INFRATIL UPDATE SEPTEMBER 2018

The industrial revolution was an energy revolution. Replacing wood fires and the toil of humans and animals with energy from coal, oil and gas freed mankind to build the world we know today.

Coal succeeded wood as mankind's principal source of fuel in about 1900 when annual human carbon emissions amounted to approximately 2,000 million tonnes and CO_2 made up 296ppm of the atmosphere. Now annual emissions are 35,000 million tonnes and atmospheric CO_2 is 408ppm.

Now the goal of the 195 countries which have signed the 2016 Paris Agreement is to reduce emissions in the hope this reduces the risk of the planet warming and the climate becoming unstable.

INVESTING IN ELECTRICITY GENERATION

As the graph below shows, electricity businesses make up a large part of Infratil; based in New Zealand, Australia and the USA. They comprise some retail and ancillary services, but most of the value is in generation plant.

Given its materiality to Infratil, it's reasonable to ask about electricity generation as an investment. Globally the electricity industry is undergoing major changes which are disrupting value and creating uncertainty. There are also the personal experiences of consumers, which may well raise questions about what is happening commercially at the other end of the wire.

If you are a New Zealand resident, it's likely your business or household is paying less for electricity today than five years ago. Even over the last ten years, while government figures show a modest increase in the average annual household electricity bill, after stripping out higher GST, line charges, and consumer prices, what is paid to generators and retailers has fallen.

However, if you are an Australian reading this, it's likely your personal experience is different. As highlighted by the recent Australian Competition and Consumer Commission finding that "retail electricity prices have increased by 80 to 90 per cent (in real terms) in the past decade."

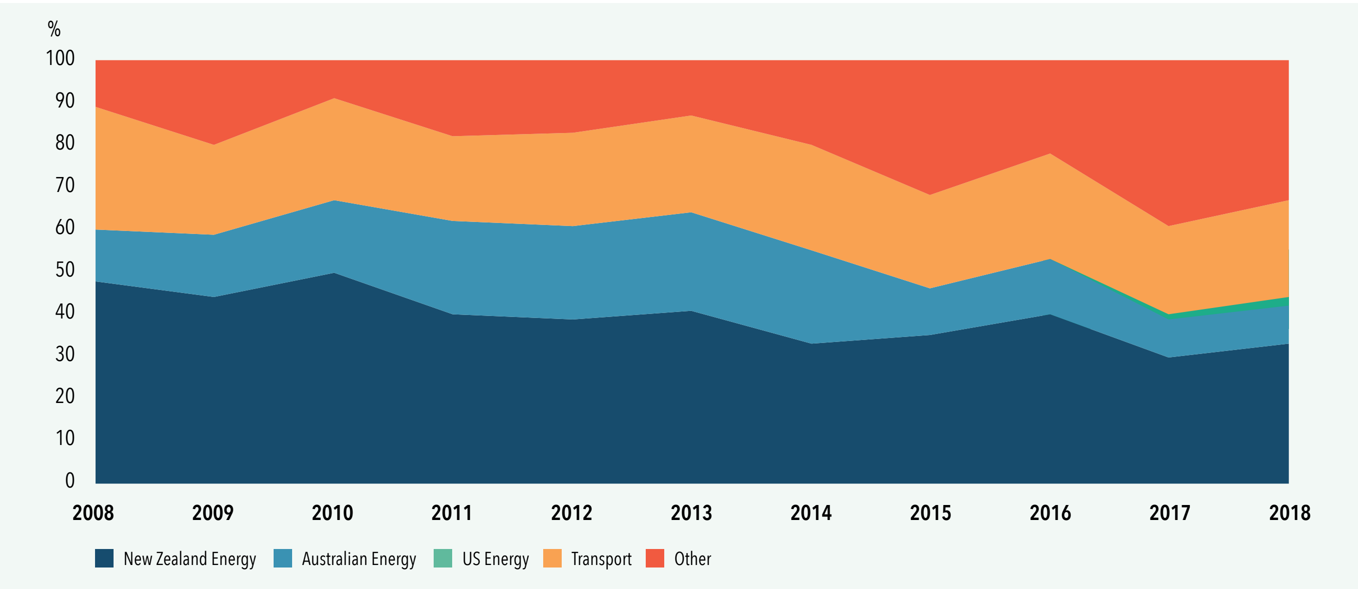
A UK resident is probably feeling the same as an Australian, while the US situation is different again as in many states wholesale prices have been driven down by falling renewables costs and lower gas prices. In the US it has been "merchant generators" (companies that generate electricity and sell into the wholesale market) which have suffered (many have entered bankruptcy) rather than consumers.

The divergent experiences illustrate the local character of countries' electricity industries and, as it happens, the costs regulators often impose on consumers and generators as they seek to reduce sector emissions and to define "solutions" for problems often created by other regulations.

In a report on the UK's cost of energy (published by the UK government last October) Professor Dieter Helm noted that "The cost of energy is too high, and higher than necessary to meet Climate Change targets. Households and businesses have not fully benefited from the falling costs of gas and coal, the rapidly falling costs of renewables, or from the efficiency gains to network and supply costs which come from smart technologies. [They] have not benefited [because] the scale of the multiple interventions in the electricity market is now so great that few, if any, could even list them all, and their interactions are poorly understood. Complexity is itself a major cause of rising costs, and tinkering with policies and regulations is unlikely to reduce costs. Indeed, each successive intervention layers on new costs and unintended consequences. It should be a central aim of government to radically simplify the interventions, and to get government back out of many of its current detailed roles."

But to return to the key question. Is generation a good investment for Infratil? The answer is equivocal. It may be (which of course also means it may not be too). This Update seeks to outline the pros and cons of investing in electricity generation, with a focus on New Zealand.

THE MAKE UP OF INFRATIL'S ASSETS



THE REAR VISION MIRROR (NEW ZEALAND)

In New Zealand, the last decade has been a relatively poor one for investors in generation and energy retailing. The one relevant company with activities entirely in New Zealand which has been listed through the whole period is Contact Energy. It experienced a 30% decline in its share price. Trustpower, benefitting from its Australian activities, now has almost the same share price as ten years ago (adjusted for the demerger of Tilt Renewables). Adding in the period's 16% lift in CPI, on the one hand, and dividends, on the other, gives a modest real return.

By way of comparison, shares in listed lines company Vector have risen 70%. Its return on capital is set by the Commerce Commission as opposed to reflecting the outcome of behaviour in competitive markets. Similarly, the unlisted national grid company Transpower conveyed 37,637GWh of electricity and charged $1,061 million in the year to 30 June 2017. A decade ago it conveyed 39,128GWh and had income of $591 million.

