Te Tai Poutini - West Coast Renewable Energy Strategy

Supporting the transition to a low emissions economy

November 2022

EnviroStrat
Impact Investment Project Development

FOREWORD

Te Whanaketanga, Te Tai Poutini West Coast 2050 Strategy outlines a collective commitment to unlock the potential of Te Tai Poutini (the West Coast) by carving our own path, front footing the change required and working in partnership with open minds and a solution-based approach to the wero (challenges) we face.

Te Tai Poutini Renewable Energy Strategy and Roadmap identifies opportunities to unlock renewable energy investment and job creation as a significant component of the overall pathway as we face a changing future.

The Renewable Energy Strategy supports us to navigate our way through the energy trilemma and to provide certainty for the sector, industry and consumers. It sets the direction for the West Coast's pathway away from fossil fuels and towards greater levels of renewable electricity and other low emissions alternatives.

Te Whanaketanga Energy Action Group 2022

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ABOUT THIS STRATEGY

The West Coast energy strategy paves the way for an ambitious energy landscape and describes options to lower emissions leveraging the West Coast's energy expertise, facilities, industries and resources. It incorporates a just transitions philosophy and consideration of future transitional pathways.

At the heart of this strategy and roadmap is a commitment to a Just Transition, benefiting the West Coast region and the national economy as New Zealand moves toward a low-emissions future.

New Zealand recorded its six highest electricity consumption peaks in the Winter of 2022 and a number of warning notices were issued by Transpower because of a lack of generation. 2023 could be very tight in terms of the supply and demand balance. This underpins the urgent need to develop new generation projects.

This strategy is based on the current situation and looks at the current energy demands of the West Coast and New Zealand as a whole. Existing thermal generation (gas and coal) that will come out of the mix, resulting in an additional 36 TWh (36,000,000 MWh) of new, renewable generation to support current industry has not been factored into the future demands of this strategy.

The WHAKAMANA i Te MAURI HIKO – EMPOWERING OUR ENERGY FUTURE report shows the expected future electrical energy demand growth for New Zealand.

"Electrification will drive decarbonisation. New Zealand appears to be unable to meet its climate change commitments without electrifying its economy with low-emission, renewable electricity. Nearly sixty per cent of New Zealand's total energy requirements will be from electricity in 2050, up from 25 per cent in 2016." [1]

Converting this into generating capacity, New Zealand will need around 12,000 MW of new, renewable generation over the next 30 years. To put this into perspective, it is equivalent to approximately twice the total hydro generation built in New Zealand over the last 130 years.

There is a need for new generation, to support the expected future electrical energy demand growth for New Zealand.

1. WHAKAMANA i Te MAURI HIKO – EMPOWERING OUR ENERGY FUTURE // MARCH 2020 Executive Summary Pg 9

1. EXECUTIVE SUMMARY

Te Whanaketanga's energy action group appointed EnviroStrat Limited to support the development of a West Coast renewable energy strategy. This strategy targets a reliable and resilient system, delivering sustainable and low emissions energy services.

The strategy will support alignment and leverage cost-effective services that meet energy efficiency and decarbonisation needs while safeguarding the environment, iwi, local businesses, and communities. The tactical deployment of the strategy will deliver tangible and non-tangible benefits to the West Coast. The strategy is locally focused and will support the region through the transition process.

New technologies and process efficiencies provide options and outputs for renewable generation and economic growth. Green technology requires non-renewable raw materials sourced from primary geological resources (mines) or secondary supply (reuse or recycling). Renewable energy sources such as hydro, geothermal and wind are among the largest producers of electricity in New Zealand (NZ). Energy generation, storage, emissions capture, and transport technology are all developing rapidly and will be essential in moving NZ towards a sustainable, low-emissions energy system.

NZ's size and location provides an ideal environment for renewable energy generation, with 84% of the electricity produced from renewable sources. This large proportion of renewable energy production ranks NZ second in the world for energy security. However, this does not necessarily translate directly to the West Coast energy system.

An opportunity exists to harness the West Coast's energy resources, skills, and infrastructure to holistically consider low-carbon industrial and energy options, to sustainably grow the economy and accelerate the national low-emissions transition. Central to unlocking this opportunity is a strategy that integrates renewable sources in coherent energy systems influenced by energy savings, efficiency measures, and new technologies.

Using a diverse mix of energy sources can increase regional resilience. With appropriate design, new local electricity sources and a robust transmission and distribution network, resilience will improve. Ongoing transport and process heat electrification introduce additional vulnerabilities that must be addressed.

The critical considerations for the strategy are:

- **Improved energy efficiency and use of renewable energy on the demand side**
  Many energy efficiency opportunities are well-proven for businesses and households but are often not implemented because of other priorities or a lack of available capital. In recent years, the central government has introduced several capital assistance programs and supported adopting new vehicle and heating technologies via contestable funds and grant programs.
- **Greater diversity of energy production through developing local renewable resources**
  The West Coast has an abundance of natural renewable resources. These resources need to be scaled to meet the needs of communities and replace fossil fuels with various renewable energy sources.
  If further technological improvements to the energy system can be achieved, the sustainability and security of the energy system will be enhanced. For example:
  - Technologies for converting the transportation and process heat sectors.
  - Introduction of flexible energy system technologies to increase resilience.
- **Local leadership and coordination**
  Central to the transition to a low-emission energy system will be the effective coordination of local stakeholders into a united voice. The creation of a shared vision will require leadership within the community.

2. TE TAI POUTINI WEST COAST ENERGY DIRECTION AND VISION

2.1 Introduction

The West Coast economic development strategy, Te Whanaketanga 2050, places significant importance on the energy sector. It identifies several actions that will unlock the potential of renewable energy and identify and advance opportunities focusing on outcomes that will drive economic growth.

Te Whanaketanga 2050's energy focus supports the transition towards a low-emissions economy. While the work is regionally centred, it acknowledges that energy transcends regional boundaries and is a complex system. The West Coast's energy initiatives will be inextricably interwoven with energy developments and opportunities in and beyond NZ.

This focus on unlocking the potential within the renewable energy sector will be enabled by developing a comprehensive Te Tai Poutini West Coast renewable energy strategy that identifies and advances opportunities in hydro, biomass, geothermal, green hydrogen, and other energy opportunities on the West Coast with a focus on viable outcomes that create jobs.

The supporting roadmap complements the strategy and provides a comprehensive overview of the actions and activities supporting the successful implementation of the strategy. The NZ Government's current energy policy focuses on transitioning to net zero carbon emissions by 2050 while building a more productive, sustainable, and inclusive economy. As NZ decarbonises, regions will inevitably become more electrified and face energy security and affordability challenges.

Transitioning to a zero-emissions energy system is achievable, but the economics for the West Coast is very challenging. A distributed, low population combined with distance to market provides a higher cost structure to economic activity and resulting impacts for energy transition activities. The interviewees consistently presented these economic challenges as barriers to greater uptake of renewable energy opportunities.

The forecasted growth in energy demand within the West Coast has not materialised and has remained static for six years. With the transition away from fossil fuels towards renewables (including process heat and transport) demand for electricity is expected to increase. Additional generation and transmission capacity will be required to meet this change in demand.

Small, low impact hydro schemes will form an important part of the solution and will also add to the overall resilience of the West Coast energy supply.

A case could also be made if a project of national significance such as a large-scale hydro plant or some way of boosting existing hydro storage could be developed.

This strategy and roadmap highlight increasing demand for Renewable energy and greater efficiency in its usage. The strategy and roadmap are designed to increase knowledge and capacity to support:

- The West Coast community to have trust and confidence in renewable energy solutions as NZ transitions to a low emissions economy.
- Energy savings through efficiency and the development of a variety of local renewable energy resources to replace fossil fuels.
- Ambitions to improve economic prosperity, lower the cost of living, restore nature, address energy inequalities and improve living standards across the West Coast.

2.2 Approach

EnviroStrat followed the enquiry methodology for developing a shared vision, strategy, action plans and change. To deliver an inclusive approach owned by the communities for whom it is designed, it was essential to engage a broad cross-section of the region collaboratively. This involved qualitative interviews and focused on aspiration and opportunity with four aspects covering primary and secondary research activity:

1. Mobilisation.
2. Targeted engagement.
3. Market and economic research.
4. Strategic plan completion and launch.

EnviroStrat interviewed 38 stakeholders across all three West Coast districts. This primary research supported the economic and marketing analysis of renewable energy options for the West Coast. Local engagement and understanding of the community's aspirations and expectations are essential in developing this strategy.

The approach does not avoid constraints or challenges but seeks to recognise the character of the businesses and the community, their resourcefulness and adaptiveness to changing circumstances as positive attributes. It uses a structured process to capture appropriate engagement and detail. One stakeholder feedback session was presented in Greymouth to members of the West Coast Energy Action group to highlight the feedback from stakeholders.

2.3 Engagement with stakeholders

Thirty-eight stakeholders representing industries, employers and other West Coast groups were interviewed. EnviroStrat asked a series of questions focused on developing a more robust understanding of energy activity and the communities' views on the challenges and opportunities for the West Coast. Most interviewees were passionate and supportive of renewable energy projects and opportunities; however, the overarching concerns were centred on cost barriers and security of supply adversely affecting economic development. Upon review and analysis of interview responses, the below themes were highlighted as material concerns raised by interviewees:

1. Resilience

- The West Coast community is nervous about the resilience of the electricity network.
- Increasing climatic shocks are exposing the perceived fragility and planning for the alpine fault magnitude event (AF8), enhancing awareness of the potential for a significant energy shock.
- Security of supply is a significant focus for the renewable energy strategy.

> *Our supply is vulnerable; resilience is our crucial issue.*

2. Regulatory/policy change

- The amount, and implications, of regulatory and policy change impacting the West Coast are of concern.
- While many saw the need for regulatory and policy change, there was negative sentiment regarding the implementation.
- The additional management and compliance reporting is seen as uneconomic and, in most respects, more about 'telling West Coast locals what they can't do'.
- The changing regulatory environment means everyone is impacted by emissions reduction and adaptation plans causing the West Coast community to feel nervous when it comes to how they can remain competitive.
- There was a strong desire for a West Coast solution to support the navigation of the regulatory and policy changes and ensure that these changes create local opportunities, not constraints.
- A key constraint in commissioning new activity highlighted was regulatory challenges.

> *The regulatory system is broken and not strategic in approach. The one size fits all approach dictated from central government is not practical or fit for purpose on the Coast.*

3. Perceived high-cost barriers

- Transition to greater electrification of the energy system is seen as a critical facet of achieving emissions reduction and adaption plan targets.
- The capital requirements for making the transition challenge the economics and has the potential to impact industries' profitability.
- Given broader environmental and economic impacts and the requirement to 'stay in business', stakeholders were reticent to make an early transition to greater electrification.
- Cost reduction through bulk or collaborative pricing was seen as an opportunity.
- There was interest in collaborative approaches to aggregated central government funding to underpin the transition process.

> *Electricity is expensive; we've got to stay competitive. Business on the Coast is challenging without adding in more compliance and operating costs.*

4. Lack of regional view

- Each West Coast district has a solid parochial voice and approach and is fiercely independent.
- While the focus on Hapori builds community at local levels, a consistent regional view has been lacking.
- Each district has several activities underway; however, there is not a shared vision or aspiration of the opportunities in renewable energy for the West Coast.
- There was much interest in ongoing and consistent activity to support the implementation of the strategy and an understanding that courageous conversations will need to be had.
- Leadership from the energy action group with strategic messaging and a roadmap is paramount in support of building a collaborative regional view of opportunities.

- There is some potential to work with other regions, explore different models and learn from their experiences.

We must coordinate local plans and have bold conversations about multigenerational opportunities for the Coast.

5. Community attitudes/apathy

- Among the stakeholder group consulted, there is still a significant reactionary perception, 'don't tell us what we can't do'.
- West Coast locals are generally not connected or up to date with the regulatory changes and are not particularly interested.
- There is a degree of apathy towards energy and energy use.
- There is little tactical energy activity outside compliance-focused works.
- While industries see the need to transition, there is a lack of knowledge or information on what the best options are to ensure an economically neutral transition.
- Stakeholders were interested in understanding the opportunities available that could result in increasing renewable energy use and how it will benefit them and their businesses.
- There was a strong desire to ensure that the strategy was more than new infrastructure and strongly linked to economic prospects.
- Consistent and targeted communication at the local level was seen as a critical activity to increase awareness and engagement with the renewable energy strategy.

Stop telling us what we can't do!

6. Environmental considerations and impacts

- The conservation estate on the West Coast is a significant influence. Comprising 84% of land holdings and managed by the Department of Conservation (DOC), the conservation estate has a substantial impact on economic and energy activity on the Coast. [2]
- Stakeholders see the estate as both an asset and a liability for the West Coast.
- Greater engagement and utilisation of the conservation estate is seen as pivotal in the development of the sustainable economic activity, both in existing and new opportunities.
- There is a degree of denial about climate change and its impacts.
- There seems to be a lack of understanding when it comes to the impacts locals can play towards mitigation through the transition.
- Stronger awareness and utilisation of carbon footprints will increase understanding for small and medium-sized enterprises regarding business viability and the household's power and heat usage.

Development of land is challenging, slow and expensive. It is difficult to keep up with policy changes and implications, and then decision making is slow in Central Government.

2. https://www.doc.govt.nz/about-us/science-publications/conservation-publications/benefits-of-conservation/the-value-of-conservation/west-coast-public-conservation-land/

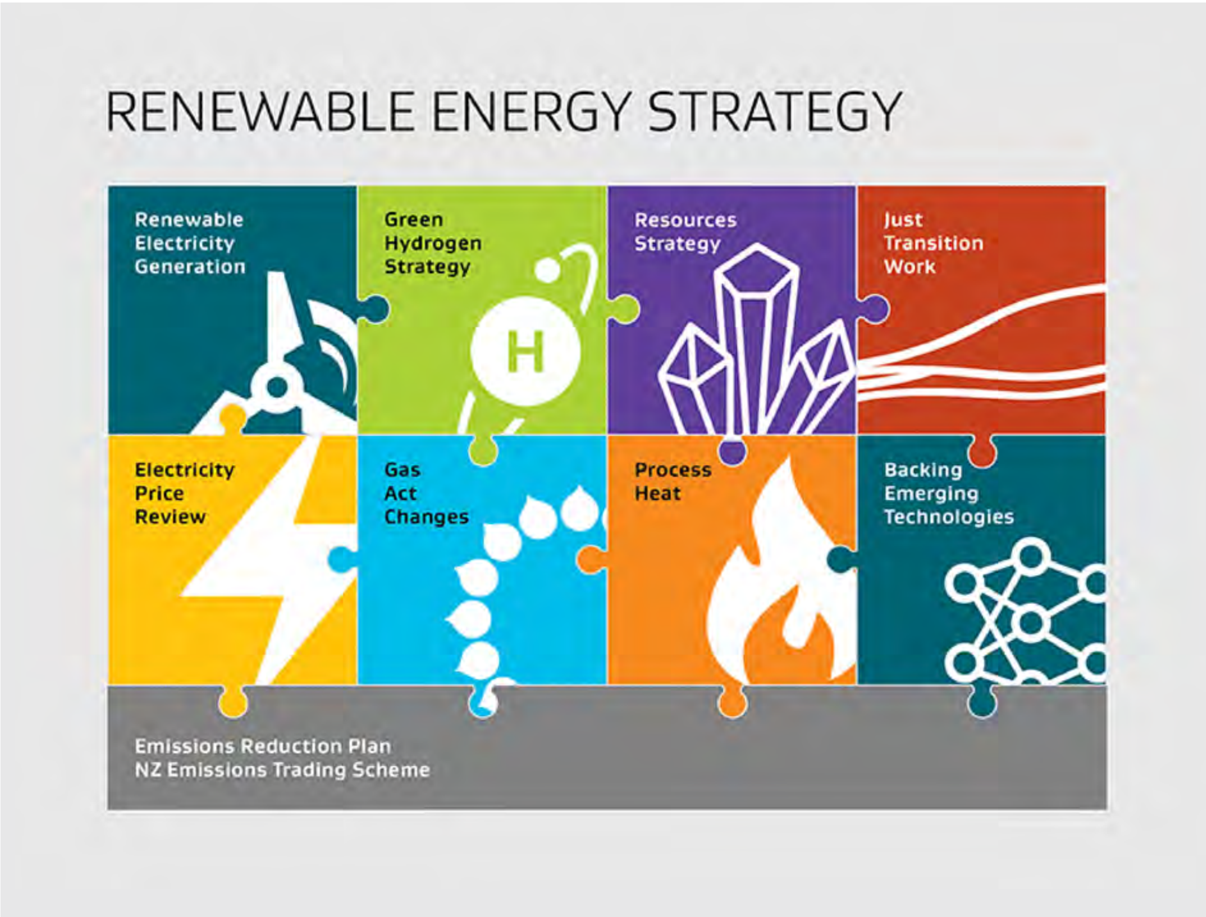
2.4 Policy and regulatory context

Over the last six years, NZ has seen significant policy and strategy work from the central government linked to climate change and the broader energy sector. The NZ Government's renewable energy vision is ***"an affordable, secure, and sustainable energy system that provides for New Zealanders' wellbeing in a low emissions world."*** [3] The renewable energy strategy work programme led by the Ministry of Business, Innovation and Employment (MBIE) focuses on three outcomes:

1. An inclusive and consumer-focused energy system.
2. A system that encourages increased investment in low emissions technologies.
3. An innovative and modern energy system that creates new opportunities for businesses and consumers.

This West Coast renewable energy strategy aligns with and supports the aims of this work programme. Keeping the NZ Government's aspirational goal of 100% renewable electricity by 2035, this strategy will position the West Coast favourably with tangible actions to transition the regional economy.

Figure 1: MBIE emissions reduction plan trading scheme



3. *https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand*

Targeting net zero emissions by 2050 and in support of international commitments, NZ's national energy policy, regulations and signals are set out below. Policies and targets (other than the 2050 net zero emissions legislation) are documented in the Emissions Reduction Plan.[4]

The national direction instrument most relevant to renewable energy development is the National Policy Statement for Renewable Electricity Generation 2019. This statement sets out the objectives and related policies to enable the sustainable management of renewable electricity generation under the Resource Management Act 1991 (RMA).[5] The other national direction instruments most relevant to renewable electricity development include:

- The National Policy Statement for Electricity Transmission 2008. Acknowledge the national grid's significance and ensure balanced consideration of the national benefits and the local effects of electricity transmission.
- National Environmental Standards for Electricity Transmission Activities 2009. MBIE, accelerating renewables uptake and encouraging changes in industrial energy use. The standards set out which transmission activities are permitted, subject to conditions to control environmental effects. They apply only to existing high-voltage electricity transmission lines.
- The National Policy Statement for Freshwater Management 2014 (amended 2017). This policy is relevant to hydro generation.
- The NZ Coastal Policy Statement 2010. Particularly relevant to renewable energy projects in coastal areas.
- National Environmental Standards for Air Quality 2004. This section is relevant to the development of wood energy facilities.
- The National Planning Standards 2019. These standards require plans to use the noise measurement methods and symbols in the NZ standard on wind farm noise.

Targeting net zero emissions by 2050 and in support of international commitments, NZ's national energy policy, regulations and signals with timings are set out below. The following policies and targets (all but the 2050 net zero emissions legislation[6] are documented in the Emissions Reduction Plan[7]) will all have an impact on the West Coast region:

- 2024 - national energy strategy.
- 2025 - no new sales of fossil fuel boilers.
- 2025 - zero-emission public bus mandate established.
- 2026 - all municipal landfills to have landfill gas capture systems (where commercially viable).
- 2030 - NZ has 100% renewable electricity generation.
- 2035 - no more new coal boilers installed.
- 2035 - zero-emission vehicles comprise 30% of the light fleet.
- 2035 - half of all energy use is from renewable resources.
- 2035 - emissions from freight transport are reduced by 35%.
- 2035 - the total distance travelled by the light fleet (cars, vans, utes) is reduced by 20%.
- 2050 - net zero emissions.

Other related West Coast policies/activities:

- 2022 Transport and Logistics Strategy.
- 2022 Conservation Framework Review.

4. https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-for-renewable-electricity-generation Section
5. Enabling development of renewable energy under the Resource Management Act 1991
6. https://environment.govt.nz/acts-and-regulations/acts/climate-change-response-amendment-act-2019/
7. https://environment.govt.nz/publications/aotearoa-new-zealands-first-emissions-reduction-plan/

2.5 Current state of the West Coast energy system

The primary and most comprehensive data source for energy use is the Energy Efficiency and Conservation Authority (EECA) which owns and maintains the Energy End-Use Database.[8] This database provides the most detailed granularity/spatial scale of energy use at the district level. However, there are limitations given that it is challenging to spatially map consumption and energy demand across the West Coast without aggregating to the three districts – Buller, Grey and Westland.

EnviroStrat has compiled the following figures (two and three) through analysis of the Energy End Use DataBase (EEUDB).

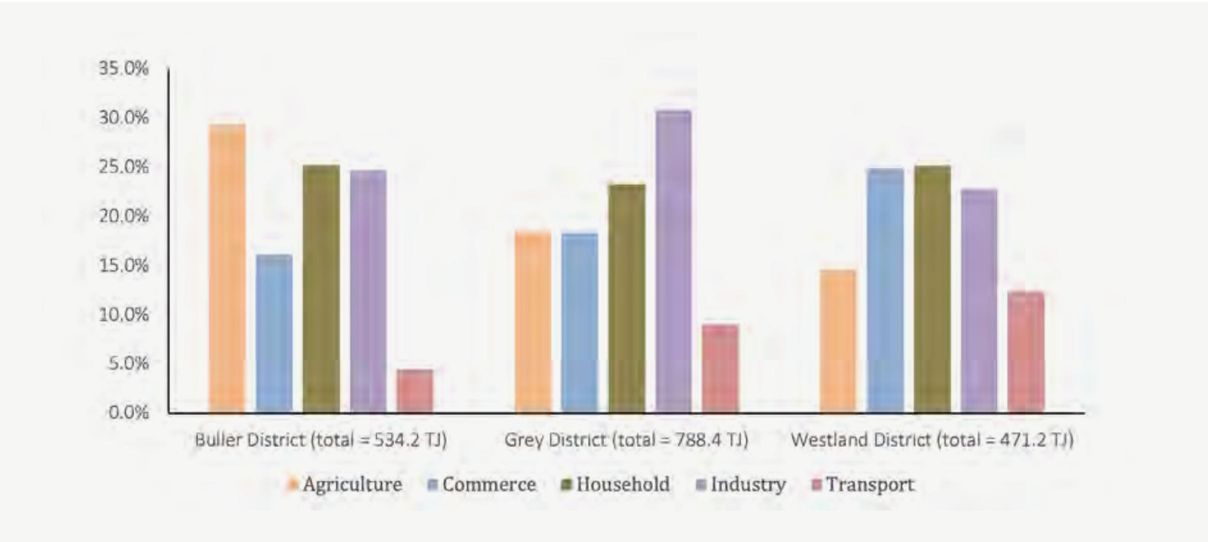
Energy use points to each district, sector and the fuel type required to provide energy. It highlights areas where renewable energy can play an essential role in supporting the sector and territorial authorities' specific workstreams. As detailed in the diagram, figure 2 below, each district has a different industry with the most dominant energy use. The total energy use for the West Coast in 2021 was 1793.8 terajoules (TJ).

The Grey district is the largest user of energy (788.4 TJ) with 43% of demand usage, followed by Buller (29%) and Westland (26%)

- Industry is the biggest user in the Grey district, with approximately 30% usage.
- Agriculture makes up the most significant proportion of use in Buller (30%).

Energy use is representative of business units and industry, reflecting the structure and industry density of the local economy.

