Government Leadership

Regional Energy Transition Accelerator (RETA)

Otago – Summary Report

September 2023

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

1 Foreword

Energy efficiency and the uptake of renewables, by industry, will play an important part in achieving net-zero carbon emissions by 2050. Currently, around a third of New Zealand's overall energy use is creating heat for industrial processes – 60% of this energy currently sourced from fossil fuels.

Understanding unique region-specific needs, opportunities and barriers is critical. EECA's Otago Regional Energy Transition Accelerator (RETA) programme aims to develop and share a well-informed and coordinated approach to help fast-track regional decarbonisation. It provides a common set of information to industry considering emissions reduction and to energy suppliers who can support the transition to renewable energy underway in the region.

Our RETA work leverages the site-specific decarbonisation pathways developed for organisations across the region through EECA's Energy Transition Accelerator (ETA) programme. The programme, run since 2019, helps energy-using organisations map out a pathway to meet long term energy reduction goals – and provided a strong foundation to work from.

Otago is well set up to accommodate new electricity demand from most RETA process heat sites. The report also highlights the significant role local forestry biomass may play. Identifying now what the regional split is likely to be across biomass and electricity will help with investment in regional infrastructure and supply chains, including how it is prioritised and staged.

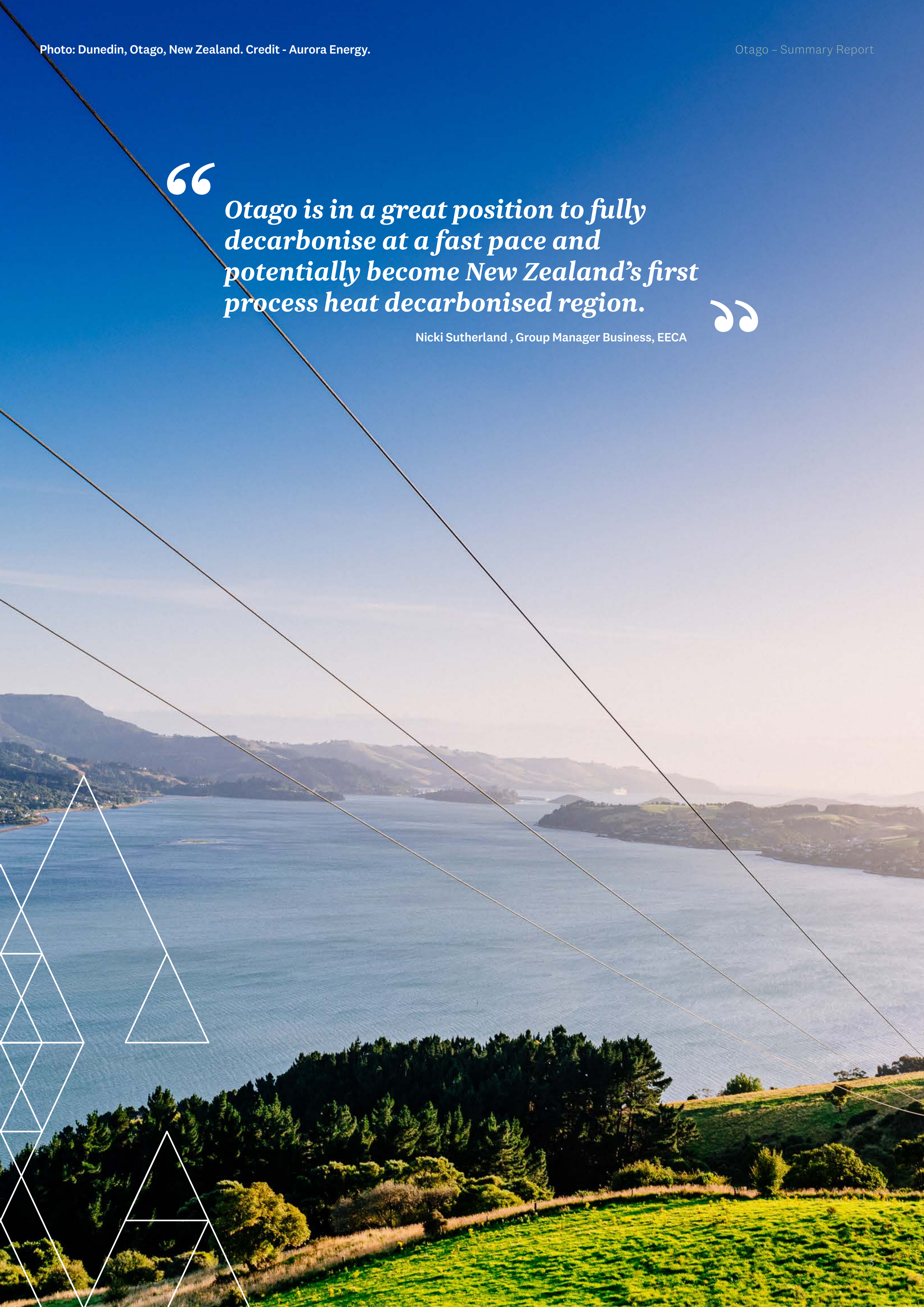
Taking a collaborative approach will accelerate efforts to reduce the region's carbon footprint and help it thrive. We are proud to have worked alongside Business South and several key groups including our RETA report workstream leads Transpower, Aurora, PowerNet, regional forestry companies and wood processors, electricity generators and retailers, and medium to large industrial energy users, to develop this Otago RETA report.

Otago is in a great position to decarbonise with a relatively small emissions profile and no major supply side constraints for either biomass or electricity. This means Otago can fully decarbonise at a fast pace and potentially become New Zealand's first process heat decarbonised region. Ready for a low-emissions economy.

Nicki Sutherland
Group Manager Business, EECA

EECA

Photo: Dunedin, Otago, New Zealand. Credit - Aurora Energy.



> *Otago is in a great position to fully decarbonise at a fast pace and potentially become New Zealand's first process heat decarbonised region.*
>
> Nicki Sutherland , Group Manager Business, EECA

2 Acknowledgements

This Regional Energy Transition Accelerator (RETA) has involved a significant amount of time, resource and input from a variety of organisations. We are especially grateful for the contribution from the following organisations:

- Process heat users throughout Otago
- Business South
- Local lines companies Aurora and OtagoNet JV
- National grid owner and operator Transpower
- Regional forestry companies
- Regional wood processors
- Electricity generators and retailers

This RETA report is the distillation of individual workstreams delivered by:

- **Lumen** – process heat demand-side assessment
- **Ahikā and Margules Groome** – biomass availability analysis
- **Ergo Consultants** – electricity network analysis
- **EnergyLink** – electricity price forecast
- **Wayne Manor Advisory** – report collation, publication and modelling assistance

The Otago region is the focus for New Zealand's fourth Regional Energy Transition Accelerator (RETA).

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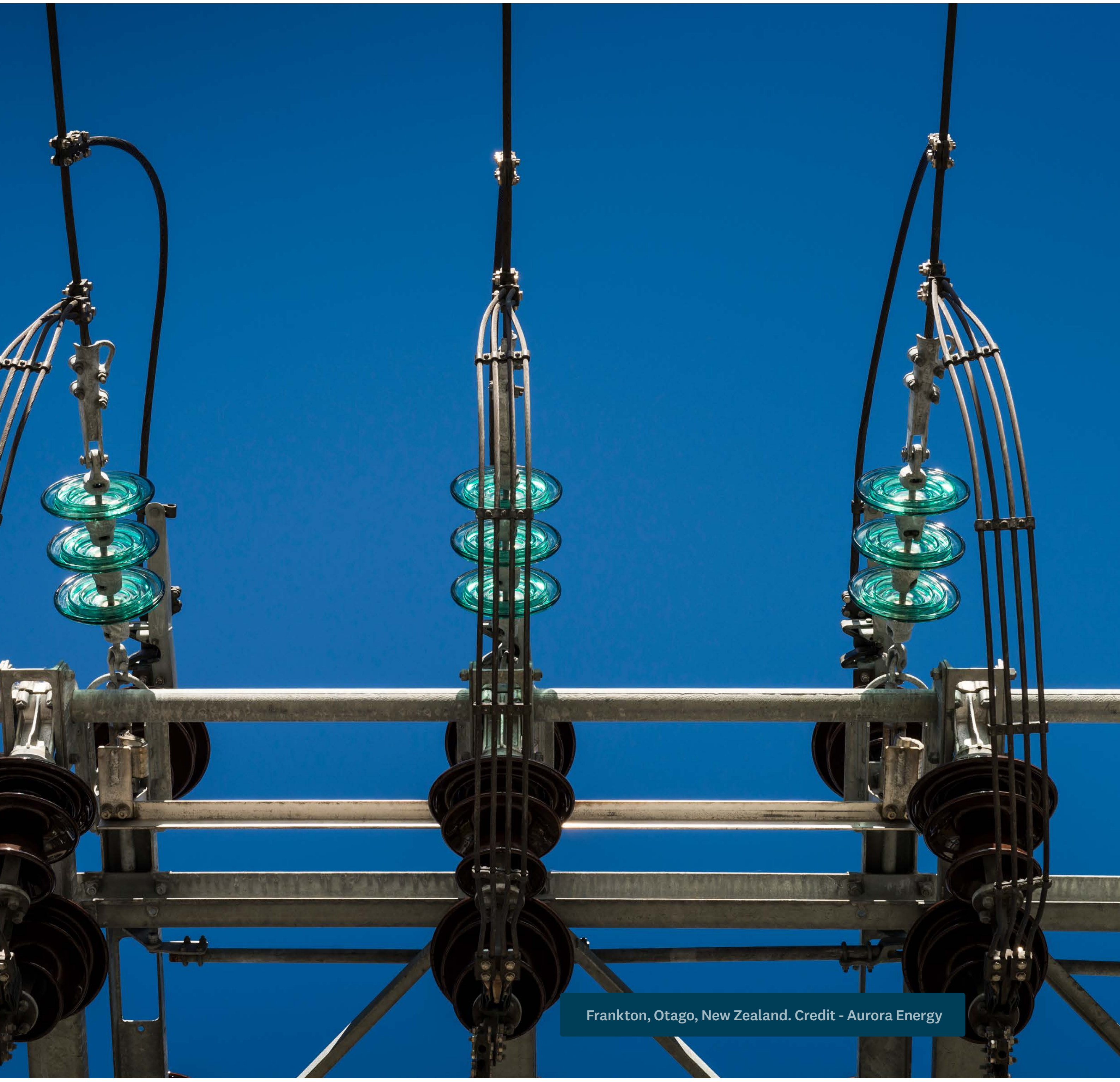
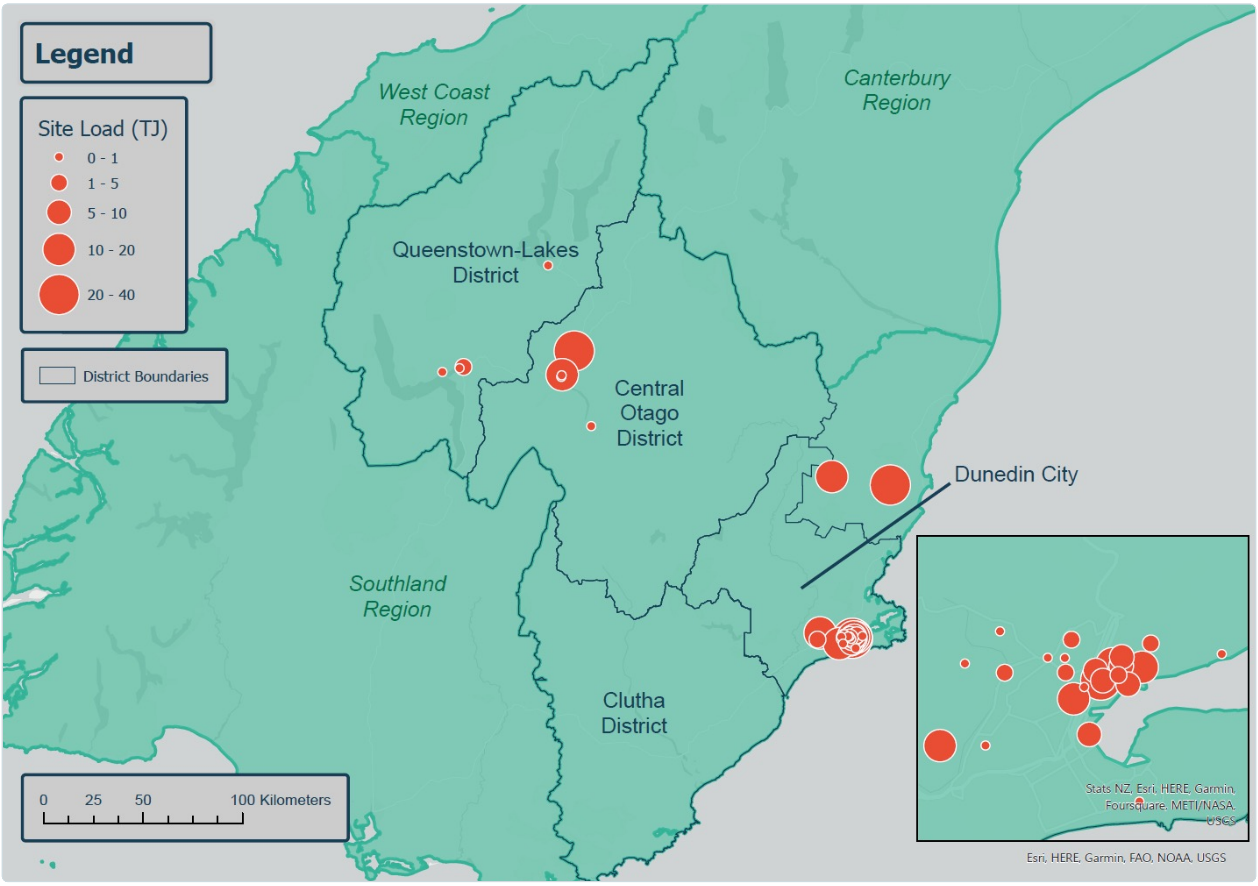

Frankton, Otago, New Zealand. Credit - Aurora Energy

4 Regional overview

The Otago region is the focus for New Zealand's fourth Regional Energy Transition Accelerator (RETA).