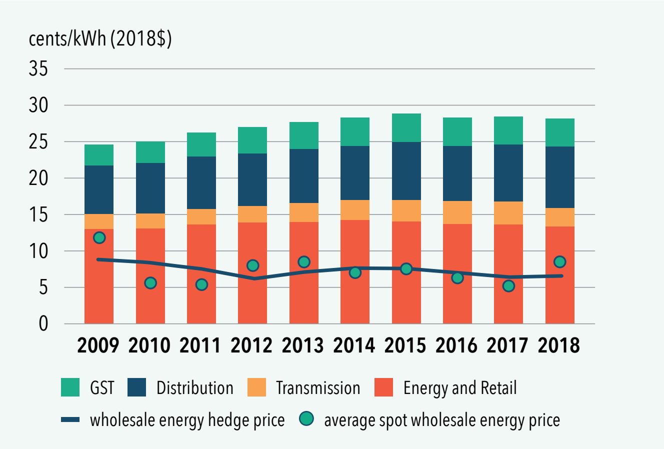
The generators have done poorly because weak demand resulted in over-supply which resulted in low wholesale energy prices and few opportunities to invest in growth.

Less electricity is being used because of better and more efficient insulation, appliances and equipment, and perhaps because winters are a little shorter and warmer. Lower demand depresses market prices.

The following graphs show the composition of the average annual household electricity bill, expressed as both price (cents per kWh) and dollars which takes account of price and quantity. Both are adjusted to take out the effect of consumer price changes. Also graphed are the real wholesale electricity price over the period, and New Zealand's electricity consumption since 1973 which shows the lack of growth over the last decade.

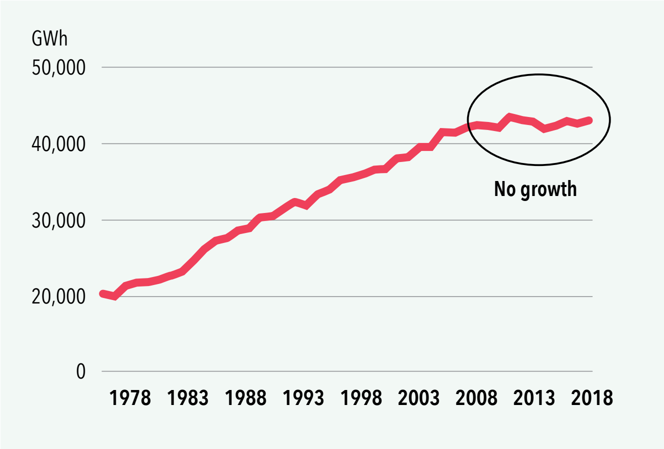
New Zealand electricity generators built capacity in anticipation of demand growth, which didn't occur. Between 1973 and 2008 there were 7 five year periods during which demand grew between 7% and 20%, averaging 13.5%. Over the following 2 five year periods (from 2008 to 2018), demand fell 0.2% before reviving 1.1%.

AVERAGE HOUSEHOLD ELECTRICITY PRICE BREAKDOWN



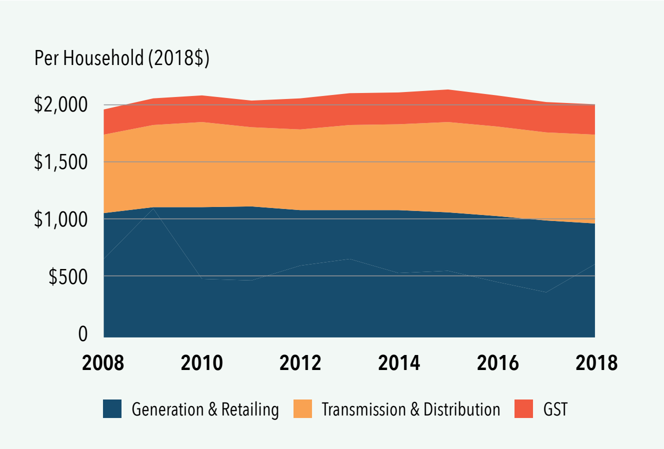
Morrison & Co

NEW ZEALAND ELECTRICITY DEMAND 1973 TO 2018



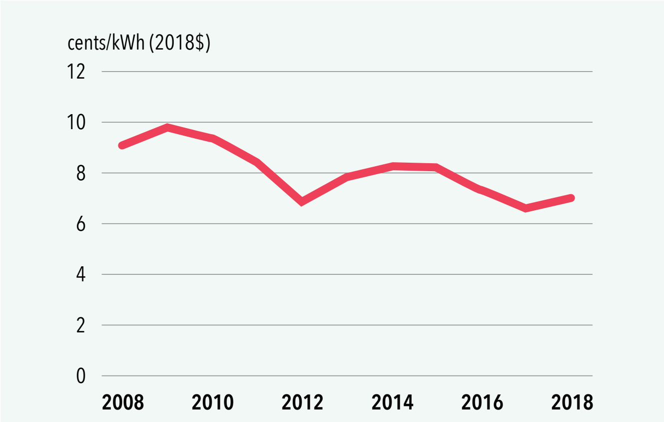
Ministry of Business, Innovation and Employment

AVERAGE HOUSEHOLD ELECTRICITY COST BREAKDOWN



Ministry of Business, Innovation and Employment

3 YEAR MOVING AVERAGE WHOLESALE ELECTRICITY PRICE



The average wholesale price of Trustpower's generation, in 2018 dollars, fell 22% over the decade. A stable price would have lifted the value of Trustpower's 2018 generation by about $37 million. The hedge market price fell 10% .

THE REAR VISION MIRROR (GLOBAL)

To quote the consultancy firm McKinsey (May 2018), "analysis of 50 major publicly listed utilities from Asia, Europe, and North America showed average total cumulative returns to shareholders of about 1% from July 2007 to July 2017, compared with 55% for the MSCI World Index." The poor returns of New Zealand generator-retailers were not unique. However, while low wholesale electricity prices were universally the culprit, different factors resulted in the low prices.

New Zealand generators built too much capacity because their forecasts of demand were optimistic. In many overseas markets too much capacity was built because of over-generous or badly structured renewable generation incentives.

An example of the scale of subsidy, and the distortion, was given by a Financial Times' columnist writing about his personal experience in the UK. In 2011 he purchased solar panels for his home for £12,800; encouraged by being able to sell for 43.3p (CPI adjusted to 2036) any electricity generated but not used in his home. What he generates and uses has halved his power bill and he receives an annual cheque of about £1,600 for what he generates and does not use.