Figure 2: Energy use by aggregated industry for the West Coast districts

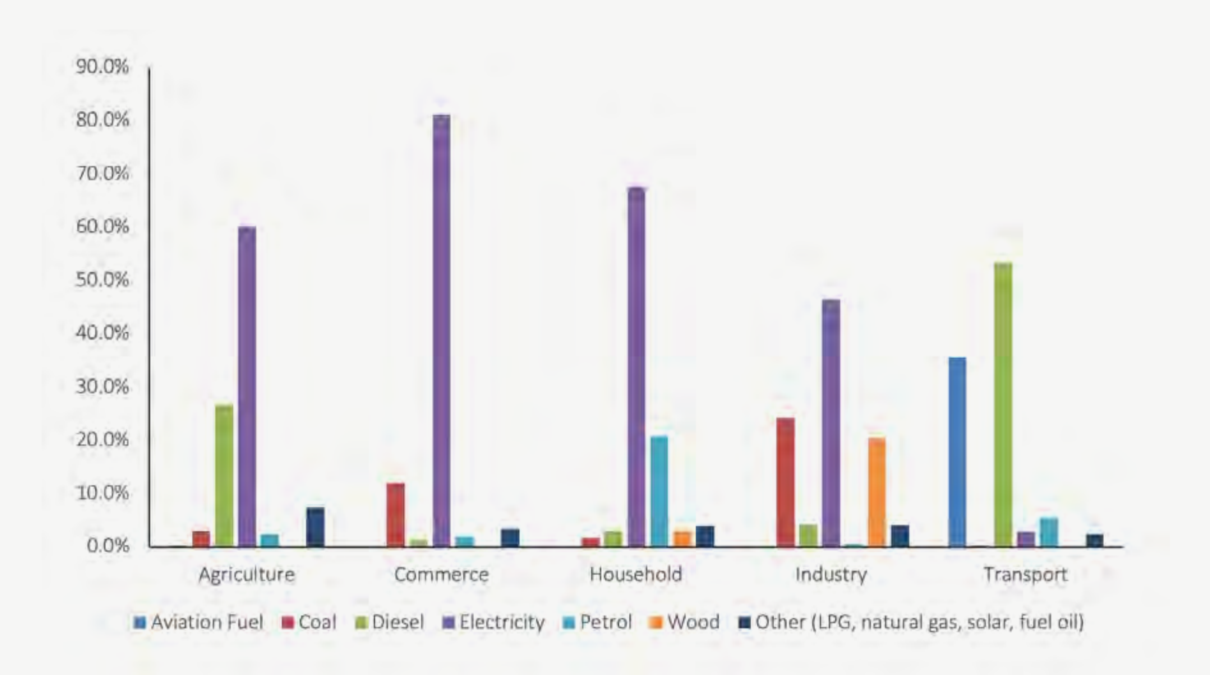


8. https://www.eeca.govt.nz/insights/data-tools/energy-end-use-database/

2.6 Overall energy demand

Electricity is the most prevalent energy use type across the region in the industry use. It makes up a significant proportion of usage in all industries except transport. Figure 3 below shows the fuel types by industry breakdown for the West Coast.

Figure 3: Fuel type breakdown for industries on the West Coast



Electricity is the critical fuel type for agriculture, commerce and households. The industry is fuelled by coal and wood (approximately 20% respectively) and 50% electricity usage.

Assessment by territorial authorities shows the following energy demand by district:

- Buller – a high proportion of Agriculture and correspondingly diesel use.
- Grey – higher proportion industry and correspondingly coal/wood use.
- Westland – balanced use with a high transport segment and corresponding high diesel use.

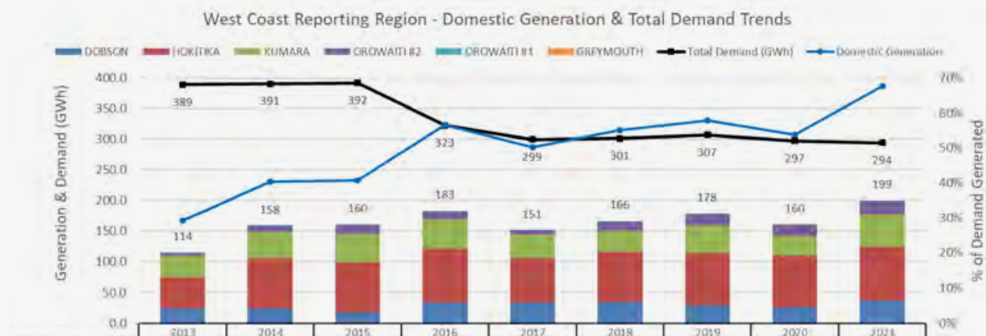
This demand analysis represented by specific fuel types provides the targets for an activity to support transition activity through greater electrification:

- Reducing diesel use in agriculture and transport.
- Reducing coal and wood use in commerce and industry.

2.7 Electricity supply and demand

Analysing Transpower data sets,[9] the West Coast is approximately 70% local and has 99% renewable electricity energy generation. Figures four and five provide an analysis of the existing generating assets on the West Coast. It is observed that less than 1% of the domestic generation electricity is supplied from non-renewable sources – for instance, the diesel generator embedded in the Hokitika grid exit point. The rest of the imported supply is 100% hydro-generated electricity. Like most of the South Island, which is a net exporter of 100% renewable energy, this makes for an extremely 'clean' grid.

Figure 4: West Coast domestic generation and total demand trends

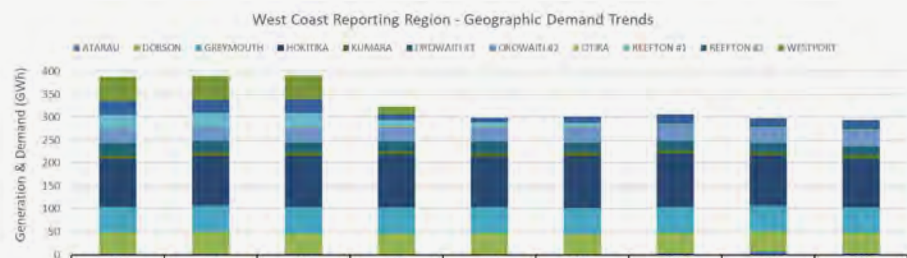


	2013	2014	2015	2016	2017	2018	2019	2020	2021
GREYMOUTH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OROWAITI #1	0.0	0.1	0.2	0.8	0.4	1.2	0.3	0.7	0.4
OROWAITI #2	4.5	8.7	14.4	12.9	5.8	14.8	17.5	17.2	20.8
KUMARA	33.6	44.1	46.1	48.4	39.7	34.4	46.4	32.9	53.8
HOKITIKA	51.2	80.4	81.0	86.8	71.8	80.6	83.5	83.3	87.4
DOBSON	24.2	24.5	18.0	33.6	33.3	34.9	29.8	26.6	36.5
Total Generation (GWh)	113.5	157.8	159.6	183.5	150.6	165.9	177.6	159.8	198.9
Total Demand (GWh)	389.2	390.5	391.9	322.5	299.4	301.0	307.0	297.4	293.9
Domestic Generation	29%	40%	41%	57%	50%	55%	58%	54%	68%

Note:

- Percentage of renewables increasing (68% in 2021) – and expected to continue towards NZ's 100% target.
- Percentage of domestic generation increasing – and is expected to continue.
- Total demand (GWh) is static and has reduced slightly over the last five years, with an average demand of 300 GWh).

Figure 5: Graphic demand trends for the West Coast



	2013	2014	2015	2016	2017	2018	2019	2020	2021
WESTPORT	54.083	51.79	51.897	16.427	0	0	0	0	0
REEFTON #2	29.433	29.648	30.839	12.389	10.27	13.099	21.506	18.534	20.133
REEFTON #1	29.429	27.563	30.025	12.951	10.567	7.036	0	0	0
OTIRA	1.543	1.577	1.493	1.514	1.42	1.596	1.408	1.281	1.205
OROWAITI #2	31.181	31.437	32.647	32.204	30.034	34.076	36.177	34.889	37.187
OROWAITI #1	27.495	23.864	20.698	21.243	24.824	20.88	19.344	18.454	17.138
KUMARA	7.244	8.692	8.507	8.125	7.998	7.353	8.539	7.711	8.533
HOKITIKA	104.417	108.854	111.478	114.339	110.606	114.53	115.83	109.589	107.033
GREYMOUTH	56.603	56.602	58.188	57.736	56.899	56.833	57.445	55.948	56.078
DOBSON	45.276	47.148	43.37	43.358	45.061	43.531	42.718	43.756	43.09
ATARAU	2.525	3.944	2.748	2.031	1.726	1.106	4.037	7.355	3.51

Note:

- Peak demand in the Westpower area during the 2020/2021 year was 45.27 MW.
- Demand is static from 2017-21 following the closures of several industrial facilities from 2010-2016 (Cape Foulwind Holcim facility, Spring Creek, Pike River), significantly reducing demand on the Westport, Dobson and Atarau nodes.

9. *https://www.transpower.co.nz/system-operator/live-system-and-market-data/live-load-data*

2.8 Generating assets

The West Coast has 12 hydro schemes providing local electricity capacity. These are detailed below.

Figure 6: Map of the West Coast with nodes, assets, and consented hydro identified.

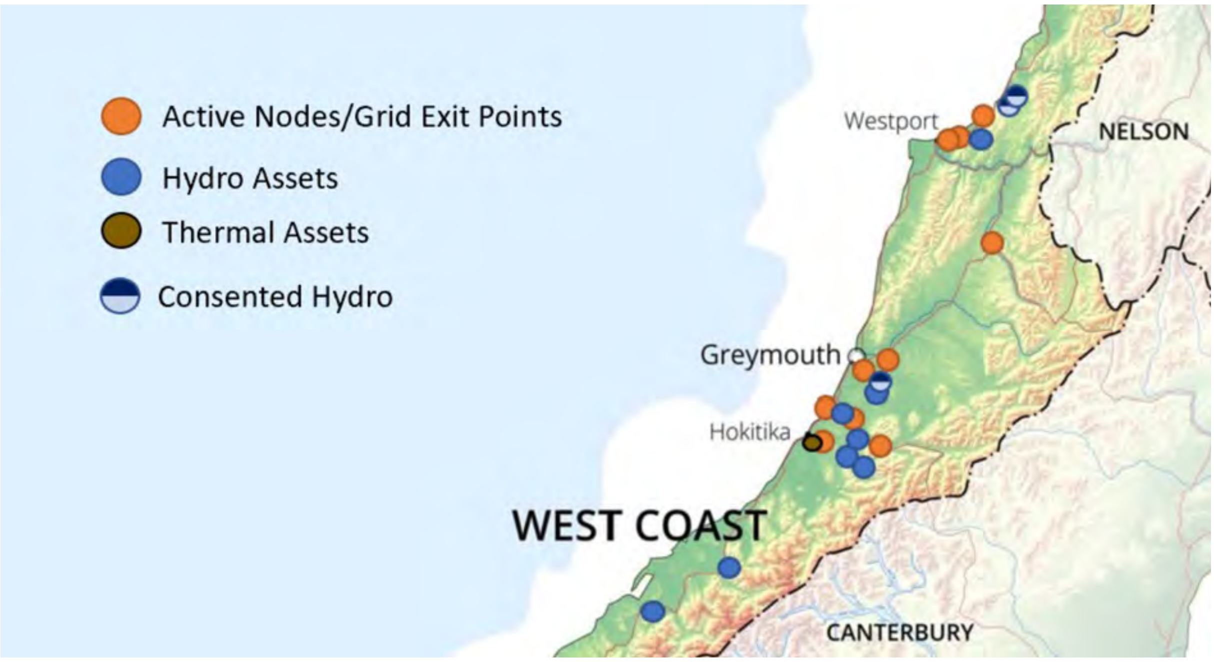


Table 1: Existing hydro schemes:

Station name	Operator	Gen type	Year	Capacity	Annual Gen	Input node
Amethyst	Westpower	Hydro	2013	7.6 MW	50 GWh	HKK0661
Arnold	Trustpower	Hydro	1932	3.1 MW	20 GWh	DOB0331
Ngahere	Mighty River Power	Hydro		0.1 MW	0.2 GWh	DOB0331
Inchbonnie	Inchbonnie Hydro	Hydro	2017	1.7 MW	7 GWh	DOB0331
Fox	Trustpower	Hydro	2009	0.8 MW	1.9 GWh	HKK0661
Kaniere Forks	Trustpower	Hydro	1931	0.43 MW	4 GWh	HKK0661
McKay's Creek	Trustpower	Hydro	1931	1.1 MW	8 GWh	HKK0661
Wahapo (Okarito Forks)	Trustpower	Hydro	1960	3.1 MW	14.5 GWh	HKK0661
Dillman's	Trustpower	Hydro	1928	3.5 MW	16 GWh	KUM0661
Kumara	Trustpower	Hydro	1978	6.5 MW	30 GWh	KUM0661
Duffers	Trustpower	Hydro	1979	0.5 MW	2 GWh	KUM0661
Rochfort	Kawatiri Energy	Hydro	2013	4.2 MW	20 GWh	ORO1101

The following generation projects have been proposed for the South Island in table 2 below. Several of the proposed schemes have been consented but not commissioned. Three West Coast hydro schemes (Stockton Plateau, McCullough's Creek and Griffin's Creek) have been consented and provide the potential to deliver 34 MW of capacity. Two schemes are in Westland District and one in the Buller District.

Westpower wants to invest in the construction, operation, and maintenance of a run-of-river hydro scheme on the Waitaha River. The proposal is to develop a hydroelectric power scheme based on a renewable resource. The scheme will produce approximately 110-120 GWh per year with a maximum or peak output of about 16 – 20 MW. This is equivalent to providing electricity to about 12,000 households. Westpower has partnered with Poutini Ngāi Tahu to request that DOC undertake a reconsideration for concession for the Waitaha Hydro Scheme. Micro-hydro schemes are not included, given the size and scale of the systems. Several small micro hydro systems across the West Coast are placed in mine tailing sites.

Table 2: Existing hydro schemes:

Region	Location / Name	Owned by	Generation type	Capacity (MW)	Status
Canterbury	Rakaia River	Ashburton Com. Water Trust	Hydro	<3	Consented
Canterbury	Balmoral Hydro	Meridian Energy	Hydro	15	Applied
Canterbury	Lake Pukaki	Meridian Energy	Hydro	35	On hold
Marlborough	Wairau	Trustpower	Hydro	70.5	Lapsed
Otago	Hawea Control Gate Retrofit	Contact Energy	Hydro	17	On hold
West Coast	McCulloughs Creek	No 8	Hydro	2	Consented
West Coast	Nagakawau	Hydro Developments Ltd	Hydro	25	Consented
West Coast	Waitaha	Westpower	Hydro	20	Applied

2.9 Electrical transmission and distribution

Transpower operates the transmission system with two lines companies operating in the region; Westpower and Buller Electricity. Westpower is the electricity network company that owns and maintains the electricity lines, cables, and substations that deliver electricity to consumers in the West Coast region, including Reefton, Greymouth, and the Glacier regions in South Westland.

Westpower is one of the smallest electricity distribution businesses in NZ. Combined with Buller Electricity, it represents around 0.6% of total electricity connections in NZ, 0.9% of total energy delivered in NZ, and 1.4% of total system length in NZ.[10] It supplies around 13,000 consumers. By number, 93.5% of Westpower's connections are small consumers. Larger consumer connections total about 25, which has been reasonably steady for the last three years. There were just two electricity users in Westpower's region consuming more than 5 MW of electricity.

Westpower's network covers a large geographical area with challenging terrain and extreme weather conditions. Its electricity distribution network comprises about 2,252 kilometres of power lines covering a region from Lyell in the North to Paringa in South Westland, an area of about 18,017 square kilometres. On average, around 8.5% to 13% of electricity is lost in transporting electricity to Westpower's network using Benmore as the reference point.

Buller Electricity[11] is the local electricity distribution company supplying 4,600 consumers located on the northern West Coast of the South Island. The Buller Electricity distribution area extends from Meybille Bay in the south (5 km north of Punakaiki) to Karamea in the north. Much of the distribution area is rural, incorporating significant dairy and beef farming, with the main population being in the Westport township.

10. Asset Management Plan; A 10 Year Management Plan for Westpower's Electricity Network From 1 April 2022 to 31 March 2032. Westpower
11. https://bullerelectricity.co.nz/buller-electricity

2.10 Challenges

The World Energy Council's 'Energy Trilemma'[12] assesses the security of a country or region's supply, decarbonisation, and affordability in a policy context. This model summarises the challenges the West Coast faces in addressing the transition to a low-carbon energy system and, ultimately, a zero-emission economy. The model highlights the tensions around the different outcomes or priorities of security of supply, energy equity, and environmental sustainability.

Figure 7: The 'Energy Trilemma

Decarbonising the energy system

As the most significant regional coal producer, there is a natural tension between the need to decarbonise the energy system and the availability and use of low-cost fossil fuels. Local stakeholders, particularly businesses, highlighted this contradiction and often defaulted to the security of supply and costs as the reason for not investing in renewable energy options. This contradiction will remain an ongoing challenge as the West Coast have built a sense of identity and a long history of being intrinsically connected to fossil fuels extraction.

Barriers to investment

NZ will need to build a significant amount of new renewable generation to meet future electricity demand and adhere to our climate change goals. Any new projects that might affect the environment, ranging from the construction of wind farms and hydro dams to installations of boilers, will require resource consent under the RMA[13]. The RMA is undergoing review with West Coast electricity entities making submissions concerning proposed renewable energy and energy efficiency changes.

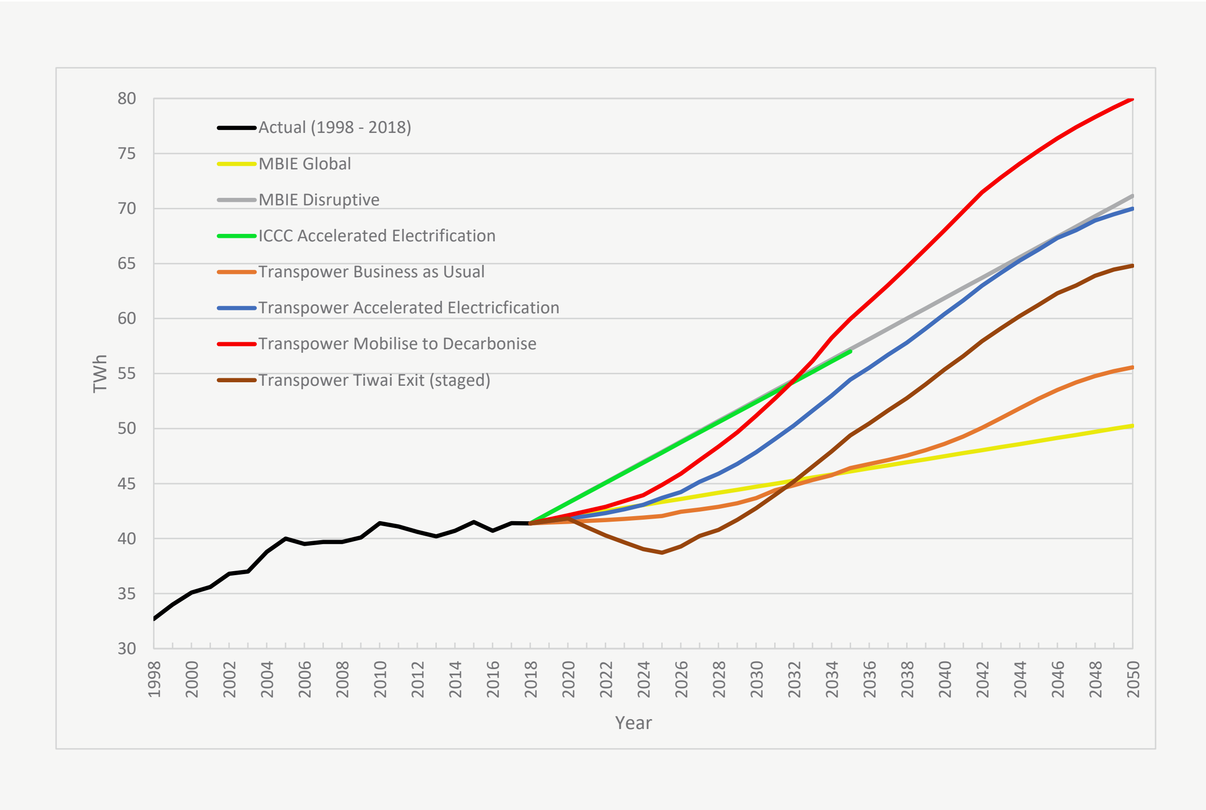
12. https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index
13. https://www.mbie.govt.nz/dmsdocument/10398-section-7-enabling-development-of-renewable-energy-under-the-resource-management-act-1991

Electricity cost

The region's overall electricity costs are comparatively more expensive due to the long distances between electricity loads and the dispersed population centres. This results in significant distribution losses and higher per-person expenses for line companies. For West Coast businesses, there is a competitive disadvantage that ultimately creates a disincentive for new business investment. These high electricity costs at a household level result in constrained discretionary spending in the local economy and negative impacts on the most vulnerable.

Industry forecasts all predict an increase in electricity demand. While demand was reasonably static between 2005 and 2018, all forecasts show increasing electricity usage as an outcome of adaptation and emissions reduction plans. Greater electrification of energy usage, coupled with demand and price increases, will create tensions in the electricity market.

Figure 8: NZ electricity demand forecasts[14]



14. https://www.ea.govt.nz › assets › dms-assets › 2022-

2.11 Opportunities

When reviewing the energy situation in its entirety, there are some clear opportunities for the West Coast Region. These include:

- The uptake of renewable energy options, particularly electricity generation.
- The creation of a flexible, efficient, integrated, and resilient electricity system.
- Supporting the wider industry to improve energy efficiency, reduce costs and transition to low emissions alternatives.
- Understanding the most considerable realisable potential, which is likely in to be in commercial buildings and industrial sectors.
- Reviewing and understanding the enablement of high-efficiency retrofits and new builds through financing arrangements.
- Supporting the adoption of low-emission vehicles.

This report's roadmap identifies opportunities that fit into two target timeframes, 2025 and 2035. Following is an overview of these opportunities and the actions identified for the West Coast:

Sustainable development of natural and human capital to enhance regional economic development

- Coordination of plans and consistent leadership.
- Open access to opportunities that will be bespoke for each district / Hapori.
- Confidence from the community that it can be done on the West Coast.

New technologies and energy efficiency

- Use measurement and tracking systems to support efficient energy consumption tracking.
- Incentivise-wise specialisation investment.
- Increase the range and availability of process heat sources.
- Expand the availability of fast charging for EVs and services.

Engaging with local and central government

- Given a large number of emissions reduction plan actions of potential relevance to the West Coast region, there is a need to identify those actions where the region wants involvement.
- Consider and focus on establishing a resource to manage ongoing interaction with central government and other stakeholders about renewable energy and emissions reduction policies and projects relevant to the West Coast.

Land-based renewable resources

Hydroelectric

- Large-scale hydro development in NZ was prolific between 1950 and 1980 but has decreased markedly since then. West Coast imports most of its electricity over Arthur's Pass and via the Buller Gorge, sourced from the Waitaki lakes. New large-scale hydro development in NZ will be challenging under the current policy settings and from a returns profile however, it should be noted that Resource Management Act 1991 is currently under review. Smaller-scale generation projects do have the potential to diversify and strengthen local electricity generation.
- With abundant natural capital assets, including water, Hydroelectricity represents the single biggest opportunity for the most significant renewable generation in the medium term. Whilst usually characterised by high capital costs, this is offset over the asset's life by relatively low operating costs and demand flexibility, including storage. The economic benefits to the region would be significant, including high-paying job creation, energy resilience and associated infrastructure spending.
- An MBIE report identified several potential small-scale hydro schemes by region (2018).[15] The West Coast was identified as having a significant opportunity in several potential plans (note table 1 – 17 schemes). Eighty-eight per cent of these are on the conservation estate. It should be noted that the Department of Conservation is currently running a process to look at reclassifying stewardship land.

