WORLD ENERGY COUNCIL | BusinessNZ Energy Council

BEC 2050: A deep dive into 2030 energy targets for New Zealand

Why a deep dive into energy targets?

New Zealand is a world leader in renewable electricity – currently 4th in the OECD for renewable penetration, with 80% of our electricity coming from hydro, geothermal, wind, and biomass.

However, we should not rest on our laurels. As a country, we have the opportunity to maintain and enhance our leadership in renewable electricity, but also to look beyond to the wider energy landscape, to major sectors such as transport and industrial heat. Unless New Zealand addresses the renewable content of our wider energy consumption we will struggle to meet our international climate commitments.

Significant changes in the global cost of technology – electric vehicles, solar and batteries – are changing the way countries both produce and consume electricity. Our energy future as a nation is inextricably tied to the way we consume energy, which in turn is driven both by economic and population growth, and the way in which we grow our economy.

To this end, the Government is contemplating setting targets for key metrics in 2030 which will frame our future energy performance. These metrics are:

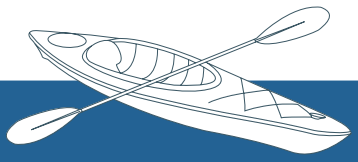
- **Energy productivity (GDP per unit of energy consumed)**
- **Proportion of primary energy supply that is renewable**
- **Proportion of electricity generation that is renewable**

These three metrics succinctly describe the interconnected dynamic we must consider as a country - growth and consumption, supply, and our nation's contribution to the challenge of climate change. The levels we aspire to will potentially have profound implications for our future and how we perform as a nation on the international stage.

BEC2050

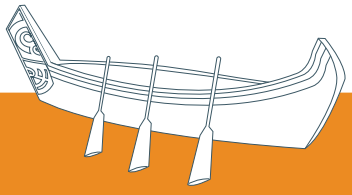
In 2015 the BusinessNZ Energy Council launched BEC2050: two New Zealand-specific energy scenarios – Kayak and Waka. Based on the work of the World Energy Council, these scenarios provided two cohesive narratives about NZ's energy future to 2050, and quantified the outcomes expected under each scenario.

BEC2050 was unique. It provided – for the first time in many years – plausible, integrated, energy sector futures developed by a broad cross-section of New Zealanders from both within and outside the energy sector. In doing so, it provided a common platform and vocabulary for an ongoing national discussion about energy, and a quantification of the future, vital to policy and investment decisions. This was achieved by using an internationally recognised modelling framework, and applying a set of assumptions to each scenario. Thus BEC2050 was able to tell two stories, but also put data in the hands of decision-makers who need to explore the many trade-offs they face when considering options and choices. Our scenarios look out to 2050, but enable us to look at the energy system in 2030, where the targets are aimed.



THE KAYAK SCENARIO

"Kayak" symbolises characteristics that are individualistic, dynamic, volatile, autonomous, independent, unconstrained, flexible and fast-moving. In this scenario New Zealanders kayak alone, we deal with situations we have in front of us, we want to go forward, efficiently and quickly, but need to go with the flow.



THE WAKA SCENARIO

"Waka" symbolises characteristics that are for the collective greater good, interdependence, integration, co-ordination, stewardship, custodianship, harmony. We're on a long-term Waka journey, with a goal in mind. In this scenario we work together as a team, using the great natural resources we have in New Zealand.

Our Kayak and Waka scenarios are not prescriptions or pathways. They are two plausible stories designed to spark a conversation about our resilience to different futures we might face.

The Economy in Kayak and Waka

Kayak: At the heart of the Kayak scenario, markets drive supply chain decisions and innovation more than government intervention, with business and consumers making informed decisions in their own interest, based on price and quality (including environmental quality).

In the Kayak scenario, free trade and higher global economic growth drive export expansion in our primary sectors, services and high-tech manufacturing. A global deal on climate change is agreed, but international commitments on reducing emissions are uncertain. The environment and natural resources remain critical to social and economic development. New Zealand leverages off its "clean and green" image and economic opportunities result in a vibrant domestic economy and higher net immigration, mainly urban. But higher density cities, pressure on water resources and weather risks increasingly give rise to capacity and resource constraints.