Figure 1 – Map of area covered by the Otago RETA



The Otago RETA brings together information about process heat decarbonisation plans from EECA's Energy Transitional Accelerators (ETAs) with individual organisations and data from the Regional Heat Demand Database (RHDD) completed by local electricity distribution businesses, Transpower and EECA. While ETAs focus on the decarbonisation pathways and plans of individual organisations, the RETA expands this focus to consider barriers and opportunities for regional supply-side infrastructure (e.g. networks and regional resources) to better support decarbonisation decisions.

This report is the culmination of the RETA planning phase in the region and aims to:

- Provide process heat users with coordinated information specific to the region to help them with making more informed decisions on fuel choice and timing.
- Improve fuel supplier confidence to invest in supply side infrastructure.
- Surface issues, opportunities, and recommendations.

The next phase of a RETA focuses on implementing recommendations from phase 1 that remove barriers or accelerate opportunities for decarbonisation of process heat.

The 51 sites covered span the dairy, meat, industrial and commercial[1] sectors. These sites either have process heat equipment larger than 500kW (i.e. process heat equipment details have been captured in the Regional Heat Demand Database) or are sites for which EECA has detailed information about their decarbonisation pathway[2]. Together, these sites collectively consume 746TJ of process heat energy, primarily in the form of coal, and currently produce 59kt per year of carbon dioxide equivalent (CO_2e) emissions.

Table 1 – Summary of Otago RETA sites fossil fuel process heat demands and emissions

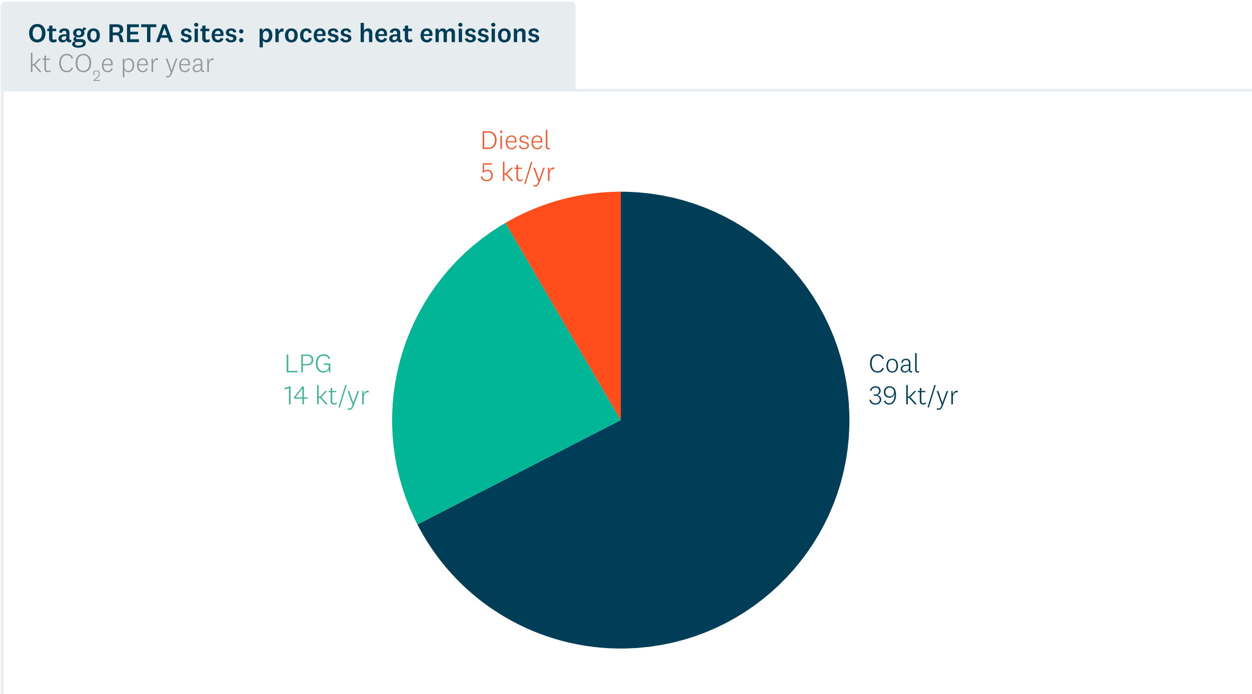
Sector	Sites	Thermal capacity (MW)	Thermal fuel consumption (GWh/yr)	Process heat demand today (TJ/yr)	Process heat annual emissions (kt CO_2e/yr)
Meat	2	10	24	86	7
Industrial	11	47	95	341	26
Commercial	38	51	89	319	26
Total	**51**	**108**	**207**	**746**	**59**

[1] The commercial sector includes schools, hospitals and accommodation facilities.

[2] That is, process heat equipment details have been captured in an ETA opportunities assessment report.

The majority of Otago RETA process heat emissions come from coal (Figure 2).

Figure 2 – 2020 annual emissions by process heat fuel in Otago RETA. Source: EECA



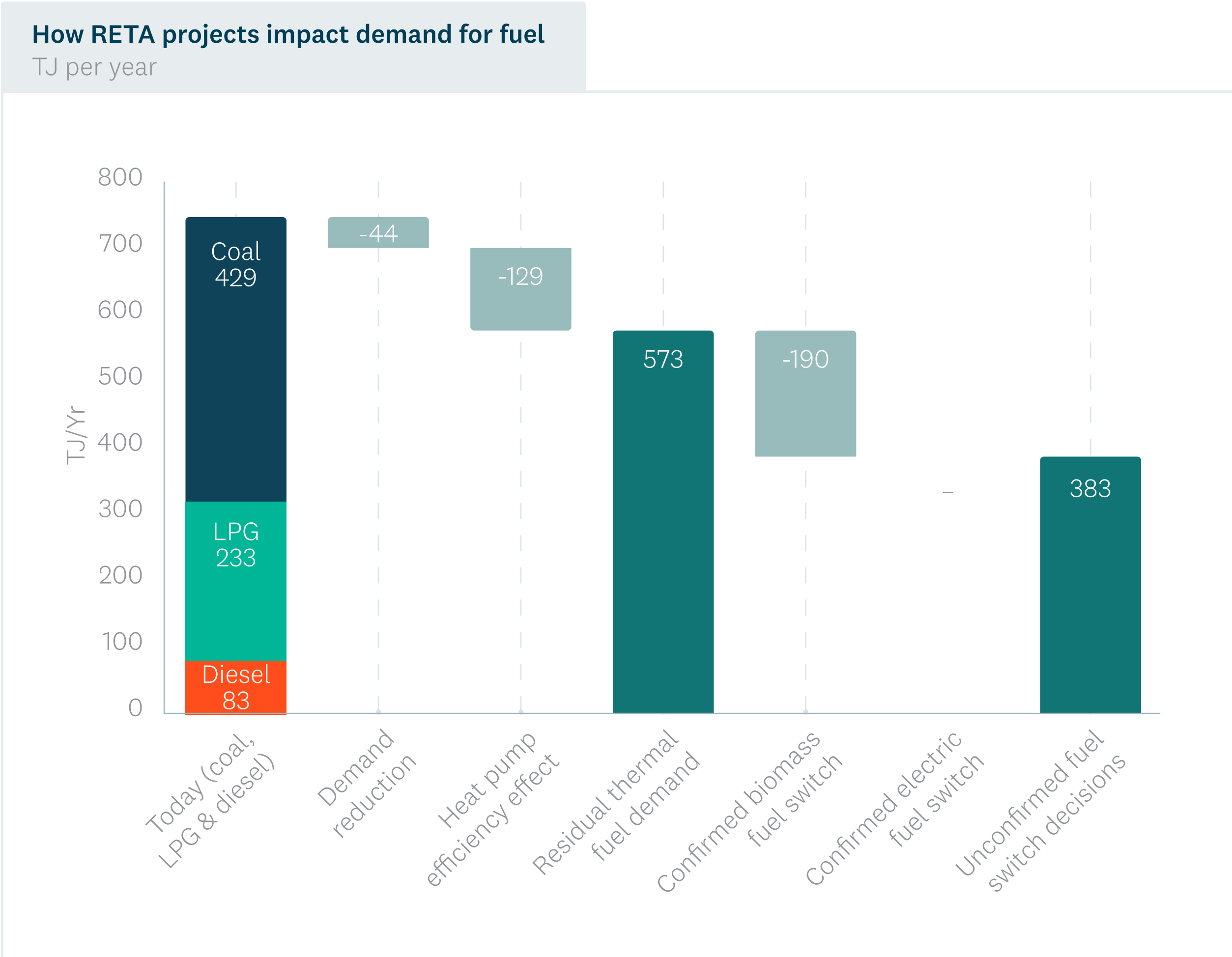
The objective of the Otago RETA is to eliminate as much of these process heat emissions as possible. It does this by supporting organisations in their consideration of:

- Demand reduction (for example reducing heat demand through process optimisation).
- Thermal efficiency (for example installation of highly efficient heat pumps).
- Switching away from fossil-based fuels, to a low-emissions source such as biomass and/or electricity.

Riverbank Substation, Otago, New Zealand. Credit - Aurora Energy.

Figure 3 illustrates the potential impact of RETA sites on regional fuel demand, both as a result of decisions where investment is already confirmed, and decisions yet to be made.

Figure 3 – Potential impact of fuel switching on fossil fuel usage, 2023-2037. Source: EECA



This RETA explores a number of pathways by which the 383TJ of unconfirmed fuel switching decisions could occur. Both biomass and electricity are considered as potential fuel sources. EECA's assessments of biomass and electricity focus on the key issues that are common to all RETA process heat sites contemplating fuel switching decisions. This includes the availability and cost of the resources that underpin each fuel option, as well as the sufficiency of the networks required to ensure that the fuel can be delivered to the process heat users' sites. This assessment is unique to the Otago region. The availability and cost of supply resources and connection can then be used to simulate RETA sites' collective decisions about fuel switching under different sets of assumptions. This provides valuable information to individual process heat decision makers, infrastructure providers, resource owners, funders, and policy makers.

4.1 RETA site summary

As outlined above, there are 51 sites considered in this study.

Across these sites, there are 79 individual projects spanning the three categories discussed in Section 6.3 – demand reduction, heat pumps and fuel switching.

Table 2 shows the different stages of completion of the RETA process heat projects. Some have been confirmed by the process heat organisation (i.e. the organisation has committed to the investment and funding allocated) but are not yet completed. Over 60% of the 79 projects are unconfirmed, in that the process heat organisation is yet to commit to the final investment.

Table 2 – Number of projects in Otago RETA by category. Source: Lumen, EECA.