15. MBIE Embedded Hydro Generation in NZ Version 2 1. 2 October: Opportunities Final 2020 Roaring40s Wind Power Ltd

Table 3 Summary of potential small-scale hydro schemes by region

Region	Number of Potential Schemes	Total Capacity Potential (MW)	Total Generation Potential (GWh/annum)	Average scheme size	Max scheme size	Min scheme size	Number within DOC land	Number outside DOC land
Northland	1	3.5	19.7	3.5	3.5	3.5	1	0
Auckland								
Waikato	9	16.5	94.0	1.8	4.2	1.0	4	5
Bay of Plenty	8	22.3	126.7	2.8	4.2	1.0	2	6
Gisborne	5	12	68.6	2.4	3.6	1.1	1	4
Taranaki	5	15.7	89.3	3.1	5.6	1.0	0	5
Manawatu - Wanganui	10	31.5	179.6	3.2	7.4	1.2	4	6
Hawks Bay	6	18.5	106.4	3.1	4.1	1.6	0	6
Wellington	4	13.6	77.6	3.4	4.4	2.8	0	4
Tasman - Nelson	3	9.5	54.2	3.2	6.5	1.0	3	0
Marlborough	3	5.6	31.7	1.9	2.3	1.0	3	0
West Coast	17	55.6	316.7	3.3	8.7	1.3	15	2
Canterbury	2	9.7	55.0	4.8	8.5	1.2	0	2
Otago	3	5.7	32.3	1.9	2.6	1.1	0	3
Southland	8	16.6	94.5	2.1	4.3	1.4	4	4
Total	**84**	**236**	**1346**	**2.8**	**8.7**	**1.0**	**37**	**47**

Biomass

Biomass supporting the transition from coal boilers is a lively topic on the West Coast. Assessing the process heat electrification opportunities, the West Coast has <20MW of electrification opportunity. Stakeholder feedback on this transition also noted that it is tough to generate the required heat from biomass to achieve the performance requirements of boilers.

Several heat plants around NZ have changed to use wood as fuel for process heat (i.e. steam and hot water). Generally, the displaced fuel has been a fossil fuel, and many have been coal boilers. Based on the publicly available information (industry newsletters, company announcements, published case studies etc.), a list of known user types of wood fuels is presented below.[16] It is worth noting that the West Coast does not have a >1MWth user.

Table 4: Residual Biomass Fuel predictions 2021

Region	Location	Boiler size; MWth	Wood fuel type	Wood fuel type demand; GJ p.a.	Wood fuel type demand; t pellets p.a.	Wood fuel type demand; Chip p.a.	Forest residues Wood fuel demand; g.t. hog .p.a.	Wood fuel demand g.t.hog. p.a. demand; g.t. hog p.a.
Northland	Dargaville	1.5	Wood pellets	38,956	2,292	-	-	-
Auckland				-	-	-	-	-
Waikato	Te Awamutu	40	Wood pellets	680,000	40,000	-	-	-
Bay of Plenty				-	-	-	-	-
Gisborne				-	-	-	-	-
Hawks Bay				-	-	-	-	-
Taranaki				-	-	-	-	-
Manawatu - Wanganui				-	-	-	-	-
Wellington				-	-	-	-	-
Tasman - Nelson	Brightwater	7	Hog fuel	36,359	-	-	5,269	-
Marlborough				-	-	-	-	-
West Coast				-	-	-	-	-
Canterbury	Christchurch City	15	Hog fuel	335,000	-	-	48,500	-
Canterbury	Burwood	6	Hog fuel	134,000	-	-	19,000	-
Canterbury	Belfast	2.25	MMW hog	80,000	-	-	-	8,607
Otago	Clutha	13	Hog fuel	290,000	-	-	42,029	-
Otago	Clutha	11	Hog fuel	245,000	-	-	35,507	-
Otago	Clutha	8.5	Hog fuel	189,000	-	-	27,391	-
Otago	Invercargill	4	Hog fuel	104,000	-	-	15,000	-
Southland	Invercargill	3.4	Chip	63,000	-	9,140	-	-
Southland	Invercargill	0.675	Chip	71,500	-	6,805	-	-
Total		**112.325**		**2,266,815**	**42,292**	**15,945**	**192,697**	**8,607**

16. Residual biomass fuel projections for New Zealand; 2021 - Indicative availability by region and source: https://www.bioenergy.org.nz/documents/resource/Woody-biomass-resi-dues-and-resources-2021-Feb2022_V5.pdf

The findings indicate that around 260,000 green tonnes per annum (at least) of wood residuals are being used as fuel.

Table 4 excludes the wood processing industry. Wood processors around NZ are the largest users of wood fuels. An estimated 2.6 million green tonnes of wood fuels are used per annum at around 100 sites in 106 boilers with around 400MWth total installed capacity. This material is typically sawdust, shavings, bark, sander dust, trim etc. This use of wood indicates that the use of wood as fuel is well established and has been used extensively by the wood processing industry for decades.

EnviroStrat's conversations with the West Coast wood processors suggested a potential constraint for biomass on the West Coast's moisture content. The dry waste provides an opportunity to increase the temperature of biomass ignition but would require a volume of material that is not obvious in West Coast Reserves.[17]

MBIE has also completed a national assessment of biomass fuel switching opportunities for process heat. The analysis shows that the West Coast has <5% of planted forest area in the region and there are limited opportunities for switching.

Further analysis has been completed by Inside Resources and DETA and presented by BT Mining investigating biomass heat availability. It found that requirements shows that biomass availability on the West Coast will decline over the next decade and that it is unlikely bioenergy will be feasible.[18]

Currently, biomass is being imported into the region (primarily from Nelson), which imposes additional costs. Transporting biomass further than 100 km almost doubles the cost of the cheapest varieties, limiting fuel use to closer to where it is grown, and it adds emissions.

Geothermal

There is significant interest in using geothermal energy on the West Coast. GNS Science[19] has completed several research papers which provide the basis for the following summary:

- Unlike solar and wind power, a geothermal resource that is viable for electricity generation would provide continuous baseload power and improved energy resilience on the West Coast.
- The sedimentary basin domain and the alpine fault domain can provide low-temperature geothermal heat on the West Coast.
- GNS investigations indicate that the sedimentary basin domain might produce temperatures suitable for hot bathing pools, greenhouses, aquaculture and accommodation.
- The alpine fault domain might have higher temperatures sufficient for some industrial processes and small-scale electricity generation.
- The size of the geothermal fluid reservoir and flow rates of hot water needs to be demonstrated as a precursor step to any commercially viable investment.

Further site-specific investigations involving drilling and testing would be required to demonstrate this. At this stage, any private funding sources would unlikely entirely fund these investigations given their infrastructure research nature.

These could be a potential energy source for existing and new businesses (e.g. Whataroa, Harihari, Hokitika and Moana).[20]

Wind energy (Onshore)

The SKM 200[21] renewable energy assessment concluded there was limited potential for commercial wind power generation due to low wind power densities in the West Coast region. The average median wind speeds above 5-5.5 m/s are considered viable for commercial wind power generation, and above 7m/sec are considered excellent. Although the average median wind speed is under 5m/s for many low-lying coastal areas, there are areas at higher altitudes where average median wind speeds of 5-7m/s occur.

A recent study identified 78 new wind farm sites in NZ, of which 21 sites were in the South Island. Of these, only one West Coast site was identified with a capacity of 75 MW.[22] Many of the areas with suitable wind speeds appear to be in existing conservation areas and, for grid-scale developments, would need to compete with other sites around NZ, which may be better positioned in relation to existing electricity networks.

In the medium term, there may be value in identifying the region's most technically viable areas for wind energy

17. MBIE https://www.mbie.govt.nz/assets/discussion-document-accelerating-renewable-energy-and-energy-.pdf
18. BT Mining - Is converting boilers from coal to biomass going to reduce emissions
19. Carey BS, Alcaraz SA, Rae AJ, Upton P, Mroczek EK, Burnell JG. 2019. Geothermal resource assessment of West Coast region, South Island. Wairakei (NZ): GNS Science. Consultancy Report 2019/44, p. 60
20. https://www.gns.cri.nz/Home/Our-Science/Energy-Futures/Our-stories/Exploring-geothermal-as-an-energy-option-for-the-West-Coast
21. SKM ZP00717-RPT-GE-001 Final Report 23 June 2010
22. MBIE – https://www.mbie.govt.nz/assets/wind-generation-stack-update.pd

generation (high median wind speed, close to the existing electricity network and consumers) and investigating the potential to overcome barriers to development.

Solar PV

The global cost of solar photovoltaic (solar PV) for electricity generation has dropped dramatically over the past decade (faster than any other renewable energy).

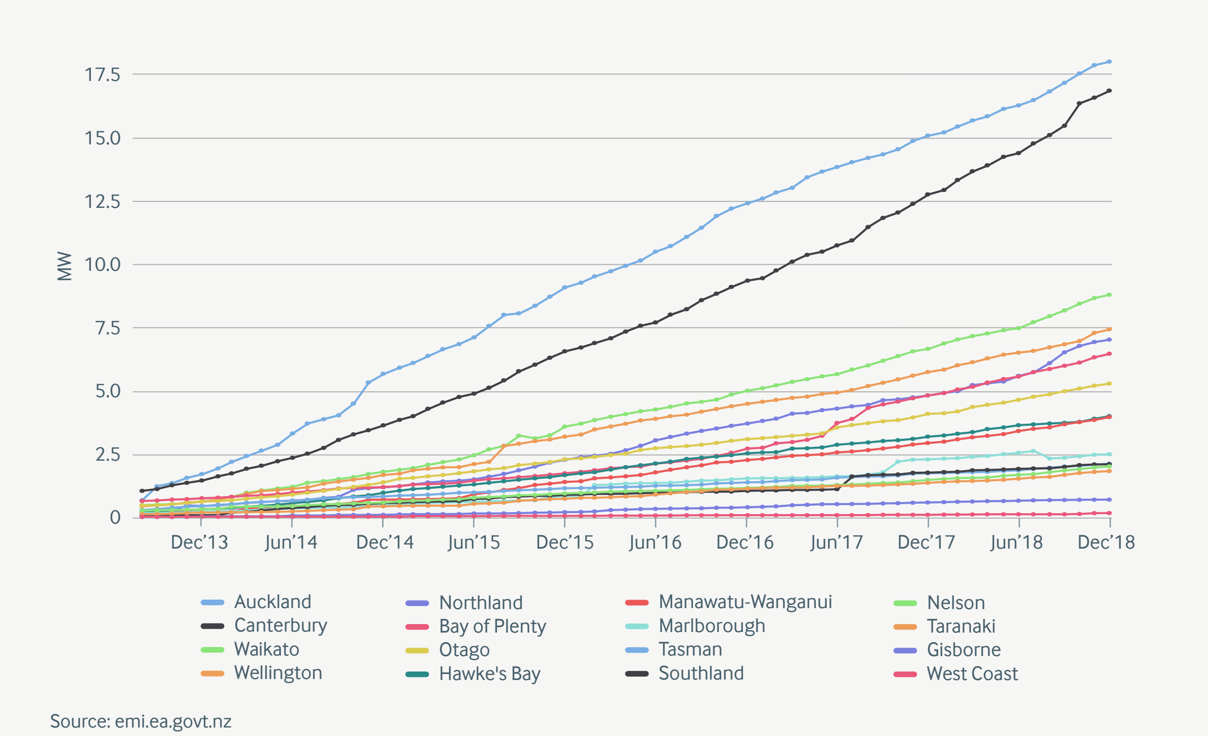
Hydrogen

As the world decarbonises, hydrogen will continue to be essential to the global economy because its role in fertiliser production and other chemical processes as chemical feedstock hydrogen is irreplaceable. Looking at hydrogen closely:

- As an energy storage medium, it has only a 50% round-trip efficiency which is much worse than batteries.
- As a source fuel cells are only 60% efficient, which is much less than electric motors and far more complex.
- As a source of heat, hydrogen costs four times as much as natural gas.
- As a way of transporting energy, hydrogen pipelines cost three times as much as power lines, and ships and trucks are even worse.
- It also has the potential to store energy produced by intermittent renewable technologies such as wind and solar.

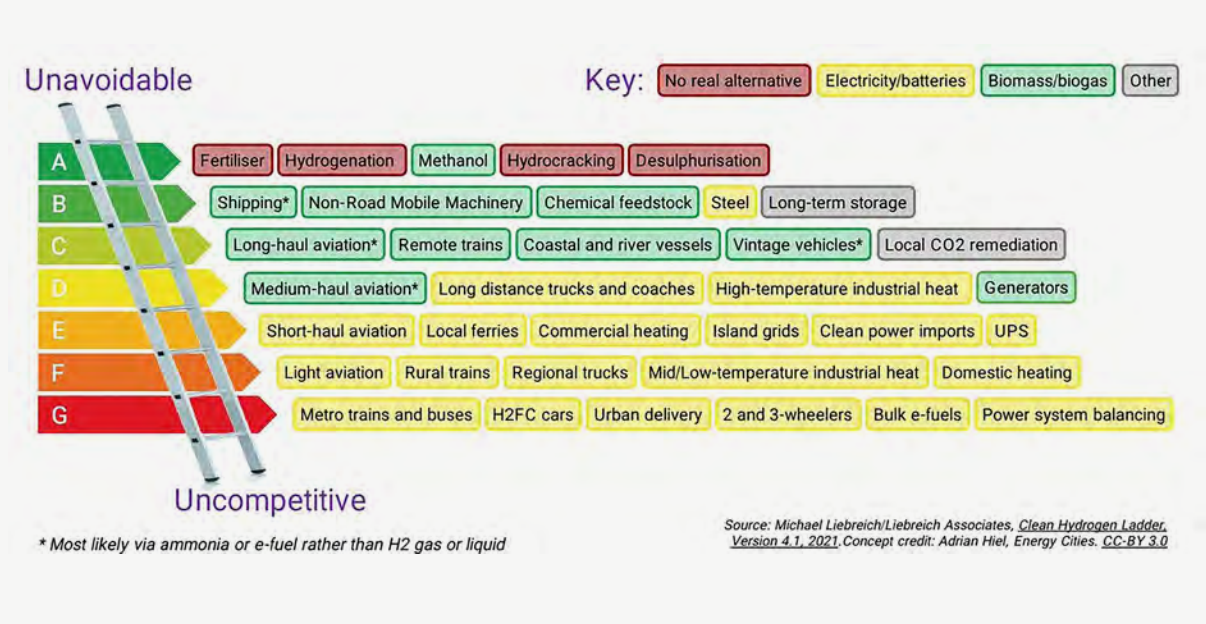
In theory, green hydrogen could be used throughout industry, transport, power and heating. However, hydrogen is going to have to win the use case. Not only will it need to beat the incumbent technology, but it also must beat every other zero-carbon option for that use case. This is highlighted in the international context shown below.

Figure 9: Solar growth in different regions of NZ



Source: emi.ea.govt.nz

Figure 10: Clean hydrogen ladder, competing technologies



Hydrogen or hydrogen-derived fuels may play a significant role in sectors such as shipping and long-haul aviation but will need to compete with biofuels. There are likely to be local situations where hydrogen can beat green electricity in industry. Some industries, including non-ferrous metals, ceramics, chemicals and food batch processes, require large amounts of energy in short bursts. These can cause voltage or frequency problems necessitating upgrading of the power grid. Although battery costs are falling, storing sufficient electrical power locally to meet bursts of demand may prove prohibitively expensive.

Waste-to-energy

Organic matter in municipal solid waste buried in landfills decomposes to produce biogas containing large quantities of methane. As methane is a powerful greenhouse gas, many sites in NZ collect biogas for flaring or as a source of energy for local electricity generation.

Several issues have been identified in the West Coast's Regional Waste Minimisation and Management Plan[23] including the proximity of the two significant landfills in the region. One of the infrastructure actions is to investigate combining Grey District and northern Westland District refuse disposal in the medium term (as cells at Butlers and McLean's Landfills are completed). A combined landfill may offer scale economies for biogas supply and local electricity generation.

There are opportunities for energy efficiency improvements and renewable electricity generation at the Central Wastewater Treatment Plant's (WWTP) at Westport, Greymouth, and Hokitika.

- The redevelopment of the Hokitika WWTP provides an early opportunity.
- Assess the viability of WtE production from landfill gas initially at Butler's and McLean's landfills.
- Move towards energy neutrality by assessing the viability of renewable energy generation at both landfills and wastewater treatment plants and implementing viable energy efficiency and demand management measures.
- Energy generation options include the use of biogas and solar PV.

23. https://www.westlanddc.govt.nz/sites/default/files/West%20Coast%20Regional%20WMMP%202018%20-%202024_0.pdf

Marine-based renewable resources

In New Zealand there is considerable potential for electricity generation from marine energy, especially from surface waves. Despite significant worldwide research and development, marine energy technologies remain in their infancy and are currently not sufficiently developed for large-scale commercial applications. Much of the West Coast has potential for wave power developments, and sites near Greymouth and Hokitika have been identified as having 'optimal locations'.

The West Coast should maintain a watching brief on the commercial development of wave energy technologies as a possible electricity generation option for the West Coast after 2030.

Wind Energy (Offshore)

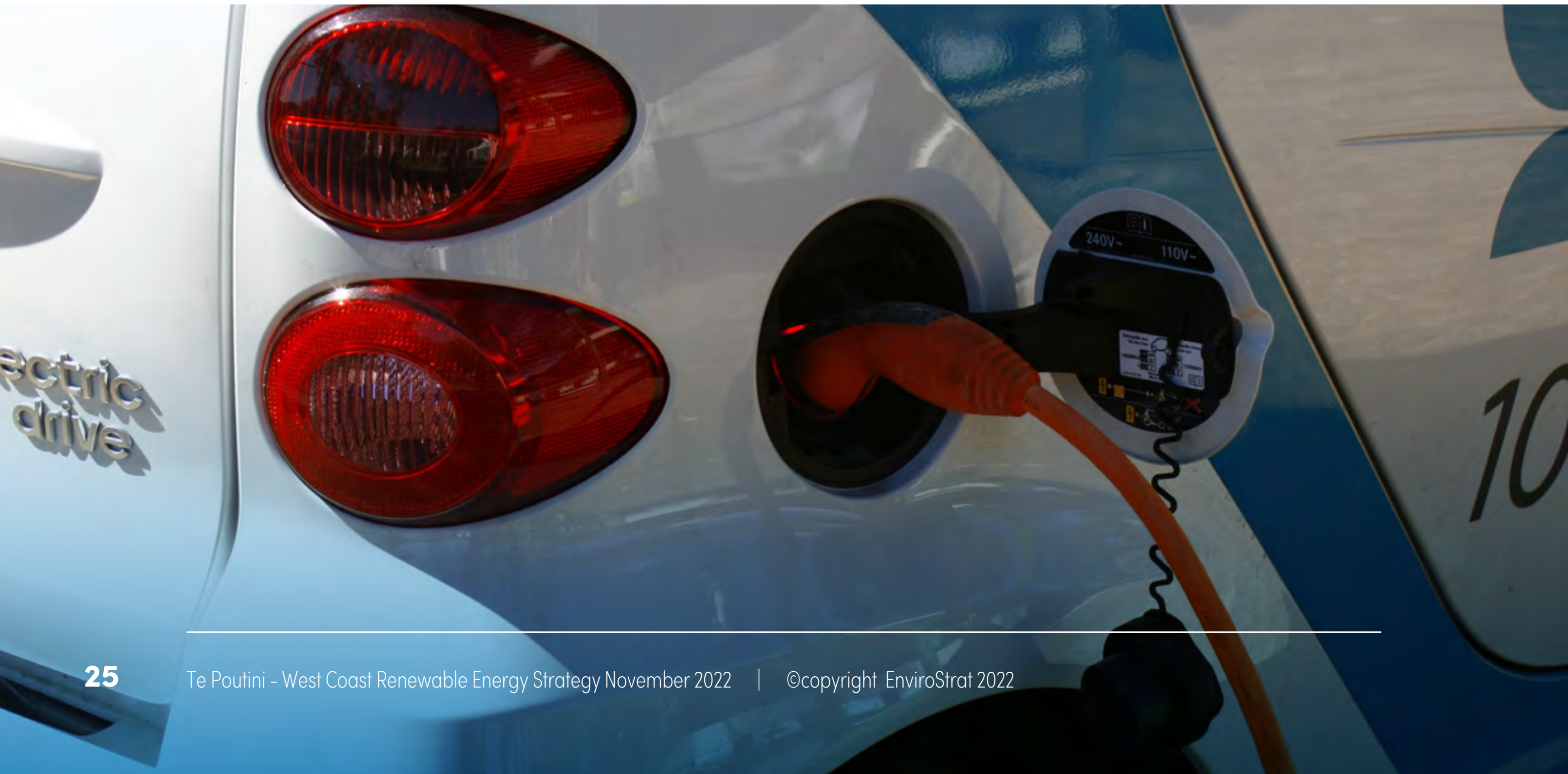
MBIE wind stack study also briefly looked at the offshore wind and identified 8,000 MW of capacity, although it noted that development was unlikely to occur before 2050 "due to the number of more attractive onshore sites in NZ".[24]

New Zealand is well placed with the technical potential for offshore wind and would be better positioned with improved regulations favouring renewables.

Transport – Electric Vehicles

- Light vehicles: As a low-emissions technology, Battery Electric Vehicles (BEVs) are particularly attractive in NZ because of our highly renewable and low-carbon electricity system. Range anxiety continues to be a barrier to uptake in regional NZ, so the realistic pathway for the West Coast will be Hybrid and Plug-in-Hybrid vehicles (PHEVs).
  A readily available and widespread rapid charging infrastructure is essential to support uptake. The NZ Government established the clean car discount scheme to make low-emission vehicles more affordable.[25] The program offers a rebate of up to $8625 on new vehicles that are low emissions, including EVs and PHEVs.
- Heavy Vehicles: BEV technology will continue to grow market share for light commercial vehicles and medium freight trucks, but until recently, its role for long-distance heavy trucks has been less certain.[26] Fuel cell electric vehicle (FCEV) technology has traditionally been thought to offer an extended range over BEVs for long-distance heavy trucks, which would require very heavy batteries. Recent developments suggest BEV technology is likely to dominate almost all trucking requirements. [27]

24. MBIE – https://www.mbie.govt.nz/assets/wind-generation-stack-update.pdf
25. NZTA - https://www.nzta.govt.nz/vehicles/clean-car-programme/clean-car-discount/overview/
26. EECA - https://www.eeca.govt.nz/assets/EECA-Resources/Research-papers-guides/REL-EECA-EV-Supply-constraints-report.pdf
27. Concept Consulting -https://www.concept.co.nz/uploads/1/2/8/3/128396759/policies_to_incentivise_the_uptake_of_zero-emission_trucks.pdf



2.12 Security of energy supply

The West Coast of NZ is particularly vulnerable to natural disasters. There is a high risk of earthquake and storm events, and its communities are held together physically by a network of fragile connections. Along with other critical infrastructure, a reliable and resilient network for the supply and distribution of energy underpins the West Coast economy, the well-being of its communities and the ability to recover from natural disasters.

There is an opportunity to increase regional resilience by using diverse energy sources. For example, with appropriate design, new local electricity sources and a robust transmission and distribution network will improve resilience. However, ongoing electrification of transport and process heat introduces additional vulnerabilities that must be addressed.

The main points of security of energy supply are:

- Planning for disruptions.
- Diverse energy generation.
- Robust transmission and distribution.

Transpower has prepared a regional plan to address future electricity demand, improve grid operations, and improve quality and reliability. The West Coast 'Lifelines Vulnerability and Interdependency Assessment report'[28] has explored the vulnerabilities of the region's energy lifeline assets to significant disasters and recommends upgrades and improvements to address these vulnerabilities.

2.13 Our energy vision for Te Tai Poutini West Coast

The energy sector, both in NZ and around the world, is undergoing a significant transformation driven by two key drivers, the need to address climate change by moving away from fossil fuels and the rapid decline in the price of renewable generation, mainly onshore wind, and solar PV.