1.3% GDP per capita growth

2.1% Annual GDP growth

GDP grows **$81b** (NZD2010 real) **between now and 2030**

Under Kayak, the growth of our major trading partners and an increasing degree of economic integration see capital and labour flow more freely (especially across the Asia Pacific region) and a higher reliance on markets results in higher GDP growth. However, economic growth is effectively borrowed from younger generations as a failure to mitigate carbon emissions will result in them facing higher costs and economic volatility post 2050 as we focus on adaptation.

1M people

Population increase to 2030

Under the Kayak storyline, high immigration drives population growth at 0.9% per annum. This effect alone results in a 60% higher growth rate in residential energy demand in the Kayak scenario, compared with Waka.

Waka: All countries choose a more environmentally sustainable path. Due to heightened environmental awareness, business and consumers work more closely with government to make decisions in the national interest, particularly to meet the country's environmental commitments.

In the Waka scenario, a comprehensive and binding global deal on climate change is agreed based on strong emissions reduction commitments. As our trading partners restructure their economies to meet climate targets, they turn to greater self-reliance and New Zealand's export earnings suffer. We shift our focus to those markets where trade barriers are lowest. Further, New Zealand's exports are less attractive than in the Kayak scenario, due to the tyranny of distance we face, where high carbon prices add to freight costs. This, combined with increased and as yet uneven carbon prices, places pressure on New Zealand's energy intensive industrial sector.

1% GDP per capita growth

1.6% Annual GDP growth

GDP grows **$57b** (NZD2010 real) **between now and 2030**

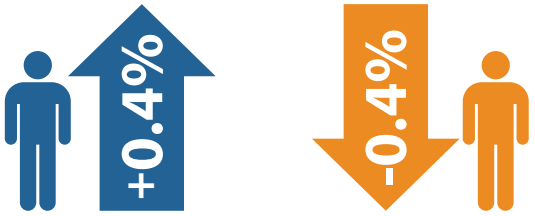
Under Waka our government, mandated by business and consumers to reduce our carbon footprint, takes a greater role in the allocation of capital in the economy. As a result, GDP growth in the Waka scenario is 25% lower than Kayak. This has a dampening effect on the growth in energy demand emanating from the industrial and commercial sectors.

0.8M people

Population increase to 2030

The Waka scenario sees a much more restrictive approach to immigration by government, limiting the impact on scarce resources and thus restricting total population growth to 0.6% per annum.

The net effect of population and economic growth on energy demand (annual)



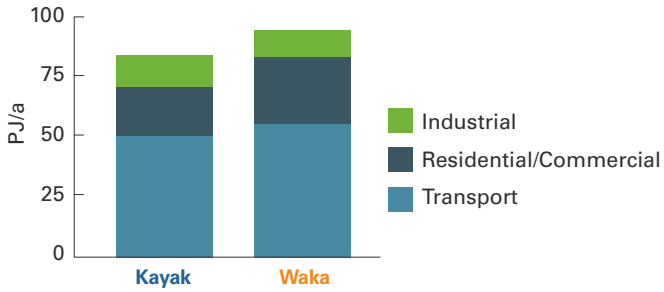
Energy Productivity

Energy productivity requires us to think about whether we get better at using energy to create wealth, not just whether we increase or decrease consumption. There are two effects here:

Energy Efficiency

While energy efficiency investments continue to be incentivised in the Kayak scenario through markets (cost of technology, financing, energy prices and required rates of return), Waka sees a much more active role for government. The Waka effect is twofold: carbon prices (and thus energy prices) are higher than Kayak, increasing the direct payoff for efficiency, while, government facilitates behaviour change through efficiency and conservation incentive programmes.

Reduction in Energy Demand due to efficiency & behaviour change (2030)



Economic Structure

The structure of our economy is changing. The last 30 years has seen significant growth in sectors such as financial services, wholesale and retail trade, relative to more traditional parts of the economy such as manufacturing and agriculture. Many of these higher growth industries are less energy intensive than their traditional counterparts. Hence, the more economic growth is driven by these sectors, the less energy intensive the overall economy becomes.