Status	Demand reduction	Heat pump efficiency	Fuel switching	Total
Completed	-	5	24	29
Unconfirmed	22	14	14	50
Total	**22**	**19**	**38**	**79**

Demand reduction and thermal efficiency are key parts of the RETA process and, in most cases, enable (and help optimise) the fuel switching decision. This RETA report has a greater level of focus on the fuel switching decision, due to the higher capital and fuel intensity of this decision.

Below we show the expected remaining fuel demands from each site in the Otago RETA, after any demand reduction projects and/or heat pump projects are accounted for. We present biomass demands both in TJs and wet tonnes (55% moisture content) and report the peak demand from the boiler should it convert to electricity.

Dunedin Energy Centre, Otago, New Zealand. Credit - Pioneer Energy.

Table 3 – Summary of Otago RETA sites with fuel switching requirements. Green shading indicates confirmed projects; orange highlighting indicates the preferred fuel option according to a commercial decision making criteria explained below.

Site name	Industry	Project status	Bioenergy required TJ ('000t)/yr	Electricity peak demand (MW)
Balaclava School	Education	Confirmed	N/A	0.02
Brockville School	Education	Confirmed	N/A	0.04
Ravensbourne School	Education	Confirmed	N/A	0.02
Tainui School	Education	Confirmed	N/A	0.02
Dunstan Hospital	Hospitals (without Surgery)	Confirmed	N/A	0.13
Dunedin Energy Centre	Other Manufacturing	Confirmed	159.26 (22.17)	N/A
University of Otago Arana College	Education	Confirmed	9.13 (1.27)	N/A
Kaikorai Valley School	Education	Confirmed	1.70 (0.24)	N/A
Bayfield High School	Education	Confirmed	1.38 (0.19)	N/A
King's High School	Education	Confirmed	1.12 (0.16)	N/A
Roxburgh Area School	Education	Confirmed	1.05 (0.15)	N/A
Dunedin North Intermediate	Education	Confirmed	0.88 (0.12)	N/A
Bathgate Park School	Education	Confirmed	0.80 (0.11)	N/A
East Otago High School	Education	Confirmed	0.71 (0.10)	N/A
George Street Normal School	Education	Confirmed	0.54 (0.08)	N/A
Silverstream Primary School	Education	Confirmed	0.49 (0.07)	N/A
Carisbrook School	Education	Confirmed	0.32 (0.04)	N/A
North East Valley Normal School	Education	Confirmed	0.29 (0.04)	N/A
Mornington School	Education	Confirmed	0.24 (0.03)	N/A
Palmerston School	Education	Confirmed	0.22 (0.03)	N/A
Elmgrove School	Education	Confirmed	0.19 (0.03)	N/A
Maori Hill School	Education	Confirmed	0.19 (0.03)	N/A
Macandrew Bay School	Education	Confirmed	0.15 (0.02)	N/A

Site name	Industry	Project status	Bioenergy required TJ ('000t)/yr	Electricity peak demand (MW)
Port Chalmers School	**Education**	**Confirmed**	**0.15 (0.02)**	**N/A**
Abbotsford School	**Education**	**Confirmed**	**0.12 (0.02)**	**N/A**
East Taieri School	**Education**	**Confirmed**	**0.12 (0.02)**	**N/A**
Outram School	**Education**	**Confirmed**	**0.12 (0.02)**	**N/A**
Waikouaiti School	**Education**	**Confirmed**	**0.08 (0.01)**	**N/A**
Portobello School	**Education**	**Confirmed**	**0.05 (0.01)**	**N/A**
Graymont Makareao	Concrete/Lime	Unconfirmed	**132.66 (18.47)**	7.83
Keep it Clean Dunedin	Pet food & rendering	Unconfirmed	**54.54 (7.59)**	4.83
Fulton Hogan Cromwell Asphalt Plant	Concrete/Lime	Unconfirmed	**44.46 (6.19)**	9.78
Oceana Gold Macraes	Metals & Mining	Unconfirmed	**27.41 (3.81)**	3.86
Goodman Fielder Dunedin	Bakery	Unconfirmed	27.35 (3.81)	**1.15**
Keep it Clean Silverstream	Pet food & rendering	Unconfirmed	25.16 (3.50)	**4.75**
Fulton Hogan Logan Point Quarry	Concrete/Lime	Unconfirmed	**22.22 (3.09)**	4.89
Gregg's Coffee	Food & Beverage (with drying)	Unconfirmed	**18.94 (2.64)**	2.80
Lion Speights Brewery	Brewery	Unconfirmed	**11.47 (1.60)**	4.27
Preens Dry Cleaners Dunedin	Laundry	Unconfirmed	**8.20 (1.14)**	1.84
Fulton Hogan Dunedin Bitumen Plant	Concrete/Lime	Unconfirmed	**6.93 (0.97)**	2.68
Lion Emerson's Brewery	Brewery	Unconfirmed	**5.17 (0.72)**	0.88
Southern Lakes Laundries	Laundry	Unconfirmed	**2.75 (0.38)**	0.84
Mercy Hospital	Hospitals (with Surgery)	Unconfirmed	**1.60 (0.22)**	0.29

Twenty-nine sites (mostly schools) have already confirmed their fuel of choice, representing a demand for 179TJ (25,000t[3]) of biomass and 1TJ (0.2GWh) of electricity.

[3] Wet tonnes (55% moisture content) and assuming a boiler efficiency of 80% (compared to coal at 78%).

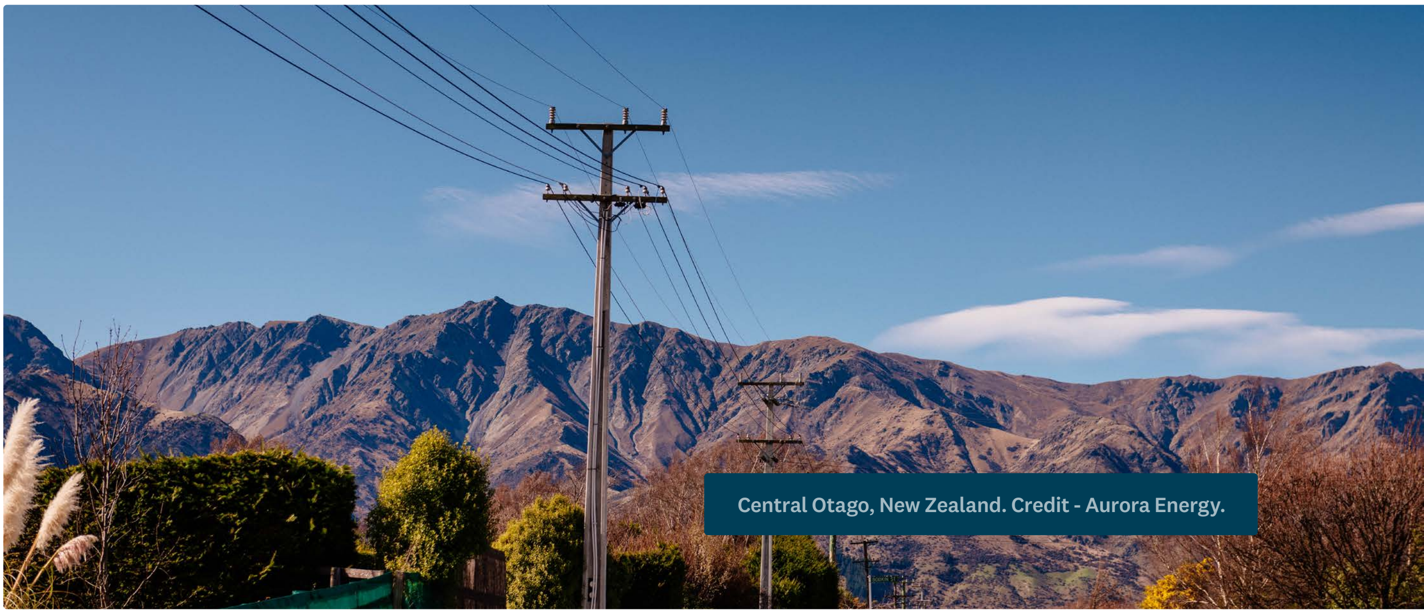
5 Simulated decarbonisation pathways

There are a range of decision criteria that individual organisations may use to determine the timing of their decarbonisation investments. Decisions are impacted by available finance, product market considerations, strategic alignment and other factors. It is challenging to incorporate many of these into a single analysis of the likely decision by each process heat user.

Rather than attempt to include all these factors, we present a range of different potential Otago-specific pathways reflecting different decision-making criteria that process heat users (who have not yet confirmed their choice of fuel) will use.

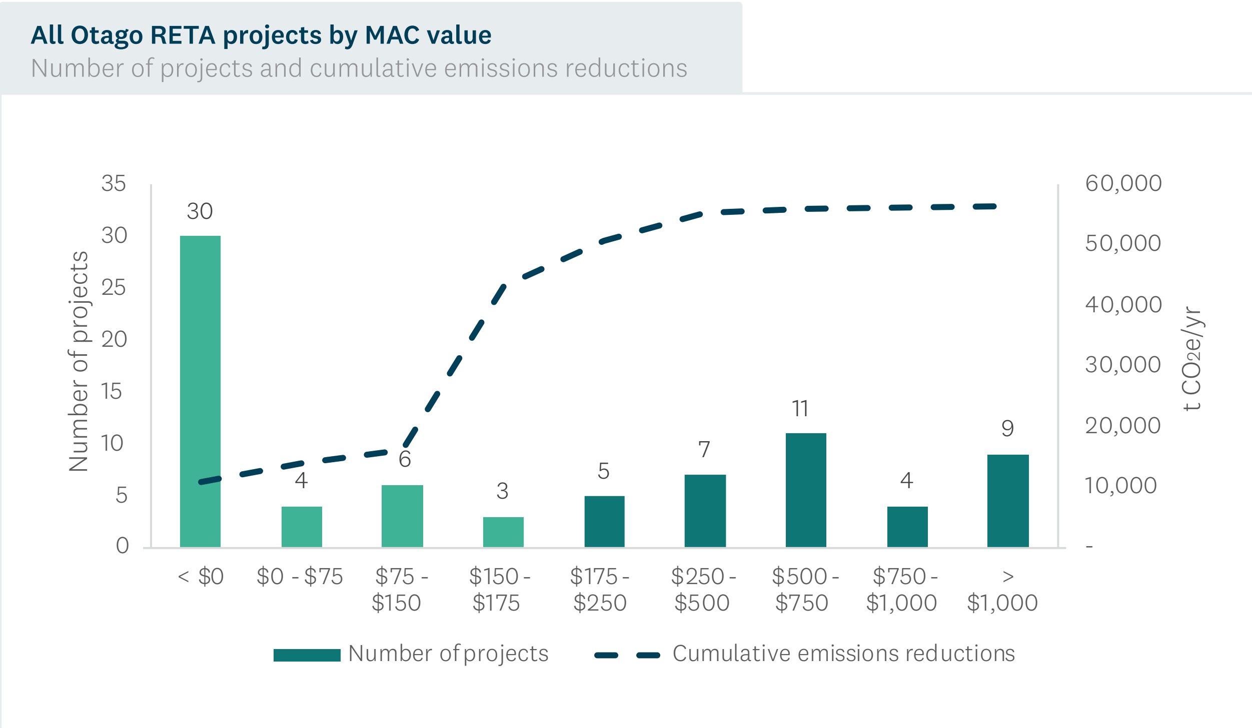
Two pathways present ‘bookends’ that focus exclusively on one of the two fuel options (biomass or electricity). Two others use a global standard marginal abatement cost, or MAC, to quantify the cost to the organisation of decarbonising their process heat. This is expressed in dollars per tonne of CO_2e reduced by the investment, and allows us to determine the timing of the investment as being the earliest point when a decarbonisation decision saves the process heat user money over the lifetime of the investment – the point in time that the MAC of the project is exceeded by the expected future carbon price.

Using the biomass and electricity costs presented in Section 6 and Section 7, Figure 4 summarises the resulting MACs associated with each decision, and the emissions reduced by these projects.



Central Otago, New Zealand. Credit - Aurora Energy.