Electrification is a crucial enabler in the transition to a low-emissions economy able to replace fossil fuels currently used for heat and transport. MBIE has considered five future scenarios which project electricity demand to grow between 18% and 78% between 2017 and 2050.[29] The challenge for the West Coast, alongside the rest of NZ, is maintaining a robust electricity system with an increasing contribution from renewable energy without reliance on fossil fuels.

Several future energy paths are possible for the West Coast, illustrated by two scenarios:

1. The zero-carbon scenario has renewable energy underpinning the decarbonisation of the regional economy, in line with central government policy but otherwise playing a supportive / reactive role in furthering economic development.
2. The green growth ('Power-to-X or P2X')[30] scenario drives the direction of the regional economy, developing large-scale renewable resources to produce zero-carbon fuels for use within NZ and export.

The zero-carbon scenario

A reliable and sustainable electricity supply meets an increasing fraction of the region's energy requirements, displacing fossil fuels and delivering zero-carbon energy for transport, heat, and other uses across most sectors. Uncertainty around this scenario is the extent of electricity demand growth on the West Coast. This will be driven by regional economic growth and the degree to which electricity is supplemented using local resources such as biomass and geothermal energy for heat.

Biofuels, hydrogen or hydrogen-derived fuels may supply hard-to-electrify applications such as shipping, medium- and long-haul aviation and some road freight. Still, because of the relatively small demand, production will likely be located outside the region. The energy security challenge is addressed through a mix of efficiency, electricity demand flexibility and greater diversity of local electricity supply. A robust interconnection with the national grid would be required to back up local generation and export surplus electricity.

The green growth scenario

The green growth scenario in the longer term enables the West Coast to develop a significant export industry mainly based on its renewable marine energy resources such as offshore wind, tidal, and wave power for the production and export of low-carbon fuels and chemicals such as hydrogen and ammonia.

This scenario is likely to be part of a national strategy, which includes other regions, to exploit NZ's abundant

28. The NZ Critical Lifelines Infrastructure National Vulnerability Assessment, 2020
29. MBIE's Electricity Demand and generation scenarios, July 2019. Four of the scenarios project growth between 435 and 78%.
30. Power-to-X describes electricity conversion, energy storage, and reconversion pathways that use surplus electric power, typically during periods where fluctuating renewable energy generation exceeds load for use in other sectors such as transport or chemicals. The X can refer to: power-to-ammonia, power-to-chemicals, power-to-fuel, power-to-gas, power-to-hydrogen, etc.

renewable resources to become a renewable energy hub in the South Pacific. It would require an increase in onshore energy demand and services to power the industries supporting offshore generation. Regional energy requirements and growth in other sectors would be supplied mainly as a by-product of marine energy development.

The renewable energy strategy focuses on these primary outcomes:

- An inclusive and consumer-focused energy system making the most of current assets (improving planning and infrastructure, energy efficiency).
- A system that encourages increased investment in low emissions technologies and provides more local renewable energy. An innovative and modern energy system that creates new opportunities for businesses and consumers, building energy-led economic development.

The proposed West Coast renewable energy strategy has the following targets for 2035:

- Enhance the contribution of local renewable sources of energy to 100% of demand (for electricity and heat) to deliver an affordable and sustainable energy supply for the region.
- Develop a more diverse supply of renewable energy sources to build a robust and resilient economy.
- Support the transition to a transport zero-emissions transport fleet with at least 50% of the light vehicles being low or zero emissions.
- Develop new sources of renewable energy to support new businesses and enable a doubling in the size of the regional economy.
- Engage the community to support energy efficiency and renewable uptake.

In the short-term, renewable energy diversification options include greater use of local wood residues for heating, developing microgrids with solar PV and battery storage for critical facilities and remote communities, and adopting plug-in electric hybrid vehicles rather than battery electric vehicles (BEV). The medium-term greater adoption of BEVs with vehicle-to-grid technology could provide short-term electricity storage and grid support.

2.14 West Coast renewable energy roadmap

Addressing challenges presented by balancing the 'Energy Trilemma', the roadmap is structured into four focus areas with seven regional priorities. There are 17 resulting workstreams to support the achievement of the targets for the strategy enabling zero and low carbon technologies and 'Power to X' opportunities.

Structurally, the roadmap highlights vital strategy areas for the activity to support:

- Demand and supply sides.
- Energy innovation priorities.
- Increasing capabilities and improving coordination.
- Strengthening linkages.

The following section summarises the key priority areas for the strategy:

- Developing a regional voice.
- Fostering a regional direction (ownership of the strategy), collaborative and unified.
- Working with central government: Accessing pools of capital and blended finance options.
- Retrofitting homes for comfort and health .
- Energy technologies, security, and microgrids.
- Making informed energy choices.

The key focus of the roadmap covers four key areas:

1. Electrification

The roadmap for greater electrification prioritises the encouragement and uptake of renewable energy options through creating a flexible, efficient, integrated and resilient electricity system. It targets more significant decentralised electricity generation, lower energy costs and optimisation of usage.

2. Process heat

The roadmap supports industry to improve energy efficiency, reduce costs and switch from fossil fuels to low-emission alternatives through an increased range of process heat sources. It supports reduction in emissions and energy savings through central government support in decarbonisation and highlights case studies on how these changes can positively impact people, buildings and the environment.

3. Transport

Supporting the increase in EV, Hybrid, and PHEV use in both the light and heavy fleets, the roadmap supports increased access to low and zero-emissions vehicles through expanding access and improved infrastructure for light vehicles, supporting increased mobility for locals and visitors to the West Coast.

4. People

Leadership for the strategy and roadmap delivery is critical in supporting successful participation and engagement with energy transition activities. Several activities to help more vital collaboration between agencies, communities and industry are identified, with additional measurement and monitoring, proposed to support efficient energy consumption.

Addressing the 'Energy Trilemma', each focus area is framed under the three sections of the trilemma:

- Security of supply.
- Energy cost.
- Greenhouse gas (GHG) emission reduction.

Electrification: Developing a diverse range of renewable energy sources

Electrification that works for the West Coast and supports the security of energy supply through:

- Developing a diverse range of renewable energy sources.
- Planning for disruptions.
- Diverse energy generation.
- Robust transmission and distribution.

Enabling zero and low-carbon technologies

To enable zero and low carbon technologies uptake, the following influences need to be considered:

- Demand and supply sides.
- Energy innovation priorities.
- Increasing capabilities and improving coordination.
- New local renewable electricity generation plants contributing to local generation.
- Energy efficiency and generation opportunities contribute to operating cost neutrality or profitability.
- Optimisation of energy demand profiles to suit generation capacity.

Homes, communities, and wellbeing

The West Coast region has a strong sense of community and proud heritage. The well-being of locals is paramount and healthy homes supporting healthy people is a critical component of Te Whanaketanga 2050.[31] Outputs from this roadmap will support:

- Retrofitting homes for comfort and health.
- Energy technologies, security and microgrids provide a guarantee of power, easing concerns or risks of loss of power.
- Being able to make informed energy choices through education and alternative energy supplies.

31. https://westcoast.co.nz/development-west-coast/key-documents/

Our Focus: Electrification

Challenges Addressed	Priorities	How it will be achieved	2025	2035
Security of supply, energy cost and GHG reduction	Enable and encourage the uptake of renewable electricity options	Improve planning for future electricity generation	Support the development of hydro generation	Decentralised / distributed electricity production
		The investment environment for renewable electricity generation is supportive and competitive	Assess options for the development of solar PV and onshore wind	Regional and local electricity generation and effective distribution results in lower energy costs
	Create a flexible, efficient, integrated, and resilient electricity system	The investment environment for renewable electricity generation is supportive and competitive	Enable lower transmission costs through collaboration among stakeholders	New local renewable electricity generation plants contributing to local generation
		Community facilities showcase renewable electricity opportunities	Assess efficiency and renewable generation opportunities (e.g. at airports, WWTPs and civic buildings)	Energy efficiency and generation opportunities contribute to operating cost neutrality or profitability
		Increase electricity demand-side flexibility and secure ongoing transmission to and from the region	Techniques to support flexibility on the demand side are understood and effectively deployed	Optimisation of energy demand profiles to suit generation capacity

Our Focus: Industrial process heat

Challenges Addressed	Priorities	How it will be achieved	2025	2035
Security of supply, energy cost and GHG emission reduction	Increase the range and availability of process heat sources	New funding models for transition to renewable sources reduce the cost of process heat	Support demonstration of new process heat projects (e.g. targeted blended finance)	All heat for new industries, new buildings and upgrades use low-emission sources
		Evaluate the case for greater local biomass / geothermal supply for process heat applications	Support industry to utilise existing central government transition funding	Identification of potential sites and pilot programmes
	Support industry to improve energy efficiency, reduce costs and switch from fossil fuels to low-emissions alternatives	Leverage government funding (such as government investment into the decarbonising industry) to decarbonise industry and commercial building's heat requirements	Support industry to utilise existing central government transition funding	Deliver energy savings and emissions reductions of 50% from buildings and industry by 2035

Our Focus: Transport

Challenges Addressed	Priorities	How it will be achieved	2025	2035
Energy cost and GHG emission reduction plan	Develop new infrastructure to support the transition to low-emission vehicles and transport modes	Expand the availability of fast charging for EVs and services	Support the uptake and development of smart charging and vehicle-to-grid solutions	The total distance travelled by the light fleet (cars, vans, utes) is reduced by 20%
		Supporting social leasing schemes and trialling an equity-oriented vehicle scrap-and-replace scheme	Reduce transport emissions through community-lead projects	Increase access to low and zero-emissions vehicles and or public transport for low-income households
	Support the adoption of low-emission vehicles	Incentivise the use of EVs and plug-in electric vehicles for light vehicles and demonstrate low-emissions heavy vehicles transition (which may include hydrogen)	Support funding for the freight sector to purchase zero and low-emissions trucks	Emissions from freight transport are reduced by 35%

Our Focus: People

Challenges Addressed	Priorities	How it will be achieved	2025	2035
Security of supply, energy cost and GHG emission reduction	Sustainable development of natural and human capital to enhance regional economic development	Strategy ownership and co-ordination supports long-term transition with partners and stakeholders	Encouraging behavioural change and workforce transition programmes	A low-emission energy system enables individuals and organisations
		Dedicated support for research and innovation	Collaborating and leveraging off existing national research entities (e.g. Ara Ake, EECA and Electricity Authority)	Measurement and tracking systems developed to support efficient energy consumption
		Improving collaboration between industry and tertiary education	Incentivise research and development in the environmental / technology/minerals sectors	Incentivise 'smart specialisation' investment
		Support a deeper understanding of energy use and participation	Increased use of smart meters/grids and distributed energy management tools	Measurement and tracking systems developed to support efficient energy consumption
		Encourage and enable low emissions within urban development and resilient housing	Demonstrate high-efficiency zero-carbon retrofits as well as leveraging government funding	High-efficiency retrofits and new builds are enabled through financing arrangements

APPENDIX
Supporting information

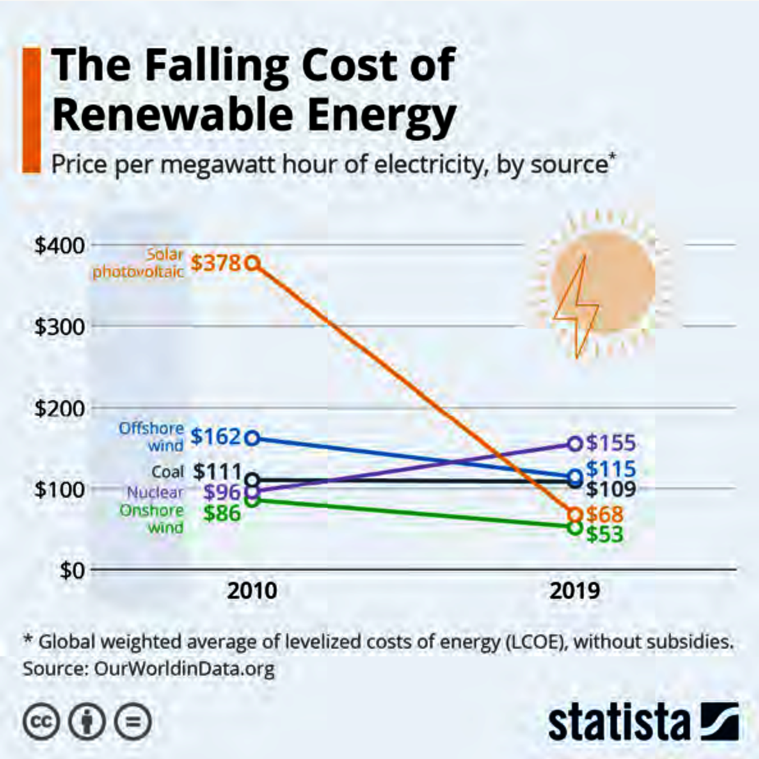
Electrification

Global and NZ electricity price trends

There has been a significant drop in global prices for renewable electricity over the past decade, which has boosted its chances of becoming much more widely adopted in the next few years.[32] The most dramatic decline has been in the price of solar PV. Their price declined from US$378/MWh in 2010 to US$68/MWh in 2019 to become the second cheapest source of electricity. Onshore and offshore wind has declined in price at similar rates. In 2019 onshore wind remained the cheapest source of new electricity at US$53/MWh.[33]

32. https://www.weforum.org/agenda/2021/11/renewable-energy-cost-fallen/
33. Ibid

Figure 11: The falling cost of renewable energy

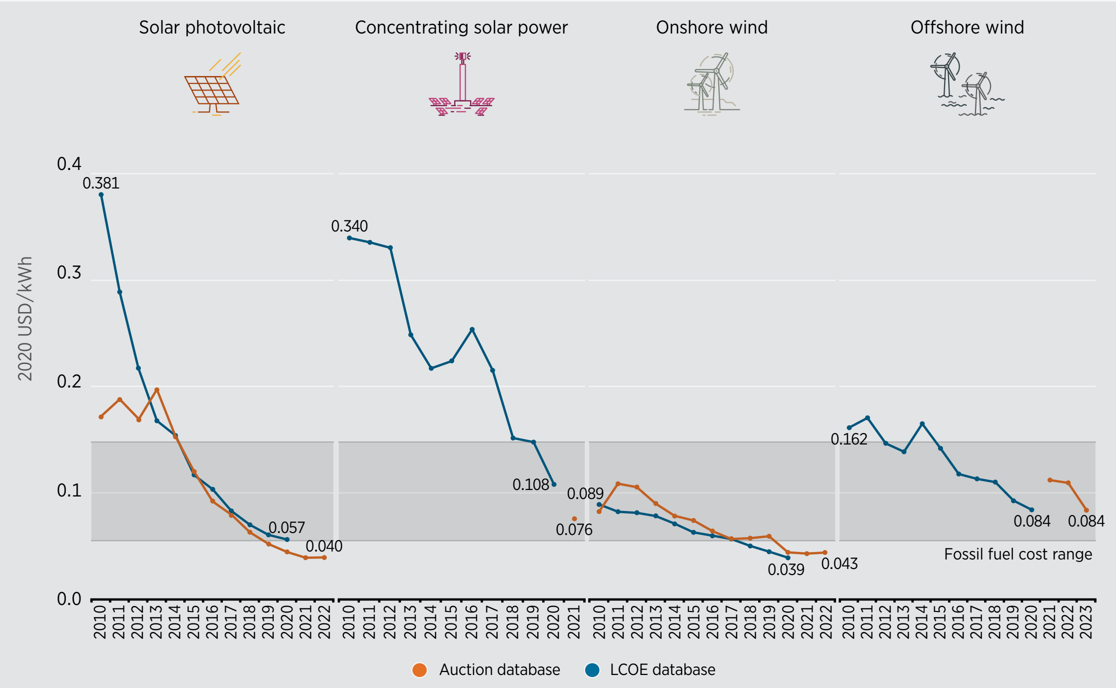


The combination of targeted policy support, the high learning rates[34] for renewable energy technologies and industry drive, has seen renewable electricity from solar and wind power go from an expensive niche to head-to-head competition with fossil fuels for new capacity. In the process, it has become clear that renewables will become the backbone of many global electricity systems and help decarbonise electricity generation, with costs lower than a business-as-usual future.

In the short to medium term, cost declines look set to continue for renewables. Data from IRENA indicate that utility-scale solar PV projects (that have won recent competitive procurement processes and that will be commissioned in 2022) could have an average price of US$0.04/kWh (Figure 11). This is a 30% reduction compared to the global weighted average levelised cost of electricity (LCOE) of solar PV in 2020.[35]

34. The learning rate is derived from the historical relationship between cost and deployment and can be applied to deployment projections to estimate future costs
35. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf

Figure 12: The global weighted-average LCOE and PPA/auction prices for solar PV, onshore wind, offshore wind and CSP, 2010-2023



Source: IRENA Renewable Cost Database

Note: The thick lines are the global weighted average LCOE, or auction values, by year. The band that crosses the entire chart represents the fossil fuel-fired power generation cost range.

Several trends are driving the global adoption of renewables, particularly wind and solar, including:

- Technological innovation.
- Cost efficiencies.
- Reliable grid integration.
- Community energy off- and on-grid.
- Emerging markets as leading markets.
- Growing scope for corporate involvement.

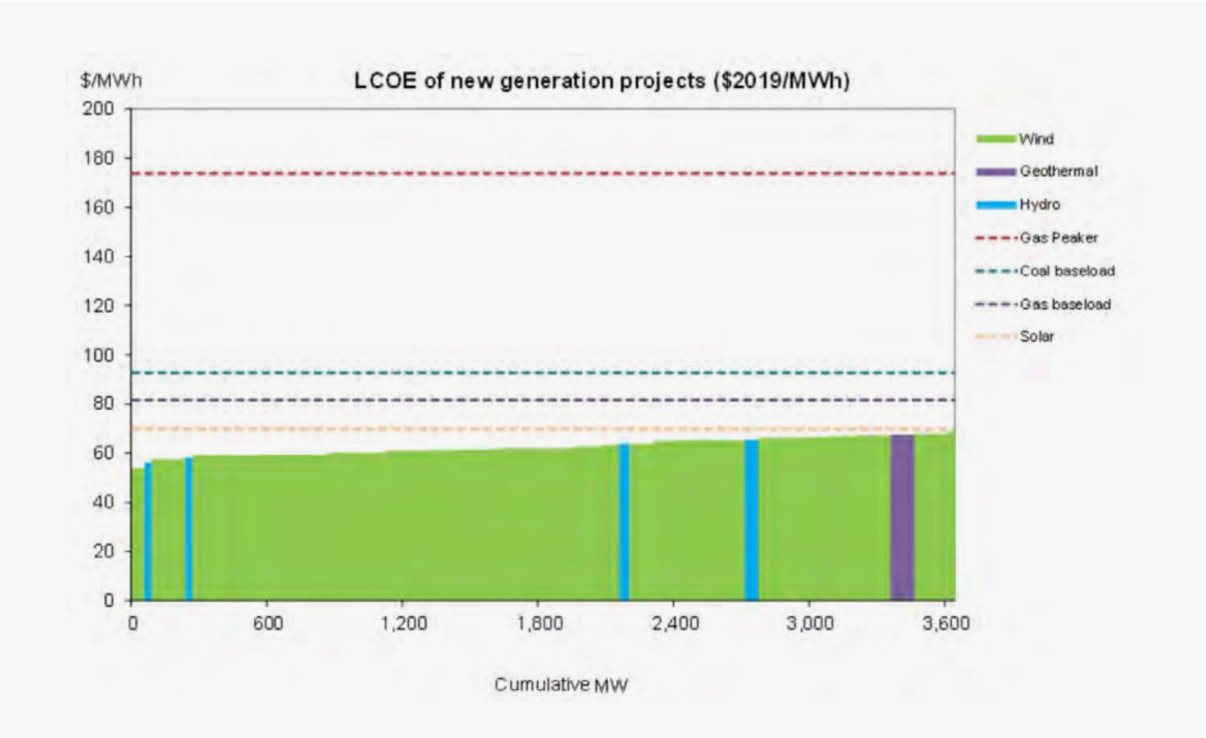
For NZ, as a technology taker, the rapid global uptake and price declines of renewables, particularly solar and wind, will affect costs of future generation locally.

NZ price trends

MBIE's Interactive LCOE tool ranks electricity generation projects from lowest to highest LCOE. The resulting curve is a simplified representation of NZ's long-run marginal electricity generation costs.[36] The LCOE is the average minimum price at which the electricity generated by the asset is required to be sold to offset the total production costs over its lifetime. Using default assumptions, the tool shows that the next generation plants that are likely to be built is either wind or hydro. However, the tool does not allow for the falling cost of both wind and solar, and several grid-scale solar developments are operational or in development (as of mid-2022).

36. https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-modelling/interactive-levelised-cost-of-electricity-comparison-tool/

Figure 13: Graph showing the LCOE comparison of new-generation projects



Solar and wind technologies have remarkable learning rates.

Over the period 2010 to 2020, which included 94% of cumulative installed renewable capacity additions, utility-scale solar PV had the highest estimated learning rate for the global weighted-average total installed cost, at 34%.[37] This technology also had the highest LCOE from new capacity, at 39%. This value exceeds all previous learning rate analyses for solar PV based on data for the earlier deployment (when learning rates might have been expected to be higher than in later periods).

37. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf

Figure 14: Learning rates for solar PV, CSP, onshore and offshore wind, 2010 to 2021/23

	Learning rates	
	Total installed cost 2010-2020	LCOE 2010-2021/23
	%	%
Utility-scale solar PV	34	39
CSP	22	36
Onshore wind	17	32
Offshore wind	9	15

The learning rate is the percentage reduction in the price/cost for every doubling of cumulative installed capacity

The importance of capacity installed cost reductions to the decline in electricity costs from utility-scale solar PV is evident in figure 15 on page 37, given the closeness of the learning rates for total installed costs and LCOE. Performance improvements that have increased capacity factors have played a larger role in falling electricity costs for the other technologies. As a result, the LCOE learning rates for CSP, onshore and offshore wind are significantly higher than those for total installed costs.

