EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

mafic

Accelerating the decarbonisation of Process Heat

August 2021

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Executive summary

Process heat is the energy used as heat in industrial and manufacturing processes as well as the residential, commercial, and public sectors. Currently, a significant portion of New Zealand's overall energy use is for process heat which is predominantly supplied through burning fossil fuels.

Around **one third** of New Zealand's overall energy use is for process heat

60% of process heat is currently powered by fossil fuels

Previous work conducted by Energy Efficiency and Conservation Authority (EECA), the Climate Change Commission, Transpower, MBIE and others have identified process heat as one of the largest opportunities to decarbonise the New Zealand economy.

The New Zealand Government's bold climate change commitments and carbon emissions reduction targets

- **30%** carbon reduction target by **2030**
- **100%** of coal boilers phased out of the economy by **2037**
- **Net zero** carbon economy by **2050**

Process heat contributes to 8.3million tonnes of carbon dioxide equivalent emitted per year.[1] Achieving the Government's carbon reduction targets will require a significant acceleration of both energy efficiency and fuel switching projects and potentially billions of dollars of capital investment to transition to a low-carbon economy. The Climate Change Commission's demonstration pathway assumes that the transition away from coal and fossil gases begins immediately at scale and that by 2040 the use of coal is largely phased out and the same for fossil gases by 2050.[2]

Given the scale of New Zealand's fuel switching challenge, Mafic Partners was engaged by EECA to undertake a market sounding with large energy users, with the objective of exploring the following key questions with representative market participants:

1. Identify the key barriers to low carbon fuel switching
2. Seek feedback on potential solutions to address barriers to fuel switching
3. Seek feedback on what support from EECA or the Government will have the greatest impact in accelerating fuel switching

The market participants engaged included the following large industrial process heat users, ecosystem players such as network operators, fuel suppliers, consultants and long-term capital providers:

[1] Ministry of Business, Innovation and Employment and Energy Efficiency and Conservation Authority, *'Process heat – Overview Fact Sheet'*, *[mbie.govt.nz/assets/8c89799b73/process-heat-current-state-fact-sheet.pdf]*

[2] He Pou a Rangi the Climate Change Commission, '*Ināia tonu nei: a low emissions future for Aotearoa'*, May 2021

Identify the key barriers to low carbon fuel switching

The market sounding provided an opportunity for large energy users to share their views on the key barriers their businesses face when considering fuel switching projects. Although there was general alignment on the key issues within each of the six categories of barriers identified, the impact and importance of individual barriers varied between each user. Key feedback themes are summarised below:

Access to capital	• *Due to their size, these participants have access to cost-effective capital, however internal competition for capital allocation drives high return hurdles, which fuel switching projects often fail to meet* • *Scale of capital required to fuel switch is significant and may be greater than users' available capital, especially with multiple competing capital demands*
Electricity supply challenges	• *Users seeking to electrify often face uneconomic upgrade costs to secure a suitably sized connection to the electricity grid* • *Electrification of high temperature process heat is not economic at current delivered electricity costs* • *Volatility and inconsistency in wholesale electricity pricing and uncertainty around future distribution costs reduce confidence in investing in electrification*
Biomass supply challenges	• *While long-term biomass supply contracts are available, lack of confidence in long-term availability of supply is making some parties hesitant to commit to long-term supply contracts* • *Constrained supply of low-cost inputs for biomass fuel (process residue by-products from wood processing) will limit the availability of low-cost biomass* • *The varying regional availability of biomass significantly impacts the delivered cost of biomass fuel across the country*
Lack of industry wide collaboration	• *EECA plays an important role in sharing learnings amongst industry and providing detailed case studies on successful fuel switching projects* • *Scale of the fuel switching challenge means ecosystem coordination may be required to avoid acute shortages of capability or equipment when carbon pricing and regulatory restrictions kick in*
Low carbon process heat alternatives viewed as uneconomic	• *Low carbon fuels are on average more expensive than existing fossil fuel solutions* • *Economics of different fuels can vary materially across regions, use cases and specific sites* • *Users face significant uncertainty regarding future fuel and carbon prices* • *Users have made large investments in existing fossil fuel solutions which are not at end-of-life yet*
Technical challenges	• *The scale of fuel switching required to meet the Government's decarbonisation targets will be difficult to deliver with current market capacity and access to expertise* • *Retrofitting low carbon solutions to existing plant and processes can be technically complex and can increase the cost of fuel switching*

The feedback above reflects the views provided by large energy users and the ecosystem participants we sounded and will not necessarily be representative of small and medium-sized enterprises (SMEs). Further detail on market responses to key barriers to fuel switching is provided in Section 2.

Seek feedback on potential solutions to address barriers to fuel switching

Market sounding participants were also given the opportunity to provide feedback on a range of potential solutions which had been identified by Mafic Partners and EECA to address some of the key barriers to fuel switching. Key feedback themes are summarised below:

Capital grants and Government loans	• *Support for the continuation of capital grant programmes with priority on projects:*
	  – *with the lowest cost of abatement*
	  – *that can be used as case studies to support innovative forms of fuel switching*
	• *Support for the recycling of ETS revenue to extend grant funding available to bridge funding gaps*
	• *Government loans would need to be highly concessionary e.g. be interest free or provide access to long-term fixed rates to be attractive to large users*

Tax support	• *Tax changes for process heat equipment could be used to offset higher fuel supply costs or to recover some of the value of impaired fossil fuel assets if replaced early* • *Incentivise fuel switching early ahead of day one economic operating costs and accelerate point at which low carbon fuels become cost neutral against fossil fuels*
Centralised source of expertise	• *EECA currently acts as a neutral and trusted facilitator of decarbonisation activities through its business programmes. It is important to continue this role in showcasing case studies and industry best practise* • *EECA can expand its role to educate the market on the risks and benefits of long-term contracting via Power Purchase Agreements and commercial finance structures*
Regulatory	*Respondents were generally supportive of Government intervention to provide:* • *additional certainty on the future cost of carbon* • *regulatory intervention into the electricity distribution and transmission market* • *transitional support (planning and consenting of water, air, waste) as a result of fuel switching* • *support for natural gas as a transition fuel to avoid lumping fixed network costs on stranded gas users and to enable users to prioritise transition from coal* • *support to minimise existing regulatory burdens to enable users to fuel switch*
Energy efficiency	• *Participants acknowledged the importance of energy efficiency improvements as an essential precursor to fuel switching activities*
Credit support	• *Credit support from the Government could help smaller users access cost effective financing, large users already have strong credit profiles* • *The offer of long-term credit support from the Government could benefit businesses who are uncertain of their long-term role in the NZ economy and would provide businesses the confidence to invest further in their own operations*
Commercial financing	• *Large users find it easy to access standard commercial financing products, but most have constraints on the amount they can borrow from these sources* • *Existing alternative commercial structures are viewed as too complex, uneconomic and users have concerns around loss of operational control to third parties* • *For alternative structures to be widely adopted, they will need to become more attractive, and the benefits of these structures will need to be clearly communicated*
Fuel supply intermediary and investment	• *Views on the necessity of Government intervention in fuel markets were mixed, participants had divergent views on whether the market is acting efficiently* • *The Government has an important market leadership role to play through its procurement of both electricity and solid fuels* • *The market supports more onshore wood processing to create increased availability of low-cost residue for biomass fuels*

The feedback above reflects the views provided by large energy users and the ecosystem participants we sounded and will not necessarily be representative of SMEs. Further detail on feedback on potential solutions to address barriers to fuel switching is in Section 3.

Feedback from capital providers

Alongside, process heat users and ecosystem players, we also engaged with Accident Compensation Corporation (ACC) and New Zealand Superannuation Fund (NZSF) as two large scale local capital providers. Both parties expressed a strong interest in providing long-term capital to accelerate fuel switching, however there are currently a lack of direct investment opportunities.

For commercial financing structures to appeal to both investors and users, the following must be taken into consideration.

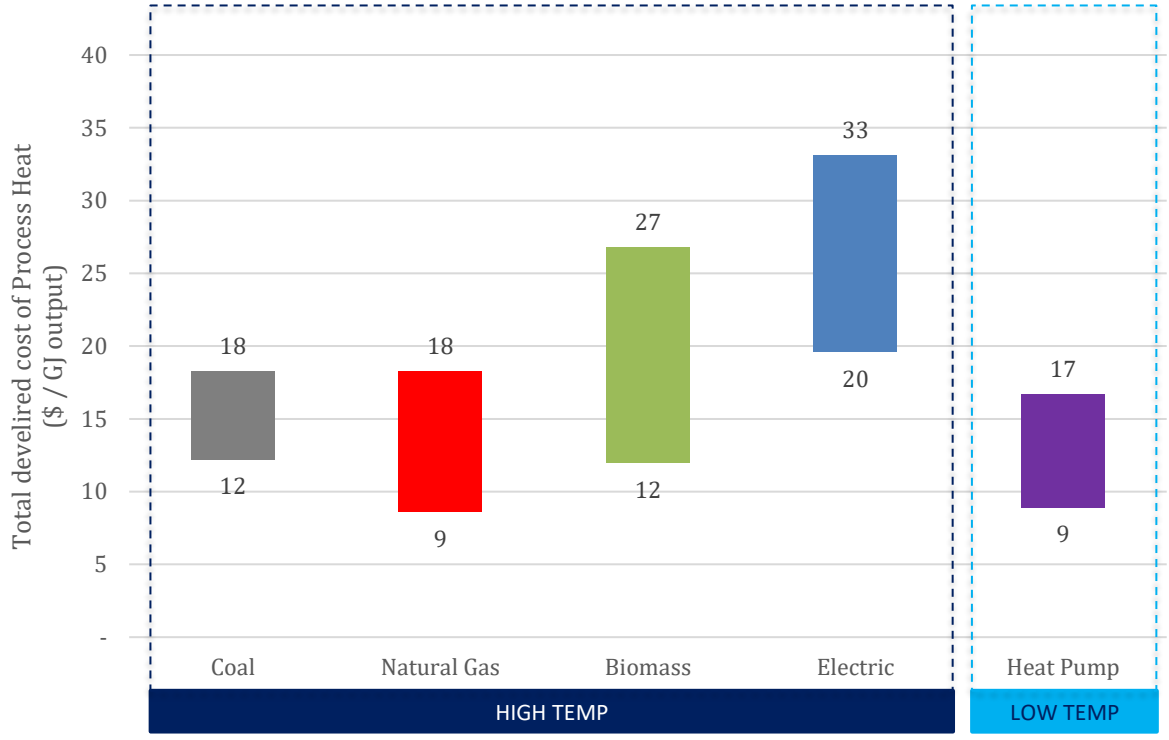
Relative economics of different fuel types

We have undertaken high level analysis to provide indicative economics ranges that compare the total cost of the use of different fuels for industrial process heat applications for a given set of assumptions.

Economics can vary significantly depending on a range of site-specific factors and varying use cases. Given this variability across fuel switching projects, projects can loosely be categorised into one of three categories:

- Projects that are currently economic and will switch or have non-economic barriers preventing the project from being implemented
- Projects that will become economic in the short to medium term. The economic tipping point for these projects may be able to be accelerated with appropriate support
- Projects that are unlikely to be economic for an extended period even with significant levels of support

Given the variability in project-by-project economics highlighted above, the purpose of the economic analysis in this report is not to provide a definitive view of the economics of fuel switching across all sites, use cases and fuel types. It is instead intended to illustrate relativities between different fuel types for a specific set of assumptions to support the design of programmes to accelerate the economic tipping point for low carbon fuels.



Large scale, high temperature process heat applications contribute the bulk of emissions in the process heat sector and is the sector where switching is the most economically challenged. We have focused the bulk of our analysis on this sector.

For lower temperature industrial process heat applications, highly efficient electric heat pumps already present a compelling economic alternative to fossil fuel solutions.

As outlined above, the variability of project-by-project economics means that while there are currently a range of projects where fuel switching makes economic sense, voluntary wholesale fuel switching may not be triggered until the economics of low carbon fuels improves further. Our illustrative analysis

focuses on the factors that may support wholesale fuel switching by achieving a greater overlap between the potential economic outcomes for low carbon and fossil fuels.

One of the factors that will improve the economics of low carbon fuels over time are increases in carbon pricing. We have used our illustrative economic ranges and the Climate Change Commission's forecast for emission values to produce a series of estimates of when the economics of each low carbon fuel may reach a level which supports wholesale voluntary fuel switching.

The following table outlines point at which biomass or electricity may reach wholesale cost parity with coal for investments that are at end-of-life or mid-life of existing assets.

	Replacement of end-of life assets with new renewable assets	*Conversion of existing, mid-life assets to new renewable assets*
Biomass	**2026**	**2037**
Electricity	**2040**	**2049**

While the above dates are illustrative only, the timing of the above economic trigger points for wholesale fuel switching highlights that there is risk to achieving the Government's decarbonisation objectives if left solely to the impact of carbon pricing. To meet the Climate Change Commission's demonstration pathway requires New Zealand to start phasing out ~1.7PJ per annum of coal immediately, with the use of coal completely phased out by 2040[3]. The equivalent carbon price trigger points for natural gas are later due to its lower carbon intensity, which will present challenges to achieving the Climate Change Commission's targets for displacement of natural gas which commence immediately but ramp up from 2030 with natural gas completed phased out by 2050[4].

As outlined above, there are many site-specific factors and use cases which will alter the range of assumptions that underpin our illustrative analysis. As a result, the economic tipping point for individual projects will vary significantly from the above timeframes. There are also a range of other factors which will impact the cost of heat beyond carbon pricing that may either accelerate or delay the economic tipping point for low carbon fuels.

There are also a range of factors that may have a direct impact on the economic rationale for fuel switching that do not directly impact cost of heat. These factors may impact revenues, funding cost or other non-heat costs and as a result accelerate tipping point for low carbon fuels.

We have explored these factors and outlined in further detail the assumptions underpinning our illustrative analysis in Section 5 of this report.

[3] Apart from residual uses in hard to abate industries like metals, cement and lime.

Why Government intervention is required in the process heat industry

If New Zealand relies primarily on carbon pricing to incentivise fuel switching, there is risk that decarbonisation targets are not met and that the fuel transition occurs in a way which potentially increases the overall cost of transition.

The market sounding has revealed that even when economic incentives align to support fuel switching, there are significant capacity constraints across the fuel supply chain (depth and liquidity) both locally and internationally, which may result in process heat users paying more for heat for an extended period. This limited market capacity also makes the imposition of regulatory deadlines to transition away from fossil fuels challenging unless it is lined with support that ensures users and the market can efficiently transition.

Any additional cost of heat from an inefficient fuel transition will ultimately be borne by all New Zealanders through reduced export revenues and increased cost of domestic goods and services. This cost will also manifest if New Zealand is required to buy offshore carbon credits to meet its Paris carbon reduction obligations, further eroding New Zealand's international competitiveness.

Targeted Government intervention could be used to minimise the cost of the fuel transition and ensure that New Zealand retains its international leadership in supporting the mitigation of the impacts of climate change.

The Government is also one of the best placed parties to address a range of regulatory, supply chain development, and informational barriers identified in the market sounding.

3 Seek feedback on what support from EECA or the Government will have the greatest impact in accelerating fuel switching

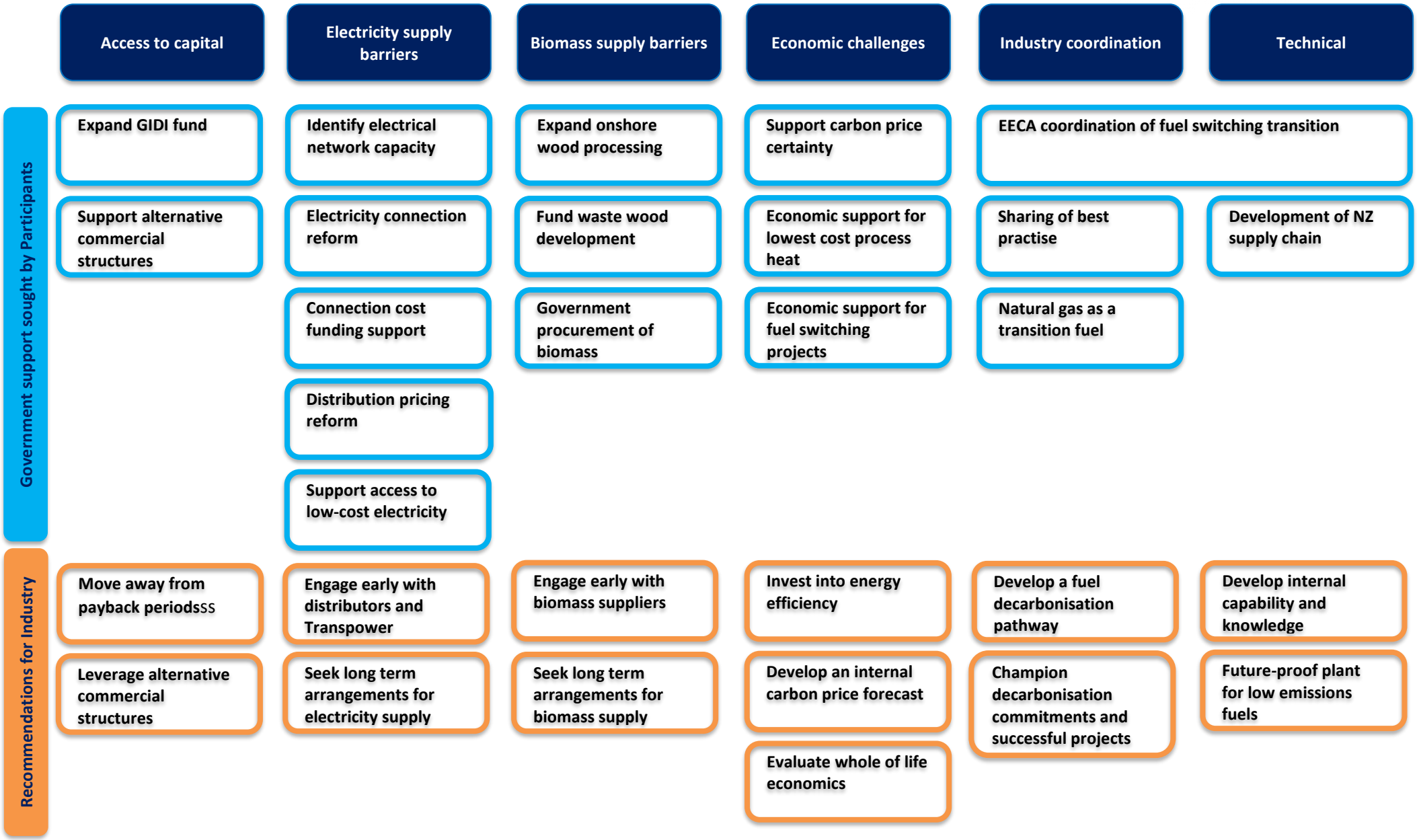
The third objective of the market sounding was to seek participant views on where Government support would be most impactful in accelerating fuel switching. Each participant highlighted two or three key areas where Government support would be most impactful for their business. These areas are summarised for each participant in section 3.3.

We have also provided a summary of the areas of Government support which had broad support across participants in section 7 of this report, the following page provides an overview of the topics covered in this section.

Recommendations for industry

The market sounding highlighted the variability in the way process heat users approach fuel switching projects. The success of the fuel transition will require industry to share learnings and adopt best practise, in conjunction with Government support, to meaningfully accelerate the transition to low carbon fuels.

We have set out in section 8 several areas where there may be opportunities for individual process heat users to adopt best practise, already adopted by other users, to support their fuel switching projects, the following page provides an overview of the topics covered in this section.


Access to capital
Electricity supply barriers
Biomass supply barriers
Economic challenges
Industry coordination
Technical
Government support sought by Participants
Expand GIDI fund
Identify electrical network capacity
Expand onshore wood processing
Support carbon price certainty
EECA coordination of fuel switching transition
Support alternative commercial structures
Electricity connection reform
Fund waste wood development
Economic support for lowest cost process heat
Sharing of best practise
Development of NZ supply chain
Connection cost funding support
Government procurement of biomass
Economic support for fuel switching projects
Natural gas as a transition fuel
Distribution pricing reform
Support access to low-cost electricity
Recommendations for Industry
Move away from payback periodsss
Engage early with distributors and Transpower
Engage early with biomass suppliers
Invest into energy efficiency
Develop a fuel decarbonisation pathway
Develop internal capability and knowledge
Leverage alternative commercial structures
Seek long term arrangements for electricity supply
Seek long term arrangements for biomass supply
Develop an internal carbon price forecast
Champion decarbonisation commitments and successful projects
Future-proof plant for low emissions fuels
Evaluate whole of life economics

Recommendations for Government

To meaningfully accelerate the transition to low carbon fuels will require a coordinated effort from process heat users and the Government.

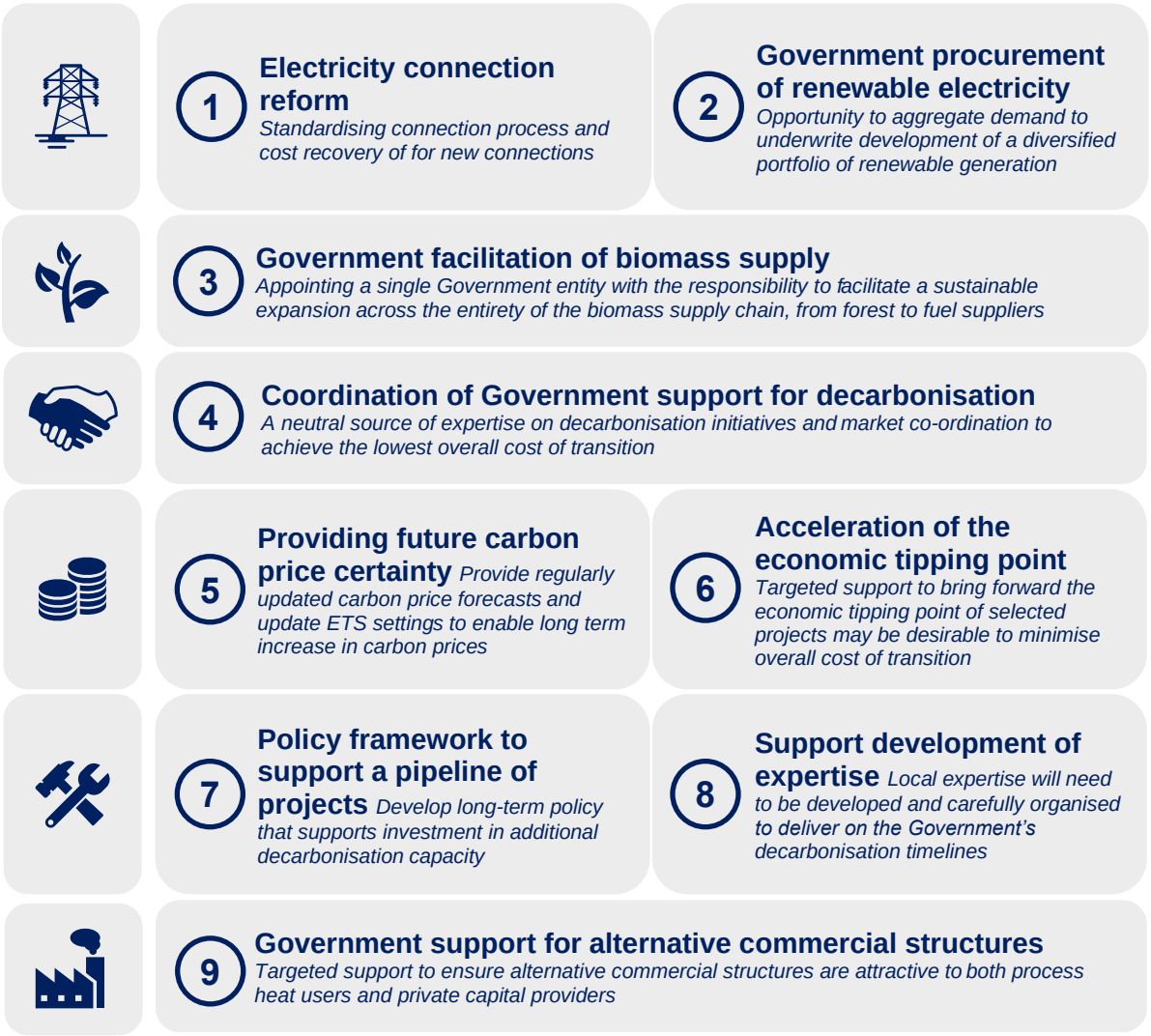
We have developed a series of targeted recommendations which outline potential ways in which the Government could support acceleration fuel switching activities. These recommendations take key learnings from the market sounding process and focus on areas where Government support could:

- Make a meaningful impact on fuel switching activities
- Maximise the use of limited Government resources and funds
- Focus on areas where the Government is the only party able to effect change
- Minimise any ongoing risk taken by the Government
- Leverage contributions both from the process heat user and the wider private sector

We have also focused on recommendations that align with those of the Climate Change Commission, with a particular focus on ways to support mobilisation of finance for low emission investments.

There are several other learnings and actions from the market sounding process that are already being implemented by EECA or do not require broader consultation prior to implementation that are not covered in this section.

Further detail on each recommendation is outlined in section 9.



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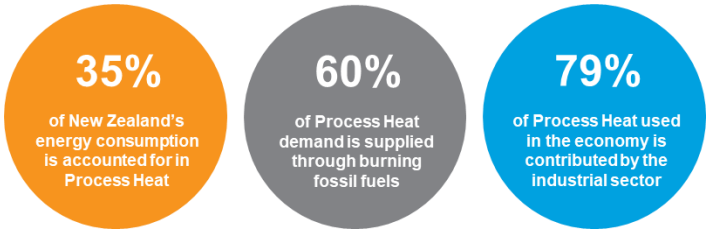
1 Introduction

1.1 Process Heat in New Zealand

Process heat is the energy used as heat in industrial and manufacturing processes and heat in the residential, commercial and public sectors, often in the form of steam or hot water. Currently, coal and natural gas are significant sources of fuel for process heat in New Zealand.



Process heat contributes 8.3million tonnes of carbon dioxide (CO_2) equivalent emissions per annum and represents 9% of New Zealand's gross emissions.[4]

The New Zealand Government have set bold climate change commitments and carbon emissions reduction targets that will see:

- A carbon neutral public sector by 2025
- A 30% reduction of emissions by 2030
- Coal boilers phased out of the economy by 2037 and a net zero carbon economy by 2050

1.1.1 Industrial process heat in the Climate Change Commission's advice

Work carried out by the Climate Change Commission (CCC) has shown that meeting the Government's targets is achievable but will require rapid acceleration of decarbonisation activities across the economy. The CCC has identified process heat as one of the largest opportunities to decarbonise the New Zealand economy.

While some manufacturers have set emissions reduction goals, committed to no new coal-fired boilers, and invested in technologies to reduce energy use while improving productivity, there is an imbalance of effort across different sectors in the economy. For example, there is currently more effort from users of low- to medium-temperature heat relative to high temperature users.

New Zealanders, across industry and multiple sectors (including hard-to-abate sectors), need to take decisive action to rapidly accelerate the uptake and ongoing use of low emissions technologies and undergo a behavioural change when making investment decisions about prioritising fuel switching.

The Climate Change Commission's Demonstration Pathway assumes significant fuel switching activity along the pathway to net zero, including phasing out the bulk of coal and natural gas usage by 2050. We have summarised the Commission's Demonstration Pathway for coal and fossil gas below.