Figure 4 – Number of projects by range of MAC value. Source: EECA



The pathways were then developed as follows:

Pathway name	Description
Biomass Centric	All unconfirmed site fuel switching decisions proceed with biomass at the timing indicated in the organisation's ETA pathway. If not indicated, timing is set at 2036.
Electricity Centric	All unconfirmed fuel switching decisions with electricity as the sole fuel at the timing indicated in the organisation's ETA pathway. If not indicated, timing is set at 2036.
BAU Combined	All unconfirmed fuel switching decisions (i.e. biomass or electricity) are determined by the lowest MAC value for each project; timing of commissioning as indicated in the organisation's ETA pathway. If not indicated, timing is set at 2036.
Linear	Each site switches to the fuel with the lowest MAC value for that site; projects ordered and timed to achieve a relatively constant annual level of emissions reduction and growth in electricity/biomass consumption (within reason)[4].
MAC Optimal	Each site switches its boiler to the fuel with the lowest MAC value for that site. Each project is timed to be commissioned in the first year when its optimal MAC value first drops below a ten-year rolling average of the Climate Change Commission's future carbon prices in their Demonstration Path.

[4] There could be a range of ways this could be observed. We suggest it could be thought of as organisations desiring to take a MAC Optimal approach, but being slowed by capital constraints, the effect of uncertainty, a more gradual emergence of biomass resources, and/or the realities of constraints on Transpower and EDBs ability to deliver network upgrades as a result of regulatory requirements, construction capacity etc.

For all pathways, the following constraints were applied to the methodology:

- Boiler conversions involving facilities owned by the Ministry of Education, Ministry of Health or the Department of Corrections are all assumed to occur by the end of 2025, consistent with the Carbon Neutral Government Programme[5].
- All RETA decarbonisation projects are executed by 2037 in line with the National Policy Statement (NPS) for greenhouse gas emissions from industrial process heat that came into effect in July 2023, which prohibits greenhouse gas emissions from existing medium temperature (<300°C) coal boilers after 2036[6]. This means that any projects that are still not 'economic' using our MAC criteria by 2036, are assumed to be executed in 2036.

5.1 At expected carbon prices, 77% of emissions reductions are economic[7]

Out of 59kt of process heat emissions covered in the Otago RETA, 48kt (77%) have marginal abatement costs (MACs) less than $166/tCO$_2$e.

Based on an expectation the carbon prices will follow the Climate Change Commission's Demonstration Pathway, these emissions reduction projects would be economic prior to 2037.

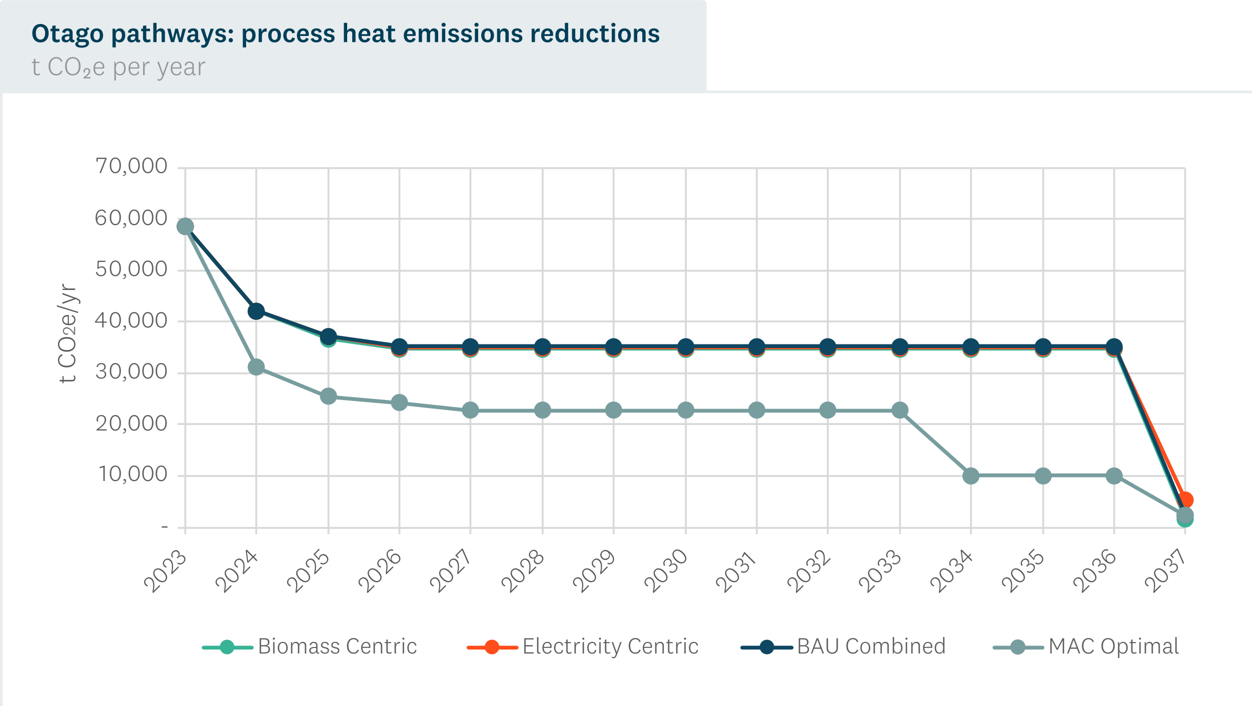
Compared to a scenario where each of these projects was executed based on the organisations' current plans (a BAU pathway), executing these projects using a commercial MAC decision-making criteria (MAC Optimal) would accelerate decarbonisation, and reduce the release of long-lived emission by 196kt over the 15-year period of the RETA analysis (Figure 5).

[5] This programme prioritises the phaseout of coal-fired boilers from the public sector, with the focus on largest and most active by the end of 2025. See https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/carbon-neutral-government-programme/about-carbon-neutral-government-programme/

[6] See https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-for-greenhouse-gas-emissions-from-industrial-process-heat/. The new National Environmental Standard which supports the NPS also places increased restrictions on process heat boilers burning fossil fuels other than coal. We assume that all RETA process heat fossil fuels will convert to a low emissions equivalent by 2037.

[7] By 'economic', we mean that at a 6% discount rate these projects would reduce costs for the firms involved over a 20-year period (i.e. the Net Present Value would be greater than zero, at the assumed trajectory of carbon prices).

Figure 5 – Simulated emissions using Electricity Centric, Biomass Centric, BAU Combined and MAC Optimal pathways. Source: EECA



The MAC Optimal pathway proceeds faster, with the majority of emissions reductions achieved by 2027. However, this pace is likely to be constrained by practical matters such as:

- The ability of process heat users to secure funding and commit to these investments in this timeframe.
- The ability of infrastructure providers to deliver the necessary network upgrades.
- The ability of forest owners and bioenergy aggregators to make sufficient resource available.

The MAC Optimal pathway sees fuel decisions that result in 14% of the energy needs supplied by electricity in 2036, and 86% of energy needs supplied by biomass in 2036.

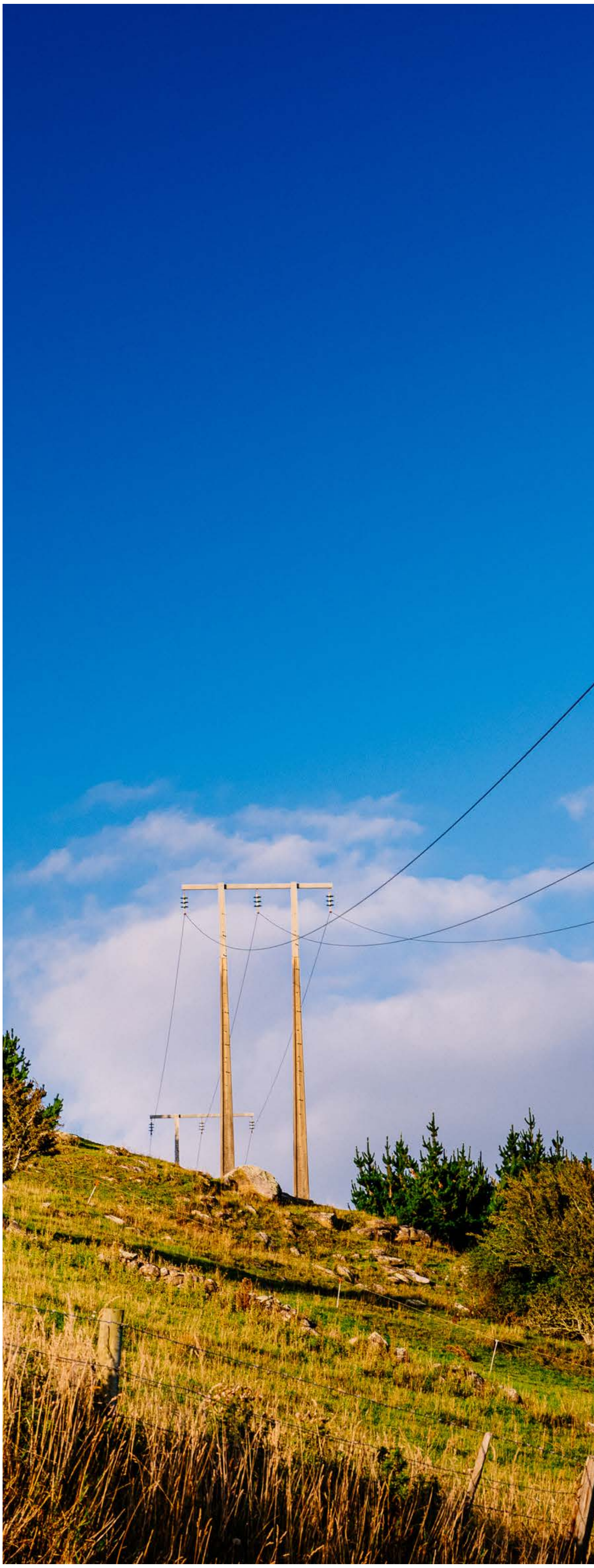
We expand further on these outcomes in the sections below.

Before doing so, it is important to recognise the significant impact that demand reduction and heat pump efficiency projects have on the overall picture of Otago process heat decarbonisation. As shown in Figure 3, investment in demand reduction and heat pumps meets nearly 23% of today's Otago energy demands[8] from process heat, which in turn reduces the necessary fuel switching infrastructure required: thermal capacity required from new biomass and electric boilers would be reduced by 15MW if these projects were completed.

[8] This is true for both energy consumption and also the peak thermal demand required from biomass or electric boilers.

We estimate that demand reduction and heat pumps would avoid investment of $15M to $23M in electricity and biomass infrastructure.

The MAC values – and therefore the timing of each decarbonisation project – are based on a number of inputs that are uncertain (for example future electricity prices and biomass costs). Our analysis illustrates that acceleration co-funding could have a modest effect on project timing, given assumptions about their economics. The expectations that organisations hold about future carbon prices also has an effect. Factors beyond pure project economics (such as internal constraints on capital) will continue to significantly impact organisations' decisions. Co-funding can perform a role in neutralising these barriers to undertaking good investments.



Central Otago, New Zealand. Credit - Aurora Energy.

