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Steven Bailey
Inquiry Director, Low-emissions Economy
Productivity Commission
Wellington

By email: info@productivity.govt.nz

Dear Steven

Issues paper: low-emissions economy

We appreciate the opportunity to comment on the issues paper *Low-emissions economy*, published by the Productivity Commission (the Commission) in August 2017. We look forward to the Commission completing this inquiry and providing advice that will help New Zealand to meet its commitments to low emissions and sustainable economic growth.

Our submission focusses on electricity and is structured as follows:

1. Introduction to Transpower;
2. Electrification as a pathway to low emissions;
3. Decarbonising electricity supply as a pathway to low emissions; and
4. Investment in the electricity supply chain.

We provide our high-level perspective on these issues and aim to draw attention to areas of interest, rather than recommend solutions.

Our business has a long-term and forward looking focus and perspective: our assets tend to be high cost with long economic life times, and typically our project time lines are measured in years. We have thought a lot about how our business and its regulation must evolve and become more agile as New Zealand and our industry respond to emerging technologies and decarbonisation of our economy. As the Commission develops its thinking we would be happy to provide further insight and analysis on our work and the dynamics of the electricity sector.

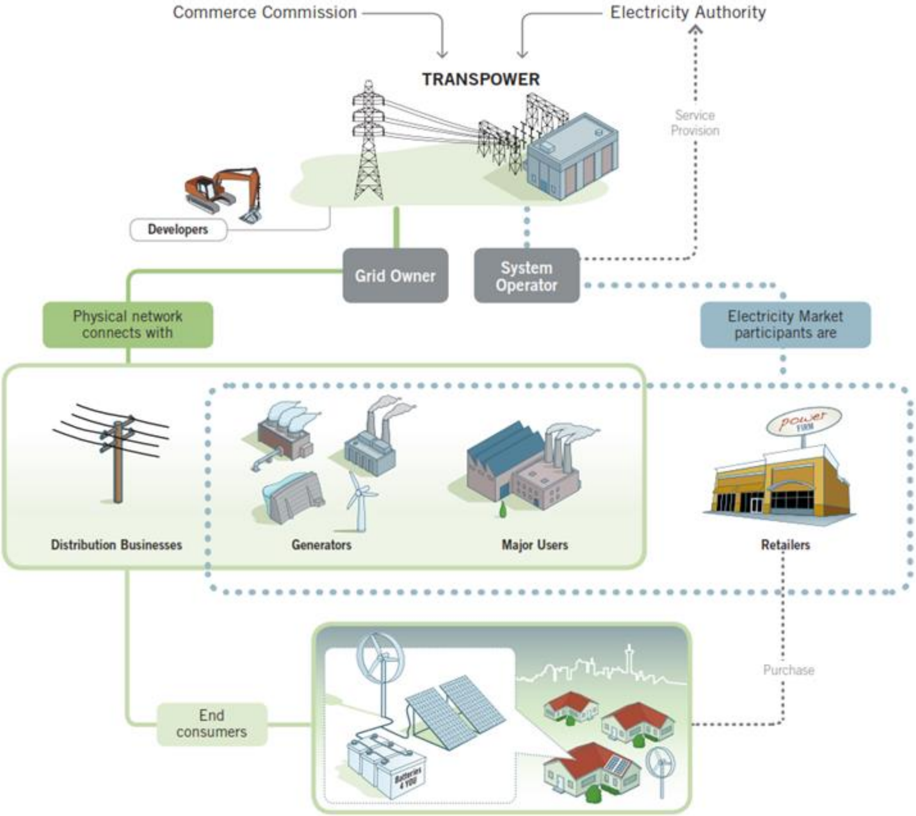
Introducing Transpower

We are a State-Owned Enterprise with two main components to our business – grid owner and system operator.

As grid owner, we own and operate the high-voltage transmission network that connects areas of electricity generation to towns, cities and industry across New Zealand, enabling energy resources to be shared and balanced.

As system operator, we manage real-time operation of the power system, ensuring the grid operates in a secure state while enabling the lowest-cost combination of resources to be used to meet energy demand.

Our main activities are regulated by the Commerce Commission and the Electricity Authority (the latter also governs electricity market arrangements).