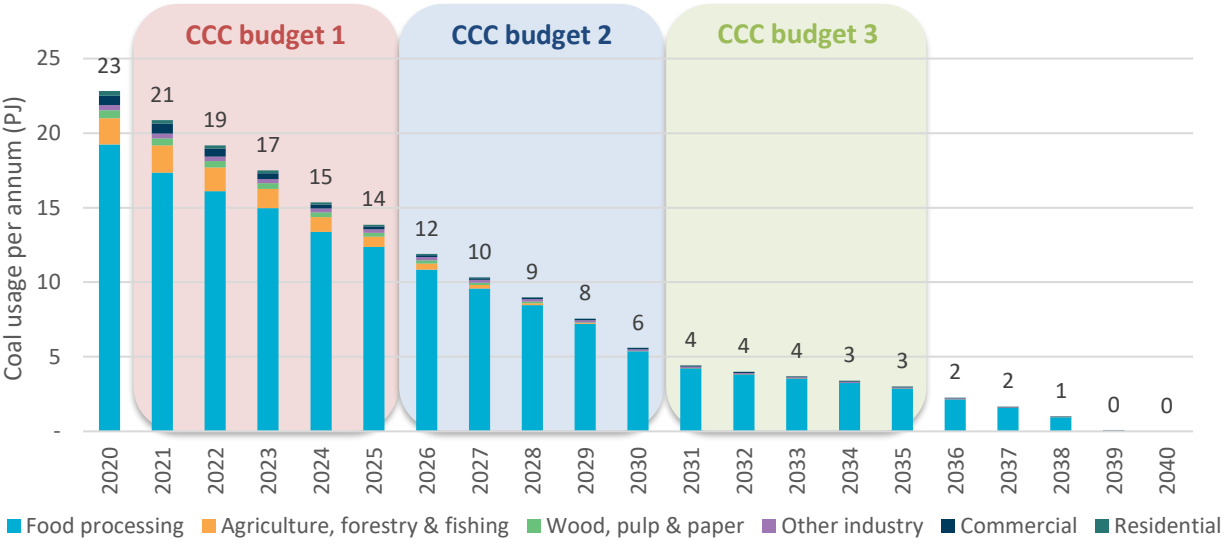
It is important to note that the carbon emissions budgets that underpin the Climate Change Commission's Demonstration Pathway are just one proposed way of meeting New Zealand's climate change commitments. The Government will be deciding whether to adopt the Climate Change Commission's carbon budgets by the end of 2021.

[4] Ministry of Business, Innovation and Employment and Energy Efficiency and Conservation Authority, *'Process heat – Overview Fact Sheet'*, *[mbie.govt.nz/assets/8c89799b73/process-heat-current-state-fact-sheet.pdf]*

Coal

The Demonstration Pathway sees the replacement of the use of coal for heat with biomass and electricity commencing immediately with an average of 1.7PJ of coal displaced each year through to 2030 (emissions budgets 1 and 2). At the end of 2030 75% of coal usage outside of the hard to abate metal and cement sectors has been displaced. The remaining 25% of coal usage continues to be progressively displaced through to 2040 when 100% of coal usage outside of hard to abate sectors has been eliminated.

Figure 1 Climate Change Commission Demonstration Pathway – Annual coal usage excluding hard-to-abate sectors and electricity generation

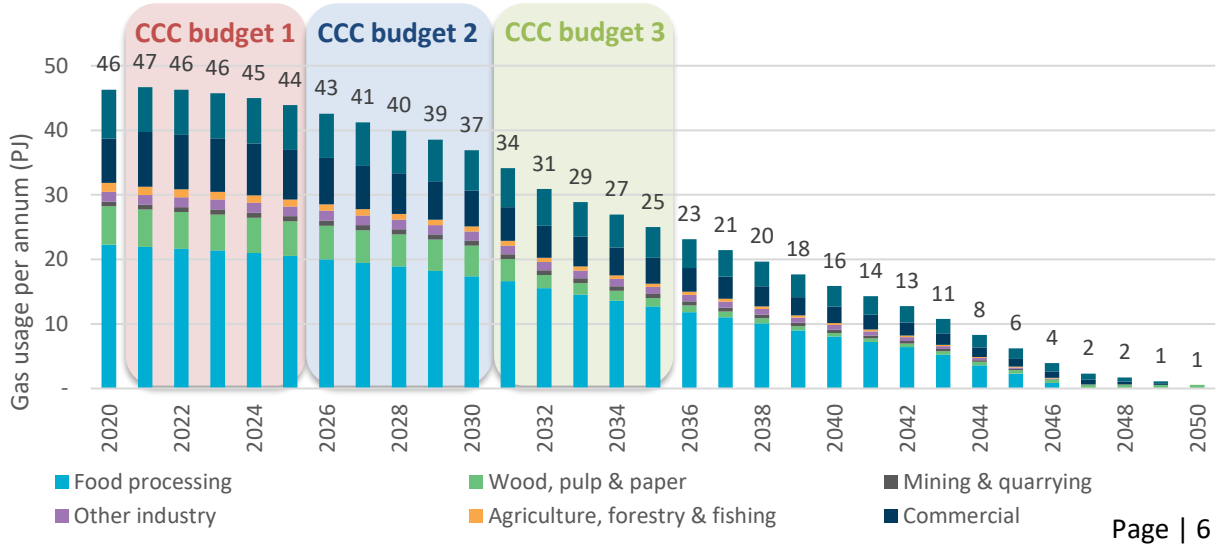


Every PJ of coal consumed emits ~90kt CO_2e. Fully replacing the 23PJ of coal currently used for heat with low emission alternatives would deliver carbon emission savings of up to ~2,050kt CO_2e per year.

Fossil Gas

The Demonstration Pathway sees the replacement of vast majority of fossil gas usage as a source of heat by 2050. While the budget assumes immediate reduction in usage of fossil gas, widescale replacement of fossil gas with biomass and electricity begins from 2030 with an average of 2.4PJ of gas demand replaced per year through to 2035. Gas displacement continues to happen at a rapid pace all the way through to 2046.

Figure 2 Climate Change Commission's Demonstration Pathway - Annual gas usage excluding chemical and hard-to-abate sectors and electricity generation



Every PJ of fossil gas consumed emits ~53kt CO_2e. Fully replacing the 47PJ of fossil gas currently used for heat with low emission alternatives would deliver carbon emission savings of up to ~2,500kt CO_2e per year.

Climate Change Commission's recommendations

To achieve these pathways, The Climate Change Commission have made the following recommendations in relation to reducing emissions from industrial process heat: [5]

1 ***Ensuring no new coal boilers are installed and setting a timetable for the phase out of fossil fuels used in boilers***

- Meeting emissions budgets and targets require a reduction of coal boilers of around 1.7PJ (~1.4PJ from food processing) per year to 2030, roughly equivalent to energy used by 1 - 2 very large dairy processing factories per year. This will require conversion away from coal to begin immediately
- Rate at which emissions can be reduced will be limited by engineering, financial and time constraints
- Additional factors include the need to establish or expand low-emissions fuel supply chains
- Consideration given to phasing out other fossil fuels in existing sites through regulatory processes and best practice requirements

2 ***Develop the policy approach in collaboration with industrial and manufacturing stakeholders***

- Further Government measures through well-targeted, contestable funding, such as the Government Investing in Decarbonisation of Industry Fund (GIDI)
- Measures placed to ensure workers have the skills to undertake energy audits, feasibility, and engineering studies, identify and deliver site-specific carbon reduction projects at a pace and scale that supports the CCC's emissions budgets
- Government leadership and cross-sector collaboration to support the development of robust low-emissions fuel supply chains, as part of the national energy strategy
- Policy that reduces barriers related to access to capital, behaviour change and infrastructure access (relates also to CCC Recommendation 4)

3 ***Supporting innovation for decarbonising hard-to-abate industrial sectors***

- Supporting a long-term strategy for hard-to-abate industries, often single company industries such as steel or cement where processes create emissions through burning fossil fuels through chemical reactions, is critical for unlocking future emissions reduction opportunities
- Strategy could include modernising exiting plants with new industrial processes and technologies, retrofitting to make use of alternative fuels and reactants, or importing products from low-emissions manufacturer overseas. Each option has associated risk

[5] He Pou a Rangi the Climate Change Commission, *'Ināia tonu nei: a low emissions future for Aotearoa',* Part 2, Chapter 15, Section 15.2 Industry, pg. 288 - 291

4	*Accelerating industry switching to low-emissions fuels for process heat and uptake of energy efficiency measures*

- Successful decarbonisation of New Zealand's process heat sources will require a combination of:
  - Reducing emissions from low and medium temperature process heat, generated mainly from boilers used primarily in food processing and wood, pulp and paper production by fuel switching to cleaner energy sources, like electricity and biomass
  - Improving energy efficiency and optimising processes and equipment. CCC's Demonstration Pathway assumes significant improvements in energy efficiency, averaging 1.1% per year. This will also improve the economics of switching to low emissions
- A high New Zealand Emissions Trading Scheme (NZETS) price signal is central to deliver acceleration

1.1.2 General policy direction in Climate Change Commission's advice

The Climate Change Commission also made a range of recommendations that applied across all decarbonisation activities, many of which also apply to process heat.

The three areas of intervention identified in the CCC's policy framework include:

- Action to address barriers
- Pricing to influence investments and choices
- Investment to spur innovation and system transformation

The CCC have provided six recommendations on policy direction (CCC recommendations 11 – 16) that will help to drive change across all sectors and are critical for enabling change at a systems level.

11 *Strengthen market incentives to drive low emissions choices*	**12** *Make investments net-zero compatible*	**13** *Enable system level change through innovation, finance and behaviour change*
14 *Increase the circularity of the economy*	**15** *Develop a thriving, climate-resilient bioeconomy that delivers emissions reductions*	**16** *Enable emissions reductions through changes to urban form, function and development*

Whilst all six recommendations will have a role in the economy, policy recommendations 11, 12 and 13 play a direct role in driving the acceleration of decarbonisation of process heat. More specific advice for the Government relating to recommendations 11, 12 and 13 include:

1. **Amending and continually improving the NZ ETS** to ensure it incentivises reductions in gross emissions
2. **Ensuring every major decision the Government makes is consistent with climate goals.** Climate change goals should be factored into all government policy and investment decisions, including decisions by local governments, Crown agencies, Crown entities and Crown-owned companies
3. **Driving low-emissions innovation.** Developing a range of options for reducing emissions in the future by supporting and encouraging research, development and innovation for low-emissions solutions

4. **Mobilising public and private finance.** Making sure public investments support low emissions outcomes will be important. The Government also needs to help redirect private capital away from emissions intensive activities and towards low emissions investments
5. **Simplifying lower emissions choices for users.** The Government needs make it easier for people to make choices that are better for the climate. It should establish a lead agency and a dedicated fund to support behaviour change

1.1.3 The fuel switching challenge

The fuel switching challenge is one of significant scale. Whilst there are proven options for decarbonising low and medium temperature process heat and there have been several large-scale fuel switching projects that have been successfully delivered (highlighted below), wide scale transition to low carbon fuels is yet to be seen.

01 **Fonterra**
Te Awamutu
43MW | 2020
Transition from coal to biomass

02 **Open Dairy Country**
Awarua
13MW | 2020
Electrode boiler installed

03 **Synlait**
Dunsandel
6MW | 2019
Electrode boiler installed

Part of the objective of this report is to understand why more projects like those listed above are not occurring and what EECA and the Government could do to increase the uptake of fuel switching.

In terms of the scale of the decarbonisation challenge in the process heat industry, a full inventory of fossil fuel based process heat does not exist but work done to identify large users indicates that 1.02 million tonnes of coal is supplied annually to 53 large scale coal boilers across New Zealand representing 954MW capacity with an additional 915MW of natural gas capacity across the North Island.[6] This is a significant portfolio to decarbonise and EECA estimates that decarbonisation of process heat could require billions of dollars of investment across the entire economy.

Decarbonisation of process heat will not only require investment at scale in new equipment, infrastructure, and local supply chains but also an investment in developing the pool of available expertise across large process heat users, supporting consultancies and in the public sector. The scale of the fuel switching challenge is expected to be significantly greater than the resources currently available. Based on current capacity in the market, transitioning just the large users identified above could take from 25 to 50 years.[7]

The Energy Efficiency and Conservation Authority (EECA) has a successful track record in assisting large energy users to decarbonise through a range of programmes including:

- EECA's Energy Transition Accelerator (ETA) programme that co-funds initial opportunity assessments for process heat users to develop a strategic roadmap to reduce energy-related emissions
- The $69 million GIDI contestable fund has already committed to delivering 3.8 million tonnes of carbon abatement for a $27.9 million investment

[6] Ministry for the Environment, *'Marginal abatement cost curves analysis for New Zealand: Potential greenhouse gas mitigation options and their costs – MACCs tool spreadsheet'*, Jan 2020

[7] Assumes a current market capacity to transition 2 - 4 large boilers manufactured per annum based on domestic and international capacity constraints

- EECA's direct engagement business advisory programme for New Zealand's largest energy users to accelerate energy efficiency and decarbonisation projects
- EECA's technology demonstration fund for early adoption of proven technology yet to be wide deployed in New Zealand

The work undertaken in preparing this report is to identify any other tools and initiatives that EECA could add to its portfolio to assist in accelerating the switch to low carbon fuels.

1.2 Scope of this report

Mafic Partners was engaged by EECA to facilitate a market sounding process with objectives outlined in Section 1.3 below.

The purpose of this report is to summarise feedback received from participant in the market sounding, particularly their views on the barriers to process heat fuel switching and potential Government support that could help accelerate the decarbonisation of process heat.

The statements in this report reflect the views of participants in the sounding process who were either large process heat users or ecosystem players and may not be representative of the broader cross section of process heat users, ecosystem players or small and medium sized enterprises.

The additional analysis in this report was undertaken to support the development of the recommendations to accelerate process heat fuel switching in section 9. The analysis in this report should not be used to support individual user's investment decisions.

1.3 Objectives of the market sounding

As outlined above EECA were interested in developing a deeper understanding of the barriers to process heat fuel switching as well as exploring additional and alternative ways to support industry in accelerating the transition away from the use of fossil fuels for process heat in New Zealand. The first step in preparing this report was a market sounding process undertaken jointly by Mafic Partners and EECA. The market sounding engaged with a range of participants who play a key role in the large process heat industry. This included:

- Large industrial process heat users across a range of different industries, fuel mixes and regional locations
- Ecosystem players including electricity network operators, electricity suppliers, biomass fuel suppliers and industry consultants
- Large scale capital providers with appetite to provide long term, low-cost capital to support decarbonisation

A cross section of participants were selected to get a representative sample of large process heat users across the wider industry. Representatives spoken to from each participating organisation include those in leadership, sustainability, strategic and managerial roles.

It is important to note that this market sounding was not conducted with SMEs and that the objectives were tailored to, and findings are representative of large process heat users only.

A list of participants, along with key personnel engaged in the process is in **Appendix A**.
The key objectives of the market sounding exercise were to:

- **Validate key market barriers** identified by work done by Ministry of Business, Innovation and Employment (MBIE), Transpower and others which are currently restricting process heat users from transitioning from fossil fuels to renewable fuels with a particular focus on identifying:
  - Any recurring issues across all participants
  - What were the underlying drivers of these barriers
  - How the importance of these barriers varies across industry sector, use case and location
- **Understand the participant's view** on a **range of potential solutions** which could be used to address these barriers
- Seek feedback on how **EECA or the Government** could **best support** the implementation of solutions to the key barriers

A market sounding presentation was developed jointly between Mafic Partners and EECA which was provided to each participant ahead of the meeting. A copy of this presentation can be found in **Appendix B**. Each meeting was attended by both EECA and Mafic representatives and focused on six key questions which were identified in the presentation materials:

Market sounding questions

What are the key barriers to fuel switching facing your business and their relative importance?	**What are the key learnings from existing fuel switching projects undertaken by your business that might assist the rest of the market in fuel switching?**
Views on the range of potential solutions canvassed in this presentation and their effectiveness in addressing key barriers for your business?	**Views on Heating as a Service structures and their effectiveness in addressing key barrier for your business?**
Appetite for involvement in any of the potential solutions and what role you might play?	**Where support from EECA and / or the Government would be most impactful in assisting your business in switching to renewable fuels?**

2 Key barriers to fossil fuel switching

2.1 Introduction to key barriers

A significant amount of work has been done by EECA, MBIE, Transpower, the Climate Change Commission and others to identify market barriers which are currently restricting process heat users from transitioning from fossil fuels to renewable fuels. Prior to the development of the market sounding, Mafic Partners undertook a literature review of work previously undertaken by the market including:

- MBIE's and EECA's technical paper, '*Process Heat in New Zealand: Opportunities and barriers to lowering emissions*' (2019)
- Transpower's '*A Roadmap for Electrification*' (2021)
- Climate Change Commission's draft advice (2021)

Following the review, six key categories of fuel switching barriers were identified:

Access to capital

- Few companies have access to ring fenced capex allocations for sustainability projects
- Fuel switching projects are longer term investments and often don't meet target return or payback period thresholds

Electricity supply challenges

- Network constraints and first mover disadvantages
- Supply disruptions and complexity of storage
- Securing access to long term, low-cost electricity supply including transmission costs

Biomass supply challenges

- Regional availability of biomass fuel
- Limited providers who can provide long term fixed price supply contracts for biomass
- Risk of future competition for biomass impacting prices and availability

Lack of industry wide coordination

- Suitability of low carbon alternatives to different use cases not well understood across the market
- Significant work and cost for individual users to establish best practice process heat solutions for their business

Low carbon process heat alternatives are viewed as uneconomic

- Coal and gas are currently (but becoming less so) a cheap fuel source, switching to low carbon alternatives can negatively impact operating costs
- Particularly challenging for assets which are not end of life

Technical challenges

- There are a range of site-specific factors that can add complexity to fuel switching projects
- Flow on impacts of upgrade on wider site operations e.g. larger footprint requirements for biomass boilers vs coal or flow on upgrades of ancillary infrastructure like pipework & cabling

These categories provided a starting point for discussion with participants to comment and provide specific feedback on.

2.2 Participant responses to key barriers

Participants generally agreed with the six categories of barriers identified and the sounding provided the opportunity for the participants to go into detail on the specific barriers to fuel switching they faced in each category and the corresponding impact on their businesses.

The following sections outline the participant's views on key barriers to fossil fuel switching. Whilst representative of the views provided by sounding participants, details in this section may not necessarily represent views of SMEs and all users in the market.

2.2.1 Access to capital

Most of the process heat users have indicated that they had access to capital either through a parent company internationally or due to their size or scale. However, ecosystem players have indicated that for smaller players or sectors with low profitability, access to capital can be an issue, although the type of issue varies on a case-by-case basis.

There seemed to be a disconnect when talking to large process heat users about the importance of capital as a barrier to decarbonisation. As outlined above, most process heat users were of the view that they had sufficient access to low-cost capital, while unachievably short internal payback thresholds were identified as the key issue. These short payback periods would indicate that even though the user had access to low-cost sources of external capital, the scarcity of this capital led to an internal capital allocation requirement to earn significantly higher returns on fuel switching projects.

This could create an opportunity to accelerate fuel switching by using low-cost, long-term financing which does not reduce the availability of internal capital allocations.

Competition for capital

Although access to capital was not an issue for most process heat users, most users indicated that securing internal capital allocations for fuel switching projects was difficult as fuel switching currently does not always meet internal payback thresholds required to receive capital allocations (see next point).

Even for businesses with ring-fenced sustainability allocations, there are other sustainability projects such as energy efficiency (heat recovery and demand reduction projects) or those that are mandated by regulatory requirements (such as wastewater treatment) and as a result, have priority in internal capital allocations.

Participants indicated that the scale and pace required for investment to decarbonise and fuel switch to meet Government and/or internal targets is immense and will exceed internal capital availability. Some participants also highlighted the importance of focusing available capital and resources first on fuel switching away from coal with natural gas as a transition fuel.

Participants also noted that while large users make up the bulk of the emissions profile and capital requirement 80% of boilers in New Zealand are small (under 1.8MW). Capital solutions will need to be flexible and adjust to specific needs of users across the size spectrum.

Internal payback thresholds

Sounding participants indicated that fuel switching projects needed to meet payback periods which typically range from 1 – 6 years and that often achieving these payback periods is difficult for fuel switching projects.

Even participants who indicated that they were willing to consider longer payback periods for fuel switching projects would still need payback periods shorter than 10 years.

For some users, these return thresholds were calculated independent of the financing strategy used for the Project. For a fuel switching project to avoid the need to meet internal payback thresholds, it would need to be financed via structures which do not impact the user's borrowing covenants or the user's borrowing capacity for other projects.

Participants had differing approaches to calculating the economic returns which fed into payback periods. For further detail refer to Section 2.2.5 on economic barriers.

Uncertainty around the sustainable level of long-term demand

For users to make the decision to upgrade process heat equipment to use low carbon fuels, they need certainty that there will be demand for that equipment over the long term. There are some large-scale process heat users who face uncertainty around their long-term competitiveness or the demand for their products. This uncertainty discourages investment in decarbonisation as the upgraded assets may no longer be required.

2.2.2 Electricity supply challenges

Securing a cost-effective connection to the electricity network

The cost of network upgrades required to support electrification can be prohibitive. One participant acknowledged that network connections costs could be range anywhere from approximately 20% of the capital cost of a boiler upgrade up to double the capital cost of the boiler.

If an upgrade is triggered, the user often needs to pay for next step change in capacity for the network, known as the first mover disadvantage. Participants indicated that solutions are often 'gold plated', driving over-investment into assets and higher prices for users. The approach of designing the network for maximum resilience may not always be necessary for users' application alone.

It is also not currently well-known which networks have spare capacity and how much, as it often requires extensive engagement and cost borne by the user to discover this. As a result, it is hard for users to focus on electrification in areas with spare network capacity.

There is an inconsistent approach from distribution companies across New Zealand on network connections in terms of willingness to engage, their cost allocation methodologies and timelines for applications for connections. Without a standardised approach, organisations with sites across the country will have to tailor engagement and agreements to each distributor.

Supply disruptions

Most users did not express any concerns with the reliability of the electricity transmission and distribution networks. Several users have noted exposure to reliability risk is present as other areas of an operational site may already be reliant on electricity to operate, even if process heat is independent.

Some users have also identified opportunities to retain existing fossil fuel solutions as back-ups or to operate when electricity price is high to assist with the operating economics and ease the transition to renewable fuels. This opportunity would also reduce the need for distribution companies to create 'gold-plated' systems and reduce risk of price escalation.

Technical challenges with electrification

Electrification currently presents a well-suited technical and economical solution for low to medium temperature process heat using heat pumps. Electrode boilers are technically suited for high pressure and temperature applications but are currently uneconomic compared to fossil fuels.

Retrofitting an electric solution, for example, converting systems from steam to hot water can lead to significant additional capital costs to replace existing infrastructure.

The industrial sector's understanding and knowledge of the latest heat pump and electrode boiler solutions are not consistent across consultants and industrial process heat users.

Wholesale electricity cost

High electricity prices and its volatility can deter investment in electrification and constrains utilisation of existing electrified plant.

With electricity procurement currently managed by procurement teams on a short-term basis via 2 – 3-year fixed price contracts, this exposes businesses to significant short to medium term price shocks. Often businesses also procure their entire electricity demand in a single round rather than entering multiple or staggered contracts to spread renewal risk over time. There is opportunity for electricity cost management to be done over the long-term akin to treasury functions undertaken for interest rates. Historically, while longer term electricity contracts have been offered by Gentailers, pricing and escalation in these contracts have been unattractive.

Meridian is currently offering a limited volume of 10-year fixed price contract to support electrification which we understand to be more attractive than previously offered contracts.

There currently is not an established, independent Power Purchasing Agreement (PPA) market of scale in New Zealand which would enable users or groups of users to contract directly with project developers to access low cost, long-term renewable electricity supply. The Major Energy Users Group (MEUG) is currently running a PPA process for its members.

There currently is no accepted source of long-term forecasts for electricity pricing in New Zealand, which adds to the uncertainty of wholesale electricity costs and is a barrier for businesses to make long-term investment decisions.

Lack of certainty on ongoing distribution pricing

Distributors have significant flexibility in setting pricing which results in a wide array of pricing methodologies across the country, and which are all subject to change. This variability can deter investment into electrification projects as the overall economics of the project could change materially over the lifetime of the investment as distribution costs are a key part of the delivered cost of electricity.

This makes it difficult for users to present long-term business cases for electrification projects.

2.2.3 Biomass supply challenges

Availability of long-term, fixed price contracts

There are biomass suppliers in the market who have long-term access to waste wood supply, an input into the biomass production process. As a result, biomass suppliers are actively looking to sign long-term, fixed price contracts.

Long term supply contracts provide biomass suppliers with confidence to invest the capital to expand their production capacity. An example of this is the contract between Nature's Flame and Fonterra to supply biomass fuel on a long-term basis to their biomass boiler at Te Awamutu. This contract gave Fonterra the price and supply certainty needed to convert the existing coal boiler to biomass and underwrote Nature's Flame expansion of their plant to deliver the contracted biomass supply.

Ensuring there is sufficient availability of the underlying long-term supply contracts for waste wood from wood processors will be key to ensuring the continuing availability of long-term contracts for biomass supply.

Availability of biomass inputs

The lowest cost of biomass fuel produced is from the by-product of wood processing. There is a limited amount of wood processing currently undertaken in New Zealand. The bulk of forestry products are currently being exported unprocessed. Increasing onshore processing would increase availability of low-cost biomass fuel.

Alternatively, investing in developing supply chains and processing equipment to recover and use forestry residue which is currently unused and a cost to the forestry industry may assist in unlocking new sources of feed for biomass production, introduce cost efficiency for the forestry industry and future-proof the biomass supply market and uptake of biomass fuel. Additional investment and analysis is required to establish whether untreated waste wood is an economically viable source of low-cost biomass fuel.

To increase availability of inputs, another source of feed that can be considered is increasing allocated tree volume for biomass fuel. The use of more expensive portions of tree for biomass fuel will however result in an increase in biomass prices for current levels. Biomass production capacity would also have to simultaneously expand to process increased inputs.

There is risk that future competition for biomass, whether for process heat or other application, pushes up price of biomass, which impacts the economics of process heat decarbonisation via biomass.

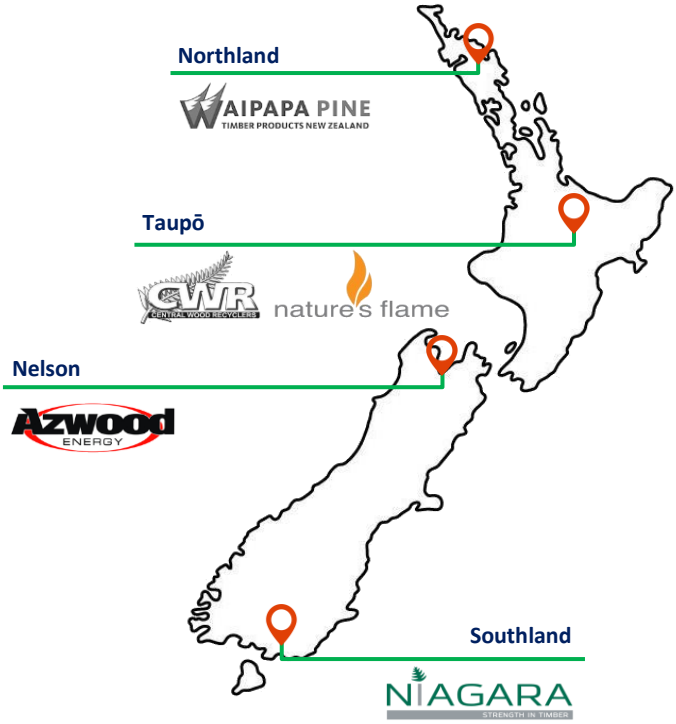
Regional availability of biomass

There are currently five large scale biomass fuel suppliers located in New Zealand, as seen on Figure 3.