Adding icing to the cake, he reported being approached by a broker offering to pay him £13,428 if he on-sold all the future subsidy payments. If he accepts that offer, he will end up with someone else maintaining his little roof-top power station, still having free power to the extent his household uses its generation, and a net £628 in the bank.

In addition to the distortions of such schemes, McKinsey also noted problems with badly structured regulation penalising generators and retailers and skewing the industry's revenue towards distribution companies.

Looking forward, McKinsey points to the need for investment returns to improve. They estimate that over the next decade US$7.2 trillion must be invested globally to ensure electricity supply keeps up with demand; which will only happen if positive returns are in prospect. (US$7.2 trillion is over 70 times the value of all New Zealand's listed companies and almost five times the value of all Australian listed companies.)

McKinsey's prescriptions for better returns are simple. Less disruptive regulation on the one hand, and for generators to transfer more electricity price-risk to consumers via long-term contracts, on the other hand.

LOOKING FORWARD

In New Zealand today there is ample supply - low prices - poor returns - no new build. This will change once demand growth revives, or old power stations are retired.

Today almost no new generation is under construction in New Zealand because the price of electricity is too low to encourage investment. There are few other barriers. A household with $5,000 can have photovoltaic generation installed on the roof and sell the output into the grid. At the other end of the spectrum, the five large generator-retailers each have access to hundreds of millions of dollars of investment capability and many fully-consented development sites. All that is holding back investment (small and big) is the low electricity price/value.

ELECTRICITY PRICES FROM HERE

Accurately forecasting electricity prices has proven to be difficult. Since 1997, Infratil has published nine Update newsletters which have addressed aspects of the New Zealand electricity market. Rereading them shows the challenge of making good forecasts (although they have been more accurate than those periodically released by government agencies).

The problem is the number of important variables. Over the last two decades electricity prices have been significantly influenced by less restrictive regulation, more competition, changes to fuel and plant economics, and fluctuating demand.

Looking forward, both demand and the cost of supply present uncertainties:

- Demand seems likely to depend on which path is taken to reduce New Zealand's CO_2 emissions. If every car is converted to battery-electric, national electricity demand would rise about 25%. On the other hand, closing New Zealand's aluminium, steel, and wood processing industries would also reduce emissions and would drop demand for electricity by about a quarter.
- The cost of generation, is a function of both the cost of different types of generation and the generation mix. For instance, wind and solar generation costs may fall, but if no gas-fired generation can be used to provide back-up to intermittent renewables (because of policies to stop CO_2 emissions) then the average price will probably rise.

As will be apparent, both demand and supply will be impacted by political decisions, especially with regards to the policies adopted to reduce New Zealand's CO_2 emissions.

REDUCING CO_2 EFFICIENTLY WITH LOW-COST ELECTRICITY

New Zealand requires investment in electricity generation to power its electric, low carbon, future. The investment will be more readily available, and the electricity will cost less, if government lets the market function.

The electricity generation industry is efficient at responding to price signals, it has the capacity to expand production to meet growing demand, and its ownership and competitive structure makes it likely that the lowest-cost projects will be the ones that get built.

To achieve Climate Change goals, New Zealand needs increased use of electricity and reduction in the use of motor spirits, gas and coal.

The cheaper electricity is, the lower will be the cost of the switch and the lower the need for direct subsidies, inducements and restrictions.

If the investors funding new electricity generation perceive a market operating without distortions or disruptive regulatory intervention they will price their capital accordingly. No single factor will be more influential in determining the electricity price required by new power stations than investors' required rate of return. The more government seeks to get involved or to change the rules around generation, the more reluctant will be investors to fund new power stations and the higher will be the cost of electricity.

Decarbonisation of the economy will be expensive. Any diversion of government's resources into electricity will mean less is available to assist those most adversely affected by the transition to lower emissions.

HOW MUCH HIGHER DO ELECTRICITY PRICES NEED TO BE (IF THE MARKET IS LEFT TO ITS OWN DEVICES)?

While little investment in new generation is now occurring, how high prices need to be before construction restarts depends on the economics of individual power stations, and the economics of the entire portfolio of power stations required to reliably provide the additional electricity.

To explain. A home with only photovoltaic panels will have an electricity cost that is based entirely on the economics of the photovoltaic panels, but it will have no electricity at night or when it's cloudy. Adding back-up for when the sun isn't shining means additional costs.

Each grid-connected consumer relies on many sources of electricity to ensure 24/7 supply and therefore their average electricity price reflects the economics of a portfolio of power stations.

Over recent years, there has not been a single day in New Zealand when hydro, wind, geothermal and gas-fired generation haven't all been used for at least some of the time. The relevance of this should not be understated, especially in the context of the industry's three paramount goals; efficiency (low cost), reliability (24/7 100% availability), and minimum emissions.

There have been suggestions that New Zealand's electricity industry should seek to use no gas or coal fired generation in a year of average hydrology. With current technology this goal is not compatible with low cost electricity that is reliable.

COMPARING TWO YEARS

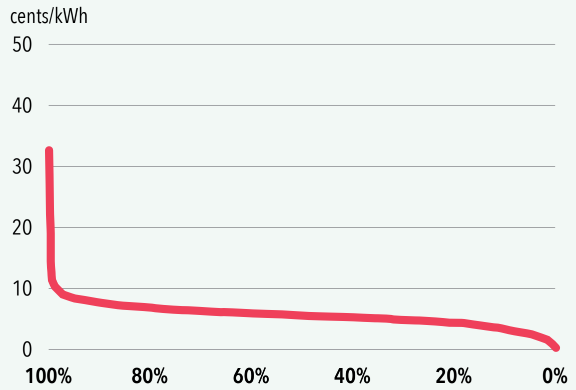
The years ended 31 March 2017 and 2018 provide a case study of generation economics and dynamics.

2017

NZ National Electricity Generation
42,531GWh (85.7% renewable)

Average Wholesale Electricity Price
5.65c/kWh

ELECTRICITY SPOT PRICES (AT OTAHUHU)



The price-duration curve graphed above ranks every one of the 17,520 half-hour prices that occurred over the year. It shows that (moving right to left) 20% of the time the price was below 4.3c/kWh and 50% of the time it was less than 5.3c/kWh.

The year was wet and windy, and renewables contributed 36,459GWh of generation. Oil, gas and coal fired generation was only required to produce 6,017GWh.