Under the Kayak scenario, we see a continuation of the efficiency and structural change trends observed over the past 10 years, achieving an increase in energy productivity of 1.8% per annum.

In Waka, despite overall GDP growth being lower, the combination of higher energy efficiency and the potential for some carbon intensive businesses to exit due to the high carbon price, energy productivity grows by 1.95% per annum.

Energy Productivity

The key components affecting energy intensity

Energy Efficiency

Market-driven improvement

Greater efficiency improvements driven by government initiatives and higher prices

Economic Structure

Commercial and industrial GDP growth strong with more dairy processing and manufacturing

Overall GDP and industrial growth trajectory lower with some energy and carbon intensive industries exiting NZ

NZ Energy Productivity

1.8% pa improvement

1.95% pa improvement

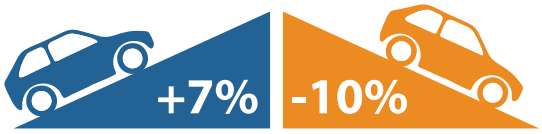
These three storylines are fundamental to our energy productivity and renewable performance in Kayak and Waka

Transport

Both scenarios see a decline in the role of fossil fuels in surface transport, but this is far more dramatic in the Waka scenario.

In Kayak, fossil fuel consumption declines as the surface transport sector becomes both more efficient (through a greater uptake of hybrid vehicles, and general improvement in combustion engines), and substitutes some petrol and diesel consumption for renewable electricity. Total fuel consumption in the transport sector only increases 0.3% annually, driven by efficiency improvements of 45% across the light and heavy fleet. This relatively slow growth rate (compared with GDP) increases energy productivity.

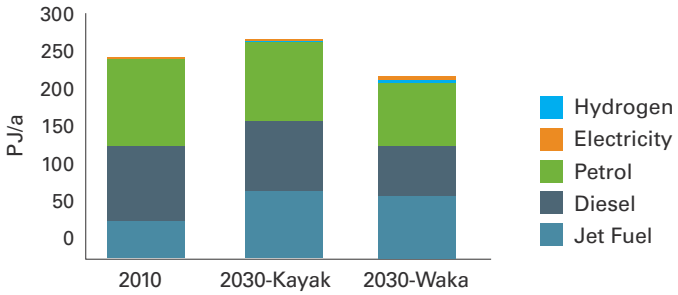
Km driven per capita in 2030 compared to today



In Waka, we choose to drive less and own fewer cars as cities evolve denser urban developments, and governments invest more heavily in public transport. This has a significant (positive) effect on energy productivity (via reduced energy consumption).

Also, Waka sees a strong emergence of electricity as a form of transport fuel for the light vehicle fleet, buses and rail. This is triggered by declining technology costs, and the improved relativity of electricity prices to energy prices. An electric-powered vehicle uses substantially less energy per kilometre of travel than an internal combustion engine, and substitutes highly-renewable electricity for petrol or diesel. The efficiency of the personal car fleet increases by 55%, with a significant effect on productivity.

Transportation Fuel Use, 2010 vs 2030, Kayak and Waka



Number of electric-powered vehicles on the road in 2030

Homes and businesses

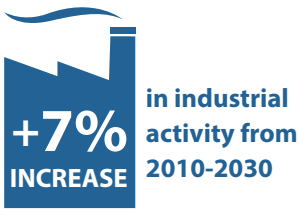
Homes and businesses will help usher in the efficiency and renewables associated with transport. In the residential and commercial sectors, a 25% improvement in energy efficiency is observed in both scenarios, as consumers adopt more efficient and smart technology. In heating and air conditioning alone, overall efficiency improvements of 47% and 54% are observed in Kayak and Waka respectively. The higher Waka result is partly due to the higher carbon price, but also to government initiatives focused on driving uptake of high-efficiency technology.

Homes and businesses increase their use of (renewable-dominated) electricity in both scenarios, but they also increase their use of solar thermal for water heating. However, about three times as much solar thermal is observed in Waka, compared with Kayak.

