The Orion Group Future Energy Scenarios

2024

About us

Orion is the electricity distribution business for Central Canterbury – we deliver electricity to over 220,000 homes and businesses

Orion Today

We own and operate the electricity distribution infrastructure in central Canterbury, including Ōtautahi Christchurch. Our network is both rural and urban and extends over 8,000 square kilometres from the Waimakariri River in the north to the Rakaia River in the south; from the Canterbury coast to Arthur's Pass. We deliver electricity to more than 220,000 homes and businesses and are New Zealand's third largest Electricity Distribution Business.

Orion is a community owned entity with two key shareholders - the Christchurch City Council, through its subsidiary Christchurch City Holdings Ltd, and the Selwyn District Council. We aim to create value for our shareholders and we contribute significantly to the economic success of our region.

Orion has a fully owned subsidiary, industry service provider Connetics, and together with Orion the two organisations make up The Orion Group.

Changing Environment

Orion faces a rapidly changing and massively different energy environment in the decades ahead.

Orion, along with Aotearoa New Zealand's other electricity distributors, has a key role to play in enabling decarbonisation and the electrification of the economy in service of the country's target for net zero greenhouse gas emissions by 2050.

The changing landscape facing Orion is primarily driven by three factors:

- climate change,
- new technology and
- increasing demand for electricity.

The increasing demand for electricity is driven by the need to enable decarbonisation at pace, and population growth.

Orion

Summary

Introduction

Orion has formed Future Energy Scenarios as a starting point to analysing and understanding the risks and opportunities presented by the energy transition in our region

Energy Transition

Energy Transition

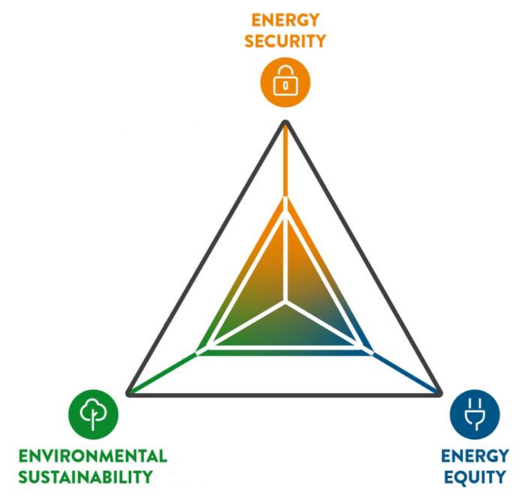
The global energy landscape is undergoing a significant transformation known as the "energy transition." The global imperative to decarbonise creates challenges and opportunities for the energy sector as it transitions away from reliance on fossil fuels and carbon emitting energy generation.

The future of energy is electric. As energy systems decarbonise, electricity will be used as a fuel for more and more applications. There will be significant growth in demand for electricity, at the same time as electricity generation will be phasing out fossil fuels. This means there will be significant demand growth for electricity seen on Orion's network.

However, there is more to the decarbonisation story than demand growth. The energy system is becoming more complex as more distributed generation and demand side flexibility is added to the system, energy storage becomes more common, and smart grid technology and data and digitalisation are adopted.

As the energy system evolves it must do so within the context of the energy trilemma. The energy trilemma is a concept that highlights the three main dimensions of the energy system that must be balanced:

- energy security,
- environmental sustainability, and
- energy equity and affordability.



Future Energy Scenarios

Orion needs to understand the opportunities and challenges of the energy transition to enable us to play our part in balancing the energy trilemma in the changing environment we face.

Orion is planning for a rapidly changing and uncertain future. This means investing in new technologies and new approaches to doing business, investing in research and innovation to better understand the challenges we face, and planning for potentially divergent futures.

For Orion this means investing in:

- network transformation and our network transformation roadmap,
- data, digitalisation and smart technology,
- research and innovation, and
- scenario planning.

Future Energy Scenarios

Orion has developed its Future Energy Scenarios to help our understanding of the energy transition. We use insights in this report to inform asset management planning and infrastructure investments, strategic business planning, and to inform innovation priority and strategy.

In 2023 we undertook consultation and engagement with our community and local stakeholders on the development of our Future Energy Scenarios. Through consultation we improved our understanding of the local energy system and needs, gathered more diverse perspectives and built transparency in our forecasting and asset management planning process. We are sharing this insights report to build on collaborative engagement in energy transition in our region.

This report presents the findings from our first round of modelling and analysis of our Future Energy Scenarios. Each section has **risks and opportunities** for Orion in the energy transition.

Summary - Orion Future Energy Scenarios

Orion's Future Energy Scenarios are divergent pathways for the electricity sector that allow us to test different developments and pathways to inform planning for our business

Orion Future Energy Scenarios

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Orion has formed four future energy scenarios, plus a fifth central scenario specifically for asset management planning. Further detail on the formation of our scenarios is available in our document [link]

The four future energy scenarios describe four plausible futures in 2050, and the pathways for how we will reach those futures. The scenarios are not intended to be forecasts. They describe different divergent pathways for the energy sector in Central Canterbury, that allow us to test different developments and pathways to inform planning for our business.

The central scenario is intended to be our best view of demand to 2035 and meets specific requirements for our asset management planning. We have extended this scenario to 2050 for comparison purposes, but do not consider it a forecast to 2050.

Business As Usual

While existing trends driven by largely external factors continue, there is little additional push towards decarbonisation in the New Zealand economy. Decarbonisation is generally high cost with little in the way of enabling technology shifts or reduction in prices. As a result there is little change in consumer behaviour, or incentive for people to interact with the energy system by way of flexibility or distributed energy resources.

Progress

New Zealand and the rest of the world shifts further down the road on decarbonisation, but progress is slowed by high costs of transition and little significant change in technology and consumer behaviour. Some new smart technology is adopted and there is some increased use of residential flexibility.

System Transition

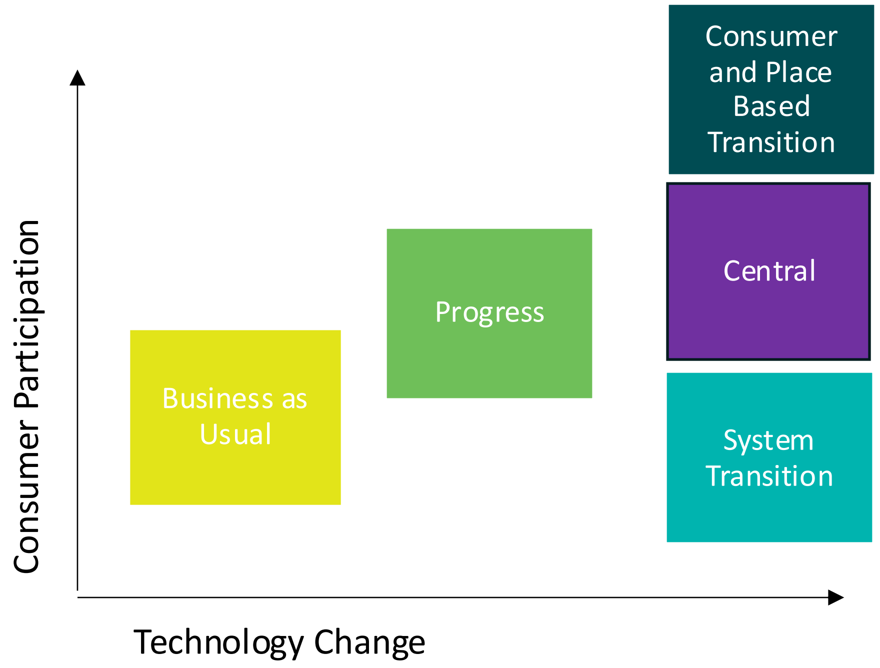
There is transitional change in the energy sector, with significant electrification and decarbonisation of electricity generation. Change is enabled by technology change, or existing technology becoming cheaper as innovation lowers production costs. Much of the change occurs at a system, or central, level. This means there is little change in the way consumers interact with the energy system and little optimisation at the consumer end of the value chain.

Consumer and Place Based Transition

New technology enables greater consumer participation in the energy sector, leading to an optimised and decarbonised energy system. Local area planning enables a place-based transition where use of existing assets is optimised, and optimized urban development reduces energy and transport demand.

Central

This scenario sets our current 'best view' of energy transition in our region to 2035. We are planning for a world of rapid electrification to meet Government targets and the use of smart technology and changing consumer behaviour to better optimise electricity use.



Summary – Key Risks and Opportunities

Key risks and opportunities for Orion highlighted in this report

Population growth will drive a significant increase in demand in the Orion region. Population projections in our Central scenario are for over 100,000 more people living in our region, growth of 24% for the region. Increases in population will act as a multiplier on the growth in electricity demand as more households and businesses shift away from fossil fuels.

To house the growing population there will be a shift in **building types.** The recent shift towards multi-unit housing is likely to extend, particularly if zoning along the proposed mass rapid transit corridor allows for more density.

It is possible that electrification of fossil fuels will initially outstrip improvements in flexibility, storage and efficiency. However, over the longer term these factors could result in more efficient consumption of electricity within each house, ultimately reducing maximum electricity demand per household in some areas.

Electric vehicles are likely to be the largest growth factor between now and the 2050s on our network. Already we see uptake in some areas 3-4 times the average and herding of charging times on our network. Unmitigated this could bring rapid growth in peak demand in some parts of the network.

Commercial light and medium vehicles could be some of the fastest segments to electrify. Once technology becomes economically viable some fleets could shift quickly to take up electric vehicles to save money. This could result in pockets of significantly increased load in a short time frame.

It isn't clear whether there will be an overall **preference for electricity** or alternative fuels like biofuel for process heat conversions, or whether there will also be regional differences across the country. There is also political and market uncertainty, with changes to supports and grants with the most recent Government change, and Carbon price uncertainty that could drive further change.

Likewise, for heavy vehicles there are multiple possible decarbonisation pathways. Electricity is not a viable conversion option yet, while **hydrogen** and other fuels could be used in some circumstances. These fuels may also have high electricity demand for production.

Solar generation is increasing on our network. There are around 3% of houses with rooftop solar, and applications for over 500 MW of utility scale solar on our network. Increasing solar generation has the potential to offset some growth in peak demand on the network, which could be useful if the acceleration of demand is high, while if Orion is not well prepared for growth on the network there could be issues with hosting capacity or lack of demand response to deal with intermittency issues.

Flexibility and the growing likelihood of households having smart devices and storage creates significant opportunity for Orion, and others in the energy sector to optimise energy consumption and reduce costs.

Our analysis shows that it is critical to understand what flexibility will be used for, and for who, and what will be optimised. Optimisation of individual households, network demand, or system wide energy consumption leads to different outcomes across the system.

1. Orion Future Energy Scenarios

1.1 Introduction

Orion has formed Future Energy Scenarios as a starting point to analysing and understanding the risks and opportunities presented by the energy transition in our region

Energy Transition

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However, there is more to the decarbonisation story than demand growth. The energy system is becoming more complex as more distributed generation and demand side flexibility is added to the system, energy storage becomes more common, and smart grid technology and data and digitalisation are adopted.

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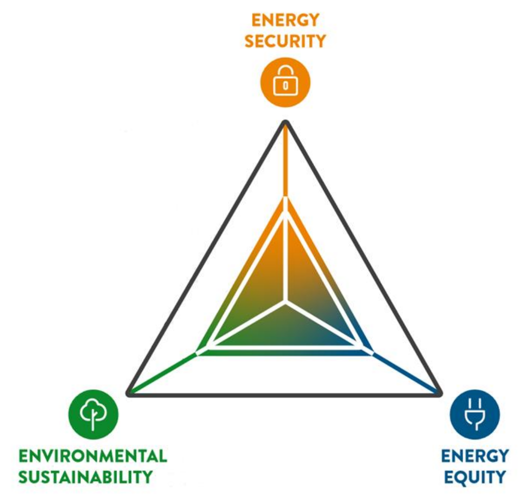

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1.2 Drivers of Change

Drivers of change are the high-level forces driving change on our network

Orion Future Energy Scenarios

Drivers of Change

Drivers of change are the high-level forces driving change on our network. We have grouped drivers of change in the energy transition into five high level areas that cover different forms of growth.

Growth and Urban Form

Christchurch and the Selwyn district are growing regions, with population growth from internal and external migration, and economic growth with new industry and commercial activity.

Population growth is an underlying driver of growth in many sectors. People use energy in their homes, and new housing developments and in-fill housing change the need for investment on the network. People require services and commercial and industrial development to support, employ and transport them.

As the population grows, urban form and transport infrastructure is a critical factor in determining the timing, scale and location of impact on the electricity network.

Transport

Electrification of transport will involve uptake of electric vehicles to different extents for light, medium and heavy vehicles. Each will have a different impact on demand for electricity.

Private electric vehicle electrification is likely to be the single largest increase to household electricity demand between now and 2050. However, there are many different pathways for development. Public transport, changes to urban form and charging behaviour could be larger determinants of the impact of charging on network demand than uptake alone.

Fleet, delivery vehicles and medium sized electric vehicles create different challenges again. Many of these types of vehicles will have high usage and low downtime, possibly also having larger batteries than private electric vehicles. While many could electrify, there are also alternative pathways, such as using hydrogen that they could take.

Process Heat

There are many large users of coal and other fossil fuel boilers in our region and these are required under law to be phased out by 2037. Orion can expect a significant uplift in electricity demand from industry compared to most other parts of New Zealand.

Surveys we have led in partnership with others, as well as local industry studies show we can expect industry conversion, primarily due to decarbonisation efforts, to add significantly to our current maximum peak demand. The significant range of uncertainty as to how much load will be added, and when, is due to the uncertainty around the availability and cost of biomass as a zero-carbon alternative to electricity in our network area.

Generation

Our region has significant potential resource and utilisation for solar generation. We have seen steady growth in connections of residential solar and applications for utility solar connections. Residential solar installations total around 25MW, and combined applications for utility solar and wind generation total 680MW.

We will have to work to understand both solar feed-in to the network and net demand reduction, where it is matched to industrial demand, rural demand such as irrigation and domestic demand. In the future there could also be significant impacts on voltage and demand fluctuation where there is local demand matched to solar and intermittent generation caused by cloud cover.

Flexibility

As the energy system develops consumer behaviour, and consumer involvement in the energy system is likely to change as well. This could be directly through changing patterns of energy consumption, or indirectly by offsetting energy use through batteries or third-party control of smart technology.

Some of these changes could be synergistic with reducing peak demand, for example consumers using batteries to reduce demand at peak and charging overnight. Or, it could in in conflict with reducing peak demand, for example third parties sending signals to charge batteries when there is abundant supply of solar generation on the wholesale market, but not on our local network.

How these changes develop will have a significant impact on when peak demand is seen on the network, and how flexibility could be used to reduce peak demand.

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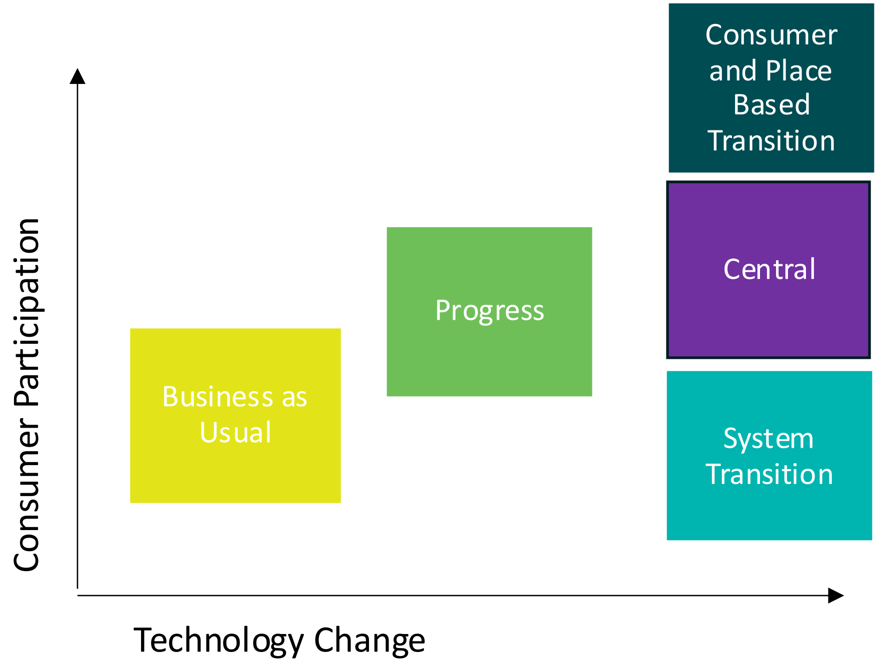


1.4 Inputs and Assumptions

The inputs and assumptions used in each of our scenarios give a richer description of the scenarios

Orion Future Energy Scenarios

Inputs and Assumptions

The table below has a basic outline of the assumptions we have made in the formation and modelling of our scenarios for each of the main drivers of change. See our earlier consultation document for detailed inputs and assumptions.