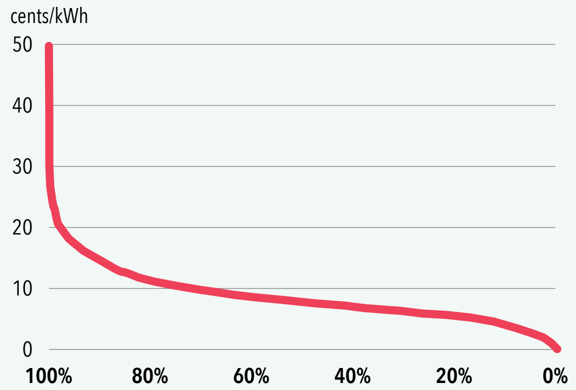
Generators will have earned approximately $2,400 million selling at the spot price. This is not entirely accurate as some hours see more generation than others which is not factored into the calculation, but it is a reasonable estimate.

2018

NZ National Electricity Generation
42,922GWh (80.8% renewable)

Average Wholesale Electricity Price
8.59c/kWh

ELECTRICITY SPOT PRICES (AT OTAHUHU)



FY2018's price-duration curve looks like its predecessor, but its numbers differ. 20% of the time the price was below 5.5c/kWh and 50% of the time they were below 7.7c/kWh.

A dry calm year saw renewable generation fall by 1,794GWh meaning that, with demand also rising, thermal generation was called on to produce 2,183GWh more than the prior year.

Approximate value of generation $3,700 million.

2017 and 2018 illustrate how the average cost of electricity reflects the cost of the whole portfolio of generation assets. The two years also show the need for back-ups and the different economics (i.e. cost) of different forms of generation.

Gas-fired peakers are typically used when there is insufficient wind and hydro available, and while we don't have the operational and financial details of such a power station over the two years, they can be illustrated.

Imagine a hypothetical 10MW gas-fired generator which cost 10c/kWh to operate (i.e. had a high variable cost). In 2017 that generator would have operated 116 hours producing net income of $162,000 (average price 27.8c/kWh, but for only 1.3% of the year). In 2018 the same generator would have been switched on 2,413 hours proving net income of $1,062,000 (average price 14.4c/kWh operating 27.5% of the year).

In the opposite corner to such high-cost, but controllable, thermal generation is wind which cannot be switched on to suit demand and hydro which has considerable variability of annual availability.

In 2017 Trustpower's hydro power stations generated (coincidentally) 2,017GWh and received an average wholesale price of 5.2c/kWh making the output worth $105 million. In 2018 Trustpower generated 2,238GWh at an average price of 8.8c/kWh, which made the output worth $197 million. Trustpower benefitted from having ample water in a year when others didn't and when prices were high.

Tilt Renewables' wind generation over the two years produced a different picture. Tilt sells all its New Zealand generation on fixed price contracts so in both years it received 6.3c/kWh. In 2017 it generated 744GWh worth $47 million and in 2018 it generated 571GWh worth $36 million.

New Zealand's portfolio of generation has a high reliance on renewables, which to ensure reliability at least-cost, creates a corresponding high reliance on back-up from gas plant.

FALLING COST AND FALLING VALUE

Reliable, lowest-cost, electricity requires a portfolio of generation which is mutually compatible and individually efficient. The optimal portfolio depends on the economics and availability of each generation unit and the pattern of demand. This means that an individual source of even very low cost electricity may not lower the market's average cost, and that a plant with a very low cost can still run at a loss because of the low value of the electricity it generates.

If New Zealand had a much higher proportion of wind generation it would lower the value of electricity when it was windy, but would require more back-up for when it wasn't. Whether the resulting average market electricity cost increased or reduced would depend on the relative impact of the cheap-wind and the expensive back-up. In either case, even if the wind-electricity was cheap to generate, that cost could still be less than the average value of electricity at the times it was being generated.

In Australia, government schemes supported wind generation, but when wind became a substantial share of generation in some states, reliability of supply became a problem and government stepped in to subsidise back-up sources of electricity. Electricity supply became less reliable, more expensive and required more subsidies because of unbalanced policies and investment.

The "low-cost and low-value" paradigm is explained at length in the recent book, Taming The Sun by Varun Sivaram. It notes that solar energy is a boon in developing markets where the alternative is no electricity or petrol generators, but not always a good proposition in developed markets. In California the marginal value of solar generation is low, even zero, while in Germany the scale of subsidies is absurd.

Graphs like those below are well known. The figures come from a well-regarded annual report produced by Lazard which shows generation costs in the USA.

The graphs show the electricity price a new plant requires if it is to cover operating costs and provide a satisfactory return on invested capital.

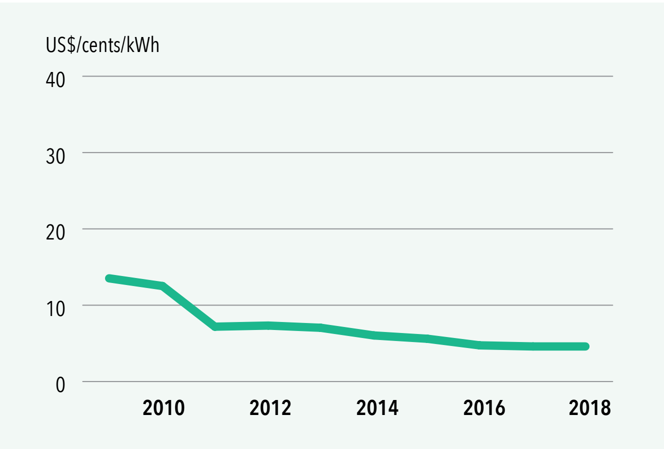
A New Zealand version of these curves would look different. New Zealand does not have the cloudless skies available in the best US solar locations. While part of the improvement to the economics of wind generation depicted in the graph relates to the development of plant suited to relatively low wind speeds. New Zealand has higher wind speeds so the cost reductions do not apply to the same extent.

However, while the breakeven cost of these sources of electricity have fallen in the USA, that's only part of the story, its also necessary to know what has happened to the value of the electricity being generated and to the average market price of electricity.

