Historical impacts of high electricity and gas prices on the New Zealand economy and industries

A GSM-NZ dynamic CGE analysis

Final report, 20 July 2025

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Key points on a page

The electricity price rises of 2017-2025 had material negative impacts on the economy

- We use a model of the New Zealand economy (GSM-NZ) to estimate what might have happened to the economy if electricity prices were lower.[1]
- We increase the supply of natural gas and hydroelectricity. These counterfactual "shocks" reduce electricity prices by 35% and gas prices by 20%.
- Comparing actual economic outcomes since 2017 with this hypothetical counterfactual scenario, we estimate the high electricity and gas prices between 2017 and 2025 led to:
    - Real GDP being 1.25% or $5.2bn lower by 2025.
    - Real household spending being 1.65% lower by 2025.
    - Real wages being 1.4% lower and employment 0.5% lower.
    - Real exports being 0.8% lower by 2025, worsening the balance of trade by $275m.

Steel & aluminium production and paper manufacturing were the hardest hit industries

- The biggest manufacturing industry losers from high electricity and gas prices between 2017-2025 were primary metals productions (i.e. steel and aluminium) and paper products.
- Under our scenario assumptions, primary metals production real GDP was 15% lower than it would otherwise have been by 2025, and paper products GDP some 7% lower.
- Other large negative impacts were on chemical production (-5%), metals mining (-2%), non-metallic minerals mining (-1.2%) and dairy processing (-1.3%).

High electricity and gas prices chilled manufacturing capex, limiting future growth

- These impacts will persist into the future due to several years of foregone energy and manufacturing sector investment while electricity and gas prices were so high and volatile.

Not all industries lose from higher electricity prices

- The high electricity and gas prices acted as an investment signal to other forms of electricity generation, including solar and wind electricity (real GDP in both were around 26% larger than baseline in 2025) and geothermal (29%).

[1] Backcasting is a challenging exercise. It is impossible to say what the 'right' electricity price path should have been, nor precisely what might have needed to different to generate such a price path. So these results are not ex-post estimates of what *should* have been. They should be seen as indicative answers to the question "what *might* have happened if electricity prices had been 1/3 lower between 2017 and 2025, based on the assumptions we have made around what might have driven them lower?".

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1. Purpose, scope and caveats

1.1. Purpose of research

MBIE has engaged Sense Partners to estimate the impact of higher-than-usual wholesale electricity prices between 2017 and 2025 on the New Zealand economy. We have been asked to estimate these impacts at the macroeconomic and industry levels.

We use an advanced dynamic computable general equilibrium (CGE) model of the New Zealand economy and its industries to quantify the direction and scale of impacts.

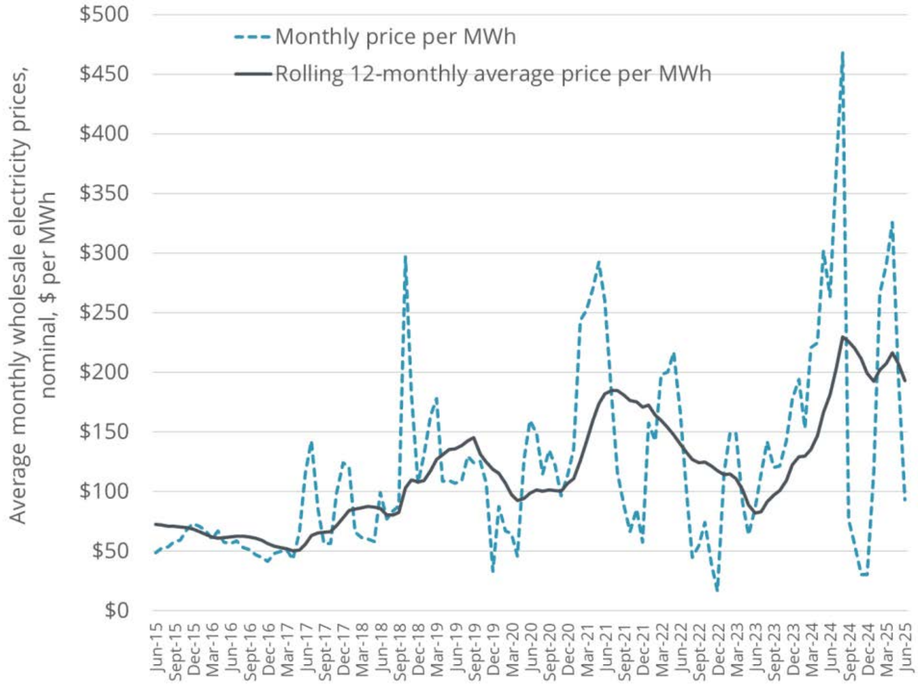
1.2. Context for analysis

Wholesale electricity prices have been materially higher in New Zealand recently than they have been historically (Figure 1):

- Between July 2014 and June 2018, prices averaged $69 per MWh.
- Between July 2018 and June 2022, they doubled to average $139 per MWh.
- Since July 2022, the average price has been $152 per MWh, with a peak monthly cost of $468 per MWh in August 2024.

Wholesale gas prices have also been high compared to history, having doubled since 2018.

FIGURE 1 WHOLESALE ELECTRICITY PRICES OVER TIME, NOMINAL $ PER MWH



The direct drivers of higher electricity prices since 2017 are well-known:

- Declining gas supply
- Low hydro lake levels during three major dry years (2021, 2024, 2025)

Our analysis focusses on these direct drivers.

We side-step questions about other indirect drivers that are often said to have contributed to the price rises e.g.:

- uncertainty about energy demand growth, with high risks to investors of significant reductions in demand if e.g. Methanex[2] or the NZ Aluminium Smelter[3] shut down
- government investment in exploring options for back up generation (e.g. Lake Onslow, announced in 2020 and cancelled in late 2023)
- a ban on new gas field exploration permits
- a difficult technological transition, with ageing fossil-fuelled (gas and coal) generation becoming increasingly expensive, on average, but needed for back-up, especially in dry years
- market power of the big four generator-retailers
- international energy price increases[4].

Those indirect factors are important. They speak to why it was that gas supply shortages and low inflows to hydro schemes had such large and sustained effects on electricity prices.

Our immediate concern is with the effects of high prices on the wider economy. Elevated electricity prices have significantly disrupted production and investment in several high-profile, electricity-intensive industries. Should prices continue to stay high, the viability of some industries – particularly in heavy manufacturing – will be at risk, with the prospect of deindustrialisation presenting concerns over regional economic development.

That being so, we focus on proximate drivers of energy price increases and leave it to others to divine the deeper reasons for electricity price shocks of recent years e.g. the government's review of electricity market performance and the Electricity Authority and Commerce Commission's Energy Competition Task Force.

[2] Methanex's maximum energy demand is roughly half that of total annual electricity production in New Zealand.
[3] The smelter's maximum demand is around 13% of total annual electricity production in New Zealand.
[4] New Zealand's energy markets are affected by events like Russia's invasion of Ukraine and resulting increases international energy prices, via import prices (e.g. for oil and coal) and export prices (e.g. for methanol).

1.3. Scope and caveats

Given this context, MBIE wants to understand how higher electricity prices[5] have affected the New Zealand economy and its industrial composition. This requires considering the counterfactual – what might the New Zealand economy have looked like if wholesale prices had not risen so much? Would GDP have been very different to actual outcomes observed? Which industries might have performed better than they did in reality?

This **counterfactual is of course hypothetical and unobservable** in practice. Therefore we need to use simulation analysis to create an 'alternative history' where the key drivers of high electricity prices are partially reversed (e.g. New Zealand *didn't* have three dry years that affected hydro storage and generation), resulting in the economy experiencing materially lower whole prices.

We use a dynamic CGE model to explore this alternative history and compare it against a baseline that maps the actual path of GDP growth and is reflective of industry output between 2017 and 2025. We then extend the modelling to 2035, albeit with no new shocks introduced past 2025.

This extension recognises that **structural shocks such as persistently high electricity prices have long-lasting impacts** – the economy does not just instantly return to its baseline when we reverse them. This is because capital investment decisions influenced by the different electricity price path can take several years to flow through the economy. Labour market and fiscal effects also take some time to filter through.

We design a counterfactual electricity price scenario that reverses some of the key drivers of high prices – namely low hydroelectricity production and natural gas supply – and results in **prices being around 1/3 lower than seen in practice**. Any number of alternative price paths and drivers could be considered, but we judge our approach to be a reasonable one for the purposes of this research question in the timeframe available. The 35% price decrease in our counterfactual is similar to the change in futures prices for electricity between 2017-2019 and 2020-2025 after adjusting for inflation, and is broadly equivalent to prices for the 2020-2025 period falling back to their pre-COVID levels.

This research was completed in a highly compressed timeframe. **We do not conduct any primary research on what pushed up wholesale prices**, drawing instead on secondary sources and our own knowledge of the energy system in New Zealand to design our modelling scenario.