6 Biomass – resources and costs

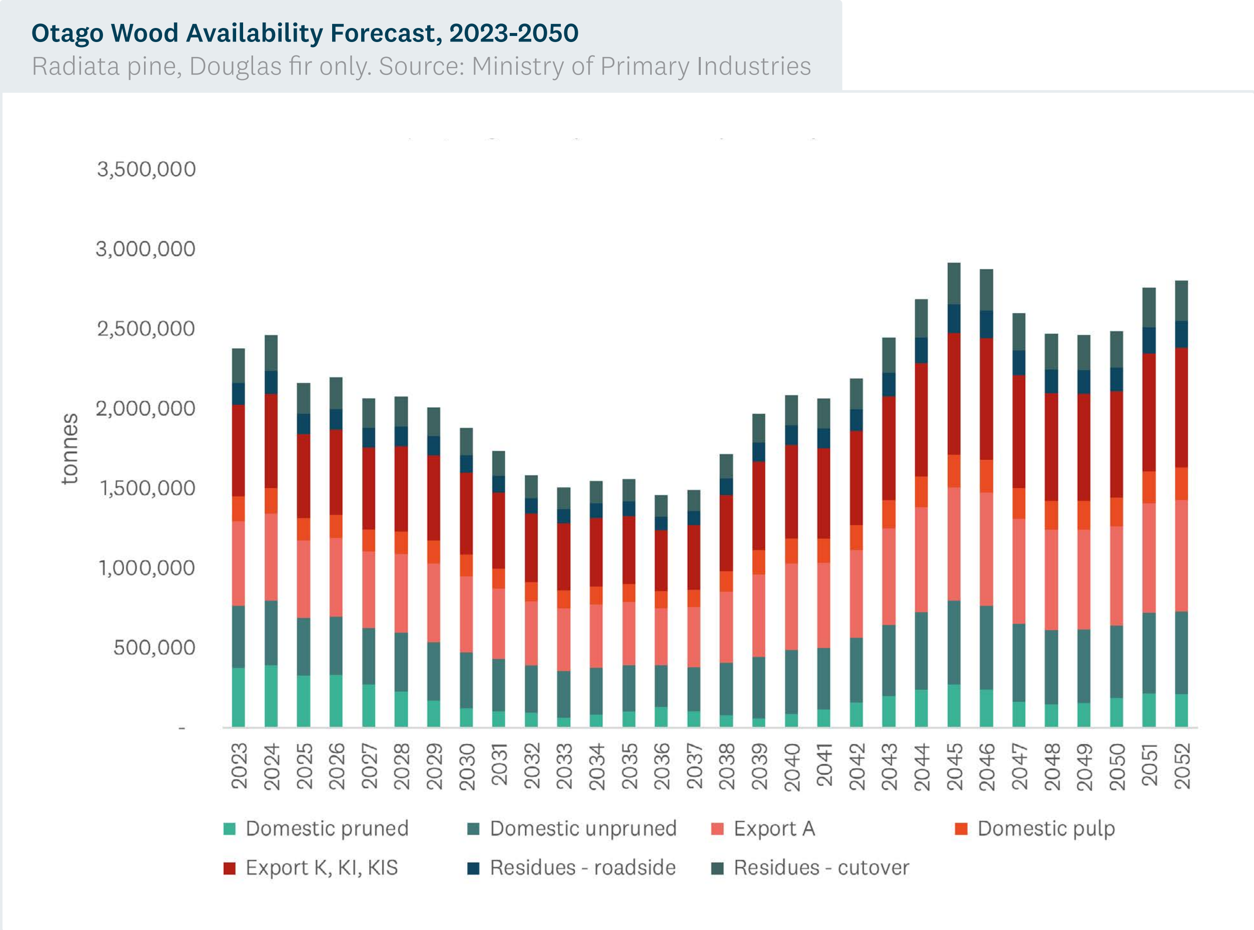
The use of woody biomass for bioenergy requires careful consideration of emissions and sustainability – for example, depending on the source, the diversion of wood to bioenergy may change the timing of the release of emissions by a significant period (compared to the natural decomposition of biomass). Suppliers and consumers of biomass for bioenergy need to be confident they understand any wider implications of their choices. No formal guidelines or standards exist in New Zealand at this point, and EECA recommends one is developed for the New Zealand context, drawing on international standards and experience.

A good sense of the total availability of harvestable wood in the Otago region requires both a top-down and bottom-up analysis (based on interviews with major forest owners), as forest owners' actual intentions will often deviate from centralised forecasts due to changes in log prices and other dynamic factors. The bottom-up analysis also provides an assessment of where the wood is expected to flow through the supply chain – via processors to domestic markets, or export markets, as well as volumes that are currently being utilised for bioenergy purposes.

A top-down analysis suggests that between 1.5M and 2.0M tonnes of wood per year will be harvested in the Otago region over the next 15 years (Figure 6). The majority of this will be radiata pine. Around three-quarters will be harvested into domestic sawlogs or Export A, K, KI and KIS grades.

Camp Hill Substation, Otago, New Zealand. Credit - Aurora Energy.

Figure 6 – Wood resource availability in Otago region, 2023-2050.

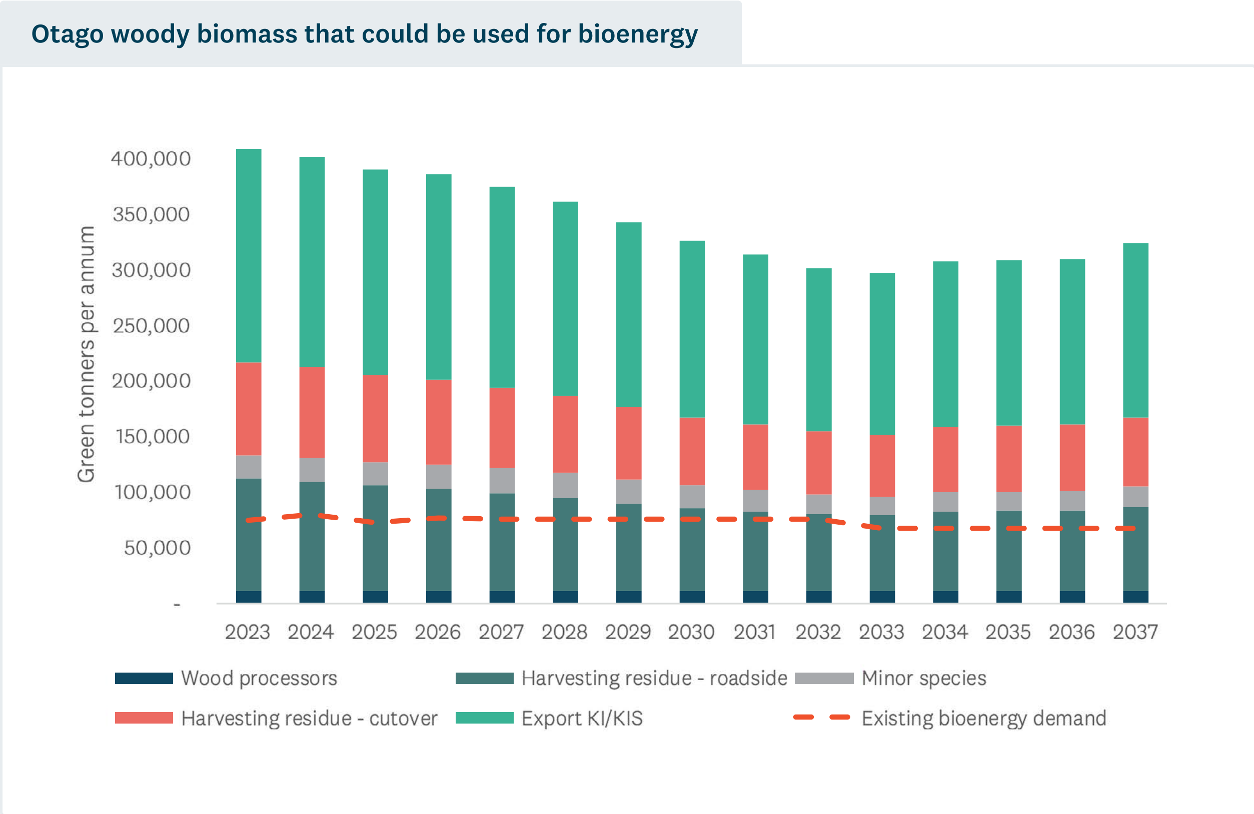


A more comprehensive view of resource availability, that combines the top-down and bottom-up analyses, reveals the potential volumes that could be available for bioenergy. This analysis:

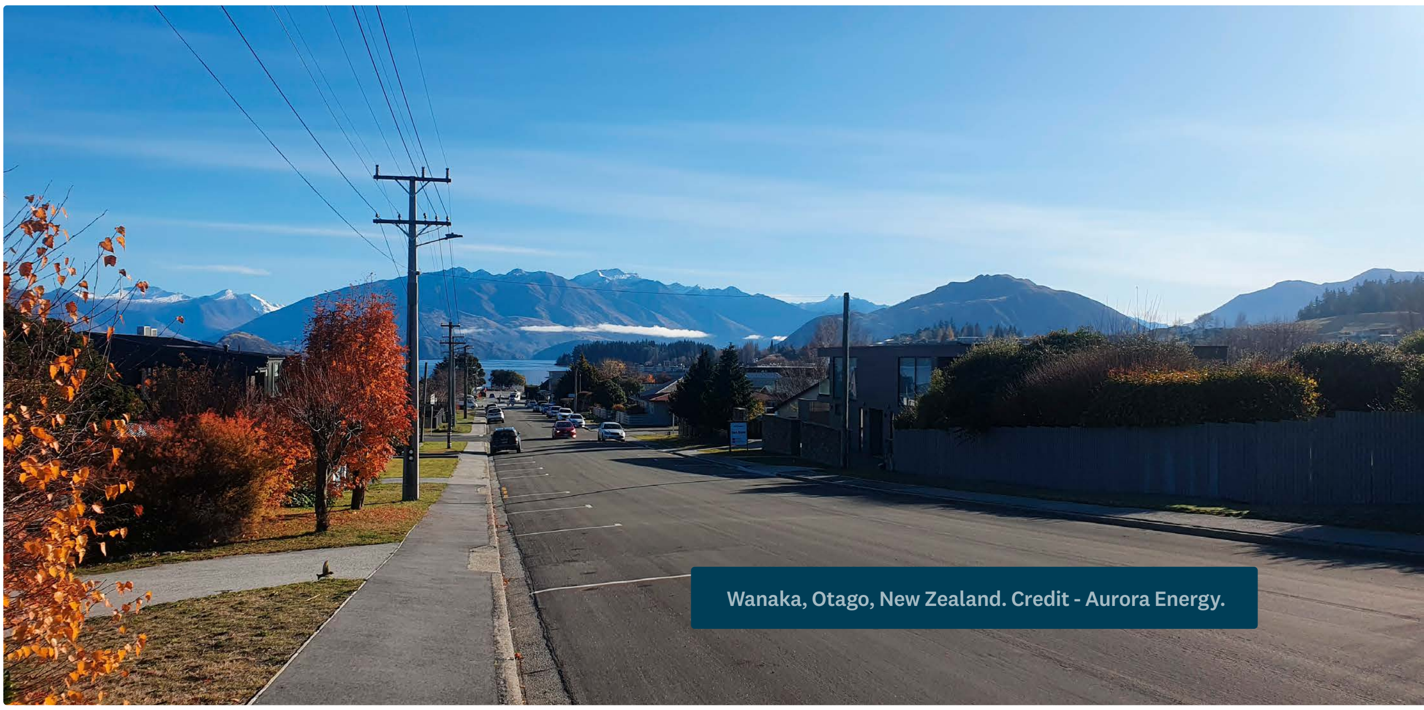
- Includes minor species (e.g. cypress and eucalyptus) that isn't accounted for in Figure 6.
- Takes a more realistic approach to estimating the potential harvesting residues (roadside and cutover) than the theoretical potential used in Figure 6.
- Considers the potential volumes arising as residues from processing sawlogs for the domestic market.
- Overlays the existing demand for bioenergy, that already draws on these resources.

The resulting potential volumes for bioenergy is shown in Figure 7.

Figure 7 – Assessment of available Otago woody biomass that could be used for bioenergy.

