TRANSMISSION TOMORROW

POWERING
NEW ZEALAND
TODAY +
TOMORROW

TRANSPOWER

TRANSPOWER OPERATES AT THE HEART OF THE NEW ZEALAND ECONOMY, PROVIDING CONNECTIONS THAT POWER OUR WAY OF LIFE.

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Contents

FOREWORD

Transpower operates at the very heart of the New Zealand economy, providing connections that power our way of life.

Our two roles as grid owner and system operator are interdependent, and both are essential for the power system to operate successfully. We are also part of a wider supply chain – working in sync with generators, distribution companies, retailers and technology providers to power New Zealand homes and businesses.

Like any business, Transpower needs to develop a realistic view of the future to ensure we continue to provide attractive, cost-effective services that meet our customers' changing needs.

Transmission Tomorrow is designed to provide this perspective for our business and to share our outlook with the wider electricity industry and other stakeholders. It identifies challenges and changes ahead and how we will respond to these – new technologies are emerging, the electricity sector is evolving and society is changing around us.

I'm confident that we can rise to the challenges and successfully navigate the changes that will occur. Close relationships with our customers and key stakeholders are integral to ensuring we continue to provide great services that are valued by end consumers.

We feel privileged to enable New Zealand to respond to its changing energy needs. Our focus as we prepare for this uncertain future remains on providing a safe, valuable and cost-effective transmission service for all New Zealanders.

Alison Andrew, Chief Executive

Our business powers New Zealand. We provide the high voltage transmission network that connects areas of generation to towns, cities and industry across the country, and we manage the real-time operation of the power system and wholesale electricity market.

POWERING

ZEALAND

TODAY...

The services we provide are easy to take for granted – nearly everyone in New Zealand is connected to the grid, and the power system has always been a part of modern life. This document looks ahead to how our world may change in coming decades and challenges us to think about what we need to do to keep providing appropriate services for New Zealanders. Electricity consumers have an expanding range of options for meeting their energy needs, and now, more than ever, we need to factor this into our plans.

As a foundation for thinking about the future, it is important for us to look at the value we provide as part of the New Zealand power system and to examine the social impact of our operations.

The value of the power system

The National Grid imports generation at 46 locations and supplies energy to 123 locations from Bluff to Marsden.

So why do people connect to the national power system?

- **Reliable access to energy**

For most customers, connection to the power system provides a highly reliable energy supply – across all customers on all distribution networks, average availability is 99.96%.[1] For an average household, this equates to less than 4 hours of non-supply per year and around two power supply interruptions per year. Very large energy users, with a direct connection to the grid, experience even higher levels of reliability.

For those customers who generate their own electricity, staying connected to the National Grid provides a highly reliable backup that avoids the need to build redundancy into their systems and to carry spares.

- **Access to a cost-competitive source of energy**

Being connected is the most cost-competitive option for most homes and businesses.

An average New Zealand household pays $175 per month or around $6 per day for grid-supplied energy. To be cost competitive, an off-grid supply would need an upfront cost of less than $16,000,[2] and this would typically need to cover generation (for example, solar panels), batteries, energy efficiency measures, control systems and a supplementary supply (such as diesel) for long cloudy periods. This compares to estimates of around $100,000 for a typical Wellington house.[3]

- **Access to practically unlimited energy and a growing range of service options**

For households and most businesses, connection provides access to as much energy as they need – at any point in time (peak demand) and for as long as needed (energy demand). This provides flexibility to install new equipment or to change usage without having to worry if there will be enough power.

Connection also enables access to a growing range of services, including traditional and newer retail options, and options for selling excess self-generation.

- **A sustainable choice**

New Zealand is in the extremely fortunate position that over 80% of our generation is from renewable sources.[4] With an overall greenhouse gas intensity of 129 g $CO_{2\text{-e}}$ per kWh,[5] our grid provides a very clean source of power.

More broadly, connection is a sustainable choice because the power system has been built up over generations using assets and resources that can continue to power New Zealand for many generations to come.

- **A truly national energy system**

The grid balances electricity nationwide – regions with surplus generation can export energy to where it is needed,

1. This figure includes planned and unplanned interruptions in transmission and distribution networks.

and all regions gain access to New Zealand's lowest-cost sources of energy.

The grid balances energy in real time, across seasons and into the future. This helps New Zealand as a whole to make the best use of our natural resources.

The impact of our operations

Providing valuable services is not enough to ensure our long-term success. We interlink with a large variety of stakeholders including customers, communities and landowners who are impacted by our operations. We must be mindful of that impact.

These are particular focus areas for our business:

- **Ensuring public and worker safety**

Our high voltage activities inherently present significant public and worker safety hazards if not actively managed.

Operating safely is our number one priority. We already have a strong safety culture, but we aim for continual improvement towards zero harm.

- **Managing our network footprint**

We have assets on over 10,000 properties, and our network traverses 30,000 properties. Corridors around our assets, free of incompatible development, are needed to ensure safety and to provide physical access to existing infrastructure for inspection and maintenance work, which supports their long life and reduces the need to build costly new structures.

We strive to maintain excellent relations with the landowners who host our assets and the communities our assets pass through.

- **Managing environmental impacts**

Our network is highly visible to local communities, and much of what we do has potential environmental impacts on land, waterways and people living or working close to our structures.

We work actively through community and environmental programmes and with local authorities to mitigate our impacts. We are particularly aware that impacts of our assets are often localised, while the benefits of our network are typically realised nationally or by a wider community and over generations.

- **Maintaining reliability**

Large or prolonged power interruptions shake business confidence and disrupt our daily lives. The economic cost of single events internationally can be counted in the billions of dollars. In New Zealand, a six-hour Auckland power cut in 2006, that affected around 700,000 people, cost an estimated $70 million. Modern economies and lifestyles have a growing dependence on electricity and therefore growing expectations of the service we provide.

The power system is complex, and attaining ever higher levels of reliability comes at a cost. It is not feasible or economic to guarantee 100% reliability. However, we continuously seek to minimise risk and improve our service to help meet the expectations that people have of us to keep the lights on.

2. For simplicity, this calculation assumes that the system has no running costs and will operate without needing to replace any components for 10 years. We also assume a financing rate at 5% real.
3. See Meridian Energy April 2015 investor presentation https://www.meridianenergy.co.nz/assets/Investors/Reports-and-presentations/Investor-presentations/Investor-day-presentation-April-30-2015.pdf.
4. Year to 30 June 2015. 'Renewable' includes solar, wind, hydro and geothermal.
5. Based on average carbon intensity for the year ended 30 June 2015. $CO_{2\text{-}e}$ refers to carbon dioxide equivalent.

TOMO

- **Operating with integrity, transparency and openness to change**

We are a large established player, providing complex network monopoly services in a sector that is experiencing substantial and ongoing consumer-led change. With that business profile, people can distrust our business and sector.

It is particularly important that we keep working hard to retain trust and respect by always operating with integrity, transparency and openness to change.

- **Being a responsible corporate citizen**

We are a large corporate citizen in New Zealand terms. Our total asset book value is in excess of $5 billion – we spend more than $500 million per year, employ more than 700 people and contract a further 1.6 million hours of work from service providers and consultants.

We have a responsibility to the people we employ and to the people who rely on our services to operate as a responsible business.