We focus on macroeconomic and industry impacts. We **do not explore regional economic impacts**. With additional time, and given the importance of electricity-intensive manufacturing

[5] While this report focuses on high electricity prices, it could equally be seen as illustrating the impacts of high electricity <u>and</u> high gas prices. For ease of drafting we refer only to high electricity prices from hereon in.

to regional economic development, regional analysis using the regional module of our CGE model would have been useful. We leave this for potential follow on work if required.

The 2017-2025 period is atypical because of the COVID-19 pandemic and its social and economic impacts (shocks to freight costs, delays to production, and large scale fiscal and monetary stimuli). Disentangling the effects of the pandemic from other economic drivers is challenging in the timeframe available. **We do not make any assumptions in the counterfactual scenario about the pandemic** – it is explicitly in the baseline (because it is based on historical economic data) and implicitly in the counterfactual scenario.

In the time available, **we did not analyse the extent to which specific industries were hedged** against spot price increases in any given year. In reality, rising wholesale prices are partially offset by hedge contracts.

Households too are insulated from increases in wholesale electricity costs. For example, retail prices were slow to rise in recent years, relative to both wholesale electricity prices and other consumer prices.[6]

But hedge contracts can only shield users for a limited amount of time. As such the broad direction and magnitude of impacts estimated are likely to be reasonable, given the assumptions we have made.

Because we are looking at the economy as a whole, and 79 industries within it, **our analysis cannot capture the individual firm-level choices made over the 2017-2025 period** as they faced higher-than-usual electricity prices. For example, while we report impacts on the paper products manufacturing industry, this industry comprises several different firms and should not be interpreted as the impact on (say) Oji Fibre Solutions.

[6] See e.g. Sense Partners (2024) "Phase out of the Low Fixed Charge regulations: Quantified price effects for the first three years".

2. Overview of GSM-NZ CGE model

We use our Global Systems Model of New Zealand (GSM-NZ) dynamic CGE model for this research.

2.1. Origin of GSM-NZ

The Global Systems Model of New Zealand (GSM-NZ) model is a highly advanced and flexible dynamic Computable General Equilibrium (CGE) model. It was developed for Sense Partners in 2019 by Dr Ashley Winston of Phylleos Inc. in Washington, D.C.

The GSM-NZ modelling suite[7] is built on the foundation of the pathbreaking and proven US GSM model. Versions of the GSM modelling framework have informed key policy reform and other economic matters in dozens of countries, including advising The White House on US biofuels and other energy reform issues.

GSM-NZ has a lineage that traces back to the MONASH dynamic CGE model developed by the Centre of Policy Studies, then at Monash University, now at Victoria University, Melbourne.[8] Dr Winston implemented several improvements to the MONASH model as a PhD student under the tutelage of Professor Peter Dixon in the late 1990s/early 2000s.

Dr Winston continued developing dynamic CGE models throughout the next two decades, including the USAGE model of the US economy[9] and the FLAGSHIP suite of models for over 20 countries, before building and continually extending the proprietary GSM suite of models from 2015.

GSM-NZ is built and run in the GEMPACK software suite.[10]

We have used GSM-NZ[11] for several New Zealand clients including MBIE (on Accelerated Depreciation and biofuels mandates), Transpower, MoT, KiwiRail, Oji Fibre Solutions, New Zealand Carbon Farming, The Treasury (on COVID policy choices), Auckland Airport, and a group of Economic Development Agencies.

2.2. What is a CGE model?

CGE models are commonly used tools for policy analysis. Such models typically consist of:

1. A **database** that represents an economy in a certain year based on input-output (IO) tables. The database specifies the interactions and relationships between various

[7] We use "suite" because we have a variety of modelling solutions, including comparative static, recursive dynamic, top-down regional, and bottom-up regional versions, with different levels of industry and commodity detail.
[8] See https://www.copsmodels.com/monmod.htm. Full documentation is in Dixon and Rimmer (2002b).
[9] See https://www.copsmodels.com/usage.htm. Dixon and Rimmer (2002a) has the technical documentation.
[10] See Horridge et al (2018).
[11] Earlier versions of GSM-NZ were called MDG-NZ.

economic agents including firms, workers, households, the government and overseas markets.

2. Behavioural **parameters** governing agents' responses to relative price changes (e.g. elasticities).[12]

3. A **system of equations** that define the model specification or theory, which is generally based on standard neoclassical economic assumptions[13], but not necessarily constrained by them.

2.3. A CGE model considers the entire economy as an inter-linked system

GSM-NZ explores how the entire economy adjusts over time to changes in policy settings or shifts in the economic environment. It captures the interlinkages between industries, households, government, workers, investors, export markets, etc ('economic agents') and the greenhouse emissions associated with production and consumption.

A key benefit of CGE models is that they explicitly take resource constraints into account. In any year, the amount of labour, capital, land, energy and intermediate inputs to production are fixed, and resources flow to their most valuable use.

This means there are 'no free lunches' in any period. If one industry uses more of an input as demand for its good or service rises, there is less available to other industries and its price will rise for all users.[14] There will always be winners and losers in a CGE modelling exercise.

In its initial baseline (or BAU) equilibrium, in every year:

- Supply equals demand for all commodity outputs (i.e. goods and services) and intermediate inputs (including electricity).

- Supply equals demand in all factor markets (i.e. labour, capital, land, natural resources).[15]

[12] We rely on published studies for elasticity estimates to calibrate GSM-NZ. Elasticities are set at values widely understood to be valid in the modelling community and can be replaced by country- or industry-specific estimates where available for specific projects.
[13] Alternative theoretical specifications can be incorporated as required.
[14] The exception is if the scenarios include technological change or efficiency/productivity improvements. In this case, the crowding out effects are moderated.
[15] However, in practice we allow for periods where labour demand and supply can be temporarily unbalanced, recognising that labour markets do not clear perfectly or immediately all the time.

In addition, a novel feature of GSM-NZ is the inclusion of "slack capital" capabilities for dynamic projections using nested complementarity relationships. This allows for endogenously determined proportions of productive capital stocks and other "fixed" factors (like land and other natural endowments) to become idle at low rates of return during periods of falling demand. Along with the labour market treatment described above, the modelling suite is capable of more realistic dynamic simulations through the

- The economy is on a pathway to meet its Net Zero emissions targets.
- Firms use intermediate inputs and factors of production (land, labour, capital, etc.) to minimise the costs (or maximise the profits) of producing a given amount of output. The choices of inputs used are governed by multiple layers of 'nests' of production technologies.[16]
- Firms make normal profits, so output prices equal the costs of production (including returns to capital, labour, land, natural resources, etc.).
- Households maximise utility by using their disposable incomes to buy goods and services and saving some of that income to fund future consumption.
- Government spending equals tax revenue plus any assumptions around borrowing (which must be funded via interest payments) and the fiscal balance.
- Export revenue less spending on imports determines the balance of trade, which must either be balanced via changes to the exchange rate or accompanied with increases in overseas borrowing.

2.4. Baseline and counterfactual scenarios

In our dynamic model, we first develop a BAU scenario and then 'shock' it off its equilibrium to reflect different scenarios. See sections 3.1 and 0 for explanation of the baseline and counterfactual scenarios in this project.

Changes in industry, investor or household behaviour in future scenarios are driven primarily by **changes in relative prices** (that is, the price of one good or service, or factor of production, relative to another). Each relative price shift has multiple flow-on effects, which filter through industries and the wider economy. For example:

business cycle, tempering a standard dynamic CGE tendency to create unrealistically fast recoveries from downturns in response to low primary factor prices.

[16] A multi-nested production structure represents the way firms transform intermediate inputs and primary factors into output through a hierarchy of nested production functions. This structure reflects economic substitution possibilities at different levels of the production process.

At the top level, firms decide between intermediate inputs and a composite of primary factors. Within intermediate inputs, further nests group domestic and imported varieties using a CES (Constant Elasticity of Substitution) function. Primary factors (e.g., labour and capital) are similarly nested to allow for substitution and factor-specific technological change. This allows GSM-NZ to reflect observed economic behaviour, such as a firm substituting imports for domestic goods when relative prices change due to trade policy or exchange rate movements.

Deeper levels of the nesting hierarchy capture the technological and behavioural relationships *within* input bundles. For example, within intermediate inputs, a nest distinguishes between energy and non-energy goods, with further sub-nests separating electricity, gas and fuel. Similarly, within the primary factor nest, capital is disaggregated into industry-specific capital types. Labour is divided by occupation.

- A shift in export demand towards more sustainably-produced products will push up the world price of (say) New Zealand's clean aluminium. This induces greater production by the aluminium industry.
- More aluminium production requires more inputs (unless it's all due to a productivity improvement). The demand for electricity rises, pushing up its price.
- This higher price for electricity pushes other electricity-using industries (e.g. pulp and paper) to either reduce output or seek other inputs to use instead to maintain output levels.
- Higher aluminium exports lead to overseas buyers purchasing more New Zealand dollars. This pushes up the nominal exchange rate (the price of New Zealand's currency), which in turn makes other exporters less competitive.
- Other exporters reduce their output, including in labour-intensive industries such as tourism or tertiary education. This puts downwards pressure on wages (the price of labour).
- Relatively cheaper labour benefits the labour-intensive, non-tradable part of the economy, such as personal services like hairdressing or food services (restaurants, bars, etc.).
- Due to the exchange rate appreciation, imports become cheaper. This benefits households as the purchasing power of their wages rises. And it benefits industries using a lot of imported materials, such as road passenger transport (for both vehicles and petrol/diesel) and construction.