	Business As Usual	Progress	System Transition	Consumer and Place Based Transition	Central
Growth and Urban Form					
Household					
Residential Growth	Low	Medium	High	High	Medium
Residential Efficiency	Medium	Low	Medium	High	Medium
Residential Gas	Slow Phase-Out	Medium Phase-Out	Rapid Phase-Out	Rapid Phase-Out	Rapid Phase-Out
Industrial and Commercial					
Economic Growth	Low	Medium	Medium	High	High
Electrical Intensity	Medium	Low	Medium	High	Medium
Commercial Gas	Slow Phase-Out	Medium Phase-Out	Rapid Phase-Out	Rapid Phase-Out	Rapid Phase-Out
Transport					
Electrification Uptake	Low	Medium	High	High	High
Mode Shift	Low	Low	Low	High	Medium
Process Heat					
Electrification of Boilers	Low	Medium	High	Low	n/a
Generation					
Rooftop Solar Uptake Utility Scale Generation Uptake	Low	Medium	Low	High	High
Flexibility					
Batteries Uptake	Low	Medium	Medium	High	Medium
Vehicle to Grid Uptake	Low	Medium	Low	High	Medium
Orion Management of Hot Water	Slow Reduction	Rapid Reduction	Rapid Reduction	Slow Reduction	Slow Reduction
Major Customer Demand Response Change	No change	No change	No change	No change	No change

1.5 Process

The establishment of the Orion Future Energy Scenarios is intended as a cyclical process

Orion Future Energy Scenarios

Establishment

These Future Energy Scenarios are the first established by Orion. Orion formed an internal scenario reference group to guide the process of establishment. The process we have taken to establish them consisted of:

- A review of existing Future Energy Scenarios in New Zealand and overseas
- Identification of drivers of change, and prioritisation according to materiality to Orion
- Formation of initial scenarios
- Internal workshops to test inputs and assumptions across the scenario range
- External consultation and engagement on the inputs and assumptions
- Review and sign off of modelling and results for Asset Management Planning
- Finalising Orion Future Energy Scenarios Report

Consultation and Engagement

Orion has undertaken consultation and engagement on our future energy scenarios. We undertook consultation to:

- Provide a rigorous check on our inputs and assumptions,
- Call for further local evidence to support our scenarios, and
- Engage our local community and stakeholders on collaborative discussions on our energy future.

We have undertaken a range of engagements, including:

- Hosting an 'Energy Exchange' event inviting locals interested in our energy future to hear about our scenarios and engage in conversation,
- Hosting a webinar and discussion on our future energy scenarios,
- Meeting one-on-one with key stakeholders.

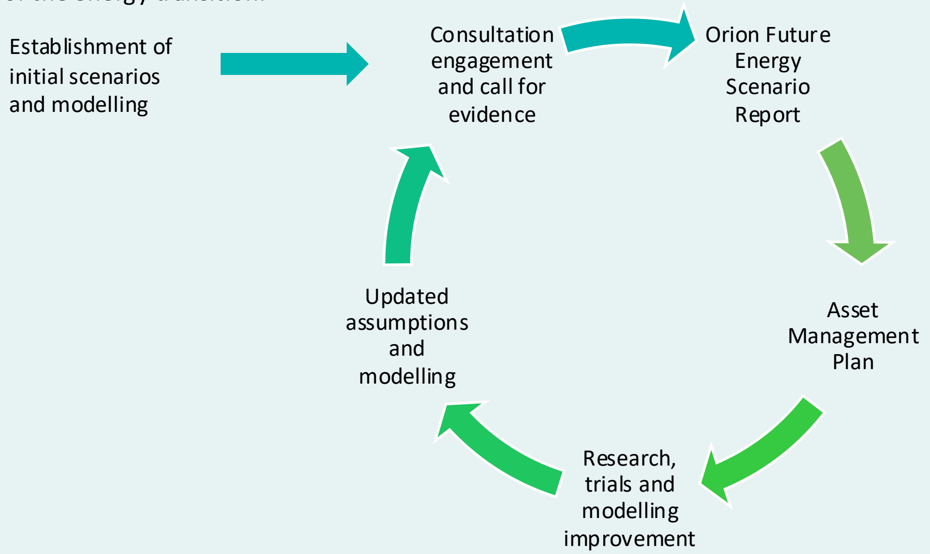
Most people and organisations we engaged with were positive, interested and engaged. We received positive feedback on the approach to pulling together energy scenarios for the region and to being approached for consultation. Many organisations were thinking about decarbonisation but different organisations are at different evolution stages and not all do long-term forecasting. Many organisations were thinking about their long-term energy needs and decarbonisation but were interested to see more about where their needs fit into the wider system.

The main points of discussion in our consultations were future population projections, transport decarbonisation pathways, and wider unknowns. Changes to inputs and assumptions for all of our scenarios were made as a result of the consultation we undertook.

Orion Future Energy Scenario Cycle

The establishment of the Orion Future Energy Scenarios is intended as a cyclical process. The cycle includes establishing our initial set of scenarios and assumptions, a process of consultation and engagement, publishing the output of our scenario modelling and insights which inform; asset management planning and establishing priorities for further research, trials and modelling improvement, and finally re-updating our scenarios, assumptions and modelling.

The process is one of continuous improvement. By developing our scenarios and the energy transformation modelling toolkit we have established a platform. As we deepen our understanding of key drivers, further develop our modelling capability and engagement with stakeholders it builds on our established platform and improves our insights and knowledge of the energy transition.



2. Scenario Overview

2.1 Central Canterbury Electricity Demand Growth

System demand growth will be in the range of 30-110% by 2050

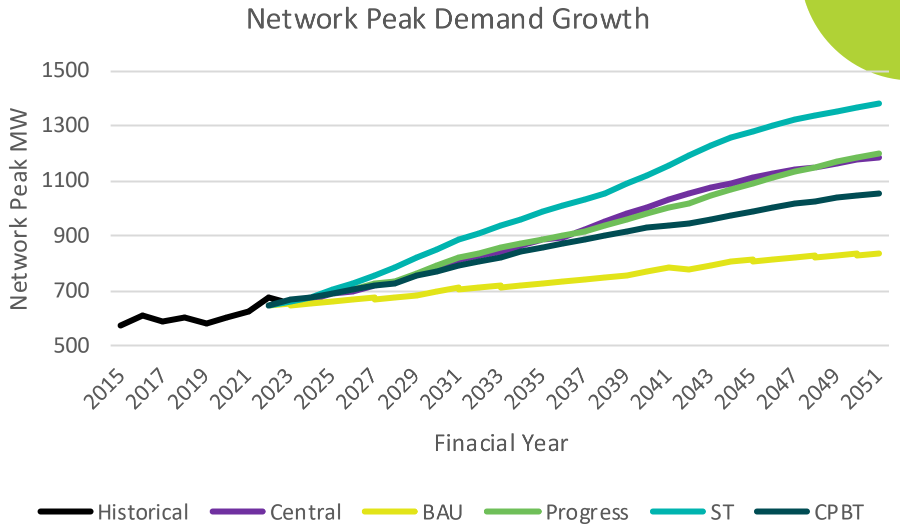
Scenario Overview

Overview

In our modelling of Future Energy Scenarios we have looked at increases in average electricity consumption, and peak electricity demand. Our infrastructure needs to be built to distribute electricity at the point in time when electricity use is highest during the year. Usually this is winter mornings and evenings when residential use of heating and cooking coincides with the heating of offices, as well as industrial and commercial processes.

We expect significant growth in demand across most of our scenarios. In the next 10 years we can expect average electricity consumption to grow between 15% to 50% and peak demand to increase by 10% to 45%, by 2050 this could grow to between around 30% to 110%.

In all scenarios growth in average daily energy demand exceeds growth in peak demand as demand from new technology is likely to be more spread across the day and night rather than falling on top of existing peak demand periods. In many of the scenarios we also expect there to be uptake of distributed energy resources and smart technology that will better optimise the



Risks and Opportunities

Rapid investment and infrastructure build	Peak demand growth of these magnitudes will require significant and rapid investment far above historical rates. Some parts of the network are also likely to grow faster than the overall growth numbers indicate, depending on suburb-to-suburb electrification rates which could be driven by demographic factors between suburbs.
Optimisation technology timing	Demand growth is more homogenous between high population and economic growth scenarios before the 2030s. Many of the technologies that allow for greater optimisation (vehicle to grid and domestic batteries) are expected to become more cost effective through the 2030s. This means that in the coming 10-15 years there could be fewer technical optimisation options. However, there are options such as incentivising charging optimisation through prices or other incentives that can reduce peak demand growth. The difference between System Transition and Progress/Central/CPBT through the 2020s and early 2030s is largely through better optimisation of EV charging.
Business development opportunities	Through electrification, renewable growth and growing our local distribution network there may be opportunities to attract new businesses from outside of the region through localised optimisation of the energy system growth.

	MW PEAK DEMAND GROWTH		% PEAK GROWTH		% AVERAGE CONSUMPTION GROWTH	
	2033	2050	2033	2050	2033	2050
CENTRAL	201	524	30%	79%	41%	82%
BAU	68	184	10%	28%	14%	33%
PROGRESS	206	533	31%	80%	38%	90%
SYSTEM TRANSITION	295	717	44%	108%	52%	113%
CONSUMER AND PLACE-BASED TRANSITION	175	392	26%	59%	34%	86%

2.1 Orion Network Demand Growth

Load growth across almost all scenarios indicates the need for additional capacity at zone substation and grid exit point in the next 10-30 years

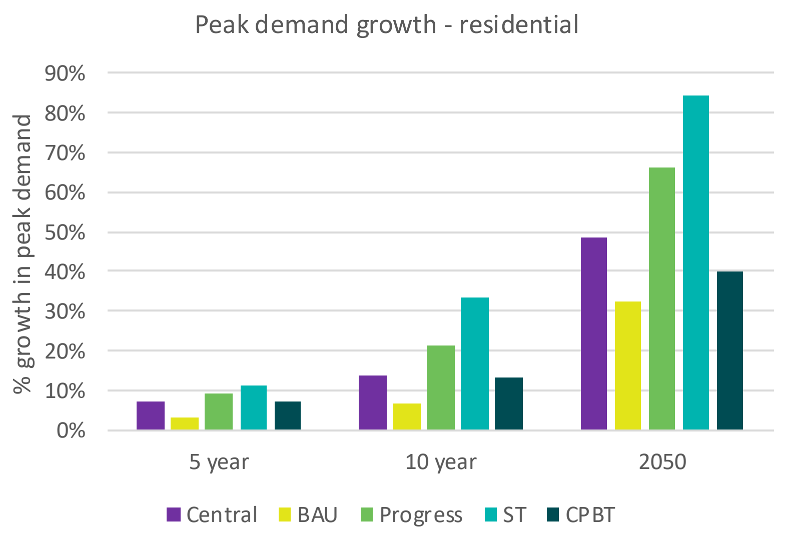
Scenario Overview

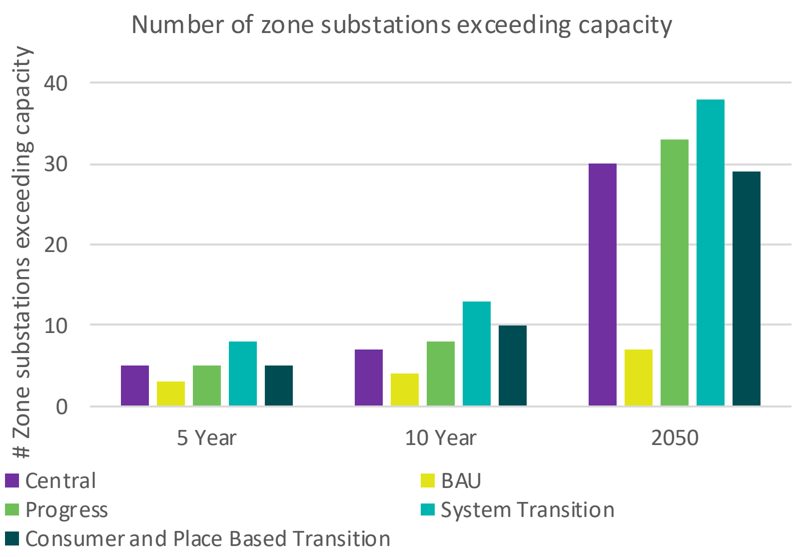
Impact on Assets

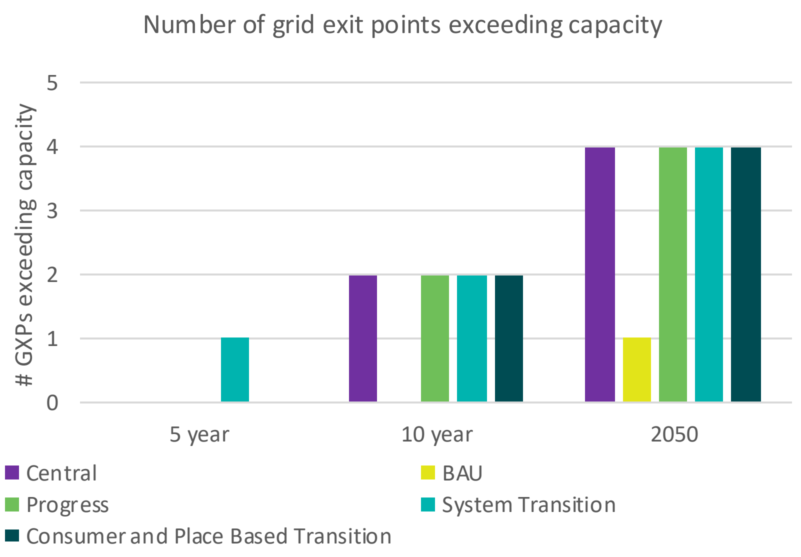
Translating the impact of growth projections onto network assets can be a difficult process. In this section we present a projection where no mitigations or load transfers between assets are taken into account. This gives a superficial view of the level of growth we expect to see on network assets, and the level of investment that could be required into the future, without taking into account network optimisation.

The bulk of growth on the high voltage network is in the 10-30 year time horizon. There are a number of zone substations close to capacity with existing growth, and a range that could become constrained in the 5-10 year period. Many of these will be able to be mitigated through load transfers or flexibility programs that are currently being implemented. However, even with optimising between substations, in most scenarios there will be a significant number exceeding capacity between 2033 and 2050 which will require significant investment. There will be flow on impacts to load on grid exit points. Although the naïve projections show constraints within the next 10 years, Orion has already planned to address these through load shifting, particularly including to the newly built Norwood GXP. By 2050 however, almost all scenarios show the need for more capacity at GXP level, with peak load exceeding the cumulative capacity of all GXPs by 2050 in most scenarios.

Our scenario modelling approach doesn't currently identify constraints on the distribution and low voltage network. However, analysis of residential growth can indicate a level of risk. With residential demand growth of 30%-80% it is likely that some low voltage reinforcement will be required in all scenarios. In 2 of our scenarios this growth is between 20% and 30% overall within the next 10 years. It is possible that this will be significantly higher in some areas, which is discussed further in the growth and urban form section.