"The power system of tomorrow will look different from the power system of today, and we have a vital role to play in those changes."

...AND

RROW

OUR SERVICES ARE VALUABLE TODAY, BUT WILL THEY BE STILL BE RELEVANT IN THE FUTURE?

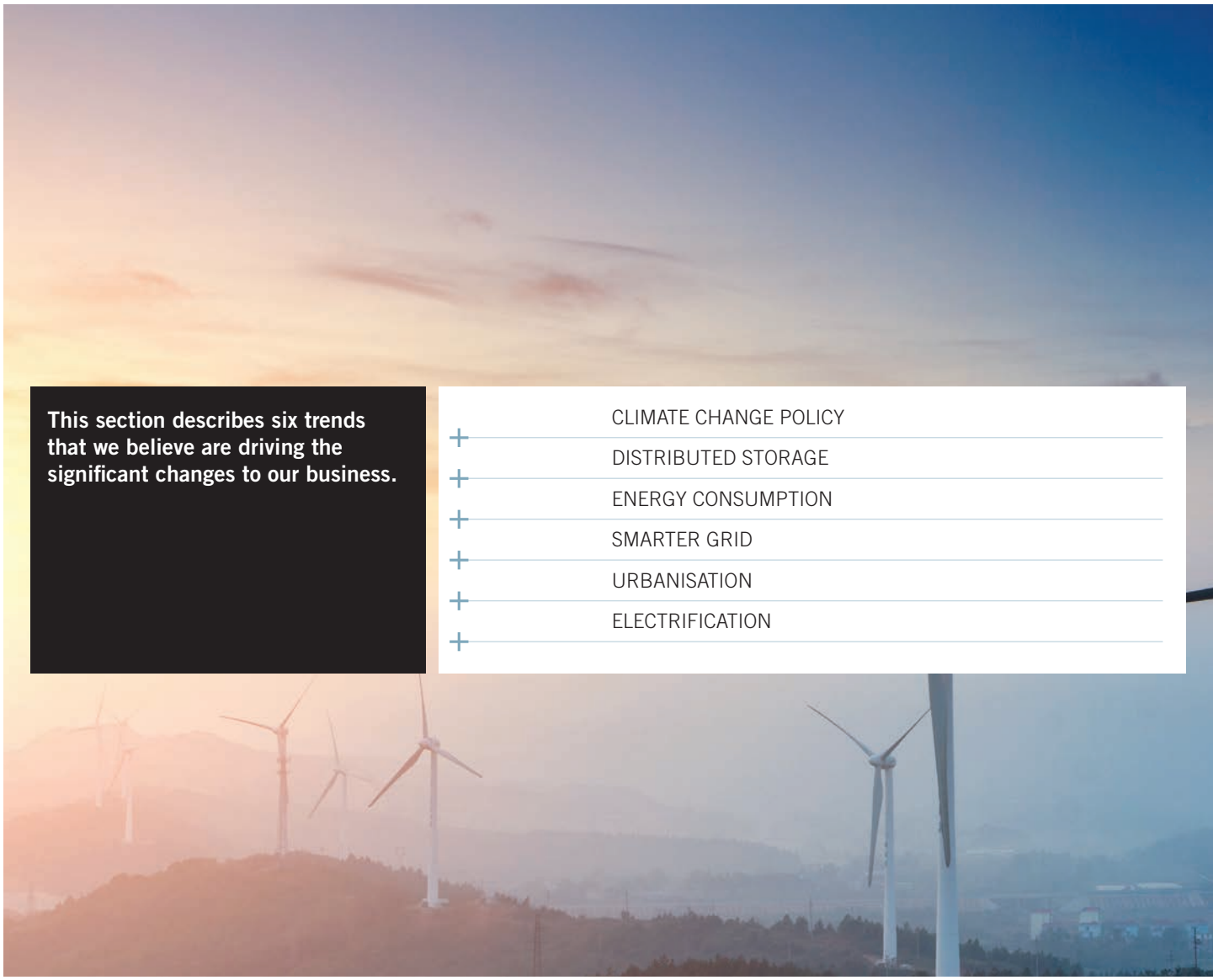
In many ways, New Zealand's energy system is on the cusp of significant change. While changes in the past have been about expanding and improving supply to homes and businesses – by connecting up new towns, developing new types of generation, expanding the grid and deploying new technologies – the changes we face today are about individuals having new options for making, storing and controlling electricity.

We think the power system of tomorrow will look very different from the power system of today, and we have a vital role to play in enabling and adapting to those changes.

Shortly, we will explain our view of how things will change over time, but first, we need to understand what is driving the changes.

NZ'S ELECTRICITY
SECTOR
DYNAMICS ARE

CHANGING...



This section describes six trends that we believe are driving the significant changes to our business.

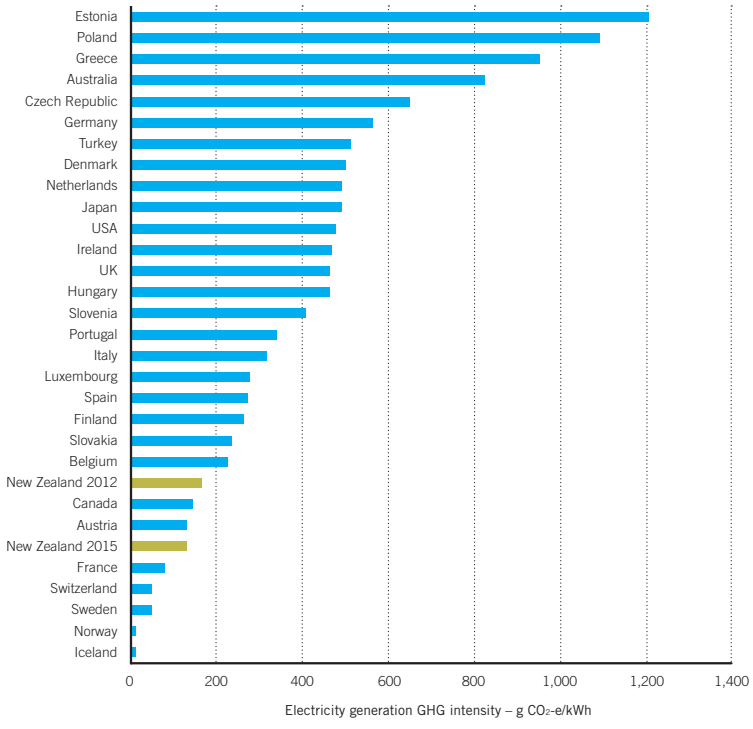
- CLIMATE CHANGE POLICY
- DISTRIBUTED STORAGE
- ENERGY CONSUMPTION
- SMARTER GRID
- URBANISATION
- ELECTRIFICATION

CLIMATE CHANGE POLICY – GOVERNMENTS WILL STRENGTHEN CARBON POLICIES, DRIVING A SHIFT TOWARDS ELECTRICITY.

Compared to most countries, New Zealand has a very low-carbon electricity supply.

Our generation output is at least 80% renewable, with a greenhouse gas intensity that puts us among the best in the OECD.

As policies and social attitudes to carbon emissions harden, there is potential for electricity to substitute for fossil fuels – especially in transport and/or where coal or diesel is used to power commercial and industrial activities. New Zealand has ample renewable generation resources that can be developed to meet these demands.