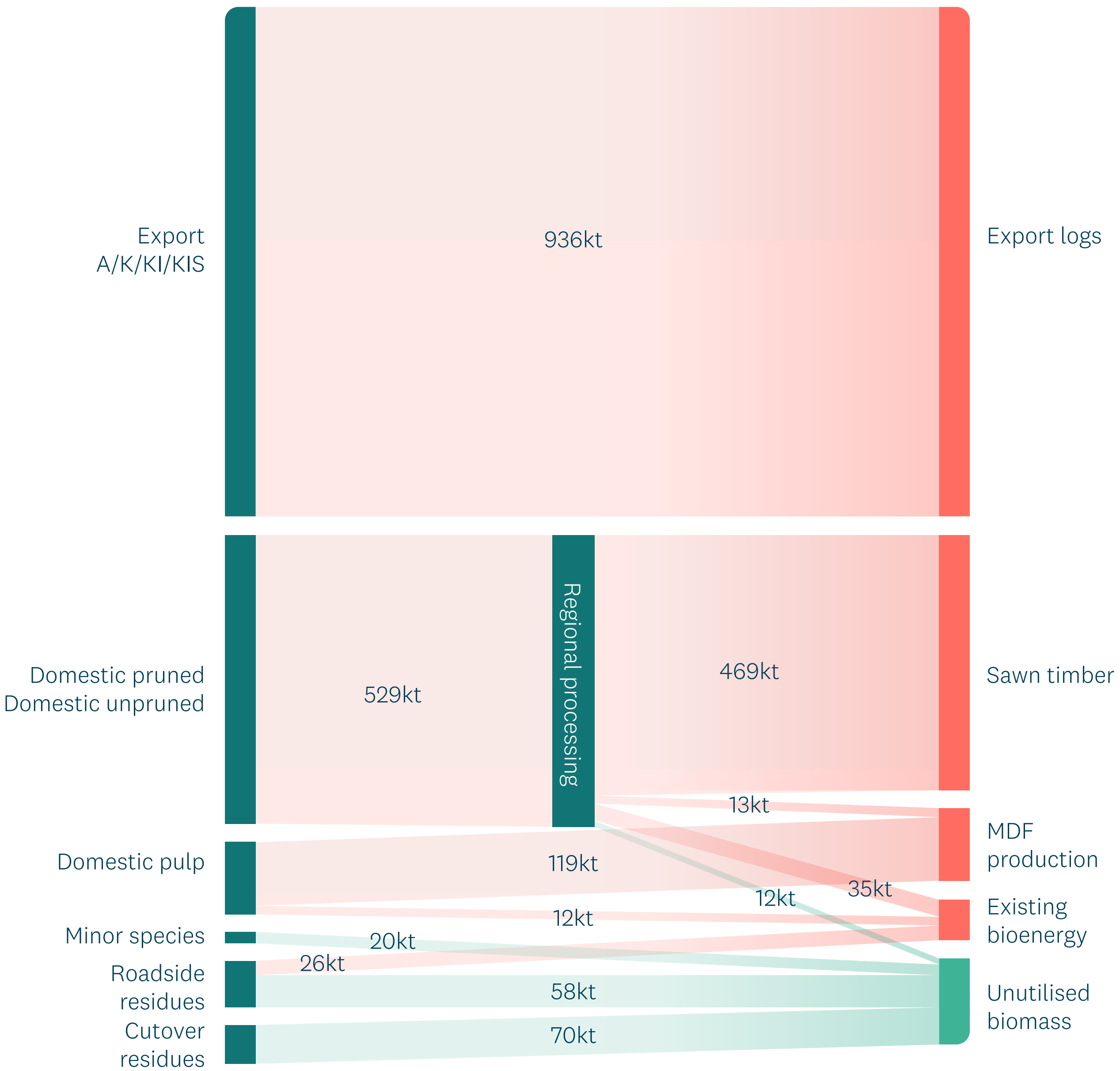


The overall analysis of the Otago region is summarised in Figure 8. Wood flows that could – in part or in full – be diverted to new bioenergy demand from process heat are shown in green.



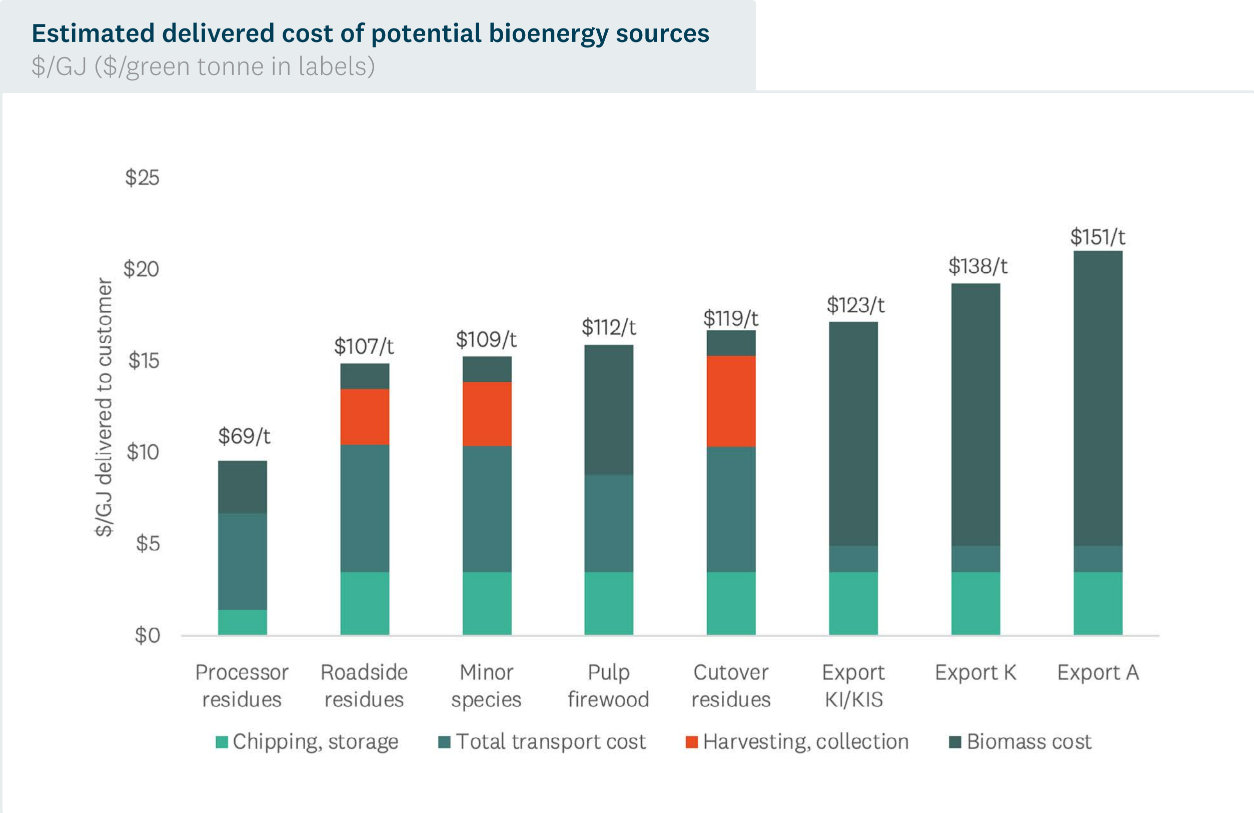
Wanaka, Otago, New Zealand. Credit - Aurora Energy.

Figure 8 – Average wood flows over 15 years in Otago region. Source: Ahikā, Margules Groome



Overall, EECA estimates that, on average over the next 15 years, **approximately 140,000t per year (1,000TJ) of Otago woody biomass is currently unutilised and could be recovered for new boiler demands without disrupting low grade export markets or existing bioenergy consumers.** The costs of accessing this biomass, and delivering it to the process heat user's site, is presented in Figure 9.

Figure 9 – Estimated delivered cost of potential bioenergy sources. Source: Margules Groome (2023), average value 2023-2037

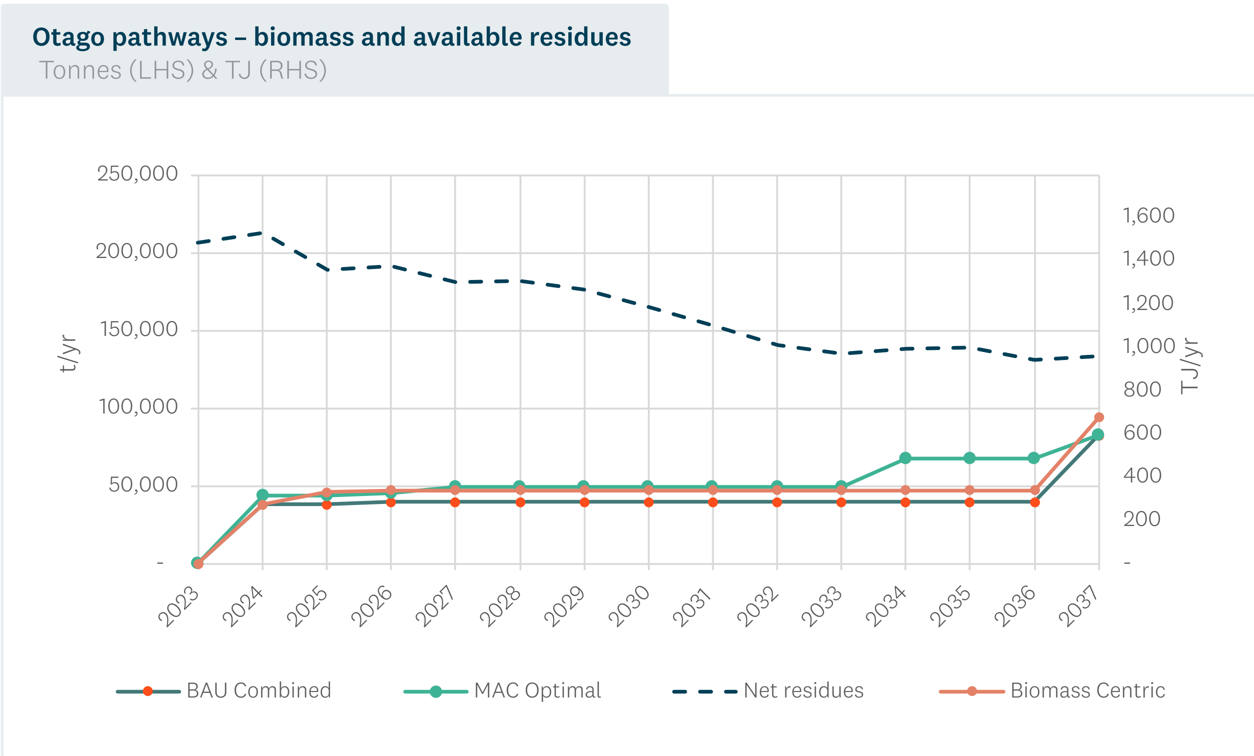


We retain export grade A logs in the analysis not because we believe these are sustainable or practical sources of bioenergy. Rather we use them in the supply curve to represent 'scarcity values' if our scenario analysis below should indicate that other more plausible and sustainable sources of bioenergy are insufficient.

6.1 Impact of pathways on biomass demand

Our pathway analysis shows the growth in biomass demand (in both tonnes and TJ per year) arising from each of the pathways. The MAC Optimal and BAU Combined pathways result in less than half the final demand from the Biomass Centric pathway.

Figure 10 – Growth in biomass demand from Otago pathways. Source: EECA



Based on the biomass cost figures provided above, our analysis suggests that, over the next 15 years, the MAC Optimal process heat market demand for these residues could be between $50M and $80M (on a cost basis[9]), including chipping, storage, and transport.

The degree to which these resources are used is a commercial decision, which would include a comparison with alternatives in terms of cost, feasibility, and desirability. Depending on the process heat users' preference of fuel type some types of resources may not be suitable. In some situations, higher cost pellets may be required, which in turn require higher-grade raw material.

[9] Cost of wood chip delivered to process heat user at $13.50/GJ (wet wood), per Section 8.7. Does not include costs associated with processing into e.g. wood pellets.

7 Electricity – network capacity and costs

The availability of electricity to meet the demand from process heat users is largely determined at a national 'wholesale' level. Supply is delivered to an individual RETA site through electricity networks – a transmission network owned by Transpower, and a distribution network, owned by electricity distribution businesses (EDBs), that connects individual consumers to the boundary of Transpower's grid (known as grid exit points, or GXPs).

The price paid for electricity by a process heat user is made up of two main components[10]:

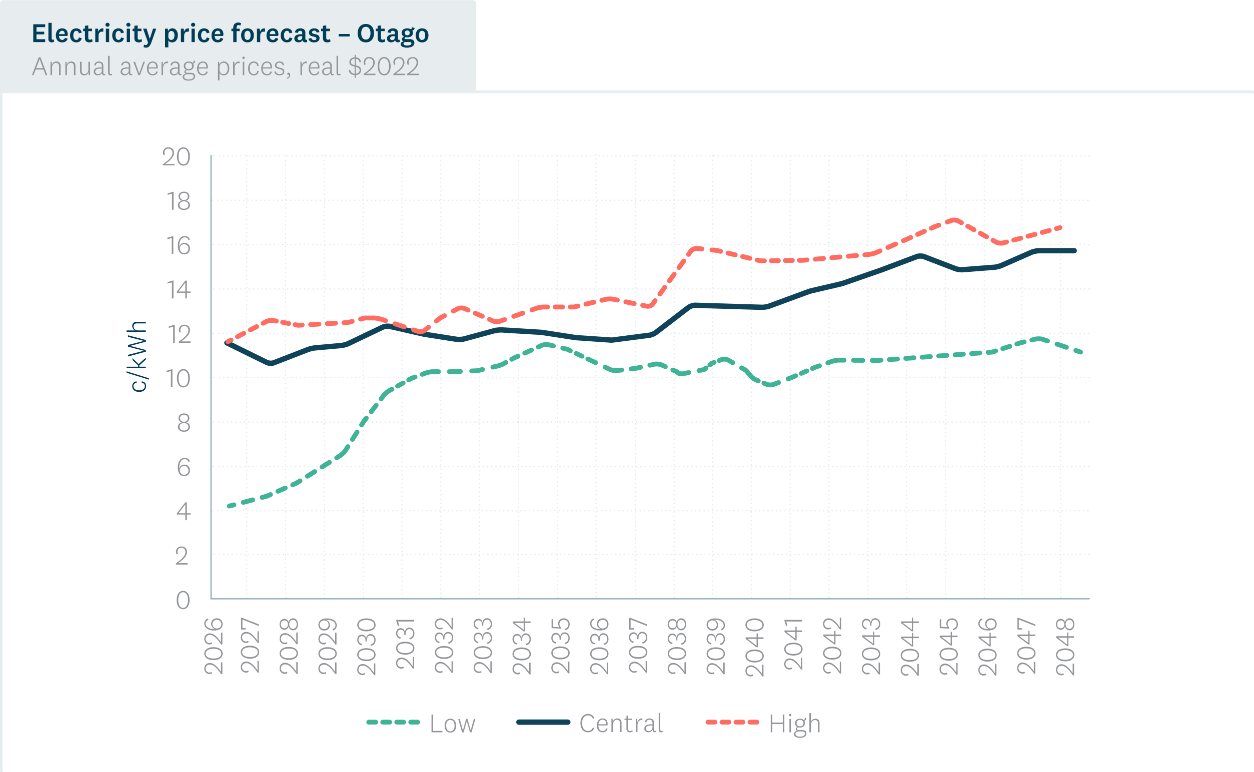
- A price for 'retail electricity' – the wholesale cost of electricity generation plus costs associated with electricity retailing.
- A price for access to the transmission and distribution networks.