In 2016 we published *Transmission Tomorrow*,[1] which provides a long-term view of our operating environment and strategic priorities. We identified climate change policy and electrification as two of the most important trends impacting the electricity sector, and highlighted sustainability as a key aspect of the value proposition for grid connection in New Zealand.

We see ourselves as a neutral player in the electricity sector. We have in interest in sustaining the long-term value proposition of grid connection, but we do not have a direct interest in the mix of grid-scale and distributed generation. Our interest in long-term value proposition means that we have a balanced view on the level of investment in our own network – preferring to improve the efficiency of the system where possible rather than incurring avoidable grid costs.

As a clear indication of this stance, the Commission may be interested in our recently published report on the value of battery storage in the New Zealand power system.[2]

[1] www.transpower.co.nz/tt2016

[2] https://www.transpower.co.nz/about-us/transmission-tomorrow/battery-storage-new-zealand

Electrification as a pathway to low emissions

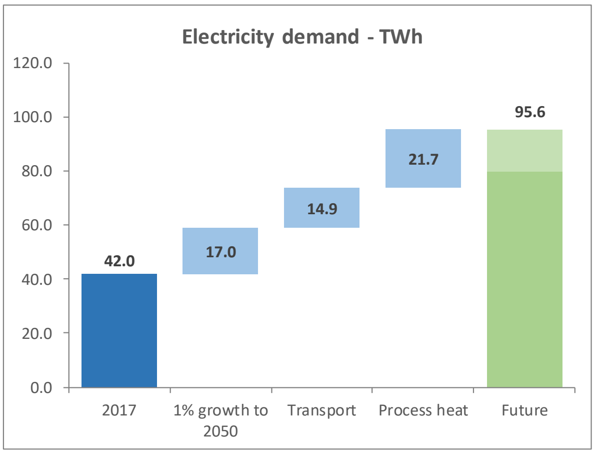
As the Commission identifies, there is an opportunity for New Zealand to reduce carbon emissions by using electricity in place of fossil fuels for transport, space heating and industrial process heat. This is both a credible and sizeable opportunity, one that could build on the renewable electricity advantage we already enjoy relative to most other countries.

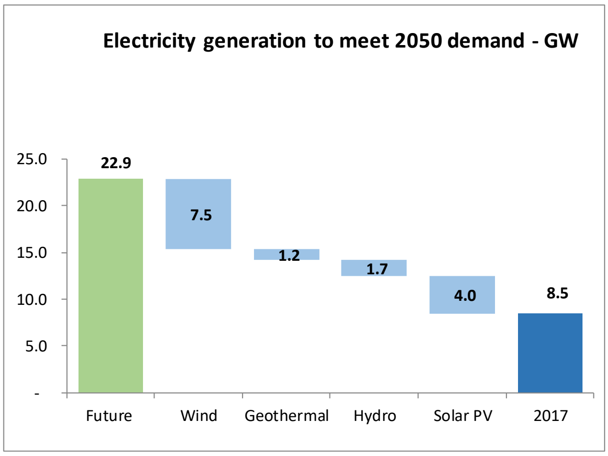
We have prepared the following analysis to provide a perspective on electrification potential relative to current demand and normal demand growth, and an indication of the amount of new generation (whether grid-connected, embedded in distribution networks or behind the meter) that would be needed to meet that demand growth.

The demand side of the diagram starts with today's annual demand for electricity, and adds a set of demand increases:

- a relatively moderate assumption of 1% underlying growth in energy demand to 2050. In practice this will be influenced by the interplay of factors such as economic and population growth, changes in the structure of our economy, energy efficiency, changes in utility (e.g. more or less home heating and cooling);
- an estimate of the increases in demand if all of today's transportation and process heat were electrified. Roughly half of the transport figure represents light passenger vehicles. In reality, the amount of travel and process heating in 2050 may be higher or lower than today and the degree of electrification is difficult to predict.

Collectively, this presents a picture that a near doubling of today's demand – to around 80 TWh – would be plausible if there were a high degree electrification (not total).