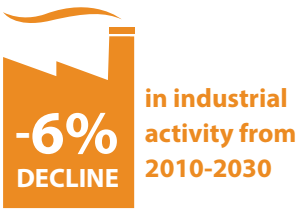
Reduction in consumption delivered by efficiency in heating and air conditioning between 2010 and 2030

Industrial Heat

While industrial activity grows in Kayak, it still lags overall GDP growth, indicating a gradually declining share of the economy (consistent with the last 30 years). The high carbon prices in Waka lead some marginal carbon intensive businesses to exit.



in industrial activity from 2010-2030



in industrial activity from 2010-2030

The efficiency of the industrial sector's use of heat increases by 15% in both scenarios. While not as dramatic as the increases observed in the residential and commercial space, this is still a significant reduction in energy use, and improves the energy productivity of industry.

Industrial heat consumption between 2010 and 2030

Under Kayak the use of coal for process heat is largely unchanged. In Waka, however, it drops 8%, mostly as a result of the reduction in industrial activity, but also due to efficiency and some limited switching to gas. However, there is no material substitution of renewables for fossil fuels.

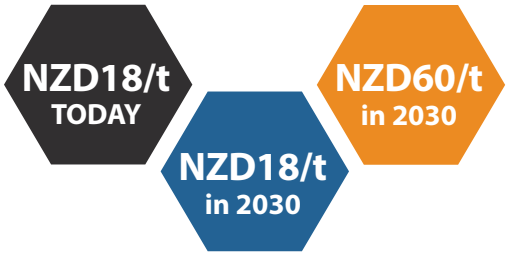
Currently, the vast majority of the 40PJ of biomass used in New Zealand is for heat. This is largely maintained under a Kayak future. However under a Waka future, despite a 20% subsidy, biomass use actually declines by 35%, through efficiency and substitution.

Renewables in Energy

A key driver of the increasing use of renewables in energy is the carbon price: in the high carbon price world of Waka, by 2030 we have already seen energy sector emissions drop by 8 million tonnes annually, while Kayak emissions remain constant.

The overall energy picture shows that growth in Kayak is underpinned by oil for transport, gas and highly renewable electricity.

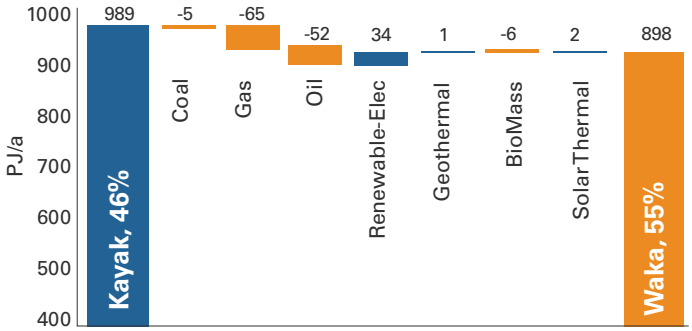
Carbon prices



Coal consumption drops in both scenarios – about half of which reflects the exit of Huntly Rankines by 2030. The residual is met by a combination of efficiency and fuel substitution in the industrial heat sector. In Kayak, this results in the renewable share of energy increasing from 40% today, to 46% in 2030.

With lower population and economic growth, Waka sees only minor increases in gas and electricity consumption.

Getting to 55% Renewables in Energy 2030

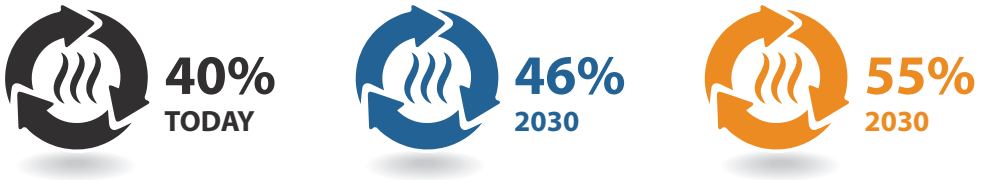


As the chart above shows, we consume less energy in Waka, but a higher proportion of it is renewable.