As shown in Figure 10, the forecast price of **retail electricity** is expected to rise (in real terms) around 10% between 2027 and 2037 (to ~12c/kWh) under a 'central' scenario. However, different scenarios could see real retail prices higher or lower than that level by 2037.

Dunedin Energy Centre, Otago, New Zealand. Credit - Pioneer Energy.

[10] Other smaller components include metering and regulatory levies.

Figure 11 – Forecast of real annual average electricity price for large commercial and industrial demand in the Otago region. Source: EnergyLink



Beyond 2037, this forecast sees more significant increases in electricity prices. However, it is difficult to predict pricing beyond the end of the RETA period. Some New Zealand market analyses suggest real prices may remain constant after 2035, due to the downward pressure on generation costs (especially solar and wind) as technology and scale increases. Other analyses see continued increases. We cannot be definitive about electricity prices 20 years into the future and suggest business cases consider a range of scenarios.

The EDBs serving the Otago region are Aurora and OtagoNet. EDBs charge electricity consumers for the use of the *existing* distribution network, and also pass through the charges they face for use of the existing transmission network. Where the connection of new electric boilers requires EDBs to invest in **distribution network upgrades**, the cost of these can be paid through a mix of ongoing of the network charges in the table above, and an up-front 'capital contribution'. Each EDB maintains policies that govern the degree of capital contribution, and process heat users should discuss these with their respective EDBs.

In addition, process heat users who connect new electric boilers directly to Transpower's grid will face equivalent **transmission charges**. Process heat users who connect to the EDBs networks will also face a share of these transmission costs, as determined by the EDBs pricing methodologies. A new Transmission Pricing Methodology (TPM), developed by the Electricity Authority, will apply to transmission charges in the 2023/24 year.

An approximation of the potential charges faced by process heat users who electrify is presented in Table 4. These are based on each of the EDB's announced prices for the year 2023/24.

Table 4 – Estimated and normalised network charges for Otago's large industrial process heat consumers, by EDB.

EDB	Distribution charge	Transmission charge	Total charge
OtagoNet	$120,000	$110,000	$230,000
Aurora (Dunedin)	$95,000	$65,000	$160,000
Aurora (Central Otago)	$200,000	$70,000	$270,000
Aurora (Queenstown)	$100,000	$85,000	$185,000

Transpower and the EDBs are experiencing an increasing need for investment as a result of continued population and business growth, distributed generation, and the electrification of transport and process heat. While this RETA analysis only examines demand from process heat electrification, and public EV charging facilities where this information is available to EECA, this broader context of potentially rapid growth in demand is important to understanding the challenges associated with accommodating new load.

The primary considerations for a process heat user considering electrification are:

- The current 'spare capacity' (or headroom) and security of supply levels in Transpower and the EDBs' networks to supply electricity-based process heat conversions.
- The cost of any upgrades required to accommodate the demand of a process heat user, taking into account seasonality and the user's ability to be flexible with consumption, as well as any other consumers looking to increase electricity demand on that part of the network.
- The timeframe for any network upgrades (e.g. procurement of equipment, requirements for consultation, easements and regulatory approval).
- The price paid for electricity to an electricity retailer (or direct to the wholesale market, for large sites), and any other charges paid by electricity consumers (e.g. use-of-network charges paid to EDBs and Transpower).
- The level of connection 'security' required by the site, including its ability to tolerate any rarely occurring interruptions to supply, and/or the process heat user's ability to shift its demand through time in response to a signal from the network or the market. This flexibility could reduce the cost of connection, and the supply costs of electricity.

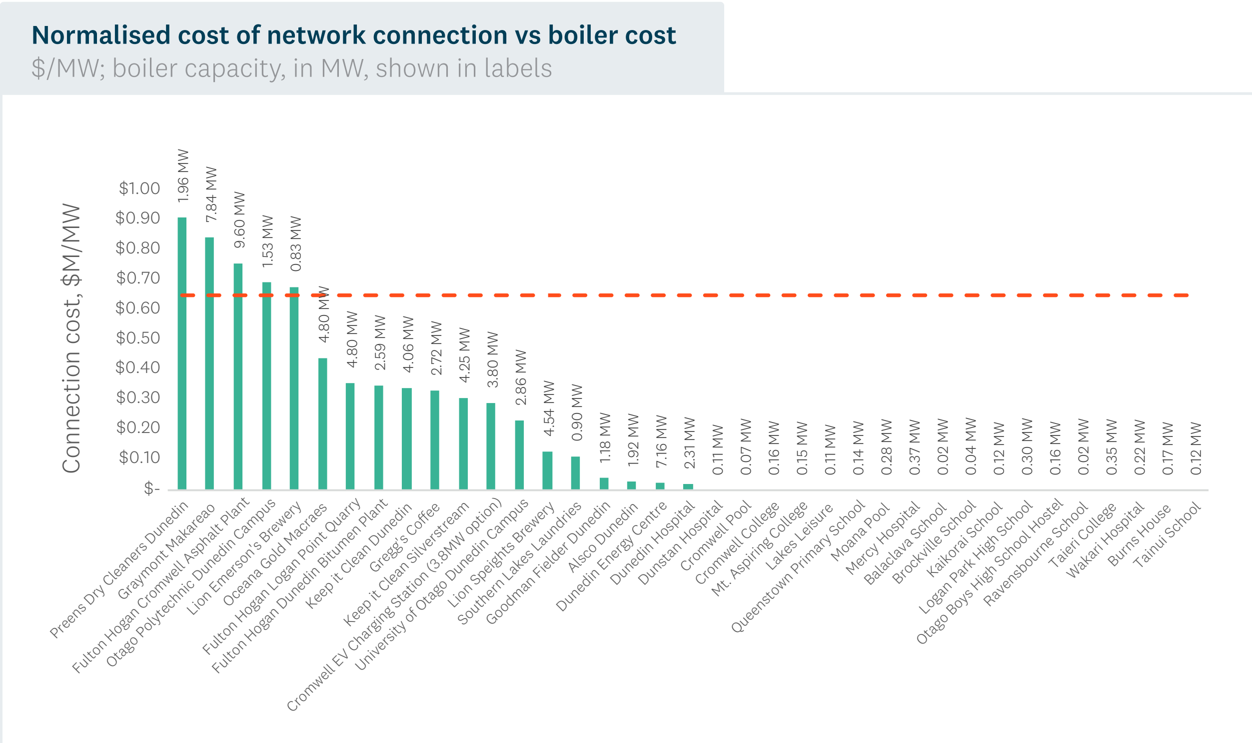
The analysis suggests that work required to accommodate the new demand from the majority of RETA process heat sites is relatively minor in complexity. The estimated costs of the equipment required to connect these sites is <$0.6M per site, and these would take between 6-12 months. These sites place relatively low demands on the network.

However, for sites with higher peak demands, the connections increase in complexity. If these more complex connections do not require upgrades to Transpower's network, indicative costs are between $0.6M and $8M. These upgrades are expected to take between 12 to 24 months.

Overall, decarbonising Otago process heat through electrification appears very achievable and is unlikely to be slowed by network constraints. This is particularly helped by the connection of new demands not being expected to trigger transmission upgrades.

The costs of connection can be a significant part of the overall capital cost associated with electrifying process heat demand. Figure 12 shows each site's connection costs expressed in per-MW terms, i.e. relative to the capacity of the proposed boiler.

Figure 12 – Normalised cost of network connection vs boiler cost, Otago RETA sites. Source: Ergo, EECA



The red dashed line in Figure 12 compares these per-MW costs to the estimated cost of an electrode boiler ($650,000 per MW[11]). The figure shows not only a wide variety of relative costs of connecting electrode boilers, but that for five sites, the connection cost more than doubles the overall capital cost associated with electrification.

The timeframes for connection above assume these investments do not require Transpower or EDBs to obtain regulatory approval. We note that if connections also rely on wider upgrades to the network, the EDB would have to seek regulatory approval for these investments, which could also add to the timeline.

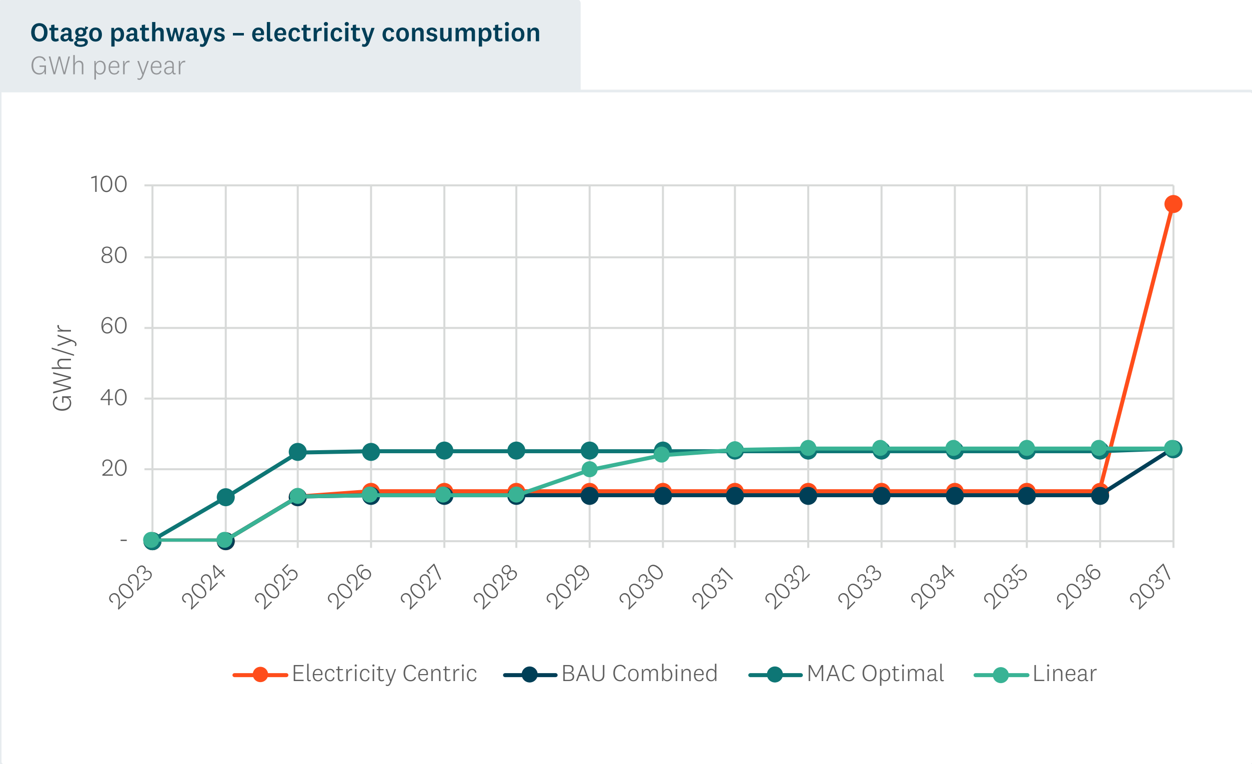
The costs provided above are indicative and appropriate for a screening analysis. They should be further refined in discussion with network owners, and the final costs in some situations will depend on the collective decisions of a number of RETA sites who require access to similar parts of the network.

[11] This is the estimate used in the development of the marginal abatement costs and pathways presented in Section 10.