The supply side of the diagram illustrates a mix of new renewable generation capacity that could be built to achieve an increase in energy demand to 80 TWh. This is based on an energy-balance analysis, without detailed analysis of the mix of supply required to ensure sufficient flexibility, stability and resilience to daily, seasonal and annual variations.[3]

The mix of new generation capacity is:

[3] The analysis is informed by public domain assumptions about relative cost and availability of generation resources, but should not be taken as presenting the optimal mix of generation. Also, the analysis does not provide for replacing existing thermal generation with renewables.

- 7.5 GW of new wind generation. For context, this is equivalent to around 50 wind farms of a similar scale to the West Wind farm in Makara (near Wellington). Wind is the most abundant economic grid-scale generation resource;
- 1.2 GW of new geothermal generation (compared to less than 800 MW installed today) and 1.7 GW of new hydro generation capacity. Hydro and geothermal are mature, dispatchable generation technologies; and
- 4 GW of solar photovoltaic (solar PV). This represents a reasonably high (but not extreme) penetration of solar – roughly representing a level where economic saturation for household installations may occur, distribution networks may increasingly require reinforcement, and half of households have a 3.5kW system installed.

Collectively, this presents a picture of New Zealand as a country with the natural resources (wind, steam, rain and sun) to achieve a high degree of electrification, albeit entailing significant investment in new generation, plus enabling investments in transmission and distribution.

Decarbonising electricity as a pathway to lower emissions

New Zealand is fortunate to have an electricity system dominated by renewable energy sources, with recent increases in the proportion of grid-scale renewables driven by the relative merits of generation options (without the mandates or subsidies that drive investment in many other countries).

We are also fortunate to have a large share of flexible hydro generation as a key part of our system. Hydro generation provides a range of services in our power system – supplying a large proportion of total energy, providing quick response for frequency keeping and reserves, storing energy across days, weeks and seasons, and providing significant capability to ramp up quickly to meet peaks in demand. The flexibility provided by hydro is an enabler for integrating less controllable supply from technologies such as wind and solar.

For all its system benefits, a challenge from our large share of hydro generation is coping with occasional (every few years) dry periods. With our current system mix, thermal generation (diesel, coal and gas) provides storable fuel and idle capacity that can be used to cover the energy shortfall we would otherwise experience during these periods. Coal-fired generation plays a key role in covering dry periods because coal is the easiest fuel to store in case of prolonged energy shortfall in dry periods. Gas is less storable and has limited supply flexibility in New Zealand. However, gas-fired generation is less emissions intensive, and more readily able (than coal) to vary output and cover intermittent capacity shortfall in peak demand periods, whether normal or dry conditions prevail.

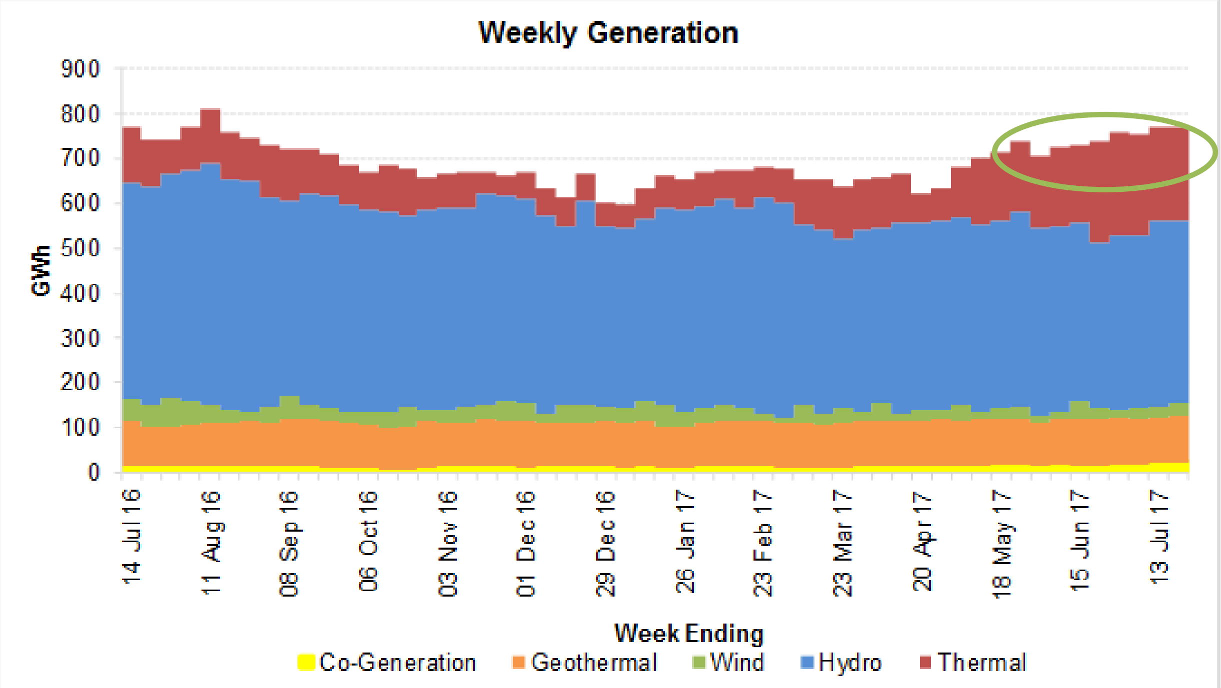
There is a complex range of factors that drive the optimal mix of generation, but it is useful to think of the proportion of renewables in the New Zealand as being mainly driven by two distinct issues – the need to cover occasional hydro energy shortfalls; and the need to meet energy demand in a normal year.