The locations of suppliers are strategically positioned next to sources of fibre the key biomass fuel production input.

Transport can be a significant portion of the delivered cost of biomass fuel for regions away from the production sources, which can make the use of biomass uneconomic. Transport costs are also affected by the type of biomass product being delivered. As an example, it is cheaper to transport wood pellets versus green woodchip.

Figure 3 Locations of large-scale biomass suppliers in New Zealand



Additional requirements of biomass operation

Biomass has several challenges which are not present with natural gas or electricity and presents a similar profile to coal. These include:

- Disposal of ash waste and impacts on stack size and/or consenting requirements (air and land)
- Space requirement for the storage of biomass fuel and additional handling and operating requirements
- Start-up procedures as biomass boilers do not instantaneously respond to demand

2.2.4 Lack of industry wide co-ordination

EECA has an important role to facilitate sharing of learnings and case studies

The work done by EECA and the Energy Transition Accelerator programme was noted by various participants to be extremely impactful in assisting businesses to decarbonise. The importance of EECA's role in providing an independent way of sharing learnings and verifying claims by interested third parties such as suppliers was also emphasised.

While the use of electricity and biomass is well established for most process heat use cases both locally and internationally, there is still the perception amongst some process heat users that the technologies are unproven.

While early adopters promote their projects and are happy to share learnings, the lack of publicly available, easy to access, up-to-date case studies that include both detailed economic and technical data is a barrier to addressing existing perceptions around biomass and electrification.

Scale of fuel switching challenge is immense

Transitioning the industry off coal by the mid-2030s will be extremely difficult to achieve with the existing level of resources in the New Zealand market.

A methodical approach to the co-ordination of upgrades is required to avoid a 'rush for the door' scenario as regulatory deadlines and carbon pricing impacts kick in. This risk is further compounded if users wait until upgrades are economic from day one (reactionary action) instead of investing ahead (proactive action).

An orderly transition will require projects with highest carbon savings, lowest cost of abatement and largest economics benefits prioritised early.

Natural gas has a potential role to play as a transition fuel to enable industry to focus on first transitioning coal. The current supply instability of the natural gas market and restriction on future exploration impacts this potential.

Minimising the cost of transition for New Zealand

The overall mix of renewable fuel type is also critical to minimise the cost of New Zealand's fuel transition. Without coordination there is a risk that as users begin to decarbonise, they will transition only to the current lowest cost renewable solution which is predominantly biomass.

Increasing competitive pressures for biomass supply could then result in increased biomass fuel prices which may then be uneconomic in comparison to alternative solutions such as electrification. Given boiler upgrades are long term investments participants would then face significant additional costs to subsequently switch to balance the fuel mix. While the cost of an inefficient transition is immediately

born by individual participants the ultimate impact on the economy will flow through to the New Zealand public.

2.2.5 Low carbon process heat alternatives are viewed as uneconomic

Economic trigger for fuel switching

Process heat users can be broadly categorised into two different buckets when it comes to the economic trigger for conversions:

- **Day one cost competitiveness:** Several large-scale process heat users export their products and are exposed to international commodity prices. To remain competitive, they cannot pass increased costs whether from carbon pricing or from fuel switching projects onto their customers. As a result, users will typically only invest in fuel switching if there is ability to maintain or reduce day one operating costs even if there is a pathway to reduced operating costs over time.
- **Savings over asset life:** Some users are prepared to take a longer-term view on the economics of fuel switching, considering the total economics of fuel switching projects over their useful life against the status quo solution.

For all users, the decision to fuel switch needs to be supported by long term certainty around the future economics for the chosen fuel solution. Third-party consultants and expertise are often engaged to perform feasibility studies to achieve an accurate cost estimation (-/+10%) required for board approval and to assess the risks of future changes in fuel and carbon pricing.

Even projects which result in an overall reduction in operating cost may not proceed because they do not generate sufficient cost reductions to meet the short-term internal return thresholds that are necessary to secure a capital allocation, see section 2.2.1 for further detail.

Uncertainty surrounding future delivered cost of fuel

Participants emphasised the importance of achieving increased certainty around the long-term delivered cost of fuel for business case development. For some users securing long term fixed priced supply contracts that provide cost certainty was almost as important as the competitiveness of the pricing achieved.

Potential variability in future distribution and transmission cost allocations was highlighted as a material challenge for some users given the large potential impact that changes in transmission and distribution pricing can have on delivered cost of electricity over time.

For biomass, the risk of future competition for fuel negatively impacting long term biomass prices was also a concern.

Uncertainties in future forecasts of carbon pricing

The current level of carbon pricing is not sufficiently incentivising businesses to explore fuel switching opportunities as current pricing still economically favours the use of fossil fuels relative to renewable fuels. It also does not consider future climate change adaptation costs.

The uncertainties and level of sophistication regarding forecast carbon pricing varied across participants. Not all participants had undertaken the work to understand the potential impact that increases in carbon pricing on their cost to run their businesses. On the other hand, there are larger users who regularly update their views on carbon pricing to help inform decarbonisation investment decisions and treat it as part of their Treasury function activities.

Most businesses would price some increase in cost of carbon into their fuel switching business case, however uncertainty made it hard to 'bank' these benefits with decision makers.

Current cost of electrification compared to fossil fuels

Although the upfront capital cost of electrified equipment such as heat pumps and electrode boilers are considerably lower compared to coal boilers, in many cases, the upfront cost of connecting to the grid or retrofitting existing plant can make the total capital cost uneconomic and deter investment.

The increased efficiency of electrified solutions can offset a portion of the higher fuel (operating) cost compared to coal and natural gas.

One participant shared that even though they are actively seeking to convert their boilers from coal to electricity, they would still require an electricity price of $43/MWh for fuel switching from coal to electricity to be economically viable.

Notwithstanding the current operating cost deficit between coal and the baseload cost of electricity the flexibility in start-up and operations of an electrode boiler and the volatility of electricity pricing have led to some users operating both fossil fuel and electro boilers in tandem to improve the economics of fuel switching. The electrode boiler is run selectively to take advantage of trading periods when the electricity pricing is low and switched to coal when pricing is high.

See Section 5 for further detail.

Current cost of biomass compared to fossil fuels

For certain use cases and locations biomass can already be cost competitive, particularly when assessed over the life of the asset.

However, the economics of switching to biomass is highly dependent on the availability of low-cost long-term biomass supply close to the user's site to minimise the cost of transport of the fuel from the biomass supplier.

See Section 5 for further detail.

Economics vary across regions and use cases

Whether biomass or electrification is economically viable for a particular user will depend on both the user's location and application.

It is important to prioritise the most economic conversions first in regions with existing biomass and electrical supply capacity and in use cases most suited to the relevant technology.

There are several examples of large-scale projects in the market which have successfully switched from fossil fuel to renewable fuels such as Fonterra's Te Awamutu boiler conversion from coal to biomass. Part of the reason this project was successful was because the boiler is located under two hours' drive from its long-term supplier Nature's Flame, minimising transport costs.

It is important to understand what the factors are that enable successful conversions and use this to identify other similar projects in the market.

Switching assets that are not end-of-life

There are further economic challenges in converting existing fossil fuel assets which are not end of life to low carbon alternatives. While some of these assets may be able to be retrofitted economically to low carbon fuel alternatives retrofitting will not be a viable alternative for all assets and use cases.

Given the long life of process heat assets waiting for these assets to reach end of life or for escalating carbon costs to render them uneconomic is unlikely to deliver on the Government's carbon abatement targets.

Solutions should identify ways to realise the value from these assets on an ongoing basis, potentially as reserve process heat or electrical supply capacity rather than fully decommissioning all fossil fuel-based assets.

2.2.6 Technical challenges

Transition challenges

The size of the fuel switching challenge is such that the New Zealand market will need to significantly expand its capacity to deliver on current decarbonisation plans. Capacity of equipment suppliers (both domestically and internationally) to deliver multiple, large-scale low carbon boilers are limited.

There are only two suppliers in New Zealand who have the capacity to manufacture one large boiler each per annum. Capacity of supporting contractors in the New Zealand market such as design consultants, civil, electrical, mechanical contractors, to install and commission these boilers may also prove to be a barrier.

Suitability of technologies to specific use cases

Biomass and electrification are currently more suited to different use cases. Biomass is well suited for high temperature, medium pressure applications, particularly to replace coal. Electrification currently presents a well-suited technical and economical solution for low to medium temperature process heat using heat pumps. Electrode boilers are technically suited for high pressure and temperature applications. Both fuel sources will be required to decarbonise process heat.

Electrification technologies continue to improve rapidly expanding the applicable economic use cases for electrification.

Retrofitting challenges

There are often technical challenges that arise from retrofitting new low-carbon process heat into an existing process or plant or repurposing existing plant to burn low-carbon fuels. Retrofitting complexities result in an increased capital cost impacting the economics of fuel switching. These technical challenges are outlined in the sections on the individual barriers for electrification and biomass.

3 Support from EECA or the Government

3.1 Introduction to potential support canvassed with sounding participants

The second key objective of the market sounding process was to identify the range of potential support mechanisms that participants thought might be most effective in addressing the barriers they face when considering fuel switching.

The market sounding materials canvassed a range of potential support structures that could be facilitated by the Government or EECA to test with sounding participants:

Capital grants

- Provision of upfront capital grants to reduce the capital cost of fuel switching projects (e.g. GIDI process)
- Project owners apply for tranches of grant funding with an evaluation process to allocate funding across projects

Government loans

- Long term Government loans available to Project owners for use to finance fuel switching projects
- Loans could be provided at concessionary interest rates, recognising wider benefits of fuel switching
- Repayments used to fund further fuel switching projects

Tax support

- Provision of a range of tax support to improve the economics of switching to low carbon fuels
- Could be structured as accelerated depreciation allowances on low carbon assets or a structure similar to the R&D tax incentive

Centralised source of expertise

- EECA or the Government act as a neutral facilitator to coordinate the fuel switching ecosystem across users, suppliers, service providers, financiers and Government departments
- Sharing of knowledge and expertise to develop and implement project best practise and address barriers
- Potential for dedicated Government funded personnel (e.g. cluster manager model) tasked to drive change across a cluster of organisations

Regulatory

- Regulatory intervention to address key barriers to fuel switching and increase the incentives to switch to low carbon fuels
- Could include regulatory intervention to address first mover disadvantages in electricity sector
- Increased certainty around future cost of carbon through reform of carbon pricing. Could include implementing series of medium to long term carbon pricing floors
- Mandated sustainability reporting requirements and sustainability ratings on products and services

Energy efficiency

- Unlocking energy efficiency opportunities are key to minimise energy needs and the cost of fuel switching
- Government / EECA support for business to unlock energy efficiency initiatives

Credit support

- Provision of Government credit support to enable businesses to access lower cost financing for process heat fuel switching projects
- Government may step in to keep financiers whole in the event a process heat user defaults

Fuel supply investment

- Direct investment by the Government in developing low carbon fuel supply chains, similar to PGF investment
- Investment targeted at enabling existing fuel suppliers to scale up operations to:
  - Meet increased demand created by fuel switching
  - Create entities which can provide bankable long term fuel supply agreements

Commercial financing

- Facilitate access to long term, low-cost commercial financing which spreads upfront capital cost over the life of the asset
- One example of a potential commercial financing structure is Heat as a Service ('HaaS')
- These structures could be used to transfer risks to financiers (e.g. fuel supply) as well as eliminate capital barriers to fuel switching
- Commercial financing could be combined with other forms of support from EECA / the Government

Fuel supply intermediary

- Government enters into long term agreements with process heat users to provide fuel at a guaranteed fixed price
- Process heat users then have a high credit quality counterparty and certainty around cost and availability of fuel supply
- Government would then seek to match this obligation with back-to-back contracts with fuel suppliers
- Government takes risk on fuel suppliers being able to continue to meet their supply obligations under these contracts instead of process heat users
- Government can also coordinate development of fuel supply chains and benefit from aggregation of demand

Additional detail on alternative commercial structures and how it may address barriers to fuel switching is in Section 4.

3.2 Participants responses to potential Government support

3.2.1 Capital grants and government loans

There is broad based support for ongoing capital grants and continuation of the GIDI process with participants indicating that the process successfully resulted in accelerating both due diligence and implementation of decarbonisation projects.

Due to the significant scale of capital required by industry to transition off high carbon fuels, grants provide a direct and simple way to meet capital requirements. However, grant funding is limited and may not achieve the same level of investment impact as commercial financing structures may achieve.

Participants particularly highlighted prioritising technology demonstration projects which provide case studies for the rest of the market.

EECA could also consider; relaxing grant criteria and maximum capital thresholds, with focus exclusively on projects with the lowest cost of abatement, streamlining reporting requirements which, in some cases, create an ongoing burden on businesses.

There is an opportunity to commit to re-investing Emissions Trading Scheme (ETS) revenue in decarbonisation grants for fuel switching projects. The recycling of funds will increase availability of capital grant funding and will accelerate emissions reductions further. The recent budget announcement in May 2021 has highlighted the Government's intentions to recycle future ETS revenue from Budget 2022.

Government loans are viewed as more complex and would need to be sufficiently concessionary either in pricing or term to be attractive to large users as it will impact user's balance sheet capacity. Given users currently have good access to competitive capital, government loans were not seen as a particularly attractive option compared to capital grants.

Several participants pointed to the relative success of the Clean Energy Finance Corporation and Australian Renewable Energy Agency (ARENA) with respects to funding renewable energy and demonstration projects to helping accelerate the low emissions transition in Australia. ARENA also successfully plays a key role in connecting investment, knowledge and people to develop the renewable energy ecosystem in Australia.

World Trade Organisation (WTO) rules around subsidies impose restrictions on some large users who trade globally from accessing government grants or concessionary loans.

3.2.2 Tax support

There is broad based support for ongoing fuel switching tax support. Tax support would be particularly impactful in addressing the ongoing operating expenditure barrier to fuel switching.

Both tax credits and accelerated depreciation would be factored favourably into business cases for fuel switching and may assist in getting projects accelerated.

Participants indicated these mechanisms may be more palatable for the Government as accelerated depreciation does not change the total tax take for the Government over the life of the asset. Tax credits also do not require upfront investment from Government and only reduce tax intake when projects are implemented.

3.2.3 Centralised source of expertise

Participants acknowledge the important role EECA currently plays as a neutral and trusted party in the decarbonisation space particularly acknowledged the impact of the Energy Transition Accelerator (ETA) process.

Electricity

There is an important ongoing role for EECA or the Government particularly in the electrification sector where several areas of support have been identified.

Participants have suggested having an accurate, regularly updated map of the distribution network and where spare capacity exists on the network may assist industry in focusing electrification efforts in these areas. Regional demand and growth profiles may also be mapped, leveraging off MBIE's existing work, to match existing spare capacity and anticipate new renewable generation intensification areas.

Participants highlighted the importance of engaging with the senior management of process heat users to provide education on the risks and benefits of long-term electricity contracting. Repositioning the responsibility for managing electricity exposure from procurement teams to a treasury function may also assist businesses to mitigate their exposure to short term fluctuations in electricity prices.

EECA or the Government could also play a role in assisting with the standardisation of Power Purchasing Agreements and the process to match electricity generators with end users.

Biomass

EECA may play a role in promoting availability of suppliers who have capacity to enter long-term biomass supply contracts as well as educating users on the risks and benefits of entering long term supply arrangements.

Shared knowledge

The industry may look to EECA to provide:

- An independent source of advice around risks and benefits of alternative financing structures like HaaS
- A full suite of developed tools made publicly available by EECA to inform decision-making on fuel switching projects such as commercial and technical data and calculation templates
- A centralised platform for process heat project information including showcasing recent domestic and international case studies, lessons learned and industry knowledge to raise awareness about the applicability and economics of fuel switching projects

3.2.4 Regulatory

Carbon pricing

Participants all thought that any action taken by the Government to provide additional certainty around future cost of carbon would aid them in building fuel switching business cases.

Some participants were supportive of the proposal by the Climate Change Commission to include a series of floors on carbon price auctions to provide medium to long-term certainty around minimum future carbon prices.

It would also be helpful for a government agency (Treasury, RBNZ etc) to provide a regularly updated carbon price a forecast which can be incorporated into business cases. The Climate Change Commission forecast of emissions values has been helpful in this regard.

There is caution from exporters around the impact of New Zealand's ETS carbon pricing on their international competitiveness.

Electricity distribution and transmission market

There is broad based support for Government regulatory intervention into the electricity distribution market. This includes standardising timeframes and requirements for new load connections. This standardisation could mirror what was implemented for generation connections.

The industry highlighted that there are often benefits of grid upgrades which accrue to other network users (often future connections) beyond the party that triggered the upgrade. Assistance in standardising how and from whom connection and grid upgrades costs are recovered will be important to address current first mover disadvantages.

Standardising distribution pricing regimes so users have certainty around future distribution charges would provide increased certainty to users constructing electrification business cases.

Participants also highlighted the possibility to reduce Transpower's target returns and dividends to reduce transmission pricing and improve the economics for electrification.

Transition

Other transitional support such as assistance with planning and consenting as a result of fuel switching projects (e.g. air emissions, water quality, biomass ash waste) and support of natural gas as a transition fuel to help avoiding lumping fixed costs of gas supply chain on last users standing.

Existing regulatory burdens

Some participants highlighted the priority of investment for other regulatory targets set by councils and the Government. These include mandated regulatory restrictions around wastewater treatment, water quality, air emissions and workplace health and safety.

If decarbonisation regulatory targets were to be introduced, users need to be supported through easing regulatory burdens in other areas and providing users the flexibility to meet targets how it best fits their business.

3.2.5 Energy efficiency

All participants acknowledged the importance of energy efficiency improvements as an essential first step in reducing demand, making fuel switching possible.

3.2.6 Credit support

While most users consulted as part of this process have high quality credit profiles, there are some large-scale process heat users who are uncertain on their long-term role in the New Zealand economy. These users would benefit from credit support. Credit support from the Government can be seen as a vote of confidence and an important signal for business owners on the importance of their industry in the wider New Zealand economy.

Credit support was also viewed as potentially being more useful to assist smaller users to gain access to low-cost, long-term financing options which may not otherwise have been available to them due to their size or lack of financial track record.

Credit support also has a role in reducing the cost of commercial financing which is a key barrier for process heat users adopting commercial structures. See Section 3.2.7 below.

Government credit support could take many forms including:

- Government providing "first loss capital" or equity into a commercial financing structure which reduces the risk taken by other financiers, lowering the cost of the overall solution; or
- Government guarantees the user's obligations under the commercial financing structure and ensures capital providers' get their capital back in the event of default by the user

3.2.7 Commercial financing

Given the scale of participants we engaged with most outlined that they had access to low-cost sources of bank financing. However, participants are constrained in terms of how much they can borrow which leads to the requirement to ration capital and for projects to meet the internal investment requirements outlined in section 2.2.1. To provide the level of capital required to fund the cost of fuel switching alternative commercial financing arrangements will need to be developed that are not subject to the rationing requirements.

Several participants had previously explored alternative commercial financing arrangements such as Heating as a Service with various Government parties and had the following observations.

Differentiation from bank financing

Previously, businesses who have explored these arrangements found the economics of these structures to be not compelling, indicating that this was due to providers requiring a higher return than other forms of capital available to the user, such as bank financing.

Participants are generally willing to consider commercial structures and HaaS as an alternative to bank financing if the economics are compelling which could be driven by a mixture of:

- **Lower delivered cost of heat:** Unit cost of heat is lower than the user's existing total cost of heat
- **Risk transfer:** The ability to transfer risk, particularly risk around long-term cost of fuel supply was seen as potentially attractive by some users
- **Access to attractive capital sources:** That is either longer term or cheaper than the organisation could otherwise access through its existing funding sources
- **Avoid impacting borrowing capacity:** For alternative commercial financing arrangements to be considered separately to bank finance these structures would need to not impact user's existing borrowing covenants

Case studies demonstrating the benefits and the successful implementation of HaaS structures will be critical for its uptake.

Complexity

These commercial structures introduce additional complexity which can become a barrier to uptake and there is a general lack of familiarity with these structures amongst participants. Participants also had concerns about being able to accurately assess the risk and benefits of commercial financing structures as users often reliant on information from solution providers who are seeking to sell a product.

Commercial structures need to be easy to understand and flexible to respond to individual user needs.

Ownership and operational control of process heat equipment

Many process heat users like to run their own boilers and equipment as energy management is considered as part of their field and expertise. This is typically applicable to large scale businesses who have in-house expertise. Accordingly, some process heat users were uncomfortable with HaaS structures due to concerns over reduced operational control.

Some users also consider energy management as a way to advance their competitive advantage in the market.

Opportunities for deployment

Several participants highlighted that the banks are looking to deploy a significant amount of cheap capital into sustainability projects through the Funding for Lending Project set up by the Reserve Bank.

Several participants also identified the opportunity to deploy HaaS in industrial and/or community heating projects to deliver process heat to multiple co-located industrial or residential users.

3.2.8 Fuel supply intermediary and investment

Electricity

There are mixed views on whether the electricity market is currently operating efficiently. Some participants pointed to the MEUG's PPA process and Meridian Energy's Electrification Project to highlight that there is an ability to contract for long-term electricity supply in New Zealand.

Other participants pointed to high current electricity prices as a sign of ongoing market failure created by entrenched Gentailers who have little incentive to support an efficient market for long-term electricity contracts.

Participants identified that the Government's approach to electricity procurement could have a significant impact on New Zealand electricity markets. The Government procurement rules are currently restricted to competitively procuring short-term three-year contracts.

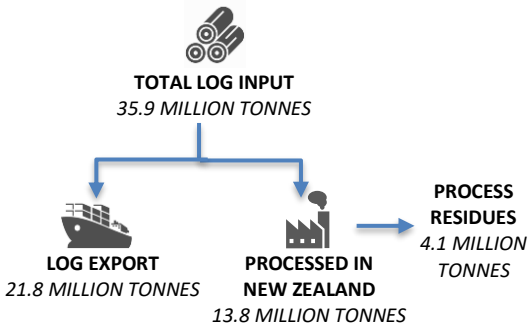
Participants highlighted the opportunity to aggregate electricity demand across multiple Central and Local Government entities to cornerstone a diversified portfolio of new renewable energy developments which can provide reliable electricity and mitigate intermittency of renewables. The Government is a highly attractive counterparty for developers and due to scale, can attract long-term, competitively lower electricity prices.

Participants also identified that Government could play a less direct role and instead facilitate the establishment of PPA aggregators (like Flow Power in Australia), PPA exchanges (to trade unneeded PPAs), support the adoption of standard form PPA contracts and education of electricity users on the benefits and risks of procuring electricity via a PPA.

Biomass

Participants are broadly supportive of Government support to develop local biomass supply but had mixed views on Government playing an intermediary role. Several participants were of the view that having the Government as a fuel intermediary in the biomass market would remove competitive advantage of fuel supply, introduce additional uncertainty, costs and stop a market-driven solution.

Figure 4 Log flow in New Zealand's Forestry industry



The log flow[8] in New Zealand's forestry industry, as seen on Figure 4, shows that ~60% of logs are exported overseas unprocessed which represents $3.8billion of the annual forestry export market of $6.9billion.[9] An additional 13.8million tonnes of logs are processed in New Zealand to produce a range of products including woodchip, pulp, poles, panels and sawlogs with exports of these products generating an additional $3.1billion of export revenue.[6]

Onshore processing currently generates an estimated 4.1million tonnes of process residue per annum which is the lowest cost source of input for the creation of biomass fuels.

Every additional million tonnes of logs which are processed in New Zealand rather than exported as logs would generate an additional 0.3 million tonnes of process residues which could be used for creation of low-cost biomass fuel while simultaneously generating upwards of an additional $360million dollars of export revenue.

There was broad based support across participants for financial and policy support to increase the amount of onshore processing of wood before export, to increase wood waste availability and support the supply chain for low-cost biomass. This aligns with The Ministry for Primary Industries' Transformation Scenario for New Zealand in which they forecast that domestic log processing will increase by 9 million tonnes between 2020 and 2030 increasing the availability of process residue by 4 million tonnes. This will however require an investment in 15 additional sawmills by 2030 and establishing export markets for the resulting products.[8]

In addition to the above it is estimated that there is 2 – 4 million tonnes of wood waste per annum which is currently not economical to recover[10]. Direct Government investment could assist in developing capability to recover and economically process currently unused wood waste generated by forestry activities and untreated construction wood waste that would otherwise end up in landfill.

Waste management business, Green Gorilla, has built a recycling plant to process large volumes of timber waste to produce wood chips for use as biomass fuel to replace coal at Golden Bay Cement in Whangarei. The Government has also previously funded programmes to recover waste wood for conversion to landscaping products as part of the Waste Minimisation Fund, use of this waste wood for the creation of biomass fuel could be explored as an alternative use.

Sharing learnings from successful projects as well of additional Government funding to further develop this part of the biomass supply chain would be required to deliver the step change in the amount of available waste biomass supply required to meet anticipated future demand.

Participants were also supportive of the Government providing market leadership by transitioning to biomass through a centralised procurement strategy for its solid fuel requirements. Participants have noted that several Government entities are still running procurement processes for coal.

[8] Based on actual figures for year ended Dec 2019

[9] Forest Owners Association, *'Facts and Figures 2019/20', [www.nzfoa.org.nz/images/Facts_Figures_2019_20_Web_FA3-updated.pdf]*

[10] Bioenergy Association, '*Biomass fuel resource availability projections*', Information Sheet 43, Aug 2019

3.3 Key areas of support sought

Each participant was given the opportunity to share what support from EECA or the Government would be the most impactful in assisting their business in switching to renewable fuels. Their responses are outlined below.

