK was from existing generation).

Germany opted for a SO-owned Strategic Reserve which had to continuously evolve the services offered to accommodate market needs

The German government has had a complex decade as it pursues an accelerated transition agenda which requires the closure of its large fleet of brown coal and nuclear power plants. Germany faced the same two fundamental issues that New Zealand does: how to maintain a balanced

market with increasing renewables while ensuring a fair transition away from thermal assets.

Germany has avoided capacity markets, stating that they 'can be expensive and inefficient.'[1] Instead, it has relied on new reserve markets where energy imbalances are traded intra-day to ensure the market remained balanced. There are currently four different types of Reserve Markets: Grid Reserve, Capacity Reserve, Safety/ Climate Reserve and Special Grid Reserve.

In some cases, reserve markets or services implemented have been proven unnecessary. For instance, in 2015 Germany established a strategic reserve of eight brown coal generators to help stage the thermal shutdowns. Under this scheme the generators were mothballed and kept separate from the market, only to be used in an extreme event where all market options had been exhausted. This was done at a cost of ~€230 million a year, with the intention of ensuring that some firm thermal capacity remained in the market. The fear of all thermal capacity rapidly exiting the market proved to be unfounded, and now in 2021 Germany is holding reverse auctions in which the remaining coal generators bid their minimum price to shut voluntarily.

Further, market changes can lead to high volatility if pricing design is not done correctly. In 2018 due to some market inefficiencies, Germany introduced a new 'mixed' pricing system. This led to a sevenfold increase in reserve price and increased the number of events requiring intervention. Within 2 years Germany reverted to their original pricing system.

There are two key learnings for New Zealand:

- A strategic reserve market requires iteration and continuous evolution to achieve a balanced market
- It relies on the planning and optimisation capabilities of the SO, which could lead to unnecessary intervention given the limited price signals from the market.

Australia is proposing a capacity mechanism based on mandated peak capacity coverage from retailers

Australia has an Energy-Only wholesale market, similar to New Zealand. Recently, the Energy Security Board (ESB) proposed to establish the Physical Retailer Reliability Obligation (PRRO). Under this new scheme (PRRO), capacity certificates would be allocated to physical resources based on their expected availability during supply stress periods. Liable entities (retailers and consumers) would be required to hold sufficient capacity certificates (rather than sufficient qualifying financial contracts) to cover their share of actual peak electricity demand. This aims to provide investment signals to timely increase capacity or orderly phase it out.

The Australia ESB proposal is very similar to how ThermalCo would operate, with the main difference being how the PRRO will be established as a new regulated market, while ThermalCo would rely on existing derivative markets backed by the high amount of flexibility already available in New Zealand. This proposal is currently under review and impact on the system is still unknown.

1 Clean Energy Wire (2016), Germany's new power market design

Three potential pathways to support the transition improving the status-quo

We have explored three alternative pathways that could keep the energy trilemma balanced whilst transitioning to a 100% renewable electricity market:

1. **The setup of a Capacity Market maintaining current asset ownership structure**
2. **The establishment of Strategic Reserve with support from Government**
3. **The establishment of a ThermalCo which consolidates all thermal assets operating in an Energy-Only market supported by risk management products.**

Market structures to keep the trilemma in balance

In the previous chapter we have considered how the market might evolve under the **status quo**. Under the status quo there is a risk of a disorderly transition which leads to sub-optimal outcomes for affordability and security of supply. In this chapter we explore three alternative market constructs to support the energy trilemma balance in New Zealand, drawing from examples in international markets (see Exhibit 9) as they transition to high shares of renewables: Capacity Markets, Reserve Payments and Energy-Only Markets supported by risk management products.

Energy Markets connect generators and purchasers to trade energy in MWh, and are often negotiated in the short term, close to delivery as the generation and consumption certainty increases. Long-term contracts and risk management products are available, driven by risk aversion of purchasers to high market prices or the need to ensure long-term price certainty, offering multiple ways to source the electricity linked to its physical delivery in the energy spot market. This market structure is reflected in this report as the **Energy-Only Market** and is the one in place in New Zealand today.

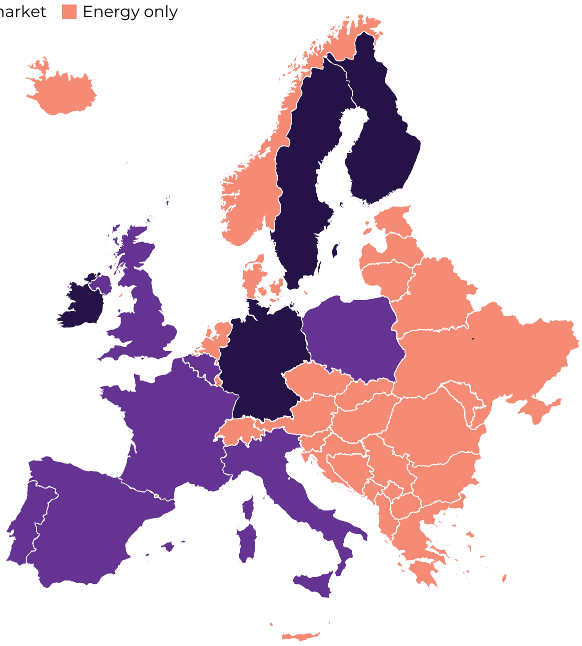
Capacity Markets trade capacity in MW and usually connect generators, procuring long-term stability in their investments, with market operators, regulators, or governments seeking to secure the system stability in the mid- and long-term. Some countries, like the UK, Italy and France, leverage Capacity Markets together with the energy market, to maintain security of supply in the long term while ensuring efficiency in the short-term dispatch. In this report we refer to this combination as the **Capacity Market**.

Other countries like Spain, Germany and the Nordics (NordPool market) have a predominant Energy-Only Market supported with additional strategic reserve mechanisms to maintain system stability. Strategic reserves can be articulated differently depending on the level of regulation in place. A more regulated setup with discrete government intervention is what we refer to in this report as the **Reserve Payments** structure.

Exhibit 9: Market structures in Europe, 2021

High-level overview of capacity mechanisms in Europe in 2021

■ Strategic reserve ■ Capacity market ■ Energy only



Iceland

Energy only market since 2003. It is 100% renewables with ~75% Hydro and 25% geothermal

France

Capacity requirements in place (capacity market operational since 2017). Capacity certificates traded through organised market sessions or OTC transactions

Spain

Capacity payments (since 2008) comprising investment incentives (only for generation capacity installed before 2016) The minister considers new capacity mechanism as a key instrument for meeting the objectives of the Energy Storage Strategy (20GW by 2030)

Norway

Is part of the Nord Pool energy only market. **It is made up of ~99% renewable energy**, generated from largely **hydro power (95%)** and wind

Germany

Grid reserve for pronounced (regional) high-demand situations

Capacity reserve as main future element with 2 GW (technology neutral) procured by SOs every 2 years

2.7 GW l**ignite-fired power plants in reserve**

SOs procure a total of 1.2 GW active power via tender

Italy

Capacity market since 2019: first 2 auctions for 5.8 GW new capacity were held in November 2019

35 GW of existing capacity were auctioned respectively for 2022 and 2023 delivery period

Ongoing discussions about new tenders for the delivery period 2024-2025.

Source: ACER based on information from NRAs and the EC, National Regulator's, TSOs; S&P Global Platts; Press Miteco; BMWi, Next Kraftwerke; RWE; Press; Elia

Thermal ownership structure to ensure an orderly transition of New Zealand's electricity market

In the specific context of New Zealand, which has a relatively small share of thermal capacity left in the market, we have explored which ownership structures could better ensure an orderly transition for the electricity market and for the people of New Zealand: Independent Ownership, Independent Ownership with Government support, and Consolidated Ownership.

Independent Ownership refers to maintaining the ownership of existing thermal assets by independent companies. Independent Ownership with Government support involves the Government entering into bi-lateral deals with thermal asset owners to agree on decommissioning dates and plans. Consolidated Ownership refers to the consolidation of existing thermal assets and its fuel supply contracts into a single entity.