Figure 15: Snapshot of process heat electrification opportunities

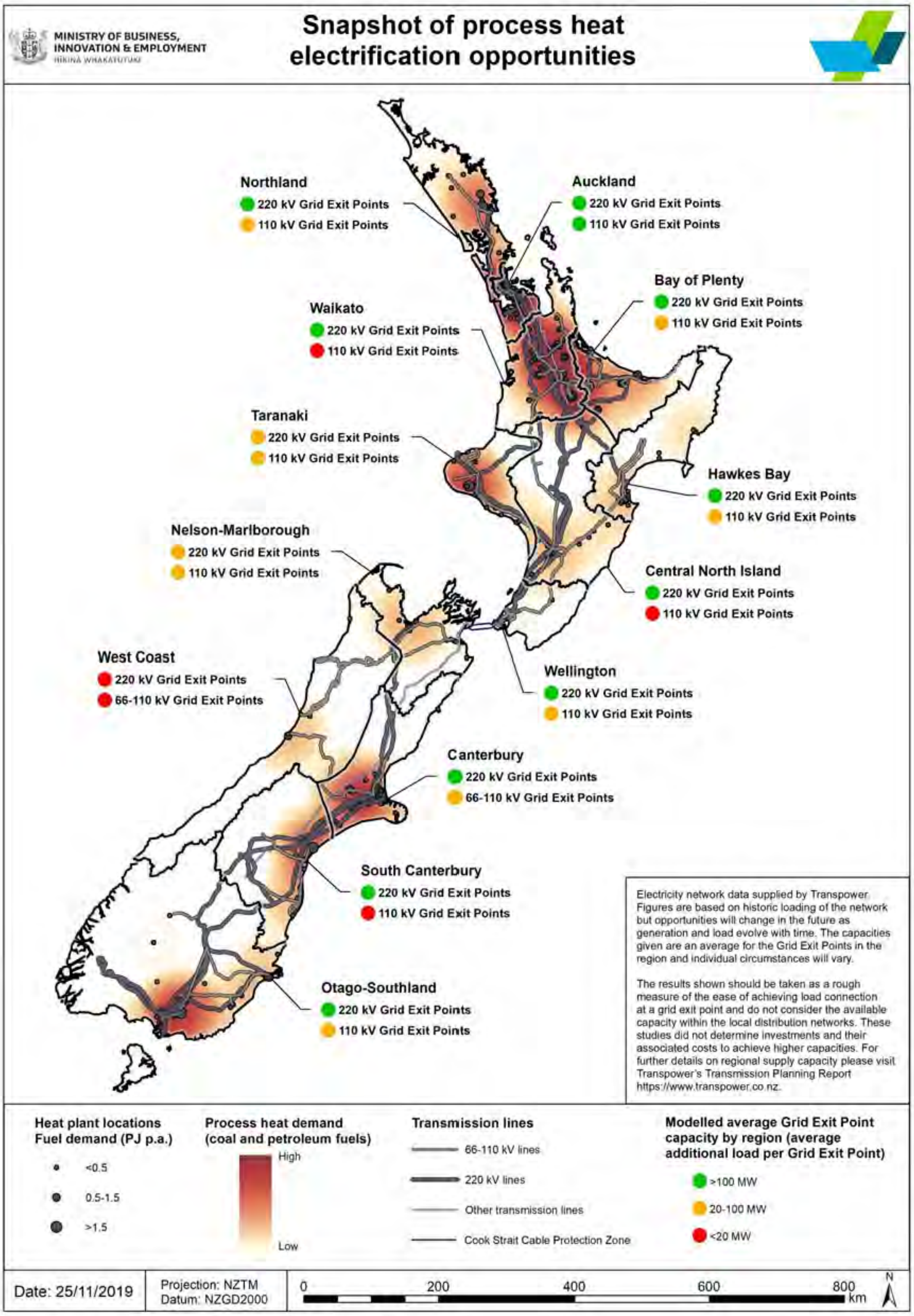
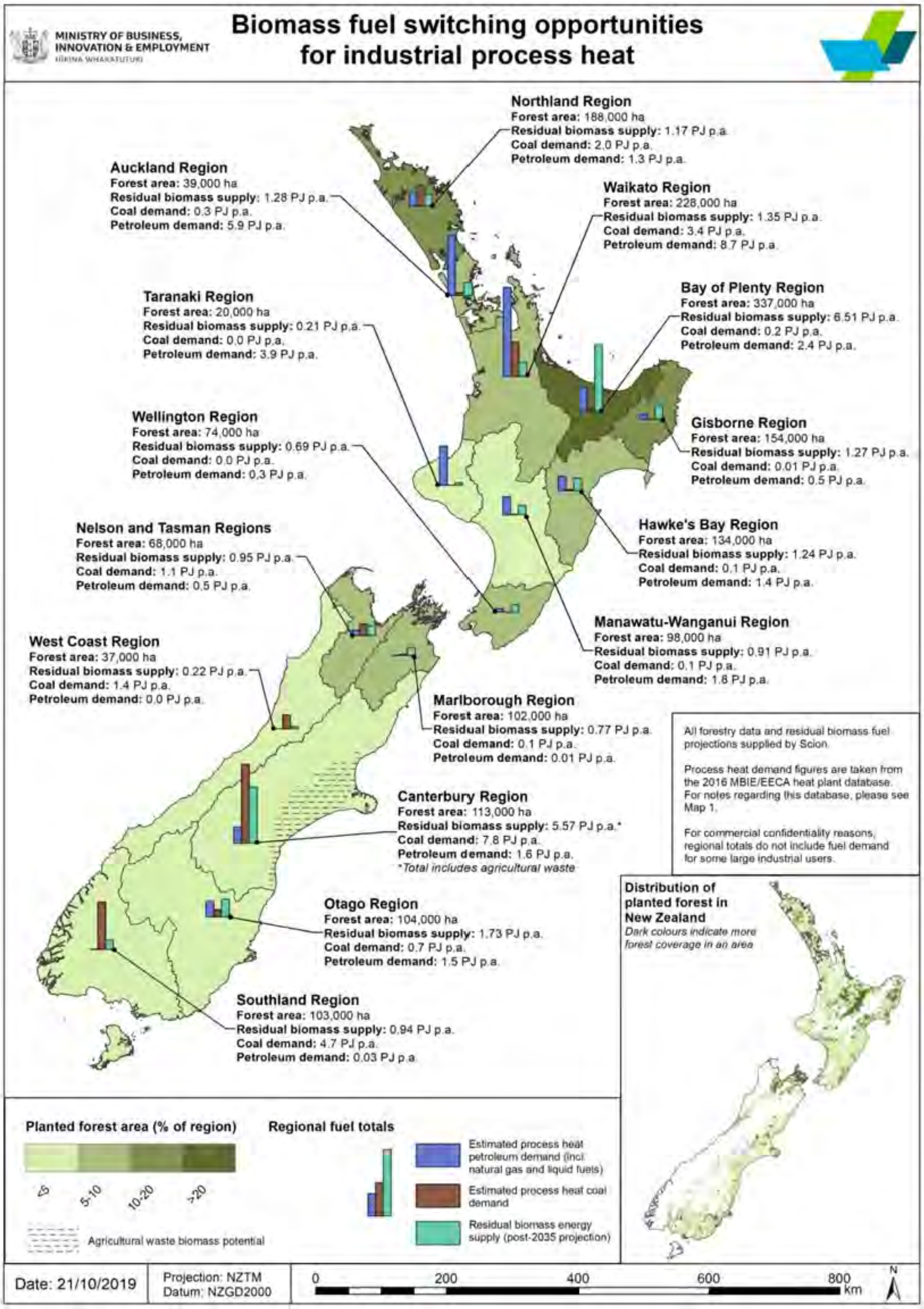


Figure 16: Biomass fuel switching opportunities for industrial process heat[38]



38. https://www.mbie.govt.nz/assets/discussion-document-accelerating-renewable-energy-and-energy-.pdf

Figure 17: Wood processing residues by region (2021-2025) [39]

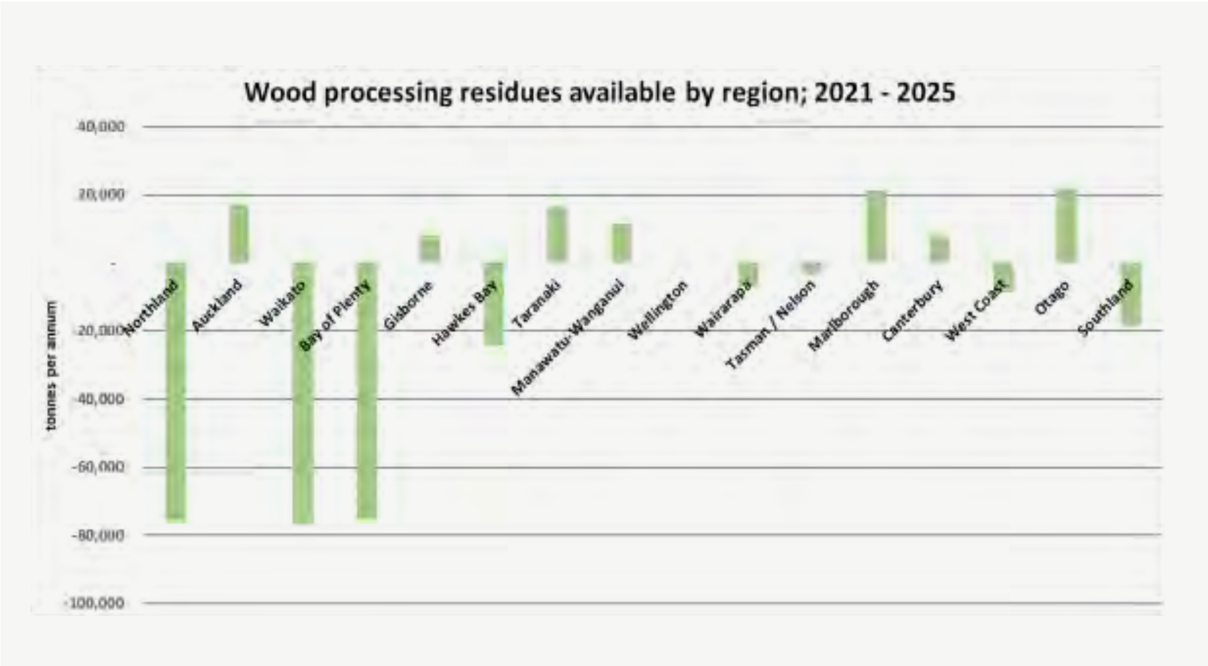


Figure 18: South Island Biomass Availability [40]

39. The learning rate is derived from the historical relationship between cost and deployment and can be applied to deployment projections to estimate future costs
40. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf

Geothermal

Background: GNS Science completed work in April 2019,[41] which included recommendations for additional investigative work in several areas on the West Coast seeking to identify the possible presence of useable geothermal resources. The study considered the possible presence of a geothermal resource and proximity to a load that might use thermal energy. As part of discussions with Westpower during the study period (2017–2019), generation was favoured closer to Hokitika and Greymouth, whilst the Waitaha project was still actively being considered.

The work identified that the alpine fault domain was the most prospective for electricity generation. Three alpine fault domain sites were identified based on possible thermal loads (possibly including some power generation).

Using thermal water for electricity generation is strongly related to the temperature of the fluids that might be available underground, which can then be delivered to the surface for use in power generation facilities. The higher the temperature, the more effective it is.

The alpine fault well at Whataroa is where the highest temperatures have been measured at ~1km depth at any location on the West Coast. Based on a gradient of 100°C per km and the increasing temperature profile with depth, drilling deeper at a Whataroa location would be a possible approach for investigation. Drilling to ~2km could see temperatures greater than 180°C. To penetrate to 2km (the bottom of the well, being to the east of the fault) would require a drilling site to be found further up the Whataroa valley.

Understanding the cost of preparation and drilling has not been attempted in any detail, but NZ$4 million is an approximate cost using extrapolation of the 2019 estimates for the stage two work.

Whatoroa is not the only location in the alpine fault domain where deeper wells could be considered. The advantage of Whatoroa is that it has the highest measured temperatures of any site. Other locations, including Franz Josef, could be considered, but these would be more speculative.

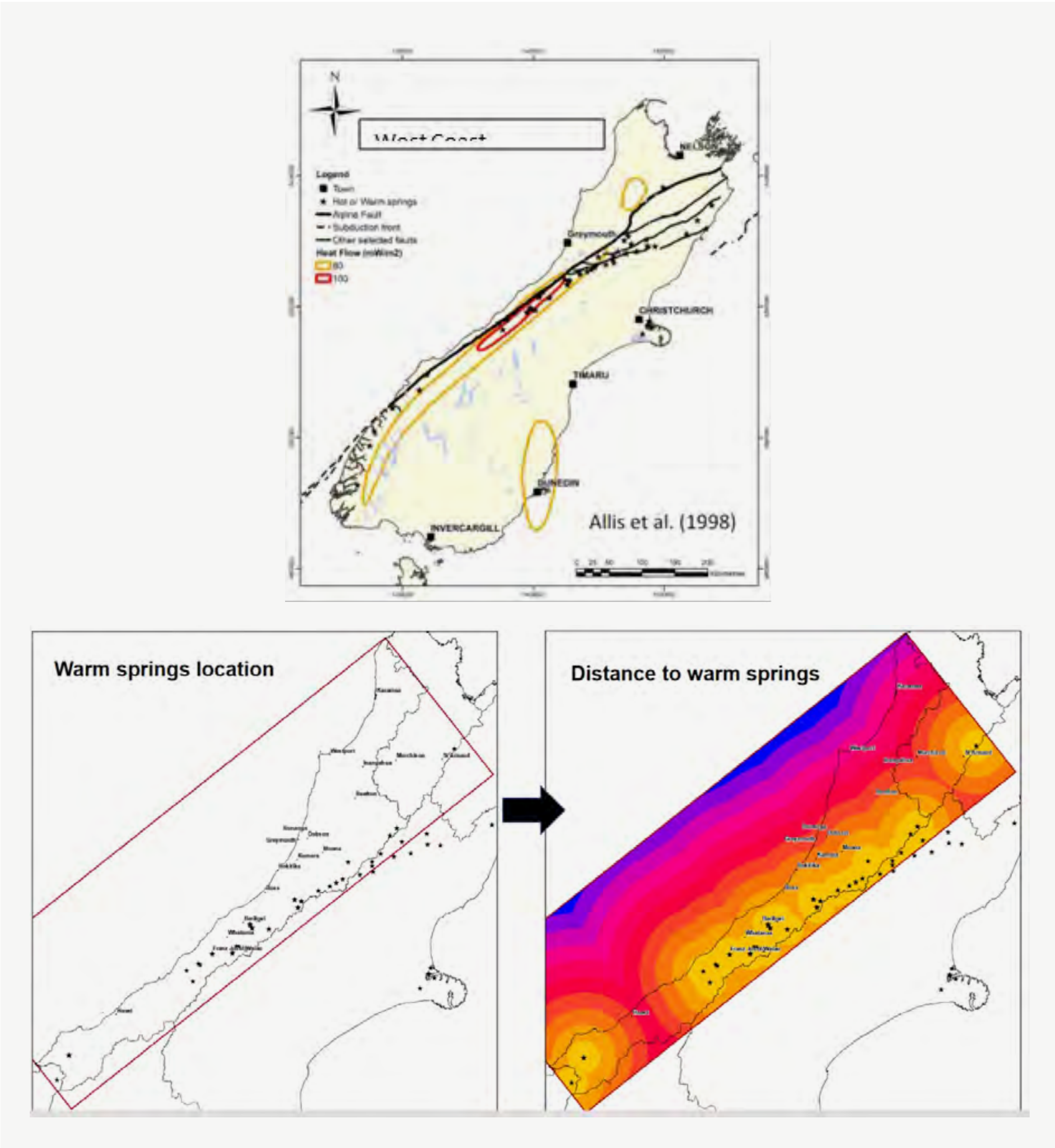
Geothermal heat can provide a continuous source of both baseload heating and electricity. For electricity, the higher the temperature delivered to power generation facilities at the surface, the greater the amount of electricity that can be produced.

GNS has undertaken a primarily desk-based investigation to bring together what is known about the geothermal conditions of the Southern Alps and the Westland Plains. The study identified that temperatures in the order of 60°C at 1000m might be found in the sedimentary basin domain and 130°C at 1000m in the alpine fault domain. To be useful, a geothermal energy resource needs to produce sufficiently high temperatures and have potential applications. Hot bathing pools, greenhouses, aquaculture, and accommodation can function with temperatures down to 60°C. Some industrial processes and small-scale electricity generation can use temperatures from 100°C to 130°C.

The location of West Coast heat domains, warm springs, and colour coding showing the level of favourability of the resource in relation to communities is shown in figure 19 on page 41.

41. Carey et al (2019)

Figure 19: Collection of maps of West Coast geothermal resources



GNS modelling work has identified that the likely sustainable production will be less than 5 MW thermal at a given sedimentary domain site and less than 40 MW thermal for an alpine fault domain site. This indicates that the sedimentary basins are best suited for horticulture and tourism activities. The alpine fault domain appears to have higher temperatures and may be able to support larger quantities of energy production for industrial process heat and some electricity generation.

GNS has further identified that small users (1 MW) need to be very close to the production site, and medium-sized users (5 MW) could be up to 5 km from the production site for an end user with a reasonable utilisation factor. For a large-sized energy supply (40 MW) at higher temperatures, distances greater than 15km appear possible.

GNS identified several locations as worth further investigation. Based on the potential uses, these have been refined down to four prospects for further examination, including drilling wells up to 1100 m deep at each site. The preferred prospects are Franz Josef, Hokitika East (Styx), Brunner Moana and Haupiri.

- Franz Josef has potential to develop a load centre supplying heat to accommodation, pools and possibly a tiny power station.
- Hokitika East may be able to supply through to Hokitika for industrial and commercial use. There is also the possibility of small-scale power generation at this location.
- Prospective development at Haupiri may focus on small-scale power generation, with an opportunity for heat supply to accommodation or commercial uses.
- Brunner Moana should focus on lower-temperature uses associated with tourism, accommodation, bathing, and others such as lower-temperature aquaculture, spirulina production or honey processing.

Proof that useful geothermal energy exists at any one of these locations requires site-specific investigation drilling. The potential use temperature governs the depth of the drilling at each site. Along with temperature, there is a need to prove and quantify permeability. These two aspects are determined as part of post-drilling testing undertaken on a drilled well. Permission would also be required as part of further work. Any geothermal activity that requires the take, use and discharge of geothermal water will need resource consent from the West Coast Regional Council.

Solar energy

Global development

Solar PV accounted for 3.1% of global electricity generation in 2020 and remained the third-largest renewable electricity technology behind hydropower and onshore wind. In 2017, solar became the leading form of new utility energy generation worldwide.[42] Solar PV is becoming the lowest-cost option for electricity generation in many parts of the world, propelling future investment. For the first time, new solar generation installed globally exceeded new fossil fuel generation built in the same year by 40%. Transpower believes that by 2050 utility solar is likely to be the world's cheapest electricity - marginally cheaper than the wind, which will also continue to fall in price.[43]

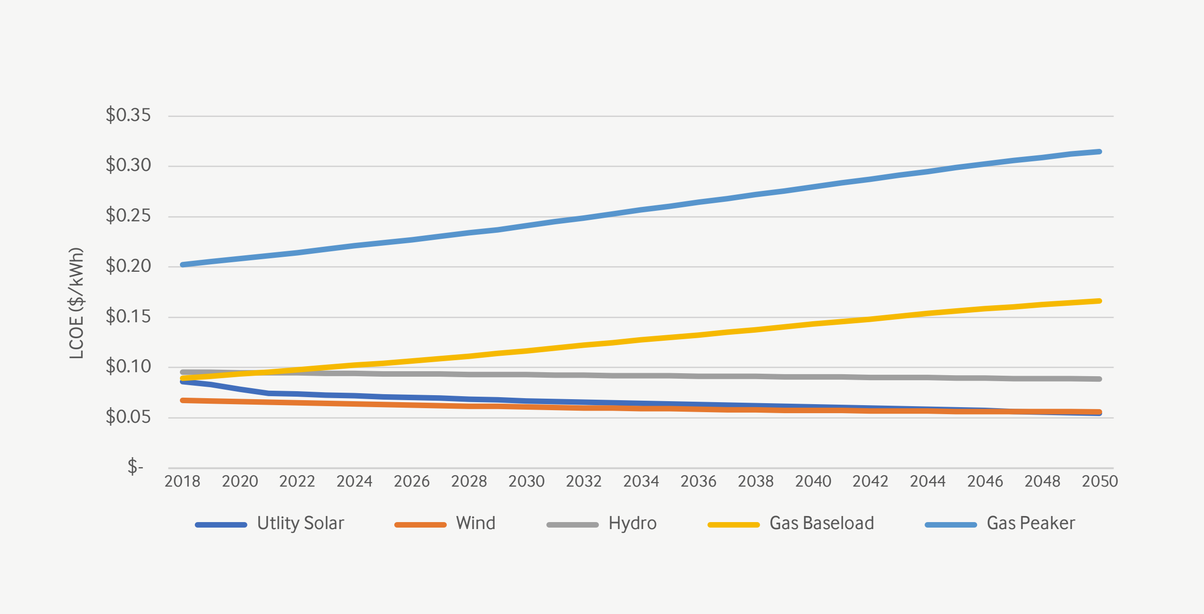
NZ resources and costs

By world standards, NZ has a relatively good solar resource. However, compared with other countries, it is under-utilised. Current penetration is far below levels in countries with fewer solar resources (such as Germany and Japan), and utilisation is several orders below its economic potential. In NZ in 2020, only 0.37% of all electricity was generated from solar power.[44] This partly reflects the dominance of our past hydro developments, our abundant onshore wind resource and solar generation traditionally adopted as a rooftop technology rather than considered for grid-scale application.

The full economics depends on the site, carbon pricing assumptions and more, but according to Transpower utility, solar is an economically viable option in the mix for NZ's energy future.[45] Figure 20 on page 43, shows the LCOE for a range of electricity generation technologies. With forecast carbon prices applied to gas-fired electricity generation, this graph shows that the cost of energy from gas-fired power stations will double the price of energy from utility solar within a decade.

42. https://www.iea.org/reports/solar-pv
43. Transpower https://www.mbie.govt.nz/dmsdocument/12112-transpower-accelerating-renewable-energy-and-energy-efficiency-submission-pdf
44. MBIE- https://www.mbie.govt.nz/dmsdocument/11679-energy-in-new-zealand-2020
45. https://www.transpower.co.nz/about-us/transmission-tomorrow/sun-rises-solar-energy-future

Figure 20: NZ$ cost of energy from different sources as technology and carbon prices evolve



The economics of rooftop solar are more nuanced. The cost of energy from rooftop solar without a battery is approaching the cost of grid-supplied electricity (a battery adds significant expense, which isn't competitive yet). Without partnering rooftop solar with batteries the electricity cannot be stored. It must be used as generated, so it is best suited to businesses such as supermarkets and hotels that use significant volumes of electricity during the day. These will likely be the early adopters over the coming years.[46]

46. https://thespinoff.co.nz/partner/28-01-2022/how-the-suns-power-is-changing-our-electricity-market

Figure 21: LCOE compared to generation and retail price ($/kWh)

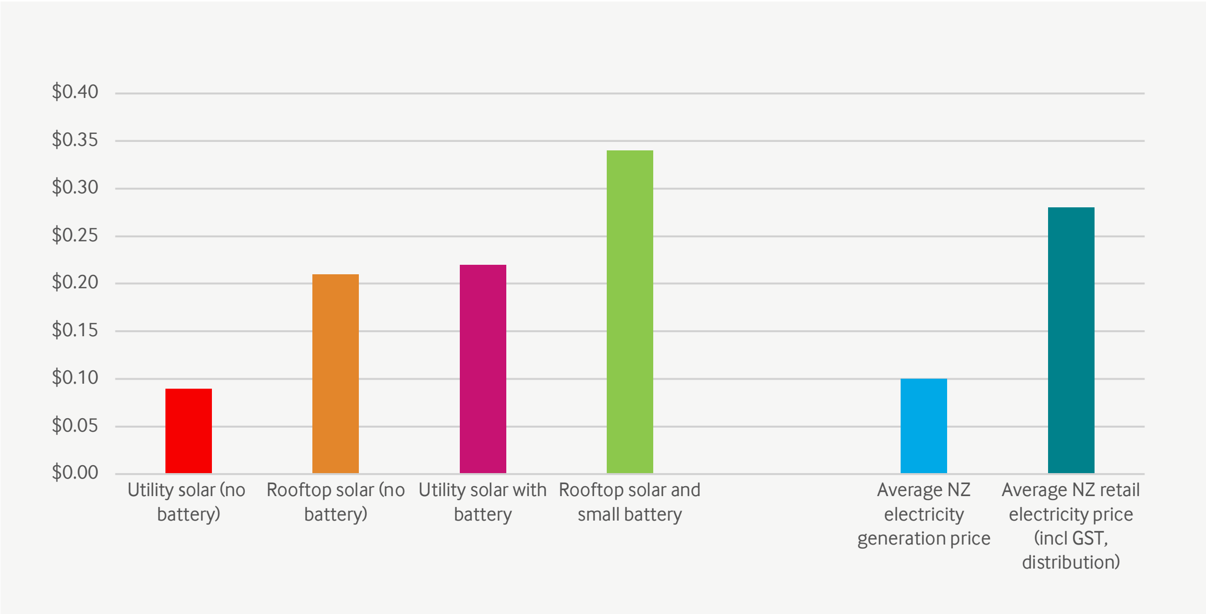
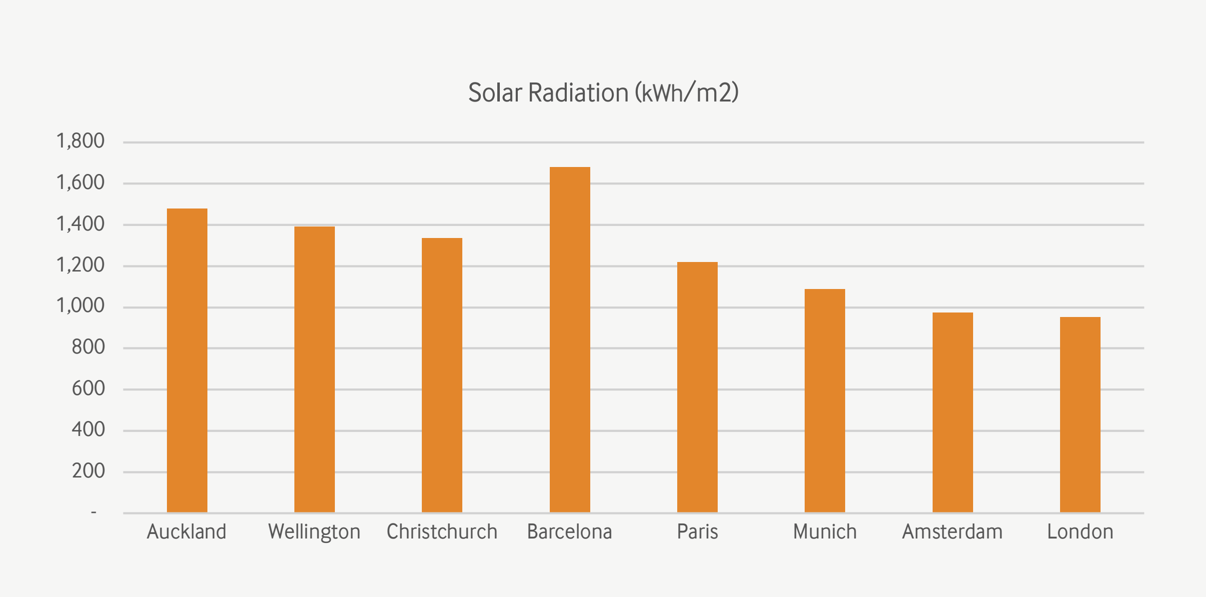


Figure 21 shows the average cost of energy produced. Utility and rooftop solar are compared with and without batteries to the average NZ generation price and retail price. Note: retail prices include the cost of distribution, transmission, and retail. Without a mortar, energy use must fit with the times of generation. Average solar irradiation was used for analysis. Generation price and retail price from 'Electricity Price Review First Report'.