Industrial Process Heat Users

User 1	1. Provide support to increase certainty around future renewable fuel availability and pricing 2. Information and data collection to assist with making decarbonisation investment decisions 3. Consider the impact of international competition, where incentives for decarbonisation projects from overseas Governments are more attractive, and New Zealand's ability to remain competitive in the global market
User 2	1. Provide clarity and certainty on future carbon pricing 2. Assist with the development and management of industry-specific decarbonisation pathways 3. Promote and showcase the use of biomass boilers in real projects
User 3	1. Promote case studies, lessons learned and industry knowledge to raise awareness and enable continuity of fuel switching projects 2. Regulation support for fuel switching projects such as planning and consenting activities (air emissions, water quality, biomass ash waste)
User 4	1. Funding support for large scale fuel switching project which recognise the benefits these projects deliver for the broader economy
User 5	1. Facilitate development of innovative and appropriate financing structures which don't impact financial covenants 2. Expand criteria for eligibility for GIDI funding and review reporting and monitoring requirements associated with receiving Government support
User 6	1. Facilitate better access to lower total delivered costs of electricity (generation, transmission and distribution)

Ecosystem players

Ecosystem player 1	1. Assistance with decarbonisation roadmaps, upfront costings and matching supply of new generation to demand 2. Scaling access to low-cost, long-term clean energy by establishment of a deep and liquid PPA market in NZ and leveraging potential scale of Government procurement 3. Allocation of GIDI fund is balanced between industry's best projects and lowest cost of abatement)
Ecosystem player 2	1. Start by incentivising smaller pilot, demonstration or pathfinder projects with lower costs and risk exposure. This can provide a meaningful kick-start to the market 2. Incentivise counterparties who demonstrate early commitment to fuel switching
Ecosystem player 3	1. Provide funding support to help underwrite next tranche of biomass capacity expansion 2. Government to become early adopters of biomass and show more leadership in the market
Ecosystem player 4	1. Showcase current and future economic viability of fuel switching 2. Identify options and journey it takes to achieve optimised solutions 3. Provide clear pricing indicators and regulatory framework for transition up to 2030 and 2050 milestones and incentivise early movers 4. Establish an NZ infrastructure fund to cover cost of upgrading network capacity
Ecosystem player 5	1. Government to act as a co-ordinator or aggregator by; • Supporting investment into large scale power generation • Owning the national energy strategy • Addressing the 'chicken and egg' situation to provide bankability 2. Government to provide views on the long-term future carbon pricing
Ecosystem player 6	1. Collate various price and cost data and create publicly available tools to assist in decarbonisation investment decisions 2. Target funding to the projects with lowest cost of abatement 3. Strategic funding to alleviate electricity supply challenges and ease the cost burden on users 4. Firming up the forward path for ETS to incentivise and accelerate investment decisions

4 Feedback from capital providers

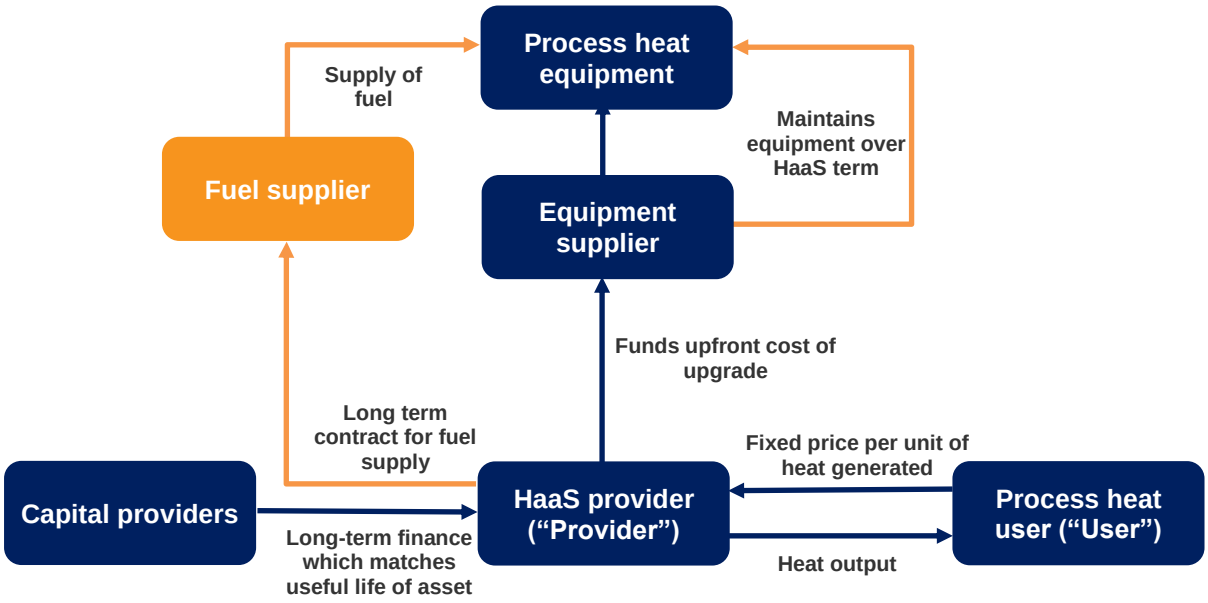
As part of the market sounding process Mafic and EECA also engaged with both ACC and NZSF, two of New Zealand's largest capital providers. These engagements focused on each participant's appetite to invest in process heat fuel switching and how investment opportunities for private capital could be created.

Both ACC and NZSF identified that investing in the energy transition is a key part of their investment strategy and they have significant amounts of funds to deploy to assist the New Zealand economy to decarbonise including via process heat fuel switching.

The issue for both parties is identifying opportunities for direct investment in decarbonisation projects which meet their investment criteria. A significant portion of the market sounding session then focused on whether Heating as a Service or similar alternative commercial financing structures could meet each parties' investment criteria to enable them to deploy capital to facilitate process heat fuel switching.

Heating as a Service ("HaaS")

HaaS structures provide an alternative to a user funding the upfront cost of process heat upgrades and instead partner with a third-party provider who funds the cost of the upgrade in exchange for a long-term commitment to purchase heat at a fixed price.



As well as funding the upfront capital cost of the upgrade, HaaS contracts can also cover cost of fuel supply and the ongoing operation and maintenance of the equipment.

When operating effectively HaaS contracts should simplify fuel switching decisions for process heat users by eliminating capital costs, reducing uncertainty, and maintaining or reducing operating costs through a competitive fixed heat price.

Advantages of HaaS	Disadvantages of HaaS
✓ Access to long term capital for up to 25 years whilst commercial financing typically limited to 5 – 7 years	× Potentially reduced control over design and operation of process heat equipment × User enters a long-term commitment to a fixed price for heat. Whilst this is a benefit, it

- ✓ Potential to access cheaper cost of finance via lower green financing rates
- ✓ Leverage economies of scale in design, procurement, fuel supply and finance to deliver lowest cost solution for Users
- ✓ HaaS provider acts as a centralised source of expertise to facilitate a market-wide transition
- ✓ Transfer fuel price exposure and maintenance risk to the HaaS provider
- ✓ Potential to be structured in a way that does not impact User's borrowing covenants

could also be a disadvantage if market pricing changes or technological solutions change

- ✗ HaaS structures are viewed as complex

Heating as a Service structures has similarities with other financing initiatives implemented by the Government including the Infrastructure Funding and Financing Act which intends to support the acceleration of the development of bulk housing infrastructure through a user pays system which does not impact on local authority borrowing capacity. A Government sponsored Heating as a Service structure could provide similar acceleration in the process heat space.

Capital providers' feedback on alternative commercial structures

As outlined above both ACC and NZ Super have appetite to invest in process heat fuel switching but need access to investment opportunities which align with their investment objectives. For alternative commercial structures such as HaaS to be of interest they would need to meet the following criteria:

Scale

Establishing alternative commercial structures requires the investment of significant resources and cost by capital provides. For these structures to be of interest to large scale capital providers like ACC and NZ Super the overall size of the potential investment opportunity also needs to be of sufficient scale. This could either be through individual projects of scale or through the aggregation of multiple smaller projects.

If achieving scale through multiple smaller projects, it is also important to minimise the cost of implementing the structure by standardising the process as much as possible including how projects apply for and are approved for funding and establishing a framework contractual structure that will apply to each project.

Achieving scale is also important to ensure that the economics of the structure are attractive to users by:

- Attracting lowest cost capital providers who typically seek to invest large sums of money
- Spreading the cost of setting up the structure across multiple projects and users
- Gaining access to economies of scale minimising the cost of procurement, fuel supply and ongoing maintenance

Credit profile

One of the benefits of alternative commercial structures is the ability to spread upfront capital costs over a longer term than otherwise available to process heat users. This however requires capital providers to take a long-term view on the credit profile of the process heat user.

Capital providers already make long term investments which require an assessment of the long-term credit profiles of larger process users, for example through investment in specialised property assets.

The assessment of the long-term creditworthiness of users may be more difficult for SMEs or users in industries with exposed long-term competitiveness. Government credit support could be a cost-effective way to expand the accessibility of alternative commercial structures to more users whilst also improving the economics of the commercial structure.

For any structure to be successful, it also needs to be attractive to process heat users. The following considerations were discussed with ACC and NZ Super as increasing the attractiveness of any structure to users.

Flexibility

Commercial structures need to be flexible to respond to the differing needs of process heat users. This is both upfront in terms of what aspects of the process heat solution are included in the structure versus retained by the user to address different levels of user control over process heat, but also be able to change over time.

This flexibility needs to be incorporated upfront into the overall framework for alternative commercial structures to minimise the ongoing costs of adapting the structure to individual users over time.

Simplicity

Successful alternative commercial structures should simplify the fuel switching decision. Structures can achieve this be eliminating upfront capital costs and a simple to understand single fixed price for heat. These structures can also transfer a range of ongoing risks from the user to the structure provider providing ongoing cost certainty to the user.

These structures can however be more complex and there is a general lack of familiarity with users on the benefits and risks presented by alternative commercial structures. Structure providers often play a dual role of educating users on the risks and benefits of the structure while also seeking to promote the structure. This conflict can often undermine user's willingness to consider alternative commercial structures.

Economics

Alternative commercial structures need to demonstrate clear value versus alternative forms of financing. For HaaS structures this is leveraging the benefits outlined above to deliver a total cost of delivered heat that is lower than:

- The total cost of delivered heat of the user's current fossil fuel solution so the structure delivers ongoing operational cost savings for the user with no capital investment
- The total cost of delivered heat that the user could achieve themselves if they implemented the same solution

Control

Several users have expressed concern over maintaining ownership and operational controllability over their process heat assets as heat / energy is a core part of their business. Some users have in-house expertise who manage and optimise energy use.

As a result, users are reluctant to transfer control to a provider via a commercial structure.

Balance Sheet impact

Alternative commercial structures can be classified as supply contracts under IFRS 16 which could mean these structures sit outside of users' borrowing covenants and do not impact their borrowing capacity.

However, achieving this requires users to transfer a level of control over the equipment to the provider.

As outlined in section 5 of this report, if delivered efficiently biomass projects can already deliver cost savings in comparison to existing coal and natural gas solutions whereas electricity is more challenging. Utilising alternative commercial structures could be one tool to drive efficiencies in fuel switching projects and increase the number of sites which can economically switch to low carbon fuels.

Examples of funding of process heat via alternative commercial structures

As well as ACC and NZ Super, there are several other local providers such and Pioneer Energy and Simply Energy who have either previously or are currently offering alternative commercial structures for the financing of process heat.

01

Pioneer Energy x Silver Fern Farms

Balclutha, Otago

An 8MW waste to energy boiler fuelled on wastewater solids, meat processing waste and woodchip

Pioneer built, own, operate and transfer heat to site

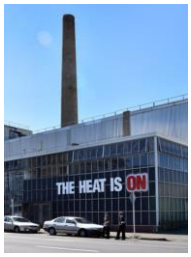
02

Pioneer Energy x Dunedin Energy Centre

Dunedin, Otago

30MWt centralised heat supply network, fuelled by co-firing coal and biomass, for Otago DHB, The University of Otago and other users

Pioneer built, own, operate and transfer heat to users



03

Contact Energy x Fonterra

Te Rapa, Waikato

An 44MW cogeneration, gas-fired plant, supplying steam and electricity to Te Rapa's milk processing plant

Contact own, operate and deliver steam and electricity to site and to the grid

04

Simply Energy x Lion Breweries

NSW and ACT, Australia

A 10 year PPA to supply solar energy to over 300 brewing sites, hotels and bars

The partnership has underwritten the development of a 120MW solar farm

The lack of widespread use of these sorts of structures can in part be attributed to the barriers identified elsewhere in this report as well as changes to the accounting treatment of these structures with the implementation of IFRS 16. Previously HaaS structures could be classified as operating leases which meant the structures were typically excluded from most users borrowing covenants and did not impact their borrowing capacity.

The test implemented with IFRS 16 provides a different set of criteria which need to be met to be excluded from users' borrowing covenants. These criteria revolve around the level of control the user has over the equipment, with lower levels of user control or the presence of multiple users supporting exclusion from borrower covenants. Solar PPAs are an example of a project structure which typically achieves the desired covenant treatment. HaaS structures could also achieve this treatment, but it would depend on the specific situation for each project.

Role of EECA or the Government

Feedback from the participants in the market sounding process is that the current suite of capital solutions available to process heat users are unlikely to provide sufficient support to deliver the scale and pace of process heat fuel switching required to meet New Zealand's decarbonisation targets.

There is opportunity for EECA or the Government to facilitate the development of alternative commercial structures on the scale required to not only successfully addresses capital constraints but also address other key barriers currently impeding fuel switching projects. A summary of potential ways to support development of fit for purpose alternative commercial structures are outlined in section 9.6.1.

5 Current economics of different fuel types

For the wide-scale adoption of fuel switching, the transition from fossil fuel to low carbon alternatives will not only need to generate carbon savings but also deliver economic savings for the process heat user.

Economics can vary significantly depending on a range site-specific factors and varying use cases. Given this variability fuel switching projects can loosely be categorised into one of three categories:

- Projects that are currently economic and will switch or have non-economic barriers preventing the project from being implemented
- Projects that will become economic in the short to medium term. The economic tipping point for these projects may be able to be accelerated with appropriate support
- Projects that are unlikely to be economic for an extended period even with significant levels of support

For lower temperature applications, high efficiency electric heat pumps already present an economic alternative to natural gas, coal diesel or boilers.

The bulk of this section focuses on the range of factors that could drive the economic tipping point between carbon intensive and low carbon fuels for high temperature projects which are not already economic.

There are many site-specific factors and individual use cases that can impact the total delivered cost of process heat for different users and fuel types. Given the variability in project-by-project economics, the purpose of the economic analysis in this report is not to provide a definitive view of the economics of fuel switching across all sites, use cases and fuel types. It is instead intended to provide illustrative relativities between different fuel types for a specific set of assumptions to support the design of programmes to accelerate the economic tipping for decarbonisation of process heat.

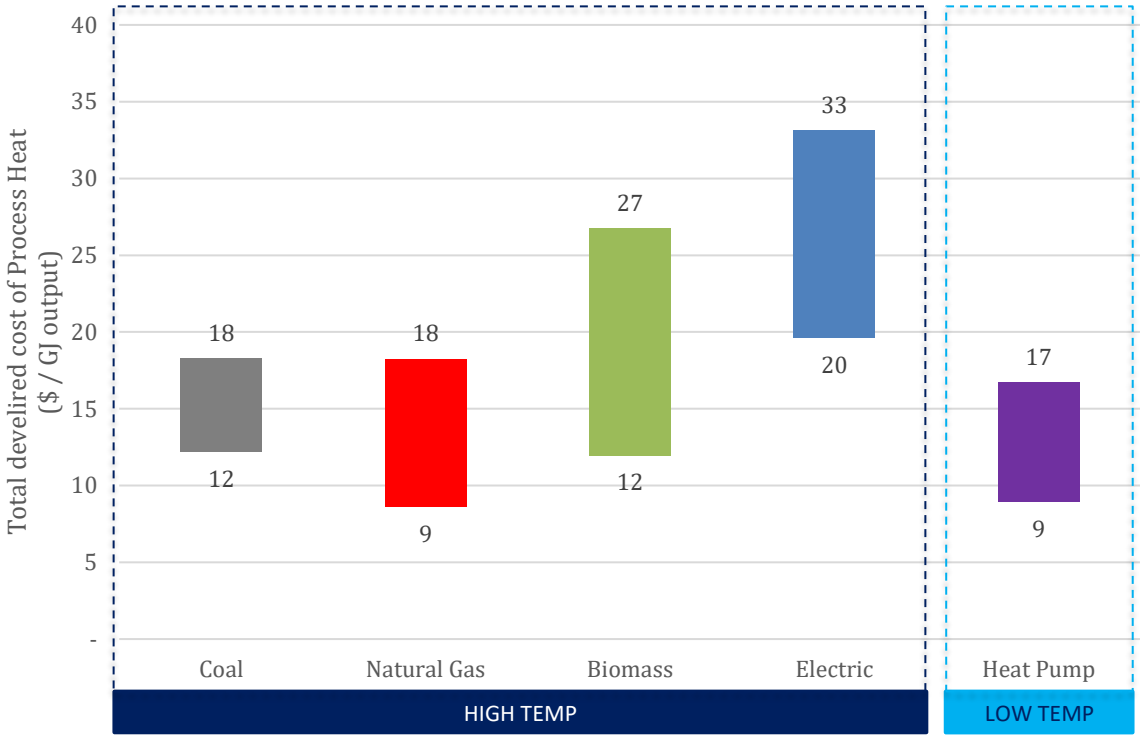
This variability also presents a challenge to fuel switching projects as often each user needs to invest significant time and effort to identify which fuel switching option is the most efficient for its location and use case.

When assessing the economics of different fuel sources in this section we have calculated the **total delivered ("all-in") cost** of process heat which spreads all the costs of running the asset over its useful life and includes the relative impact of differing capital costs, efficiencies, operating costs as well the delivered fuel costs for different boiler fuel types.

5.1 Relative economics of process heat fuels

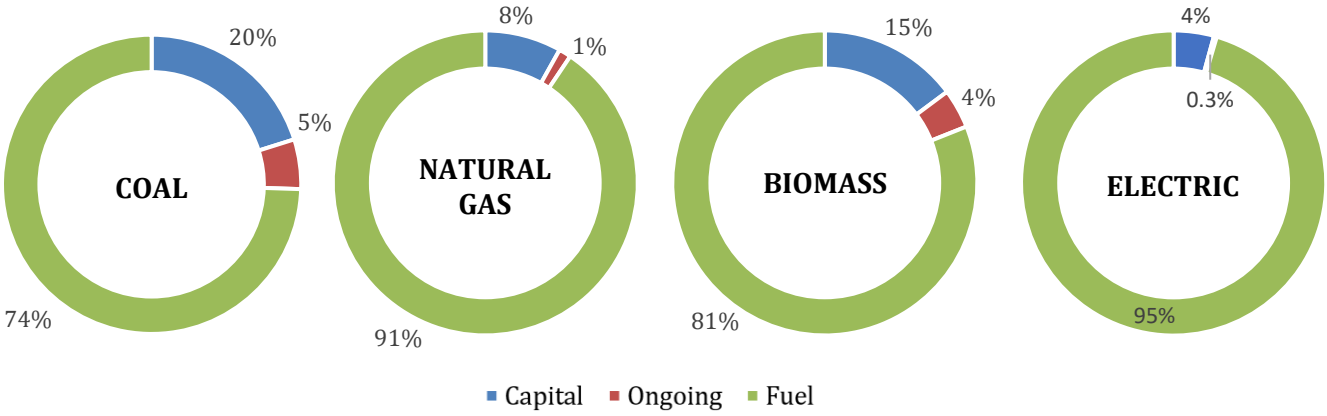
This section presents a series of indicative ranges for the current total delivered cost of process heat (in $/GJ) across fuel types for a new investment in a process heat equipment.

Figure 5 Comparative total delivered cost ($/GJ) of Process Heat with different fuel types



The figure below presents a proportional build-up of the total delivered cost of each fuel and how it differs depending on fuel type.

Figure 6 Breakdown of total delivered cost of fuel for high temperature applications



5.1.1 Assumptions

The assumptions underpinning the analysis in Figure 1 are outlined in the table below. As outlined earlier, the values in this table are not intended to capture the full range of potential outcomes for individual users or projects but have been informed by a combination of literature review and discussions with market participants. They are intended to generate an illustrative range of potential economic outcomes for new investments in process heat boilers to support policy development.

The top of the cost ranges presented in Figure 1 represent a combination of the least cost-effective assumptions recorded below (highest capital cost, most expensive fuel etc) whereas the bottom of the range represents a combination of the most cost-effective assumptions. This approach has been adopted to ensure our ranges capture a wide range of assumption combinations, individual projects will have alternative combinations. For example, a project with higher capex may be able to access higher levels of efficiency or lower fuel costs.

Table 1 Analysis for different fuel types

	Units	**Coal**	**Natural Gas**	**Biomass**	**Electric**	**Heat Pump**
Capital cost	*$ / kWth*	750 - 800	250 - 300	800 - 1,110	250 - 500	1,000 - 1,050
Ongoing cost	*% capex p.a.*	2.5%	1.5%	2.0%	0.5%	3.0%
Cost of fuel supply (at $40/tCo2-e)	*$ / GJ*	6.8 - 10.0	6.5 - 13.5	8.0 - 18.0	18.6 - 30.6	18.6 - 30.6
Cost of fuel supply (at $40/tCo2-e)	*$ / unit*	115 – 170 tonne	6.5 - 13.5 GJ	57 – 320 tonne	67 – 110 MWh	67 – 110 MWh
Carbon intensity	*kg CO2e / GJ fuel*	93.7	60.3	1.6	32.4	32.4
Typical efficiency	*%*	80% - 70%	87% - 80%	90% - 80%	99% - 97%	400% - 250%

The analysis also makes the following assumptions across all fuel types:

- Useful life for all process heat upgrades of 25 years
- Capital cost spread over the useful life using a WACC of 5% for green fuels and 8% for brown fuels
- Capacity factor of 75%
- Carbon cost factored into above fuel costs at of $40/tonne of CO_2-e
- Apart from the instances noted in the commentary below no allowances were made for additional site-specific retrofitting or other costs

The series of assumptions above will vary significantly from project to project based on individual user's use case, access to capital and ability to access competitive pricing for fuel and equipment supply.

In particular, the capacity factor can vary significantly across projects, the lower the capacity factor the higher impact capital cost of the boiler will have on the delivered cost of heat. Scale can also impact the relative cost effectiveness of projects. For example, smaller scale projects will typically have a high capital cost per unit of capacity than the values presented above which will negatively impact the total delivered cost of heat. Assumptions above assume a large-scale project.

5.1.2 Commentary

Coal

There are limited companies seeking to install new coil boilers particularly given the Government's proposal to ban new low and medium temperature boilers by the end of 2021 and phase out existing boilers by 2037. This ban does not apply to high temperature boilers recognising that for some higher temperature applications there are limited alternative options. Coal boilers also represent a significant portion of New Zealand's existing process heat capacity, with many of these having significant remaining useful life. Establishing the economic tipping point for these boilers is also important, see section 5.1.3 for more detail.

Coal boilers typically have a relatively higher upfront capital costs, lower efficiencies and higher ongoing and operational costs but have access to some of the lowest cost of fuel supply.

Large users have historically strategically located their production facilities close to coal mines and as a result can access highly competitive coal pricing which makes transitioning to other fuels challenging, even when factoring the lower efficiencies of coal boilers. Often these locations are also not well positioned with regards to biomass or electrical supply.

Coal pricing does however have the greatest cost exposure to increases in carbon pricing due to having the highest carbon intensity of all fuel sources. There is also an ongoing risk of price increases for stranded users if other large customers switch to alternative fuels causing local coal mines to shut. The impact of these factors is explored in more detail in section 5.1.3.

Coal requires onsite fuel storage and handling which contributes to the higher ongoing cost of coal boilers.

Natural Gas

The use of natural gas for process heat is predominantly confined to the North Island in regions with access to the gas distribution network. No piped natural gas is available in the South Island. As part of the Government's announcement on the proposed ban of new coal boilers, they have also proposed a ban on other fossil fuel boilers, including natural gas, where economically viable alternatives exist. Based on the current economics of alternative fuels the applicability of this policy to high temperature applications currently looks challenging.

Natural gas boilers typically have a relatively lower upfront capital costs, medium levels of efficiency and lower ongoing and operational costs and have traditionally had access to highly competitive fuel supply.

Several participants in the market sounding emphasised the importance of ensuring natural gas's ongoing economic viability to enable New Zealand to first focus on decarbonisation of coal which has a higher carbon intensity. The viability of natural gas has been heavily impacted by recent increases in natural gas prices due to supply shortages and restrictions on new exploration. Historical pricing for natural gas ranged from $5.50 - $6.50 / GJ (bottom of our economics range) with pricing over the last twelve months averaging $13.50 / GJ (top of our range).

There is also a risk of ongoing price increases for stranded natural gas users. There are significant fixed costs associated with the extraction of natural gas and the transmission of it via pipeline infrastructure to users. As users exit the natural gas market, these fixed costs will need to be absorbed by the remaining users. The impact of increases in natural gas pricing is further explored in section 5.1.3.

Unlike coal and biomass, natural gas boilers do not require onsite storage of fuel, are highly controllable, leave no residues for disposal and have no fuel handling costs which contributes to lower operational / ongoing costs.

Biomass

Biomass has several similar properties to coal, which can mean that some existing coal boilers may be suitable to be retrofitted to burn biofuel instead. The economic viability of doing so ultimately depends on the cost of retrofitting, the price the user currently pays for coal and its ability to secure a cost competitive biomass supply agreement.

Biomass boilers typically have moderately higher upfront capital costs in comparison to coal boilers, medium levels of efficiency and higher ongoing and operational costs and typically with a higher cost of fuel supply.

Biomass boilers can broadly be split between boilers which run on hog fuel, those that run on wood chip and those that run on wood pellets. Each of the biomass fuel types above represents different levels of processing with hog fuel being the least processed and pellets the most.

Which type of biomass fuel is most economic for each project will be dependent on a variety of factors including local availability. Typically, less processed fuels are cheaper, have lower energy density (increasing transport costs and space requirements), require additional handling and sorting and the associated boilers have higher capital costs. The opposite dynamic applies for more processed biomass fuels like pellets.

Transport costs can materially impact delivered cost of biomass fuel. The bottom of our economics range ($8 / GJ) represents delivered cost of wood chip close to the source of production whereas the top of our economics range ($18 / GJ) represents delivered cost of pellet fuel at a maximum delivery distance. Pricing of hog fuels

Biomass has the lowest level of carbon intensity and therefore is least exposed to future carbon price rises. It is also currently more cost effective than transitioning to electricity which potentially creates risk of future pricing increases if demand outstrips supply. Impact of future biomass price changes is further explored in section 5.1.3.

Biomass, like coal, requires on site fuel storage, fuel handling and ash disposal which contributes to higher ongoing costs.

Electric

New Zealand has a world leading portfolio of renewable generation which could be used to decarbonise process heat in New Zealand. However, the economics of currently doing so are challenging with a material cost premium between electricity and other fuel solutions.

Electro boilers typically have lower upfront capital costs, the highest levels of efficiency, lowest ongoing and operational costs and have the highest cost of fuel supply.

While electro boilers may typically have lower upfront capital cost for the boiler itself, the cost of securing the necessary electrical connection capacity can materially increase the cost of the project. The bottom of our economic range ($250 / kWth) represents a project that can connect to the grid within existing capacity whereas the top of our range ($500 / kWth) represents a project where connect costs double the total project cost. Feedback from the market sounding process indicated that these connection costs can range from 40% to 200% of the capital cost of the boiler. These connection costs can be material barrier to electrification projects proceeding when users must fund these costs upfront and meet short term payback periods. When these additional costs are instead

spread over 25 years of useful life, they have limited impact on overall economics (~4% increase in unit delivered heat cost) particularly in comparison to the impact of fuel costs.

Electricity costs represent ~95% of the total delivered cost of electric process heat. A user's delivered electricity cost includes both the cost of the electricity and cost to deliver it to site via the transmission and distribution network. There is significant variability in both elements of delivered electricity cost across sites and users depending on their location and procurement strategy.

The bottom of our transmission and distribution cost range represents the average charge paid by a large user connected directly to the transmission network ($12 / MWh) whereas the top of our range represents a large user connected to an efficient distribution network ($30 / MWh).

Both ends of our economic range for electricity assume users can access long term supply contracts for electricity, with the bottom of the range aligning with estimates of pricing available via Meridian's process heat electrification programme ($55 / MWh) and the top of the range aligning with an estimate of the firmed long run cost of renewable generation ($80 / MWh). Current wholesale electricity pricing is significantly higher than both values. Section 5.1.3 explores the impact on the viability of electrification if these elevated prices continue.

There is also an opportunity to recognise the potential value that electro boilers could provide the electricity market by their flexibility of operation. Incorporating the ability to turn down demand from electrified process heat when overall demand for electricity is high could reduce the effective electricity price paid by process heat users below the above baseload values while reducing the prices paid by the rest of the market. Applicability of these sorts of structures will depend on the processing needs of end users but could be implemented as part of a suite of other process heat sources including existing coal, biomass, and natural gas assets.

Lowering the delivered cost of electricity will be key to enabling more users to transition to electricity. Section 5.1.3 examines the impact of decreasing electricity prices in more detail.

Electricity is currently more carbon intensive than biomass but less than coal and natural gas. If the electricity grid achieves 100% renewable generation or users contract directly with renewable generation projects, this will reduce exposure to increased carbon pricing.

Like natural gas boilers electro boilers do not require onsite storage of fuel, are highly controllable, leave no residues for disposal and have no fuel handling costs which contributes to lower operational / ongoing costs.