DISTRIBUTED STORAGE – FALLING COSTS AND IMPROVING TECHNOLOGIES WILL OFFER OPPORTUNITIES TO SMOOTH OUT DEMAND PEAKS.

Power systems have always been built to continuously balance generation with demand in real time, because there has not been a viable means of storing electrical energy at point of use. This drives much of the complexity, risk and cost in modern power systems.

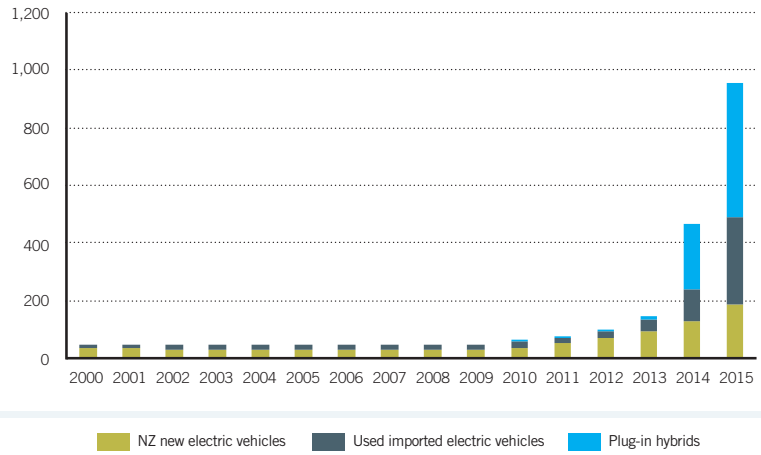
Increasingly, there is the prospect of distributed storage – batteries and other technologies located at or near points of energy use – which alters what is a fundamental aspect of most modern power systems.

Battery production volumes are increasing, technology is improving and prices are falling, while investment in hydrogen-based energy systems also continues.

Batteries large enough to shift consumption within a day are becoming available to households – as standalone products, combined with solar photovoltaic (PV) systems and as an integral component of plug-in electric vehicles – while larger batteries are beginning to be used by distribution and transmission businesses.

Although batteries are unlikely to become an economic means of storing energy across seasons, they will increasingly provide capability to smooth out daily peaks. Since transmission grids, distribution networks and generation stations are built to meet peaks, distributed storage offers the potential to help alleviate pressure – reducing the need to invest in new capacity.

ELECTRIC VEHICLE PENETRATION



Source: Transpower/Ministry of Transport

ENERGY CONSUMPTION – NEW TECHNOLOGIES WILL CHANGE THE PROFILE OF DEMAND.

New technologies are increasing opportunities for residential and commercial consumers to reduce electricity use, decide when they will use electricity and produce their own electricity.

Products and services with falling prices and increasing consumer appeal and availability include:

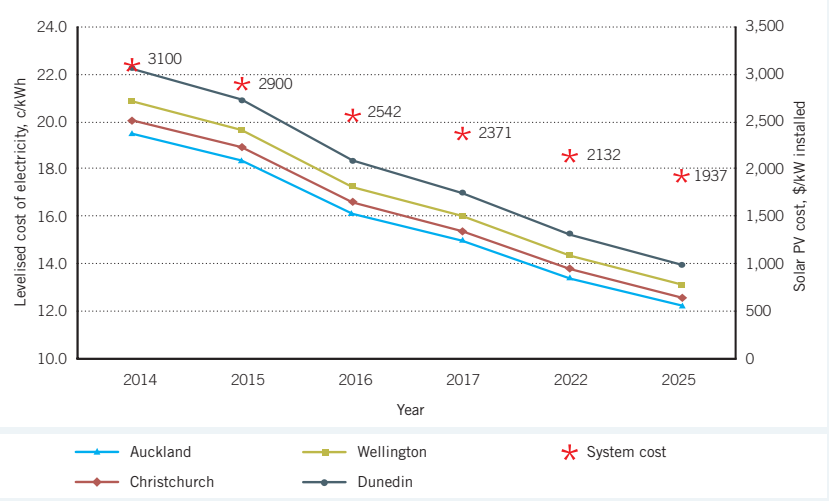
- plug-in electric vehicles
- home automation systems with energy management capabilities
- solar PV, including systems with integrated battery storage.

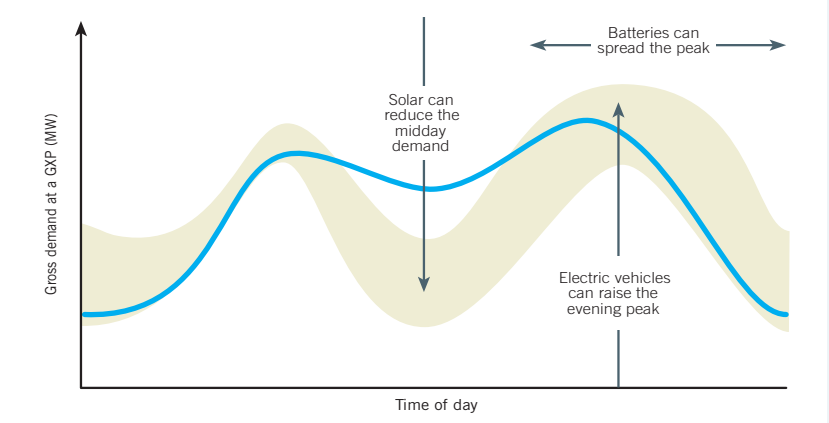
Uptake of new technologies is often reinforced by social preferences and perceptions relating to the environment and energy independence.

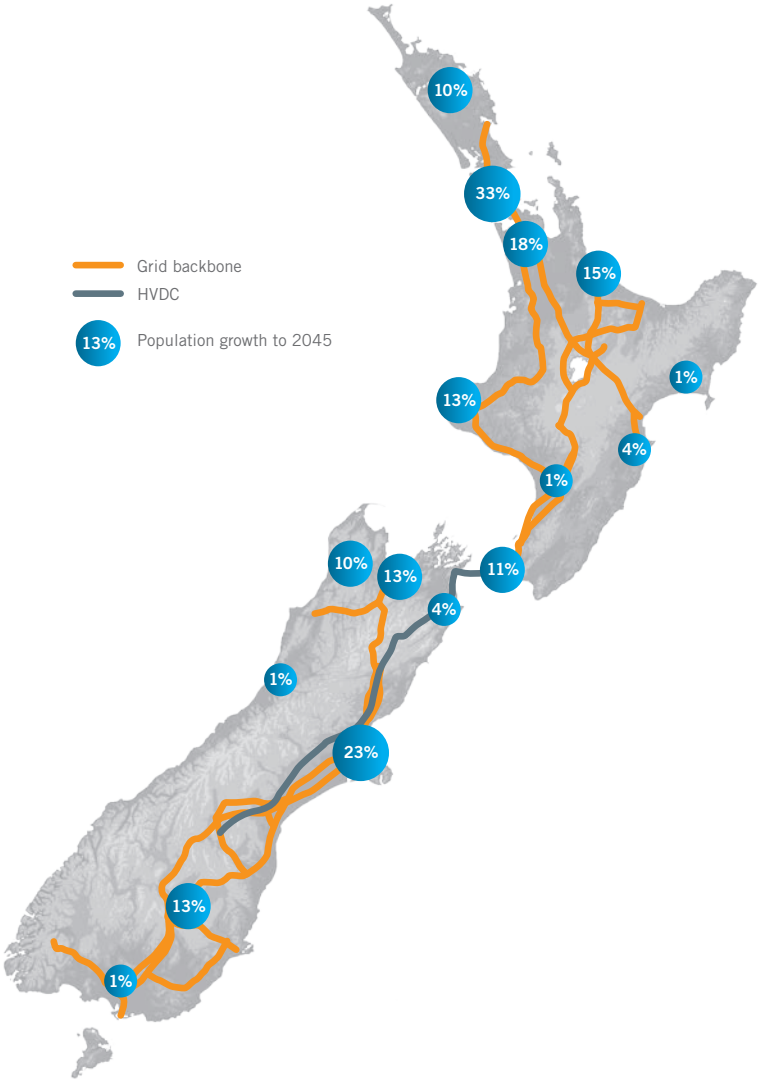
Changes in residential usage have particularly strong impact on grid demand profiles – residential usage accounts for 32% of electricity demand and is a disproportionate driver of winter peak demand and network investment.