Defining three potential pathways to support New Zealand's transition

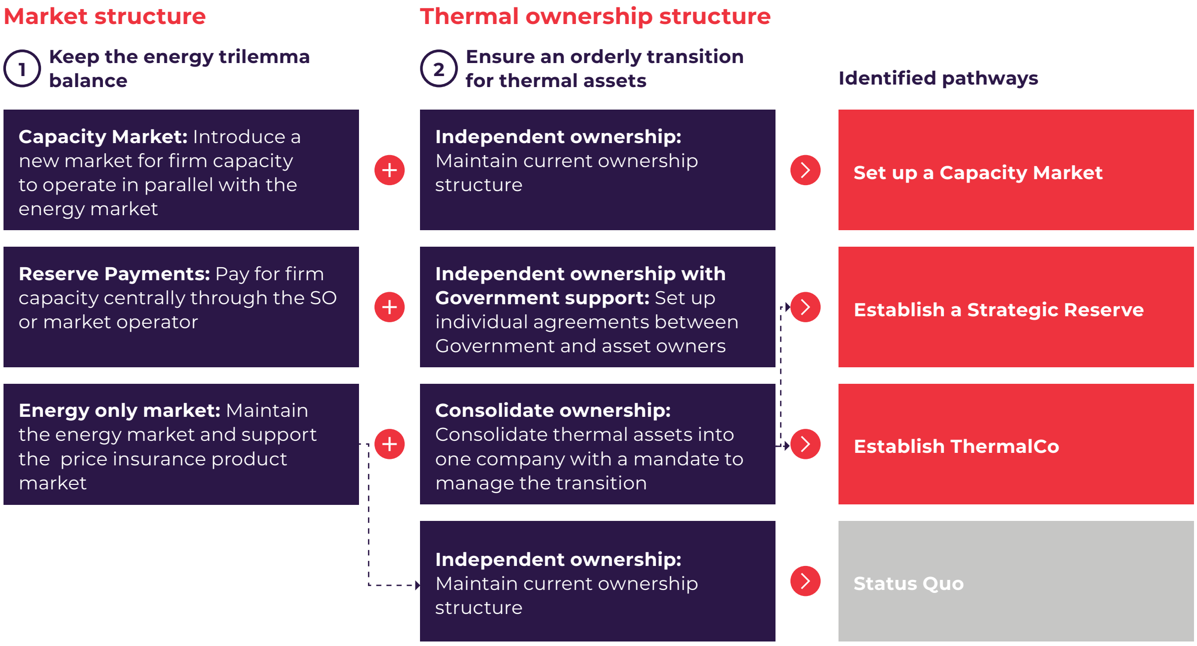
The combination of the market structure constructs with their most natural ownership structure led us to define three alternative pathways to support New Zealand's transition:

1. Set up a Capacity Market, based on continuing the Independent Ownership of the assets
2. Establish a Strategic Reserve, based on Independent Ownership with Government support
3. Establish ThermalCo, based on Consolidated Ownership.

These pathways and the combinations of market structures that led us to them are outlined in Exhibit 10.

Below we outline each pathway in detail: Capacity Market, Strategic Reserve and ThermalCo. We then review the effectiveness of each in solving the trilemma of decarbonisation, security of supply and affordability, as well as how the pathways contribute towards an orderly transition. Finally, we assess the implementation feasibility of each.

Exhibit 10: Three pathways for New Zealand's transition



Set up a Capacity Market

Under this pathway, New Zealand would set up a **Capacity Market** to work jointly with the existing energy market, leaving the current **Independent Ownership** structure untouched.

The Capacity Market would remunerate power plants for the capacity they provide to the market, instead of for the energy they generate. The objective is to incentivise the installation and maintenance of firm capacity in the market, in exchange for fixed payments ($/MW) that are organised through auctions. These auctions ensure that the most cost-effective capacity is operational in the market to cover demand (winter peak and dry year demand) in the mid and long term. In capacity markets, contracted capacity will need to provide the required firm electricity in periods defined by the System Operator. The demand for capacity would be set by the System Operator (SO), which would decide the frequency (typically yearly) and duration of capacity payments (typically with auctions ranging from 1 year to 10 year offers).

All existing and new power plants could bid into these auctions to offer their firm capacity contribution (calculated by System Operator) and be entitled to receive the capacity payments if they are awarded. The total cost of the Capacity Market would be passed to customers in their bills through a Capacity Market levy.

Power plants still participate in the energy market to cover their variable costs and capture additional returns not covered through the capacity payments. Also, asset owners maintain ownership and dispatch control of the asset, which is still driven by short-term market signals.

The Capacity Market approach has been one of the most common mechanisms in Europe to mitigate the impact of an abrupt increase of renewables penetration, given the ambitious targets set by the European Union. Capacity Markets are a fundamental shift from an Energy-Only market and are used to solve structural market deficiencies. This market typically takes a long time to achieve results, especially when capacity markets are added to operational energy markets as both markets need to operate in conjunction, providing the right signals for both the short and long term to achieve efficient outcomes.

Establish a Strategic Reserve

Under this pathway New Zealand would establish a Strategic Reserve anchored on existing thermal assets. The ownership structure could:

- maintain existing Independent Ownership complemented by targeted Government support; or
- be consolidated as a single Strategic Reserve company.

Strategic Reserve would be supported by **Reserve Payments**, which are long-term contracts between strategic asset asset owners and the Government or System Operator. These contracts are designed to ensure assets are available to provide firm and flexible capacity in exchange for a payment to cover fixed costs. The process to award contracts can be through regular auctions or tenders, or negotiated bilaterally. The objective is to provide a stable source of income to strategic assets to keep sufficient capacity in the system, so they remain operational when the system needs them. The duration and eligibility of assets would be at the discretion of the Government or SO.

Typically, these reserve mechanisms come with specific guidelines on how the power plants receiving these payments can operate in the energy market. For example, in Germany or the NordPool (the common energy market for all Scandinavia), the power plants receiving reserve payments can only operate in the market if dispatched by the System Operator. This would happen only in situations when supply is scarce, and the variable costs of operations will be recovered at an agreed price. New Zealand had a system similar to Strategic Reserve, through the Whirinaki power plant. This approach was eventually discontinued in 2010 as it reduced incentives on market participants to manage their own risk, distorted market signals for investments on new capacity, and caused regulatory uncertainty according to the Ministerial Review of the Electricity Market[24]

Ownership of assets subject to reserve payments vary by country. In some implementations, System Operators or government owned Strategic Reserve companies are established to isolate these plants from the rest of the market, as is the case for some specific reserve services in Germany (such as Climate or Safety Reserves). In other scenarios, such as in the NordPool example in Scandinavia, ownership of the strategic power plants is private with large utilities, large industrial consumers, energy purchasers or financial investors being the owners of these assets. For New Zealand, we explored pathways where thermal asset ownership is maintained with bilateral government support or consolidated with government support.

There are examples of Strategic Reserve approaches which fall mid-way between a Capacity Market and Reserve Payments, such as the availability payments approach used in Spain. In these schemes, the government pays a fixed payment to selected plants that provide availability in times of scarcity, but it is done at the regulator's discretion instead of following the auction-based, market-wide process characteristic of Capacity Markets. For the purpose of this report, the Strategic Reserve pathway takes the more stringent definition of this approach in

24 MBIE (2015), Chronology of New Zealand Electricity Reform

the comparison of alternatives, acknowledging that certain implementations of it could provide outcomes that are mid-way to capacity payments.

Establish a ThermalCo

ThemalCo builds on New Zealand's existing **Energy-Only Market** structure supported by financial risk management contracts to guarantee long- and mid-term energy supply. The main difference of ThermalCo versus the status-quo would be the establishment of an independent vehicle that **consolidates ownership** and operates all existing thermal assets and upstream fuel supply contracts, with the mandate to sell transparent and liquid risk management products (for both dry-year and peak demand) to all purchasers, while ensuring an orderly phasing out of the thermal capacity when more efficient technologies emerge.