Heat Pumps

Heat pumps are already a cost-competitive low carbon alternative for low-temperature applications. While the upfront capital cost of heat pumps is greater than fossil fuel alternatives, high efficiencies result in a highly competitive total delivered cost of heat over the lifetime of the heat pump.

There are however factors that limit the application of heat pump technology including difficulty in applying it to high temperature applications and the need for existing excess heat sources to be available onsite.

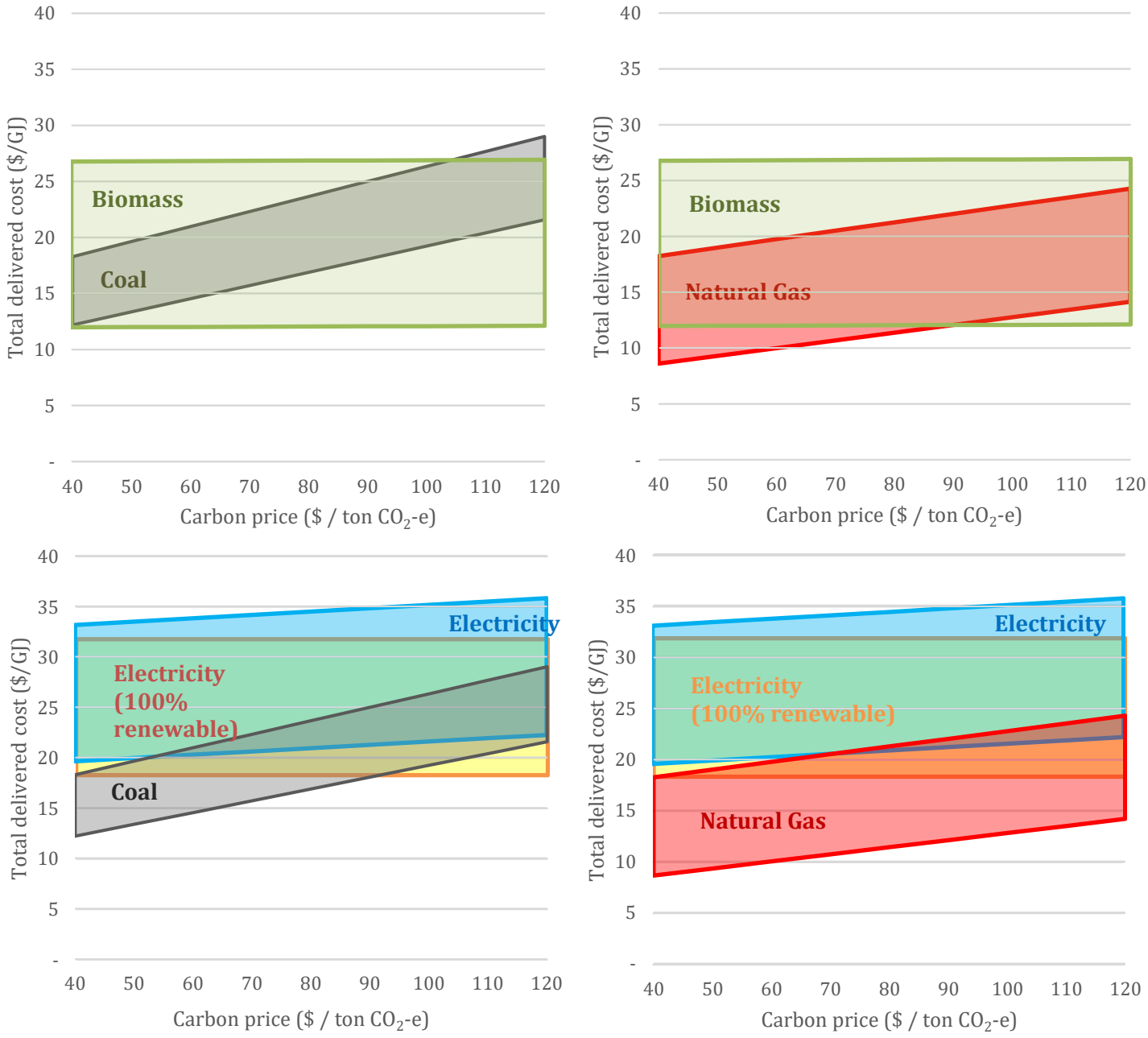
5.1.3 Path to cost-competitiveness

The variability of project-by-project economics means that while there are currently a range of projects where fuel switching currently makes economic sense, for many projects, switching from existing fossil fuel solutions to low carbon fuels would result in an increase in operating costs. This section explores a range of factors that could bring forward the economic tipping point for low carbon fuels. These include increases in carbon pricing or reduction in the cost of low carbon fuel supply.

There are also several pricing pressures which may impact the cost of natural gas and coal which are explored further in this section.

Carbon pricing

Figure 7 Carbon price impact on total delivered cost of process heat



We have used our illustrative cost ranges to generate a series of estimated economic cross over points between renewable and fossil fuel solutions in the table below:

Table 2 Carbon price at which renewable solutions become economic over fossil fuel solutions

	Biomass	Electric	Electric renewable
Least cost-effective coal Most cost-effective renewable	Already competitive	$53 / tonne	Already competitive
Most cost-effective coal Most cost-effective renewable	Already competitive	$128 / tonne	$92 / tonne
Least cost-effective coal Least cost-effective renewable	$104 / tonne	$188 / tonne	$141 / tonne
Most cost-effective coal Least cost-effective renewable	$166 / tonne	$290 / tonne	$207 / tonne
Least cost-effective gas Most cost-effective renewable	Already competitive	$72 / tonne	$41 / tonne
Most cost-effective gas Most cost-effective renewable	$89 / tonne	$340 / tonne	$180 / tonne
Least cost-effective gas Least cost-effective renewable	$156 / tonne	$394 / tonne	$220 / tonne
Most cost-effective gas Least cost-effective renewable	$309 / tonne	$722 / tonne	$374 / tonne

While carbon cost is not currently included in electricity pricing, the analysis above assumes that the users' cost of heat includes the cost of carbon associated with the current emissions intensity of the electricity grid. If users procure electricity directly from renewable projects or if the electricity generation market switched to 100% renewable electricity this would eliminate electricity's carbon profile. This would in turn reduce electricity's carbon price break even points against coal and natural gas.

Our indictive analysis highlights that the most cost-effective biomass projects are already cost-competitive with the most cost-effective coal projects. This is anecdotally supported by the successful conversion of several large-scale process heat projects from coal to biomass. The most cost-effective electricity projects, assuming no carbon cost is priced into the electricity price, are already cost-competitive with least cost-effective coal projects but require further carbon price appreciation to be competitive with the most cost-effective coal projects which also aligns with feedback received from market sounding participants.

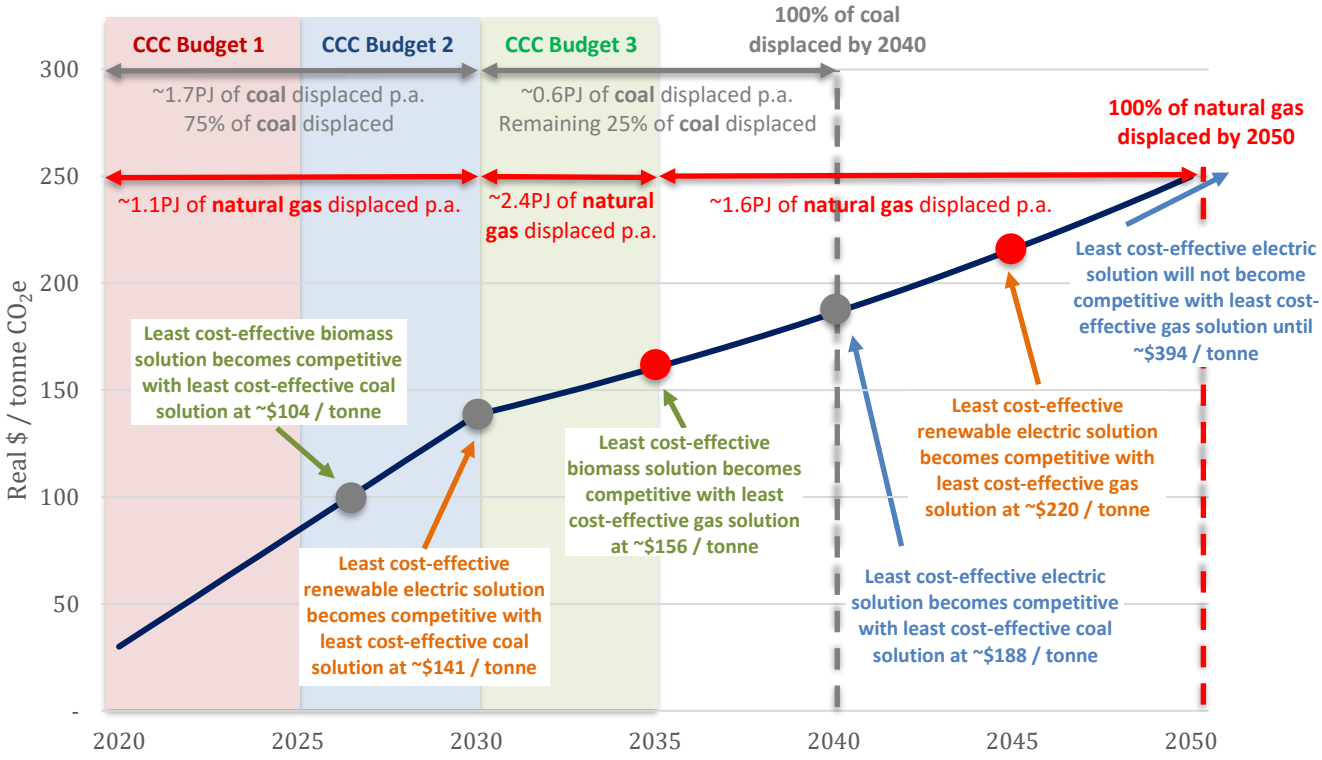
As the use of natural gas emits less carbon compared to coal, the total delivered cost of natural gas is less exposed to increasing carbon pricing. This pushes the carbon price break even points for natural gas higher than coal.

We have used the above illustrative analysis to estimate the carbon price that would be required to support widescale adoption of low carbon fuels. Given the variability of the economics for individual projects there will be a range of projects that are economically viable to switch at all carbon prices. To estimate at what point this range of economic projects is sufficient to support widescale switching activities, we have identified the point at which the highest cost biomass projects outperform the highest cost coal projects. At this point, based on our illustrative analysis, the entire set of potential economic outcomes for biomass projects sit within the economic envelop for coal boilers. While there will still be projects that are uneconomic at this point (e.g. a project which is a highly cost-effective

coal site but least cost-effective biomass site) the overlap should ensure there are sufficient projects in the range where economics overlap to support broad based switching activities.

This analysis assumes no energy efficiency or demand response improvements prior to fuel switching. Users who seek to increase energy efficiency may see carbon price break even points lowered. Improvements in demand response may also positively impact carbon break even points.

Figure 8 Emissions values for the energy sector applied by the Climate Change Commission's Demonstration Path to a low emissions future [11]



While this analysis is illustrative only and will not be representative of all projects or users, using the Climate Change Commission's forecast for emission values in their demonstration pathway, we can estimate when these illustrative trigger points may be reached:

- Biomass to coal target of ~$104 / tonne in approximately 2026
- Electricity to coal target of ~$188 / tonne in approximately 2040
- 100% renewable electricity to coal target of ~$141 / tonne in approximately 2030

Given natural gas' lower emissions intensity the equivalent illustrative carbon price targets may be reached:

- Biomass to natural gas target of ~$156 / tonne in approximately 2034
- Electricity to natural gas target of ~$394 / tonne in approximately 2070
- 100% renewable electricity to natural gas target of ~$220 / tonne in approximately 2045

The dates above suggest that if the fuel transition is driven primarily by increases in carbon pricing with no other economic triggers, New Zealand is at risk of not achieving targeted levels of emissions reductions.

This will require the phasing out of 75% of coal use by 2030 (within CCC budgets 1 and 2) and eliminating it completely before 2040. Achieving these targets require the transition away from coal

[11] Climate Change Commission, *'Ināia tonu nei: a low emissions future for Aotearoa'*, pg. 101, 31 May 2021

to commence immediately at scale, while the target carbon price for widescale conversions is only achieved in 2026 for biomass and 2030 for renewable electricity.

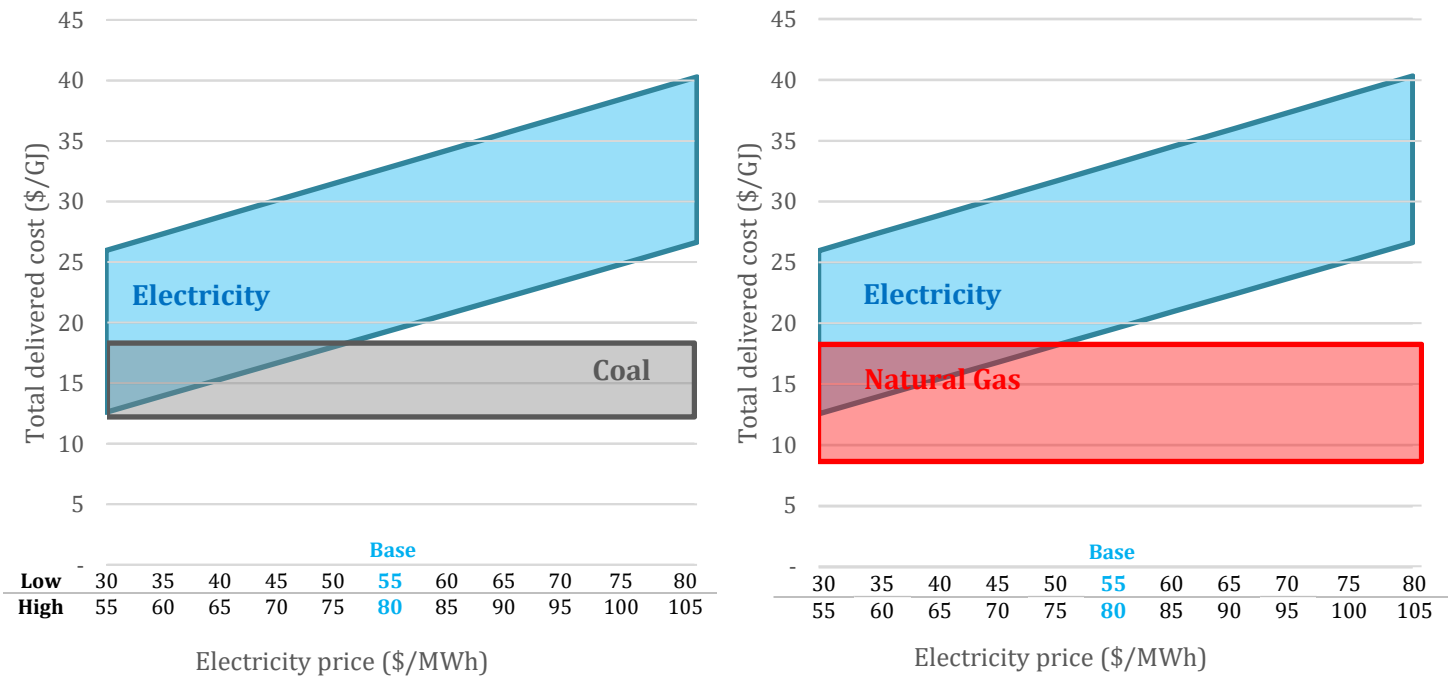
Targeted emissions reductions also assume that switching activities begin for natural gas immediately but do not ramp up till 2030 onwards, with 100% of natural gas displaced by 2050. The carbon price targets for widescale natural gas conversions are more challenging with these only achieved in 2035 for biomass and 2045 for renewable electricity.

The above analysis also only applies to investment in new equipment, we explore the impact of existing midlife assets on switching activities in section 5.1.4.

Changes in electricity pricing

Given the lower capital and operating costs of electro boilers the price at which users can get electricity delivered to site is ~95% of the total cost delivered cost of heat. There is also significant variability in electricity prices and transmission and distribution costs across users depending on their location, scale and procurement strategy. However, the economics for even the most cost-effective of electricity projects are challenging when compared to coal or gas-based solutions.

Figure 9 Total delivered cost of electricity with changes in fuel supply pricing



Note: electricity price on x-axis above refers to wholesale electricity costs only and doesn't include transmission and distribution costs which are added on top separately.

For large scale users who connect directly to the transmission network, electricity starts to become cost competitive with the most expensive coal at a total delivered electricity cost of ~$62 / MWh ($50 / MWh electricity cost).

Since the beginning of the 2021 calendar year wholesale electricity pricing has averaged ~$240 / MWh with elevated prices driven by a combination of low hydrology and increasing gas prices. While our analysis assumes that users can access long term electricity price contracts that align to closer to the long run marginal cost of either existing generation or newly developed firm renewables, availability

and pricing of these types of long-term contracts will also be dependent on overall wholesale market dynamics.

Electricity wholesale pricing will continue to be impacted on an ongoing basis by a range of factors including:

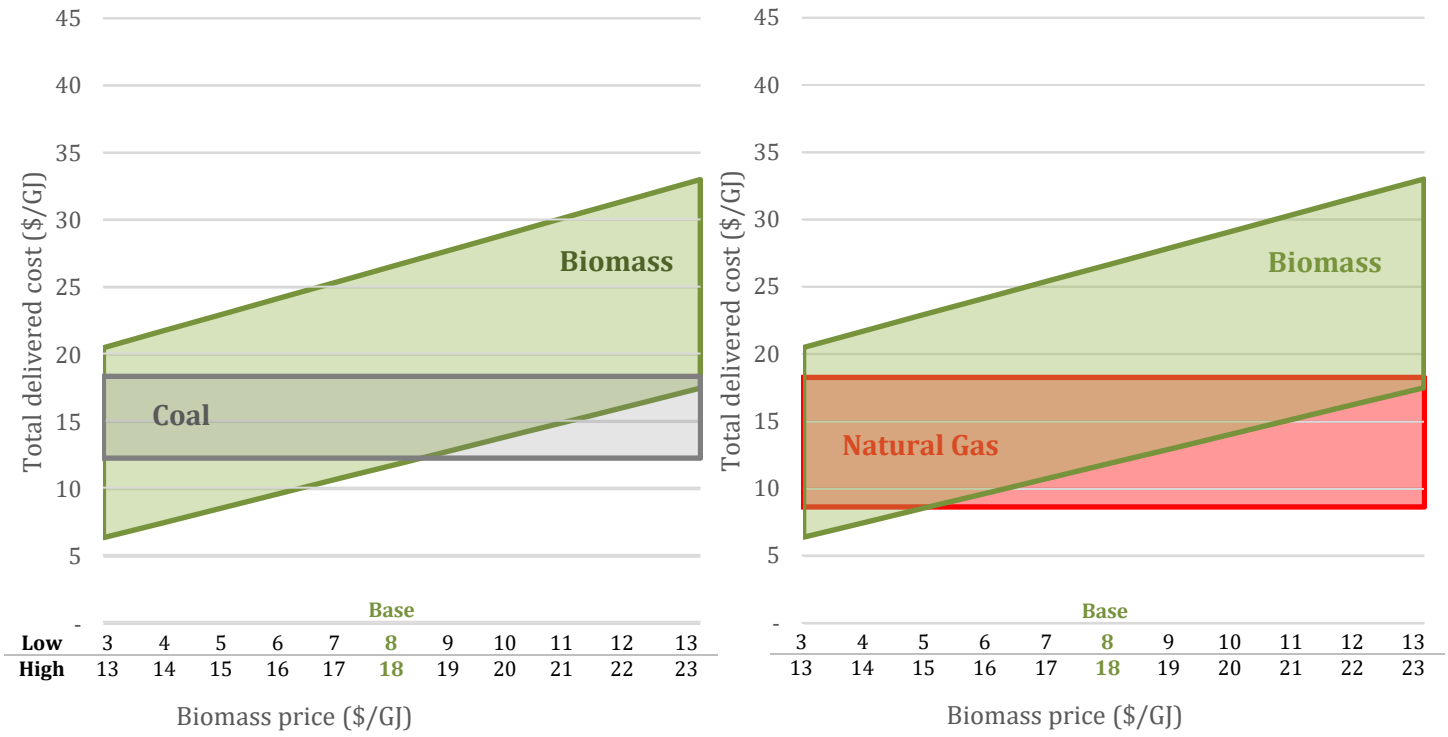
- **Variability in hydrology:** The amount New Zealand's hydro assets can generate in any given year is dependent on the amount of rainfall in their catchment regions and the amount of water in storage lakes, loosely referred to as hydrology. Over 50% of New Zealand's annual electricity generation is produced by hydro assets and as a result wholesale electricity pricing is heavily impacted by hydrology. The impacts of climate change are expected to increase the variability of hydrology over time which in turn could increase volatility in electricity wholesale markets.
- **Increases in demand:** Several market sectors are seeking to decarbonise through electrification which will increase electricity demand. Beyond the electrification of process heat the uptake of electric vehicles and hydrogen generation via electrolysis are expected to create significant additional demand for electricity. All other things being equal, increases in demand are expected to increase wholesale electricity prices.
- **Increase in supply:** The balancing item to increases in electricity demand is development of additional electricity generation. If development of new generation assets lags increases in demand this will drive increases in wholesale electricity pricing. There are several reasons which could cause a lag in the development of new generation:
  - Uncertainty created by the potential exit of large users like the New Zealand Aluminium Smelter at Tiwai Point and the resulting impact on long term electricity prices can provide a deterrent to new investment in generation capacity. This dynamic played out in the middle of 2020 when Tiwai announced its planned exit from the market. At this point most generation projects were put on hold, although following announcement of the extension of Tiwai's operations to the end of 2024 most of these projects are back under development
  - Development of new generation is triggered when pricing signals indicate that the asset will be able to generate sufficient revenue over its useful life to cover the cost of developing the asset. Without being able to sign a long-term offtake to sell the electricity produced by the assets through a Power Purchasing Agreement project developers often require a higher return which increases this pricing threshold and delays development of new generation
  - Even when pricing signals are sufficient to trigger development of new generation, there is a lag between the economic trigger point and completion of the project due to consenting and construction time frames. These timeframes can be significant for wind and geothermal developments but are shorter for solar
- **Cost of electricity supply:** The total cost of new generation is determined by a mixture of generation equipment, installation, balance of plant, network connection, property rights, operating and financing costs. While the cost of renewable generation equipment such as wind turbines and solar panels are expected to continue to decline the other delivery and operating components are expected to increase over time. Cost of financing depends on the overall level of risk in the generation development as well as prevailing interest rates. When these cost factors are considered as a mix the overall cost of generation is still expected to decline, but not as much as implied by reduction generation equipment prices. This should reduce the economic trigger point for the development of new supply over time.
- **Cost of electricity firming:** The electricity system needs to balance the total amount of electricity generation and demand to ensure the correct functioning of the electricity grid. Current dispatchable coal and natural gas assets play an important role in the electricity market as they can be easily turned up or down to match short term shifts in supply and demand as well as offset longer term changes in hydrology. Replacing these carbon intensive assets with intermittent renewable alternatives will both increase the amount of firming

required to balance short term fluctuations in supply and demand and require alternative solutions to mitigating variations in hydrology. Whether this is achieved via an overbuilding of renewable generation or deployment of other flexibility technologies like batteries or pumped hydro this will result in an increase cost of running the electricity grid which will need to be recovered through increased electricity prices.

Changes in biomass pricing

While the lowest cost biomass projects are already cost competitive against some coal and natural gas sites, there is also significant variability in biomass pricing driven by transport costs and uncertainty amongst some users around the long-term sustainable biomass price.

Figure 10 Total delivered cost of biomass with changes in fuel supply pricing



Based on our indicative analysis the lowest cost biomass solutions are already cost-competitive, or in many cases, cheaper than the highest cost coal solutions.

There are a range of factors that could improve biomass pricing over the long-term:

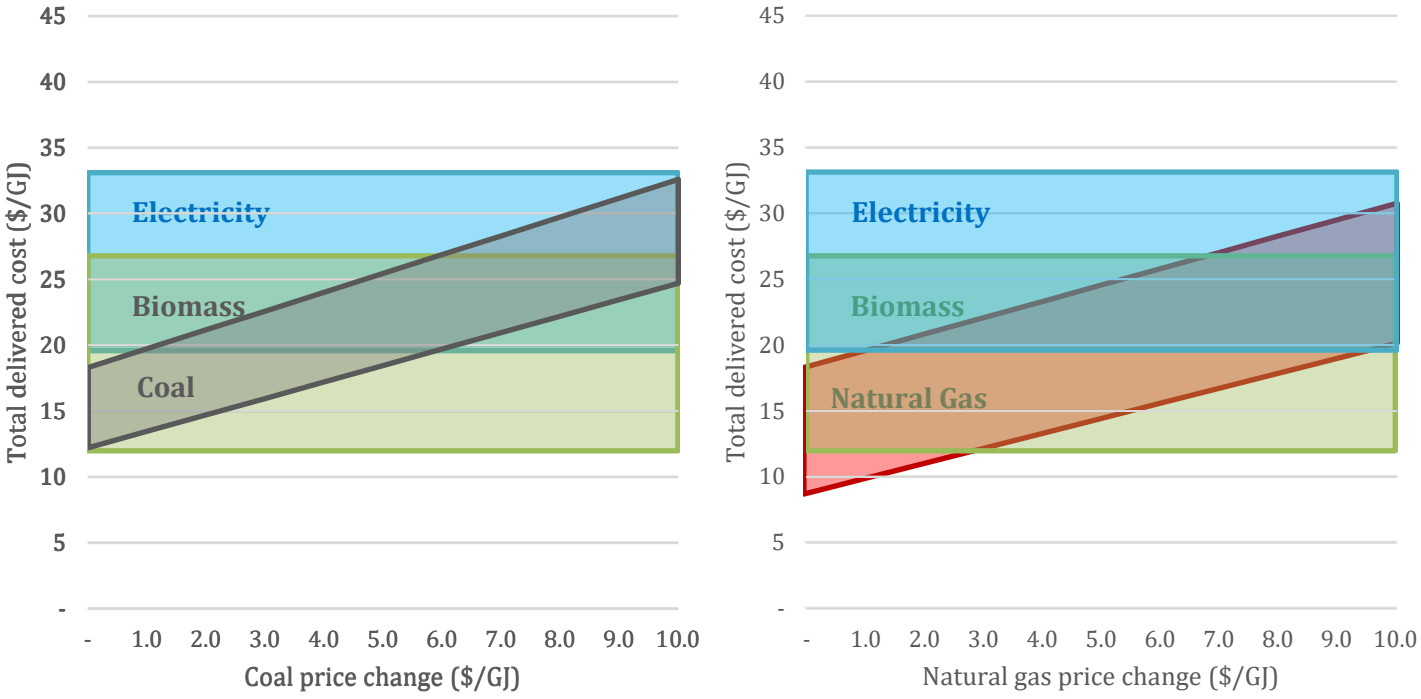
- Expansion of the biomass supply into additional regions across the country and expansion of domestic freight routes to help reduce transport costs associated with biomass fuel
- Investment into more onshore domestic wood processing to generate more process residue to be used as a low-cost input to biomass fuel production
- Investment to build capability to capture divert waste wood from landfill and forestry activities to be used as a low-cost input to biomass fuel production

There is also risk of demand for biomass outstripping the market's capacity to supply low-cost biomass, which could result in an increase in long-term pricing. Given current economic relativities appear to strongly incentivise users to switch to biomass over electricity there is potential that this dynamic in turn increases biomass fuel prices.