The chain of logic extends a long way. In any scenario, there are many thousands of prices changes – some of which we input into the model as exogenous variables as 'shocks', and others which adjust as the economy reacts.

In each scenario, unless we tell the model otherwise, the price of every input to production changes, as does the price of every industry's output.

These price changes flow into the demand functions of households, overseas buyers, investors and the government sector. The extent of changes in quantities demanded and supplied as prices move – **behavioural change – is determined by thousands of elasticities of demand and elasticities of substitution**. The larger the elasticity, the more demand or supply adjust. Each industry or economic agent has its own set of elasticities.

2.5. Results represent the difference between the initial and new equilibriums

Following the introduction of shocks to represent different scenarios, supply and demand iteratively adjust across commodity and factor markets until a new equilibrium is reached.

The results are reported as deviations – that is, as the difference between the baseline results and the policy simulation results for each variable. This enables us to report results that capture only the impact of the scenario shocks themselves.

The model produces results for every year, including macroeconomic aggregates (e.g. GDP, household spending) and a huge amount of detail at the industry level – output, value added, exports, employment and wages, capital investment, etc.

The model's results are generally presented as percentage changes from the baseline, but it also generates certain impacts as changes from the baseline in 'ordinary' or levels measures (dollars, PJs, MT CO2-e, etc.)

We focus on the headline macroeconomic results and industry impacts in our reporting and are happy to provide more detailed results in supporting spreadsheets to support your analysis and advice.

2.6. Key dynamic features of GSM-NZ

GSM-NZ contains four key **dynamic mechanisms** that link successive years:

1. The deviation in the real wage rate away from its forecast path in year *t* caused by a policy shock equals the deviation in year *t-1* plus a term reflecting the gap in year *t* between the employment deviation and the deviation in labour supply. That is, real wages deviate from the baseline based on the gap between the changes in the labour supply and employment caused by a policy shock.

   Real wages are sticky in the short term, meaning labour market impacts are felt more through changes in employment. Further out in the projection period, employment gradually returns to the baseline, meaning impacts are more commonly seen through real wage changes.

2. Capital at the start of year *t* equals capital at the end of year *t-1*.

   Capital stock in an industry at the end of year *t* equals the capital stock at the start of year *t,* depreciated at a given rate, plus investment in year *t* for that industry.

   Investment in year *t* for an industry is a function of the expected rate of return (i.e. gross operating surplus) in that industry. The expected rate of return is a function of the rental and asset prices of that industry's capital in year *t*, depreciation, taxes on capital, and expected changes in those variables.

3. Net foreign liabilities at the start of year *t* equal net foreign liabilities at the end of year *t-1.* Net foreign liabilities at the end of year *t* equal net foreign liabilities at the start of year *t* plus the current account deficit for year *t.*

   The current account deficit for year *t* is imports less exports plus interest payments for foreign liabilities less exports of royalties, and less net transfers from foreigners to New Zealand residents.

4. Public sector debt at the start of year *t* equals public sector debt at the end of year *t-1*.

   Public sector debt at the end of year *t* equals public sector debt at the start of year *t* plus the public sector deficit for year *t*.

2.7. Database aggregation for this project

In the interests of reducing computational time for solving the model, we have aggregated and diagonalised the database in this project to 79 single-product sectors,[17] and not utilised the regional module.

The greenhouse gas emissions associated with each sector's activities, and those of end users such as households, are also incorporated into our database.

The database for this project incorporates:

- 79 single-product industries, comprising:
    - 12 primary sector industries and primary processing industries
    - 4 extractive industries
    - 12 industrial manufacturing industries
    - 15 fuel industries
    - 8 types of electricity generation[18], plus an electricity distribution industry
    - 3 utilities industries
    - 7 freight and passenger transport and logistics industries
    - 17 government, business and recreational services industries.
- 10 natural resource endowments[19]
- 18 energy/fuel types[20]
- 17 types of greenhouse gas emitting activities[21], producing 8 different gases[22]

[17] We have aggregated many of the dozens of services industries in the database, as they are not so crucial for this project.
[18] Hydro; Geothermal; Wind; Solar; Gas; Coal; Oil; Biomass.
[19] Forests; Fish; Coal; Oil; Gas; Metals and minerals; Arable land; Semi-arable land; Marginal land; Non-arable land.
[20] Coal, coke, and tar products; Natural gas; Petrol; Diesel; Advanced Aviation Fuel; Heavy Fuel Oil; Other Petroleum Products; Ethanol; Biodiesel; Advanced Marine Fuel; Biomass Fuel; Hydrogen; Light Vehicle Fuel blend; Heavy Vehicle Fuel blend; Aviation Fuel blend; Marine Fuel blend; Manufactured gas.
[21] Enteric fermentation; Manure management; Ag soils - excreta + other; Ag soils – fertiliser; Urea - CO_2; Liming; Field burning; Coal mining fugitive; Gas fugitive; Oil fugitive; Chemical process; Non-metallic mineral production; Metals production; Geothermal fugitive; Sewerage treatment fugitive; Waste processing fugitive; Land use, land use change & forestry.
[22] Carbon Dioxide; Methane; Nitrous Oxide; Fluorinated gases; Nitrogen Oxides; Carbon Monoxide; Non-methane Volatile Organic Compounds; Sulphur Dioxide. Converted to CO_2-e using GWP.

- 8 labour market occupations[23] in each industry
- Dozens of different tax and government spending instruments.

[23] Managers; Professionals; Technicians and tradespeople; Community and personal services; Clerical and administration; Sales; machine operators and drivers; Labourers.

3. Modelling approach

The majority of CGE modelling exercises examine forward-looking "what if?" scenarios. Our baseline usually reflects a BAU set of economic projections drawing on Treasury forecasts, and the counterfactual scenarios incorporate different assumptions around what the future might look like.

Our research question here is backward-looking: how might the New Zealand economy have developed if electricity had not been so high between 2017 and 2025? So we need to take a different modelling approach, as outlined below.

3.1. Historical database construction and baseline

We need to start our analysis in 2017 to consider what might have happened between then and now if electricity prices were lower than occurred.

We therefore backcast the New Zealand economy and industry composition from 2025 levels to 2017. We draw on official data from StatsNZ to rescale the economy to 2017, using official data on labour force growth, capital stock growth, productivity growth, electricity prices, gas prices, etc.

Our baseline is accurate at the macroeconomic level, matching economy-wide GDP, household consumptions, employment, etc. Accurately matching industry GDP is more challenging due to our database being at a more detailed level of disaggregation to StatsNZ's official industry GDP series, and official measures of industry structure (i.e. input-output tables for 2013 and 2020) are quite different in terms of industries and commodities covered. However, we are comfortable the paths of industry GDP are reasonable and reflective of actual developments since 2017.

The baseline incorporates smoothed prices for hydro-electricity, gas electricity and natural gas supply between 2017 and 2025. It was neither possible, nor desirable, to exactly match wholesale prices from year to year.

Spot market prices are very volatile and don't fully reflect what firms consider when making production and investment decisions. Indeed, firms typically hold insurance (hedges) against price volatility. What really matters is sustained changes in prices and expectations for future price changes. As such, some smoothing was necessary. The start and end points in 2017 and 2025 are accurately represented, however.

This gives us an 'actual history' modelling baseline that closely approximates the development of the New Zealand economy from 2017-2025. It shows us what actually happened in terms of macroeconomic outputs (GDP, exports, household spending, investment etc.) and is reflective of industry growth over this period.

We then extend the baseline out to 2035. We include the 2025-2035 period because structural shifts such as long-lived elevated electricity prices have long-lasting impacts that cumulatively affect the economy over time. We project the baseline using the latest Treasury forecasts.[24]

3.2. The counterfactual: how we model the impacts of lower electricity prices

With the baseline in hand, we start our analysis at 2017 and design a counterfactual ('policy') scenario in which electricity prices are materially lower than those seen in reality. We are projecting forward to 2035 from a 2017 base, but with different assumptions around the most important drivers of high electricity prices for 2017-2025.

Drawing on our knowledge of the proximate factors that pushed electricity prices higher from 2017, we design an 'alternative history' scenario where we partially reverse some of these drivers' impacts, leading to a materially lower wholesale electricity price across the 2017 to 2025 projection period.

Note we do not simply impose the lower price path on the model. Doing so would play havoc with the model's capital accumulation dynamics.[25] Instead, we design shocks that explain *why* electricity prices might have been lower.

Specifically, **we exogenise the composite primary factor productivity (a1prim) in the hydroelectricity and natural gas supply industries.**[26] We design a path for a1prim in each industry that leads to falling prices in each industry.