2.2 Business As Usual

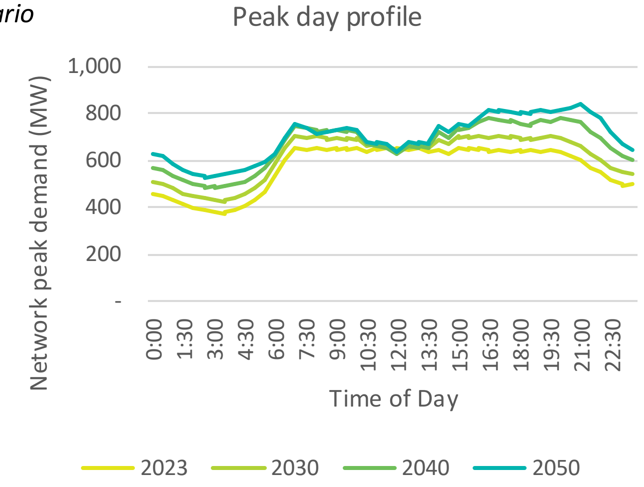
Electrification of process heat is the largest short term growth driver in the business-as-usual scenario

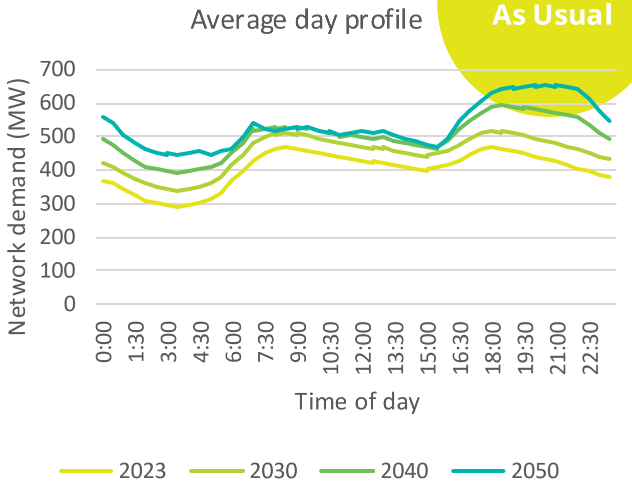
Business As Usual

Overview

The business-as-usual scenario shows the lowest growth in demand. The low growth assumptions mean there is limited overall load growth from residential growth and industrial and commercial growth. However, there will still be some pockets of relatively higher demand in some areas, as residential building growth in some areas is offset by efficiency improvements across the entire housing stock.

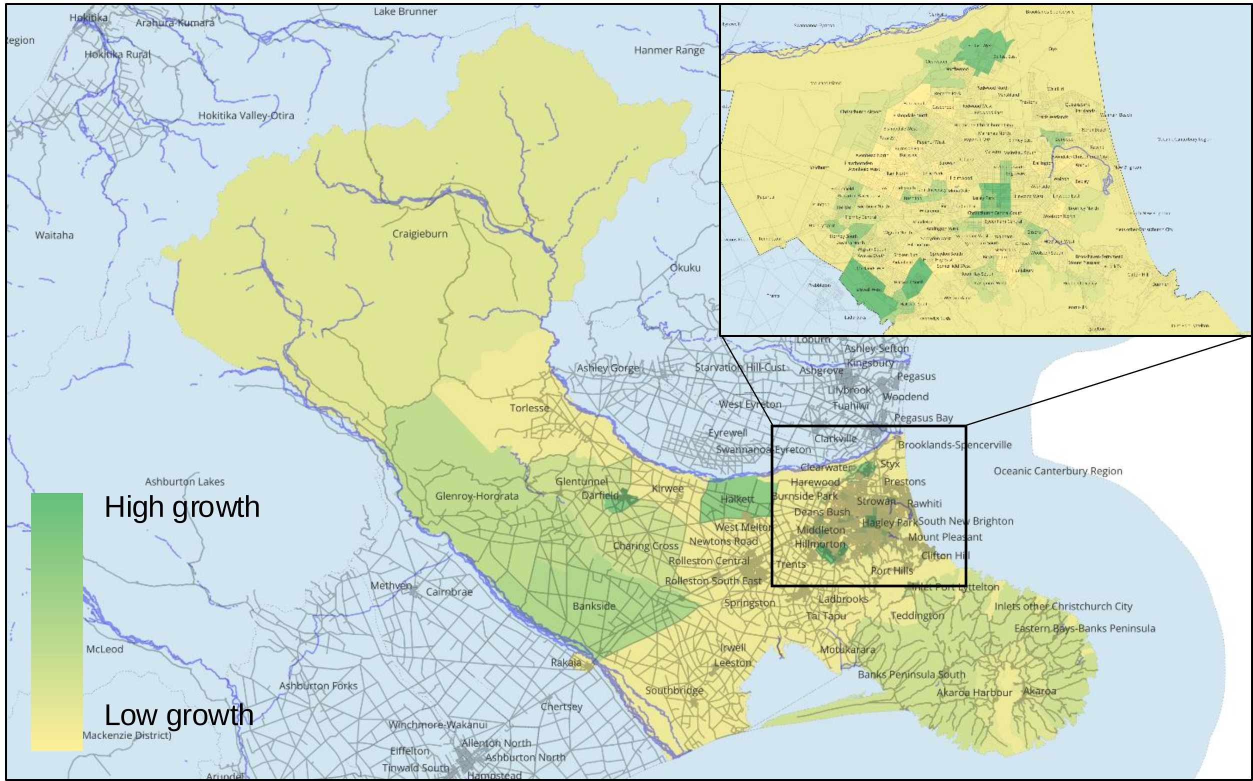
The largest growth is expected to come from the electrification of process heat in the short term, and electrification of transport in the longer term. These are both energy transition drivers that are expected to continue to progress in a business-as-usual world.





Risks and Opportunities

Uneven electrification rates between suburbs	Despite low growth overall there can be pockets of rapid growth driven by housing developments and electrification. In this scenario while the overall uptake of electric vehicles will be low, we still expect pockets of high uptake, particularly in higher income areas. This could impact on Orion's low voltage network, in places where uptake of electric vehicles is high and optimisation or shift in charging time in response to retail pricing is low.
Climate change impacts	Although we haven't modelled the impact of changes in weather for these scenarios, the BAU scenario describes a world with high physical climate change impacts. This could significantly shift patterns in energy consumption and could include changes in urban form and population relocation over time.



2.3 Progress

The Progress scenario has low levels of optimisation

Progress

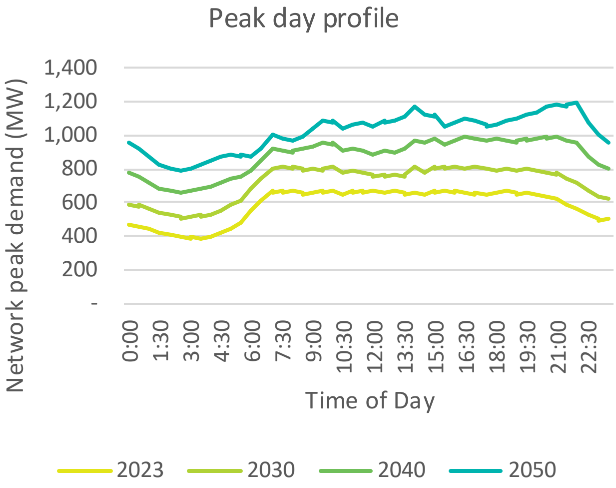
Overview

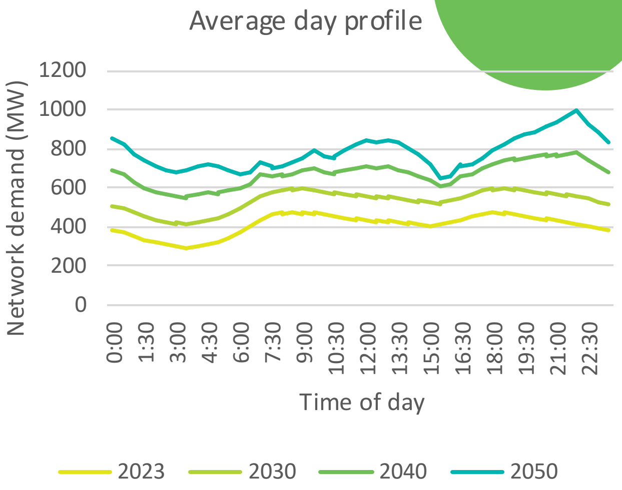
The progress scenario has lower levels of electrification than the central scenario, but with less optimization, peak demand growth remains similar. In the short term there is growth from process heat and residential growth. Growth in demand from transport becomes a larger driving factor after 2035.

Peak demand growth in later years is limited to some extent by use of batteries, vehicle to grid and distributed solar generation, as well as the continued use of Orion's hot water load management.

Peak day demand follows similar patterns for most of the scenario period, but in later years peaks begin to shift later in the evening as charging of EVs become the main driver of peaks. Solar generation becomes more of a factor during the day, which also allows for more use of demand side flexibility during the day.

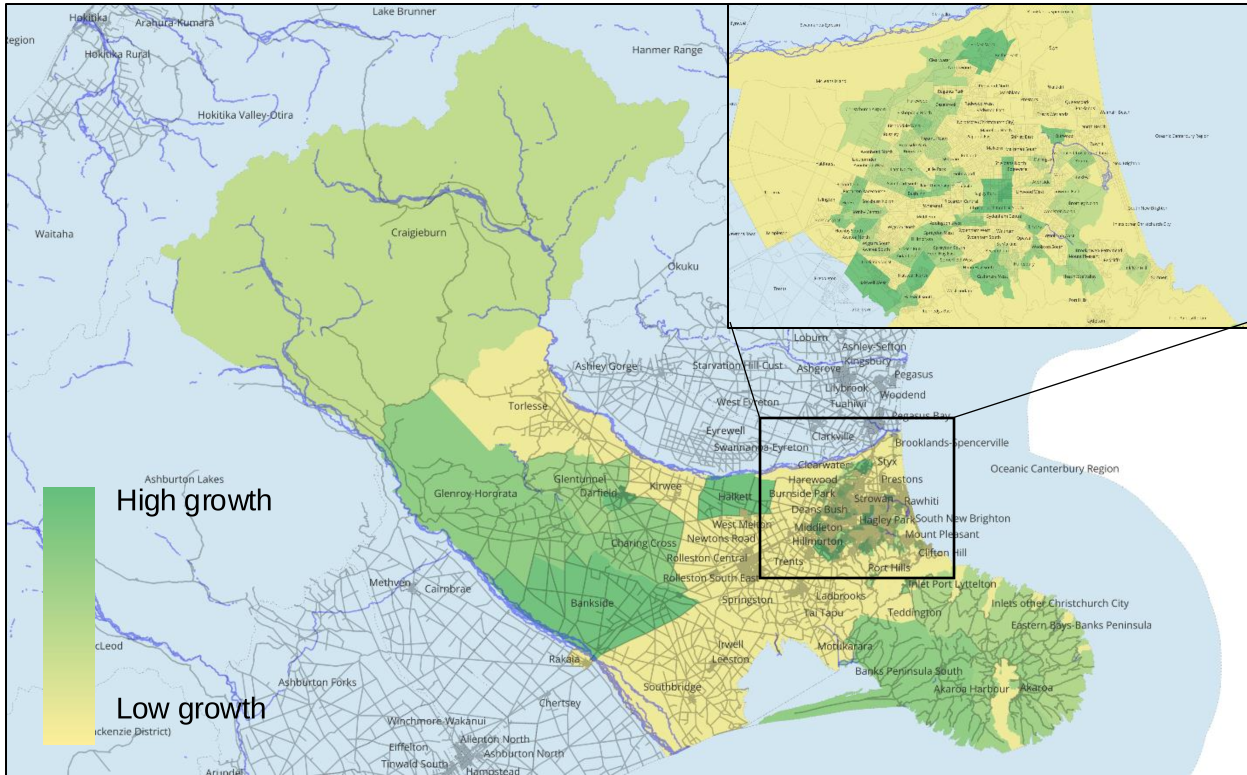
Growth in demand is spread across the network, but there are growth areas where housing becomes concentrated in the central city, and along the mass rapid transport corridor. There is also expected to be significant increases in urban areas of Selwyn, including Rolleston, Lincoln and Darfield.





Risks and Opportunities

Solar intermittency	As more distributed generation comes onto the network there is potential for daytime peaks due to intermittency, particularly where there is less local optimisation with batteries or matched demand. If there is change in demand as distributed solar becomes more common, such as shifting hot water cylinder heating into the day and turning off night heating or load management controls there could be much greater local optimisation, but also higher risk from intermittency in generation.
Rapid, uneven growth	As with the business-as-usual scenario, there could be rapid growth in demand in some pockets with concentrated building development, and high electrification of private transport. This could have impacts on Orion's network development and investment.



2.4 System Transition

System Transition has the highest demand growth of all our scenarios

System Transition

Overview

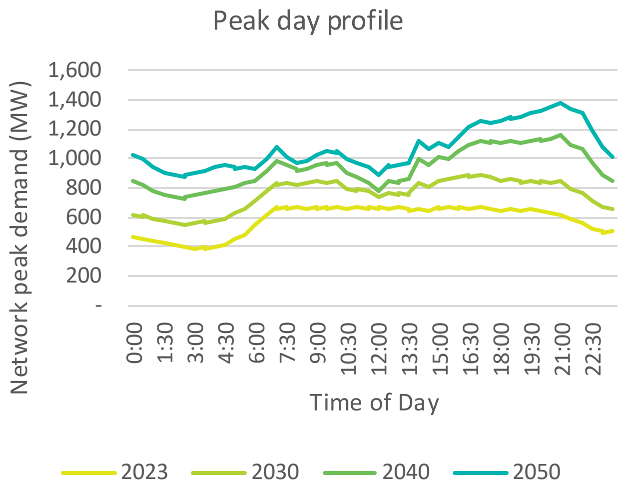
This scenario has the highest demand growth. Process heat is the largest driver of peak demand growth in the short term, although there is also significant growth due to residential growth, transport electrification, and changes to hot water management.

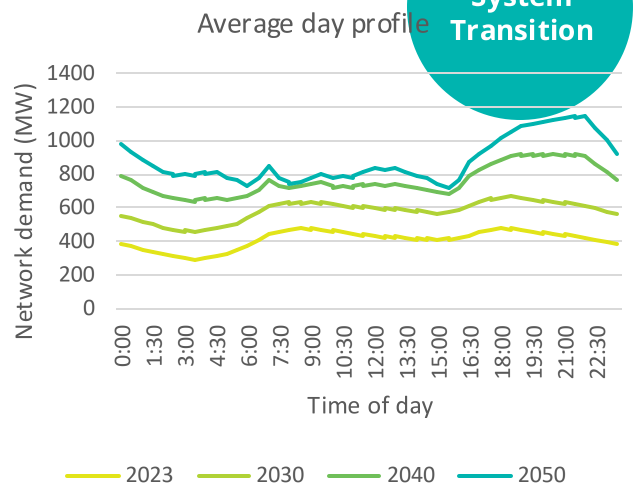
By 2050 transport electrification is the largest driver of peak demand growth on the network. This comes from a combination of light and heavy vehicle electrification, and limited optimisation of charging.