So how does Waka get us the extra 9% of renewables? A combination of:

- A dramatic reduction in oil consumption: a trifecta of driving less, increased engine efficiency, and the introduction of renewable electricity into the transport sector
- Further moderating our direct use of gas and coal for process heat, driven by a high carbon price
- Switching more of our gas-powered electricity generation to hydro, geothermal and wind.

Proportion of renewables in energy



Renewables in Electricity

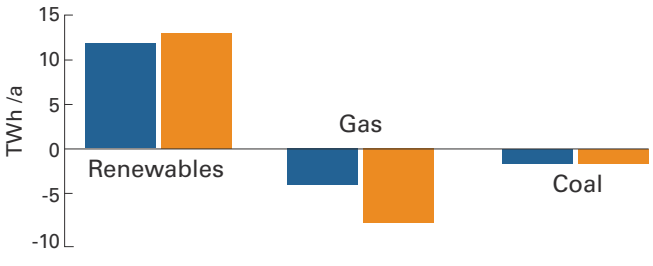
In electricity, both scenarios see increased investment in renewable electricity generation.

Proportion of renewables in electricity

The amount of investment in renewables to 2030 is similar in each scenario ($3.7b). However, the resulting penetration of renewables in Waka is much higher in 2030 due to the fact that demand growth is lower than Kayak, and renewables substitute away from gas more aggressively (underpinned by the carbon price). This allows the Waka scenario to fully leverage relatively cost-effective renewable resources, including large government-facilitated hydro stations.

The higher demand growth in Kayak sees it largely retain gas (with a more modest carbon price) as well as build renewables. Beyond 2030, however, Kayak exhausts the cost-effective renewables, with gas, solar and coal (with carbon capture and storage) being the next most cost-effective options.

Net Increase in Generation, 2010-2030



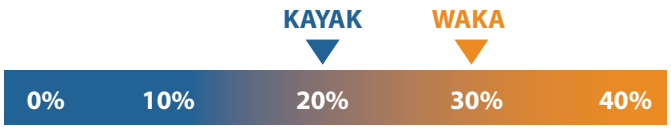
Gas capacity is preserved in the Waka scenario (but at very low load factors) to meet the requirements of intermittent wind and solar, as well as variations from year to year in hydro inflows.

Insights

For targets to be credible, and to support a stable policy environment, we need to get a glimpse of how we might get there.

Energy Productivity

If part of the story is to substantially increase energy productivity as a nation, how can we achieve this? Kayak uses a mix of efficiency and growth from higher value goods and services to achieve a 20% improvement. What will unlock this? Waka relies on the exit of energy intensive businesses to achieve its additional productivity. Is this what we really want? If we still aspire to high economic growth, what will replace these energy intensive businesses and how soon? And, under a level international playing field for carbon, will a high carbon price really drive out export-based energy intensive businesses, especially if we are carbon efficient producers? If not, the achievement of ambitious productivity targets hinges on the substantial growth of businesses that have low energy intensity (e.g., technology), and/or investment in energy efficiency.



Renewables in Energy

Our scenarios suggest that a large increase in renewable energy could be enabled by a transformation of the transport sector, coupled with highly renewable electricity, and increasing efficiency in process heat (thus reducing the consumption of fossil fuels).

What needs to be done to achieve this? The Waka narrative suggests a combination of strong government interventions to change driver behaviour, measures that significantly improve the uptake of electric vehicles, and a significant improvement in the efficiency of the heavy transport sector.

The Kayak scenario informs us that, if the transport transition does not occur, getting much above 45% renewables by 2030 requires a far more dramatic shift elsewhere; most likely in process heat.

Our scenarios did not show an uptake of biomass as an alternative to fossil fuels for process heat. This does not mean it is not worth considering but in moving away from coal and gas to biomass we must consider where the feedstock is coming from, and how much is available. A material increase in biomass usage has significant implications for land use and distribution logistics. However, technology may evolve to the point where electricity (e.g. via heat pumps for industrial water heating) becomes more cost effective for industrial processes, providing another opportunity to leverage renewable electricity. This requires deeper investigation.