Changes in coal and natural gas pricing

There are many factors that may impact the wholesale pricing of coal and natural gas. The analysis below outlines the impact of changes in wholesale coal and natural gas prices on the cost competitiveness of electricity and biomass.

Figure 11 Changes in coal and natural gas pricing on the total delivered cost of fuels



The local market for natural gas and coal are currently impacted by a number of headwinds which may increase pricing, including:

- **Natural gas supply outages:** The wholesale market for natural gas is currently being impacted by declining production from the Pohokura production field. This has driven an increase in wholesale gas pricing from an average price of $5.70 / GJ prior to start of the production decline in 2018 to an average price of $13.50 in the last 12 months. While many large users of gas will have locked in long term gas contracts which have insulated them from the short-term impact of shifts in the wholesale market once these contracts roll off, they will be exposed to currently elevated gas prices. The bottom of our economic range at $6.50 / GJ aligns with a large user with access to a long-term contract while the top of our economic range at $13.50 represents a user paying current wholesale rates.
- **Stranded fixed costs:** As the market continues to decarbonise, the demand for coal and natural gas will reduce. There are significant fixed costs associated with the production, storage and transmission / delivery of coal and natural gas will still need to be covered by declining number of users as users transition off fossil fuels. This will result in the remaining users of coal and natural gas paying a higher delivered cost of fuel reducing the economics of fossil fuels.

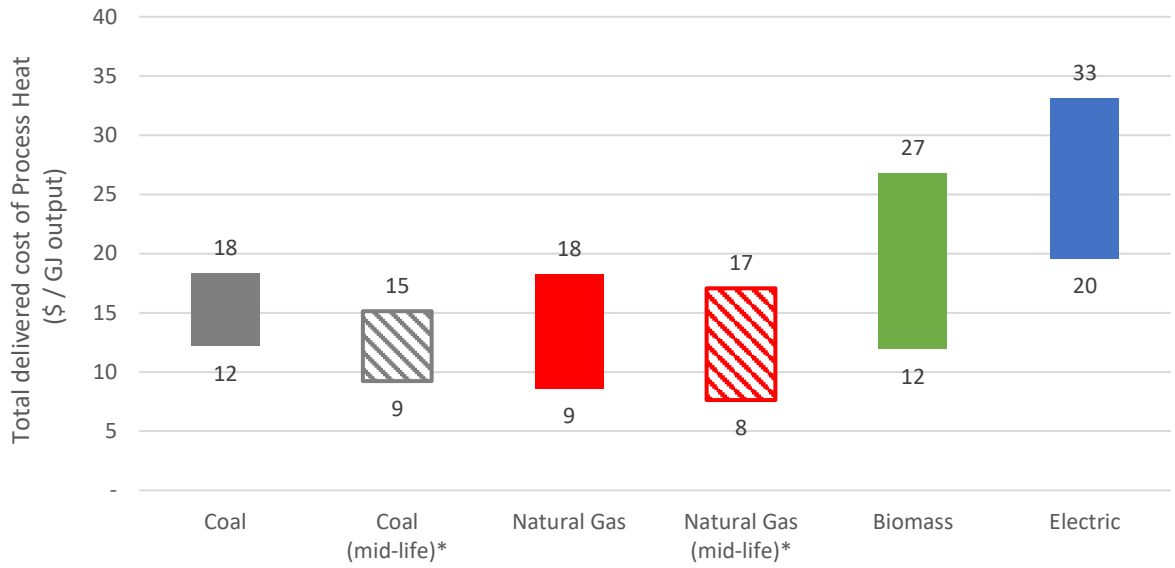
With their higher carbon intensities coal and natural gas are also more exposed to changes in carbon pricing which is explored in earlier in this section.

5.1.4 Early replacement of existing fossil fuel boilers

While capital costs represent a small proportion of the total delivered cost of heat, especially when spread over 25 years of useful life, several users have invested significant amounts of capital in existing fossil fuel boilers which are only partway through their useful lives.

While some of these boilers may be able to be retrofitted to use low carbon fuels, in particular via co-firing or converting coal boilers to biomass, this will not be possible for all sites and use cases. In this instance the economic trigger for replacement will be higher than those outlined in earlier sections as the capital investment in these assets are effectively a sunk cost. The graph below demonstrates the impact on our illustrative analysis of removing sunk capital investments from user's investment decisions by pulling out capital costs from the total cost of delivered heat for existing coal and natural gas assets.

Figure 12 Total delivered cost of process heat removing sunk capital investments for coal and natural gas

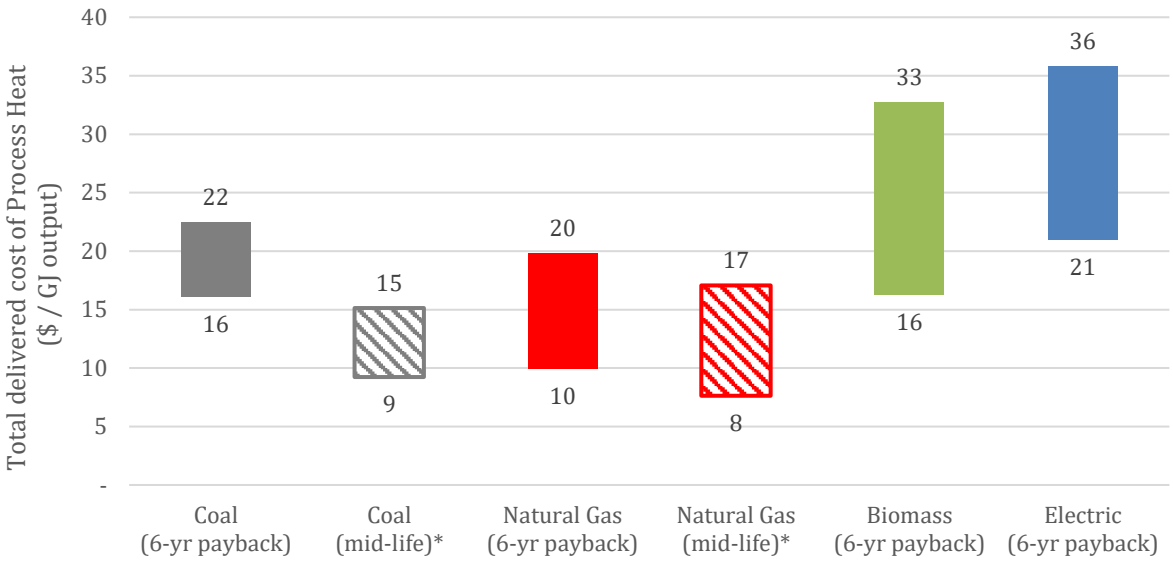


**Mid-life values calculated without the capital portion of the total delivered cost of process heat*

The removal sunk investment costs mean that investments in new biomass and electricity boilers would need to be on average 25% and 10% more cost-effective to trigger conversions from existing coal and natural gas boilers. This would push out the breakeven carbon price targets for biomass and electricity presented in the previous section, on average, by an additional ~~$20 / tonne for biomass and renewable electricity and an additional ~$30 / tonne for electricity.

Our illustrative analysis spreads the upfront capital cost of new low carbon boilers over an assumed 25-year useful life using a competitive WACC. As outlined in section 2.2.1, users typically seek to recover the cost of fuel switching projects over payback periods of one to six years rather than the 25-years assumed in our analysis. The graph below shows the relative economics of the different fuels if the upfront capital cost is recovered over six years instead of 25 years.

Figure 13 Total delivered cost of process heat comparing removing sunk capital versus 6-year payback threshold requirements



This further increases the breakeven carbon price targets for biomass and electricity by an average of $45 / tonne for biomass, $14 / tonne for renewable electricity and an additional $22 / tonne for electricity.

The combined impact of sunk investments in fossil fuel assets and shorter user payback periods would be to increase our illustrative breakeven carbon price and year for wholesale adoption for:

- **Biomass:** from $104 (2026) to $173 (2037) to replace coal and $156 (2034) to $253 (2050) to replace gas
- **Electricity:** from $188 (2040) to $246 (2049) to replace coal and $394 (2070) to $486 (2082) to replace gas
- **100% renewable electricity:** from $141 (2030) to $184 (2039) to replace coal and $220 (2045) to $271 (2053) to replace gas

The analysis above is intended to be illustrative only and wont representative of all projects or use cases. It also represents a worse-case scenario and excludes energy efficiency improvements that precede fuel switching. However, it is intended to demonstrate the potential impact on economic trigger points for users with existing investments and constrained investment criteria.

Minimising the impact of this delta and increasing the chance of achieving the Government's decarbonisation objectives will require:

- **Alternative commercial financing:** access to long term third-party financing solutions such as Heat as a Service which avoid users' short term payback periods by removing the upfront capital requirement, transferring fuel supply and pricing risk and maintenance obligations to third party providers
- **Retrofit existing fossil fuel assets:** identify opportunities to fuel switch, repurpose or cofire existing fossil fuel assets. Users should have the flexibility to implement the opportunities that best suits their business
- **Development of innovative solutions:** to realise value from existing fossil fuel assets. Some users have identified the opportunity to retain existing fossil fuel solution as back-ups or to provide operation flexibility to avoid periods where renewable fuel prices are high to improve operating economics

There are also a range of other economic factors, beyond the direct cost of heat, that may have an impact on the economic rationale for fuel switching. These factors may impact revenues, cost of

funding or other cost lines and as a result accelerate the economic tipping point for low carbon fuels. Some of these potential factors could include:

- **Tariffs on emission intensive products:** the EU and US have recently announced that they are considering imposing levies on emission intensive foreign goods. If these levies are broadly implemented and their scope is expanded to cover New Zealand's exports and scope two emissions this could either improve or reduce the international competitiveness of our exports depending on the relative emission intensity of New Zealand exports versus competitors. For example, this could support the competitiveness of the aluminium produced at Tiwai Point which uses 100% renewable electricity
- **Investor focus on sustainability:** institutional investors have an increasing focus on ensuring that companies they invest in have robust environmental, social and governance frameworks which include mitigating the carbon emissions associated with their operations. This is off the back of growing evidence that companies with a strong ESG proposition correlates with superior long-term financing performance.[12] An increasing number of investors have implemented mandate restrictions that exclude investing in certain carbon intensive industries like oil and gas. If these mandate restrictions expand to include companies with above average emissions profiles, process heat users will need to either need to decarbonise to retain access to the broader pool of green capital, or risk facing higher funding costs from a declining pool of available investors
- **Premium for sustainable products:** New Zealand's clean, green image has traditionally presented a competitive advantage for New Zealand exporters. Leveraging New Zealand's renewable fuel supply to decarbonise our exports will provide a tangible point of difference that supports our clean green image. This point of difference could support a price premium for New Zealand exports as consumers develop a growing awareness of the importance of the sustainable credentials of the products they purchase

[12] W. Henisz, T. Koller and R. Buttall, *"McKinsey Quarterly: Five ways that ESG creates value"*, Nov 2019

6 The need for Government intervention

Our illustrative analysis indicates that if New Zealand relies on carbon pricing as the primary economic incentive to drive process heat fuel switching, there is risk that New Zealand will not keep pace with scale of process heat decarbonisation in the Climate Change Commission's budgets. While our analysis is indicative only and there are a variety of economic factors and cost pressures outside of carbon pricing that may accelerate this tipping point, headwinds also exist in the supply chains for electricity and biomass which could in turn cause delays. Leaving the timing of the fuel transition primarily to economic drivers and carbon pricing increases may also increase the overall cost of the fuel transition.

The market sounding has identified that there are significant capacity constraints across the New Zealand fuel switching supply chain. This means that even when the economic incentives start to align to incentivise fuel switching it may take an extended period to physically implement the transition. This will result in process heat users potentially paying significantly more for process heat for an extended period. This limited market capacity also makes the imposition of regulatory deadlines to transition away from fossil fuels challenging unless combined with support for users and the market to achieve an efficient transition.

An increased cost of heat will not only impact process heat users but will erode New Zealand's international competitiveness, reducing export earnings as well as increasing the cost of goods and services for New Zealand citizens. This cost may also manifest in New Zealand needing to buy offshore carbon credits to meet its Paris carbon reduction obligations. Purchasing offshore credits, rather than investing in local decarbonisation projects will further erode New Zealand's international competitiveness.

Ultimately the cost of an inefficient fuel transition will be borne by everyone in New Zealand.

Government intervention to bring forward the economic tipping point of fuel switching, supporting the development of market capability and removing non-economic barriers is important to deliver a lowest cost and orderly fuel transition for the nation. There is also international competition for the expertise and manufacturing capability necessary to support the fuel transition. If New Zealand is behind the curve on fuel switching, it risks being stuck behind other economies in accessing this critical resource.

There is also potential that without Government coordination, user's individual economic incentives may lead to inefficient outcomes for the overall market. For example, current economic incentives favour biomass as the primary low carbon fuel. There is a risk that without intervention, the market will predominantly switch to biomass-based solutions. As outlined elsewhere in this report, if the resulting demand outstrips the supply of economic biomass fuel this could lead to the cost of biomass-based heat becoming economically inefficient. Given boilers are long term investments, users and the market would then face a significant cost to rebalance the mix of process heat between electricity, biomass and other renewable fuel sources.

There are also several areas where the Government is one of the only parties able to address certain key barriers identified through this sounding, including:

- Regulatory intervention in the electricity distribution and transmission markets
- Ability to invest ahead of future demand or prior to the commercialisation of supply chains
- Ability to recognise the value of positive externalities that provide a benefit to the wider economy
- Being a trusted party with the ability to influence market behaviour through policy and education

The next section sets out a summary of the areas of Government intervention sought by participants of the market sounding. Section 8 sets out a summary of the potential areas where industry can support the fuel transition. Section 9 sets out a range of key recommendations for consideration by the Government that could meaningfully accelerate fuel switching in New Zealand.

7 Government support sought by participants

This section sets out a summary of the areas of Government intervention sought by participants of the market sounding. As set out earlier in this report the summary in this section reflects the views of the participants engaged through the market sounding process and may not be reflective of the view of small to medium enterprises or the broader market.

While the summary below is detailed, it covers the key areas of intervention sought by participants and is not an exhaustive list of all topics covered in the market sounding.

7.1 Access to capital

7.1.1 Expansion of the GIDI fund

Government grants were highlighted through the market sounding as the most straightforward way to improve project economics for large users. All participants were supportive of the continuation and expansion of the GIDI programme and highlighted that the application process had successfully accelerated the evaluation of and commitment to a range of projects.

In terms of recommended changes to future rounds of the GIDI fund:

- Increase the amount of funding available, potentially fund this increase via recycling proceeds from the Emissions Trading Scheme
- Focus GIDI funding on demonstrator projects which can be used as case studies to educate the market
- Streamline application criteria with the key criteria being identifying projects which deliver the lowest cost carbon abatement

7.1.2 Support for alternative commercial structures

Participants acknowledged that the scale of the capital required to fund the transition from coal and natural gas was such that Government grants in combination with users' available capital are unlikely to be sufficient to deliver transition at the pace required to meet New Zealand's carbon abatement commitments.

Large users engaged through the market sounding also highlighted the relative unattractiveness of Government loans, given their access to comparatively attractive sources of bank financing.

What users did highlight is that alternative financing structures are not currently viewed as attractive. Government assistance would be helpful to support development of attractive and fit for purpose alternative commercial structures like Heating as a Service which can tap the significant pools of private capital seeking to aid in the carbon transition.

Using alternative commercial structures to spread the cost of the fuel transition over the useful life of the boiler assets and avoiding user's shorter payback periods will support acceleration of the economic trigger point of transition.

7.2 Electricity supply barriers

7.2.1 Identify existing electricity network capacity

In terms of capital cost of electrification, the most efficient opportunities will be in areas of the electricity transmission and distribution network which have spare capacity to accommodate electrification projects without any upgrade of the network.

Participants identified that there is not currently a resource that outlines where there is spare capacity in the electricity network. This results in users needing to spend significant time and cost working with distribution networks to establish whether their electrification strategy is viable.

Establishing a nation-wide electricity distribution network map with up-to-date estimates of regional availability of spare capacity would assist industry in focusing electrification efforts in these areas.

7.2.2 Electricity connection regulatory reform

All participants in the market sounding process identified securing an economic connection to the electricity grid as a material barrier to large scale electrification projects.

Participants highlighted that reform is needed both to standardise the process for users to apply for a connection to the electricity distribution network and with regards to how the cost of this connection is calculated, apportioned and recovered from current and future users.

Important to ensure that users who trigger upgrades are only paying their proportional share of upgrade costs rather than being penalised for capacity which is being installed to accommodate future connections to the grid - commonly referred to first mover disadvantage.

7.2.3 Connection cost funding support

Participants also sought Government funding support to provide concessionary financing to spread the cost of electricity network capacity upgrades for process heat electrification across the useful life of upgraded assets.

The concessionary nature of this funding support would not only make grid upgrades more economic versus funding the cost upfront or via connection agreements with Transpower / local distributors, but this funding could also be used to prefund connection costs which will be recovered from future connections to the distribution network.

7.2.4 Distribution pricing reform

Current regulatory regimes provide certainty regarding the total cost of running the transmission and distribution networks. Participants highlighted however that there is significant ongoing uncertainty around how these costs are allocated and recovered from different users over time. This is most noticeable with the level of pricing discretion currently afforded to different distribution networks.

This uncertainty impacts users' ability to build business cases around electrification as it makes it hard to forecast the total delivered cost of electricity over time, a key component of the total cost of heat.

Providing standardised pricing and cost allocation methodologies which apply across all electricity distribution networks would materially reduce user uncertainty and improve the appeal of electricity

projects. This could be via implementing a similar approach to pricing and cost allocation used for the Transmission Pricing Methodology.

7.2.5 Supporting access to low-cost electricity

The economic viability of electrification is heavily dependent on users being able to secure access to low-cost electricity. Some participants indicated that for electrification to be cost competitive it would require an electricity price below $50 / MWh.

Current wholesale electricity prices are materially higher than the levels required for economic switching to electricity. Current elevated prices have ultimately driven by a scarcity of electricity supply caused by a combination of low hydrology, restricted gas supply and periods of low wind.

To ensure that current elevated pricing levels do not continue or repeat themselves in the future will require development of a diversified portfolio of renewable generation to expand electricity supply and reduce exposure to fluctuations in the availability of any one fuel source.

Some participants were in favour of the Government providing support to ensure that the development of new renewable generation happens at the pace required to balance both the transition away from existing thermal generation and increasing electricity demand from electrification of transport and industry to support downwards pressures on electricity prices.

This could be through facilitating the development of an efficient Power Purchasing Agreement market of scale in New Zealand, updating Government procurement practises to support development of renewable generation and via education programmes aimed at communicating the benefits of directly procuring electricity from additional renewable projects.

7.3 Biomass supply barriers

7.3.1 Expand New Zealand wood processing

Certain types of onshore wood processing create process residue which is the cheapest input for the creation of low-cost biomass fuel. Participants were all in favour of any support mechanisms which would increase the level of onshore wood processing. Providing support to aid in the expansion of onshore wood processing is consistent with the Ministry for Primary Industries long term strategy for the New Zealand forestry section and will also increase export revenues and expand the supply of cheap biomass.

Participants acknowledged that expansion of the onshore wood processing sector has been a longstanding goal and that further work would need to be done to identify the avenues of support which would most effectively trigger the development of additional onshore processing capacity and the requisite export markets, with a particular focus on processed wood products that support the creation of inputs for additional low-cost biomass fuel.

7.3.2 Fund waste wood development

As outlined earlier in this report another potential source of low-cost input for biomass fuel is to utilise waste wood from forestry activities and untreated construction waste which currently represents a cost for the economy.

Participants were supportive of Government funding support to establish the economic opportunities to recover this waste wood for use as biomass fuel. Government funding has previously been provided

via the Waste Minimisation Fund to support the creation of landscape products from waste wood. Application of similar funding to process this waste wood into biomass fuel would support expansion of fuel supply.

7.3.3 Government procurement of biomass

Participants highlighted the importance of the Government's role in promoting the adoption of biomass fuel through its own procurement practises. Participants supported the Government championing the viability of biomass by immediately replacing existing coal procurement with biomass.

7.4 Lack of industry wide coordination

7.4.1 EECA sharing process heat best practise

Participants were highly supportive of the continued role for EECA as a trusted source of case studies which provide detailed technical and operational data from demonstrator projects which demonstrate the economic and technical viability of low carbon alternatives.

Participants also had suggestions to expand the current suite of tools made publicly available by EECA to support users in identifying what are likely the most effective fuel switching options for their specific site or use case. This could include the following information to help users estimate the total delivered cost of heat for different fuels:

- Regularly updated estimates of currently contractable long term fuel prices for both biomass and electricity. Pricing should be regional and demonstrate the estimated impact of transport costs for biomass and local distribution pricing for electricity
- Regularly updated forecast of carbon pricing
- Estimated efficiencies and capital cost of different fuel solutions
- Local electrical network spare capacity in the user's region

This could materially accelerate users' identification of the most efficient fuel switching solution for their site, reducing the cost of the fuel transition.

Some participants also suggested that EECA could explore avenues to support education, at a senior governance level, on managing exposure to fluctuations in fuel prices as part of their treasury function and alternative approaches to financing decarbonisation projects. This education should focus on the risks and benefits of alternative commercial structures and long-term contracting for electricity and biomass supply. Supporting this education with detailed case studies of successful transactions will be key to providing users with confidence to adopt similar approaches.

7.4.2 Natural gas as a transition fuel

Certain participants highlighted that the transition of the existing coal assets in the New Zealand economy already presents a significant challenge to fuel switch by the 2037 deadline. They outlined the importance of maintaining existing natural gas boilers as an economic option for process heat while the economy focuses on transitioning away from coal to ensure that New Zealand maximises the pace and cost efficiency of its carbon abatement.

Recent increases in the wholesale price of natural gas are eroding its viability as an economic transition fuel. If natural gas prices continue to increase either due to supply challenges or by spreading fixed costs over a declining user base this may create the economic incentive to switch natural gas process heat ahead of the more carbon intensive coal process heat. Given the market's capacity constraints

to accommodate fuel switching activities this may result in coal switching efforts being deferred. If coal switching projects are deferred in favour of natural gas this would present a risk to achieving the Climate Change Commission's decarbonisation targets, which currently prioritise switching from coal up to 2030.

While Government support of natural gas may seem counter intuitive to supporting decarbonisation it may be necessary to ensure fuel switching of coal is prioritised.

7.4.3 EECA coordination of fuel switching transition

Given the scale of the fuel switching challenge, Participants were supportive of an ongoing role for EECA to ensure that the most economic fuel switching projects are identified early and then provide the support required to be executed early. This support and coordination will be important to establish a consistent pipeline of fuel switching projects around which suppliers can then build additional capacity. This support could be via an allocation from the GIDI fund, or any other future forms of Government support.

7.5 Economic challenges

7.5.1 Providing carbon price certainty

Participants highlighted that for carbon pricing to act as an effective mechanism to incentivise decarbonisation users need certainty around the future path for carbon price. The scenarios provided by the Climate Change Commission provide a helpful resource for users to assess the potential impact of future increases in carbon pricing on fuel switching business cases. Ensuring there is a regularly updated set of forecasts for emissions values or scenarios published either by the Climate Change Commission or another trusted Government entity will be important to making sure the impact of carbon pricing is not purely reactionary.

7.5.2 Supporting access to low-cost electricity, biomass and commercial financing

As outlined in section 2.2.5, participants highlighted that the key driver of the economics of fuel switching project was the ability to access low-cost fuel renewable fuel supply. To improve the economic tipping point for fuel switching projects requires facilitating access to low-cost fuel supply.

As outlined in section 2.2.1, participants also understood the challenge that short term internal payback periods presented to the economics of fuel switching. Facilitating access to attractive alternative commercial structures will be another avenue to improve the economic tipping point for fuel switching projects.

7.5.3 Economic support for fuel switching projects

As outlined earlier in this report, the economics of fuel switching can vary significantly with projects loosely categorised into three categories:

- projects that are currently economic and will switch
- projects that will become economic in the short to medium term, and
- projects that are unlikely to be economic for an extended period even with significant levels of support

While this section outlines several avenues through which the Government could support the acceleration of the economic tipping point of fuel switching projects, Participants highlighted that

there will still be projects where fuel switching is still uneconomic, particularly where users have existing assets which are not end of life.

Participants were supportive of additional economic support to help neutralise the increased cost for uneconomic fuel switching projects, with a preference for:

- **Accelerated depreciation:** either accelerated depreciation on new renewable assets or tax write offs recognising the value of existing fossil fuel assets that are being replaced
- **Government grants:** for example, via expansion of the GIDI fund as referenced in section 7.1.1
- **Discounted transmission pricing:** reducing the Government's return requirement for Transpower to decrease transmission costs and improve the economics for electrification

7.6 Technical challenges

7.6.1 Development of the New Zealand supply chain

Participants highlighted through the market sounding that the capacity of the New Zealand supply chain to deliver large low carbon boilers is a significant constraint with only two local suppliers who can deliver one to two large boilers each per year. There are also further dependencies on international manufacturers for inputs for these boilers, with these international manufacturers also having capacity constraints which New Zealand users will need to compete against other countries for. Constraints are not just in the manufacturing sector a significant step change in the availability of technical and consulting expertise will be required to deliver the scale of process heat decarbonisation required to meet the Climate Change Commission's proposed demonstration pathway.

The need for Government support to develop the manufacturing capability and expertise required was highlighted by participants. The first step to developing this additional capacity will be to ensure that Government policy and statements support process heat fuel switching projects. This is important to ensure that all participants in the fuel switching industry have certainty around the forward pipeline of projects so they can invest in the people and manufacturing capacity required to deliver that pipeline.

7.6.2 EECA coordination of fuel switching transition

The description of Participants' support of EECA's role in coordinating the fuel switching transition in section 7.4.3 would also help ensure that the most effective use of the available capacity in the New Zealand fuel switching supply chain. This echoed various participant's support of prioritising projects and users with lowest cost abatement opportunities.

8 Recommendations for industry

Decarbonisation of New Zealand's economy will require coordinated effort by both the Government and industry. This section sets out a summary of the areas identified through the market sounding process where there are potential opportunities for process heat users to support the acceleration of fuel switching by adopting alternative practises.

Existing practises vary significantly across industry so the potential opportunities presented in this section will not apply or be available to all process heat users or may have already been adopted.

8.1 Access to capital

8.1.1 Move away from payback periods

Through the market sounding process, participants consistently highlighted the difficulty of finding fuel switching projects that met internal payback period requirements which typically range from one to six years. Several participants highlighted that projects with sustainability benefits had board support to be assessed against longer term payback periods than standard investments recognising the non-financial benefits of sustainability projects.

While the adoption of extend payback periods for sustainability projects is an encouraging sign, the use of payback periods as the key criteria for assessing sustainability projects is potentially overly simplistic, understates the importance of sustainability and fuel switching projects and reduces the likelihood of New Zealand achieving its decarbonisation targets.

Along with evaluating whole of life economics for fuel switching projects as outlined in section 5.1, users' business cases should also consider the broader set of potential risks associated with retaining existing fossil fuel solutions and the potential benefits associated with switching to law carbon fuels.