Covering Hydro Shortfall

Electricity demand is currently around 42 TWh per year, and a dry sequence in key hydro catchments can reduce energy production by around 2 TWh. As such, hydro energy shortages can amount to around 5% of annual demand in a dry year (or less when averaged across multiple years). During a dry sequence, hydro shortfall can be on the order of 15% of weekly or daily demand.

These figures are indicative only, because we do not have a long history of inflow and production data (relative to the return period for extreme dry weather), the interaction of electricity supply and demand is dynamic, resource consent conditions for hydro catchments can change, and climate change may alter future inflows. Nonetheless, the proportions are useful for illustrating the relative scale of the hydro shortfall issue.

The chart below further illustrates the impact of hydro shortages by showing weekly generation across a twelve-month period that spanned a dry sequence during the winter of 2017, and a more normal sequence through the winter of 2016. In winter 2017, dry conditions in major South Island hydro catchments were partly offset by strong inflows in smaller North Island catchments and the residual shortfall was largely filled by North Island thermal generation (gas and coal).



There are fundamentally three solutions to the hydro energy shortfall issue, and these can be used in combination:

1. Use thermal generation – coal can be stockpiled for use during dry sequences but is the most emissions-intensive form of generation. Gas is a lower-emissions form of generation, but achieving flexible gas supply is more challenging given the relatively small scale of our gas sector and limited connection to other markets;
2. Use more renewables – in theory a renewables-only solution may be attainable if the system provides an over-supply in a normal year. This requires additional investment in generation plant such that the system spills excess energy (or leaves some plant idle) most years. Additionally, some resource consents provide for lakes to be lowered below their normal operating range under extreme hydro shortfall conditions;
3. Ration demand – through price response or administrative mechanisms, consumer response can make some contribution to addressing hydro shortfall.

The extent that these solutions are used in practice is not a matter that any single party determines, and not a matter that can be resolved in isolation from a myriad of other investment, operational, commercial and policy considerations. However, some observations that may be useful for the Commission are:

1. When considering pathways to low emissions, the role of thermal generation to cover hydro shortfall is much less material than the opportunity for electrification of transport and

process heat (discussed above), or use of thermal generation to meet demand in a normal year (discussed below);

2. All things being equal, if there is growth in demand for electricity due to electrification then the hydro shortfall issue will become a proportionately smaller issue than it is today – both in annual terms and during a dry week or month;
3. While hydro shortfall cover is a proportionately small issue in terms of the pathway to low emissions, ensuring that industry arrangements sustainably deliver a supply mix and level of demand response to address hydro shortfall has always been a challenging issue.

Meeting Demand in a Normal Year

Setting aside hydro shortfall, the other driver of electricity sector emissions is the mix of generation used to meet demand in a normal year. This depends on the generation built to meet demand growth, plus the extent to which new generation displaces existing generation.