New technologies have the potential to exacerbate or alleviate the strain that residential usage places on energy infrastructure, depending on when, and how, they are taken up.

FORECAST OF SOLAR PV COSTS IN NEW ZEALAND







SMART GRID – NETWORKED DIGITAL DEVICES IN HOMES, BUSINESSES AND NETWORKS OFFER POTENTIAL FOR A MORE EFFICIENT ELECTRICITY SYSTEM.

There is an increasing penetration of networked digital devices across the electricity supply chain, from generation through transmission, distribution, homes and businesses. This is steadily increasing the potential for efficiency gains through better information, remote interrogation and automated control.

The biggest potential gains are at the end-user and distribution network levels and at a whole-of-system level. In the near to medium term, the biggest potential is in moving energy use from peak times to off-peak times. In the long term, the greatest potential is in realising the potential benefits from distributed storage. Both of these developments present significant opportunities to accommodate more energy demand using existing grid capacity.

URBANISATION – NEW ZEALAND WILL CONTINUE TO BECOME MORE URBANISED, WITH GROWTH CONCENTRATED IN THE UPPER NORTH ISLAND.

The Treasury forecasts that, by 2045, another 1.2 million people will be living in New Zealand, that most (>90%) of this increase will be across just five regions and that Auckland alone will account for 60% of this growth.

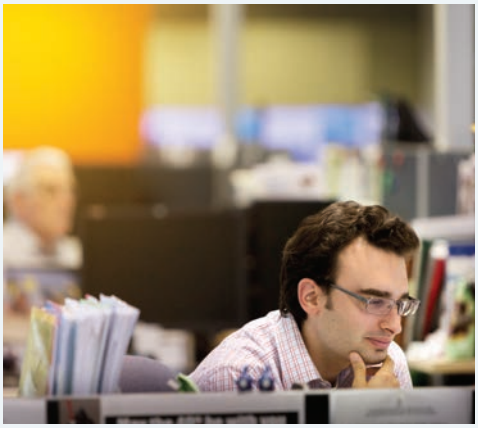
Smaller centres are likely to face the challenge of sustaining infrastructure for comparatively small consumer numbers, while larger urban centres will need to accommodate new network connections and pressure on peak demand.

Growth in population and economic activity in Waikato, Bay of Plenty and Auckland reinforces the predominantly south-to-north flows that have driven development of the New Zealand power system. Urban growth increases the value of our corridors for other purposes and can be expected to increase friction over future reconductoring and new investments, especially in Auckland.

On top of this, demographics and working habits are changing, which will also impact on demand and daily usage profiles.

ELECTRIFICATION – ONLY 25% OF NEW ZEALAND'S ENERGY USE IS MET BY ELECTRICITY.

Electricity is a clean, attractive, versatile power source. Across many households, commercial and industrial applications, there has been a trend

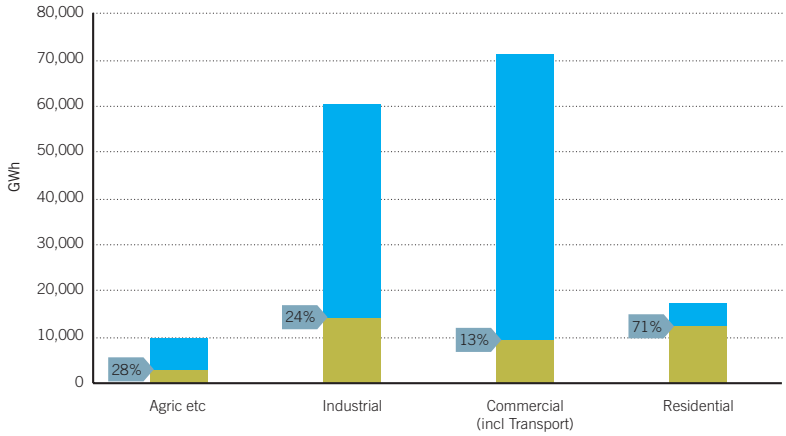


towards increasing use of electricity as a fuel of choice – whether providing heating, powering machinery or driving industrial processes.

There is considerable scope for further electrification – the overall penetration of electricity remains relatively low, and New Zealand has abundant renewable resources that could be developed to meet new demand.

Underlying electrification trends are likely to be given extra impetus from other trends such as climate change, smart grid and urbanisation.

TOTAL ENERGY DEMAND VERSUS ELECTRICITY DEMAND PER SECTOR



Source: MBIE

...BUT A **RELIABLE AND ROBUST** TRANSMISSION SERVICE WILL ENABLE CHANGE...

Identifying trends is a good start, but what happens when we put them all together?

Taking into account all of the changes that we anticipate may occur in coming decades, we see the grid continuing to provide a valuable role as part of New Zealand's energy system.

We reached this view with the help of scenario modelling designed to test the extremes of demand changes and technological impact. This 'what-if' exercise differs from our standard practice of extrapolating from past trends to identify a range of likely outcomes. In total, we have explored four 'what-if' scenarios.

One of our 'what-if' scenarios combine zero underlying demand growth with very strong uptake of solar PV – reaching 2,100 W_p per person by 2050 (compared with 5.5 W_p in New Zealand today, 180 in Australia and 440 in Germany).[6]

Even with this challenging combination, we find that the transmission grid still has a valuable role to play because:

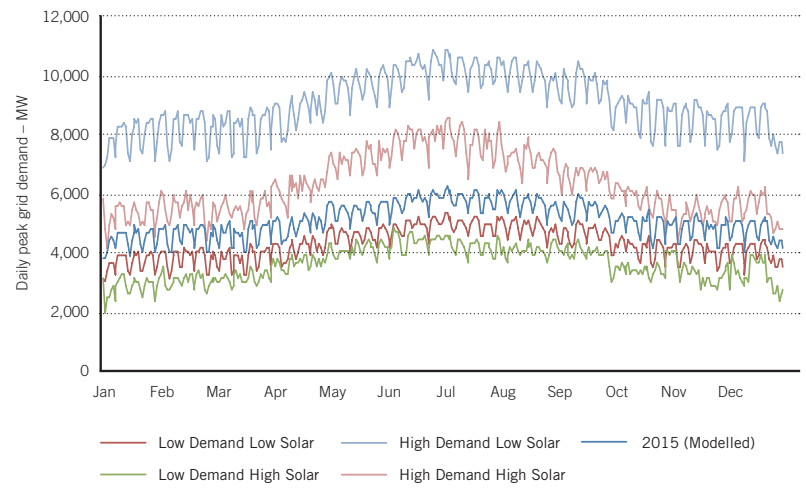
- solar PV is less effective in winter, when demand for electricity is at its highest.
- distributed storage can help carry surplus energy across a day or several days but is unlikely to be a cost-effective way of saving up summer production for use in winter.
- not all users, or all regions, are likely to produce enough energy to meet their needs, so there is value in being able to move excess energy to places with excess demand.
- grid energy remains an attractive, cost-effective complement to self-supply.