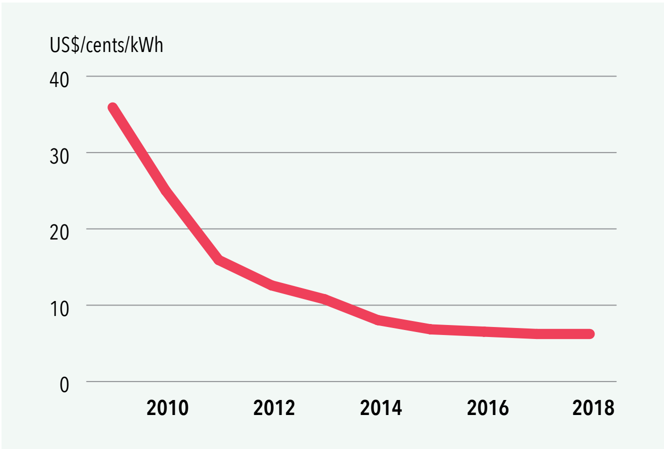
Berkeley Laboratories of California produced a fascinating piece of research on this topic. The graph over the page on the top left shows the increasing share of all California's electricity generation which comes from solar (the bars) and the average value of that generation as a proportion of the average market price (the line). In 2012 solar made up 2% of total Californian generation and, had it been sold at spot prices, would have received an average US$ 3.8c/kWh which was 126% of the average electricity price that year. In 2017 solar made up 16% of generation worth an average US$ 2.5c/kWh which was only 79% of the average market electricity price.

The graph over the page on the top right shows the average California market price of solar electricity (as derived by Berkeley Lab) and the Lazard estimated breakeven electricity price required by new plant. There are two things to note, the value of solar generation in California is falling faster than the cost, and the value has been consistently below the cost. Notwithstanding this, solar generation has, and is, being built in California thanks largely to generous subsidies.

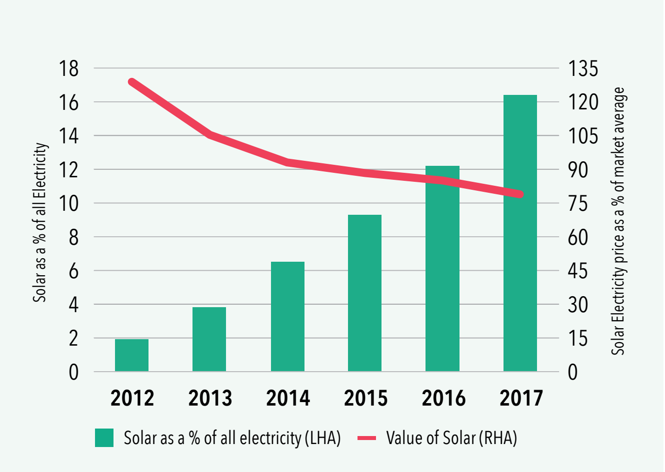
THE COST OF US WIND GENERATION



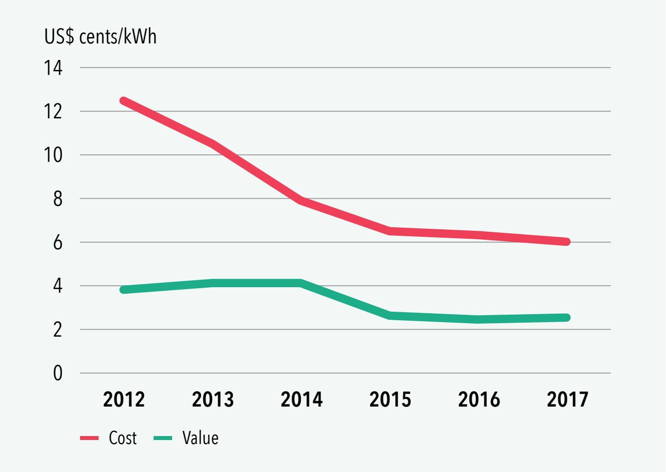
THE COST OF US SOLAR GENERATION



CALIFORNIA SOLAR ELECTRICITY



THE COST AND VALUE OF SOLAR ELECTRICITY (CALIFORNIA)



STORAGE. THE BIGGEST PROBLEM

The average electricity price consumers face depends on the portfolio of generation required to provide 24/7 availability with 100% reliability.

As shown in the below graph on the right, on an average day, national New Zealand demand can fluctuate between 3,000MW and 7,000MW. The left-hand graph shows weekly and seasonal patterns and how one year varies from another. The graphs show the fluctuations and irregularities of demand, which is only half the story as wind and hydro power stations have their own irregularities.

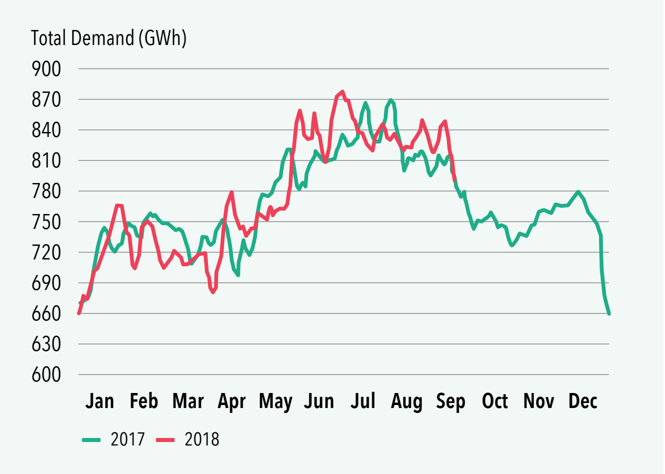
There are two relevant ways to store energy for peaks in demand and for when some power stations are unavailable: coal/gas/oil and water. New Zealand uses both and needs both.

The touted alternative, batteries, are currently irrelevant. They store little and cost lots. The most efficient battery costs over $300 per kWh of storage.

In other words, to store sufficient electricity to power ten 100 watt lightbulbs for 1 hour costs at least $300. The average household uses about 7,000kWh a year so to store one household's annual electricity needs would cost $2,100,000. Another way of looking at it is that the water stored in Lake Pukaki alone can generate 1,595GWh of electricity (about 4% of national annual consumption). To replicate that amount of storage in a battery would cost $480,000,000,000 ($480 billion).

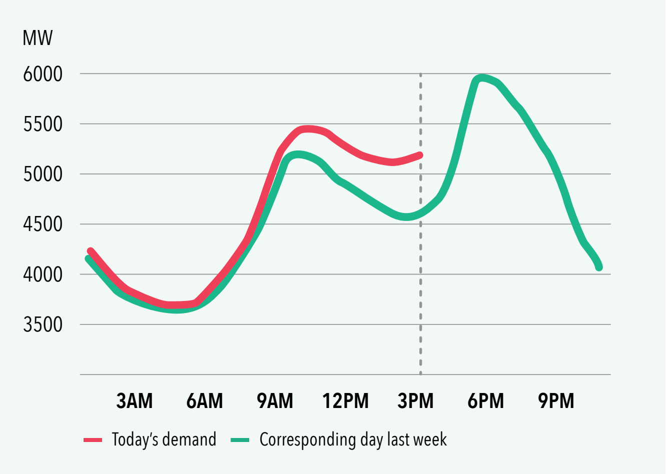
Batteries are fine on Great Barrier Island which has no mains power, and they may be viable in special situations where transmission assets are very expensive and there are short gaps in the availability of grid power, but not usually. Of course it is possible that the research now being directed at battery storage improves their viability, also once electric cars are prevalent their batteries may be available to store energy for more uses than just powering the vehicle.