We have outlined below a range of additional factors that users could consider when developing fuel switching business cases:

- Reduced exposure to future increases in New Zealand carbon pricing or the application of carbon tariffs by international trading partners
- Reduced exposure to future increases in the cost of carbon intensive fuel sources or loss of access to carbon intensive fuels as users transition to low carbon alternatives
- Reduced exposure to the cost or risk of needing to comply future with consenting or regulatory requirements associated with existing fossil fuel solutions
- Avoiding additional investment in upgrading or maintaining fossil fuel-based equipment which may become obsolete due to future regulatory requirements
- Risk of being unable to secure future capacity to enable fuel switching projects if deferred and associated increases in cost. This could equally apply across biomass (securing low-cost long-term biomass supply contracts) and electrification projects (securing existing available connection capacity or taking advantage of long-term electricity supply contracts)
- Increased investor focus on sustainability and ESG outcomes is progressively being passed down as more active sustainability requirements on investee companies. Failing to meet these requirements may result in investors or lenders applying high return requirements or ceasing to provide funding. Implementing fuel switching projects ahead of regulatory requirements may also provide users with access to the significant pools of green capital seeking to support global decarbonisation efforts, which may come with lower funding costs
- Retaining existing fossil fuel assets risks a loss of social licence which may reduce access to key markets or resources. Consumers and staff are becoming increasing discerning regarding the carbon and sustainability profile of the products and companies they choose

to support. Increasing the sustainability credentials of products may also enable users to charge a premium if competitors have a higher carbon profile

- Reduces exposure to climate change litigation risk. Globally there are litigation proceedings that seek to recover the cost of responding to climate change from the entities which have significantly contributed to it. For example, in the United States there are several proceedings that have been lodged against the oil and gas industry. Acting early to mitigate carbon emissions via fuel switching projects is one way to mitigate the risk of future litigation

Including these additional climate change / sustainability criteria and the associated implications of retaining existing fossil fuel solutions when assessing fuel switching projects could materially bring forward the economic tipping point of fuel switching projects.

8.1.2 Explore alternative commercial structures

For users with fuel switching projects that are unable to secure a capital allocation (even post adopting the recommendations in the previous section) there is an opportunity to engage with providers of alternative commercial structures who may be able to fund the project in a way which does not impact internal capital allocations.

As outlined elsewhere in this report, alternative commercial structures will require users to make a long-term commitment to the project and may require the user to relinquish control and ownership of the process heat equipment, particularly if users want these arrangements to sit outside of banking covenants. If process heat users are near other businesses with heat requirements, alternative commercial structures can be a particularly efficient way to deliver heat and potentially electricity for multiple users through district heating schemes, reducing the cost of heat for all users.

The market sounding has identified there are counterparties and capital providers that are committed to facilitating alternative commercial structures that deliver target outcomes for all parties. Counterparties will need to remain flexible and open-minded to different ways of operating and approaches to asset ownership.

8.2 Electricity supply barriers

8.2.1 Engage early with electricity distributors and Transpower

The cost and time required to secure a connection to the electricity grid to support electrification projects can be material and potentially prohibitive. Prior to investing significant time or resources in exploring electrification opportunities users should engage with the relevant local electricity distributor and / or Transpower to understand, if possible, the available connection capacity and the indicative cost of securing additional connection capacity.

This early engagement will assist users in determining whether electrification is likely to be feasible or whether to focus on alternative renewable fuel solutions.

8.2.2 Seek long term arrangements for electricity supply

As outlined elsewhere in this report the cost of electricity is the key cost input for electrification projects. Recent elevated wholesale electricity pricing and the potential for increased volatility as New Zealand retired thermal generation assets presents a challenge to the economics of electrification projects. This does however present an opportunity for process heat users to reform their existing electricity procurement practises and instead of hedging electricity exposure through

short-fixed tariff contracts to contract for electricity on a longer-term basis directly with renewable generation.

The pricing of long-term electricity supply contracts from projects seeking to develop new renewable generation is reflective of the cost of developing that project rather than current wholesale market dynamics. Pricing for long-term supply contracts for renewable projects are at a discount to current wholesale prices. These long-term electricity supply contracts are also key to enabling the construction of these projects as it supports them to access long term financing.

There are several well publicised renewable development projects that users could engage directly with, alternatively the Major Energy Users Group is running a process to assist some of its members to access renewable power purchasing agreements. Alternatively, users could engage with electricity retailers in the market with existing generation assets, such as Meridian Energy, who are offering competitive 10-year contracts as part of their Process Heat Electrification Programme.

Fuel procurement should be managed on a long-term basis as part of each user's treasury function, rather than via procurement departments. Users should evaluate the trade-off between achieving additional price certainty via long-term contracting versus loss of flexibility to respond to market changes. Users should shift away from standard market practises of contracting for fuel supply on a rolling three-year basis to progressively hedging fuel exposure via a series of long-term contracts over multiple years.

8.3 Biomass supply barriers

8.3.1 Engage early with biomass suppliers

As outlined elsewhere in this report the delivered cost of biomass supply is the key cost input for biomass projects. The delivered cost of biomass can vary significantly between projects and users depending on each site's distance from biomass suppliers (determines delivery costs), size of their biomass supply requirements, term of supply contract sought and each supplier's available capacity. Prior to investing significant time or resources in exploring biomass conversions, users should engage with suitable biomass suppliers to understand the delivered fuel cost and implications of this on the viability of conversion to biomass.

Early engagement with a well-suited supplier will assist users in determining whether biomass is likely to be feasible fuel source or whether to focus on alternative renewable fuel solutions.

8.3.2 Seek long term arrangements for biomass supply

The marketing sounding identified that there are biomass suppliers who are prepared to offer long-term supply agreements to biomass fuel users. When investigating biomass fuel switching projects users should explore the possibility of entering longer term supply arrangements rather than shorter term rolling supply contracts. These long-term arrangements provide additional certainty for both process heat users and suppliers. This certainty not only helps process heat users to develop the long-term business case for biomass fuel switching but has flow-on benefits on the ecosystem by providing suppliers with the certainty around future demand for their product enabling them to invest in the further development of the biomass fuel supply chain.

Biomass supply arrangements should also be incorporated into user treasury functions in line with the recommendations for electricity supply in section 8.2.2.

8.4 Lack of industry wide coordination

8.4.1 Champion decarbonisation commitments and successful projects

Users who already have internal decarbonisation commitments should ensure the details and pathways are publicly known and available, not only for market and branding benefits of demonstrating this leadership, but to enable and encourage other users, such as SMEs to develop their internal commitments in similar ways.

The importance of detailed case studies on fuel switching initiatives was highlighted by participants of the market sounding. While participants indicated they are typically are happy to share learnings from projects with other users if approached and most publicise their key projects through case studies, detailed information on these projects is not typically publicly available. To assist users in developing an initial understand of fuel switching solutions it is important that these case studies include sufficient detail for other users to make an informed assessment of economic and technical applicability of the solution to their business.

This information could include:

- Detailed breakdown of the total capital cost of the project which captures all ancillary costs required to deliver the project (e.g. professional fees plus ancillary works like network connections or retrofitting costs)
- Manufacturer technical specifications for the chosen process heat solution
- Key operating metrics such as utilisation, fuel usage, output, achieved efficiencies, maintenance downtime, maintenance costs, operating requirements, and operating costs

We appreciate that depending on the user some of the above information may be viewed as proprietary. Ultimately the more detail that is publicly available on the actual upfront and ongoing cost of renewable process heat solution will help dispel the view held by some users that these solutions are not viable replacements for current fossil fuel solutions.

8.4.2 Develop a fuel decarbonisation pathway

The economics of fuel switching range from projects that are already currently economic, to projects that will become economic in the short to medium term, to projects that are unlikely to be economic for an extended period.

Process heat users would need to undertake the work required, such as feasibility and engineering studies, to:

- identify and prioritise the most economic opportunities for energy efficiency, decarbonisation and fuel switching
- understand current state of business' energy use
- understand business exposure to changes in carbon price and how it will impact the economics trigger point for fuel switching opportunities in their portfolio of assets

Users are then able to develop an informed, business-specific fuel decarbonisation pathway that aligns with the Government's decarbonisation targets, the Climate Change Commission's emissions budgets and the individual business' sustainability goals to 2050.

For most large process heat users, the scale of fuel switching challenge is significant. By developing a fuel decarbonisation pathway and prioritising the most economic projects, businesses can ensure that limited internal resources are being used in the most cost effective and proactive manner to deliver internal sustainability targets, rather than on a reactive basis once regulatory requirements and increased carbon pricing kicks-in.

EECA's ETA programme could help fund up to 40% of the cost of an initial opportunities assessment to produce a strategic roadmap.

8.5 Economic challenges

8.5.1 Invest in energy efficiency projects

Investing into energy efficiency projects is often one of the most cost-effective ways to reduce a site's overall energy demand and emissions levels. These projects will play an important role in delivering emissions reductions in hard-to-abate sectors. The Climate Change Commission's demonstration path assumes significant improvements in energy efficiency across the food processing sector, averaging 1.1% per year. It is expected that the increasing focus on identifying incremental energy efficiency opportunities will drive increased demand for technical expertise creating more employment opportunities.

Undertaking energy efficiency projects prior to fuel switching can also help reduce the cost of fuel switching, accelerating the economic tipping point for fuel switching projects.

8.5.2 Develop an internal carbon price forecast

Some participants in the market sounding indicated that they have an internal set of carbon price forecasts which they regularly revise and that they use these forecasts when evaluating fuel switching projects. However, the market sounding indicated that this approach is not widely adopted by industry.

As outlined elsewhere in this report, future increases in carbon pricing are expected to be a significant driver of fuel switching activity. When investigating the feasibility of fuel switching projects all process heat users should be factoring in the cost of an increasing carbon price and the resulting cost impact on existing fossil fuel solutions.

All process heat users are encouraged to develop capability and knowledge to form internal carbon price forecasts, which are regularly updated and are supported by senior decision makers. The CCC's carbon pricing scenarios provide a useful starting point for process heat users looking to develop an internal forecast of emissions values.

8.5.3 Evaluate whole of life economics

When evaluating investments in fuel switching projects users should consider the investment over the useful life of the asset rather than just against the current economics of the status quo solution.

As outlined elsewhere in the report, the variability in the assumptions and use cases for individual fuel switching projects means that the underlying economics of fuel switching projects will also vary significantly. Expanding the definition of what is the criteria for a fuel switching project to be deemed economic from projects that deliver day one operation savings to projects that deliver sufficient savings over their useful life will bring forward the economic tipping point of fuel switching projects.

Investment analysis should factor in:

- Forecast increases in carbon pricing (as outlined in section 5.1.3)
- Future increases in wholesale prices for fossil fuels (driven by declining supply and stranded infrastructure)

- Cost of maintaining and operating existing aging assets
- The risk and cost of future regulatory intervention
- The limited capacity of the fuel switching supply chain, which may either drive delays in future switching activities (result in users incurring higher costs from the economic tipping point) or increase cost of future switching activities

It is important that this assessment captures the various factors outlined above such that the total "all-in" cost of heat is used when evaluating the cost-competitiveness of existing process heat solutions against low emissions fuels.

8.6 Technical challenges

8.6.1 Develop internal capability and knowledge

As outlined earlier in this section, the scale of fuel switching required by large process heat users is likely to be significant and market capacity and expertise is constrained. Along with developing a fuel decarbonisation pathway and prioritising the most economic fuel switching projects as described in section 8.5.3, process heat users will need to develop additional internal resource, capability and expertise to deliver the decarbonisation pathway and establish ongoing partnerships with external providers, suppliers and advisers.

Along with establishing the additional internal capability to manage the delivery of the decarbonisation pathway, it is also key that senior decision makers and the board buy into the decarbonisation pathway and understand the potential implications of not achieving the pathway's goals. This includes ensuring that these decision makers understand the process heat user's exposure to changes in carbon pricing and that they support the forecast for emissions values developed under section 8.5.2.

8.6.2 Future-proof process heat equipment for low emissions fuels

The New Zealand Government and the Climate Change Commission are aligned in the importance of phasing out the fossil fuels for process heat. The Government has already started implementing regulatory restrictions on the installation of certain new coal boilers and are seeking to phase out existing coal boiler by 2037. The Government is also investigating how to phase out other fossil fuels through reconsenting process and National Environmental Standards. The Climates Change Commission's targets for phasing out coal and natural gas are even more ambitious.

While the timing of additional regulatory requirements to phase out existing fossil fuel solutions is uncertain, it appears increasing likely these regulatory requirements will be imposed.

Any additional investment in existing fossil fuel-based process heat equipment should consider the equipment's potential obsolescence or impact on future costs of switching to low emission fuels. Where possible this investment should be aligned with options that also future-proof existing and new plant for the transition to low emissions fuels. While these future proof options may represent a higher upfront investment cost than alternatives, users should seek opportunities where this increased cost is offset by reducing the future cost of transitioning to low emission fuels.

This aligns with the Climate Change Commission's policy recommendation 12 to make investments net-zero compatible. It is important that investments do not lock users into high emissions pathways or increase exposure to the impacts of carbon pricing and climate change. Users should include in their business cases the requirement to ensure long-lived assets and infrastructure are net-zero compatible.

9 Recommendations for Government

To meaningfully accelerate the transition to low carbon fuels, the key barriers to fuel switching need to be addressed through a package of solutions. While addressing individual barriers is helpful, each of the barriers identified can be a significant deferent to a fuel switching project. Achieving the scale of decarbonisation targeted by the Government and the Climate Change Commission will require a coordinated effort from process heat users and the Government. It will also require ongoing monitoring and engagement with the market to ensure that additional key barriers are addressed as they manifest over time.

This section of the report sets out a series of targeted recommendations which outline potential ways in which the Government could support acceleration fuel switching activities. These recommendations take key learnings from the market sounding process and focus on areas where Government support:

- Make a meaningful impact on fuel switching activities
- Maximise the use of limited Government resources and funds
- Focus on areas where the Government is the only party able to effect change
- Minimise any ongoing risk taken by the Government
- Leverage contributions both from the process heat user and the wider private sector

We have focused on recommendations that align with those of the Climate Change Commission, with a particular focus on ways to support mobilisation of finance for low emission investments.

There are several other learnings and actions from the market sounding process that are already being implemented by EECA or do not require broader consultation prior to implementation that are not covered in this section.

9.1 Electricity supply barriers

The three key electricity supply barriers identified through the market sounding were:

Without addressing the above barriers, it is likely that electrification will continue to lag behind biomass conversions.

9.1.1 Electricity connection reform

Uneconomic electricity grid connection costs and the difficulty engaging with certain electricity distributors was the most common barrier to electrification raised by participants. Reform is needed both in the process to secure new connections but also how the cost of these connections is calculated and recovered from users.

Connection process reform

As outlined earlier in this report there is no standardised process or timeframes for applications for new or upgraded load connections to the various electricity distribution networks. This can result in

users having to wait significant periods of time to understand the potential costs of their connection request depending on the available resources of the local distribution company.

Standardising the connection process for new electricity load connections through regulation would materially improve user's ability to execute electrification projects. This approach also has a relevant precedent in New Zealand with the Part 6 of the *Electricity Industry Participation Code 2010* which provides a standardised process for the connection of new generation assets to the electricity distribution network.

Connection cost recovery reform

Any addition to the *Electricity Industry Participation Code 2010* should also standardise the way new load connections to the electricity distribution network are costed and how this cost is recovered from users.

There are two issues to solve through cost recovery standardisation:

- **First mover disadvantage:** Users who trigger capacity upgrades will often pay for the next step change in capacity. This step change in capacity is often more than the user's requirements alone as the marginal cost of adding additional capacity when upgrading is low. Even though this capacity will also be used by future connections the user can often be charged the full cost of the connection. Users should only pay for their proportion of the capacity upgrade with the remainder of the cost recovered from future connections. This approach would align to the approach taken with other enabling infrastructure such as the local council development contribution model. To enable this approach, someone would need to provide funding to bridge the period between capacity upgrades and the materialisation of the additional connections.
    - This could be managed by the electricity distribution networks who could then recover the cost of this funding plus the unrecovered connection costs from future users. This could however create incentives for distribution networks to minimise the amount of connection costs they need to fund by inefficiently sizing upgrades given the uncertainty around the timing of future connections
    - Another alternative would be for the Government to provide this bridge funding (see below)
- **Gold plating of assets:** Users should also be provided with the option to accept lower service levels for their connection with a commensurate reduction in the upfront connection cost

Government funding support for connection costs

The Government could seek to further improve the economics of electricity grid connections by establishing a fund to spread the cost for users over time. This fund would invest capital at concessionary rates to fund the upfront cost of electrical network capacity upgrades and recover this over time from:

- **The user who triggered the capacity:** Users would repay their share of the upgrade cost through a series of payments over a period of 25+ years. These payments could be recovered via the electricity distribution company via charges on the user's electricity bill. Network operators already offer similar financing structures through network connection agreements. Government funding would need to be sufficiently concessionary either on term or pricing to be an attractive alternative.
- **Future connections that benefit from the capacity:** Users would repay their share of the capacity upgrade costs via a series of payments which start from their date of connection. This form of funding is not typically offered by network operators due to the uncertainty around the connection timing of future users. Providing patient Government funding to bridge the gap between grid upgrades and the connection of these new users is one mechanism to reduce the cost charged to both the initial user that triggered the upgrade and future users.

One of the benefits of this funding structure is that Government funding support for electricity connections is recovered over time from the users that benefit from the connections. This sort of funding support could also be incorporated into Government support for Heating as a Service structures as outlined in recommendation 9.6.1.

9.1.2 Government procurement of renewable electricity

There are several renewable generation projects across New Zealand that are yet to start construction due to the difficulty of securing a long-term offtake for the electricity produced by the project. Without long-term offtake, renewable generation projects have difficulty securing the financing needed to undertake construction.

Expanding the supply of diversified renewable electricity generation in New Zealand will be one of the most effective ways to displace existing thermal generation and support downwards pressure on electricity prices, which will in turn, increase the economics for electrification activity.

The Government already centralises electricity procurement through All of Government electricity contracts which are administered by MBIE. There is an opportunity to rework this existing electricity procurement process to include a requirement to purchase some or all the Government's electricity demand on a long-term basis from new renewable generation projects. This could be via a competitive auction process (to ensure the lowest cost projects are prioritised) into which developers of new renewable project can bid long term electricity prices to secure a rolling series of long-term Power Purchase Agreements, that will:

- Provide Government entities with access to carbon neutral and additional renewable electricity, likely at a lower rate than they would otherwise access through their current procurement processes
- Support the development of a mix of renewable generation technologies to mitigate the impact of hydrology and wind / solar intermittency and reduce the cost of required firming
- Free up existing generation capacity for sale into the wholesale market which will reduce prices for other users

The benefit of this approach is that the Government could directly support the construction of new renewable energy projects without any direct capital investment. This could both reduce electricity prices paid by Government entities while at the same time reducing prices for other users in the market. Similar models have been successfully implemented in overseas jurisdictions to support renewable development. Both the Power Purchasing Agreement used by the Government to contract with projects and the prices received through the competitive auction process should be publicly disclosed to support price discovery and to support other businesses to take a similar approach. The Government's Power Purchasing Agreement could then be adopted as the standard form for the New Zealand market.

Additional expertise would need to be either developed at MBIE or externally contracted to manage and match the generation profile of the diversified portfolio of generation projects with the combined demand profile of All of Government. This could be augmented through a combination of trading strategies and potentially contracting for firming services.

To achieve the procurement scale required to support the development of a diversified generation portfolio the Government could expand the All of Government procurement processes beyond Central Government entities to also procure low-cost electricity on behalf of:

- **Process heat projects**: potentially at lower a cost than users themselves could access, which could particularly be the case for SMEs. If this is the case, it would improve the economics of electrification projects

- **Local Government:** would not only assist Local Government entities accessing low-cost renewable electricity for existing operations but could also improve the economics of the electrification of public transport fleets. If these fleets are electrified this would represent a significant source of incremental electricity demand

9.2 Biomass supply barriers

The two key biomass supply barriers identified through the market sounding were:

Constrained supply of cheap inputs for biomass fuel

Regional availability of biomass fuel

Without addressing the above barriers it is likely that the limited availability of long-term, low-cost biomass supply contracts will significantly constrain the pace of fuel switching. Without sustainably expanding supply, demand pressures including from competing uses like biofuels may also increase the cost of biomass for process heat to uneconomic levels.

9.2.1 Government facilitation of biomass supply

With the growing focus on the importance of decarbonisation, there has already been a significant increase in the demand for biomass fuel. This demand is expected to continue to grow, with increasing competition for biomass fuel expected to provide upwards pressure on fuel prices.

While Government has an important role in providing market leadership by implementing its own transition from coal to biomass, the demand for biomass fuel from large private process heat users is a multiple of the Government's and will ultimately drive dynamics in the biomass supply chain.

The scale of biomass fuel supply required to meet the solid fuel demands of process heat users is significant. Biomass suppliers will need to invest significant resources to develop the biomass supply chain and they will need to coordinate their investment with other partners in the broader forestry and wood processing supply chain.

The Government has an important role in facilitating the sustainable expansion across the entirety of the biomass fuel supply chain, from the forest to the fuel supplier, and that this expanding supply is efficiently matched with demand. Given the expansion of the supply chain will primarily be driven by the market, we recommend identifying a single Government entity tasked with responsibility for these facilitation activities so there is a clear point of engagement for the market. Their responsibilities could include:

- Establishment of a centralised service which seeks to match existing and future biomass supply with demand from process heat users across New Zealand. Users and suppliers could provide the service with available supply and demand profiles. The service could then seek to match users to suppliers that are in closest proximity to their site and meet their fuel requirements. The service could also publish aggregate levels of biomass supply and demand in each region to help users and suppliers identify opportunities for further investment
- Expanding the supply of process residue from wood processing activities and identifying opportunities for these residues to be used more effectively. This could be combined with funding support to help expand the availability of process residue
- Identifying sources of biomass fuel inputs that are not currently being utilised (e.g. forestry or construction waste) or are being used to create lower value products (e.g. landscaping

products). This could be combined with funding support to help suppliers explore the feasibility of economically utilising the identified unused input for biomass fuel

- Optimising the overall level of transport required to deliver biomass fuel to users. Transport costs can make up a significant portion of the total delivered cost of biomass and creates additional emissions. Minimising these costs either through efficient matching of suppliers to the closest source of demand or by supporting the establishment of suppliers in underserved regions with demand will minimise the overall cost of the fuel transition for New Zealand
- Conversion from coal to biomass will also require investment in upgrading existing coal boilers. The entity could also provide advice to users evaluating alternative commercial structures described in recommendation 9.6.1.

9.3 Lack of industry wide coordination

The two key barriers to industry coordination identified through the market sounding were:

Need for verifiable data and case studies from demonstrator projects

Scale of transition will require coordination to meet targets and minimise cost

Without addressing the above barriers, it is likely that several large users will continue to view low carbon fuels as unproven, slowing pace of decarbonisation. There is also a risk that without central coordination the current differential between the cost of biomass and electricity may lead to over investment in biomass fuelled process heat solutions, rather than an optimal balance of low carbon fuels.

9.3.1 Coordination of Government support for decarbonisation

Participants all acknowledged the important role that EECA plays in providing a neutral source of expertise on decarbonisation initiatives. The market sounding also identified several areas where EECA could expand its tools and education materials to address areas where certain industry players may be lacking expertise. This included supporting education at a senior governance level around the risks and benefits of procuring fuel via long term supply arrangements (which are managed as part of treasury functions). The importance of detailed case studies was also highlighted and any financial support from EECA or the Government should be contingent on recipients disclosing the detailed information required to support other users making similar investment decisions.

While we agree with the general principle espoused by most participants that EECA should focus on supporting projects which represent the lowest cost abatement opportunities, EECA also has an important role to ensure that focusing on lowest cost of abatement for individual projects does not result in increases in the overall cost of transition for New Zealand.

An example of a situation where this dynamic may manifest is the current economic relativity between biomass fuel and electricity for high temperature applications. If Government support is focused solely on supporting the conversion of biomass projects this may result in long term supply shortages of biomass fuel, increasing fuel prices and undermining the long-term economic viability of biomass conversions. While many electrification projects may currently be more expensive than biomass alternatives and therefore require more Government support to become economic, providing additional support to these projects now to ensure a balanced future fuel mix may lead to a lower long term overall cost of the fuel transition.

A similar approach may be required to support different regions in New Zealand to develop renewable fuel supply chains due to the varying economics of existing fossil and renewable fuels across the country.

9.4 Economic challenges

The three key economic barriers identified through the market sounding were:

For many projects low carbon fuels are higher cost than fossil fuel alternatives

Uncertainty in long-term fuel and carbon costs

Existing investments in mid-life assets

Until the switch to low carbon fuels generates both a carbon and an operating cost saving, the pace of decarbonisation of process heat will always be constrained. Given the scale of the transition challenge, waiting until carbon pricing creates sufficient economic incentive to trigger fuel switching activities could lead to significant negative externalities for the New Zealand economy - which will ultimately impact all New Zealanders. While addressing the various barriers outlined elsewhere in this report, our indicative analysis in Section 5 highlights that the use of additional economic incentives may be necessary to support orderly change in the timeframes currently contemplated by the Government's carbon abatement goals.

9.4.1 Providing future carbon pricing certainty

Current levels of carbon pricing are not sufficient to support widescale fuel switching activities. The market sounding highlighted that while most participants accepted that carbon pricing would increase not all industry participants have a well-developed view on forward carbon pricing and as a result has difficulty factoring future increases in carbon pricing into fuel switching business cases.

The Government should provide a regularly updated set of carbon price forecasts that process heat users can use to inform their own internal forecasts. For example, the Government could publicise the shadow carbon price developed by Treasury used to conduct benefit to cost analysis for Government budget bids along with regularly updating the emission value forecasts published by the Climate Change Commission.

Another avenue to provide process heat users with additional certainty on future carbon price increases would be to adopt the Climate Change Commission's recommendations to increase the auction reserve and costs containment reserve price triggers in the NZ ETS to support higher levels of carbon pricing. It is important that these revised settings support increases in ETS pricing that align with the incentives require to support fuel switching activity. CCC recommended targeting a minimum price of $140/tonne CO_2-e in 2030.

Providing additional certainty around future carbon price increases will enable process heat users to include these increases in their fuel switching business cases which should accelerate the economic tipping point for these projects.

9.4.2 Acceleration of the economic tipping point for low carbon fuels

The biggest factor impacting the economics of fuel switching projects is the ongoing cost of fuel. Implementing the recommendations in this section to expand biomass and electricity supply should improve the overall economics of fuel switching if this is accompanied by reductions in cost of fuel. Establishing Government supported alternative commercial structures should provide further support

to accelerating economic tipping points by avoid user's high internal funding costs / payback thresholds.

Even when fuel supply costs and capital funding is optimised there will still be projects that remain uneconomic. There may be compelling reasons to provide additional Government support to accelerate the economic tipping point for these projects to minimise the overall cost of the fuel transition. For example, as outlined in recommendation 9.3.1 this could be by providing additional economic incentives to support electrification projects to achieve a balanced fuel mix. There will be other situations where this level of additional support is also warranted to support lowest cost transition, there could be opportunities to avoid material Paris commitments to purchase international carbon credits through targeted support.

Additional economic support could be wrapped into the Government sponsored alternative commercial structures recommended in section 9.6.1 and could include any of the avenues of economic support outlined in section 7.5.3 including access to additional concessionary Government capital, accelerated depreciation or access to reduced transmission charging.

9.5 Technical challenges

The two key technical barriers identified through the market sounding were:

Capacity of New Zealand suppliers to facilitate transition to low carbon fuels

Retrofitting costs and site-specific factors

Given the size of the fuel switching challenge, local capacity will need to be developed and carefully organised to delivery on the Government's decarbonisation timelines. Site specific challenges will always be a reality for users seeking to transition fuels, but EECA has an important role in identifying these potential issues early to ensure users adequately consider mitigation options in their decarbonisation roadmap.

9.5.1 Policy framework to support a pipeline of projects

While Government policy support for process heat fuel switching via the GIDI Fund has been highly successful in generating significant acceleration of work on fuel switching project so users could meet application deadlines, there is an opportunity to develop a wider long term policy framework that will support counterparties across all aspects of the fuel switching supply chain to invest in developing additional capacity to deliver the fuel transition.