Solar potential is measured in terms of solar radiation per square metre of surface area. Auckland, Wellington, Christchurch and even Invercargill are sunnier than the UK, Germany and even many parts of the north of Spain. NZ's solar resource is no barrier to solar energy growth.[47]

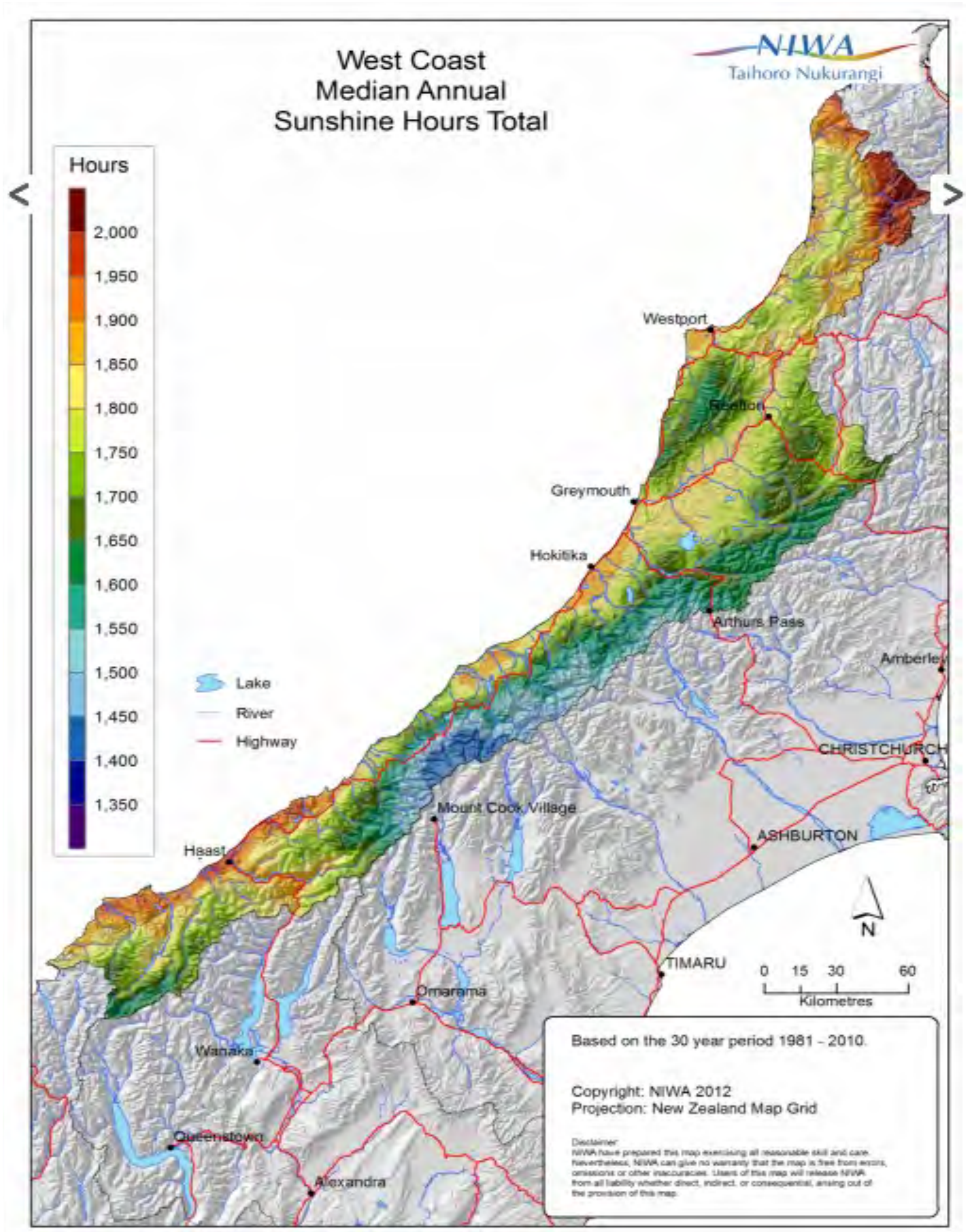
47. https://niwa.co.nz/publications/wa/vol13-no4-december-2005/solar-energy

Figure 22: Comparison of NZ cities with international cities



Although some regions have more sunshine, the West Coast still has considerable solar resources. The region's median annual sunshine hours are shown on the map. The highest sunshine hours are in the north and the south around Haast, Westport, Greymouth, Hokitika and surrounding areas all have moderate sunshine hours.

Figure 23: West Coast median annual sunshine hours

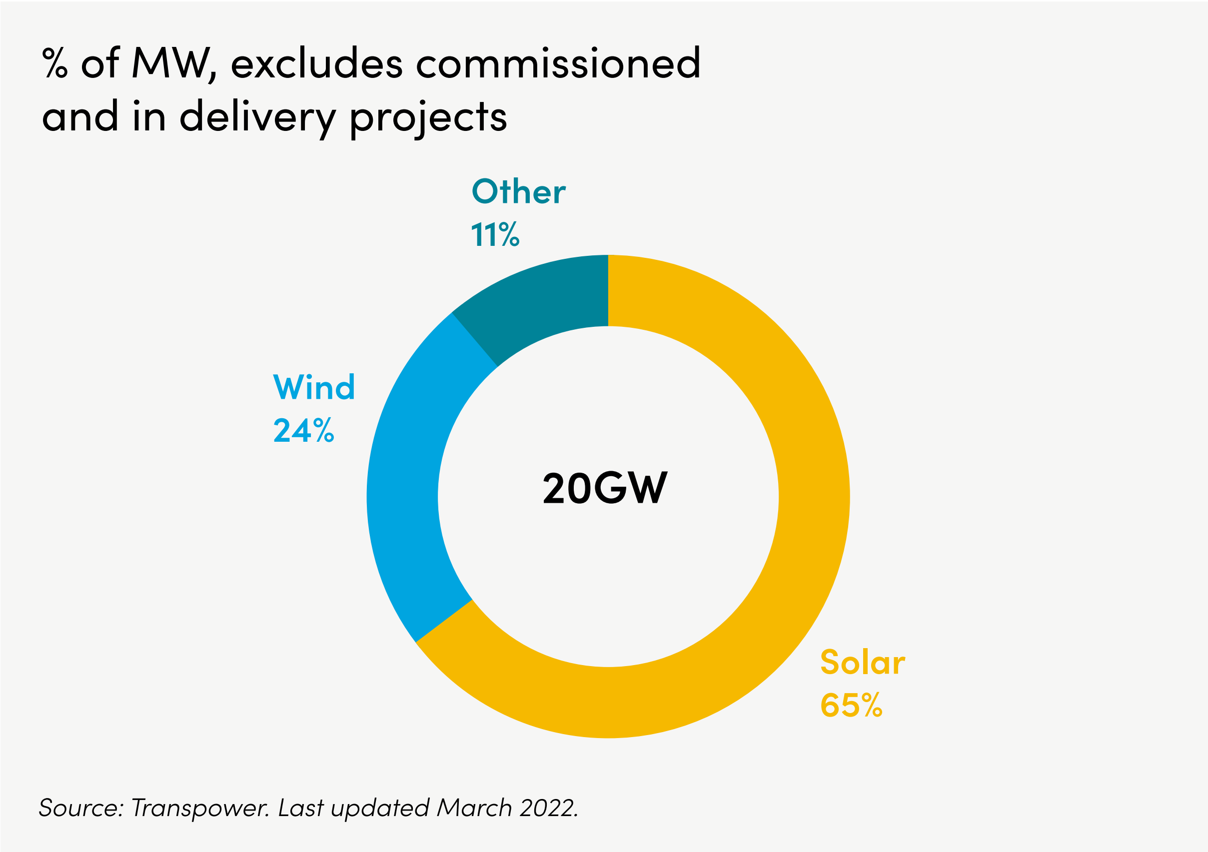


While annual hours of sun in Westport (1791) and Hokitika (1894) are less than Blenheim (2487) and Christchurch (2144), they exceed Dunedin (1680) and Palmerston North (1733). They also significantly exceed many European cities, such as Berlin (1626), London (1633) and Paris (1662). Solar-thermal and PV systems are well suited to urban areas with little space for wind turbines.

Grid-scale solar electricity generation in NZ

Over the last five years, large-scale solar farms have developed rapidly from a low base. Transpower has seen enquiries from utility-scale generation developers ramp up significantly since 2019/20. The enquiries from developers were dominated by solar.

Figure 24: Breakdown of enquiries by generation type



Some examples of recent NZ solar developments and announcements include:

- 1.6 MW Kea energy development in Wairau Valley, Marlborough, operating since 2021.
- 2.1 MW Sunergise Kapuni Solar Power Plant in South Taranaki, operating since 2021.
- MW development covering 6.1ha at Gisborne Airport expected to be complete in 2023.
- 16 MW Lodestone Energy development at Pukenui, on the Aupōuri Peninsula, due for completion in 2023.
- 39 MW Lodestone Energy development at Kaitaia due for completion in 2023.
- 150 MW first phase development at Kōwhai Park to be located near Christchurch airport.
- Nova is planning a 300 MW South Island development.
- 400 MW solar farm planned for the Taupō region.

Images of NZ solar farms

Household solar electricity generation in NZ

The decline in the global cost of solar PV has also led to price reductions for domestic-scale systems in NZ. During 2020, 0.37% of all electricity generated in the country was generated by solar power.

Table 5: West Coast solar generation[48]

Network reporting region	Installations	Uptake (%)	Total capacity (kW)
Buller (Buller Electricity)	27	0.56	132
West Coast (Westpower)	58	0.41	309
Total NZ	38,572	1.73	201,668

48. MBIE "Energy in New Zealand | Ministry of Business, Innovation & Employment"

NZ onshore wind resource

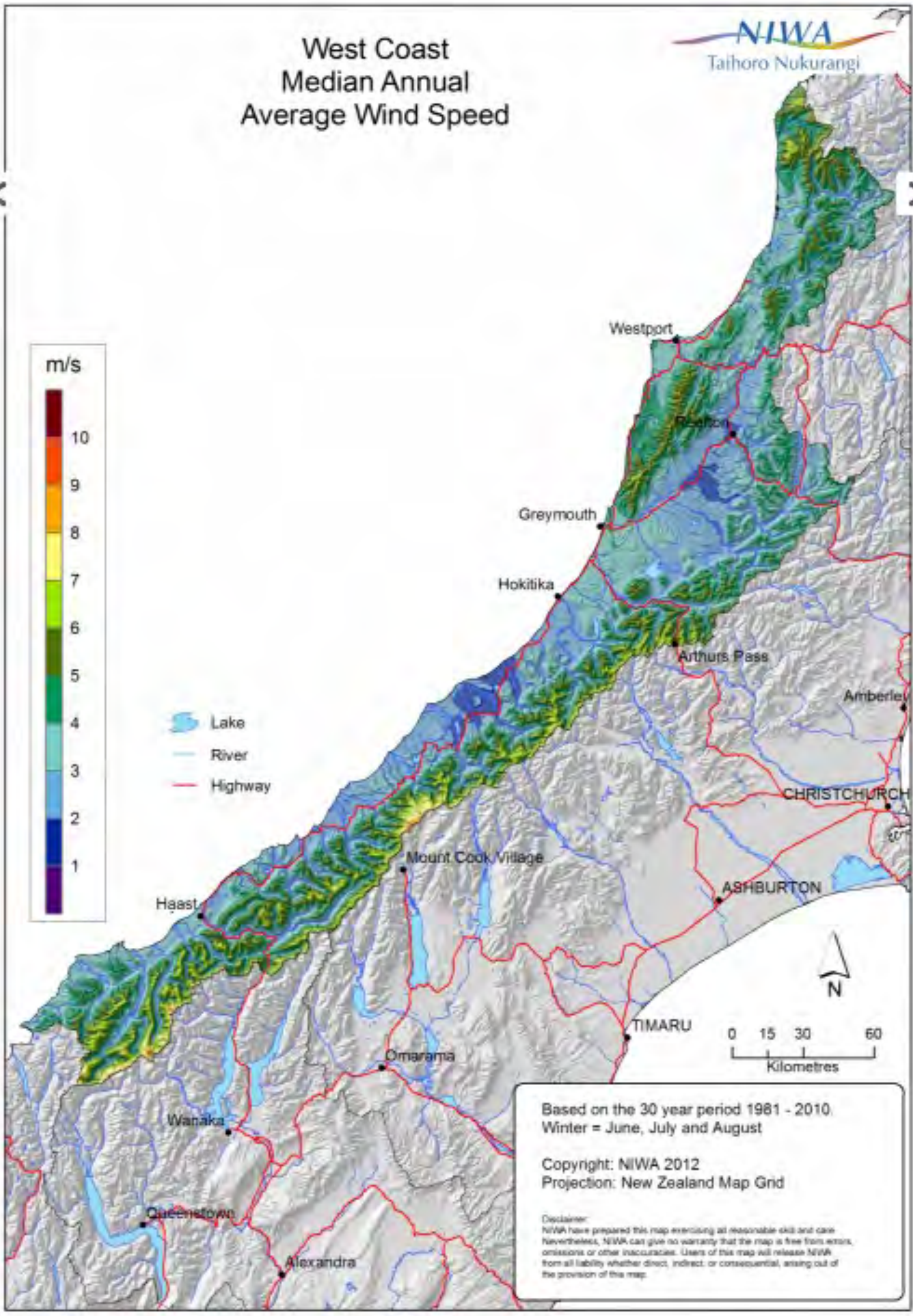
Table 6: Summary of onshore wind sites identified by region[49]

R40s geographical region	R40s geographical region - Name	Number of projects	Wind speed (m/s)	Total capacity (MW)	Regional contribution of total onshore	Lower estimate - Net generation (GWh/yr)	Upper estimate - Net generation (GWh/yr)
	Onshore						
1	Far North	3	8.5	350	3.2%	1,247	1,413
2	Northland	7	8.3	960	8.9%	3,307	3,748
3	Auckland	5	8.2	500	4.6%	1,702	1,928
4	Waikato	6	7.9	625	5.8%	2,057	2,331
5	BOP-Taupo	8	7.7	1,160	10.8%	3,693	4,186
6	Eastland	4	8.3	475	4.4%	1,604	1,818
7	Central Plateau	4	8.3	675	6.3%	2,331	2,642
8	Hawkes Bay	1	8.4	100	0.9%	360	408
9	Taranaki	3	8.6	500	4.6%	1,631	1,849
10	Manawatu	5	7.8	850	7.9%	2,810	3,184
11	Wairarapa	6	9.8	1,250	11.6%	4,795	5,434
12	Wellington	3	9.7	215	2.0%	779	882
13	Southern Wairarapa	2	8.9	250	2.3%	885	969
	Total - North Island	**57**		**7,900**	**73.4%**	**27,200**	**30,800**
14	Marlborough	2	9.3	125	1.2%	355	403
15	West Coast	1	6.6	75	0.7%	271	307
16	Canterbury	5	8.9	545	5.1%	1,910	2,165
17	Otago	5	8.5	1,250	11.6%	4,116	4,665
18	Southland	8	9.2	875	8.1%	3,122	3,538
	Total - South Island	**21**		**2,900**	**26.6%**	**9,800**	**11,100**
	Total NZ - Onshore	**78**		**10,800**	**100.0%**	**36,900**	**41,900**
	Offshore						
4-0	Waikato	1	8.3	4,000		13,721	15,551
3-0	Auckland	1	8.3	2,000		6,870	7,786
9-0	Taranaki	1	9.6	2,000		7,703	8,730
	Total - Offshore	**3**		**8,000**		**28,300**	**32,100**

The median annual average wind speed map for the West Coast region is shown below. Areas with an average speed of 7-8 m/sec are limited and remote. Those areas with wind speeds of 6-7 m/sec are mainly in elevated regions which appear to be on DOC-administered land. NZ's median annual average wind speed map is also included for comparison. This shows, for example, significant land areas in Central Otago with wind speeds of 6-7 m/sec.

49. MBIE - https://www.mbie.govt.nz/assets/wind-generation-stack-update.pdf

Figure 25: West Coast annual average wind speed [50]



50. https://niwa.co.nz/climate/national-and-regional-climate-maps/west-coast

Offshore wind energy

Figure 26: NZ offshore wind[51]

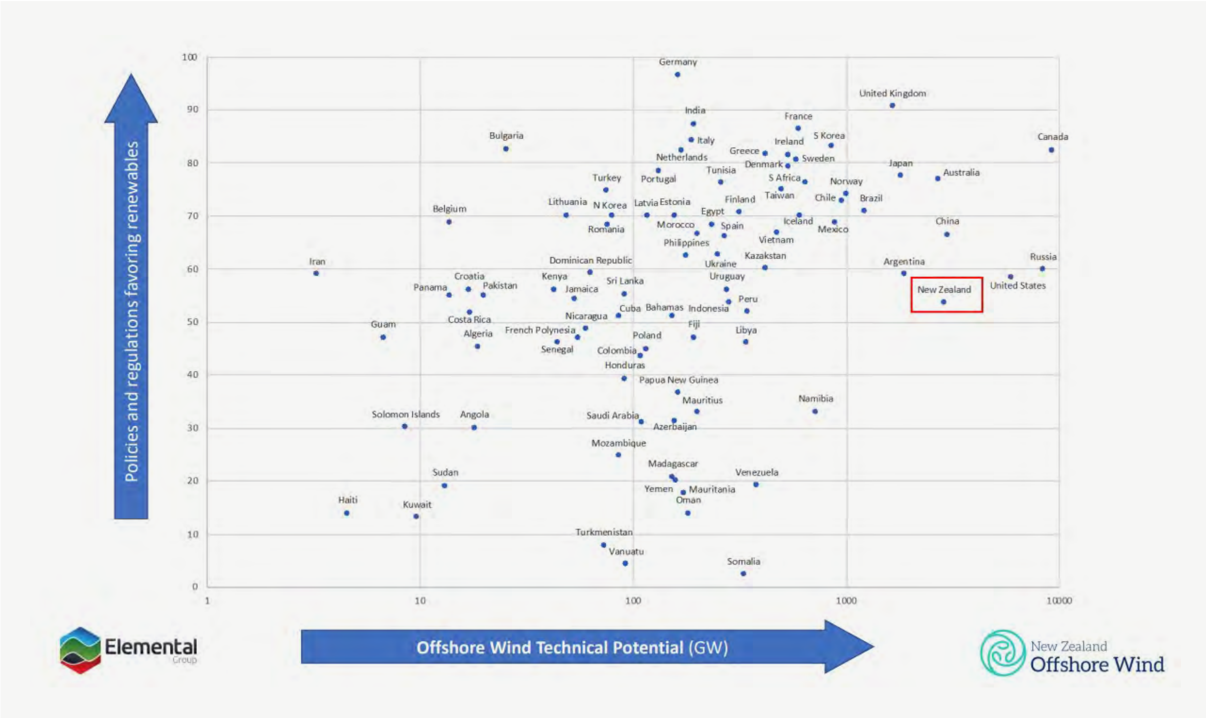
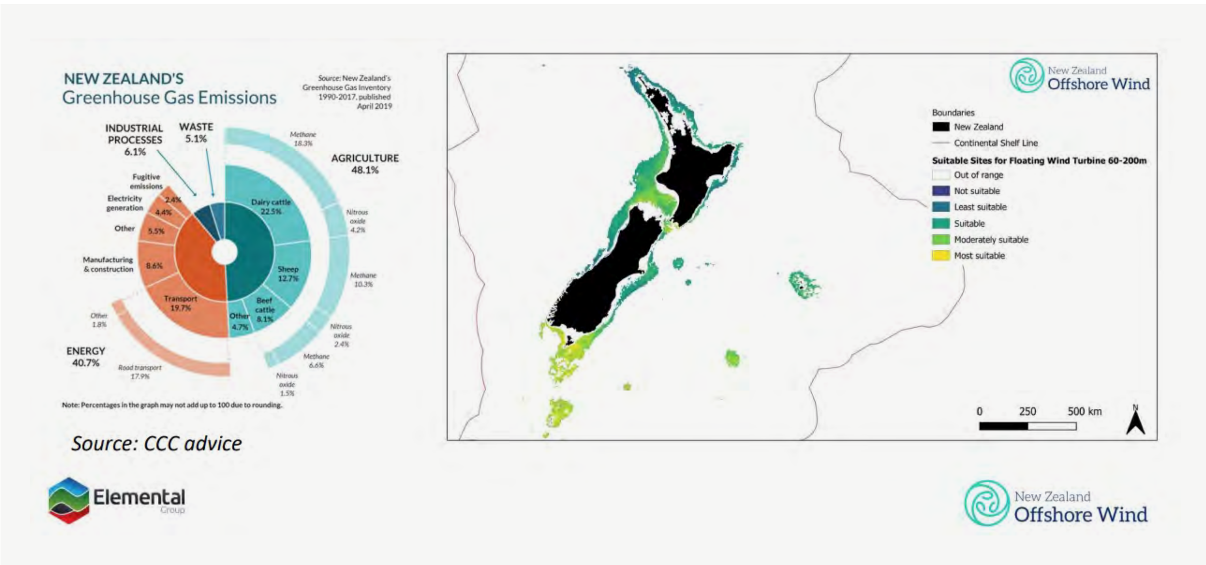


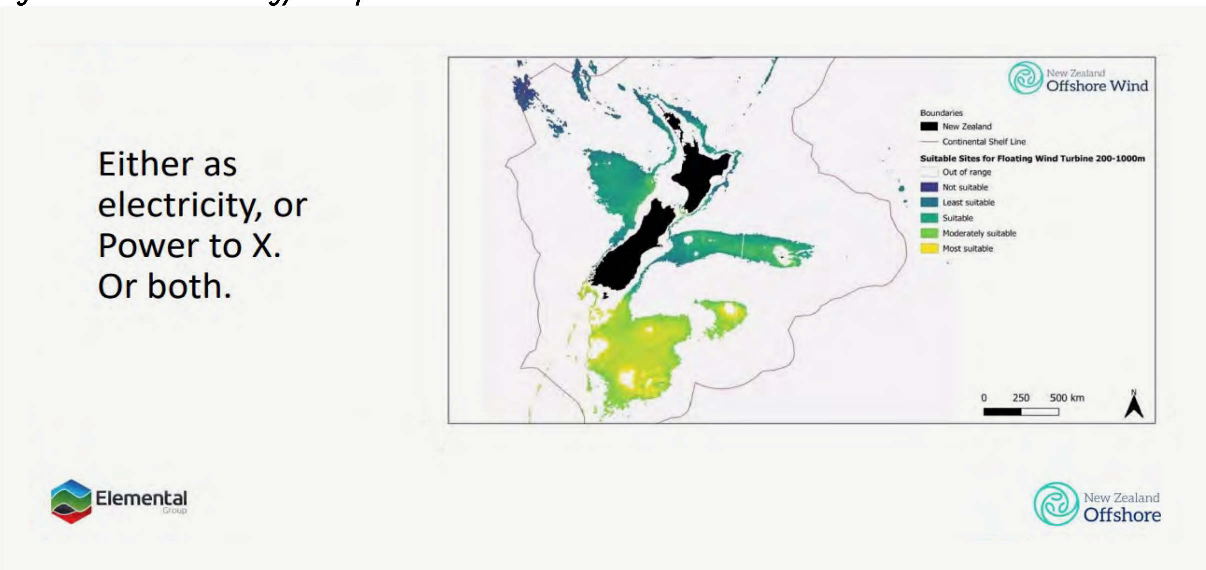
Figure 27: Phased development – Phase 1, Electrification of NZ[52]



51. https://www.araake.co.nz/assets/Uploads/Offshore-Future-Energy-Forum/Nick-Jackson-Director-Elemental-Group.pdf
52. ibid

Further analysis from New Zealand Offshore Wind[53] has identified areas around the NZ coast that show potential for offshore wind. The West Coast has areas (in the north of the region) where wind flow is suitable for electricity generation.