NEW ZEALAND ELECTRICITY DEMAND (ROLLING 7 DAYS)



Transpower

TOTAL NEW ZEALAND DEMAND (1 JULY 2018)



EM6Live

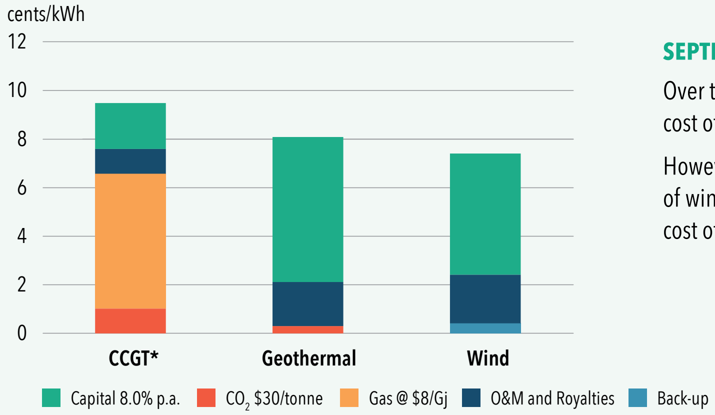
THE COST OF NEW PLANT IS (MOSTLY) FALLING

Although the previous sections have focussed on the portfolio of generation required to provide 24/7 reliability, the average cost of generating electricity (and therefore the price to consumers) depends on the cost of the individual sources of generation as well as their individual contributions.

The following set of graphs show Morrison & Co's current and historic calculations of the breakeven economics for the three types of power stations which are most relevant for New Zealand.

The graphs show the electricity prices required in dollars of the day. To better reflect the changes in plant economics they would be adjusted to reflect that the CPI has risen 9% since March 2011 and 4.5% since December 2015. Consequently, while the graphs show a 20% drop in the break-even price required by wind over the seven years, in real terms it's 28% lower.

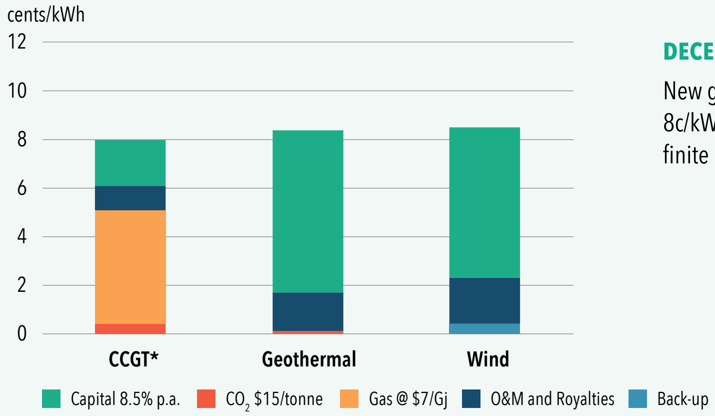
Also provided are the key costs, both to show what has changed over the seven years, and the relevance of the cost of capital. While the largest cost of a gas-fired power station is from fuel the main cost of a wind farm relates to the money used to build it.



SEPTEMBER 2018

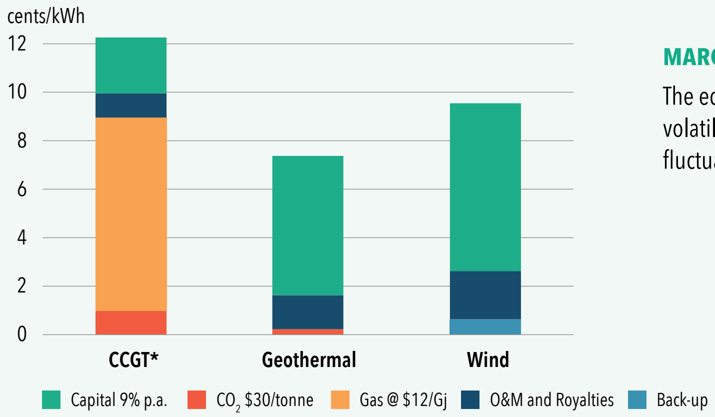
Over the seven years, wind has been the winner thanks to a lower cost of capital and lower plant costs.

However, if the NZ$/US$ were to fall to 60 cents the break-even cost of wind generation would be back to 8c/kWh. While a 1% hike in the cost of capital would add about 1c/kWh to the break-even price.



DECEMBER 2015

New geothermal electricity has remained anchored at about 8c/kWh. But access to suitable geothermal liquids is probably finite making this source of electricity also limited.



MARCH 2011

The economics of gas-fired generation has shown the most volatility thanks to big changes in local gas prices and fluctuations in emission costs.

* Combined Cycle Gas Turbine

CARBON

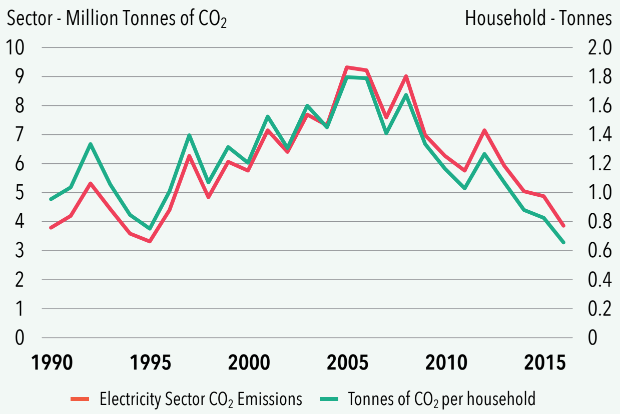
As the graphs in the previous section show, the price of carbon emissions matters for gas-fired and, to a lesser extent, geothermal generation.

But as shown in the comparison between the generation in 2017 and 2018, gas/coal fired generation is a small part of the total, and likely to become smaller. A higher carbon price will make some generation more expensive, but the overall price impact will be muted. The cost of gas fuel may be more material than the cost of CO_2 emissions.