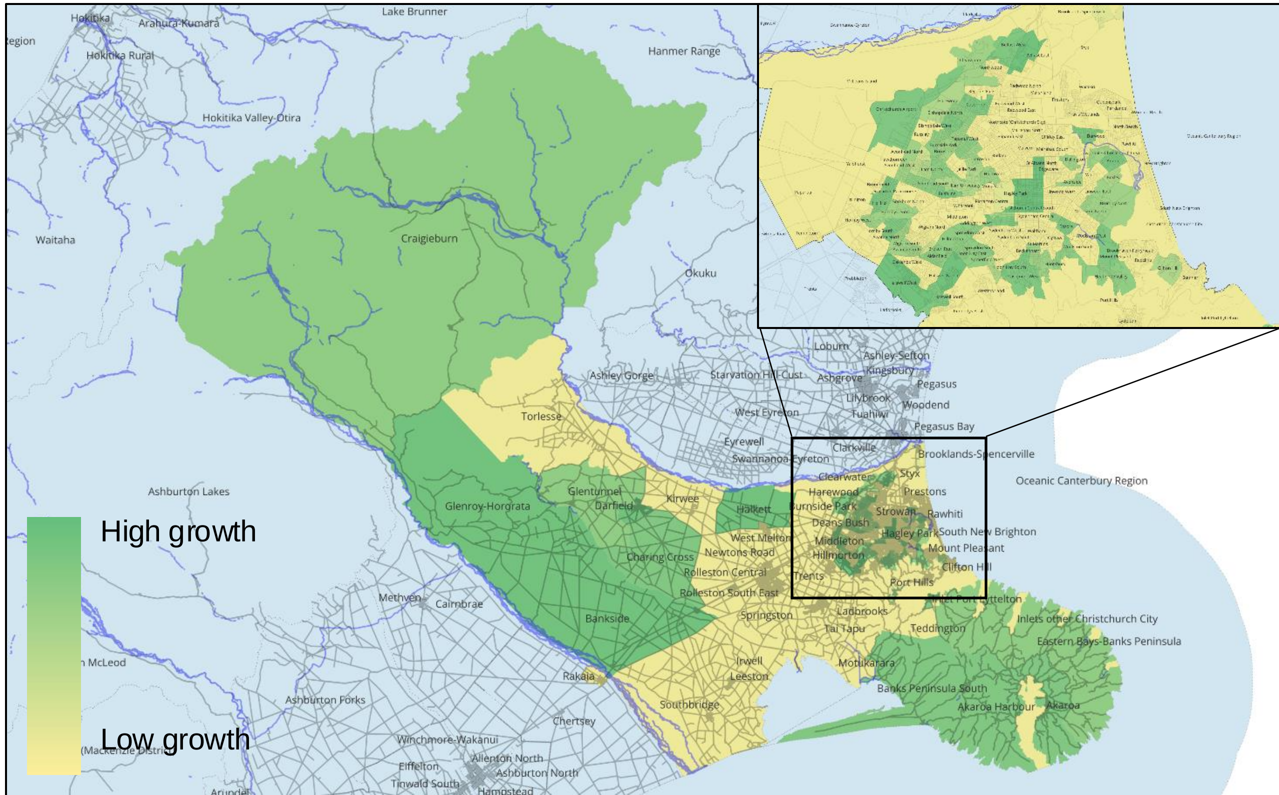
There is significant growth in the Selwyn region, driven by greenfield expansions. Growth within Christchurch City is more spread, as the mass rapid transit corridor doesn't develop. This also means there is higher demand for private vehicle transport over time.

Risks and Opportunities

Rapid demand growth	Orion will need to build ahead of demand, but with annual increments in peak demand of up to 4.5% across the network, ensuring investment and infrastructure can be finalised ahead of time will be challenging.
Rapid low voltage demand growth	Very rapid uptake of electric vehicles and low optimisation could cause significant challenges for the low voltage network. Additionally, rapid electrification in the heavy transport sector could result in a number of large and complex connection requests, on top of decarbonisation of the process heat sector.
Value in large scale storage	With limited optimisation at the consumer end of the supply chain, it is possible that more of the value in optimising demand or responding to intermittent generation will be captured by utility or grid scale storage. While this may optimise energy consumption for the overall system, or wholesale market, there could be larger underlying variation in demand within the network and the value of localised optimisation not being realised.







2.5 Consumer and Place Based Transition

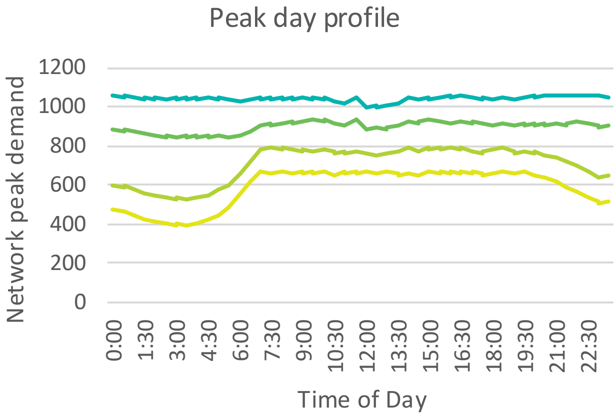
A highly optimised system could mean a different role for Orion in the future

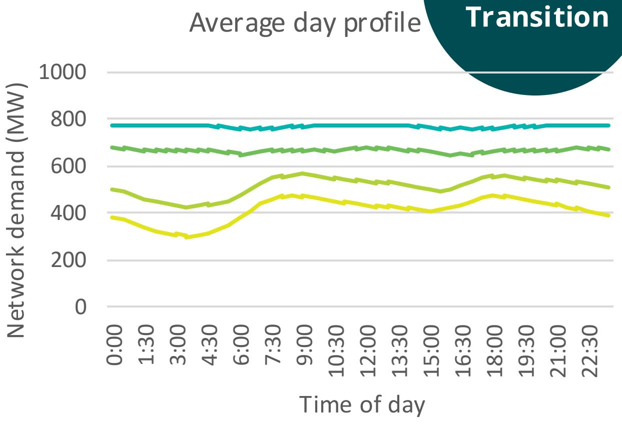
Consumer and Place Based Transition

Overview

The consumer and place-based transition scenario has the highest rates of optimisation and efficiency in the system. Despite population and economic growth at the highest ends of the scale, greater optimisation of charging and use of flexibility in combination with distributed generation significantly reduces potential demand growth. Centre city growth is higher within Christchurch city along the mass rapid transit corridor, and there is also high growth in Selwyn urban areas. Place-based optimisation significantly reduces total energy demand from transport. More active transport and higher use of public transport leads to more efficient use of transport and lower demand on electricity.

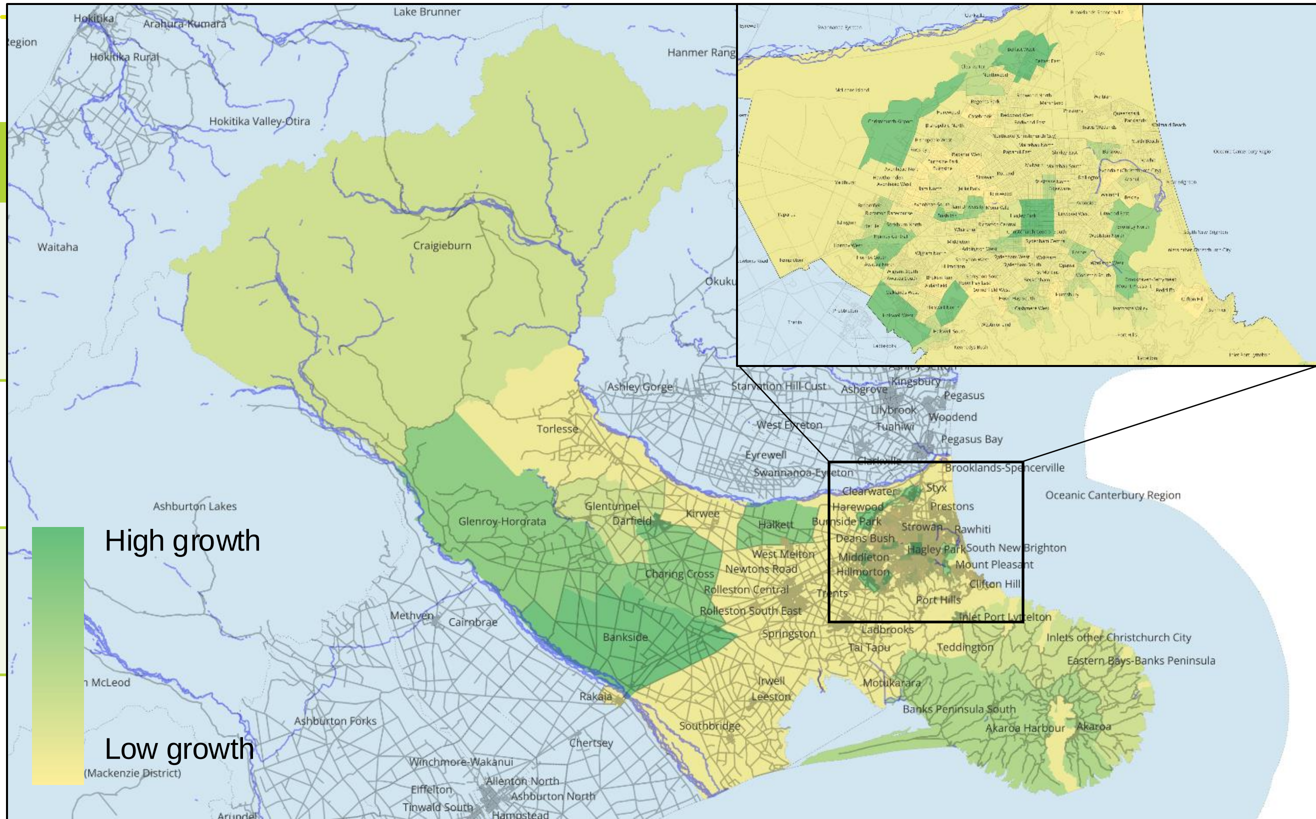
The combination of solar generation and use of batteries and vehicle to grid technology could reduce growth in peak demand by nearly 200 MW (~20%) by the year 2050. This highly optimised consumer based system means limited growth on the low voltage network. On some parts of the residential network growth in peak demand per household between now and 2050 could be negative, as high users take up batteries or vehicle to grid technology to optimise their consumption.





Risks and Opportunities

Local system operation	In a highly optimised system Orion could play a significantly different role. With flexibility potentially reducing demand by 200MW (~20%) on peak days. In this scenario a larger part of Orion's core business could be involved in the day to day balancing of supply and demand within our network and facilitating optimisation within communities.
Longer term demand balancing	In this scenario the storage capacity would be sufficient to shift demand between days, meaning optimisation of demand across a week. To achieve this there would be significant investment in forecasting and digitisation to ensure systems are set up to optimise over longer periods without impacts on customers.
Community resilience	There would also be sufficient distributed storage and generation to allow optimisation within communities and suburbs and allow for greater community resilience. However, if there is concentration of these distributed energy resources in wealthier communities it could lead to unequal transition.
Over-investment	There is risk that demand optimisation and greater flexibility occurring after initial demand increases from electric vehicles could result in a rise and then drop in peak demand on parts of the network. This could increase risk of over-investment and stranded assets if we initially plan for a future with less optimisation.



2.6 Central

Demand optimised to the wholesale market could change when we see peaks on the local network

Central

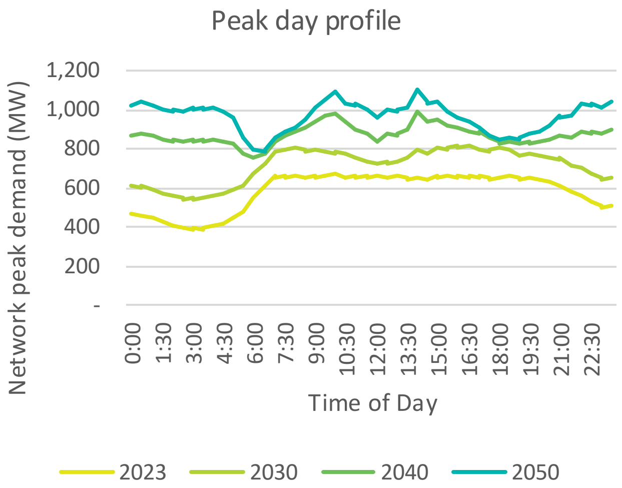
Overview

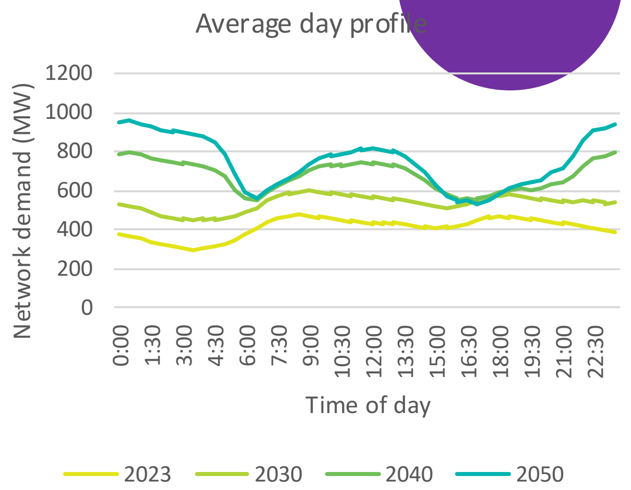
Demand growth is initially driven by residential growth and process heat, but transport becomes a much larger contributor to growth by 2050. This scenario assumes that most of the growth in demand from electric vehicles can be shifted outside of peak times and into the overnight and daytime period.

In the long term demand shifts over time towards the middle of the day. This is based on the assumption that as more of the marginal generation in the wholesale market is made up by solar generation. Over time lower prices likely worked into retail tariffs will see households or third parties look to increase daytime demand to match low-cost solar production, however, on peak days local generation could be inconsistent.

There is also large demand growth during the day from electrification of some large industrial loads. The final profile shown may be an unrealistic exaggeration of the issue, but it does highlight the risk of increasing daytime load and intermittent local generation.

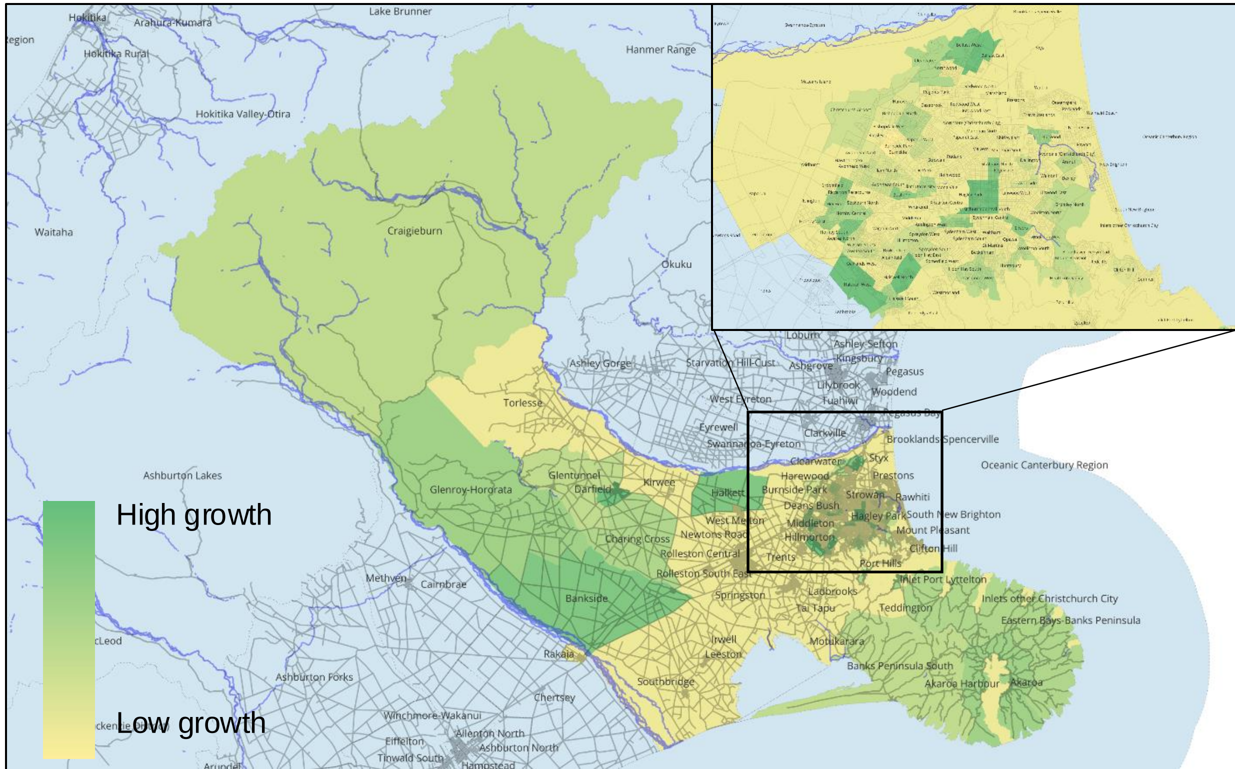
Growth is relatively concentrated in some areas in this scenario. In particular areas with new greenfield developments, and areas likely to have more in-fill housing, particularly along the mass rapid transit corridor proposed by the Greater Christchurch Partnership.





Risks and Opportunities

Increased daytime demand and local intermittency	In the long-term increased day time demand could result in midday peaks on the local network, with reduced demand during the traditional morning and evening peak periods as there is more injection or behind the meter use of batteries or vehicle to grid. If peaks occur during the day, the impact of intermittency of distributed generation could also become more significant.
Reliance on new technology and incentives	In this scenario a significant amount of demand is assumed to be shifted out of peak into overnight and daytime periods. This relies on pricing and market incentives to make the shift and new technologies being deployed within the next 10 years.