Figure 28: Renewable energy for export



53. https://www.araake.co.nz/assets/Uploads/Offshore-Future-Energy-Forum/Nick-Jackson-Director-Elemental-Group.pdf

Marine (wave energy)

Locations of wave energy in NZ

Marine energy encompasses various forms of ocean energy, including tidal and waterpower which derives power from surface waves. According to Statista, in 2011, South Korea and France had the world's highest tidal and wave power capacity, holding about 256 and 240 MW of installed capacity, respectively.[54]

Among marine energy, energy derived from waves has the largest potential for electricity generation. The worldwide resource of coastal wave energy, while much less than wind, is considerable and has been estimated to be greater than two terawatt hours. Despite considerable research and development over recent decades, marine energy remains in its infancy. Marine energy resources are attractive because their daily and seasonal cycles make them a potential complement to other renewable energy sources like wind and solar.

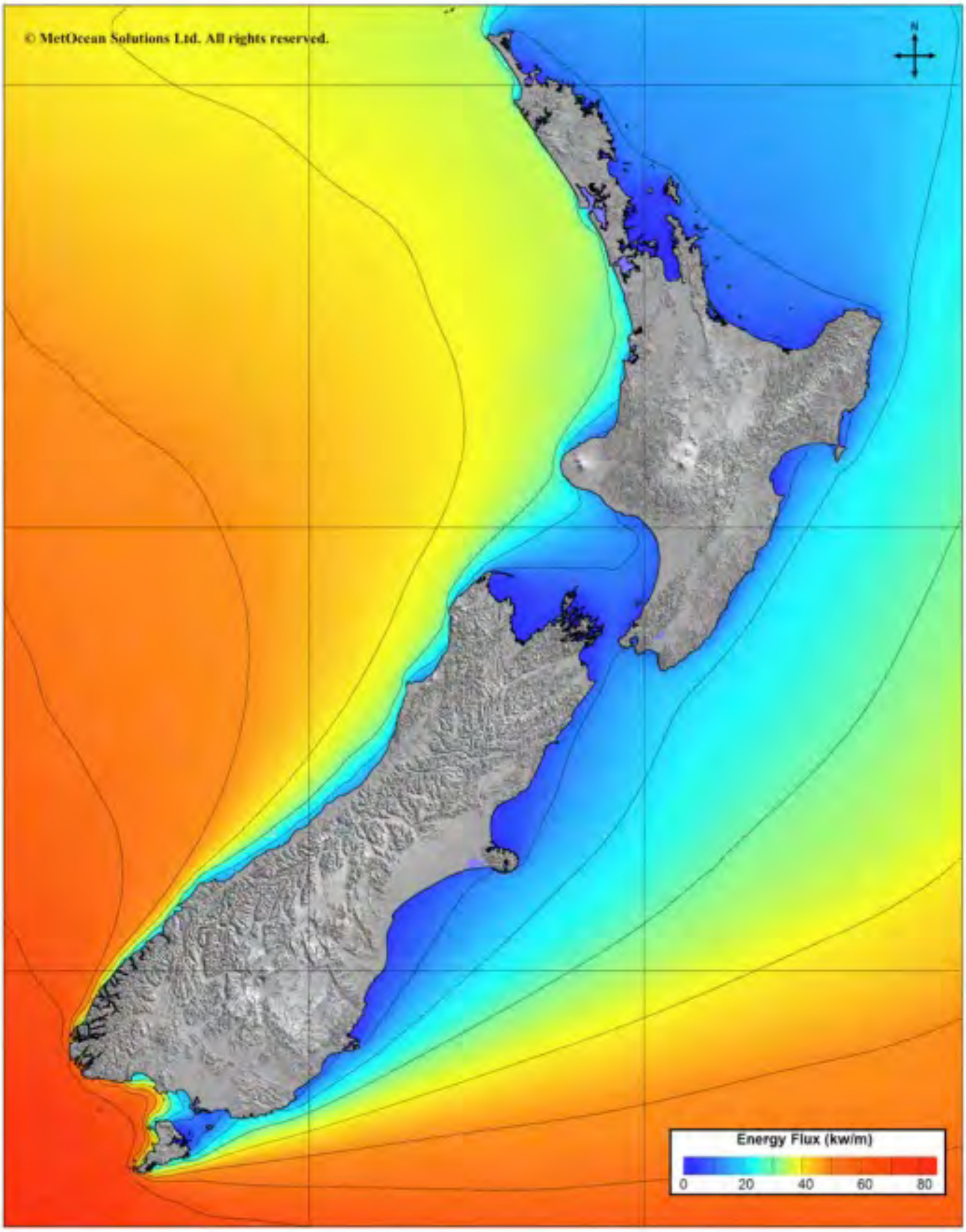
NZ is considered a strong candidate for wave energy projects, with 70% of the population living near the coast (< 10 km) and the world's sixth-largest exclusive economic zone. NZ also has high energy wave conditions with about ~ 25 kW/m coastlines. Almost any location on the west or south-facing coasts has significant potential for wave energy projects, as shown in figure 29 on page 54.

The University of Waikato has examined the suitability of various areas around NZ for utility-scale wave energy projects.[55] Figure 30, on page 55, shows potential wave energy installation areas after applying various exclusion factors (social, environmental, technical, cultural, and economic). These areas comprise much of the West Coast and a large area south of the South Island. Locations were then weighted according to distance to a port and the electricity grid to find optimal wave energy project sites. Figure 30 shows this investigation's results, including several areas west of Auckland, New Plymouth, Greymouth and south of Invercargill.

54. https://www.statista.com/statistics/494197/global-installed-ocean-power-capacity-by-key-country/

55. Bertram, et al., 2020. A systematic approach for selecting suitable wave energy converters for potential wave energy farm sites. Renewable and Sustainable Energy Reviews 132, 110011. DOI

Figure 29: Wave energy flux around NZ (kW/m)[56]

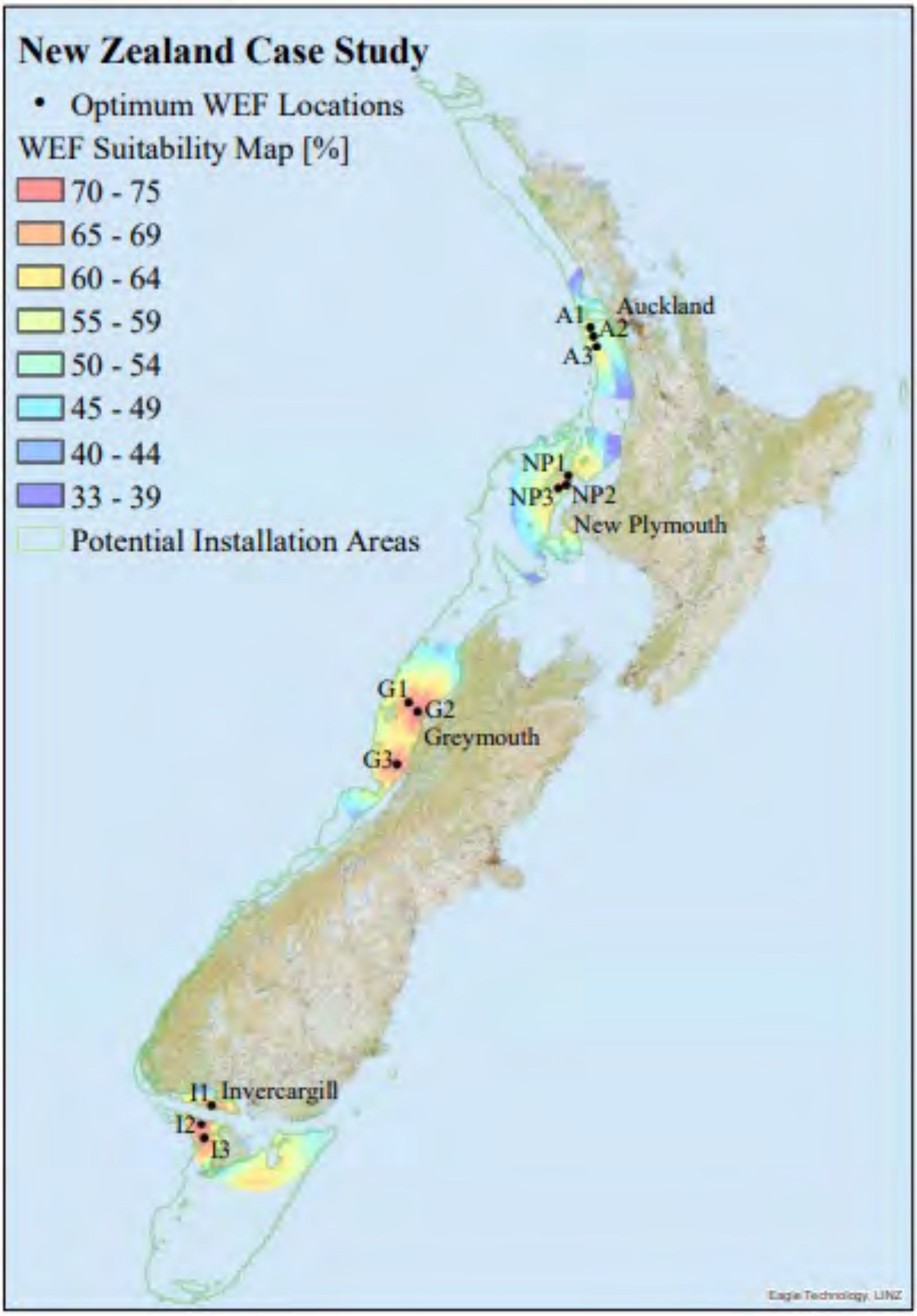


56. Electricity Authority: Development of Marine Energy in NZ 2008- https://www.ea.govt.nz

Figure 30: Potential areas for wave energy projects[57]

57. Electricity Authority: Development of Marine Energy in NZ 2008 - https://www.ea.govt.nz

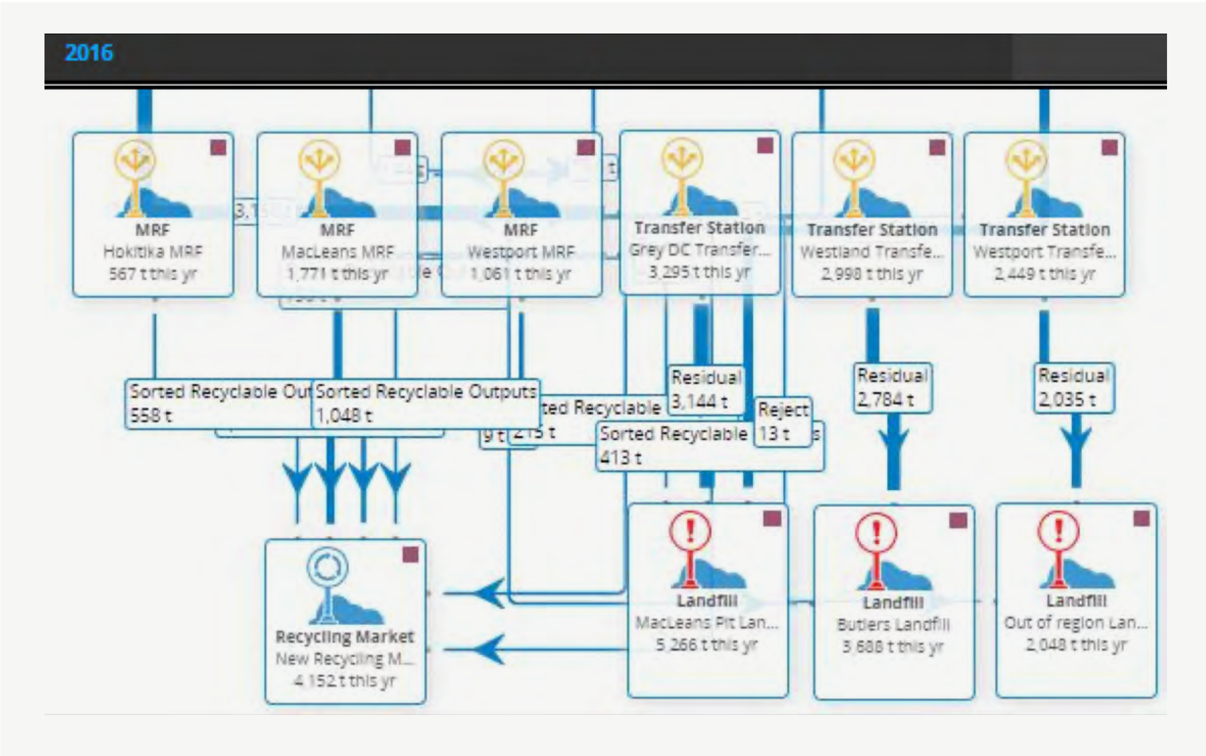
Figure 31: Results of installation areas for wave energy[58]



58.Electricity Authority:Development of Marine Energy in NZ 2008 - https://www.ea.govt.nz

Waste to energy opportunities

Figure 32: Waste flow diagram – Collection, processing and disposal (2015/16 figures) [59]



59. *Tonkin Taylor: West Coast Regional Waste Minimisation and Management Plan 2018*

Transport

Light vehicles

Global BEV production will continue to proliferate and will likely dominate light vehicle production sometime during the 2040s. PHEVs will support the transition. This pathway results from significant improvements in battery technology and rapid price reductions.

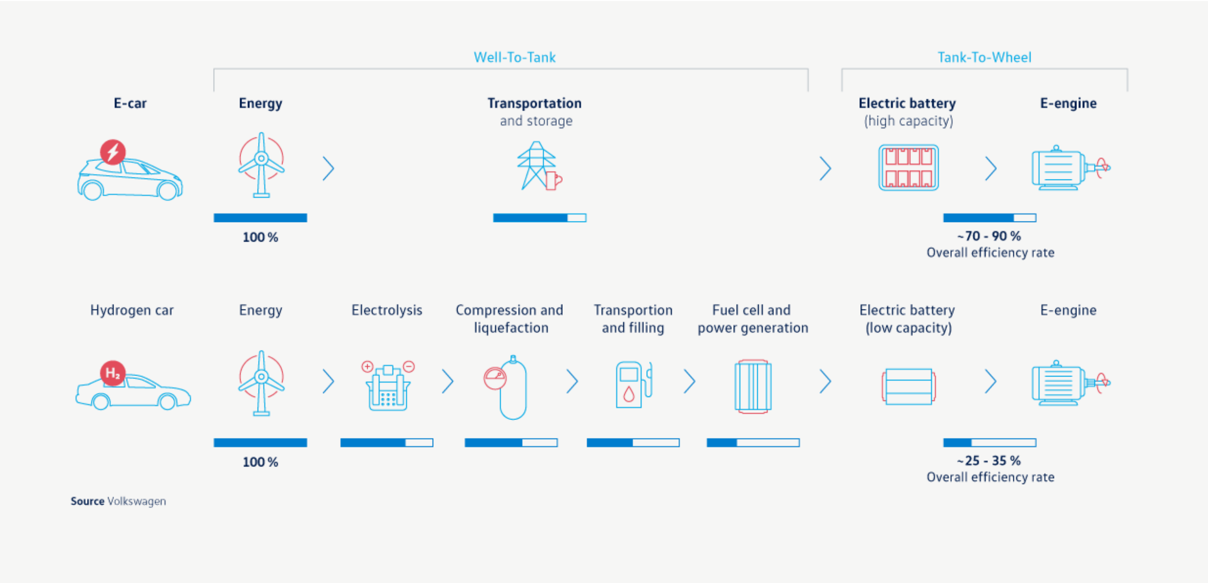
In NZ, internal combustion engine vehicles will comprise a significant portion of the light vehicle fleet during 2040 and their refuelling infrastructure. As a low-emissions technology, BEVs are particularly attractive in NZ because of our highly renewable and low-carbon electricity system. A readily available and widespread rapid charging infrastructure is essential to support uptake.

PHEVs are a low-emissions option in areas with limited rapid charging infrastructure or concerns about the electricity network's robustness. PHEVs will likely remain cheaper than BEVs in the short term and can also use biofuels. Over the last two decades, various low-emission solutions such as biofuels, hydrogen, hybrid vehicles, and BEVs have competed to reduce or replace petrol and diesel fuel for light vehicles. A key advantage of BEVs is the greater efficiency of the electric motor and regenerative braking compared with the internal combustion engine and hydrogen fuel cell technology (see diagram below).

Disadvantages of BEVs until recently have been their limited vehicle range and high cost due to expensive lithium-ion batteries. However, over the past decade, the energy density of lithium-ion batteries has continued to increase while prices have declined by nearly 90%.[59]

Two of the largest car manufacturers have announced they will only build electric cars and trucks in the future, Volkswagen by 2030 and Toyota by 2040. Also, Ford's European division will build only EVs and PHEVs after 2026; General Motors and Audi set 2035 goals. In 2020, Volkswagen publicly stated its position on hydrogen and battery cars, pointing out that a hydrogen car consumes two to three times more electricity for the same distance than a battery car. Given that scarce green electricity should be used as efficiently as possible, they stated, "Hydrogen would therefore be a serious mistake for passenger cars...."[60]

Figure 33: Hydrogen and electric drive efficiency rates in comparison using eco-friendly energy



59. https://www.bloomberg.com/graphics/2021-inside-lithium-ion-batteries/
60. Volkswagen: https://www.volkswagenag.com/en/news/stories/2020/03/battery-or-fuel-cell--that-is-the-question.htm

Electric Vehicles – Global situation and trends[61]

- In 2021, 6.6 million EVs were sold globally, accounting for about 10% of car sales.
- EVs are not yet a global phenomenon – China, Europe and the US account for 95% of sales.
- IEA expects electric vehicle sales to grow from 10% in 2021 to about 35% in 2030.
- Expansion of electric vehicle charging and electric grid capacity is required.

61. IEA Trends in electric light-duty vehicles - https://www.iea.org/reports/global-ev-outlook-2022/trends-in-electric-light-duty-vehicles

Figure 34: Electric car sales continue to break records[62]

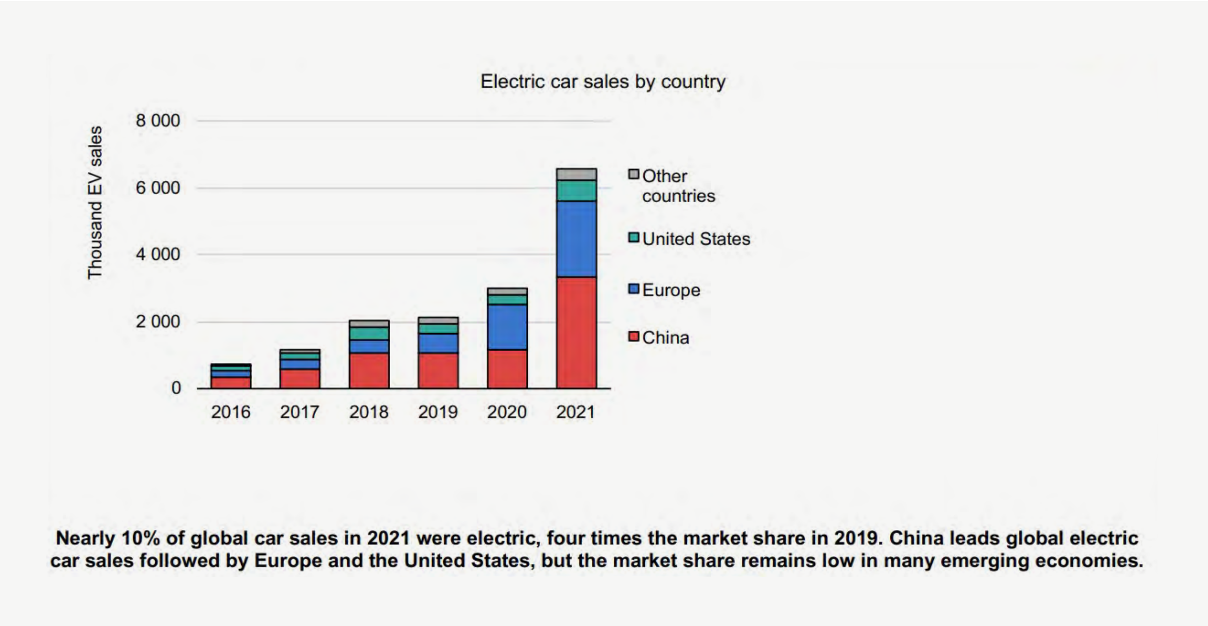
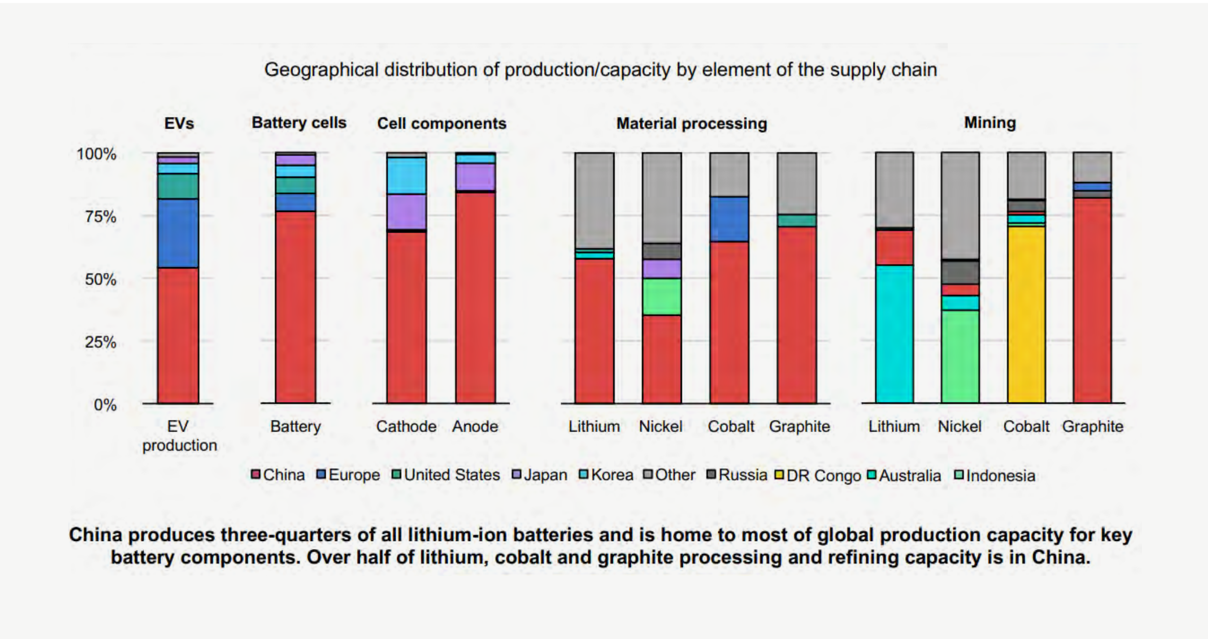