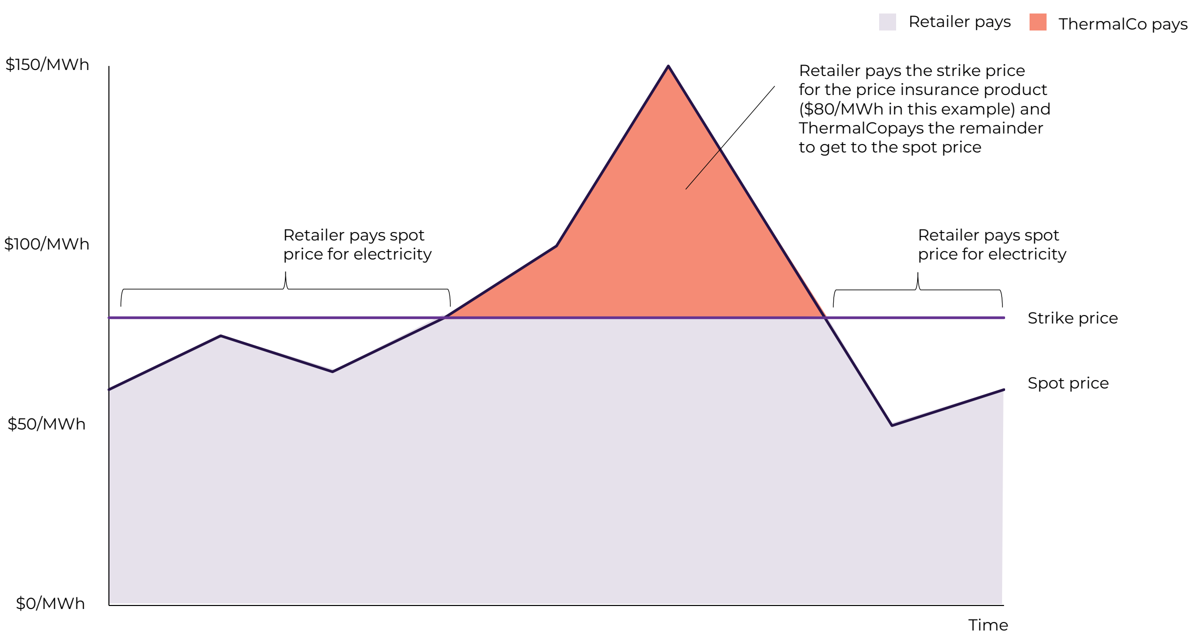
Under a ThermalCo, upfront revenues to asset owners are obtained from risk management products (see Exhibit 11), which will also deliver sufficient returns on the assets to recover fixed costs. As the transition unfolds and new flexible technologies emerge as a competitive alternative to thermal assets, purchasers will reduce the number of hedges with ThermalCo, gradually phasing out thermal capacity.

ThermalCo targets electricity purchasers willing to hedge their exposure to dry years and demand peaks. ThermalCo purchasers will hedge their exposure in advance by buying risk products that, at a certain strike price, can be called so that ThermalCo covers the customer consumption. Risk products offered to ThermalCo customers would cover long-term and short-term needs, with hedging fees directly proportional and strike prices inversely proportional to product tenure (e.g. long-term products will be composed by a high hedge fee and a low strike price).

The Consolidated Ownership structure could be composed of current thermal asset owners, private/ infrastructure investors and potentially other stakeholders in the power sector interested in being part of it, such us retailers, large consumers, or other generators.

ThermalCo builds on New Zealand's existing regulations and draws on the types of products that have worked well in the past, adding the latest industry trends around asset type specialisation. Recent European examples show how major utilities are de-merging thermal assets, (such as E.ON), which are then being consolidated in companies that aim to focus on providing flexibility or managing thermal assets, like Uniper or Fortum (see page 41: Consolidation of thermal portfolios).

Exhibit 11: Example of the mechanics of price insurance products



Price insurance products allows a retailer to set a maximum price for electricity that they expect to purchase, regardless of the spot price

Comparing expected outcomes from the three pathways

Below we explore how these three pathways could support New Zealand's energy trilemma balance in an increasingly renewable electricity market while ensuring an orderly transition for the electricity market. A synthesis of these findings is shown in Exhibit 12.

Exhibit 12: Comparison of pathways for New Zealand's transition

■ Positive contribution ■ Moderate contribution □ Minor contribution

		Capacity market	Strategic Reserve	ThermalCo
Definition		Capacity market operates in parallel to energy market through **capacity auctions**, remunerating available firm capacity through **fixed payments** ($/MW) **Demand** for firm capacity **defined by SO** and **open for new and existing generators**	**Establishment of contracts** between SO and strategic assets **to provide firm capacity** to the system through regular auctions or LT contracts **Dispatch typically regulated** and limited to emergency situations	**Consolidation of existing thermal assets** into an entity to **offer risk management products** to market participants **Continuation of existing market dynamic** driven by energy only market supported by hedging products
Maintaining balance in energy system	Decarbon-isation	Creates a new revenue source for renewable energy, but this may be minimal for intermittent generation projects	Maintains energy market price signals to attract new renewable projects, with moderate risk of muting scarcity price signals which attract investments in clean flexibility	Maintains energy market price signals to attract new renewable projects in the locations where they are most needed through nodal pricing
	Security of supply	Ensures sufficient capacity is in the system through capacity payments but does not provide assurance that capacity will actually be available when required	SO ensures security of supply by directly contracting (reserve payments) with strategic assets	Market participants pay for risk management products to ensure their energy needs are covered, incentivising enough capacity to remain in the system
	Energy Affordability	Skews incentives for least cost generation through introduction of new value stream Does not always result in lower energy prices, due to the introduction of new system costs Does not benefit from operational synergies of existing assets	Risk of reserve payments to be extended beyond the actual need of the assets, leading to uneconomical support of stranded assets May disincentivise the attraction of flexible technologies	Market dynamics put downward or upward pressure on risk management product pricing to ensure capacity mix adapts to system needs Limits impact of volatility to only unhedged market participants Benefit from operational synergies
Orderly transition		Does not directly guarantee the staged and planned shutdown of thermal plants, but it provides long-term transparency through market results	Ensures there are no shock thermal exits but SO decisions can change wholesale market price outcomes and investment decisions	Allows one entity to plan and stage shutdown of thermal plants, benefiting from synergies and learnings Gives one point of communication for government and communities
Feasibility		Requires a new market to be introduced and regulated, which typically needs years to find an equilibrium	No market change required, but it requires change of mandate to SO to be able to source and dispatch capacity, as well as building capabilities	Market already exists and requires no changes. Requires wide-industry agreement and Commerce Commission approval

All pathways would support market decarbonisation, with additional upside from Consolidated Ownership of thermal assets

Renewable electricity investment attraction

Emissions reduction will be mainly achieved through the substitution of thermal capacity with renewables. Renewable electricity investment is expected to occur under the current market structure, driven by the investment conditions already described in Chapter 2 such as market prices and grid stability.

ThermalCo and Strategic Reserve would both help maintain the balance in the system by securing sufficient capacity to ensure security of supply. ThermalCo would secure capacity based on purchasers' willingness to hedge their risk exposure; while the Strategic Reserve would secure capacity based on thorough analysis of the system needs. On the other hand, Capacity Market would need to coordinate capacity needs determined by the System Operator with the energy needs defined by the market, which could pose some challenges to strike the right technological balance at different points in time as the transition progresses.

All three pathways should increase certainty in revenues: ThermalCo through long-term risk management products, Strategic Reserve through long-term contracts with asset owners, and Capacity Market directly through fixed payments on capacity, which could include renewable plant.

Overall, all pathways would drive investment in renewable electricity by maintaining the market equilibrium, although Capacity Market will require an additional effort to coordinate capacity (incentivised by the capacity payments) with energy needs to avoid oversupply.

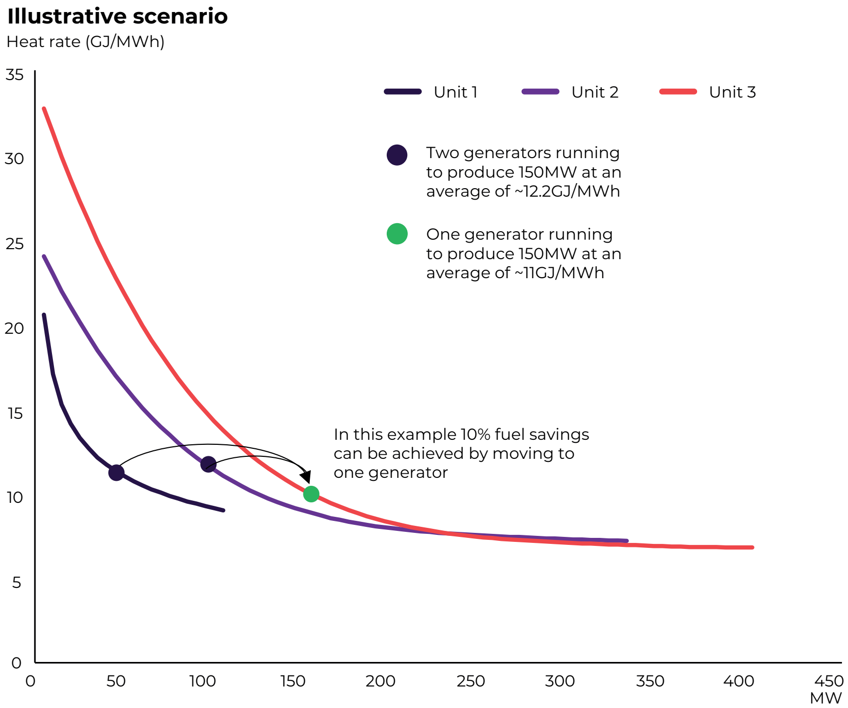
Emissions reduction through operational efficiency

Beyond the increase in renewable penetration, emissions can also be reduced by increasing the efficiency of the thermal capacity operating in the market.