At the other extreme, one of our 'what-if' scenarios with strong underlying demand growth and more limited self-supply sees peak grid demand increase by around 80% by 2050.

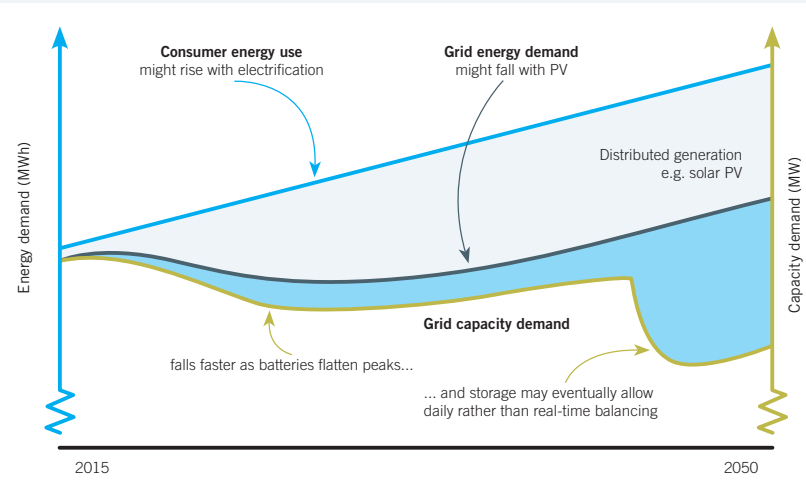
The other scenarios lie within the bounds of these two scenarios in terms of the level of peak grid demand, but produce differing mixes of generation.

6. 2,100 W_p per person means that, for every person in New Zealand, there is an installed capacity of solar generation with the potential to produce up to 2.1 kW under ideal conditions. This compares to an average size of 3.5 kW per household for recent residential installations in New Zealand.

DAILY PEAK GRID DEMAND – 2050



POTENTIAL EFFECTS OF TECHNOLOGY ON DEMAND



"Even assuming a very high uptake of solar PV (nearly 400 times current levels) and no underlying demand growth, the transmission grid will remain essential for meeting New Zealand's energy needs."

...EVEN IF DEMAND FOR GRID

CAPACITY

MAY 'WAX AND WANE'

To help guide our planning, we have developed a view of three sequential states for the New Zealand electricity sector:

1. EVOLVING GENERATION
2. CHANGING LOAD
3. EXTENSIVE STORAGE

Knowing that the grid has a long-term future is a good start, but the scenarios by themselves don't provide a truly useful planning tool.

To help guide our planning, we have found it useful to develop a view of three sequential states for the New Zealand electricity sector:

- 'Evolving generation' – our current state and immediate future.
- 'Changing load' – our medium-term future (emerging from around 2020).
- 'Extensive storage' – an eventual switch to a new future (perhaps around 2040).

We call this sequence our planning trajectory. Overall, it paints a picture of the uncertainty we face today being gradually overtaken by a period where New Zealand's growing population and economy leads to growing demand for electricity.

This puts pressure on grid capacity at the same time that new technologies are increasingly creating opportunities to accommodate growth using existing grid capacity.

Eventually, a breakthrough in the ability to leverage the full benefits of distributed storage leads to swift transition into a period where we can both simplify our operations and accommodate much more energy growth with the grid capacity already in place.

We do not know how changes in the sector will actually play out, so our planning trajectory is designed to not only capture a reasonably likely sequence of events but to provide a 'least regrets' basis for our planning.

"Thinking about least regrets is a prudent approach for the steward of an essential service..."

For example, planning now for a dramatic decline in grid usage could take us down a 'high regrets' path that would be difficult and costly to reverse if we were wrong. Thinking about least regrets is a prudent approach for the steward of an essential service based on long-lived assets.

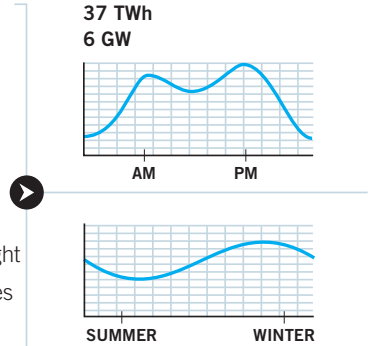
1 'EVOLVING GENERATION' STATE (PRESENT TIME)

This state is here and now, and its key characteristic is a level of uncertainty that makes planning difficult for everyone in the sector. After years of steady demand growth and investment in generation and grid capacity, we are in a period of flat demand and changeover in the mix of generation. Questions about the uptake of emerging technologies make it difficult to predict whether there will be a return to growth and what shape future demand profiles may take.

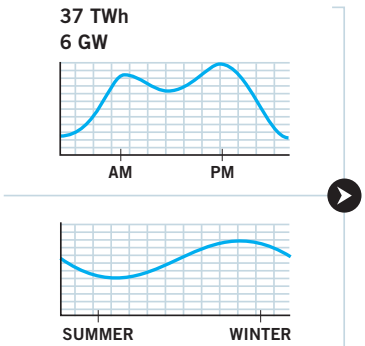
This fundamental uncertainty is compounded by questions around the closure of thermal generation facilities, the future of large industrial plants such as the Tiwai aluminium smelter, potential changes to transmission prices

DRIVERS – EVOLVING GENERATION

- Major transmission investment commissioned
- Thermal plant closures
- Investment uncertainty (Tiwai), transmission pricing, demand growth, carbon price)
- Incremental development of large renewable resources commercially fraught
- New and cheaper consumer technologies emerging but not yet mainstream
- Growing climate change concern



OBSERVATIONS AND IMPLICATIONS – EVOLVING GENERATION



- Current load and load profiles remain roughly as now
- Incremental and just-in-time generation investment
- Increasing generation intermittency, decreasing inertia
- Tight security margins, higher dry-year risk (Tiwai closure would buy time)
- Risk of hasty political intervention over security concerns
- Our licence to operate under pressure

and the future path of carbon prices and other policies.

While New Zealand has abundant resources to support new generation, investment is commercially fraught in the current environment. We expect any generation investment to be small and just in time, requiring us to respond rapidly to connection requests. Security margins are likely to tighten, causing heightened concerns and increasing the risk of hasty political intervention.

While new technologies are one of the factors contributing to planning uncertainty, uptake remains very modest, and there is limited impact on operations. This means there is a window of opportunity for distribution businesses in particular to ensure they are well prepared for a future where emerging technologies enter the mainstream.