In 2016 (the year of the most up to date data) generating the electricity consumed by the average household produced 0.66 tonnes of CO_2 a cost of $16.60 for the year (plus GST) at an emission price of $25/tonne.

It is likely that the electricity sector's carbon emissions will continue to fall absolutely and per unit of total generation and the price of emissions will have little bearing on the average electricity price. There have been suggestions that electricity generation in New Zealand should be placed on a path towards zero emissions by 2030 (drought and low hydro generation being extenuating circumstances). This is not a practical goal and would make it impossible to achieve the largest possible national emission reduction for the least cost.

Gas-fired generation is an important source of back-up for intermittent renewables and if it can't be used in that capacity, the cost of electricity will rise a lot (unless reliability is sacrificed). High-priced, unreliable, electricity will make it much harder to encourage people to get out of petrol cars into electric ones as well as to make the other changes sought to lower national emissions.



The electricity industry has significantly decarbonised over the last decade. The CO_2 emissions produced in providing an average household with its annual electricity requirements has fallen 63%. Sector emissions caused by burning coal, gas and oil have fallen 66%.

Total sector emissions include those from geothermal generation.

THE AVAILABILITY OF CAPITAL

Before commenting on electricity demand (more briefly than the commentary on the price of supply) it's worth drawing attention to research undertaken by analysts at UBS. They estimated that New Zealand's big-five generators are now spending about $180 million a year to keep their generation plant going, but that over the longer term about $490 million a year will be required to maintain current generation levels. They also note that if generation output was required to grow by 1% per annum investment of an additional $230 million a year would be necessary.

If annual investment in electricity generation has to rise from $180 million to $720 million, the capital will presumably have to come from a mixture of additional debt, equity and higher sector earnings. An average price rise of 1c/kWh would, for instance, provide generators with about $300 million per annum of cash after tax. But whether funds are internally generated or provided by investors and lenders, capital will only be allocated on the prospect of a satisfactory return.

The table summarises UBS's figures of the cash flows of the five main generators for their most recent financial years.

$ Millions	Mercury	Genesis	Contact	Meridian	Trustpower
Total EBITDAF *	$556	$358	$484	$682	$243
NZ Generation EBITDAF*	$334	$197	$339	$512	$183
Interest	($96)	($73)	($84)	($81)	($32)
Tax	($78)	($29)	($100)	($87)	($45)
Operating cash flow	$382	$256	$300	$514	$166
Dividends	($272)	($168)	($200)	($492)	($110)
Remaining funds	$110	$88	$100	$22	$56
Capex	($118)	($87)	($75)	($58)	($17)

* Earnings before interest, tax, depreciation and amortisations; a proxy for net operating cash flow. The five companies also have earnings from activities unrelated to New Zealand generation.

As noted, the difference between the capital now being allocated to generation and what is required to maintain current levels of output was estimated by UBS to be approximately $310 million a year. The current level of capital spending will keep existing power stations ticking over, but at some point, replacement not just refurbishment is required.

UBS did note that hydro power station dams can have exceptionally long lives; pointing to a dam built by Egyptian pharaoh Sethi in about 1285BC as still functioning after 3,300 years. Unfortunately, it is in Syria so evidence as to this assertion is scant. The oldest hydro power station operating in New Zealand is Trustpower's Waipori which started generating in 1907.

IN SUMMARY

Over the last decade electricity demand in New Zealand has been flat, and because the industry built in anticipation of demand rising, excess supply resulted in weak prices and poor returns on invested capital.

If demand increases it will remove excess supply and require investment in capacity. To increase national generation output by 1% per annum will require over $500 million of additional capital each year. This will only be forthcoming if prospective returns are satisfactory, which almost certainly requires higher wholesale electricity prices.

It is however difficult to forecast the required price level as it depends on both generation technology, financial market variables, and the operation and regulation of the electricity market. If there are no dramatic changes to these factors, the likely future price range will be 8-9c/kWh. The average of the last five years was about 7.1c/kWh.

While technology, finance, and regulations will each contribute to future electricity prices, the suite of policies adopted to reduce CO_2 emission will be important. The more policy makers rely on direct initiatives such as regulating the use of gas-fired generation rather than on placing a price on CO_2, the higher will be the cost of electricity.

DEMAND

In the five years to 2004 New Zealand electricity consumption grew on average by 967GWh per annum. This was then followed by nine years where annual consumption increased only 49GWh, and then by four years during which average increases were 281GWh. This century the average increase so far has been 0.2% per annum.

The policy initiatives now being developed to decarbonise the New Zealand economy will require individuals and industries to shift from coal/gas/oil to electricity. But estimating the scale of additional generation required is more guess than forecast.

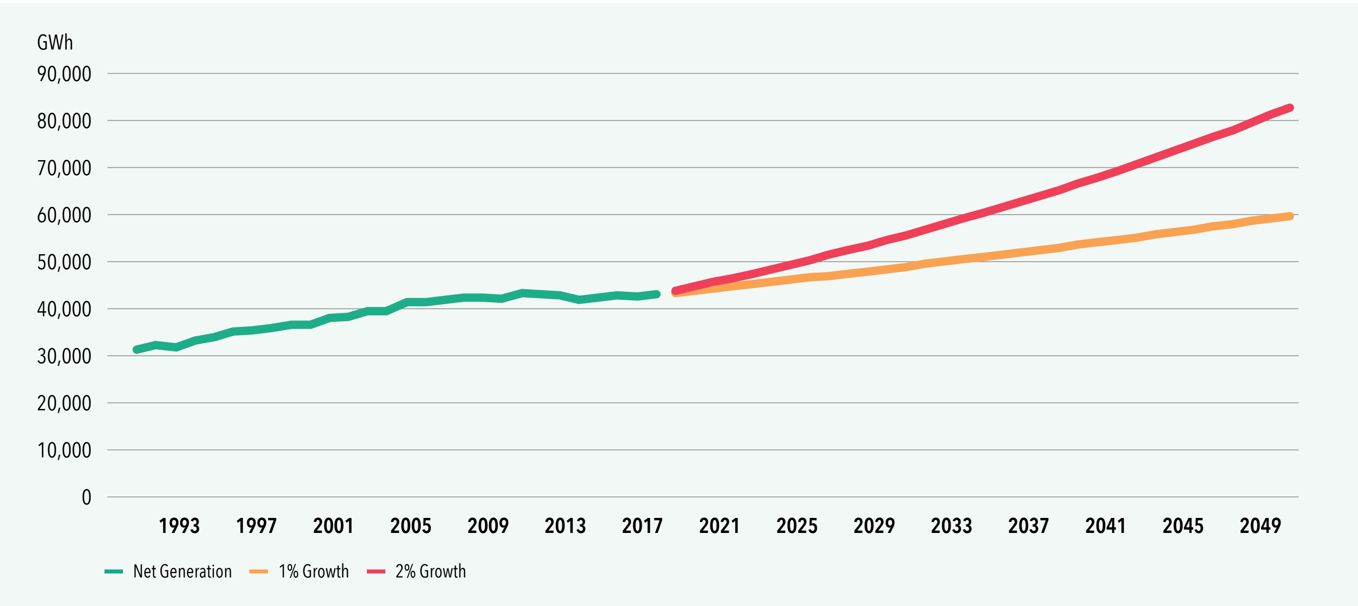
Most estimates of the growth required is in the 1-2% per annum range which over the next three decades amounts to an average annual increase of 500GWh to 1,200GWh.