Increasing the overall thermal efficiency of the market would require a joint optimisation approach with all assets participating to determine the optimal operation point of the whole portfolio. That could be achieved if thermal assets are consolidated into one portfolio to ensure that the next thermal MWh is delivered by the cheapest plant/asset available.

It should be noted that in New Zealand players already optimise their thermal portfolio by establishing bilateral agreements to cover

Exhibit 13: Potential operational efficiency gains



Total impact in the system from July 2020 to June 2021 could be:

~4.5% emissions reduction

$18M gas and CO2 costs avoidance

demand more efficiently. This is demonstrated by tolling deals between thermal generators,[25] where a CCGT plant from one generator displaces another generator's peakers. This clearly indicates an appetite among players to optimise their thermal asset base and the desire to seek innovative solutions to reduce fuel consumption and carbon emissions. The advantages of consolidated ownership are that these synergies occur by default, with much lower transaction costs.

Exhibit 13 illustrates how two assets operating at the same time at a non-optimal heat rate could jointly balance their production to achieve a higher efficiency. Over the last 12 months an additional $18 million[26] could have been saved through fuel savings and reduced emissions (from a 4.5% efficiency increase) if the whole portfolio of gas peakers and CCGTs were optimised as a single fleet. This assumes there are no operational constraints, so is likely to be at the upper end of the potential synergy gains. Out of the three pathways, ThermalCo and Strategic Reserve would be best positioned to capture these operational synergies available through consolidated ownership. In a Capacity Market, the optimisation continues to be carried out separately by each asset owner, and ownership consolidation appears less likely.

At a global level, there is also a trend to de-merge thermal assets and consolidate them into specialised vehicles or companies. This is done to achieve a higher operational efficiency, and to isolate the carbon footprint from other business and project a more sustainable image to the market (see page 41: Consolidation of thermal portfolios).

25 Contact operating report (2019)
26 This is a theoretical value and may not account for all real time operational constraints

Exhibit 14: Pathway outcomes by hydro variability

Does not solve | Partially solves | Solves

		Status quo	Capacity Market	Strategic Reserve	ThermalCo
Remuneration mechanism to maintain capacity		**Spot market**, e.g. continuous energy markets combined with frequency markets	**Government auctions with fixed payments** per MW of firm capacity installed/ maintained and **spot revenues**	**LT contracts with SO** with regulated fixed return on assets and pass through OpEx at an agreed cost	**Sales of risk management products** with target return on assets
Capacity phase-out drivers		**Determined by spot** market revenues and some bilateral hedging	**Determined by government** planning, e.g. duration of capacity payments to maintain capacity	**Determined by SO** based on expected system balancing needs and portfolio stress-tests to identify capacity gaps	**Determined by market demand** for swaptions (e.g. profile hedges) and its **competitiveness versus other flex technologies**
Advantages		Incentivises capacity to be delivered by the **cheapest technology** available	**Secures capacity** as long as there is political will	**Maintains capacity and fuel storage** based on a central view on the system needs	**Maintains capacity** and ensures smooth phase-out to cheaper sources of flexibility
Disadvantages		**Security of supply is less certain, especially during the transition to renewables**	Does not avoid a **potential excess of thermal (and other) capacity** sitting idle in the system or **incentivise fuel storage for dry-years**	**Abrupt phase out** based on the termination of LT contracts and potential to undermine investment incentives	Capacity installed **depends on purchasers understanding of load and flexibility needs** across time
Solves for...	Dry-year	Partially solves	Partially solves	Solves	Solves
	Winter peak	Partially solves	Solves	Solves	Solves

All pathways reinforce security of supply, with varying impact on the market

Implementing the Capacity Market pathway would secure capacity through System Operator organised auctions. Auctions could vary in terms of duration of capacity payments, time ahead of the delivery and frequency. Asset owners are incentivised to keep their assets running or to install new capacity, as fixed costs should be recovered by fixed payments and variable costs can be recovered in the energy market. However, due to the trade-off between complexity and effectiveness, a Capacity Market would typically take more than 5 years to achieve results, as seen in the United Kingdom.

The ThermalCo and Strategic Reserve pathways would deal with security of supply in a more targeted manner, relying on the demand for flexible, thermal generation in the market. This demand can be provided by either risk management products in the case of ThermalCo, or by the System Operator in the case of Strategic Reserve.

ThermalCo would ensure security of supply provided sufficient upfront revenues are collected through risk premiums contracted by purchasers. This is dependent on large consumers and retailers accurately pricing the risk they are exposed to. ThermalCo would only phase out capacity if the risk perception of purchasers decreased, reducing thermal demand.

Strategic Reserve would secure supply by sizing the market needs and contracting the necessary capacity with thermal asset owners to meet demand. Capacity would only be phased out when the System Operator determines that the market does not need it and stops the payments.

Of the pathways, ThermalCo provides better market signals and affordability for consumers

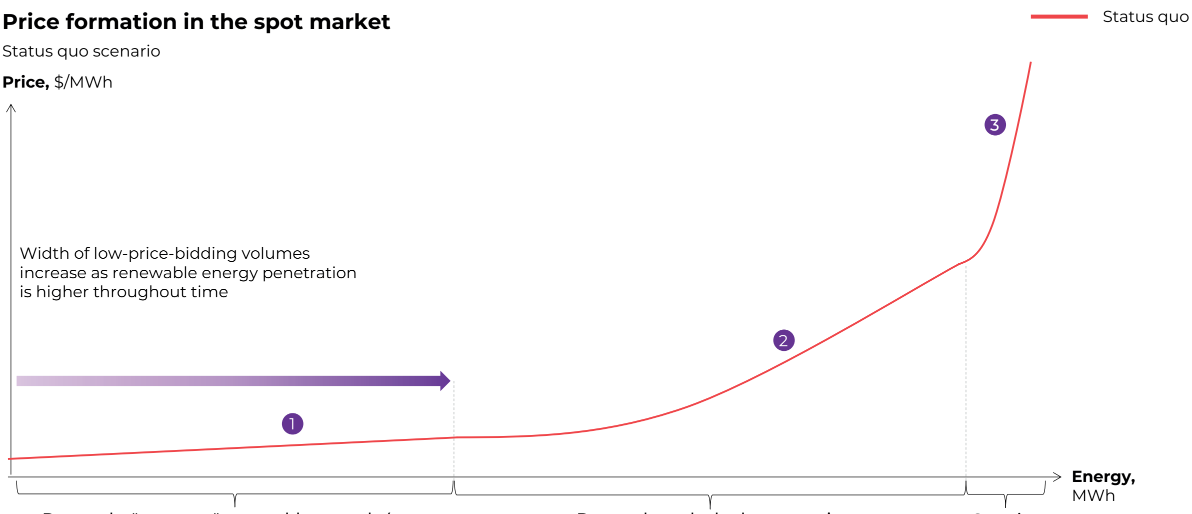
Decrease in price volatility to reduce prices for consumers

To keep market price volatility within acceptable bounds, asset fixed costs would need to be recovered through alternative mechanisms than the energy spot market alone. In a spot market, with fewer periods of high prices (as reviewed in Chapter 2), those periods will have all energy paid at very high prices so thermal generators cover their fixed costs, raising risk premiums that ultimately get paid for by consumers. Hence, the chosen pathway should ensure the recovery of fixed costs without distorting market dynamics and ensuring the least cost for the market.

Exhibit 15: Price drivers

Price formation in the spot market

Status quo scenario



	Demand < "must run" renewables supply (e.g. Wind, solar, hydro run-of-river, geothermal)	Demand met by hydro reservoirs and/or thermal variable cost	Scarcity
	Price = <10	10 < Price < ~200	Price > ~200
2022	2%	97%	1%
2030	7%	89%	4%

Spot price formation and its potential effect on volatility are illustrated in Exhibit 15, with three differentiated sections in the 'price ladder'.