7.1 Impact of pathways on electricity demand

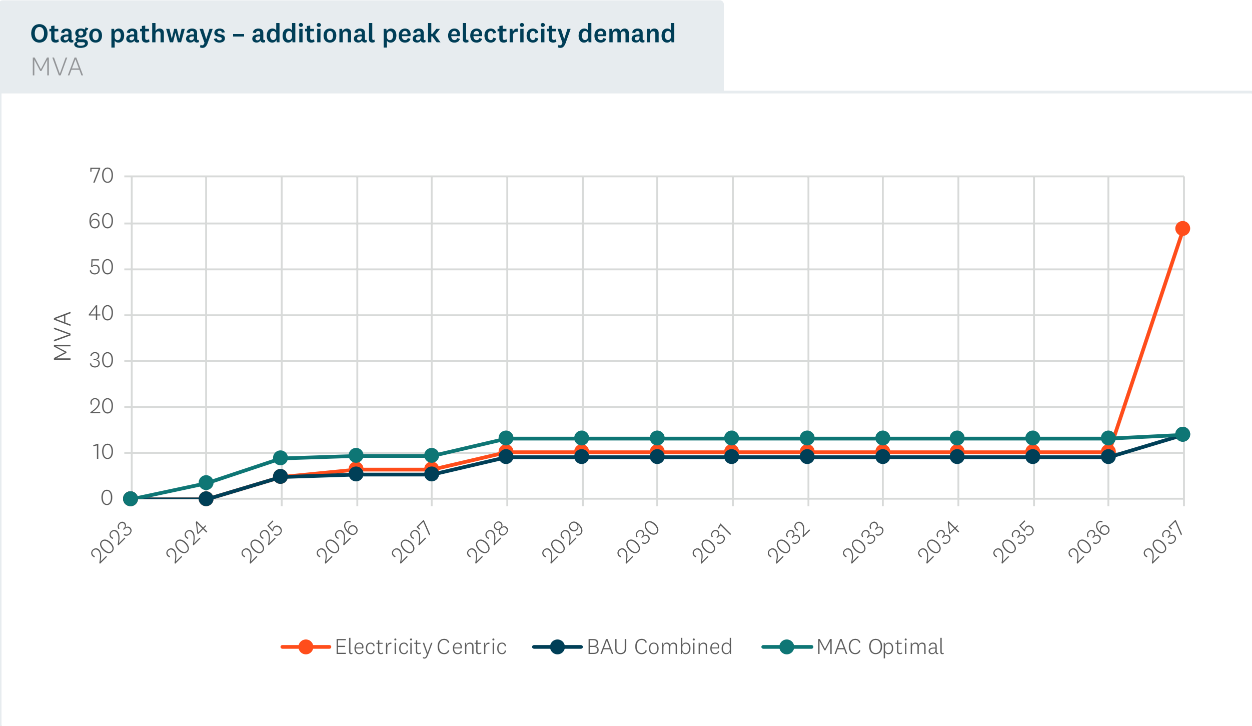
The figures below show the pace of electricity demand growth under the different pathways, both in terms of electricity consumption and potential peak electricity demand (which drives the capacity requirements from the network).

Figure 13 – Growth in Otago electricity demand from fuel switching pathways (unconfirmed RETA sites). Source: EECA



Even in an Electricity Centric world, electricity consumption in Otago would only grow by around 5% compared today, although not until 2036. Under the MAC Optimal, Linear and BAU Combined worlds, consumption would only grow by 1%. The vast majority of this growth would be observed in the next two years in a MAC Optimal pathway.

Figure 14 – Potential Otago peak electricity demand growth under different pathways.



The difference between the scenarios through time is relatively minor – ranging between 10MVA and 13MVA – until 2037 where the Electricity Centric pathway reaches much higher peak demand levels than all other pathways. Prior to that, the additional peak demand from the electrified boilers and heat pumps represents a 3%-5% increase in the combined networks' coincident peak demand. However, this relatively small percentage disguises the impact on particular parts of the network.

Table 5 shows how the connections potentially affect each EDB's network.

Table 5 – New connections (MW) and customer-driven connection costs under Electricity Centric and MAC Optimal pathways

EDB	Electricity Centric pathway		MAC Optimal pathway	
	Connection capacity (MW)	Connection cost ($M)	Connection capacity (MW)	Connection cost ($M)
Aurora (Dunedin)	32	$4.9	10	$1.0
Aurora (Central)	14	$3.6	4	$-
Aurora (Queenstown)	1	$0.1	0.2	$-
OtagoNet	12	$4.4	-	$-
Total	**59**	**$13**	**14.2**	**$1.0**

Table 5 shows that Aurora's Dunedin network will experience the largest increase in process heat-related electricity demand, irrespective of whether the electricity-centric or MAC Optimal pathway results. That said, compared to other regions studied so far, the connection cost estimates suggest that between $1M to $13M will be spent connecting new process heat plant to the local networks, depending on the pathway.

Note that the network upgrade costs presented in Table 5 may not necessarily reflect the connection costs paid by RETA organisations, as they may be shared between the EDB and the new process heat user. The degree of sharing ('capital contributions') depends on the policies of individual EDBs.

7.2 Opportunity to reduce electricity-related costs through flexibility

There is a potentially significant opportunity for process heat users considering electrification to reduce the costs of connection, and the total costs of purchasing electricity, by enabling flexibility in their consumption. This could take the form of being able to shift demand by a relatively small number of hours; allowing for a very small probability of interruption to their electricity supply; or maintaining a standby supply of fuel to be used in prolonged period of high electricity prices. The lowest cost way for flexibility to be enabled is for it to be designed into the electrification investment. Several service providers provide this expertise.

Central Otago, New Zealand. Credit - Aurora Energy.

8 Recommendations

Our analysis has highlighted a range of opportunities and recommendations which would improve the overall process heat decarbonisation 'system'. These recommendations are summarised here.

Recommendations to improve the use of biomass for process heat decarbonisation:

- **More analysis, and potentially pilots, should be conducted to understand costs, volumes, energy content (given the potential susceptibility of these residues to high moisture levels) and methods of recovering harvesting residues.**
- **Work should be undertaken with forest owners to understand the logistics, space and equipment required for harvesting residues.**
- **The development of an E-grade would greatly assist in the development of bioenergy markets. Further, clarity regarding the grade and value of biomass should help the 'integrated model' of cost recovery, outlined above, achieve the best outcomes in terms of recovery cost and volumes.**
- **Analysis is required to determine the impact of recovering harvesting residues on soil quality, carbon sequestration, the risk of forest fires and what actions may be required to offset this.**
- **National guidance or standards should be developed, based on international experience tailored to the New Zealand context regarding the sustainability of different bioenergy sources, accounting for international supply chain effects, biodiversity, carbon sequestration and the risk of forest fires.**
- **Wood processors are encouraged to explore the production of pellets locally, based on the likely demand provided in this report.**

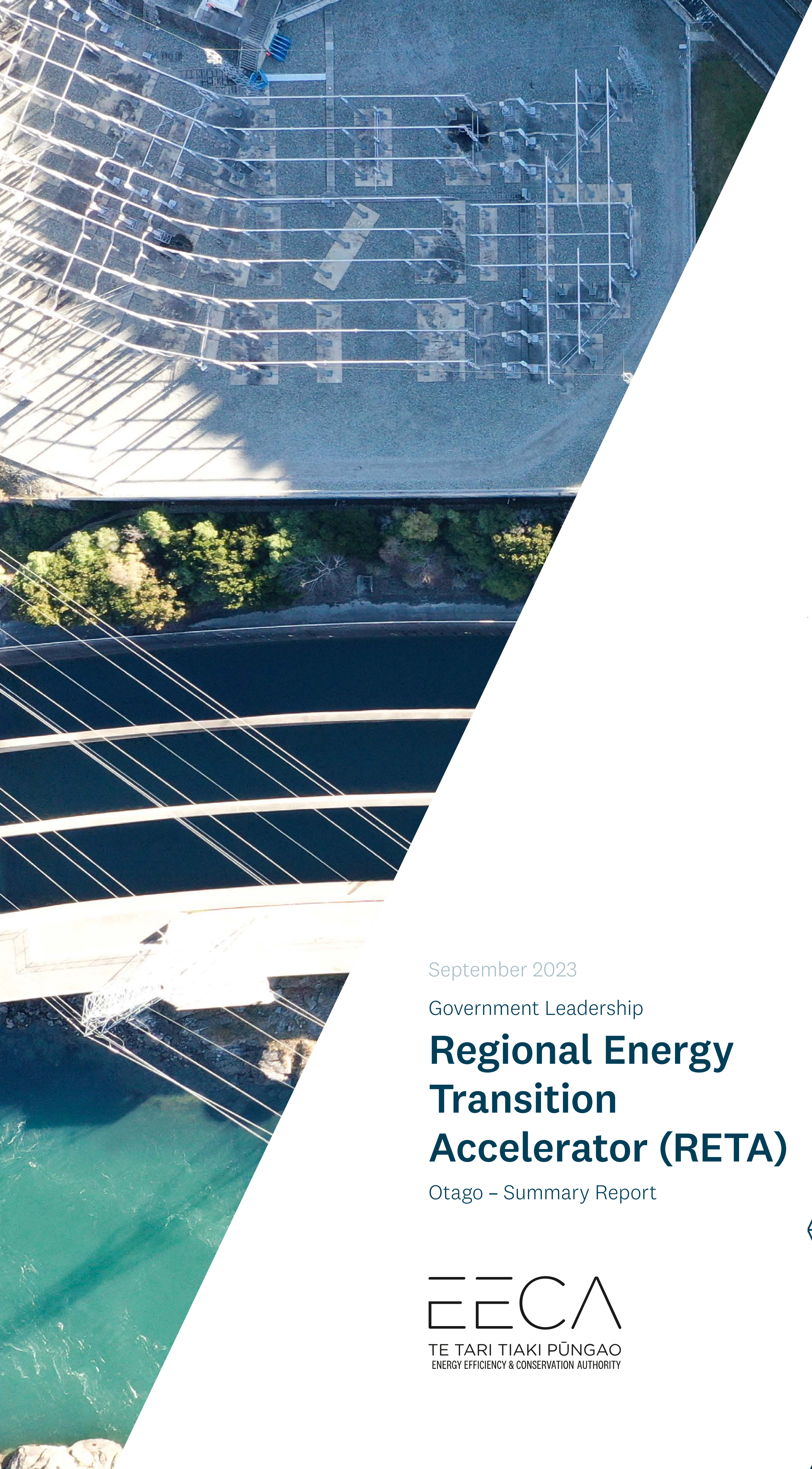
Recommendations to improve the use of electricity for decarbonisation:

- **EDBs should proactively engage with process heat users to understand their intentions, and help process heat users obtain a greater understanding of required network upgrades, cost, security levels, possibilities for acceleration, use of system charges and network loss factors.**
- **EDBs should develop and publish clear processes for how they will handle connection requests in a timely fashion, opportunities for electrified process heat users to contract for lower security, and how costs will be calculated and charged, especially where upgrades may be accommodating multiple new parties (who may be connecting at different times).**
- **EDBs and process heat users should engage early to allow the EDB to develop options for how the process heat user's new demand can be accommodated, what the capital contributions and associated lines charges are for the process heat user, and any role for flexibility in the process heat user's demand. This allows both EDBs and process heat user to find the overall best investment option.**

- **To support this early engagement, EDBs to explore, in consultation with process heat users and EECA, the development of a 'connection feasibility information template' as an early step in the connection process. This template would include a section for process heat users to provide key information to EDBs, and a network section where EDBs provide high-level options for the connection of the process heat user's new demand. Information provided by EDBs would include the potential implications of each option for construction lead times, capital contributions, network tariffs and the use of the customer's flexibility.**
- **Retailers, EDBs and the Electricity Authority should assist by sharing information that helps process heat consumers model the benefits of providing flexibility.**
- **EDBs and retailers should ensure that the tariffs they offer process heat users are incentivising the right behaviour.**

Recommendations to assist process heat users with their decarbonisation decisions:

- **Ministries (such as Ministry for the Environment) to work with reputable organisations to develop scenario-based carbon price forecasts that decarbonising organisations can incorporate into their business cases.**
- **Process heat users should enquire about government co-funding where the economics of decarbonisation are challenging; where they are economic, EECA encourages organisations to explore the potential for self-funded acceleration.**



September 2023

Government Leadership

Regional Energy Transition Accelerator (RETA)

Otago – Summary Report

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