Increasing a1prim can be thought of as a convenient and efficient way of mimicking:

- higher rainfall and hydro lake storage – we have higher natural resource productivity (more rain filling hydro lakes), which supports better capital utilisation (capital productivity gain) and generates more output per worker (labour productivity gain).
- more gas discoveries (natural resource productivity gain) and accompanying capital expenditure (capital productivity) because of a reduction in uncertainty around the oil and gas exploration ban and Lake Onslow project, both of which likely curtailed private sector gas exploration and investment.

The figures below show the a1prim shocks imposed on the model and their flow-on effects to lower hydroelectricity and gas supply prices. We include gas electricity prices here too, as they fall (endogenously) as gas prices decline.

[24] https://www.treasury.govt.nz/publications/efu/budget-economic-and-fiscal-update-2025
[25] Usually a lower price means lower marginal revenue product, leading to lower rates of return on capital, which makes investment less attractive. Depending on the extent of the drop in capex in electricity generation, this could see economy-wide GDP decrease when electricity prices fall rather than increase.
[26] This composite productivity parameter incorporates labour, land, capital and natural resource productivity, weighted by cost shares.

The drop in electricity prices we model (around 35%) is similar to the change in futures prices for electricity between 2017-2019 and 2020-2025 after adjusting for inflation and is broadly equivalent to prices for the 2020-2025 period falling back to their pre-COVID levels.

FIGURE 2 SHOCKS IN COUNTERFACTUAL SCENARIO

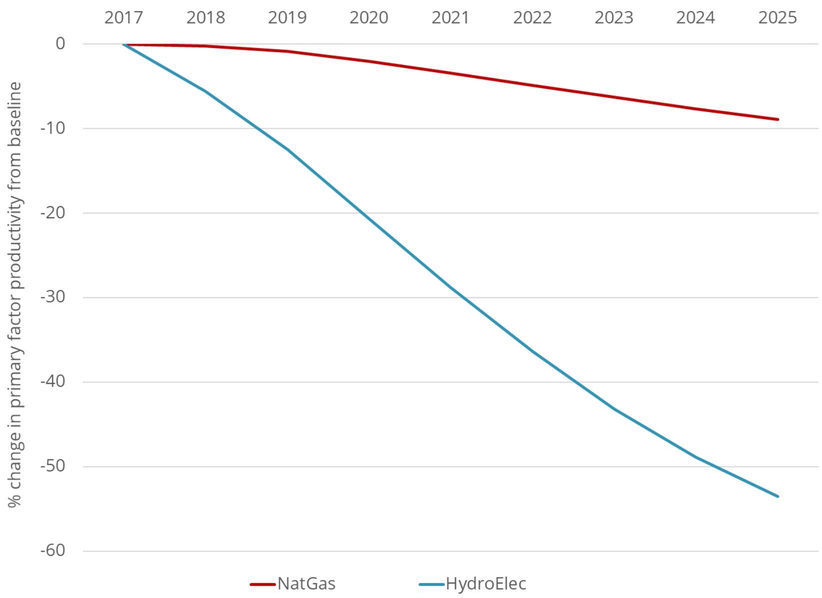
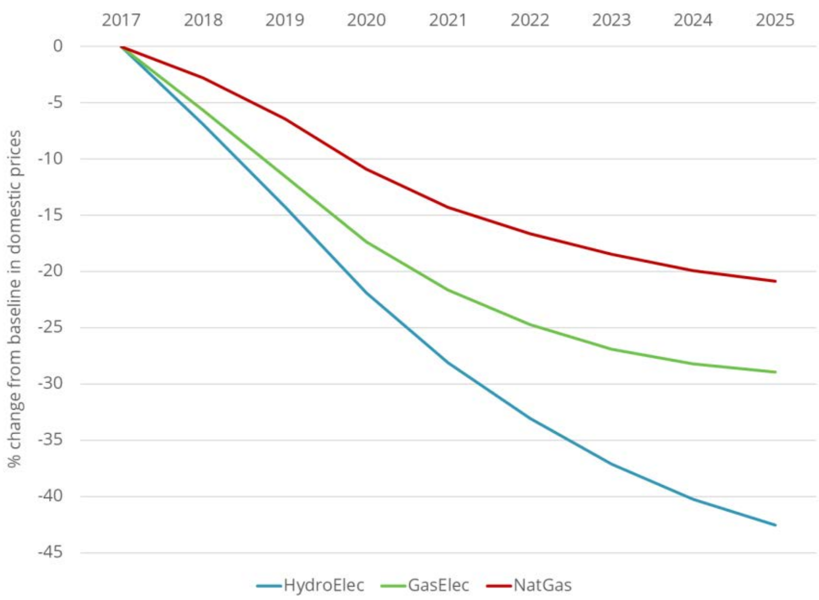


FIGURE 3 IMPACTS OF SHOCKS ON HYDRO AND GAS PRICES (REAL)



We do not specify how the additional gas is distributed across users. This is determined endogenously within the model – the additional gas will flow to its most profitable end-use.

Hydro-generation and gas supply costs are the most direct drivers of electricity prices, at least historically. Electricity production costs reflect the opportunity cost of gas, the opportunity cost of stored water, and the interplay between the two. If hydro capacity (lake levels) is low, the value of gas goes up. If gas supply is constrained, the value of water goes up. Either way, electricity prices go up.

There are numerous other ways we could have specified the counterfactual. But none would have been as direct, transparent or reflective of widely agreed causes of high prices.

For example. we could have shocked the productivity of other kinds of generation – say wind or solar or geothermal. Those shocks would reduce demand for stored water (other things being equal) and thus reduce its opportunity cost and lower electricity prices. But that would be a more circuitous route to the more direct effect we have modelled. Also, to specify that shock we would have had to entertain very large changes in the amount of solar, wind or geothermal generation that are very far outside historical experience.[27]

We could also have considered demand-side scenarios, such as Methanex closure which would release a large amount of gas into the market and drive down both gas prices and opportunity costs of stored water. But a shock like that would ultimately reflect a judgement on, amongst other things, the global demand for and supply of methanol, rather than being a shock that is embedded in the supply-side of the electricity market.

The counterfactual shocks we have modelled are at least not overly restrictive in the sense that the results would not change materially if we did include additional sources of shocks such as increased investment in renewable generation. Notice too that the shocks we have applied are sustained and on average i.e. structural changes. We have not sought to model the effects of avoiding specific one-off shocks like the Pohokura outage that played havoc with the market in 2018.

3.3. Model closure choices

The 'closure' of a CGE model refers to the elements that we tell the model about (**exogenous variables**) and those which we want the model to tell us about (**endogenous variables**).

In GSM-NZ the closure is extremely flexible, allowing us to incorporate a wide variety of inputs into simulations depending on the availability of data, often including expert speciality forecasts from official or other expert sources.

We use a standard set of closure assumptions for this project, including:

- The fiscal balance as a share of GDP in the policy scenarios remains the same as in the baseline, with indirect taxes as the adjusting variable.
- The balance of trade as a share of GDP in the policy scenarios remain the same as in the baseline, with the real exchange rate adjusting to ensure this holds.

[27] We would almost certainly have had to consider the costs and availability of a range of complementary technologies such as battery storage and new transmission and distribution network assets. Otherwise our 'shocks' might not make any sense.

- The economy is linearly transitioning to its Net Zero targets, with economy-wide ETS emissions exogenised and the ETS unit price varying to clear the emissions market (i.e. how much emissions can be generated by each industry).

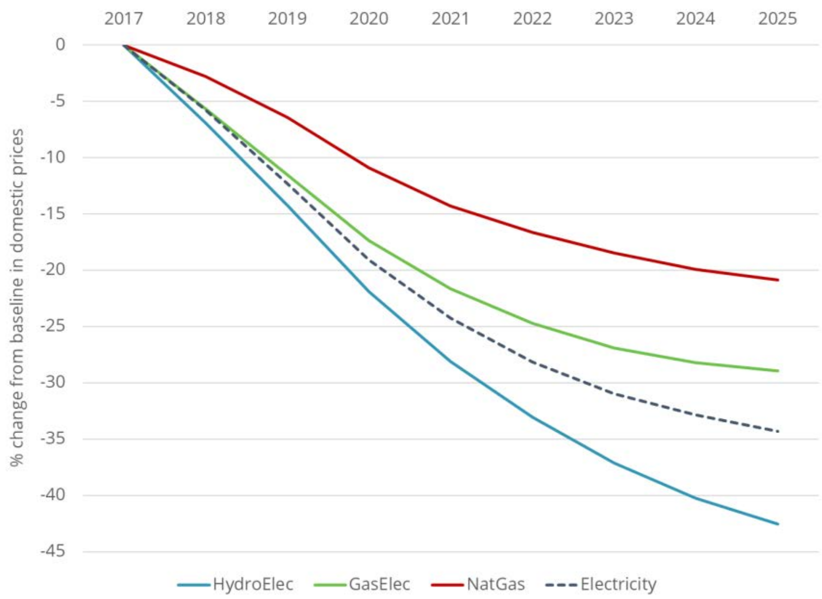
4. Results

4.1. High-level narrative for impacts of lower prices

As hydroelectricity and gas supply production expand due to our assumed primary factor productivity growth, the output prices of these industries fall. Gas-fired electricity expands because of the additional gas supply coming onstream, and its prices fall too.