1. In periods with lower **demand than 'must-run' generation**, prices will likely go low, as geothermal generators offers need to ensure they keep running and wind or hydro will start to spill.

2. When **demand is met by hydro reservoirs**, prices are set by the water value (next best alternative), which is usually determined by the offers of the thermal assets that could be dispatched instead. As renewable electricity penetration increases throughout time, thermal offers will increase unless fixed costs are recovered alternatively.

3. In periods of **scarcity**, when all peaking capacity in the market is deployed, remaining hydro reservoirs or last resort thermal peakers can set the price at values close to unserved energy or demand response leading to extreme price spikes.

To fully understand price formation in the spot market, it is key to analyse how the different pathways may lead to power plant offers in the market, and what the pricing structure and logic to recover fixed costs over varying time horizons would be (Exhibit 16).

- ThermalCo pricing structure would be composed of two elements: a fixed hedge fee, as a service fee for the hedging service, and the strike price, which would be the price at which the ThermalCo would cover

Exhibit 16: Pricing structure to recover fixed costs

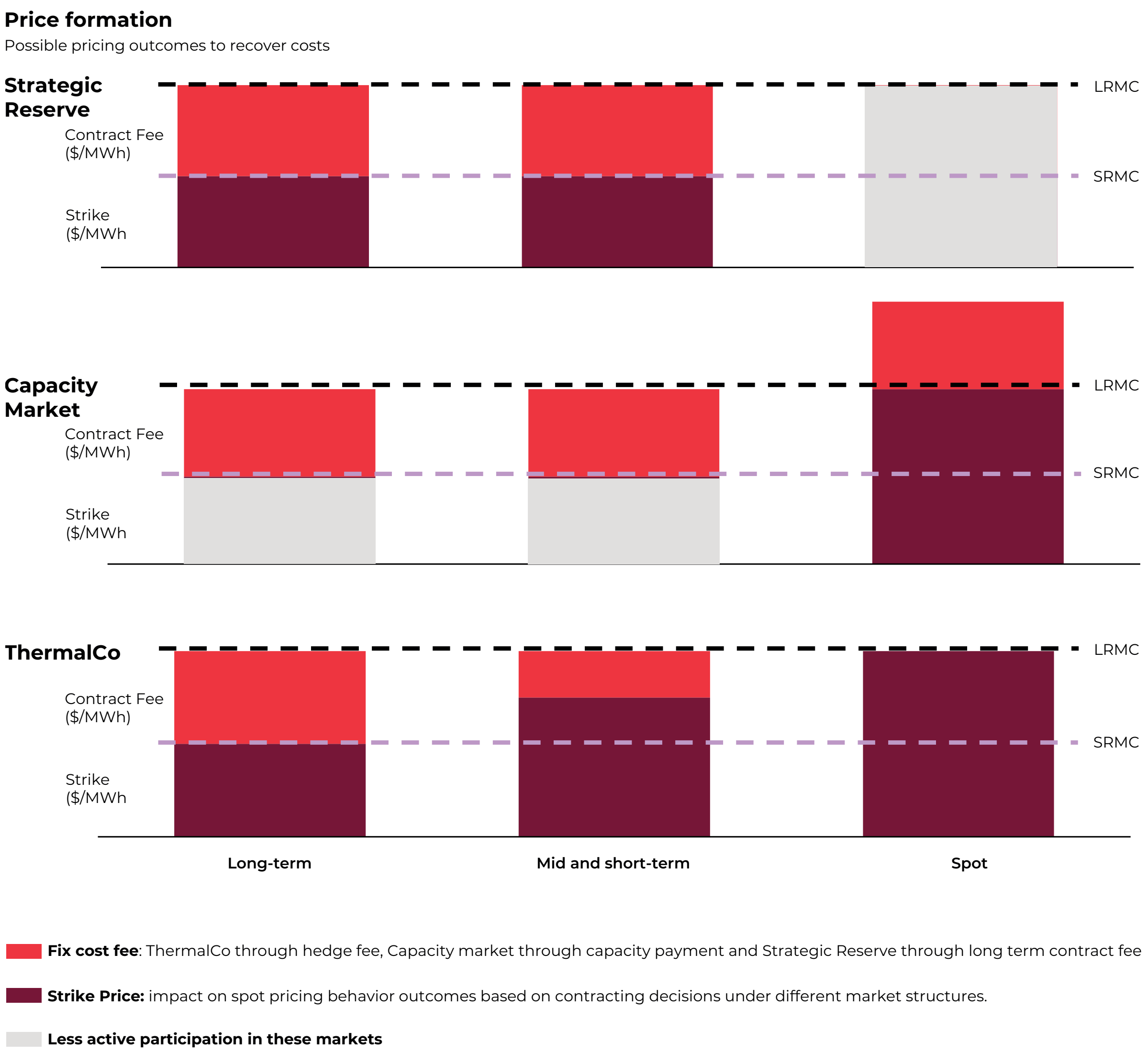
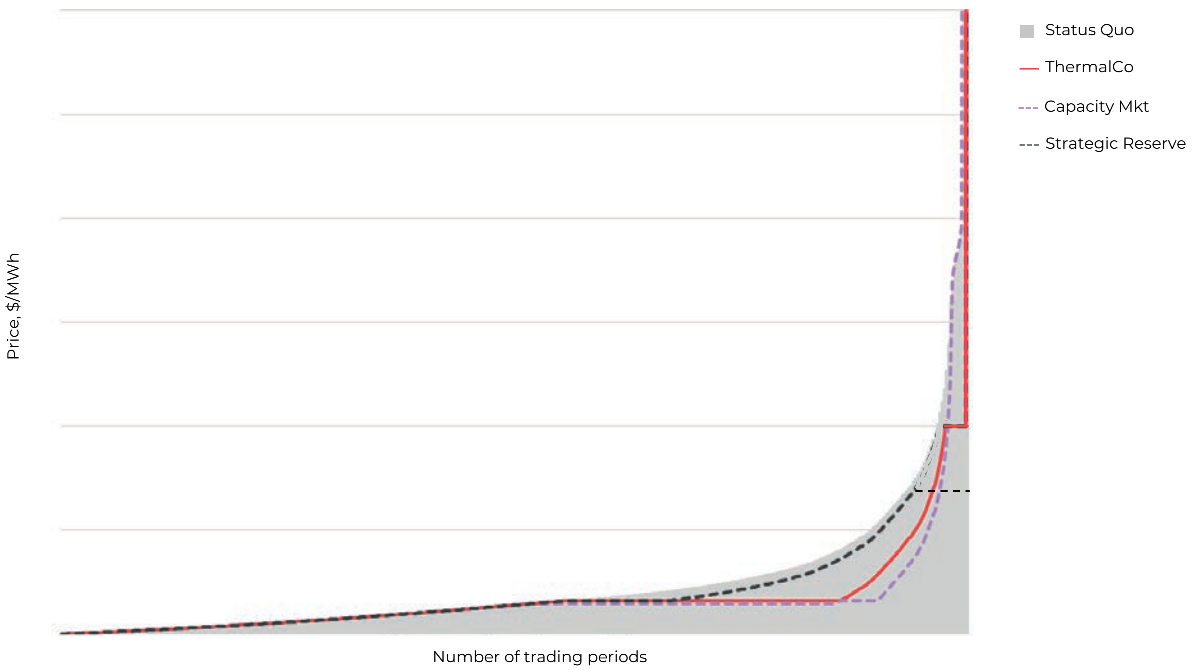


Exhibit 17: Illustrative spot price formation for different pathways compared to status quo



the retailer demand in case the spot market price goes above the strike price. Strike prices would be inversely proportional to product tenure as the risk premium increases when delivery time approaches, e.g. a 5-year hedge would have lower strike prices than a week-ahead hedge that reflected expected tight market conditions over the next week. On the other hand, the hedge fee would be directly proportional to the risk product tenure, as offering a prolonged service should be more expensive than only doing it for a brief period like a week or a day. Overall, the combination of the two elements would provide the right level of economic cost recovery.

- Capacity Market would move players to form their prices taking into account the capacity payment they are already receiving in the long term. Hence, players may reduce their activity in the derivative or hedging markets as most of their costs would be already recovered. Instead, they would focus their activity on the spot market to capture additional scarcity opportunities to further monetise their flexibility.

- Strategic Reserve would also reduce the activity of players in the hedging market for these assets as they would already recover the fixed costs through long-term contract fees and the operation of their capacity would be at the discretion of the System Operator. In the spot market, price spikes would be capped by the capacity contracted by the Strategic Reserve, limiting additional opportunities for new peaking capacity.