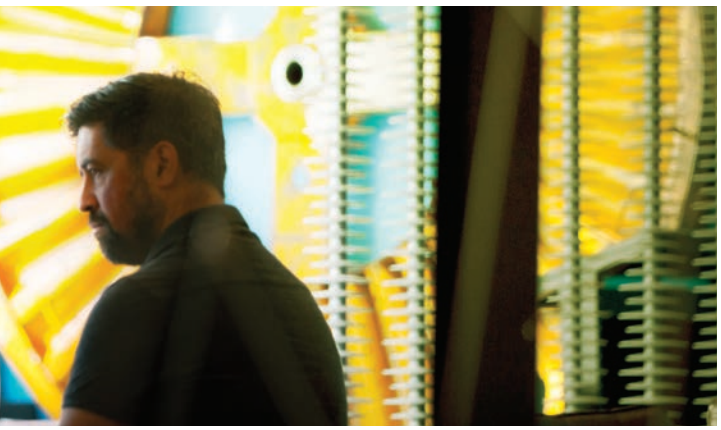
2 'CHANGING LOAD' STATE (~2020+) – GRADUAL BUT FUNDAMENTAL CHANGES IN DEMAND DYNAMICS

From some time around 2020 to 2025, we can expect maturing and more mainstream adoption of emerging technologies – electric vehicles, solar PV, home and network batteries and automation systems for homes and businesses with powerful energy management capabilities.

The net impact of these changes is uncertain, but there is potential for our network to become more efficient overall – with a smoother demand profile that has less pronounced peaks. At the same time, we expect that population growth, economic growth and electrification – spurred on by strong carbon policies – mean there will be a net increase in the amount of energy transferred across the grid.

Our key challenge will be to find ways to accommodate growth and sustain the headroom needed to take grid assets out for maintenance or replacement while limiting the need to invest in new grid capacity. Investing in new capacity pushes our costs up and becomes particularly risky given our view that demand for grid capacity may ease again when we enter the third 'extensive storage' state. We call this dynamic of increasing then easing demand for grid capacity the 'wax and wane' effect.

While we are cautiously managing capacity requirements across the grid, we may also need to invest in



"Our key challenge will be to find ways to accommodate growth … while limiting the need to invest in new grid capacity."

opening up capacity to bring new renewable generation onto the grid and in reconfiguring the grid to meet changes in the mix of generation and the size and location of direct-connect industries. Overall, we expect almost all grid assets to remain used and useful, but there will always be calls to write down the value of our assets to ease power prices.

During this period, some end consumers may find it attractive to go off-grid – particularly customers with high connection costs (such as those in remote, sparsely populated areas) and good access to local energy resources – but we don't expect widespread disconnection. Being connected remains an attractive proposition for the vast majority of people.

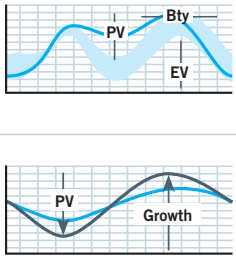
The changing power system will mean new challenges and opportunities in the way we manage the grid and operate the power system. Our asset management practices, system operation tools and commercial practices will need to evolve during this period.

We expect distribution businesses to have mixed fortunes in this period. Most distributors will have moved away from current pricing structures that can

DRIVERS – CHANGING LOAD

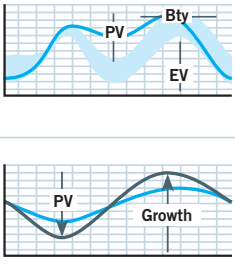
- Urbanisation and growth in population, economy and energy efficiency
- Mainstream commercialisation of micro generation (especially PV), electric vehicles (EV), batteries and energy management systems
- Electrification of transport and heat
- Strong carbon policies or price
- Uncertain evolution of direct-connect industries

37 – 40 TWh
6 – 8 GW



OBSERVATIONS AND IMPLICATIONS – CHANGING LOAD

37 – 47 TWh
6 – 9 GW



- Uncertain net change to demand, but peak demand still drives need for grid
- Increase in off-grid consumers at distribution level
- Low physical grid asset stranding risk, but increasing financial stranding risk
- Distributors evolve, rationalise and drive regulatory and market changes
- Commercial stress on some generators, distributors and retailers

"We expect distribution businesses to have mixed fortunes in this period."

shift costs among consumers and will have worked through the engineering challenges and opportunities of new technologies.

Some will have successfully reviewed the scope of their activities, and some will have strong growth in their regions to underpin ongoing investment needs. Other distributors will be struggling through failure to adapt early or due to a small or declining economic base to support necessary investment. Diverging fortunes may ultimately drive rationalisation and regulatory changes in the distribution sector.

There will be a similar picture in generation and retail markets. Some generation stations may not adapt to new demand profiles, while many generators will be well placed to bring new, competitive resources online to meet growing demand. Retail markets will continue to change, with a wider scope for offering truly attractive services and increasing activity by non-traditional players. Market and regulatory arrangements will need to evolve to meet changing needs.

We don't have a stake in the success of individual businesses in the sector, but our position means we have a strong interest and ability to influence the way the power system performs through this time.

'EXTENSIVE STORAGE' STATE (~2040+) – BATTERIES ON THE CHARGE

Eventually, perhaps around 2040, there will be a swift and game-changing transition when the capability emerges to fully leverage the batteries (or other storage systems) that have gradually made their way into our homes, businesses, vehicles and distribution networks.

Batteries will progressively flatten demand profiles across each day and reshape seasonal profiles. They will also play an ever-expanding role in providing system services (such as frequency keeping and reserves) and will provide an increasing number of end users with the backup to ride through short interruptions in grid or local power supply.

For our business, the big breakthrough comes when distributed storage becomes so extensive, visible and well co-ordinated that reliability

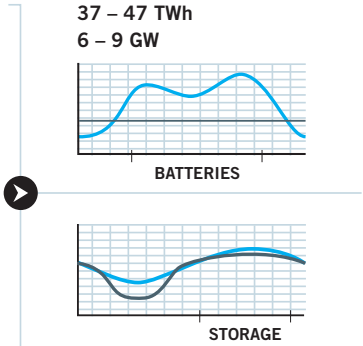
"…the big breakthrough comes when distributed storage becomes so extensive, visible and well co-ordinated that reliability 'behind the grid' begins to substitute for reliability of the grid."

'behind the grid' begins to substitute for reliability of the grid. In this state, loss of grid supply doesn't impact end users – provided we can restore supply before distributed storage runs too low. Our business fundamentally changes from providing 24/7 reliability and real-time balancing to providing a resilient battery-charging service.

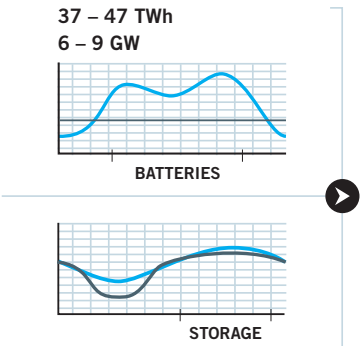
To reach this state requires extensive penetration of distributed storage plus successful evolution of technical, commercial and operational arrangements. Once in place, the grid capacity we have available becomes capable of accommodating significantly more growth in energy demand – relieving the earlier pressure to invest. This provides tremendous opportunity to provide more value from our grid assets, and we have a strong interest in timely and successful transition to this state.