The aggregate electricity price – our proxy for wholesale prices – follows suit. **By 2025, the electricity price is 35% lower** than in the baseline.

FIGURE 4 DECLINE IN REAL WHOLESALE ELECTRICITY PRICES IN COUNTERFACTUAL, % CHANGE FROM BASELINE



As electricity and gas prices fall, **the cost of intermediate inputs for industry users dro**ps (see Figure 5 cost indices for selected heavy energy users). This cost improvement **supports additional investment, growth and exports** in these industries, relative to the baseline.

Stronger output growth in the manufacturing sector **drives additional demand for support services** such as road and rail freight transport, wholesale trade and technical and professional services (engineers, consultants, lawyers, etc.).

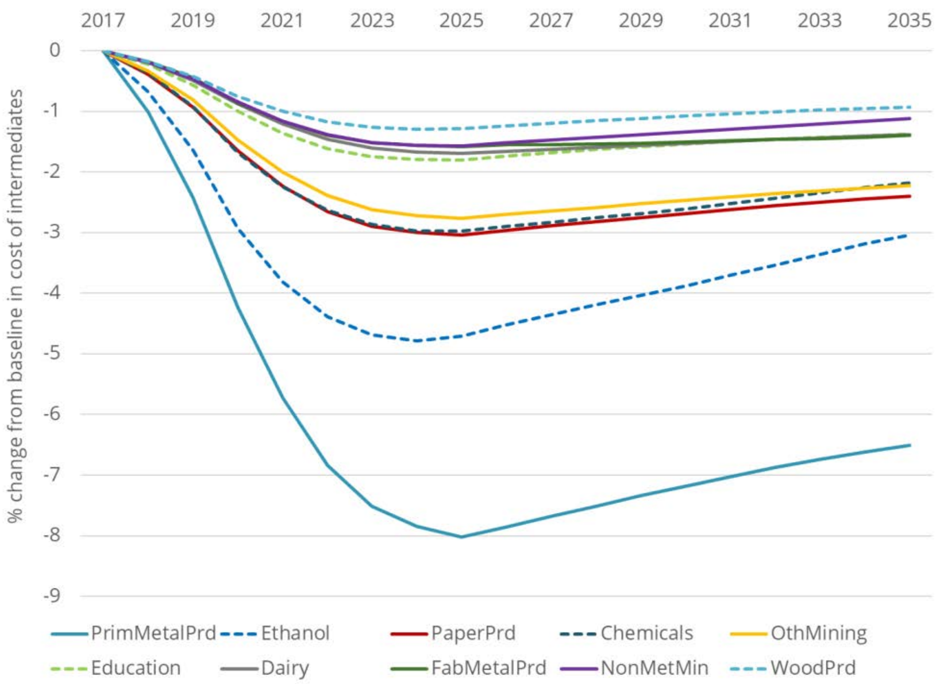
Resources (land, labour, capital, natural resources) flow into these growing industries, leaving fewer available for other parts of the economy, such as wind and solar generation, coal mining and air transport. But **overall, the economy grows faster than baseline**.

A faster-growing economy leads to **higher tax revenue** (from income tax, corporate tax, GST, etc.) than collected in the baseline. Government-supplied services such as **healthcare and education expand** relative to the baseline as tax revenue increases.

As the economy expands relative to the baseline, **the demand for labour rises**. In the short-term, employment rises more than wages as real wages are 'sticky' (i.e. take some time to adjust) in our dynamic model set-up. Further out in the projection period, employment starts returning to its baseline level and higher labour demand is seen more through stronger real wages growth.

Employment growth and real wage growth boost household spending, relative to the baseline. Lower electricity prices faced by households further improve their purchasing power, allowing them to spend more on goods and services (or save more). Since household spending accounts for around 60% of expenditure GDP, this boost has a material impact on aggregate GDP.

FIGURE 5 FALL IN REAL INTERMEDIATE INPUT COSTS, SELECTED INDUSTRIES, % CHANGE FROM BASELINE

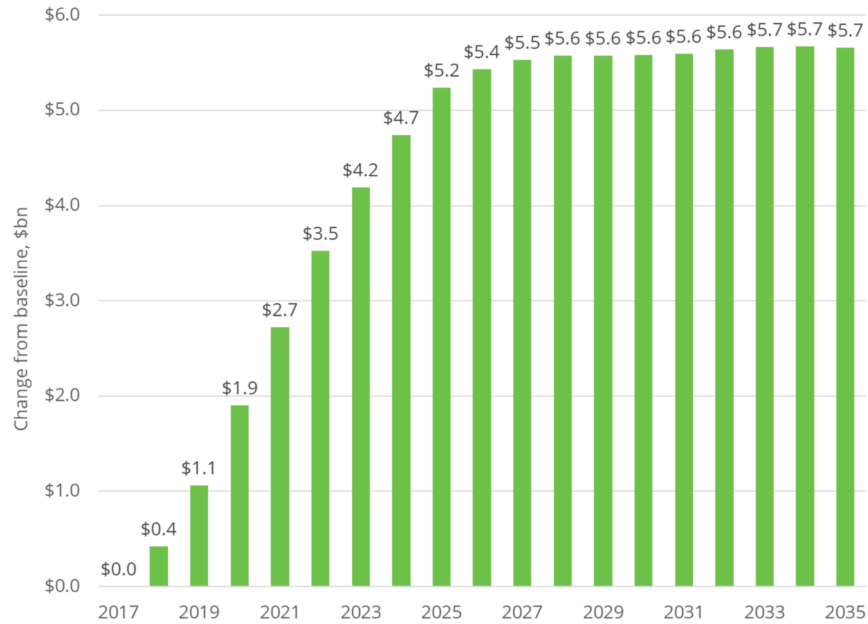


4.2. Macroeconomic impacts

The macroeconomic impacts of electricity prices being around 35% lower than occurred in practice over 2017-2025, based on the assumptions we chose on what could drive these prices lower, are shown in Figure 6.

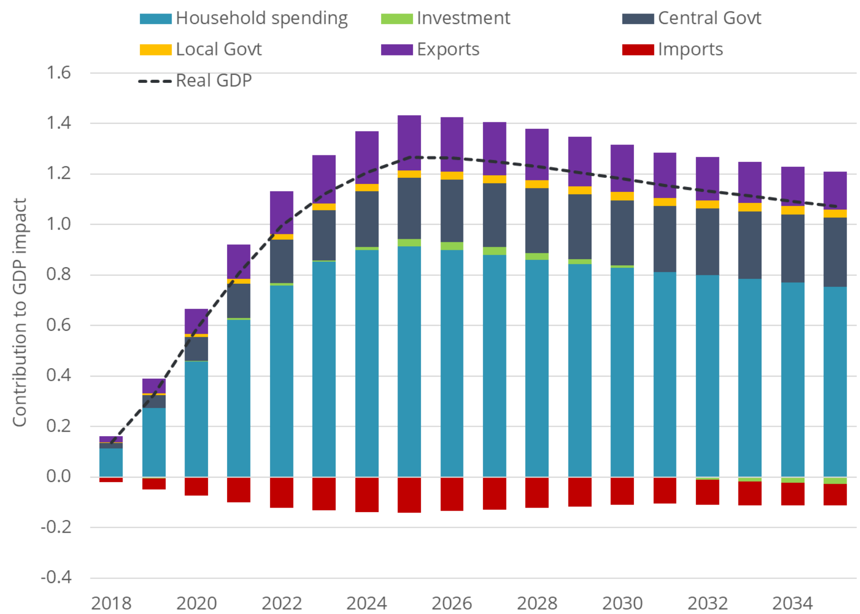
The **economy would have been around $5.2bn bigger by 2025**. The additional economic activity persists into the future past 2025 because of the net additional investment from expanding industries. This expands the capital stock, pushing up the productive capacity of the economy, relative to the baseline.

FIGURE 6 REAL GDP IMPACTS OF LOWER ELECTRICITY PRICES, CHANGE FROM BASELINE, $BN



As discussed above, the **GDP impact is driven primarily by additional household spending** as incomes rise due to job growth and real wage increases. Real GDP would have been around 1.6% higher in 2025 than occurred in reality if electricity prices were lower (black dotted line in Figure 7).

FIGURE 7 DECOMPOSITION OF MACROECONOMIC IMPACTS OF LOWER ELECTRICITY PRICES (REAL)



Material positive contributions to GDP growth also come from higher exports (as most exporters' cost base decreases, lifting their international competitiveness) and higher central government consumption (as tax revenue lifts).

Investment makes a small positive contribution initially as lower electricity prices improve the marginal revenue product of heavy electricity users, pushing up the rate of return on capital and incentivising more capital spending. Further out – when we stop applying productivity shocks past 2025 – investment comes back to baseline over time and makes a very small negative contribution.