Based on this pricing logic, but also acknowledging that spot price formation is highly uncertain in a close to 100% renewable electricity market, our analysis suggests that the influence of the three pathways versus an Energy-Only market without risk hedging products could play out as follows (Exhibit 17):

- An Energy-Only market without hedging products will have a price ladder driven by LCOE of thermal assets, which will vary significantly between dry and wet year conditions

- ThermalCo would have moderate strike prices in the middle of price curve, as fixed costs are recovered by long- and mid-term hedging fees. Risk averse buyers who secure energy in advance will pay higher premiums but will likely benefit from strike prices close to SRMC. On the other hand, more risk tolerant buyers will wait until risks are closer to manifest, when ThermalCo will recover less of their costs though premiums and more through higher strike prices. In this scenario, even when scarcity pricing is evident, most buyers would have had the chance to hedge their purchases at lower prices. Therefore, this pathway forms a more continuous price curve and will likely improve the outcome of the market as it operates today.

- A Capacity Market pathway would slightly lower prices offered by thermal generators in comparison with an Energy-Only market, as fixed costs will be recovered with capacity payments and energy prices required to recover LCOE will be lower. However, since fixed costs are already recovered in a Capacity Market, there is less incentive to offer hedges (when compared to ThermalCo). So as scarcity develops, Capacity Markets will tend to offer relatively more unhedged volumes into the spot market (at the prevailing scarcity prices).
- The assets comprising the Strategic Reserve would be offered in at SRMC when they are called on. So prices near the top of the duration curve would tend to be capped by these offers. Any thermal units held outside of the Strategic Reserve would still be trying to recover fixed costs in the energy only market so prices in the mid-section of the curve could follow the status Quo more closely.

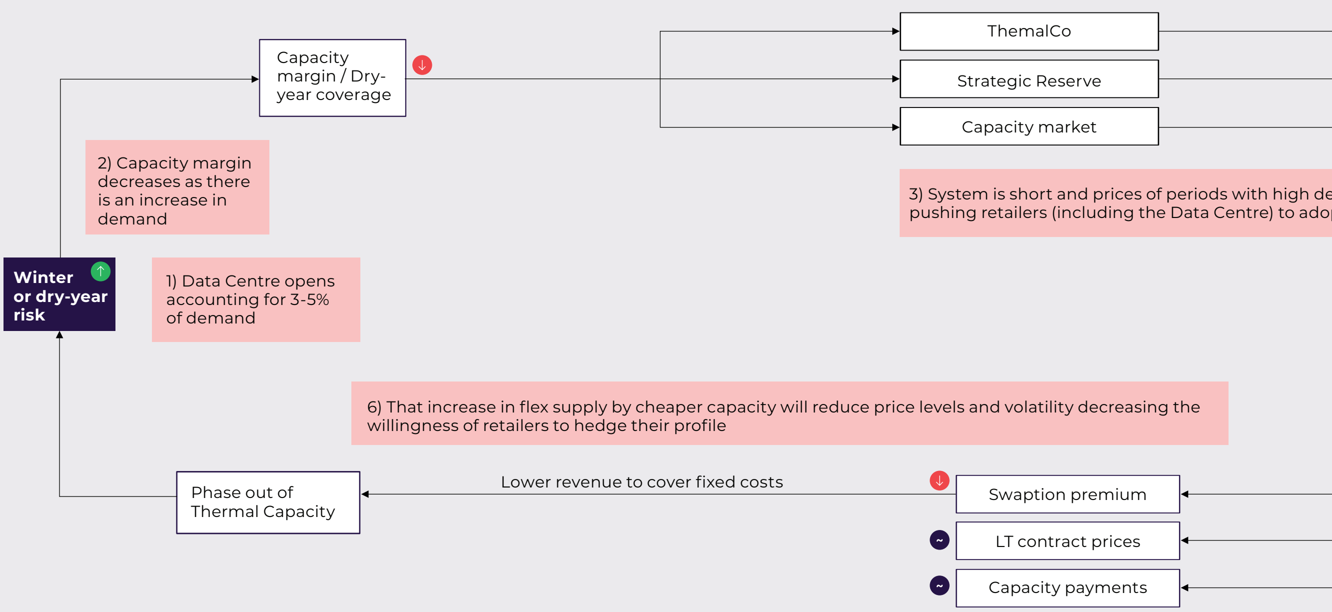
Bring the most competitive technologies to keep an affordable supply mix

When assessing the impact on system costs and the affordability of each pathway, a key element to be addressed is how the market would incentivise investment in new flexible technologies to replace existing ones when they become economic.

In this area, pathways diverge. While Capacity Market and Strategic Reserve opt for a more central-planning logic based on the mandate of a regulated authority (Government, Regulator or System Operator), a ThermalCo would drive capacity replacement through market pricing of its risk products (see Exhibit 18).

In the Capacity Market, the decision on which type of capacity is incentivised and which should be phased out would depend on the Capacity Market rules. If regulators unintentionally underestimate the firm capacity contribution of new technologies, new technologies could be at a disadvantage. On the other hand, if regulators unintentionally overestimate the firm capacity contribution of new technologies, new technologies could benefit from it, but security of supply could be at risk. The duration of the capacity contract may also limit investment signals from market changes, especially if auctions are not held regularly.

Exhibit 18: Illustration on how different pathways can drive capacity mix



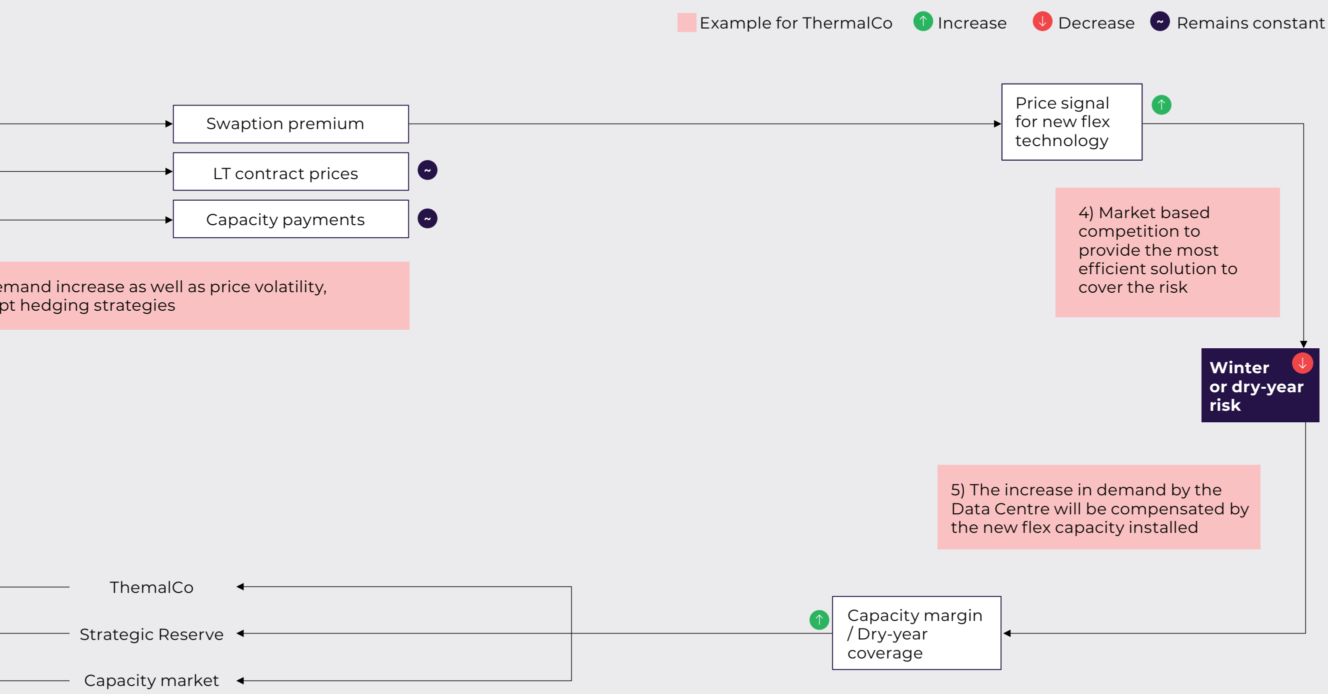
Strategic Reserve would also have some challenges responding to market changes and would require a thorough analysis from the System Operator to identify capacity needs in the system. The selection of strategic assets may bias the technologies selected to traditional sources of flexibility where its performance is well known, reducing the incentives for innovation and new technologies to come online. Typically, reserve payments are long-term contracts, which limits the flexibility to adapt to sudden market changes, which could result in non-competitive assets being kept online during the duration of the contracts.