3. Drivers of Change

3.1 Summary

Population and economic growth will drive as much growth in demand as electrification of transport

Drivers of Change

Overview

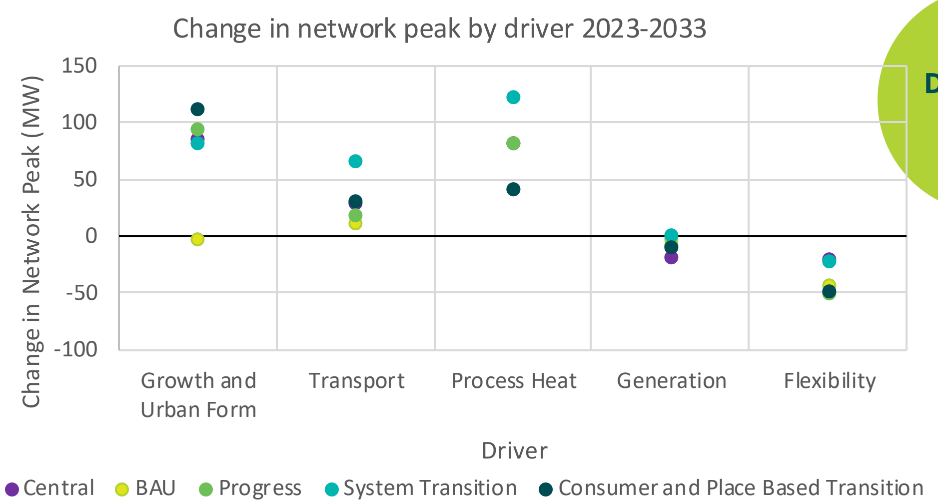
By analysing the individual drivers of change we get a more detailed look at the risks and opportunities involved in the energy transition. We are also able to look at how, where and when change will occur across our network.

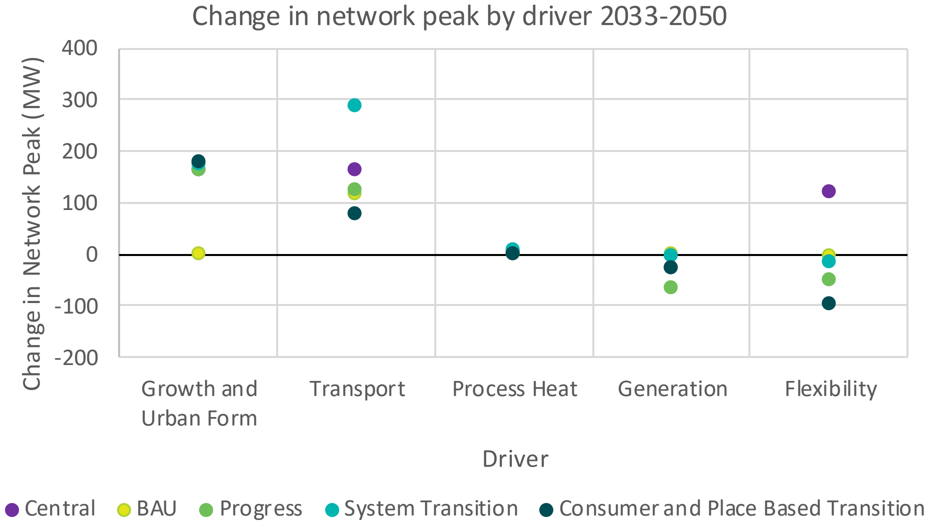
In the next 10 years we expect continued growth from our traditional growth areas, residential and industrial and commercial growth. Significant housing development, and internal migration within New Zealand, particularly to the Selwyn region, will continue to increase demand. There is however, significant spread between high and low estimates of growth for each driver. In particular, population growth estimates have a significant impact on future load estimates, because they act as a multiplier for other electrification trends.

Electrification of process heat and transport are likely to be the main drivers of energy transition in the next 10 years. Although there are existing electrification trends in both of these areas there is still significant uncertainty about the rate of change, and even the decarbonisation pathway for process heat and heavy transport, where alternative fuels have viable futures.

Across the following two decades, transport becomes a much stronger driver of increasing peak load. Generation and flexibility also start to have a stronger influence on peak load. Growth and change in urban form continue to drive changes in peak load. Across this timeframe there are much greater spreads in our estimates as we have less confidence in the assumptions we use in our scenarios.

Looking at the growth of different drivers, and our subjective confidence ratings, we can see that Transport and Flexibility, with high change, high spreads between scenarios and low confidence are key areas for improving our understanding.





	2023 - 2033	2023 - 2050	Confidence in Assumptions
Growth and Urban Form	-3 – 111	-1 – 292	Medium
Transport	11 – 65	109 – 354	Medium/Low
Process Heat	41 – 123	42 – 134	Medium
Generation	-19 – 0	-69 – 0	Medium/Low
Flexibility	-51 – -22	-144 – 102	Low

3.2 Growth and Urban Form

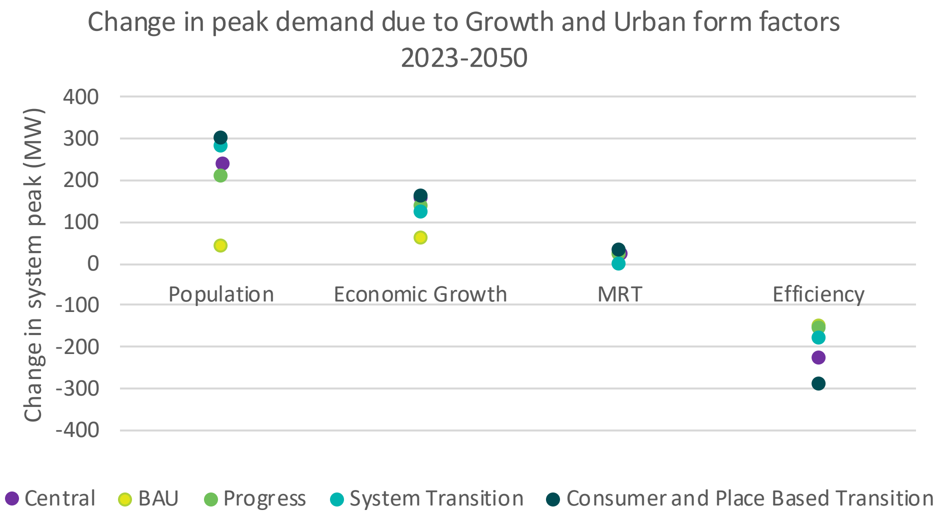
Population growth will continue to drive large growth in housing and residential demand

Overview

In the short term the largest change in peak demand is likely to come from population and residential growth. Our analysis shows that in the Central scenario these factors drive around 70 MW (~10%) of net growth in peak demand (taking into account efficiency savings) over the next 10 years, and 213 MW (~30%) net growth in peak demand by 2050. Initial growth is projected to be particularly strong in Selwyn, including Rolleston, Lincoln and Darfield. Some scenarios show high growth from infill housing within Christchurch city, particularly along the mass rapid transit corridors where that has been modelled.

In some scenarios this is nearly, or completely offset by efficiency improvements. We currently do not have an in-depth understanding or complex modelling for how residential efficiency could improve and have projected forward small variations on historical rates to understand the potential spread.

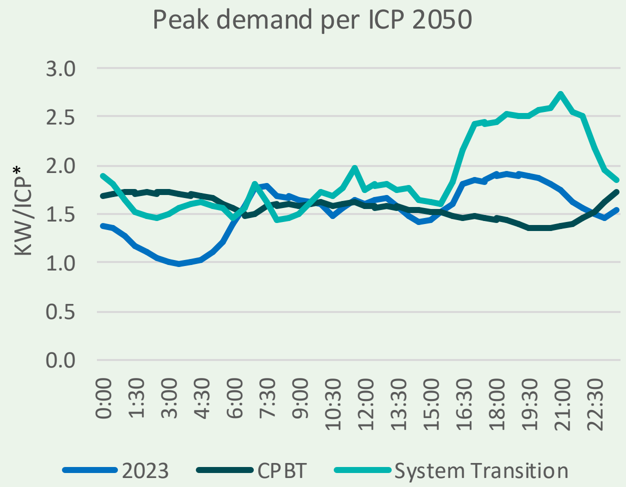
Industrial and commercial demand grows along with population and economic growth. More people and economic mean more jobs, services and economic activity. Our current modelling approach for industrial and commercial growth is simplistic and could be improved in future iterations. We assume an electrical intensity per unit of GDP, and project this forward, reducing over time to account for efficiency improvements. This approach is useful as a broad-based estimate but needs improvement to give more granular estimates.



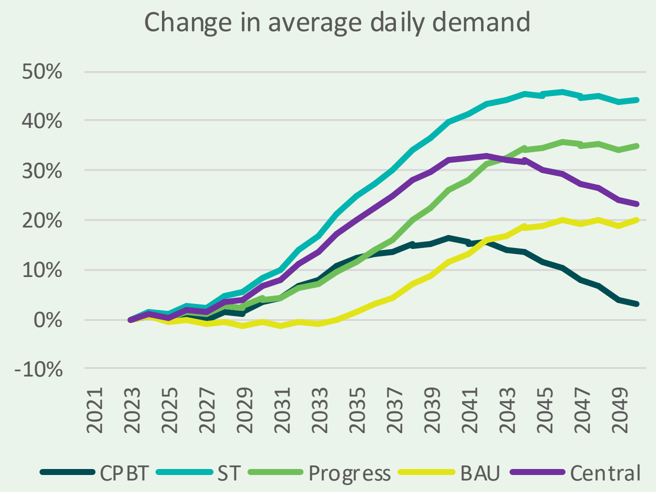
Residential

Changes in residential demand come from the combination of population and residential building growth and change in demand within households. Change in demand within households will come from a combination of increasing electrification, changes in efficiency and changing intra-day demand profiles. In some scenarios we see minimal or negative peak demand per household. In scenarios where there is high levels of optimisation average demand per household could rise as electrification of transport occurs, and then fall as efficiency improves and more people shift to public or active transport.

There is a significant spread in potential peak demand at household level in the future. If there is a high level of optimisation at consumer level through shifting demand to overnight and use of solar and batteries, peak demand per household could fall between now and 2050. Alternatively, with high levels of electrification and low optimisation there could be over 40% growth in peak demand at the household level.



*not an LV estimate – averaged at high aggregation



3.2 Growth and Urban Form

Access to DER will drastically change residential demand

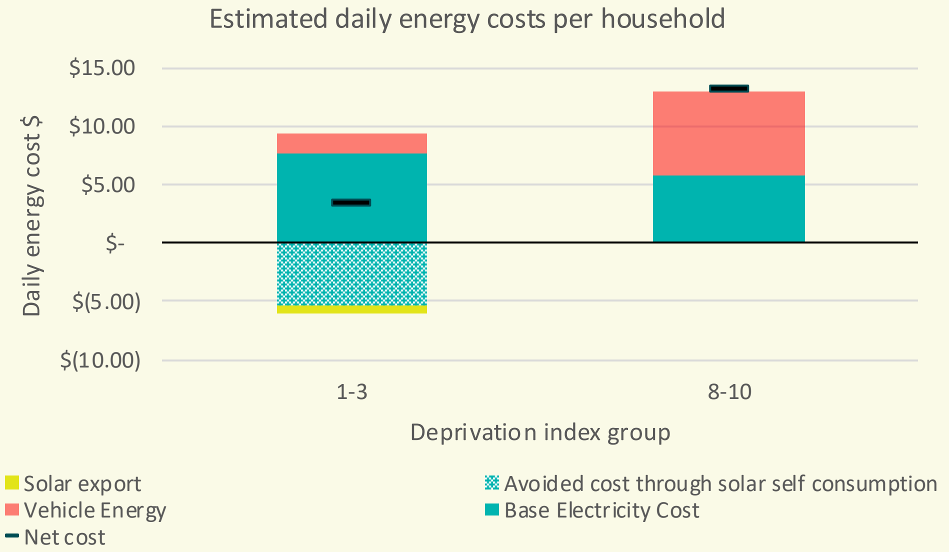
Drivers of Change

Demographics

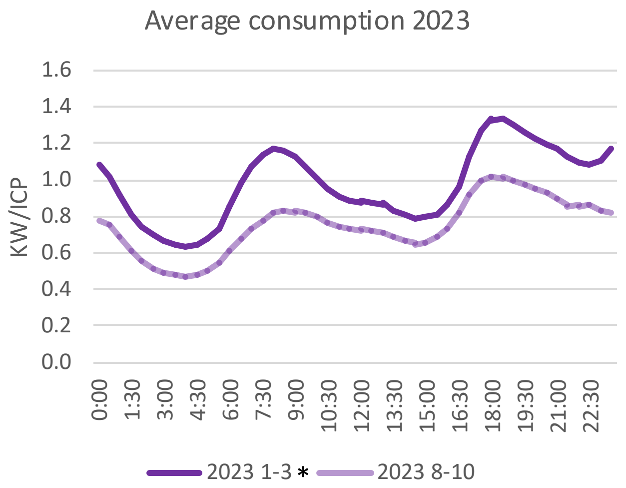
There are large differences in energy demand between areas with different demographic make ups in the Orion region. There is also potential for significant divergence over time, depending on the uptake of different technologies.

We have analysed electricity demand in different suburbs grouped by their deprivation index score.* At the lower end of deprivation (deciles 1-3) average daily electricity demand is currently around 30% higher than suburbs with higher deprivation (deciles 8-10).

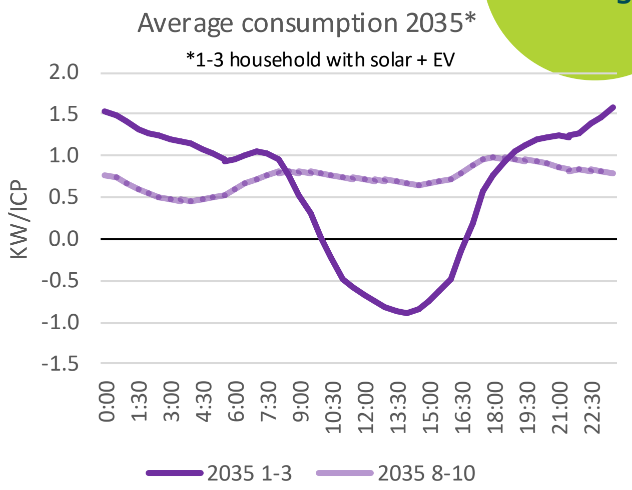
Under our Central scenario by 2035, a low deprivation household with an electric vehicle and rooftop solar generation will have around 65% higher daily electricity demand than the higher deprivation households, however, they may have the same demand from the grid, with the balance being supplied by their rooftop solar. A rudimentary analysis of daily energy costs for these two households suggests that the higher deprivation household would pay around 4 times what the lower deprivation house would pay in this scenario, although the lower deprivation household would likely have made higher capital investment in the solar and vehicles. Regardless, the significantly reduced marginal cost of energy for lower deprivation households could drive significant behaviour change in the way they consume energy.



https://www.otago.ac.nz/wellington/departments/publichealth/research-groups-in-the-department-of-public-health/hirp/socioeconomic-deprivation-indexes-nzdep-and-nzidep-department-of-public-health



*Deprivation index (lower = least deprived)

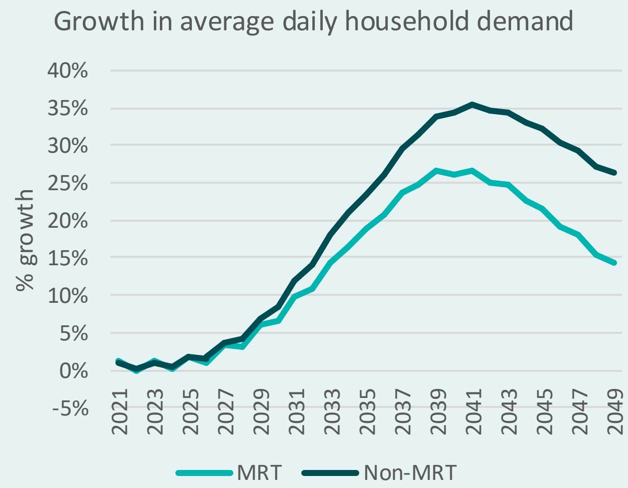


MRT

The Mass Rapid Transit Corridor proposed by the Greater Christchurch Partnership has high potential to influence where and how we see energy demand in the future. Aside from the influences on private transport and electricity demand from what the choice of public transport would be, the primary influence would be directing where housing stock accumulates.