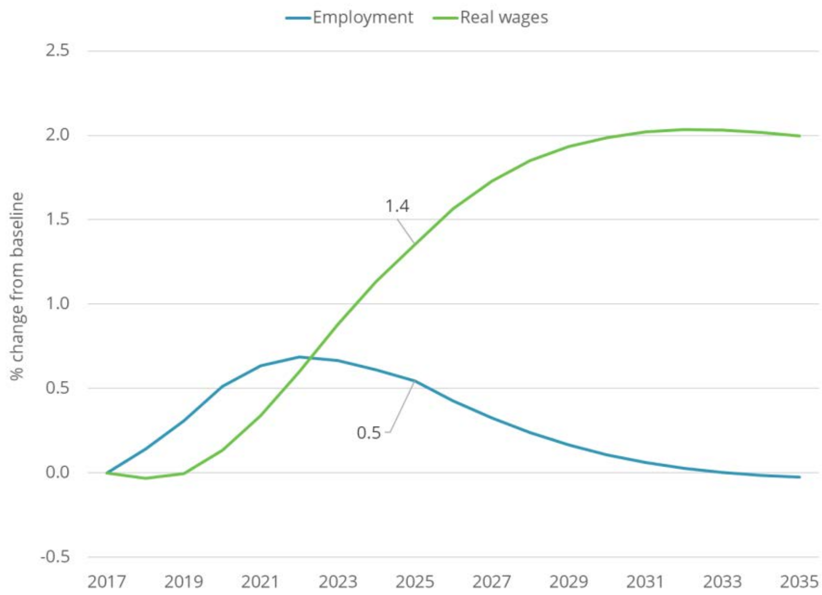
This can be interpreted as the economy's capital stock having expanded to meet additional demand in the 2017-2025 period but then holding steady and depreciating slightly as the economy returns to a steady state.

Price inflation, as felt by households at least, would have been around 0.7% lower than baseline by 2025.[28]

4.3. Labour market impacts

Economy-wide employment would have been 0.5% higher and real wages 1.4% higher in 2025 if electricity prices had been 35% lower than seen in practice, based on the modelling assumptions employed to drive prices lower (Figure 8).

FIGURE 8 LABOUR MARKET IMPACTS OF LOWER ELECTRICITY PRICES



[28] This doesn't mean CPI would have been 0.7pp lower, rather that the price of a basket of goods purchased by the average household would have been 0.7% lower – a moderate impact.

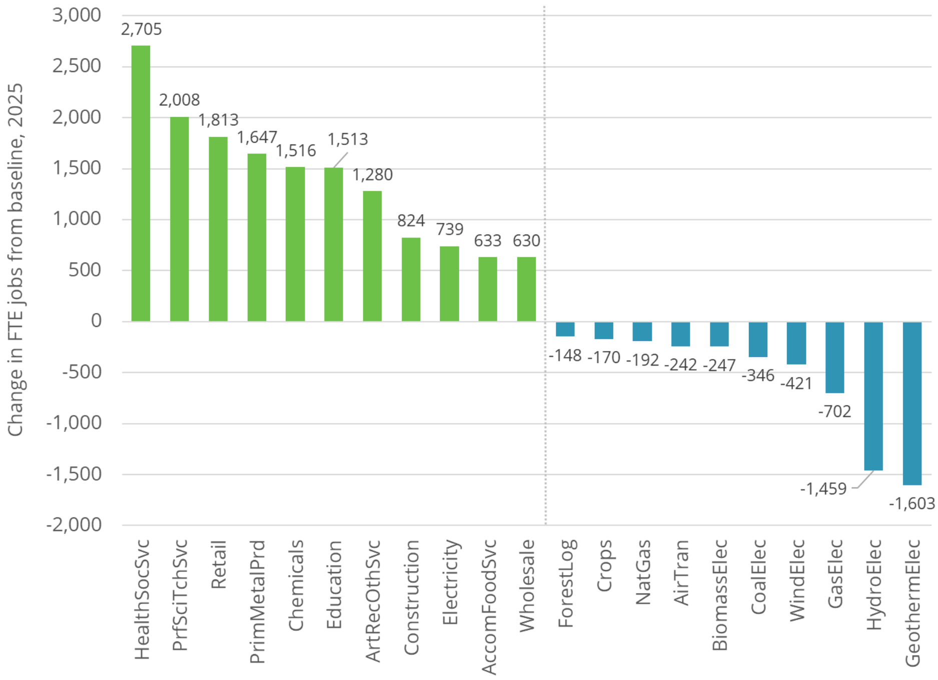
Figure 9 shows the change in the number of FTE jobs for the most affected industries, relative to the baseline in 2025. The biggest job gains come in the service sector, which employs around 70% of New Zealand's workforce:

- Professional, scientific and technical services jobs grow to provide inputs into the expanding manufacturing sector
- Health and social services and education jobs grow as government spending increases
- Retail jobs expand as households spend more.

In the goods-producing sector, jobs in primary metals production and chemicals production increase above baseline as lower electricity prices boosts output.

Jobs contract, relative to the baseline, in several electricity generation industries, along with air transport, crops and forestry (all labour-intensive and thus harder hit by higher real wage costs).

FIGURE 9 JOB IMPACTS, SELECTED INDUSTRIES, CHANGE IN FTE FROM BASELINE 2025



4.4. Industry impacts

4.4.1. What drives the industry GDP impacts?

When we impose the 'alternative history' policy scenario on the database between 2017 and 2025, the shocks drive down the aggregate electricity price relative to the baseline. This relative price shock causes the model to reallocate resources (land, labour, capital, energy, intermediate inputs) across industries in each year until it finds a new equilibrium.

The main drivers of industry impacts are:

i. The share of electricity in their cost base.

ii. Their upstream and downstream linkages to heavy users of electricity and/or exposure to household spending (which should rise as electricity prices drop).

iii. Their ability to substitute between factors of production and intermediate inputs, including energy.

iv. Their ability to substitute between energy (and energy-related) intermediate and non-energy intermediates.

v. Their technical ability to switch between different energy sources.[29]

4.5. Industry impacts

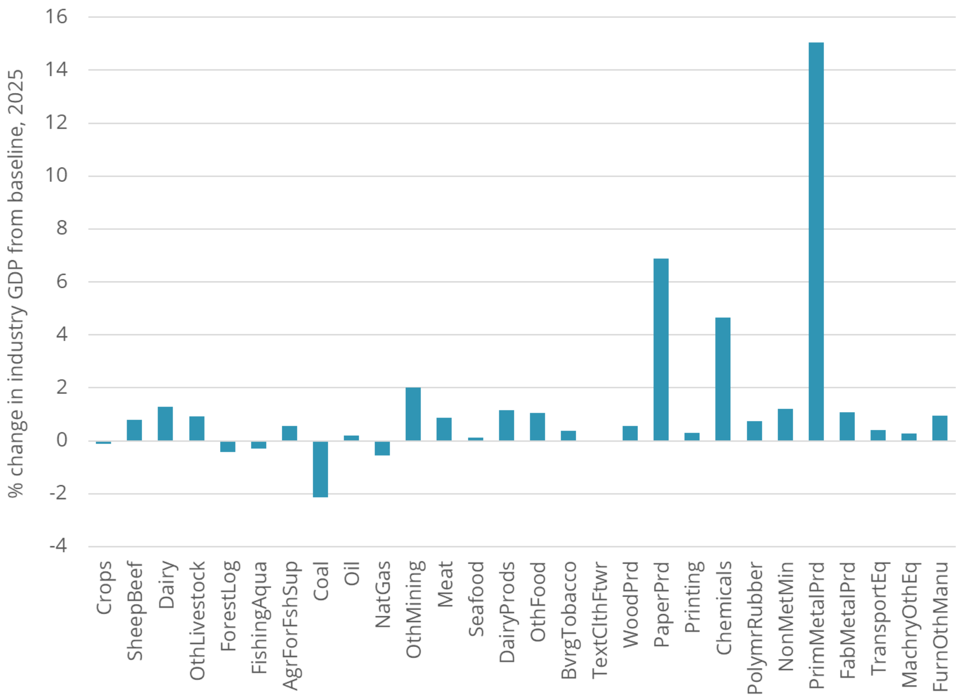
4.5.1. Goods-producing industry GDP impacts

The real GDP impacts from lower electricity prices in our hypothetical counterfactual scenario on goods-producing industries are shown in Figure 10. Key themes include:

- The primary sector sees minimal output changes as these industries are not particularly electricity-intensive.
- Coal mining output declines slightly relative to the baseline as resources – especially capital – are drawn into other expanding industries and the rental price of capital rises.
- The primary processing sector, including dairy, meat, seafood, other food processing, and beverage and tobacco manufacturing (mainly wine) all expand slightly as their energy costs fall. Their growth is curtailed by higher labour costs as real wages rise.
- In the energy-intensive industrial sector, the real GDP impacts from lower electricity prices are more noticeable. For example, if electricity prices had been 1/3 lower between 2017 and 2025:
    - Primary metals production (i.e. steel and aluminium) GDP would have been some 15% higher than otherwise by 2025
    - Paper products GDP would have been some 7% higher.
    - Chemical production GDP (including fertilisers) would have been around 4.8% higher.