In the ThermalCo pathway, phasing out thermal capacity would be determined by the demand for hedges and willingness of energy purchasers (large consumers and retailers) to be short on supply. If the capacity margin decreases, swaption strike prices will increase along with the risk perception of purchasers, providing positive investment signals for new flexible capacity. Under this pathway, the mix of long- and short-term hedges will ensure stability for the most competitive assets to remain online securing supply – while keeping the less competitive assets dependent on short-term hedges with high strike prices, putting them in direct competition with new emerging technologies.

An orderly transition is more likely with a consolidated ownership of thermal assets provided by ThermalCo or Strategic Reserve

With regards to supporting an orderly transition for the electricity market and for New Zealanders, the key to success will be providing transparency in the phase-out plans so that the transition can be adequately managed. Transparency and visibility will be critical for upstream gas supply industry to guide their investment decisions, for employees in the power plants and for the communities that live around these assets, and could be heavily impacted by decommissioning decisions.

The shared ownership structures that could be provided by a consolidated Strategic Reserve and the ThermalCo pathways will necessarily deliver greater transparency and accountability. This will eliminate any game theory involved in delaying or accelerating decommissioning decisions based on portfolio strategies by individual players during this short transition period, limiting the possibility of negative cascading effects that could put security of supply at risk. It will also decrease the operational risk of maintaining low utilised assets and give more demand certainty to the upstream gas industry. More importantly, there will be a clear point of accountability and coordination with Government and communities. Additionally,



the learnings in planning and managing decommissioning of thermal assets, including finding alternative economic activities for the regions, will be more easily shared as a single company rather than as individual companies, benefiting people and communities.

In contrast, while Capacity Markets will guarantee recovery of most fixed costs for the thermal assets, the risk will solely reside with individual players, whose decisions can be rapidly affected by changes in capacity auctions rules or capacity demand thresholds set by the Capacity Market operator.

All pathways have different feasibility implications, with ThermalCo the least disruptive to the current market

In considering the feasibility of the three pathways there are several elements to consider: market disruption, stakeholders involved, and time to implement.

Implementation feasibility would depend on the required changes in the current market structure and regulation. The ThermalCo pathway is the less disruptive option as it leverages currently available tools for all market participants, such as existing risk management products. Strategic Reserve would require a larger regulatory effort as it would require the change in the System Operator mandate. The SO would potentially need to incur additional costs to upgrade its capabilities and develop a new market-based function. The Capacity Market pathway could be the toughest solution to implement as it would imply the creation of a new market, and would require coordination between the Government, SO and market participants to align capacity and energy needs, as well as the design and operationalisation of the auctions.

The stakeholder participation required for the successful operational functioning of each pathway is also a determining factor in the implementation feasibility. Capacity Market and Strategic Reserve are solutions that require deep involvement from multiple stakeholders; in addition to thermal asset owners, participation from the Government and/or the System Operator would be required to set up new market rules. Further, while these two solutions could be immediately launched with Government mandate, it is likely they will require broad industry syndication to be effective. ThermalCo would be more independent in this sense and would only require the participation of thermal asset owners in the process to find consensus on an industry solution (and only after that seek approval from the Commerce Commission to operate). However, for ThermalCo to efficiently run, broad industry alignment will be needed to ensure appetite from buyers of risk management products.

The ThermalCo pathway would be the fastest solution to implement as it leverages existing tools in the market such as risk management products or hedges, with no need to adjust regulation and therefore minimising implementation risks. However, an additional legal and financial effort would be required to demerge assets from current owners and consolidate them in the ThermalCo; this would include pricing of assets, sizing decommissioning liabilities and developing a clear operational mandate.

Consolidation of thermal portfolios

E.ON and AGL are some of the largest utility providers in Germany and Australia respectively. Both were seeing mounting pressure on their thermal generation assets, driven by the rapid increase in renewable generation, while the assets were still critical to maintain security of supply in the system. Both companies decided to demerge their portfolios and create specialised companies to manage the transition of the thermal assets into renewables.

E.ON carved out its thermal portfolio into Uniper to then divest its shares

E.ON carved out in 2016 its thermal generation assets (nuclear and coal) into Uniper, following mounting pressure on the accelerated closure of nuclear plants in Germany. Two years later, in 2018, E.ON sold its remaining shares of Uniper to Fortum, to fully decarbonise its footprint. Fortum's new business unit is specialised in managing thermal assets through their transition.

Five years after the carve out was announced (2016), E.ON market capitalisation has increased 92%. The market also had a positive reaction to Uniper absorption of thermal assets increasing its market capitalisation by 219% since the carve-out execution

AGL announced demerger aims to split thermal assets into Accel Energy

AGL reached maximum share price in 2017-2018 period, following a series of successful acquisitions of coal power plants and maximum historical wholesale prices in the National Energy Market. As renewables gain a higher presence and market prices decrease, AGL's value in the market decreased. In March 2021, with wholesale prices following a sharp decline, AGL announced a demerger to split its thermal generation assets and renewables operations into Accel Energy, leaving its retail, flexibility and renewable PPAs into AGL Australia. To date, market reaction has not reversed the downwards trend of the share price, which remains 42% down in market capitalisation since the decision was announced.

ThermalCo: a market-based pathway for New Zealand

After exploring three potential pathways to keep the energy trilemma balanced in a transition to a close to 100% renewable electricity market, we propose the establishment of ThermalCo

ThermalCo is an entity that owns and operates all existing thermal assets and upstream fuel supply contracts, with the mandate to offer transparent and liquid risk management products (for both dry-year and peak demand) to all market participants, while orderly phasing out the thermal capacity when more reliable low emission technologies become economic.

During the transition, New Zealand will need to pursue two main objectives:

1. **Maintain its world class balance across the trilemma, as more renewables economically replace fossil fuelled generation; and**
2. **Ensure an orderly transition of New Zealand's electricity market to 100% renewable generation.**

While all three pathways present benefits for the New Zealand market in terms of their contribution towards decarbonisation and security of supply, we believe ThermalCo has the strongest potential to lower system costs while simultaneously ensuring an orderly transition. ThermalCo also presents the best trade-off in implementation feasibility, as it builds on a market that works effectively today. It will operate within existing market rules, minimising the risk of unintended consequences in an already well-functioning market, as well as reducing the need to modify regulation.

Given New Zealand is well underway towards a 100% renewable electricity market, we believe ThermalCo can be a fit-for-purpose transition vehicle that drives Aotearoa all the way there

- with low establishment costs; and
- reducing the risk of losing the energy market balance through an uncoordinated transition; while
- providing fair remuneration to security of supply services by sharing the costs across most market participants that benefit from them.

The establishment of ThermalCo will maintain the energy trilemma balance as:

- The offer of risk management products to cover all thermal capacity in an open platform will be a further evolution of the hedging market helping to support **transparency and liquidity** for market participants to cover dry-year and peak demand risk.
- Consolidated ownership of thermal **assets increases the availability of capacity** that could be offered to derivative markets, as outage risks are spread across a larger portfolio
- Security of supply risks, priced through hedging contracts, will provide the **price signal to incentivise the market-led investments of the lowest cost, reliable technologies** that address these risks. Long-term hedge premiums will support dry-year coverage, while short-term strike prices will provide price signals for new flexible capacity
- **Fixed costs recovery through a premium** on risk management contracts will **reduce price**

volatility in the spot market as only variable costs will need to be recovered. Most market participants will likely prefer to cover their risks rather than be exposed to price spikes, providing a more **equitable distribution of fixed costs**.

The establishment of a ThermalCo will ensure an orderly transition of New Zealand's electricity market as:

- Consolidated ownership will provide greater **certainty in the mid- and long-term demand for thermal assets,** allowing for a more optimal planning of the transition of these assets when new technologies can displace them
- **It maintains a stable regulatory framework** that works well today.

Continued development of the hedging market to further support access to all market participants

One of ThermalCo's foundational objectives and a key commercial driver will be to support the continued development of the hedging market in New Zealand. We envisage a ThermalCo which acts as a derivative market maker, putting its entire capacity available through long- and mid-term risk management products in a visible and transparent platform. Any market participant keen to cover its position could buy long-term products to cover their dry-year risk and peak shaped products to cover specific peak demand risks. Products would follow standardised structures to simplify market access for all participants, reducing transaction costs. Products could consist of a combination of premium (fixed payment) and strike price (variable cost at which the plant will bid into the market).