Figure 35: Phased development – Phase 1, Electrification of NZ[63]

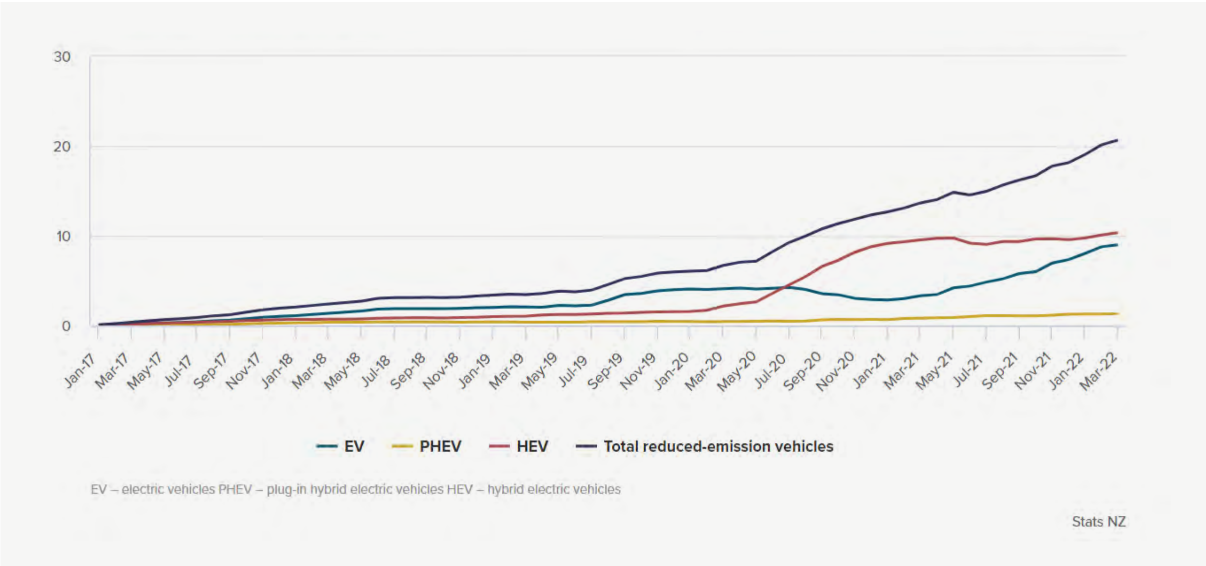


62. IEA IEA Global Electric Vehicle Outlook 2022 - Press Release May 2022 - https://iea.blob.core.windows.net/assets/88769b0e-338a-47e2-a615-f51cff6164fd/GEVO2022_press_launch.pdf
63. Ibid

NZ sales

In early 2022 reduced emission vehicle sales (electric vehicles, PHEVs, HEVs) accounted for just over 20% of the market share of imported vehicles.[64] In NZ, EV sales continued to proliferate in 2021, with 25,194 hybrids, plug-in hybrids and dedicated EVs registered in 2021 compared to 12,997 in 2020. Breaking that down further, sales of pure BEVs increased by 344 per cent in 2021. Plug-in hybrid sales were up 228 per cent, and hybrid sales were up 59 per cent.

Figure 36: Percentage of market share of imported reduced emission vehicles, the year ended January 2017-March 2022 [65]



64. Stats NZ: Electric vehicle imports accelerate as New Zealanders look to the future- https://www.stats.govt.nz/news/electric-vehicle-imports-accelerate-as-new-zealanders-look-to-the-future/
65. Stats NZ: Electric vehicle imports accelerate as New Zealanders look to the future - https://www.stats.govt.nz/news/electric-vehicle-imports-accelerate-as-new-zealanders-look-to-the-future/

Heavy Vehicles

Electric trucks were less than 0.5% of global sales in 2021, but model availability is increasing fast, with about 170 models currently available.[66] On an ongoing basis, BEV trucks are projected to be materially lower cost options than hydrogen FCEV trucks for almost all NZ trucking applications up to at least 800km range. Zero-emission trucks face significant fuel availability and range barriers, meaning they will likely treat the higher total cost of ownership options from a private truck owner's perspective for many years.

There is an ongoing debate about whether hydrogen fuel cells or battery electric technology will become the dominant global solution for long-distance heavy freight transport. Heavy truck manufacturers are already offering battery electric models with ranges of more than 300km and costs are expected to be similar to or less than diesel trucks by 2035. As for light vehicles, plug-in hybrid trucks are a low-emissions and highly resilient option for long-distance tasks where there are concerns about the robustness of the electricity network and the availability of rapid charging infrastructure. They are a highly versatile option given their 'dual fuel' capability, compatibility with the existing diesel supply infrastructure and future biofuels.

A US Department of Energy[67] study shows:

- By 2035, electric medium and heavy-duty trucks will cost the same as or less than diesel trucks.
- By 2030, nearly half of electric medium and heavy-duty trucks will be cheaper to buy, operate, and maintain than diesel trucks.
- Battery electric trucks are expected to become cost competitive for smaller trucks before 2030, while heavy trucks with less than 830km range are projected to be cost competitive by 2035
- Hydrogen FCEVs are expected to become cost competitive for long-haul, heavy-duty trucks with a greater than 830km range by 2035.

An initial assessment of technologies shows that electric trucks have a ~100km range, whereas hydrogen trucks have a ~500km range. This difference presents some challenges for the West Coast due to its isolation. In addition to the range constraints, charging for e-trucks will increase demand from 37MW in 2020 to 62MW in 2035.[68] At the same time, generation is forecast to remain steady at 35MW per year. This demonstrates an energy supply deficit for the region and a potential constraint for the transition to low-carbon alternatives.

Hydrogen is an appealing long-term option for the West Coast but requires the development of a dedicated network and potentially a circular economy to create the fuel within the region using renewable energy sources. Overall, the following are some key strategic considerations:

- E-trucks have a low-cost set-up and are relatively easy to implement, meaning they could be an excellent short-term option to shift towards low emissions.
- Hydrogen is suited for long haul, whereas e-trucks are not due to range constraints.
- Modelling assumes energy only and excludes transmission and distribution costs.

Battery electric trucks are expected to become cost competitive for smaller trucks before 2030, while heavy trucks with less than 800km of the range are projected to be cost-competitive by 2035. Hydrogen FCEVs are expected to become cost competitive for long-haul, heavy-duty trucks with greater than 800km of range by 2035.[69]

In 2021 truck manufacturer Scania noted that the rapid development of electric solutions for heavy-duty vehicles would gradually overtake their fossil and biofuel-powered solutions in most transport applications. It said that the cost for a hydrogen vehicle would be higher than for a BEV as its systems are more complex. By 2025, Scania expects that electrified vehicles will account for around 10% of total vehicle sales volumes in Europe, and by 2030, 50% of our total vehicle sales volumes are expected to be electrified.

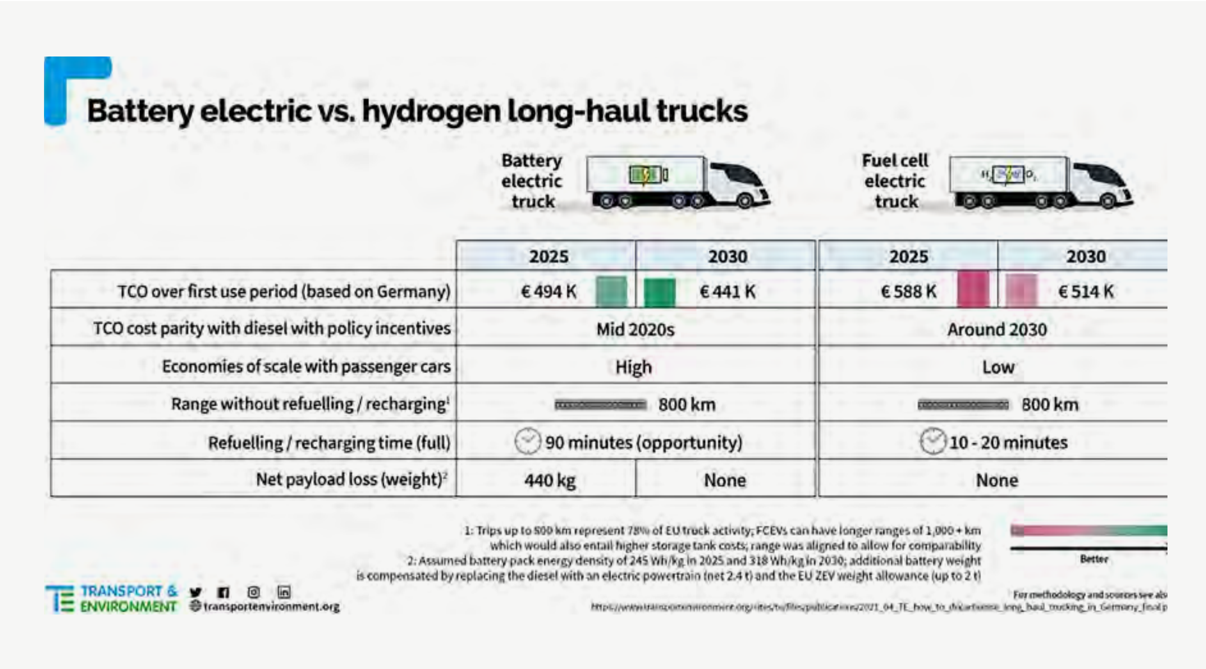
BEV technology will continue to grow market share for light commercial vehicles and medium freight . Still, until recently, its role for long-distance heavy trucks has been less certain. FCEV technology has traditionally been thought to offer an extended range over BEVs long-distance heavy trucks, which would require very heavy batteries. Recent developments suggest that BEV technology will likely dominate almost all trucking requirements.

66. Stats NZ: Electric vehicle imports accelerate as New Zealanders look to the future- https://www.stats.govt.nz/news/electric-vehicle-imports-accelerate-as-new-zealanders-look-to-the-future/
67 Stats NZ: Electric vehicle imports accelerate as New Zealanders look to the future - https://www.stats.govt.nz/news/electric-vehicle-imports-accelerate-as-new-zealanders-look-to-the-future/
68. IEA Global EV Outlook 2022
69. DOE Projects Zero Emissions Medium- and Heavy-Duty Electric Trucks Will Be Cheaper than Diesel-Powered Trucks by 2035 - https://www.energy.gov/articles/doe-projects-zero-emissions-mediumand-heavy-duty-electric-trucks-will-be-cheaper-diesel

A recent May 2022 Concept Consulting report[70] has projected that BEV and hydrogen FCEVs will have lower total cost of ownership options than ICEVs. However, global manufacturers' more rapid development of BEV trucks indicates that BEVs will overtake ICEVs several years earlier than FCEVs from a cost-effectiveness basis, with it also being likely that BEVs will remain lower cost options than FCEVs for most NZ's trucking requirements.

The European Federation for Transport and Environment claims BEV long-haul trucks with an 800km range will likely reach cost parity with diesel as early as 2025 if the right policy incentives are in place. Also, European truck manufacturers are set to begin series production of fuel cell trucks only in the second half of the decade.

Figure 37: Battery electric v hydrogen long-haul trucks [71]



Battery electric vs. hydrogen long-haul trucks

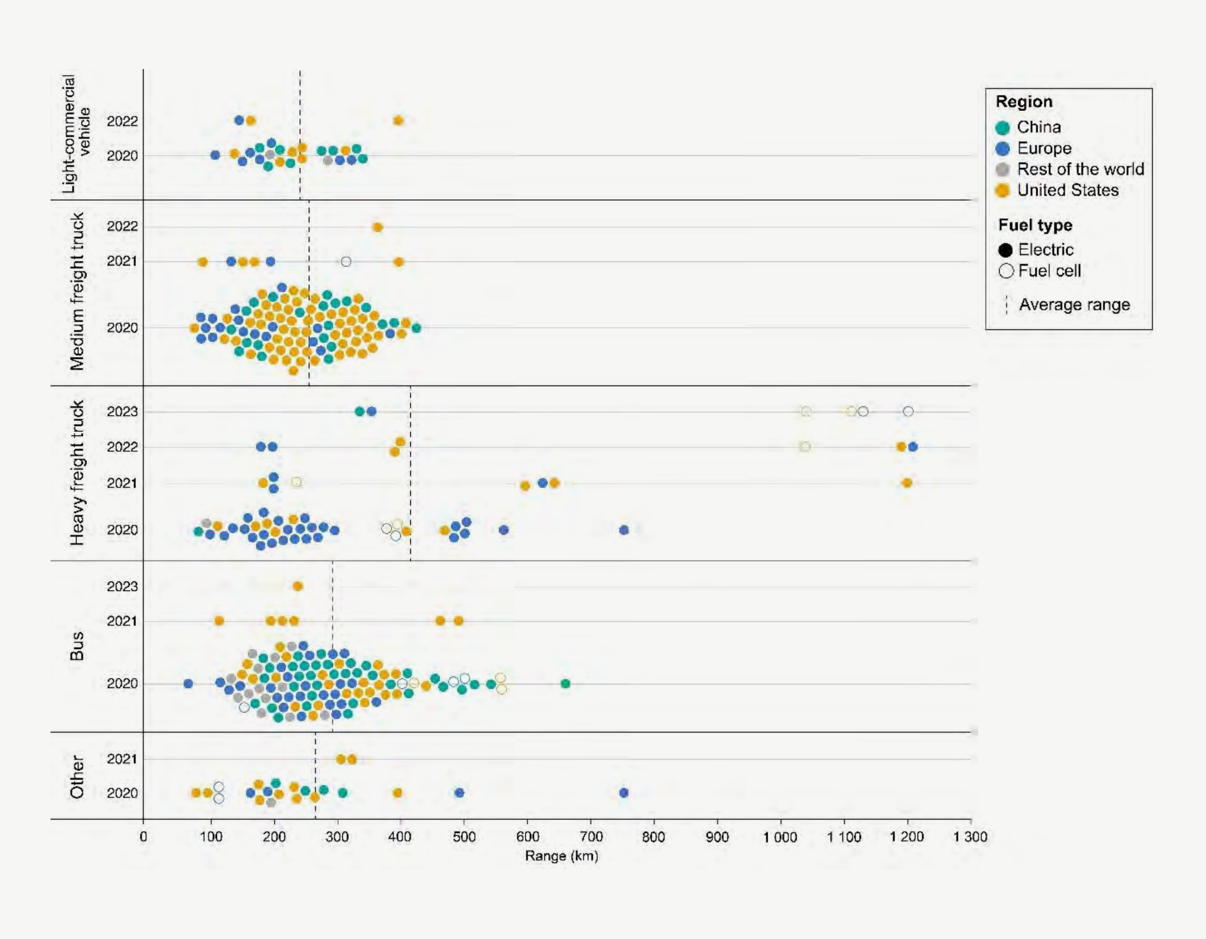
	Battery electric truck 2025	Battery electric truck 2030	Fuel cell electric truck 2025	Fuel cell electric truck 2030
TCO over first use period (based on Germany)	€ 494 K	€ 441 K	€ 588 K	€ 514 K
TCO cost parity with diesel with policy incentives	Mid 2020s		Around 2030	
Economies of scale with passenger cars	High		Low	
Range without refuelling / recharging[1]	800 km		800 km	
Refuelling / recharging time (full)	90 minutes (opportunity)		10 - 20 minutes	
Net payload loss (weight)[2]	440 kg	None	None	

1: Trips up to 800 km represent 78% of EU truck activity; FCEVs can have longer ranges of 1,000 + km which would also entail higher storage tank costs; range was aligned to allow for comparability
2: Assumed battery pack energy density of 245 Wh/kg in 2025 and 318 Wh/kg in 2030; additional battery weight is compensated by replacing the diesel with an electric powertrain (net 2.4 t) and the EU ZEV weight allowance (up to 2 t)

Figure 37 shows the zero-emission heavy vehicle models (current and announced) by class, country and range as of November 2021. It indicates that BEV technology is dominant for light commercial vehicles, medium freight trucks and heavy freight trucks. FCEV technology is most prevalent for heavy freight trucks with a range of over 800km.

70. Policies to incentivise the uptake of zero-emission trucks- https://www.concept.co.nz/uploads/1/2/8/3/128396759/policies_to_incentivise_the_uptake_of_zero-emission_trucks.pdf
71. Why the future of long-haul trucking is electric - https://www.transportenvironment.org/discover/why-the-future-of-long-haul-trucking-is-electric/

Figure 38: Zero-emission heavy vehicle models (current and announced) by class, country and range as of November 2021 [72]



Of interest is the decision by Sweden's Scania AB in 2021 to bench its FCEV programme and focus on full electric power trains for its zero-emission transport future. Scania, one of the world's largest heavy-duty truck and bus manufacturers, considers the use of hydrogen for such applications will be limited since three times as much renewable electricity is needed to power a hydrogen truck compared to a battery electric truck. Scania referred to the large amount of energy lost in the production and distribution of hydrogen and its conversion back to electricity. Also, the purchase and maintenance costs for a hydrogen vehicle will be higher than for a BEV as its systems are more complex.

72. https://www.iea.org/reports/trucks-and-buses

GLOSSARY

MBIE	Ministry of Business Innovation and Employment
EECA	Energy Efficiency and Conservation Authority
EV	Electric vehicle
BEV	Battery-powered electric vehicle
PHEV	Plug-in hybrid electric vehicle
WtE	Waste to Energy
GHG	Greenhouse gas
PPA	Power purchase agreements

Electrical Units

Units of demand

Demand reflects the instantaneous amount of work required to perform the function desired (such as creating light or physical force, powering a microchip, etc.). Similarly, capacity reflects the instantaneous ability to provide energy required to do work (such as generator capability to provide electricity, transmission capability to transmit electricity, etc.). Demand and capacity are commonly measured in the following units:
W = watt
kW = kilowatt
MW = megawatt
GW = gigawatt

To convert between these, you can use the following:
1 kW = 1,000 W 1 MW = 1,000 kW
1 GW = 1,000 MW

Units of energy/usage

Energy or usage reflects demand or capacity multiplied by the amount of time that demand or capacity is in use. For instance, a 15-watt light bulb used for 2 hours creates 15 watts X 2 hours = 30 watt-hours of usage. Energy and usage are commonly measured in the following units:
Wh = watt-hour
kWh = kilowatt-hour
MWh = megawatt-hour
GWh = gigawatt-hour

Other units

MWth = means the net rated thermal input of an appliance which is the rate at which fuel can be burned at the maximum continuous rating of an appliance multiplied by the net calorific value of the fuel and then expressed in MW; The conversions between the units are:
1 kWh = 1,000 Wh
1 MWh = 1,000 kWh
1 GWh = 1,000 MWh

Source: https://energyknowledgebase.com/topics/electric-units.asp

BIBLIOGRAPHY

- Asset Management Plan; A 10 Year Management Plan for Westpower's Electricity Network From 1 April 2022 to 31 March 2032. Westpower 2022.
- Bertram, et al., 2020. A systematic approach for selecting suitable wave energy converters for potential wave energy farm sites. Renewable and Sustainable Energy Reviews 132, 110011. DOI.
- BT Mining- Inside Resources Eamon Rood, Is converting boilers from coal to biomass going to reduce emissions April 2022.
- Carey BS, Alcaraz SA, Rae AJ, Upton P, Mroczek EK, Burnell JG. 2019. Geothermal resource assessment of West Coast region, South Island. Wairakei (NZ): GNS Science. Consultancy Report 2019/44, p.60.
- Concept: How New Zealand can accelerate the uptake of low emission vehicles.
- Development West Coast - Key Documents.
- DOE Projects Zero Emissions Medium- and Heavy-Duty Electric Trucks Will Be Cheaper than Diesel-Powered Trucks by 2035.
- EECA - Review and analysis of electric vehicle supply and demand constraints.
- EECA End user data base.
- Electricity Authority TPM 2022 Decision Paper.
- Electricity Authority: Development of Marine Energy in NZ 2008.
- Elemental Nick Jackson Director, NZOWL Wind Forum, Dec 2020.
- How the sun's power is changing our electricity market.
- https://bullerelectricity.co.nz/buller-electricity/
- https://environment.govt.nz/acts-and-regulations/acts/climate-change-response-amendment-act-2019
- https://environment.govt.nz/publications/aotearoa-new-zealands-first-emissions-reduction-plan
- https://www.doc.govt.nz/about-us/science-publications/conservation-publications/benefits-of-conservation/the-value-of-conservation/west-coast-public-conservation-land/
- https://www.ea.govt.nz › assets › dms-assets › 2022-
- https://www.gns.cri.nz/Home/Our-Science/Energy-Futures/Our-stories/Exploring-geothermal-as-an-energy-option-for-the-West-Coast
- https://www.iea.org/reports/solar-pv
- https://www.mbie.govt.nz/assets/discussion-document-accelerating-renewable-energy-and-energy-.pdf
- https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/renewables-statistics/
- https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index.
- IEA Global Electric Vehicle Outlook 2022 - Press Release May 2022.
- IEA Global EV Outlook 2022.
- IEA Trends in electric light-duty vehicles.
- IEA Trucks and Buses.
- IRENA Renewable Power Generation Costs 2020.
- Leading countries in installed tidal and wave power as of 2014.
- MBIE - Section 7: Enabling development of renewable energy under the RMA.
- MBIE - Discussion Document: Accelerating Renewable Energy and Efficiency, December 2019.
- MBIE - Energy Strategies for NZ.
- MBIE – Wind generation Stack update.
- MBIE Embedded Hydro Generation in NZ Version 2 1. 2 October: Opportunities Final 2020 Roaring40s Wind Power Ltd.
- MBIE Emissions Reductions Plan.
- MBIE Energy in New Zealand 2020.

BIBLIOGRAPHY

- MBIE Interactive Levelised Cost of Electricity Comparison Tool.
- Ministry for the Environment National policy statement for renewable electricity generation.
- NIWA Solar energy.
- Residual biomass fuel projections for New Zealand; 2021 - Indicative availability by region and source Generic Public Client Report (bioenergy.org.nz).
- SKM ZP00717-RPT-GE-001 Final Report 23 June 2010.
- Stats NZ: Electric vehicle imports accelerate as New Zealanders look to the future.
- The Hidden Science Making Batteries Better, Cheaper and Everywhere.
- The NZ Critical Lifelines Infrastructure National Vulnerability Assessment, 2020.
- The Sun Rises on a Solar Energy Future.
- Tonkin Taylor: West Coast Regional Waste Minimisation and Management Plan 2018.
- Transpower Load Graphs.
- Transpower MBIE Accelerating Renewable Energy and Energy Efficiency Consultation Submission.
- Volkswagen: Battery or fuel cell, that is the question.
- WEF The price of solar power has fallen by over 80% since 2010. Here's why.
- West Coast - NIWA.
- West Coast Regional Waste Minimisation and Management Plan.
- Why the future of long-haul trucking is electric.

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