DRIVERS – EXTENSIVE STORAGE

- Economic saturation of PV and other distributed generation, but...
- Grid-delivered hydro and other renewables still economic
- Batteries (in electric vehicles and static) and other storage widespread
- Low-carbon economy and climate change impacts



OBSERVATIONS AND IMPLICATIONS – EXTENSIVE STORAGE



- Daily and winter peak demand profiles flatten
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ULTIMATELY, OUR BUSINESS WILL BE RADICALLY **DIFFERENT** TO WHAT IT IS TODAY.

In our long-term horizon, battery or other storage technologies installed within homes and businesses, vehicles, distribution networks and grid substations could fundamentally alter our business by covering short-term imbalances in supply and demand.

Despite these changes, however, the services that the National Grid provides will be enduring.

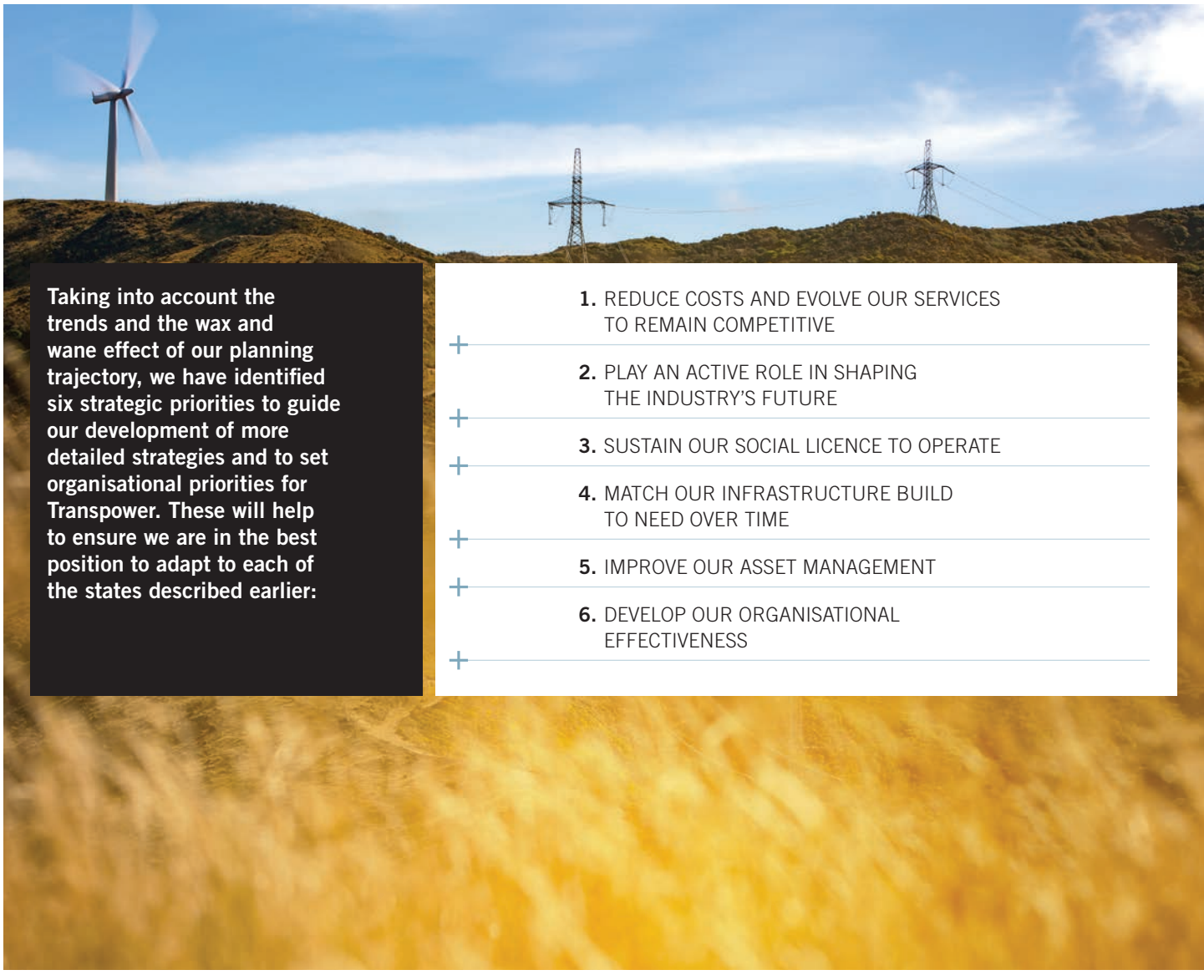
For our grid business, we will be able to design and operate assets on the basis that outages will not interrupt supply if we can restore service before batteries are depleted. This shifts our priority from achieving very low failure rates in our network to ensuring we can quickly restore supply. This essentially moves the transmission service from reliability to resilience.

We will also be able to operate the power system differently, having radically more flexibility to schedule energy transfers and grid outages to optimise the use of the grid, grid generation and distributed energy resources over the course of days, weeks and even months.

Technologies, retail and distribution business models and consumer choices will change significantly in coming years, bringing new challenges and opportunities for our business. Delivering the best value for New Zealand from our assets will increasingly depend on information flows, technical standards and co-ordination mechanisms (including price signals) that span the entire sector. With our central roles in the supply chain, we are uniquely placed to play an active role in shaping the industry's future.

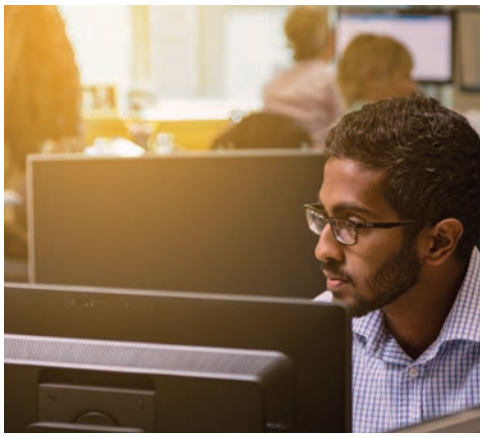
While we expect significant changes in the future, we will still be in the business of carefully and safely managing long-lived assets and complex systems that provide essential services to New Zealand communities, households and businesses. We have a continual focus on reducing costs and becoming more innovative while sustaining a focus on good asset stewardship and risk management.

MEETING THE FUTURE OF TRANSMISSION TOMORROW



Taking into account the trends and the wax and wane effect of our planning trajectory, we have identified six strategic priorities to guide our development of more detailed strategies and to set organisational priorities for Transpower. These will help to ensure we are in the best position to adapt to each of the states described earlier:

1. REDUCE COSTS AND EVOLVE OUR SERVICES TO REMAIN COMPETITIVE
2. PLAY AN ACTIVE ROLE IN SHAPING THE INDUSTRY'S FUTURE
3. SUSTAIN OUR SOCIAL LICENCE TO OPERATE
4. MATCH OUR INFRASTRUCTURE BUILD TO NEED OVER TIME
5. IMPROVE OUR ASSET MANAGEMENT
6. DEVELOP OUR ORGANISATIONAL EFFECTIVENESS



"Uncertainties in demand, carbon policy and emerging technology uptake are creating new challenges, but also new opportunities..."