[29] Due to the multi-nested CRESH production structure of industries in GSM-NZ, there is no single elasticity of demand or substitution for each industry with respect to electricity prices. See separate technical note for further explanation.

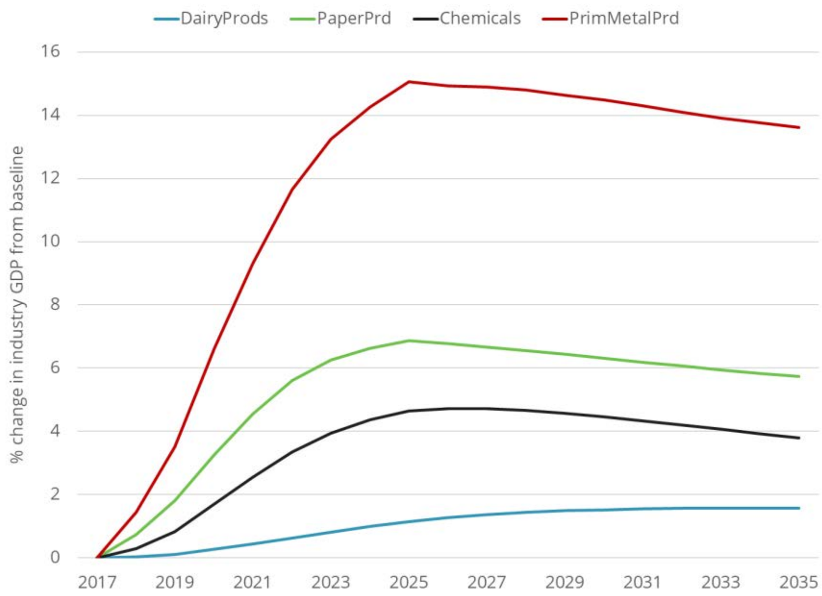
FIGURE 10 IMPACTS OF LOWER ELECTRICITY PRICES ON GOODS-PRODUCING INDUSTRIES, % CHANGE IN REAL INDUSTRY GDP FROM BASELINE IN 2025



Because lower electricity prices improve profitability (gross operating surplus) and marginal revenue product in these industries, there is higher investment in new capital between 2018 and 2025.

This means **the industry GDP impact of lower electricity prices persists over time** – these industries' capital stock is higher than would otherwise have been the case and their production expanded above baseline for many years beyond just the period of higher electricity prices (Figure 11).

FIGURE 11 INDUSTRY GDP IMPACTS – SELECTED MANUFACTURING INDUSTRIES, REAL, % CHANGE FROM BASELINE



4.5.2. Services sector industry GDP impacts

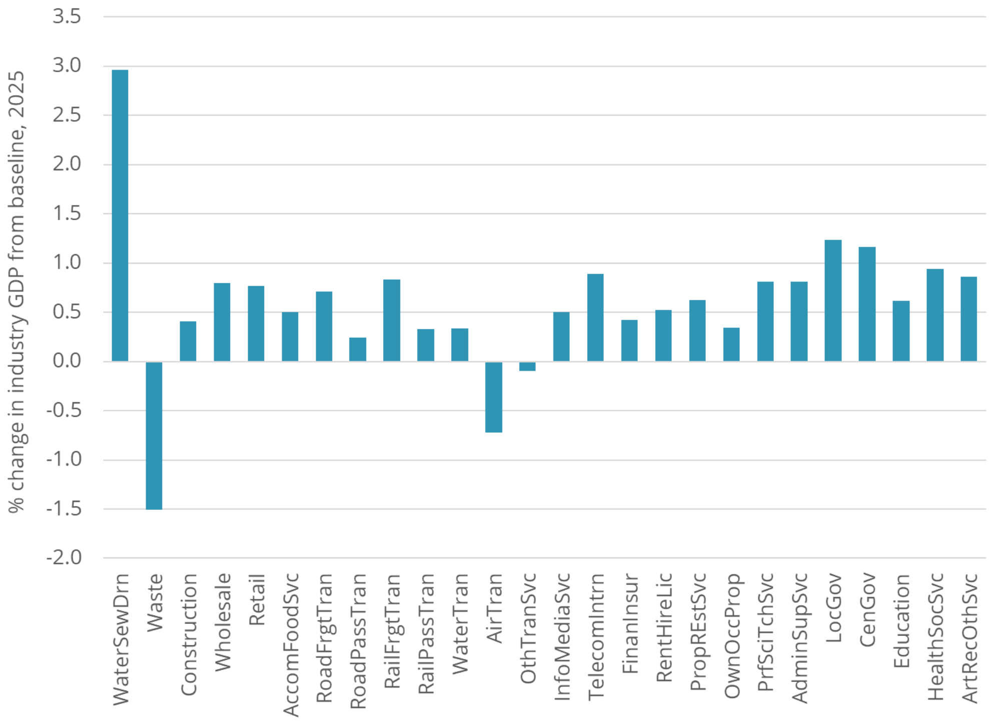
The chart below shows the 2025 services sector real GDP impacts, relative to the baseline, of the lower electricity prices we determined in our counterfactual scenario.

Key points to note:

- The scale on this chart is much shorter than in Figure 10 for goods producers. In general, the impacts of lower electricity prices on the services sector are relatively minimal – between 0-2%.
- While services industries do benefit from lower electricity prices, they tend to use less electricity per unit of output than goods producers. As such, their direct gains are proportionately lower.
- In addition, services industries tend to be more labour-intensive than goods producing industries. They face higher real wage costs as the economy grows faster than baseline, which limits their ability to expand.
- The services industries that benefit proportionately more include the freight sector (moving more goods to market), government services (as tax revenue increases) and some commercial services (which tend to grow in line with the broader economy). Water, sewage and drainage services expand as the heavy manufacturing sector grows above baseline, requiring more utilities services.
- Industries associated with tourism, such as air transport and accommodation and food services, grow relatively less, in part due to higher labour costs and in part due

to a higher exchange rate as goods producers expand their overseas sales, pushing up the NZD (see section 4.6).

FIGURE 12 IMPACTS OF LOWER ELECTRICITY PRICES ON SERVICES SECTOR, % CHANGE FROM BASELINE IN REAL INDUSTRY GDP, 2025



4.5.3. Energy sector impacts

As a result of the partial reversal of the dry year and reduced gas supply drivers of electricity prices in the counterfactual scenario, electricity generation increases substantially – by around 19% above baseline by 2025 (Figure 13). Electricity prices would have been some 35% lower than baseline by 2025.

That is, the electrification of the New Zealand economy would have happened faster than it did, based on the shocks incorporated into our counterfactual scenario and the way we designed them.

In the counterfactual scenario, there is a strong compositional shift in electricity generation to hydroelectricity. This is due to the productivity assumptions used to 'correct' for dry years. While we also shocked gas supply, which passed through to lower gas electricity costs and prices, it was not large enough to cause gas to displace hydro-generation.[30]

In addition, hydro accounts for a large share of generation in the baseline. In general in our modelling framework, when there is competition between industries to fill a demand gap the larger industries will tend to dominate.