In recent years, the proportion of renewable generation in New Zealand has increased due to addition of wind and geothermal, and retirement of some gas-fired generation. There have also been improvements in the efficiency of existing hydro schemes, and there has been some interest in new gas-fired generation.

The process of generation expansion and retirement is driven by the relative merits of each investment option. One of the factors that influences this is the price of carbon emissions, and the investor's expectations about future carbon policy. Investing in new generation is a risky, long-term commitment, so investors can be heavily influenced by their expectations about the stability and direction of policy and regulatory settings.

Investment in the electricity supply chain

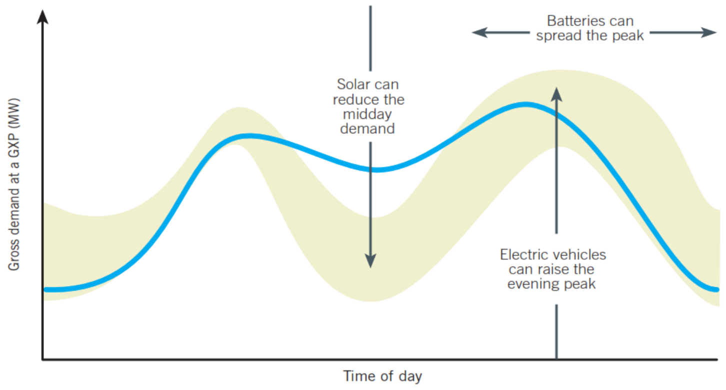
From the discussion above, a pathway to low emissions via electrification is a credible and sizeable opportunity that would involve relatively significant investment. This part of our submission briefly surveys key investment considerations at each level of the electricity supply chain, plus general observations about regulation and investment.

End users

End users of electricity have increasing options for self-supply, energy efficiency, electrification and optimisation of their electricity demand. The choices that end users make about the use of these technologies will play a significant part in the way the electricity system evolves, influencing the amount of demand growth, and the efficiency or productivity of the system.

Network investment is driven by the need to meet peaks in demand and to provide resilience through redundancy. These two needs traditionally mean that networks are lightly utilised most of the time. Contributing to this has been the limited scope and motivation for typical users to shift their demand to times when demand is lower.

As the uses of electricity change, and the scope for digital control systems and distributed storage (including the batteries in electric vehicles) to optimise demand increases, the productivity of the electricity system could improve. Conversely, technologies such as solar PV and electric vehicles also have the potential to decrease the productivity of the electricity system (for example, by reducing demand during the daytime in summer and increasing evening demand peaks).



One of the key issues for end user uptake and use of new technologies is ensuring that pricing structures are suitably cost-reflective so that they play a constructive role in influencing investment and operational decisions (such as vehicle charging patterns). Most end users today have pricing structures that over-stimulate self-production, under-stimulate efforts to moderate peak usage, and overly deter electrification.

This is a well-recognised issue within the sector, but will be challenging to address – requiring changes to distribution tariffs across 29 distribution businesses. The rationale for change is difficult to communicate to a wide audience, there is no perfect pricing structure, and the transition will alter the way costs currently fall. The Electricity Networks Association is doing good work in this area, and will need good support if the sector is to achieve a successful transition. This will in turn support the efficiency of electrification as a pathway to low emissions.

Distribution

Distribution tariff reform will help distributors defer the onset of investment pressures from electric vehicle charging peaks and high solar PV injections. However, electrification will still bring new investment challenges for the distribution sector – including network reinforcement to meet new or increased demands, and investment in digital technologies to support enhanced ability to plan for, and manage, more complex flows on distribution networks.

Aside from managing reform of tariff structures, we consider the key issues in the distribution sector centre around whether all 29 distribution businesses have the capacity and capability to invest in new technologies and network growth. It is also important that regulatory funding arrangements support distribution sector innovation.

Transmission

We have relatively good arrangements in place for efficiently managing the grid and meeting investment needs, but there would nonetheless be challenges involved in executing investment to meet significant electrification.