The transparency of risk management products will provide accurate price signals for hydro reservoirs to calculate their hydro storage opportunity cost, providing a transparent, risk-based expectation of future price outlook in case of scarcity. The transparency will also promote competition across other risk management products that are not linked to thermal power plants – like batteries or demand response – where a transparent and liquid trading platform will set the benchmark for negotiation.

Increased availability of assets for hedging products

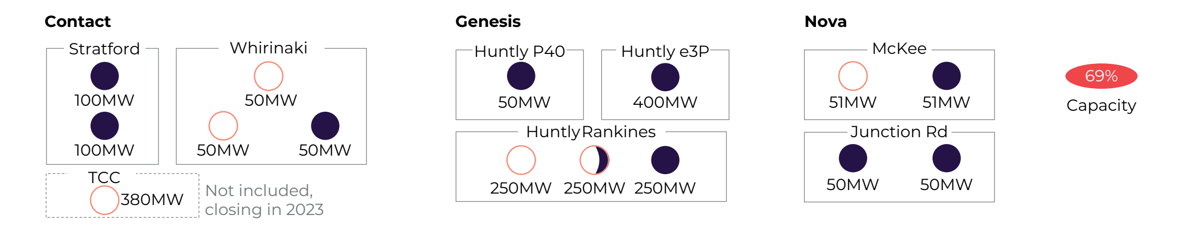
Liquidity of hedging products will increase as ThermalCo would be able to offer more capacity given the lower absolute safety margin required for unplanned outages.

For example, assuming all thermal asset owners follow a N-1 security criterion in their hedging strategy (always keeping one contingent unit to cover for an unplanned outage on the largest operating unit), Exhibit 19 illustrates how ThermalCo could increase available capacity by 8%. Under individual ownership, excluding bilateral agreements, each player will keep some assets on hold for contingency, resulting in ~69% of capacity being offered for long-term risk management. With a Consolidated Ownership model enabled by ThermalCo, keeping three Whirinaki units and one Rankine on hold would be sufficient, resulting in 77% of capacity in the market.

We should note that today, the market operates with some bilateral agreements between thermal assets owners to increase the capacity available, but a ThermalCo Consolidated Ownership structure could further increase the efficiency of these contracts.

Exhibit 19: Simulation of capacity available for derivatives under single ownership versus individual ownership

Individual owner hedge profile without bilateral agreements:



Source: 20151030 Existing Generation Plant; Press releases

Price signals to incentivise lowest system cost

The balance between guaranteed cost recovery through premiums versus spot market prices for energy required can provide a dynamic signal for the addition or retirement of different sources of supply. When the premium is not enough to cover the fixed costs of the plant providing the services, capacity will be retired, increasing the spot price until equilibrium is achieved with new generation. Alternatively, if new technologies can provide the same long or short term risk coverage at lower costs, they will be able to enter the market securing long-term revenue streams through lower premiums and displacing existing thermal plant.

Equitable fixed costs recovery through risk premiums

Risk management contracts do not only provide the price signals to attract new technology investments and industrial consumers, but also enable a more equitable recovery of the system fixed costs.

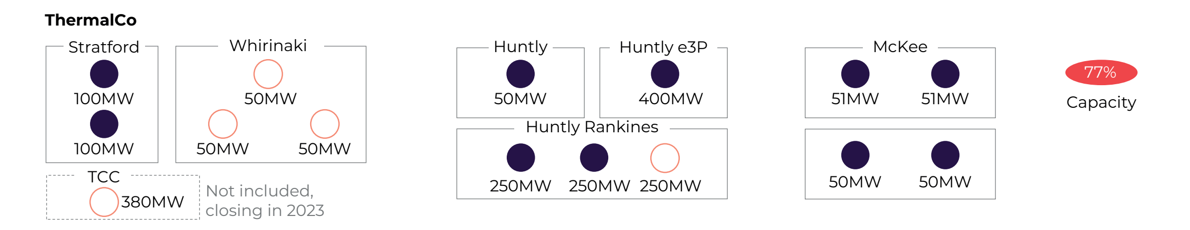
The creation of a transparent platform with market-based pricing for thermal based risk management products sets the right incentives for all market participants to hedge their position and mitigate security of supply risks. The alternative will be to remain exposed to a very small fraction of the unhedged capacity, where emergency mechanisms like load-shedding services could result in pronounced price spikes, or invest in alternative means to cover this exposure. These spikes will have a very limited effect on the consumers, as they will only affect the small share of participants that choose not to cover their physical supply risk position. Conversely, all participants that choose to cover their true delivery risks will be contributing to the fixed costs required to keep the thermal plants available for the times when they are needed.

The more that fixed costs are recovered by premiums, the lower wholesale price volatility will be. While market participants could decide not to hedge their exposure and benefit from the lower prices without incurring in any fixed costs (known as the free-rider effect), their downside risk of being exposed to scarcity pricing could be significant. It is expected the standardisation of risk management contracts and reduced transaction costs, in addition to the scarcity price risk, will provide the right incentives for purchasers to cover their risks. Alternatively, whilst mandating retailers to purchase hedge cover is not part of our preferred approach, it is being considered in other jurisdictions (see page 25 on Australian reliability obligations) as a solution to avoid this free-rider effect.

Higher certainty in the mid- and long-term outlook of thermal assets

The proposed consolidation of the thermal assets into a single entity, and the transparent provision of risk management products across a range of time horizons, will provide clear market based price signals for when thermal capacity and associated fuelling requirements are no longer required. This will support clear decommissioning decisions, helping to support security of supply.

Potential future:



Further, a single point of accountability will minimise the need of coordination across multiple parties. ThermalCo will be the single point of coordination with all other stakeholders, working directly with the government and collaborating with communities in forming their transition plans – applying learnings from one asset to the next.

Maintain a stable regulatory framework

A key benefit of ThermalCo against the alternative pathways is the ability to be implemented within the current regulatory framework. Given the transitional nature of the thermal assets in New Zealand in the journey towards 100% renewable electricity and the significant regulatory change the other solutions would entail, ThermalCo would bring the least disruption to the market. This pathway would avoid a period of unstable regulation, which can lead to periods of decreased investment, and/or increases the costs of investment, and may result in a longer, less affordable transition.

The consolidation of thermal assets could increase the efficiency of the current market structure, as scarcity pricing insurance coverage would be readily available for all market participants. The hedge disclosure system could be further enhanced with ex-ante details reported in a ThermalCo platform. These products will still be subject to competitive dynamics, both from other existing sources of flexibility, such as hydro reservoirs and large-scale demand response, or from new rapidly emerging technologies like batteries. The New Zealand energy market already has the regulation in place to avoid any potential non-competitive abuse from any player under scarcity pricing situations through the High Standard of Trading conduct provisions and the Undesirable Trading Situation (UTS) mechanism that would ensure fair outcomes for customers.

In fact, ThermalCo could start operating today within the current regulatory framework, requiring only to get the Commerce Commission approval and to secure a broad consensus in the industry around the ThermalCo consolidation structure and its operational mandate.

Our analysis suggest that ThermalCo is a robust transition pathway, providing a market-based, low risk way to advance the journey towards a 100% renewable electricity market in New Zealand, and could be implemented immediately. ThermalCo is an industry-wide, market-based solution with benefits that meet the two primary objectives of keeping the energy trilemma balanced while ensuring an orderly transition of New Zealand's electricity market. A balanced market will allow Aotearoa to capture the opportunity that a close to 100% renewable electricity market could provide as global decarbonisation pressure mounts.

Broad industry-wide alignment will be required to implement ThermalCo. In addition to agreement between current thermal asset owners, buy-in and contribution of all market participants (gentailers, independent retailers, generators and large customers) will be a key success factor to its success. As previously described, ThermalCo's efficient operation requires all purchasers of electricity contributing to cover their supply risks through derivative products. As industry-wide alignment is reached and appetite from industry participants confirmed, it will be critical to work closely with regulators to set up all the required framework for ThermalCo operations.

Ngā tapuae ō inanahi rā, hei huarahi mō āpōpō
The steps of our forbears, form the pathways for tomorrow.

We invite support from stakeholders that want to collaborate and contribute to building a market-led transition to a 100% renewable electricity market in New Zealand that not only achieves environmental targets, but also meets the challenges of security of supply and affordability while ensuring an orderly transition for all

contact

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