In our Central scenario we estimate that the existence of the MRT corridor would add around 16 MW (~1% growth) net peak demand growth by 2050, however, this comes through a combination of additional housing stock adding around 26 MW and 10 MW of gains from transport efficiency. Over time we expect per household demand to fall within the MRT compared to households outside the MRT with more, newer more efficient households, and lower demand for private transport.

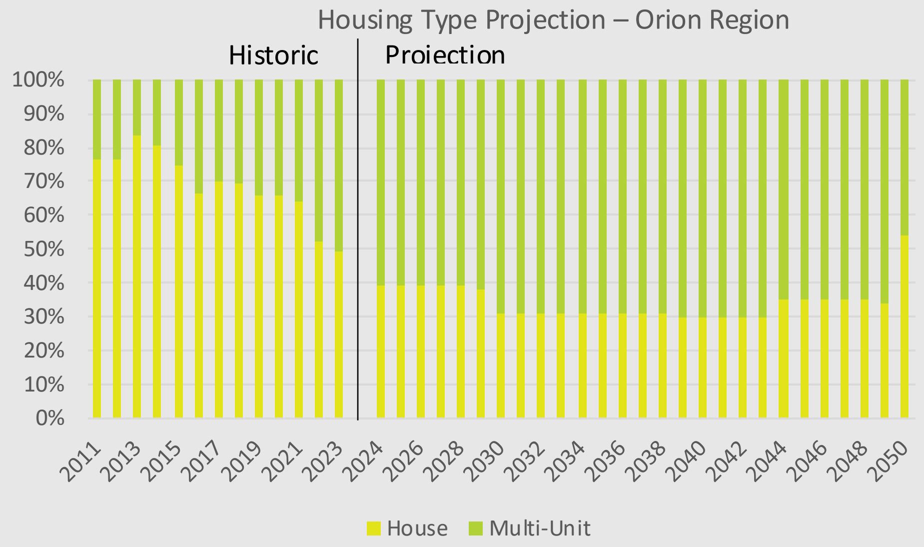
We have not yet estimated the additional demand from public transport on the corridor.



3.2 Growth and Urban Form

Efficiency improvements are potentially one of the largest drivers of change in future demand

Housing Type Change



There has been a significant and continued shift towards multi-unit housing in Christchurch, with around 65% of building consents in 2023 being for multi-unit housing. While most building consents in the Selwyn region are still standalone houses, there is still some potential for shifts to multi-unit housing in urban centres there too.

In most scenarios we expect this to continue, particularly within Christchurch, and along the mass rapid transit pathway. In our analysis we have split the Orion region into 3 zones, 1 being within the proposed MRT area, 2 being outside the MRT but within the Christchurch metro area (excluding Banks Peninsula), and 3 being outside the Christchurch metro area and Selwyn, and assumed that 90%, 70%, and 10% of new houses in each zone will be multi-unit. This shows that both the proportion and number of new houses in the Orion region built as multi-unit homes will continue to grow, with up to 70% of new homes built being multi-unit during the 2030s.

Risks and Opportunities

Efficiency unknowns	Improvement in efficiency is a significant opportunity to reduce overall energy consumption. Increases in household electricity efficiency could take up to 300MW (~30%) off winter peak demand by 2050 if it continues to improve at near historical rates. It could also improve much more slowly, particularly if alongside efficiency improvements there are more and more electronic devices that add to a households baseline consumption, while it is also possible that improvements in electronic device efficiency slow down. Changes in efficiency of buildings can also be hard to predict, as more new houses are added the thermal efficiency of homes will increase, as with renovations. However, as thermal efficiency increases some households will increase use of heating devices as their performance becomes more effective.
Overbuild	There is risk that in some areas residential electricity demand increases as fossil fuels are electrified, but then falls as efficiency improves and more optimisation occurs as a household level. This could lead to the risk for Orion of stranded assets or over investment in some areas. We see this in some scenarios at the ICP level, where more technology such as home batteries or V2G becomes viable later in the 2030s and peak demand falls. This could be seen at the low voltage level of the network, but at higher levels of aggregation on the network this effect is likely to be overcome by growth in new households and businesses.
Significant growth on existing assets	The existence of the mass rapid transit corridor could make a significant impact on daily household electricity demand for the suburbs with access to it for daily use. These households will have less demand for electric vehicle charging. The building density required to service this area will also mean significant demand growth on central city assets, which could require investment alongside transport infrastructure building. Uncertainty over the development of the MRT could cause significant uncertainty in the timing of investment in those areas.
Increase in multi-unit dwellings	The increase in the proportion of new homes built being multi-unit will mean a change in energy consumption patterns in some parts of the network. In many cases new multi-unit dwellings will replace older individual houses on existing electricity and other infrastructure and increase the demand on infrastructure in the area. This could mean the replacement of a single homes demand with up to 10 units in some places. With changes in the consenting process for these houses, change could be more difficult to predict and occur faster.

3.3 Transport

The distribution of EV uptake will be difficult to predict

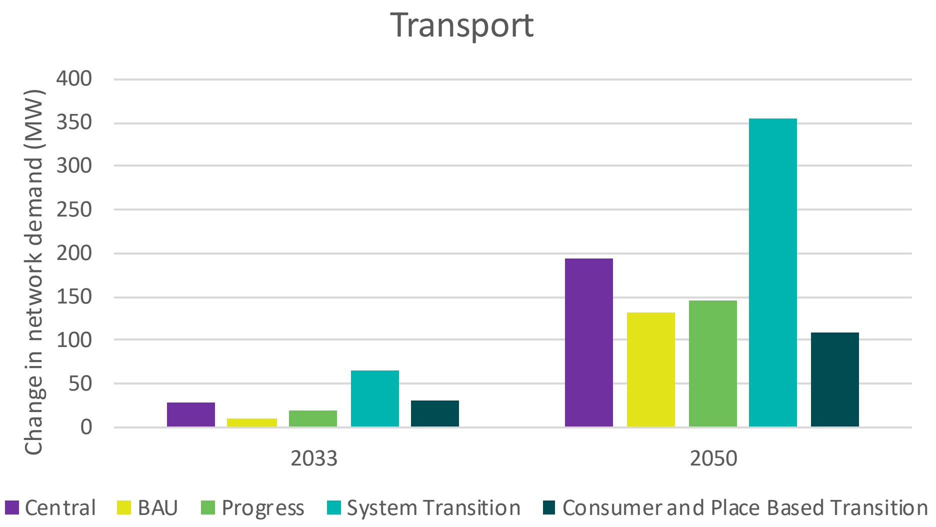
Drivers of Change

Overview

By 2050 transport electrification is likely to be the largest individual driver of demand growth. In the system transition scenario, where there is full electrification of light electric vehicles, and nearly full electrification of heavy transport, with minimal optimisation at the consumer level, transport could add over 350 MW to peak load by 2050, more than 50% of existing total peak demand.

Within the next 10 years, electrification of transport could add between 11 MW and 65 MW(~2-10%) depending on uptake rates and charging behaviour. Growth in peak demand from the electrification of transport is likely to be highest after 2030 as uptake of electric vehicles increases.

With electric vehicles there is high uncertainty, and high variability possible. It is currently unclear whether large vehicles will use electricity in the future or alternative fuel sources, or how quickly the light fleet could electrify.

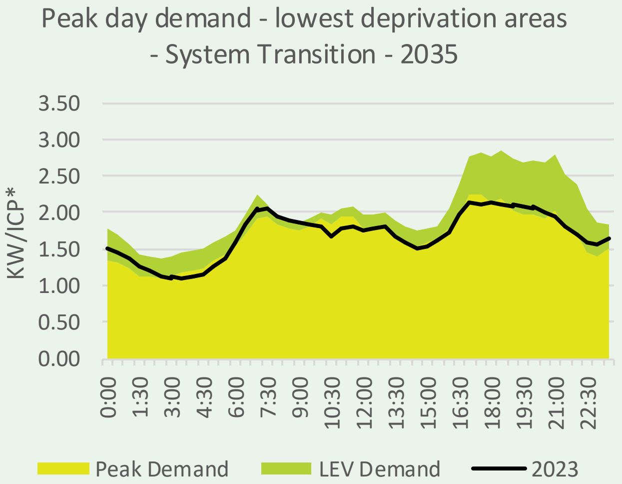


Light Vehicle Charging

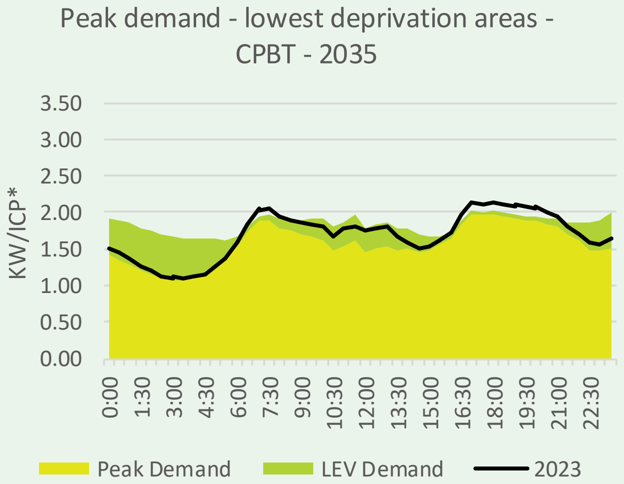
Most of the additional demand from transport electrification is likely to come from light vehicles. Uptake is increasing around the world as more manufacturers start to build electric vehicles and either subsidies or higher fuel costs drive consumers towards electric vehicles. There is a clear path towards electrification but the rate of uptake is uncertain.

Uptake of electric vehicles could also be highly variable within the region. Already we see that around 3% of households have electric vehicles in our region, but in the suburbs with the highest uptake around 10-12% of households have electric vehicles. This could mean that some regions see electrification impacts far ahead of others. While on the whole electric vehicle uptake may not be a major contributor to peak demand by 2033, in some suburbs it could be the driver of new peaks within 5 years.

The graphs opposite show peak demand in the least deprived suburbs (assumed to have fastest EV uptake) under our highest uptake scenarios. Depending on whether charging is optimized we could see little or no increase in peak demand on the low voltage network, or we could see around 35% increase in demand by 2035.



*not an LV estimate – averaged at high aggregation



*not an LV estimate – averaged at high aggregation

3.3 Transport

The medium sized commercial vehicle segment could electrify quickly if the economic conditions are right

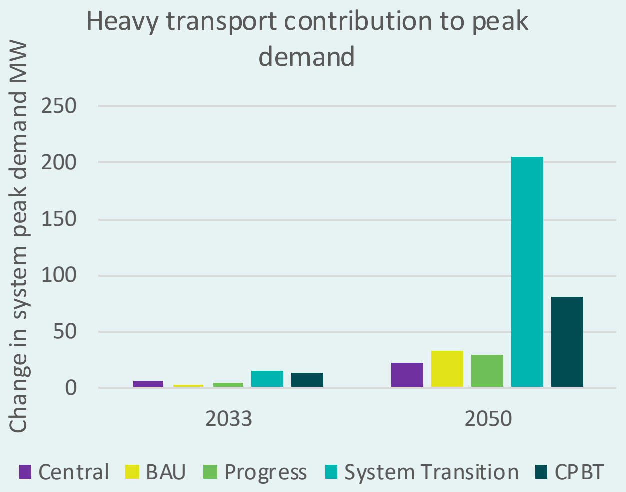
Drivers of Change

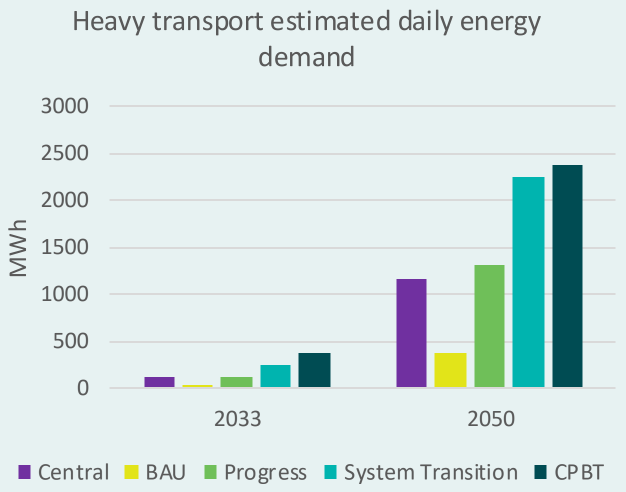
Heavy Transport

Heavy electric vehicles have a much more uncertain decarbonisation pathway than light vehicles. There are some examples of public transport electrifying, but heavier vehicles and those travelling longer distances have a less certain pathway. Hydrogen or other fuels could be an option in the future. Alternatively mode shift within the heavy vehicle class could include more road freight shifting to rail or to coastal shipping.

Our modelling of heavy electric vehicles is simplistic and gives a broad overview of potential energy demand over the heavy vehicle sector rather than specific insights into different vehicle types and locational charging. We have projected forward changes in VKT and used broad assumptions about electricity uptake across the scenarios and modelled potential charging profiles.

Overall we expect heavy electric vehicles to add around 1000 MWh to daily energy demand in 2050, and about 20 MW (>1%) to peak demand in our central Scenario. This could be as high as 2200 MWh in the System Transition scenario, adding around 100 MW (<10%) to peak and as low as 360 MWh and 15 MW added to peak in the BAU scenario, where we have assumed low uptake and potentially more heavy freight using hydrogen as a fuel.





Risks and Opportunities

Fast uptake and clustering	The uptake of electric vehicles is difficult to forecast, particularly taking into account their spatial uptake within our region. There is risk that demand will increase significantly within a short space of time within some clusters of the region, particularly if the speed of uptake is determined by income or wealth. It is also a risk that this early uptake group could have some herding in response to low retail prices and cause local network spikes before any significant effect is seen at a regional or wholesale market level. It is also likely that electric vehicles will have higher usage per vehicle than ICE vehicles, due to the lower marginal cost of maintenance and fuel in EVs.
Commercial fleet clustering	There is risk that medium sized electric vehicles used for commercial purposes could be the most rapidly changing segment of the market. If these vehicles become commercially viable, uptake could be rapid as vehicle fleets are turned over more quickly than private vehicles. There is also potential for this segment to have much more highly regimented charging patterns to match downtime and work hours, potential for faster charging demand than for private vehicles, and for rapid localised increases in network demand as fleets transition. We currently have little insight into this segment of the market to apply to our modelling. Heavy electric vehicles have less developed viable electric technology, but over a longer timeframe could bring similar challenges.
Optimisation opportunity	There are significant opportunities with smart charging and vehicle to grid technology to optimise network demand. The uptake of electric vehicles means a significant increase in energy storage in EV's that could be used on the electricity to optimise local energy consumption and improve the value of locally generated renewable energy. There are significant behavioural, technical and economic challenges to accessing vehicle batteries for network or grid purposes. There is risk that even with controls or smart charging on some electric vehicles, it will not be evenly distributed enough to even out demand on the low voltage network or spread the benefits across all communities in the region.

3.4 Process Heat

Over 40% of existing process heat energy use comes from nearly 50 different consumers

Drivers of Change

Overview

Identified boiler capacity in our region is around 350 MW. However, increased efficiency from electricity reduces this potential conversion load to 145 MW, and we do not expect all process heat consumers to transition to electricity. Overall we expect approximately 85 MW (~13%) of maximum demand growth from process heat conversions. Demand growth from process heat is expected to be strongest in the late 2020s and early 2030s, with most transitions occurring before the coal boiler legislative cut-off in 2037.