This could be achieved by adopting clear targets for each of the recommendations in this section:

- Seeking to support ~150MW of fuel switching projects each year for the next 10 years through Government sponsored alternative commercial structures outlined in section 9.6.1
- Supporting procurement of ~100MW of additional renewable electricity generation via 25-year power purchasing agreements each year for the next 10 years, for example through the recommendations in section 9.1.2
- Supporting procurement of ~1.3PJ of long-term biomass fuel contracts from fuel suppliers every year for the next 10 years, for example through the recommendations in section 9.2.1

It is important that policy statements are aligned with the emissions budgets adopted by the Government. The above targets broadly align with the level of change required between now and 2030 to achieve the Climate Change Commission's coal and fossil gas reductions in the demonstration pathway. Policy statements also need to be specific and provide enough detail around fuel mix and

target regions for market participants to align themselves into consortia ahead of procurement events. It is important to demonstrate that the scale of the opportunity is significant enough to support the significant investment of capital, time, and expertise to expand the supply chain and that this expansion is sustainable.

9.5.2 Support development of expertise

New Zealand's ability to meet its fuel switching goals will also be dependent on having access to people with the technical, commercial and financial expertise to deliver successful fuel switching projects. Continuing Government support for STEM education pathways, apprenticeships and other career pathways will be important to develop the skills and capacity required to deliver the fuel transition.

9.6 Access to capital

The two key capital barriers identified through the market sounding were:

If the funding of process heat fuel switching is constrained to when Projects meet users' return thresholds or when capital allocations are available, the speed of the fuel switching will be significantly constrained and increases the chance that replacement will only occur when assets are at the end of their useful life.

9.6.1 Government support for alternative commercial structures

The Government's GIDI fund has been highly successful in accelerating significant decarbonisation activity by users as they sought to advance projects and business cases to secure access to grant funding allocations. The $27.9m advanced through round one of the GIDI process will deliver 185,000 tonnes CO_2e in annual emission reductions, which is the equivalent to taking 62,500 cars off the road. Grant funding through processes like the GIDI fund will have an ongoing and important role in supporting acceleration of decarbonisation projects.

However, given the billions of capital funding required to fund the transition from coal and natural gas, Government grants when used in combination with users' available capital are unlikely to be sufficient to deliver transition at the pace required to meet New Zealand's carbon abatement commitments. The market sounding also identified that Government loans are relatively unattractive to large users.

Finding a solution that addresses competition for user's limited capital allocations and short internal payback periods by enabling users to tap the significant pools of private capital seeking opportunities to invest in aiding in the carbon transition will be key to delivering the transition in the targeted timeframe.

While alternative commercial structures have the potential to address both barriers, feedback from the market was that these structures are not currently viewed as attractive. Users indicated they were not attractive economically and presented additional complexity. One way to maximise the impact of limited Government funds would be to investigate providing targeted support to ensure that alternative commercial structures, like Heating as a Service, are attractive to both process heat users and private capital. If alternative commercial structures are identified as the Government's preferred

mechanism to deliver financial support to fuel switching projects this would also incentivise users to engage with and understand these structures.

Two of the key benefits to the Government for supporting alternative commercial structures are:

- Alternative structures leverage private capital from investors like ACC and NZ Super to fund the cost of the decarbonisation and increase the impact of limited Government funding
- While Government support or financial incentives can be incorporated in alternative commercial structures to reflect the wider benefits of carbon abatement, they are fundamentally user-pays structures, where the bulk of the cost of fuel switching projects are recovered over time from the process heat user. It is important that process heat users contribute to their share of the cost of transition

Support of alternative financing structures also aligns with recommendation 13 of the CCC's final report to enable system level change through innovation, finance and behaviour change. The CCC have recommended mobilising private finance as a critical pathway to improving access to low-emissions finance and scaling up low-emissions investments which underpin New Zealand's ability to achieve the emissions reductions targets. The CCC specifically identified ACC and NZ Super as potential providers of this finance and the recommendations in this section incorporate feedback received from both these entities through the market sounding of what would be required to make alternative financing structures work.

To increase the appeal of these structures the Government could establish a programme where projects could apply for Government support to improve economics, which could include:

- Provision of a small amount of Government capital into the project (e.g. 10% of total capital cost) to sit alongside private capital either at a concessionary rate and / or to take first loss in the structure. Both approaches would improve economics of the structure and de-risk the investment for private capital providers. This would also provide the Government with an ability to recycle invested capital over time into other projects
- Provision of a Government targeted support package / credit support into the structure to reduce risks taken by private financiers. This would materially broaden the applicability of the structure, particularly to smaller users and improve the overall economics of the structure. No Government funding would be required unless the risks / events covered by support package are triggered. Credit support could also be structured to cap the Government's overall level of exposure in downside events
- Supporting projects to access longer term, lower cost fuel supply contracts than users would otherwise have access to. This is particularly important given the impact that fuel costs have on the overall economics of fuel switching. This could be facilitated through:
    - Including sponsored project's fuel requirements in the procurement activities undertaken by Government under recommendation 9.1.2 and 9.2.1
    - Providing projects with access to sculpted fuel supply contracts with lower fuel prices upfront (when carbon pricing is lower) with the discount recovered via higher fuel prices later (when carbon pricing is higher)

  Depending on how the fuel supply support is structured this could also require no direct Government funding

As outlined earlier in this report there is a precedent of establishing and supporting these sorts of structures which utilise private capital to accelerate transition / development through the Infrastructure Funding and Financing Act.

Appendices

Appendix A – List of Market Participants

Appendix B – Market Sounding Pack

Appendix A - List of Market Participants

The following **industrial process heat (IPH) users** were invited and participated in the market sounding process.

IPH User	Date Time	Attendees	Process heat context
Fletcher Building	20 Apr 3:00PM	**Helen Jenkins** – GM Sustainability FBU **Scott Morrison** – Marketing & Innovation Manager at Fletcher Steel **John Jamison** – Technical and Development Manager at Winstone Wallboards **Simon Cooper** – National Manufacturing Manager / GM (acting) at Winstone Wallboards	• Process heat accounts for 30% of Fletcher's emissions (excl. Australian operations and Golden Bay Cement where coal is used) • **Winstone** uses gas in Auckland and reticulated LPG in Christchurch sites and are currently building a brand-new plant in Tauranga to replace the end-of life Auckland plant, providing a 10%-30% reduction in carbon emissions • Plant will still use gas, electrification and biomass were explored but concerns around unproven technology, cost and fuel supply • **Fletcher Steel** is currently looking at replacing gas ovens (on paint line) with electric ovens which will mitigate the bulk of their emissions
Pan Pac Forest Products	30 Apr 3:00PM	**Tony Clifford** – MD **Roger Jones** – GM - Pulp **Peter Campbell** – Business Development	• 80-90% of heat requirements met with biomass, residual via natural gas • Investigated electrification at their Otago site but installed an advanced technological biomass boiler instead • Use 450,000ton/yr of biomass in Napier and up to 150,000ton/yr of biomass in Otago
Lion Nathan	3 May 11:00AM	**Justin Merrell** - Group Environment Director **Kat McDonald** - Sustainability Manager NZ	• Committed to operate on 100% renewable electricity by 2025 and a 55% carbon reduction in the next 10 years (set by parent company, Kirin) • Have transitioned several processes to electric heat pumps. Investigating biomass in parts of their Australian business
OJI Fibre Solutions	3 May 1:00PM	**Philip Millichamp** - Group Manager Environment and External Relations **Terry Skiffington** – COO	• Have converted its Kawerau Mill to run on geothermal steam • Kinleith Mill is currently powered by natural gas. Have been investigating large scale conversion to biofuel (with electricity generation) but does not meet internal return hurdles
Fonterra	4 May 9:30AM	**Linda Mulvihill** – Head of Energy and Climate **Haley Mortimer** – NZ Manager Government Affairs **Antony Oosten** – Energy Manager	• Fonterra sites operate on a mixture of coal and natural gas. Focus on transitioning coal to biomass with first full conversion at Te Awamutu • Achieved 20% improvement on energy efficiency target between FY03 to FY20 (avoided 3.3m ton of carbon emissions / 6.7PJ of energy) • Targeting carbon zero by 2050 and coal free by 2037

Talley's Group	5 May 10:00AM	**Andrew Talley** – Executive Director **Steve Koekemoer** – CEO of Open Country Dairy **Karl Rademacher** – Operational Improvement and Automation Manager at Talleys *Apologies: Nigel Stevens – CEO of AFFCO NZ*	• Open Country Dairy investigating biomass at Whakaroa site and investigating opportunities to further electrify Invercargill site • Talley Seafood diesel and coal boilers are at end-of-life but fuel switching to biomass is difficult to achieve • AFFCO use of cascade heat pumps to replace coal boilers, reducing to only one coal boiler in operation by end of 2021

[1] The Alliance Group were also invited to participate but did not respond.

The following **ecosystem players** were invited and participated in the market sounding process.

Ecosystem player	Date Time	Attendees	Process heat context
Transpower	21 Apr 9:00AM	**Richard Hobbs** – GM Strategy	• Transpower connects generators to load which is primarily distribution networks, but also has 9-10 direct connects to large industrial users • Plays a role as an enabler to electrification and is responsible for the implementation of TPM • Become involved in connection conversations between distributors and users, particularly when cost of connection is expensive
EA Networks	22 Apr 8:45AM	**Roger Sutton** – CEO	• Owns and operates an electricity distribution network in mid Canterbury • Currently working with EECA and Transpower to map major users of process heat
Natures Flame	22 Apr 10:00AM	**John Goodwin** – Operations and Commercial Manager **Scott Fairbairn** – Sales & Marketing Manager	• Taupo based producer of biomass wood pellets with third party storage outside of Hamilton and distribution centres in Christchurch and Dunedin • Currently have 85,000 ton / year plant capacity, underwritten by long-term contract from Fonterra • One of four wood pellet producers in NZ and have appetite to provide long-term contracts for biomass supply to underwrite further expansions
Simply Energy	22 Apr 12:30PM	**Murray Dyer** – MD *Apologies: Andy Sibley – Chief Business Officer*	• Commercial arm of Contract Energy • Works with large process heat users to structure electricity supply and funding solutions which help them fuel switch • Currently working with users to electrify coal boilers in the South Island and address economic cost gap to coal

DETA Consulting	22 Apr 2:00PM	**Jonathan Pooch** – MD **David Taylor** – Consultant **Jeff Smit** – Director	• One of New Zealand's leading sustainability consultants • Works closely with EECA on a range of projects • Ongoing partnerships with users to decarbonise business case development, roadmap strategy and development and execution of the project
Meridian Energy	3 May 3:00PM	**Lisa Hannifin** – CCO **Ryan Kuggelejin** – Strategic Development Manager **Sam Fleming** –Government Relations	• One of the five large New Zealand Generator / Retailers with 100% renewable generation – also the key supplier to Tiwai • Currently running an Electrification Programme which offers long-term electricity price agreements and funding to support electrification projects

The following **capital providers** were invited and participated in the market sounding process.

Long-term finance providers	Date Time	Attendees	Introduction and interest in Process Heat
ACC	19 May 4:00PM	Ian Purdy – Head of Direct Property and Infrastructure Investment Louise Marsden – Director, Direct Investments	• ACC are interested in investment opportunities that also reduce carbon emissions • Actively looking at ways to reduce carbon in their investment portfolio such as not investing directly into fossil fuels but recognises it can be difficult to fully eliminate as existing portfolio covers construction and aviation
NZ Super Fund	21 May 1:00PM	Josie McVitty – Senior Advisor, Infrastructure Alice Mew – Senior Investment Strategist Sebastian Nicholson – Investment Analyst	• Developing an infrastructure investment strategy internally with a key focus on energy transition, digital infrastructure and growth sectors such as water and rail • Decarbonisation of process heat forms a key part of NZ Super Fund's energy transition strategy • Interested in progressing conversations on financial structures that can commercially and technically deliver decarbonisation and fuel switching projects • Able to provide large-scale capital upwards from $150 million

Appendix B

Market sounding presentation

Acceleration of process heat fuel switching

This document is for discussion purposes only and does not represent EECA or Government policy

May 2021

This document is for discussion purposes only and does not represent EECA or Government policy

Introduction

Accelerating process heat fuel switching will be a key part of the Government's 2021 Emissions Reduction Plan, EECA is interested in exploring alternative means to achieve this acceleration

- Significant work has been done by EECA, MBIE, Transpower and others to identify barriers which are currently slowing down the transition from fossil fuels to renewable fuels for process heat
- Fuel switching will require a significant investment in new equipment, infrastructure, supply chains and expertise
  - Given the current barriers faced by the market, if this investment is reliant solely on process heat users and their suppliers, there is risk fuel switching lags behind current emissions goals
- The purpose of this sounding exercise is to understand the market's view on:
  - What are the key barriers to fuel switching;
  - What are the range of potential solutions which could be used to address these barriers; and
  - How the Government / EECA can best support these solutions
- As part of this process, we will be talking to industrial process heat users as well as other parties who could play a role in delivering the solutions identified including network operators, fuel suppliers, equipment suppliers and capital providers
- Feedback from this process will be used to provide a report to the EECA board in June summarising the findings of the market sounding process as well as suggestions to accelerate process heat fuel switching
- **This market sounding process is a separate initiative to the Government Investment in Decarbonising Industry ("GIDI") Fund**
  - **While we appreciate the market's interest in that process, we are unable to comment on the ongoing GIDI process**

The process heat challenge

Around One third of New Zealand's overall energy use is for process heat

60% of process heat is currently powered by fossil fuels

Process heat fuel switching is key to achieving New Zealand's long term emissions goals.

Key barriers to process heat fuel switching

Previous studies on process heat fuel switching have identified various barriers which can be summarised into the following categories

Access to capital

- Few companies have access to ring fenced capex allocations for sustainability projects
- Fuel switching projects are longer term investments and often don't meet target return or payback period thresholds

Electricity supply challenges

- Network constraints and first mover disadvantages
- Supply disruptions and complexity of storage
- Securing access to long term, low-cost electricity supply including transmission costs

Biomass supply challenges

- Regional availability of biomass fuel
- Limited providers who can provide long term fixed price supply contracts for biomass
- Risk of future competition for biomass impacting prices and availability

Lack of industry wide coordination

- Suitability of low carbon alternatives to different use cases not well understood across the market
- Significant work and cost for individual users to establish best practice process heat solutions for their business

Low carbon process heat alternatives are viewed as uneconomic

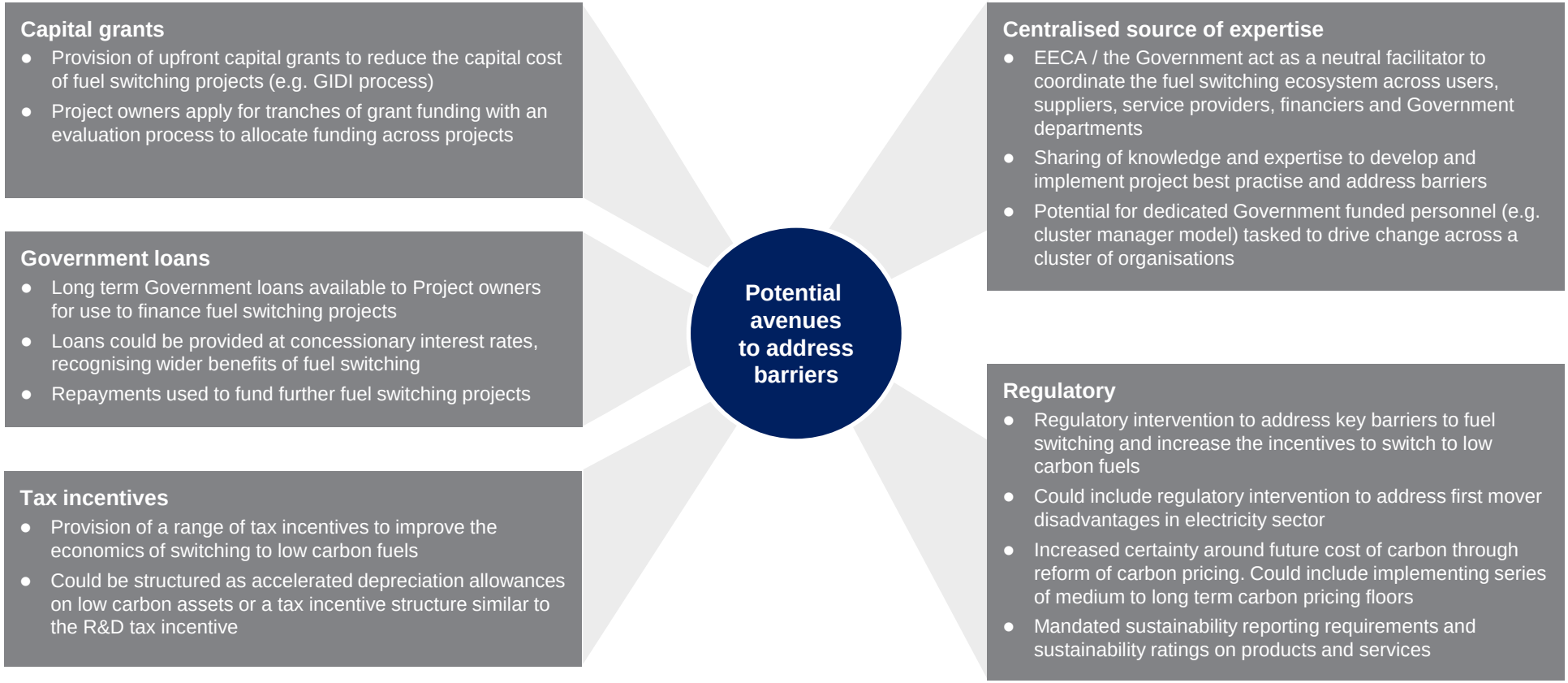
- Coal and gas are currently (but becoming less so) a cheap fuel source, switching to low carbon alternatives can negatively impact operating costs
- Particularly challenging for assets which are not end of life

Technical challenges

- There are a range of site-specific factors that can add complexity to fuel switching projects
- Flow on impacts of upgrade on wider site operations e.g. larger footprint requirements for biomass boilers vs coal or flow on upgrades of ancillary infrastructure like pipework & cabling

Potential avenues to address barriers

EECA is seeking to understand how future support from EECA / the Government could be best leveraged to eliminate remaining barriers to process heat fuel switching – possible approaches include:



Potential support from EECA / the Government

EECA is seeking to understand how future support from EECA / the Government could be best leveraged to eliminate remaining barriers to process heat fuel switching – possible approaches include:

Energy efficiency

- Unlocking energy efficiency opportunities are key to minimise energy needs and the cost of fuel switching
- Government / EECA support for business to unlock energy efficiency initiatives

Credit support

- Provision of Government credit support to enable businesses to access lower cost financing for process heat fuel switching projects
- Government may step in to keep financiers whole in the event a process heat user defaults

Commercial financing

- Facilitate access to long term, low cost commercial financing which spreads upfront capital cost over the life of the asset
- One example of a potential commercial financing structure is Heat as a Service (Haas) – outlined in more detail in Appendix A
- These structures could be used to transfer risks to financiers (e.g. fuel supply) as well as eliminate capital barriers to fuel switching
- Commercial financing could be combined with other forms of support from EECA / the Government

Potential avenues to address barriers

Fuel supply intermediary

- Government enters into long term agreements with process heat users to provide fuel at a guaranteed fixed price
- Process heat users then have a high credit quality counterparty and certainty around cost and availability of fuel supply
- Government would then seek to match this obligation with back to back contracts with fuel suppliers
- Government takes risk on fuel suppliers being able to continue to meet their supply obligations under these contracts instead of process heat users
- Government can also coordinate development of fuel supply chains and benefit from aggregation of demand

Fuel supply investment

- Direct investment by the Government in developing low carbon fuel supply chains, similar to PGF investment
- Investment targeted at enabling existing fuel suppliers to scale up operations to:
  - Meet increased demand created by fuel switching
  - Create entities which can provide bankable long term fuel supply agreements

Feedback sought

We are interested in understanding the market's views on the following topics as well as any other insights that may be helpful in accelerating process heat fuel switching

Interested in seeking your views on:

What are the key barriers to fuel switching facing your business and their relative importance?

What are the key learnings from existing fuel switching projects undertaken by your business that might assist the rest of the market in fuel switching?

Views on the range of potential solutions canvassed in this presentation and their effectiveness in addressing key barriers for your business?

Views on Heating as a Service structures and their effectiveness in addressing key barrier for your business?

Appetite for involvement in any of the potential solutions and what role you might play?

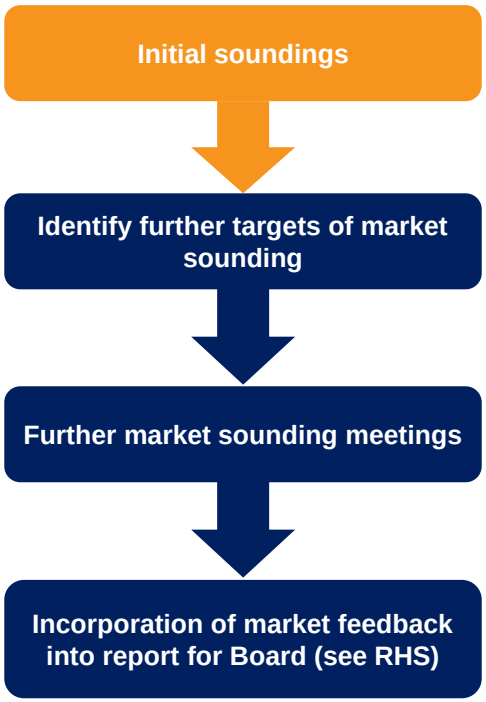
Where support from EECA and / or the Government would be most impactful in assisting your business in switching to renewable fuels?

Opportunity for sounding participants to provide written feedback on each of the above areas to anna.shaw@eeca.govt.nz and alex.kirch@mafic.co.nz.

Next steps

We are targeting incorporating the findings from the current market soundings process into a report to the EECA board at the end of June

Market sounding process



Current stage of market sounding process

Review feedback from initial user soundings to identify key market participants to sound in next stage

Report to EECA board

- The key output from this market sounding process will be a report to the EECA board outlining alternative approaches to accelerate process heat fuel switching
  - Currently targeting completion of the report in June
- Key focus of the report will be:
  - Providing a summary of the key barriers to process heat fuel switching identified by the market;
  - Presenting a range of potential approaches that EECA / the Government could consider to maximise the carbon abatement impact of any future support that may be available to facilitate acceleration of process heat fuel switching
- Report will also include a summary of views from market sounding participants on both of the key topics outlined above

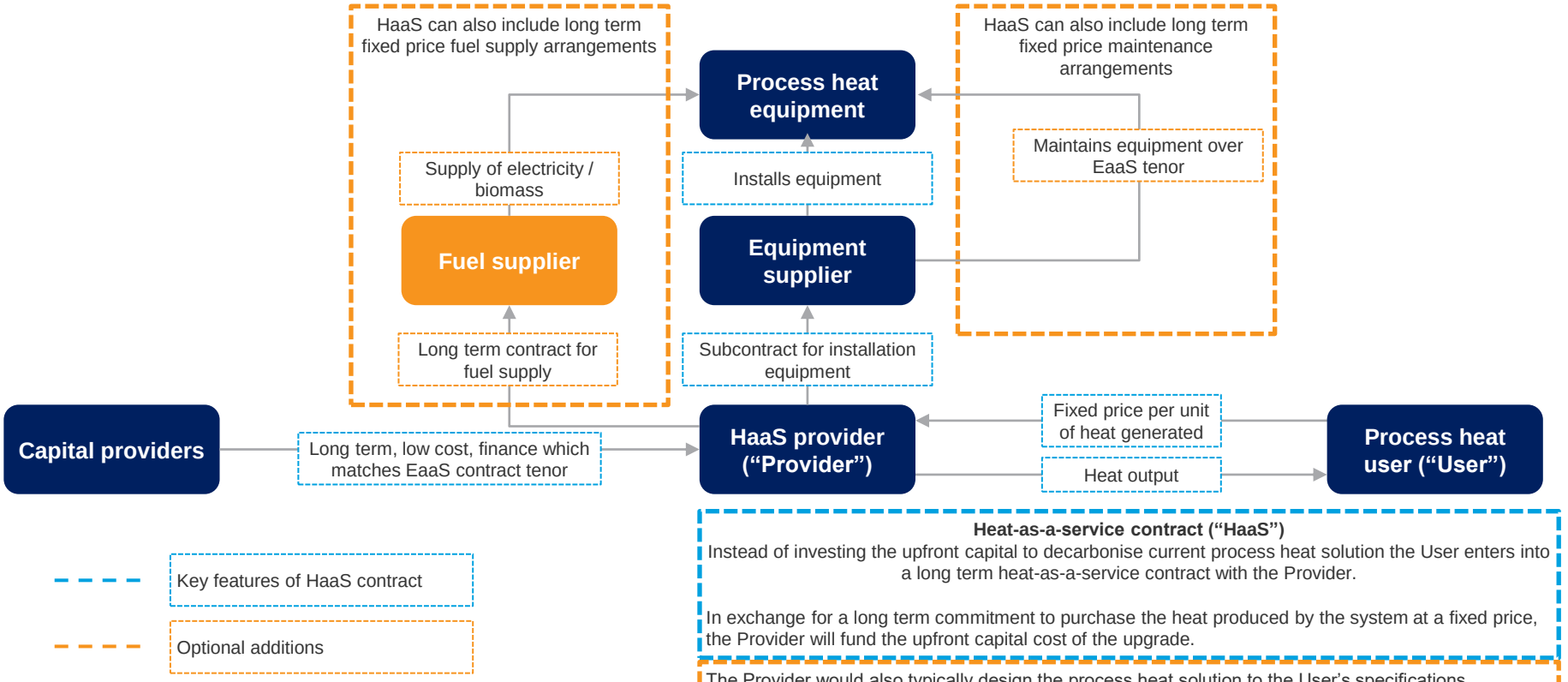
A

APPENDIX

Commercial financing structures

Commercial financing structures

There is an opportunity to utilise commercial financing structures such as ‘Heat-as-a-service’ contracts to simplify the upgrade decision for process heat users



Does HaaS address the barriers to process heat fuel switching?

HaaS structure have the potential to not only remove capital barriers to fossil fuel switching but can also be used to help address the other barriers as well

Access to capital

- No capital funding required from User
- Capital provider's investment horizon matched to the useful life of the process heat equipment
- HaaS contracts treated as an operational expense rather than lease under IFRS 16 (off balance sheet)
- IFRS treatment depends on fact scenario for each HaaS contract

Electricity supply challenges

- Network connection costs funded by Provider – however network constraints may still limit electrification areas
- Long term electricity supply could be included in HaaS fixed price
- Options to address electricity supply disruptions via solution design (onsite generation / batteries) or via contractual mechanisms (availability warranties)

Biomass supply challenges

- Long term biomass supply could be included in HaaS fixed price
- Dependent on availability of counterparties able to write long term supply contracts
- Availability of long-term supply contracts may support further investment in the supply chain

Lack of industry wide coordination

- HaaS provider acts as a centralised source of expertise to facilitate a market-wide fossil fuel switch
- Leverage best practice from previous projects to streamline cost / time of future projects
- Coordinate with Government on how to address remaining barriers to fossil fuel switching

Low carbon process heat alternatives are viewed as uneconomic

- Leverage economies of scale in design, procurement, fuel supply and finance to deliver lowest cost solution for Users
- Low carbon alternatives becoming increasingly economic with increases in carbon price
- Carbon pricing will increase over HaaS term increasing economic appeal of structure

Access to long term, low cost financing | **Potential avenues of risk transfer** | **Centralising expertise** | **Scale efficiency**