Given the uncertainty about the extent to which we can rely on either a transport or process heat transformation, an aspiration for a highly renewable energy system needs to be backed by:

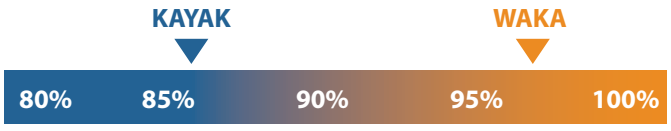
- initiatives which support travel behaviour change
- a greater understanding of how efficiency and renewables (e.g. biodiesel) can be introduced into freight transport
- a credible path to substantial electric vehicle uptake
- a strong commitment to research and development around a range of renewable process heat technologies.

Renewables in Electricity

The scenarios highlight that a key challenge in significantly increasing renewables in electricity relates to the role of thermal. The consequence of increasing renewables is decreasing gas generation; however, flexible thermal fuel is currently the way New Zealand manages the year-to-year variability in hydro. In both scenarios, hydro remains as a significant contributor to our renewable energy mix.

So, to enable a sustained high penetration of renewable electricity over the medium term, we may need to consider:

- changes to the market design and/or commercial structures which support a high degree of stand-by thermal (and flexible fuel supplies); and/or
- an increased role for sustained demand response, possibly enabled through smart technology and associated retail prices and offerings.



Further, if electric vehicles become a key part of the transport mix, what will be the impact of charging on the profile of power consumption? And will this, along with a higher penetration of solar, other forms of distributed generation, and electric storage require us to transition sooner to a smarter grid and system operation?

Key Messages

This deep-dive offers a perspective on New Zealand's energy targets based on two story-lines. They are neither right nor wrong, and are by no means the only two scenarios for New Zealand's future. There are other scenarios and assumptions; our goal in putting Kayak and Waka forward is to have a richer conversation.

Our analysis shows that opportunities to improve our performance in productivity and renewable penetration lie in every part of the energy supply chain. While productivity and renewables are not necessarily mutually exclusive, we need to consider the best policy balance. Our country is richly endowed with resources so do we primarily focus on economic growth and rely on carbon prices to guide renewable penetration, or do we need stronger policy support for low-carbon economic output? With an economy heavily driven by trade, the cost of our choices has direct consequences for our international competitiveness. And, since our future is uncertain, how do we remain responsive and resilient to changes in the world around us?

Kayak and Waka paint two distinct scenarios. A valid question is: how can the targets, backed by good policy, help us steer a course which borrows the best from both scenarios? Good policy should help businesses seize opportunities to invest, and should consider how:

- the targets, like the entire energy system, are interconnected and should not be considered in isolation from each other. Policy targeted at one part of the energy system will have impacts on other parts. Also, demand-side initiatives have implications for supply chain investment; and
- we cannot afford for policy to be based on a single "pathway" – as soon as a narrow set of choices and technologies is relied on, we immediately lose our resilience to different futures. For example, highly aspirational renewable targets should pursue more than just electric vehicles – alternative transport modes, freight, aviation, and process heat must all be enabled in a climate of uncertainty.

Targets can – and should – be aspirational. One of the biggest challenges is that, today, we often cannot see the technological innovations that could enable the future we want. The policy which supports these targets needs to strike a balance between being grounded in today's known technology, while not being heavily reliant on assumptions about future advances. Further, good policy should consider the ability of our economy to absorb new technology, and whether that can be increased.

Our analysis highlights areas we need to understand more, for example:

- the role for bioenergy in transport (especially freight) and industrial heat: what technology might support this, and what are the physical and commercial challenges for uptake across the bioenergy supply chain?
- the changing energy intensity and productivity of our economy: what is the best policy balance between encouraging greater efficiency in what we do today, and facilitating structural change in favour of less energy (and carbon) intensive sectors?

The divergence between our Kayak and Waka scenarios highlights the need to support a broad range of potential future paths, leaving the option open to strengthen policy settings in the future as we gain a clearer view.

For more information, go to **www.bec.org.nz/projects/bec2050**

Project partners

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