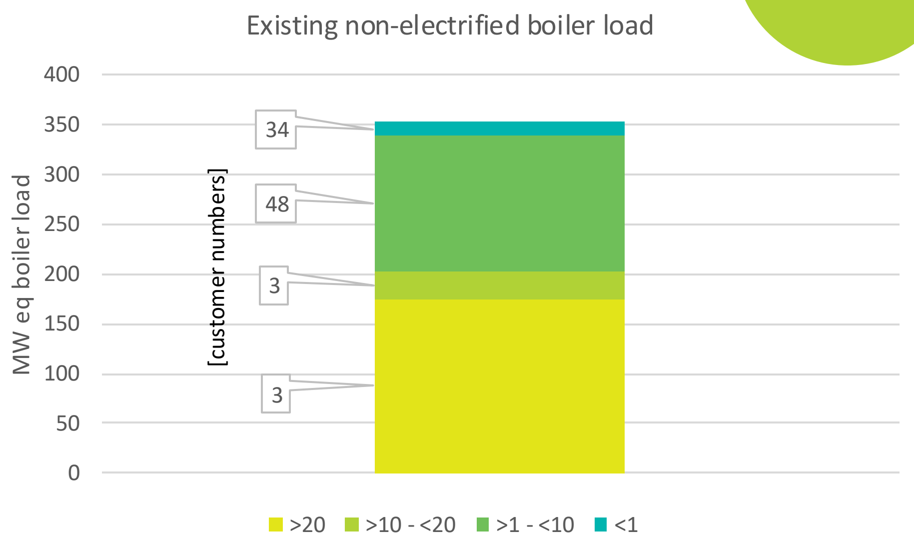
There is still significant uncertainty of the rate of change and the decarbonisation pathways for process heat, which is reflected in the large spread between scenarios, with the lowest showing 43 MW growth and the highest showing 145 MW. It is also possible that more large industrial customers shift into our region over time, growing this effective process heat conversion potential.

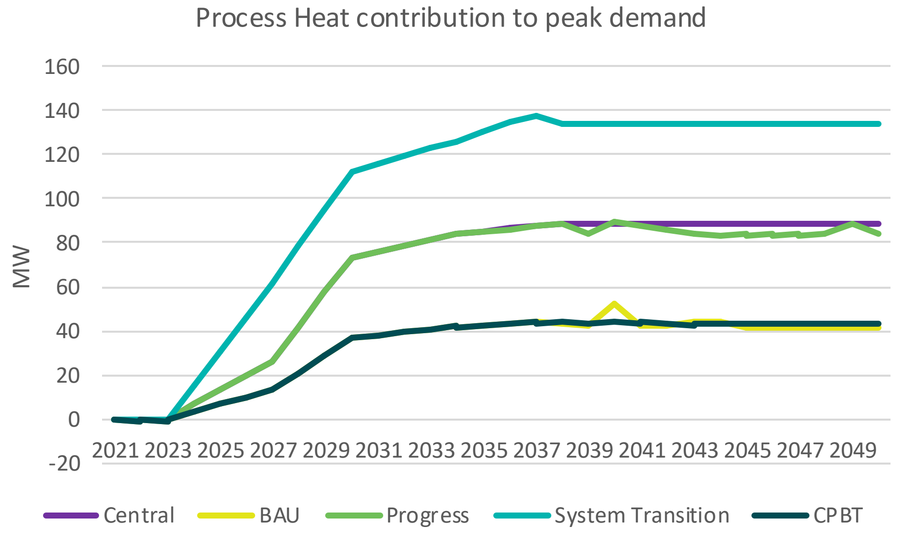
Around half of the existing boiler load is from 3 large coal users. Another 40% of the load comes from 48 customers with boilers under 10MW, and 34 customers have less than 1 MW. It is from these conversions and from potentially unknown sources of similar size that higher risks could be possible as many small conversions mount up or change quickly.

Recent changes to Government and announced policies could have an impact on process heat conversions. The Government and Industry Decarbonisation Initiative fund the funding some large industrial coal users to decarbonise is being scrapped which could slow conversions, while other changes could strengthen prices in the emissions trading scheme leading to increased carbon prices.

Risks and Opportunities

Rapid small conversions	One of the largest risks in process heat conversions is having unexpected fast conversions, particularly from the 40% of existing boiler load spread across customers under 10 MW. Process heat conversions are likely to come in large lumps that cumulatively could have a significant impact on regional electricity demand.
Uncertainty over fuel preference	Despite our work to identify and work alongside customers there are significant uncertainties still present. It isn't clear whether there will be an overall preference for electricity or alternative fuels like biofuel, or whether there will also be regional differences across the country. There is also political and market uncertainty, with changes to supports and grants with the most recent Government change, and Carbon price uncertainty that could drive further change.
Load management opportunity	With increased process heat conversions there is potential load management opportunities. Technology exists that could allow large users to switch to batteries (including thermal batteries) at peak times on the network that could lower their connection costs and even out demand across the day or match demand to shifting prices.





3.5 Generation

We expect a significant increase in rooftop solar uptake

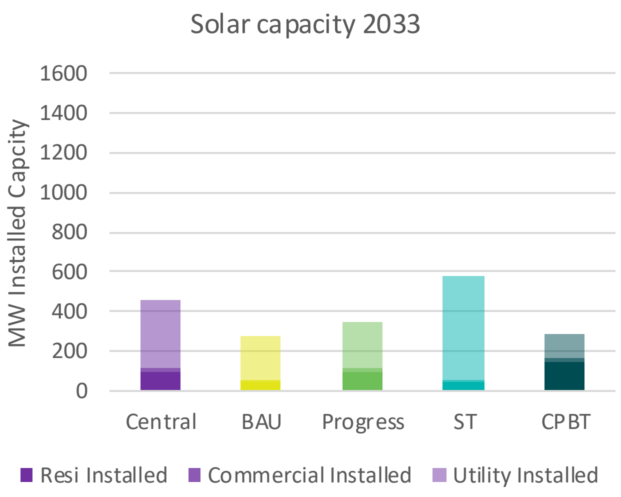
Drivers of Change

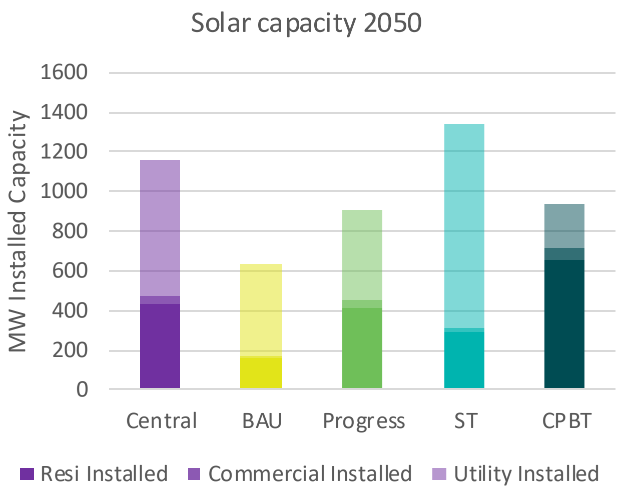
Overview

Solar generation can limit net demand on certain assets if there is high self-consumption of solar production, or it is used by consumers within an area that limits load on network assets further up the chain. The impact on net demand depends on the timing of generation relative to peaks, or the combination with flexible assets that would allow demand to flex into times with higher solar production.

We expect solar generation to increase significantly in our region as costs come down and more households invest. The amount that this generation can be optimised to meet demand depends on when peak demand is expected, access to flexibility, and how households and business change their consumption behaviour. In some scenarios we expect increasing daytime demand as more price elastic technology (batteries and EV charging) takes advantage of reducing daytime prices from more solar being offered on the wholesale market.

In the System Transition and BAU scenarios, which have low optimisation, additional EV charging adds to evening peaks and drags the peaks later into the evening, meaning solar generation has limited impact on local network peaks in winter. Some parts of our region however, have higher demand in summer, driven by irrigation and dairy farms. There is significant opportunity for this to be offset with solar generation in the future.



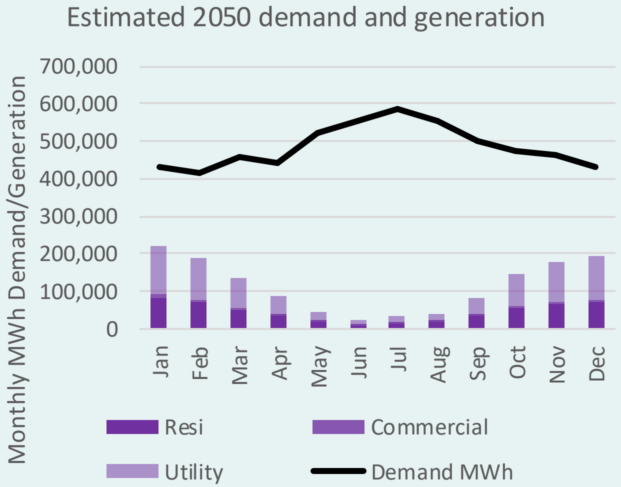


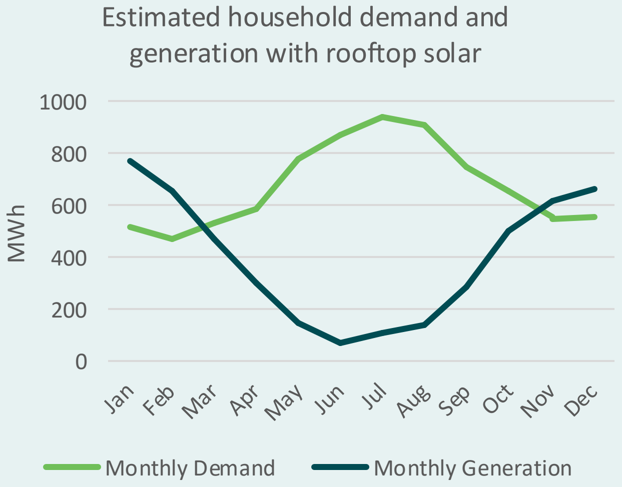
Total Generation

Generation from distributed solar could be significant by 2050 but is unlikely to be such that Canterbury as a region, or individual houses within the network will be self-sufficient or a net energy exporter of solar generation. Our Central scenario shows up to 1,300 GWh of annual solar generation by 2050, with a projected annual demand of around 5,800 GWh.

There are also intra-day and inter-season demand imbalances. It is possible that the Orion region could be a net exporter of solar generation by 2050 at times during summer months, but during winter our Central scenario shows generation reaching less than 10% of total demand.

While on the aggregate level generation may not exceed demand, there will be differences at the household and low voltage level. An individual house may have excess generation during the summer months, and even at times during winter months. In areas where solar generation clusters there could be significant excess generation and potential for export.





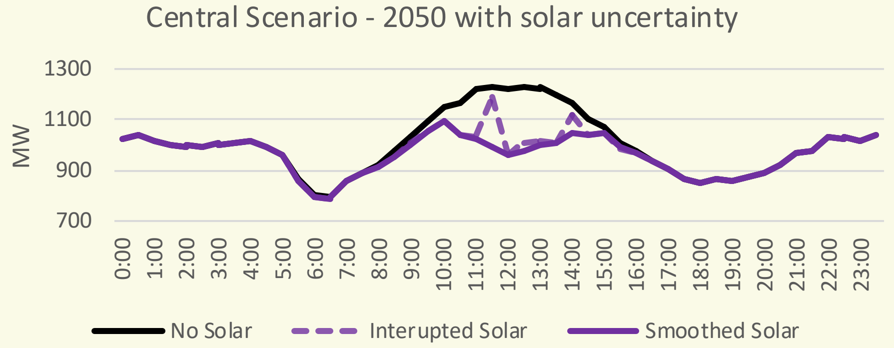
3.5 Generation

Utility scale solar generation applications total over 500 MW in the Orion region

Drivers of Change

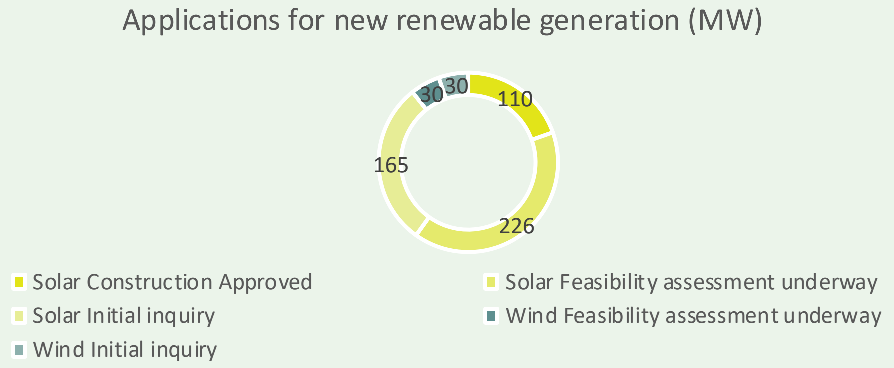
Intermittency Risk

There is risk that, while forecastable, there will be significant intermittency of local solar generation on some days. In our peak day profile we have a solar profile based on actual solar irradiance from a peak day, which shows large fluctuations depending on cloud cover. The chart below shows our 2050 Central scenario with smoothed solar and no solar, which highlights the intermittency risk at any point in time. If local solar generation drops out we may need significant local demand response or load management to react.



Other Generation

Our analysis has focussed on distributed and utility scale solar generation. There is however opportunity for more types of generation growth on our network in the future. There are inquiries and feasibility assessments underway for utility scale wind generation, and distributed wind generation is a possible consideration in the future, particularly in rural areas on the Canterbury plains.



Risks and Opportunities

Ensuring sufficient hosting capacity	Increasing distributed generation, and distributed energy resources more generally, could become a difficult balancing act for distributors like Orion, but an opportunity for households in the region. Increasing solar generation has the potential to offset some growth in demand on the network, which could be useful if the acceleration of demand is high, while if Orion is not well prepared for growth on the network there could be issues with hosting capacity or lack of demand response to deal with intermittency issues.
Opportunities for optimisation	With more distributed generation and storage, Orion will need to investigate the potential for new business models developing within the region, including community generation and storage, and what would need to change for them to economically viable or how Orion would best service these consumers. Local optimisation of locally generated renewable energy can reduce energy bills and improve the value of installing rooftop solar.
Potential for unequal transition costs	There is potential for unequal outcomes in energy consumption and costs between different groups, as highlighted in the Growth and Urban Form section. Customers with solar generation will have lower marginal energy costs. Those who don't have access to capital for installation or live in rented housing could face barriers to installing solar, likewise, the economics of installing solar might not stack up for some households for example those with lower energy demand or smaller roofspace. Some of these circumstances could lead to unequal transition costs across households as rooftop solar becomes more common.

3.6 Flexibility

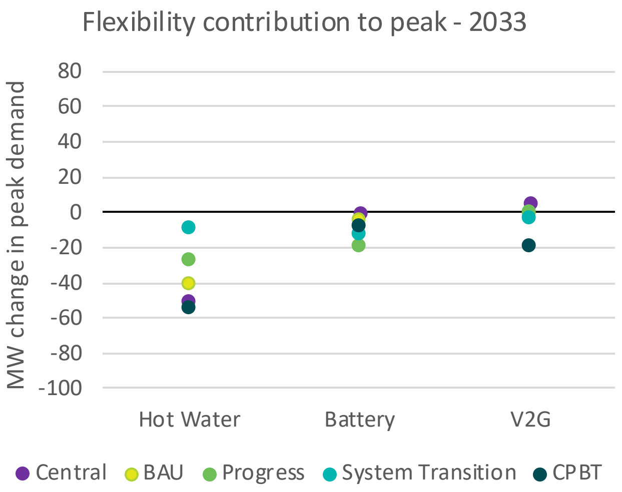
New flexibility technology presents a significant opportunity to optimise load

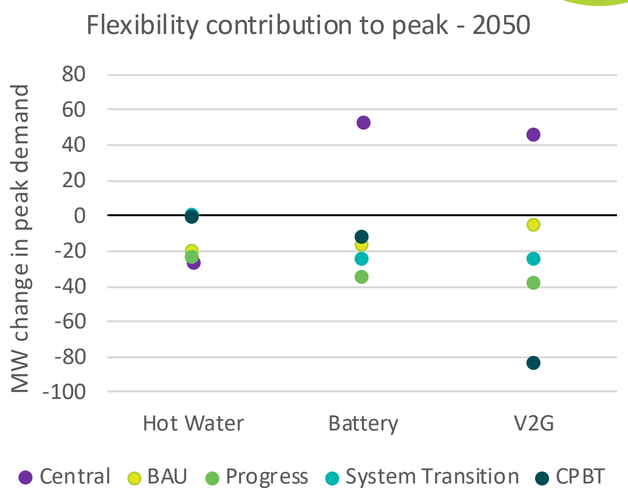
Overview

There is significant opportunity for use of flexibility to optimise demand across the system. In our Consumer and Place Based Transition scenario we have assumed high rates of local optimisation, with over 100MW (~10%) of additional peak demand reduction by 2050.