1 REDUCE COSTS AND EVOLVE OUR SERVICES TO REMAIN COMPETITIVE

We provide an essential link in New Zealand's traditional electricity supply chain. Falling costs for distributed generation and storage technologies will reduce the traditional supply chain's cost advantage and market share and will affect the services demanded from the grid. Modern economies have a growing dependence on reliable electricity supply, but some communities will struggle with affordability, and a growing proportion of users will self-supply some part of their electricity needs.

Economic growth and increasing electrification should support the need for grid-supplied electricity, but we need to reduce costs and evolve our services to remain as competitive as possible.

We will continue to reduce spending through cost-reduction projects and business process improvements while ensuring we understand and manage asset risk profiles. We will anticipate changes in the way New Zealanders use electricity, and we will adapt our grid and system operator services.

2 PLAY AN ACTIVE ROLE IN SHAPING THE INDUSTRY'S FUTURE

In the near term, uncertainties in demand, carbon policy and emerging technology uptake are creating new challenges but also new opportunities for energy industry participants. Successful adaptation by distribution and generation businesses and accommodation of new technologies will be important in the medium term.

Overall, there is tremendous and increasing opportunity for the sector to deliver more value at lower cost by leveraging information, automation and storage technologies across the entire energy supply chain. A system-wide view will be required to make the most of these developments, and we are well placed to contribute.

We will continue to support effective design and operation of regulatory arrangements for our business and for distributors – and look for new ways to work with our distributor customers on adapting to the changing environment. We will play an increasingly active role in working with the industry on the evolution of market and security-of-supply arrangements, and we will support successful integration of new consumer and industry technologies into the power system.

3 SUSTAIN OUR SOCIAL LICENCE TO OPERATE

As a large business with a long-term future providing critical services to New Zealanders, it is essential that we continue to focus on ensuring confidence in our operations. Sector transformation and increasing consumer self-reliance may strain some of the existing goodwill, and we will need to adapt to these changes.

We will sustain our focus on worker and public safety as a top priority, continue to deliver world-class grid security and reliability and continue our constructive and transparent approach to economic regulation. We will plan ahead for transmission corridor challenges and work to integrate sustainability practices more strongly into our business.

4 MATCH OUR INFRASTRUCTURE BUILD TO NEED OVER TIME

Our planning trajectory indicates a need to anticipate and rapidly respond to changes. Examples of new challenges include accommodating rapid generation connection and commissioning, planning ahead for new renewables development, managing 'wax and wane' capacity pressures and evolving our market systems.

We will revise our processes to accelerate new generation connection and plan ahead for the generation development challenges of the future, increase our forecasting and technology anticipation abilities, evolve our tools for managing demand growth pressures and develop a more flexible approach to grid asset lifecycle planning.

5 IMPROVE OUR ASSET MANAGEMENT

Our grid and system operation services are both asset intensive. We manage hundreds of thousands of assets valued at more than $5 billion, with more than $400 million of maintenance, replacement and enhancement expenditure required each year. Asset management must be a core competence, and there are many opportunities to improve our systems to be more effective, lift performance and reduce costs.

We are improving the way we collect and process information on the condition and criticality of our grid assets, which helps us to make better decisions around our asset risk and therefore investment. We are improving our works scheduling, grid outage planning, supplier procurement and relationships and revising our asset management processes for the information systems that support our system operation service.

6 DEVELOP OUR ORGANISATIONAL EFFECTIVENESS

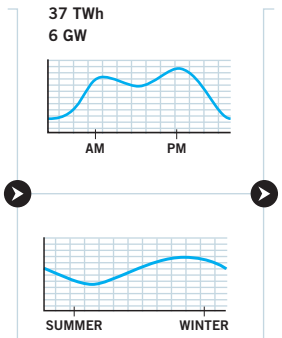
Completion of a major asset build programme has shifted emphasis within our business towards ensuring effective management and maintenance of existing assets. The potential for an increase followed by a decrease in demand for grid capacity over coming decades and for changes in system operations means we must be a forward-thinking but careful and strategic asset investor. These drivers, together with the need for improved cost-effectiveness, motivate our transformation and organisational development efforts.

We have redesigned our business operating models, revised our organisational structure and begun work to embed and improve our updated processes. We have work under way to enhance our risk management processes and to develop our people – increasing aspiration, improving engagement and lifting performance. We are reviewing and will improve our management systems for recruitment, induction, development and succession. Each year, we will shape operational plans and set individual targets that align with our revised priorities and higher aspirations.

EVOLVING GENERATION

DRIVERS

- Major transmission investments commissioned
- Thermal plant closures
- Investment uncertainty (Tiwai, transmission pricing, demand growth, carbon price)
- Incremental development of large renewable resources commercially fraught
- New and cheaper consumer technologies emerging but not yet mainstream
- Growing climate change concern



OBSERVATIONS AND IMPLICATIONS

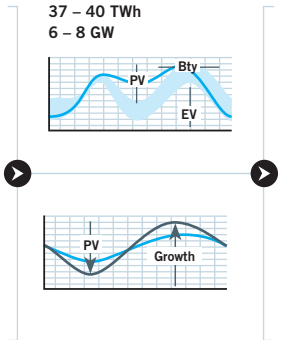
- Current load and load profiles remain roughly as now
- Incremental and just-in-time generation investment
- Increasing generation intermittency, decreasing inertia
- Tight security margins, higher dry-year risk (Tiwai closure would buy time)
- Risk of hasty political intervention over security concerns
- Our licence to operate under pressure

GRADUALLY, 2020+

CHANGING LOAD

DRIVERS

- Urbanisation and growth in population, economy and energy efficiency
- Mainstream commercialisation of micro generation (especially PV), electric vehicles (EV), batteries and energy management systems
- Electrification of transport and heat
- Strong carbon policies or price
- Uncertain evolution of direct-connect industries



OBSERVATIONS AND IMPLICATIONS

- Uncertain net change to demand, but peak demand still drives need for grid
- Increase in off-grid consumers at distribution level
- Low physical grid asset stranding risk, but increasing financial stranding risk
- Distributors evolve, rationalise and drive regulatory and market changes
- Commercial stress on some generators, distributors and retailers

RAPIDLY, UNLIKELY BEFORE 2040

EXTENSIVE STORAGE

DRIVERS

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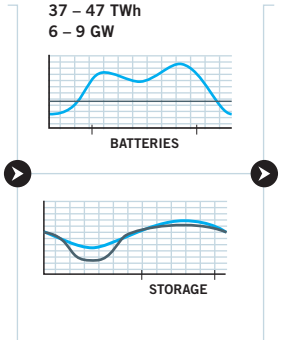

OBSERVATIONS AND IMPLICATIONS

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STRATEGIC PRIORITIES

1 Reduce costs and evolve our services to remain competitive

2 Play an active role in shaping the industry's future

3 Sustain our social licence to operate

4 Match our infrastructure build to need over time

5 Improve our asset management

6 Develop our organisational effectiveness

For more information, please contact us:

www.transpower.co.nz

communications@transpower.co.nz

KEEPING THE **ENERGY** FLOWING