One of the key challenges is managing the opposing risks of over and under-investment. Transmission comes in large increments, so it is inherently challenging to match infrastructure build to long-term need. We are careful to manage the risk of building too much transmission too early, but if there is large-scale electrification then new grid capacity will be required to enable new generation and to accommodate new or growing offtake points.

As described in Transmission Tomorrow, there is heightened planning uncertainty in the near term and in the long-term there is the prospect that extensive distributed storage will provide a level of distributed resilience that alleviates some of the need to build high levels of redundancy and reliability into the transmission network. We are enhancing our ability to navigate these uncertainties by developing 'least regrets' approaches to grid investment, and are working with the Commerce Commission to adapt our regulatory settings to better support flexibility and staged commitment to large investments.

These steps will improve our ability to navigate an uncertain planning environment, but will not eliminate the challenge that rapid changes in generation mix or demand could at times outpace our ability to bring new transmission capacity into service.

There are a related set of challenges around coordinating commitment to investment across multiple parties in the supply chain. This is best illustrated by considering the challenge of establishing new transmission capacity to support potential wind generation in the Wairarapa. There are multiple proponents of wind farms in the Wairarapa that have a combined capacity of more than 1 GW. If we (or another party) were to establish a grid connection with sufficient capacity to accommodate all the wind farms, then fixed transmission costs would remain high per unit of new production for years or decades as the wind farms are progressively developed. Under current industry arrangements there is no clear path to resolution of this, or similar, investment coordination challenges.

Generation

New Zealand has an electricity supply system with relatively small rates of annual growth in demand, and with no connection to other markets. This makes investment in grid-scale generation inherently challenging due to the risk of causing an over-supply in the market. This challenge would be alleviated to some extent if suppliers began to have more confidence that high levels of electrification were likely to occur.

Aside from the general challenge of expanding supply in a small market, there are two factors that currently heighten the risk of investing in new generation:

1. The aluminium smelter at Tiwai does not have a long-term commitment to its energy supplier and represents a material proportion of New Zealand's total energy demand; and
2. There is an ongoing review of the structure of transmission pricing, which causes uncertainty regarding a potentially material input cost.

The first two challenges above mean that any new generation investment is likely to involve relatively small increments, and just-in-time investment commitment.

Regulation and Investment

We expect the Commission would not see itself adding value by investigating detailed regulatory settings within the electricity sector. However, items that may be a good fit for the Commission's investigation could include considering:

1. Methods for strengthening stable signaling of policy goals to support investment commitment and increase impetus to resolve investment challenges;
2. Whether there are any issues with overlapping functions amongst the different regulatory institutions and whether this creates any problems e.g. matters falling through the cracks, or being dealt with inconsistently; and

3. Whether the mandates and roles of existing regulatory institutions lead to the right matters being addressed with an appropriate set of considerations.

To illustrate the final point from above, it may be useful to consider the way the Electricity Authority's mandate shapes its consideration of issues relating to distribution tariffs and electric vehicles.

The Electricity Authority is very clear that it interprets its statutory objective as excluding "consideration of pan-industry externalities such as carbon emissions". [4] The Electricity Authority has also been clear that "effects on carbon emissions are outside the Authority's statutory objective. These effects are nevertheless relevant considerations for other policy makers and may be relevant considerations for distributors". [5] This approach limits the scope of the Authority's consideration and potentially leaves a gap in terms of regulatory consideration of the full sets of costs and benefits relating to tariff reform. Similar limitations could arise from the framing of the Commerce Commission's objectives for electricity sector regulation.

We would welcome further engagement

As the Commission develops its thinking we would be happy to provide further insight and analysis on our work, and our understanding of the electricity sector and its regulatory and policy environment. We would also be happy to discuss any points made in this submission.

We have a unique perspective as a central party in the electricity supply system, and we are guided by our interest in sustaining and improving the long-term value proposition of connection to the New Zealand power system.

Yours sincerely

Ross Parry

Strategy and Regulatory Planning Manager

[4] Electricity Authority, *Interpretation of the Authority's statutory objective*, 14 February 2011, paragraph 2.4.1.

[5] Electricity Authority, Consultation Paper, *Implications of evolving technologies for pricing of distribution services*, 3 November 2015, footnote 1.