FIGURE 13 ELECTRICITY PRODUCTION AND PRICES, % CHANGE FROM BASELINE, REAL

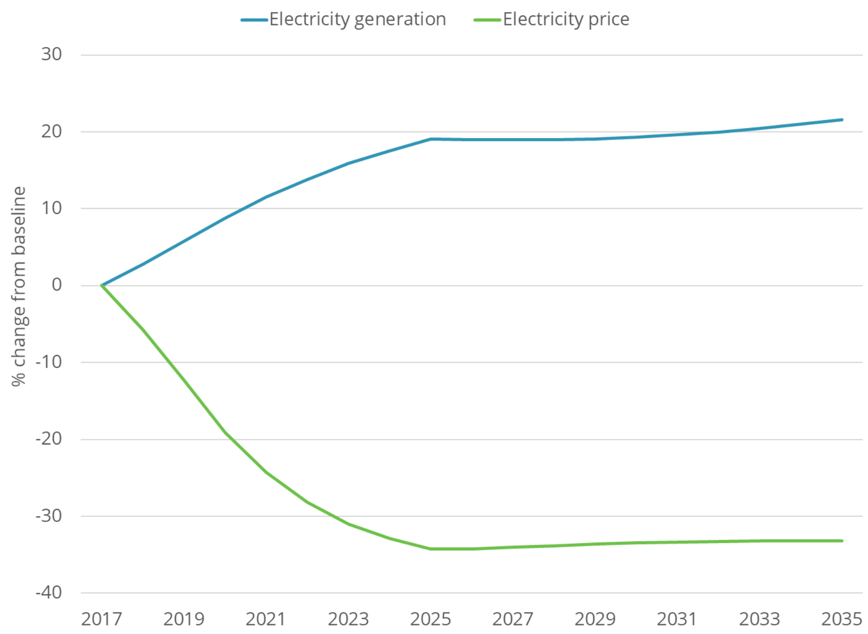
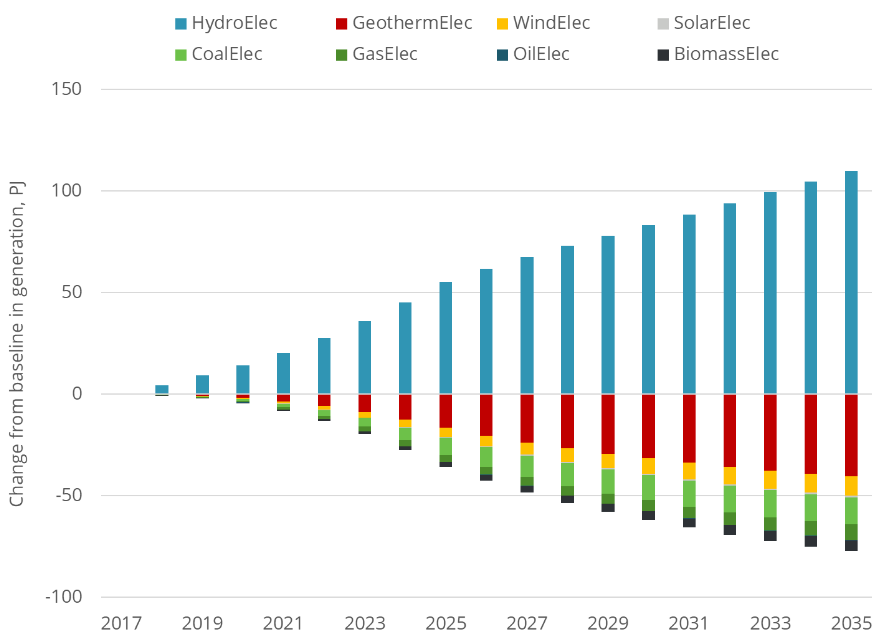


FIGURE 14 IMPACTS OF LOWER ELECTRICITY PRICES ON GENERATION BY TYPE, CHANGE IN PJ FROM BASELINE



4.6. Trade impacts

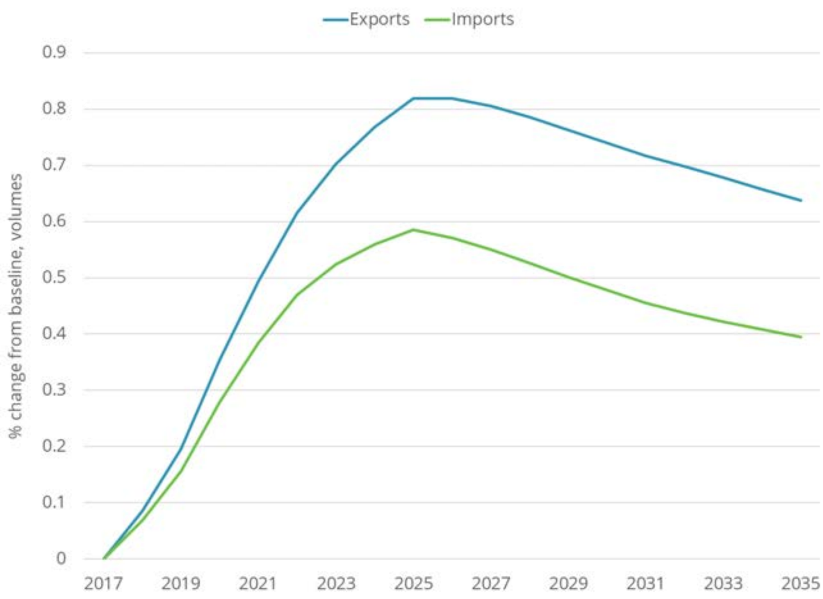
As electricity prices fall below baseline in our counterfactual scenario, **the international competitiveness of energy-intensive trade-exposed exporters increases.** This is because the electricity price shocks we are examining are New Zealand-specific and will not affect our competitors.

Exports would have been around 0.8% higher than baseline by 2025.

While imports would have grown faster too to meet higher household spending demand, they would have grown less than exports (around 0.6% above baseline by 2025). This is largely a function of our external closure assumption, which requires the balance of trade as a share of GDP to be the same as the baseline. GDP is higher in the counterfactual scenario, which means the balance of trade must also be proportionally larger (i.e. exports must grow faster than imports).

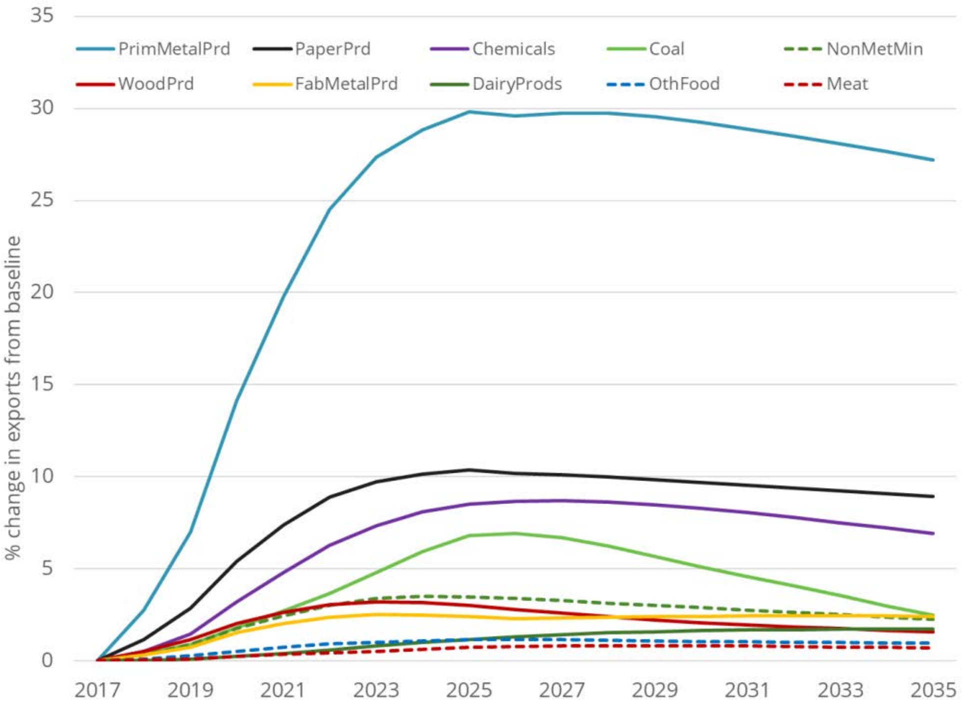
As a result, **the balance of trade would have been around $275m higher than baseline by 2025** if electricity prices hadn't been so high and were lower due to the assumptions in our scenario design.

FIGURE 15 GOODS AND SERVICES EXPORT AND IMPORT IMPACTS, % CHANGE FROM BASELINE, VOLUMES



In terms of industry exports, the lower electricity prices would have supported higher exports for many of the electricity-intensive heavy manufacturing industries (Figure 16), most notably primary metals production, paper products, chemicals and coal. The primary processing sector also benefits, albeit to a lesser extent.

FIGURE 16 EXPORT VOLUME IMPACTS, SELECTED INDUSTRIES, % CHANGE FROM BASELINE



5. Conclusion and implications

This CGE modelling exercise has sought to illustrate how the New Zealand economy and its industries might have fared between 2017 and 2025 if:

(i) Electricity prices were around 35% lower and gas prices around 20% lower than they were in practice; and

(ii) The reasons for lower electricity prices were due to higher primary factor productivity in the hydroelectricity and natural gas supply industries.

This is just one potential counterfactual scenario that we might have explored. Any number of 'alternative histories' could be conceived of. We make no claims here that our counterfactual scenario is the 'right' one. As such, our findings are indicative of what might have happened in a world where New Zealand's electricity and gas prices weren't so high historically.

Based on the assumptions we have made, and the modelling judgements we have exercised, our analysis suggests the following thematic findings:

- The New Zealand economy would have grown faster than it did, to the extent of 1.3% or $5.2bn of real GDP by 2025.
- Our heavy manufacturing industries would have seen stronger output growth than we saw between 2017-2025, especially primary metals production and paper products production.
- A faster-growing economy would have supported stronger employment growth and higher real wages, which in turn would have boosted household spending, by around 1.6% above baseline by 2025.
- New Zealand's trade performance would have been slightly better, driven by higher exports from industries whose international competitiveness improved as their cost base decreased when electricity and gas prices fell.
- Business investment would have been slightly higher than the actual outcomes witnessed. As per-unit costs fall due to lower electricity and gas prices, industry profitability increases, driving higher capital spending to support expansion.
- This additional investment would have expanded the national capital stock, lifting its productive capacity permanently above the baseline. As a result, lower electricity and gas prices would have had long-lasting positive economic impacts.

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