Some of the biggest unknowns, however, are where in the system will most flexibility develop (whether at the consumer end or higher up the chain with larger batteries) and to what signal the system will optimise. Currently Orion uses hot water load management to effectively flatten load on peak days, however, more players in the system are looking at using flexibility to optimise for different uses. Depending on the highest value use of flexibility, we could get different outcomes depending on whether it is used to optimise for a household's tariffs, the wholesale electricity market, or local networks.

In the Central scenario we have assumed that most load management and demand response would be used for optimising to the wholesale energy signal, and this could see it causing localised peaks on the Orion network during the 2030s. This could become significant by 2050, with more demand for charging batteries during the day driving peaks when local solar production is low.

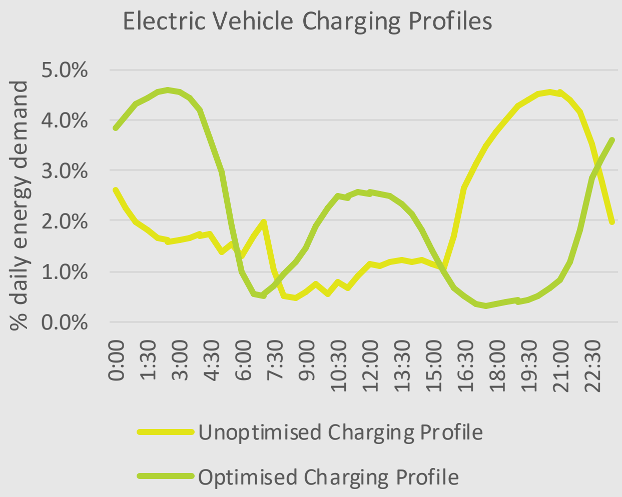


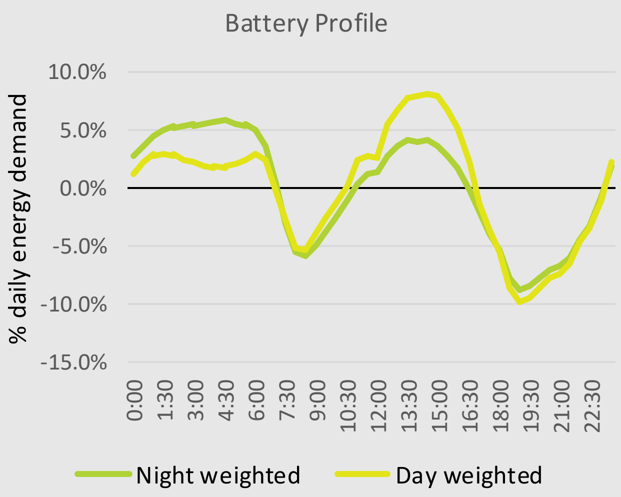


Shaping Demand Profiles

Our scenarios have taken into account direct management of devices for optimisation through demand response, and the shaping of demand through price or structurally controlled or timed devices.

The structure of these demand profiles for EV charging, or the charging and discharge of batteries drives significant differences in outcomes for demand how demand is spread across a day. For example, optimizing the EV charging profile in the System Transition scenario would reduce the winter peak demand by around 120 MW (~10%), or 52 MW for the BAU scenario. Having a less optimal EV profile would add around 25 MW in the CPBT scenario. In some scenarios the choice of the optimized profile reduces peak demand in the short run but adds to it in the long run as the combination of EV and battery charging creates new peaks. It is likely that in the long run some re-adjustment to the optimized profiles would occur to match demand profiles.





3.6 Flexibility

Our load management capacity could need to double by 2050 to maintain our current levels of optimisation

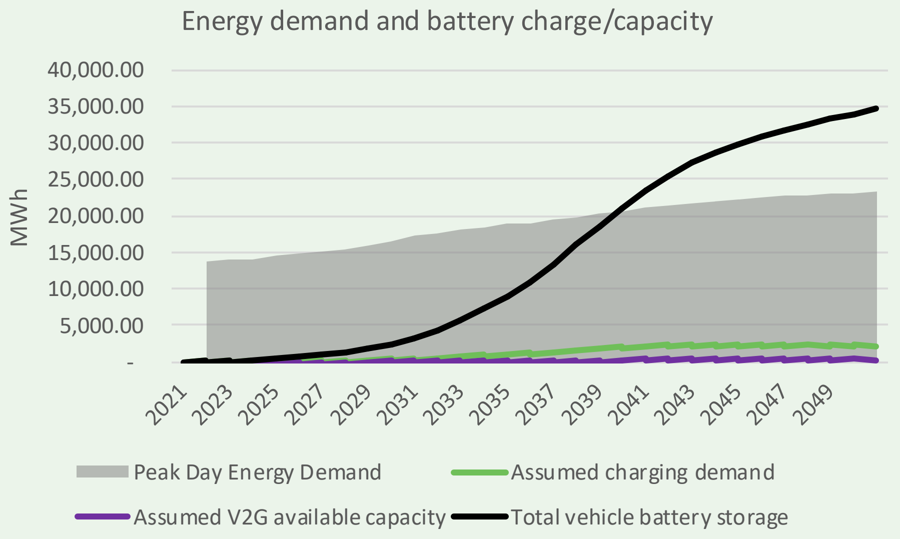
Drivers of Change

Vehicle to Grid Potential

Most of our analysis assumes relatively low use of vehicle to grid technology, whether behind the meter or true vehicle to grid. However, in terms of short-term storage, this is one of the biggest opportunities if it becomes technically and economically feasible in the future.

By 2050 our assumptions of near 100% electrification of light vehicles and growth of number and size of vehicles show that there will be significantly more energy storage in vehicles than most other sources of storage, and even more storage than daily electricity demand on the network.

For our Central scenario, by 2050, we have assumed that 20% of vehicles will have some sort of V2X connection, and of those, 20% of vehicles will be available at any point in time, allowing up to 40% of their battery to be used, effectively meaning we are accessing 4% of the vehicle fleet and 1.6% of the vehicle battery storage. Even marginal increase in those accessibility numbers would bring significant increases in potential optimisation.

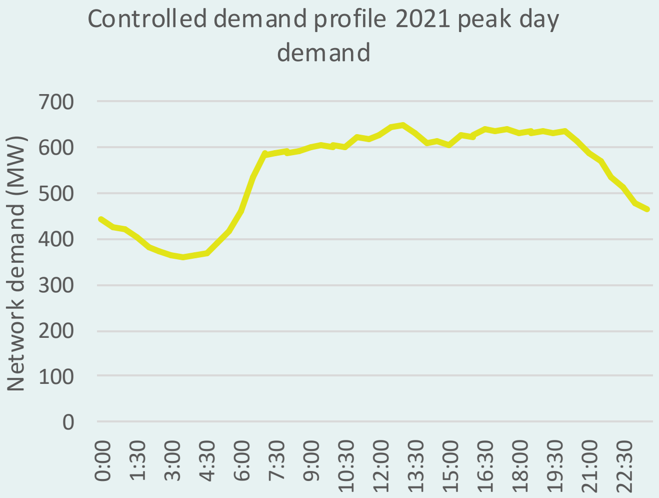


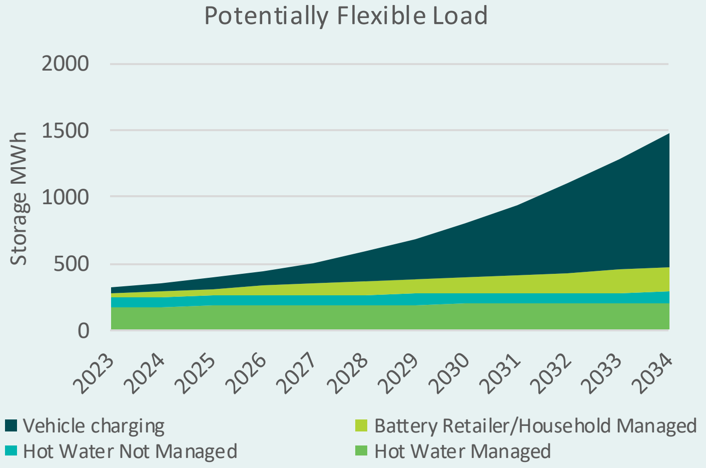
Maintaining Optimisation

In many external future energy scenarios that Orion reviewed in the formation of these scenarios there is an assumption that peak growth will grow less slowly than overall electricity demand as the system becomes more optimised over time. However, Orion's use of hot water load management already drives a highly optimised network load profile on peak days.

Our analysis shows in most cases optimisation on peak days would reduce overtime as there is growth in network load, intermittent generation and more flexible loads that may be controlled for different purposes than network optimisation.

While currently the hot water load that Orion manages is the majority of flexible load on the network, overtime this will become a smaller and smaller proportion of the load that could be used for flexibility. This could mean that there are opportunities to increase our use of flexibility, or that others will be using more flexibility on our network.





3.6 Flexibility

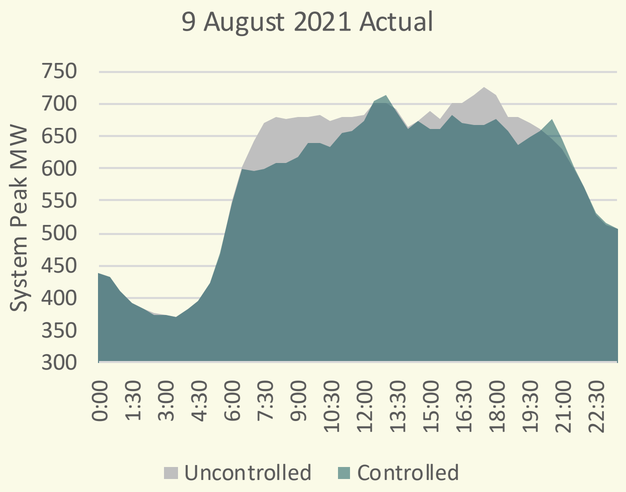
Flexible resources could increase network peaks if they are optimised for different purposes that have higher value

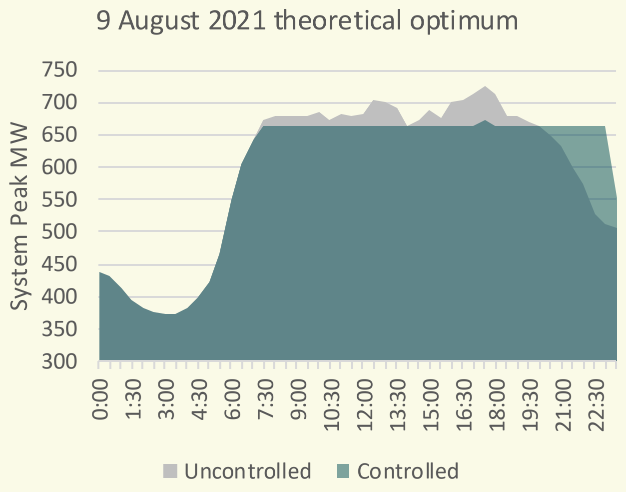
Hot Water Optimisation

Orion's load management currently consists of hot water load management, where hot water cylinders are remotely controlled to reduce demand at peak times of network demand, and major customer demand response. In this analysis we have looked at the potential to further improve our optimization of hot water load.

In most cases our hot water load management is effective at flattening demand across the day. However, on the highest demand days often the effectiveness of our load management is reduced as it must be controlled over longer time periods and there are challenges to smoothly re-instating demand from hot water cylinders as they are turned back on. Technically, there is room for improvement to optimize how we use load management on the highest demand days.

By optimizing the hot water cylinders based on the amount of energy we can shift over time relative to forecast demand, rather than our current approach of focusing on the amount we can shift at a point in time, we can better estimate how long and at what rate load can be shifted without causing secondary peaks. There are, however, significant technical challenges to implementing this approach, including the accuracy of day ahead demand forecasts.





Risks and Opportunities

Significant flexibility opportunities	Flexibility and the growing likelihood of households having smart devices and storage creates significant opportunity for the improvement of localised optimisation, and others in the energy sector to optimise energy consumption and reduce costs. We have only looked at a small subset of the potential sources of flexibility over time. Far more optimisation could be driven by interruption of loads of other devices. Over time, Orion will need to increase its management flexibility in order to maintain its current level of optimisation. There are also opportunities to increase the optimisation of our current hot water load management. There is a significant opportunity in access to vehicle batteries. The cumulative potential storage in vehicle batteries is likely to exceed daily demand by the early 2040s. However, that storage has competing demands, obviously primarily for use in transport. Our estimates show that transport demand will probably account for just 6% of total car battery storage, so in theory there is potential for a significant amount of car battery to be used for other purposes.
Risk of non-aligned signals for flexibility	Our analysis shows that it is critical to understand what flexibility will be used for, and for who and what will be optimised. Optimisation of individual households, network demand, or system wide energy consumption leads to different outcomes across the system. One of the risks we face is that optimisation will have a higher value for other parts of the system, resulting in changes to the shape of demand profiles on our network, and the potential for new peaks.

Appendix

Definitions

Definitions and commonly used abbreviations in this report

Definitions

Electricity Distribution Business (EDB)	The owner of electricity distribution networks at local level in New Zealand. A system of power lines, substations, transformers, and other infrastructure that delivers electricity from the national transmission network to consumers. It operates at lower voltages than the transmission network and serves homes, businesses, and other end-users within a specific geographic area.
Energy Demand	Energy demand refers to the amount of energy required by consumers within a given timeframe to meet their various needs, including electricity, heating, transportation, and industrial processes.
Peak Demand	The maximum level of electricity usage within a specific time period, typically occurring when consumption is at its highest during the day or year. This usually happens during periods of high energy demand, such as cold winter mornings and evenings when heating demand is highest. Managing peak demand is important for network operators to ensure reliability and prevent overload.
Demand Side Flexibility	Demand side flexibility is when consumers adjust their electricity usage in response to grid signals or market conditions, helping to balance supply and demand and improve grid stability. For example consumers can use high energy appliances outside of peak times, use smart technology to time or allow control of appliances like EV charging, or shifting load using batteries.
Distributed Generation	Distributed generation refers to the production of electricity from many small-scale sources, often located close to where the power is consumed. Distributed generation technologies largely refer to rooftop solar in our region but include, wind turbines, and small-scale gas generators. These systems can help improve grid resilience, reduce transmission losses, and increase the integration of renewable energy sources.
Distributed Energy Resources (DER)	Decentralized, small-scale energy technologies typically located close to the point of consumption. DER encompasses a variety of sources such as solar panels, wind turbines, battery storage systems, and microgrids. They provide benefits like increased grid reliability, reduced transmission losses, and support for renewable energy integration.
Vehicle to Grid (V2G) or Vehicle to anything (V2X)	A technology that enables electric vehicles (EVs) to not only receive power from the grid for charging but also to send stored energy back to the grid when needed.
Installation Control Points (ICPs)	A point of reference and connection to a home, business or specific area for networks and regulatory authorities to track and monitor the distribution of electricity within a particular area.
Mass Rapid Transit (MRT)	A high-capacity public transportation system designed to efficiently move large numbers of passengers within urban areas. It typically consists of trains or other rail-based vehicles running on dedicated tracks, with frequent service and high speeds. In this context it specifically refers to the MRT system proposed by the Greater Christchurch Partnership which consists of transit and high density housing and business zoning in the nearby corridor.
Deprivation Index	Deprivation indices are statistical tools used to measure socio-economic disadvantage within a population or geographic area. These indices are typically constructed using various indicators such as income levels, education attainment, employment status, housing quality, and access to services like healthcare and transport ation.

Further Information and Useful Links

- **Get in touch:** For any questions, contact Ivan Luketina at ivan.luketina@oriongroup.co.nz or haveyoursay@oriongroup.co.nz
- **Have your say:** Future Energy Scenarios for mid-Canterbury | Orion Have Your Say (oriongroup.co.nz)
- **Get connected**: Orion Online Services (oriongroup.co.nz)

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