While the growth estimates are plausible, conviction seems to be lacking as no construction of significant new generation capacity is actually happening.

Impediments to reliable estimates of future electricity demand include uncertainty about government climate change policies and uncertainty about the cost of switching from CO_2 fuels to electricity.

Disconcertingly, Transpower the national grid, has shown that decarbonisation and no electricity demand growth could both occur if the economy shrinks by 3% per annum. Which is hopefully not what happens.

NEW ZEALAND GENERATION

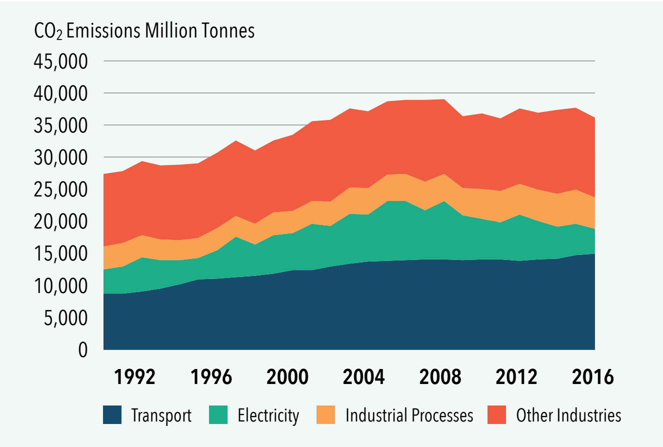


GOVERNMENT POLICIES TO DECARBONISE THE ECONOMY

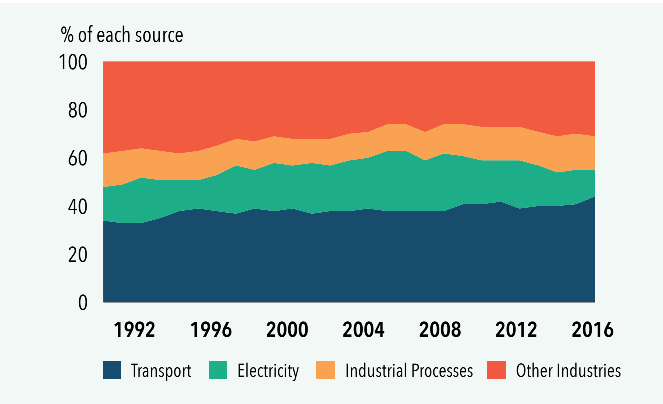
Leaving out agriculture, waste, and the land sectors (emissions and sequestration), New Zealand's emission profile over the 26 years since 1990 is as depicted in the following graphs. Over that period, the annual CO_2 emissions of the energy, transport and industrial sectors rose from 27.4 million tonnes to 36.2 million tonnes, with 71% of the increase coming from transport.

A raft of policies are now being developed to reduce these emissions, but it will take years before there is clarity about how they work. De-carbonising New Zealand industry and transport could involve transitioning motorists and manufacturers from oil/gas/coal to using electricity, or it could involve closing New Zealand's aluminium, steel, wood processing (and other) industries and banning cars.

NZ CO_2 EMISSIONS: TRANSPORT, ELECTRICITY, INDUSTRIAL



THE % OF CO_2 EMISSIONS: TRANSPORT, ELECTRICITY, INDUSTRIAL



THE COST OF SWITCHING

A price on CO_2 emissions will encourage motorists, manufacturers and households to switch from coal/gas/oil to electricity. But at present there is little more than guesses as to where switching will occur between $25 and $250 per tonne of CO_2.

- When Nissan first offered its all-electric Leaf in New Zealand it didn't sell, probably because the cost was over $50,000 which was $25,000 more than a comparable petrol vehicle. However now there is good take up of second-hand Leafs imported from Japan.

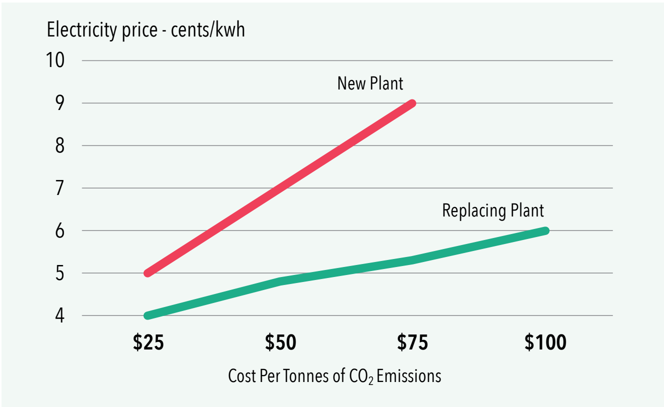
  It seems that people will take a punt if the car costs less than $20,000 (even if it is still more expensive than a petrol equivalent). They will now be learning how electric cars compare to petrol ones with regards to range, maintenance, comfort, safety, reliability, resale, fuel cost, road-user charges, and so on.

  With approaching 10,000 electric vehicles on New Zealand roads, the knowledge base will be growing quickly. But it will still be some time before it is possible to anticipate what difference CO_2 prices make. Few people will switch from petrol to electric just because of higher priced fuel. They need information about all the factors which determines a vehicle's suitability.

- Recently, milk processing/marketing company Synlait announced the construction of an electric milk dryer rather than one using gas or coal to provide heat. First NZ Capital analysed Synlait's decision; looking at the relative costs of coal and electric plant and fuel. They also estimated what it would take for Synlait (and other milk processing companies) to replace existing coal plant with the electric equivalent.

  The graph below shows First NZ Capital's estimated "indifference curve". Where they feel someone looking to dry milk will be indifferent between using coal or electricity. The calculations are loose, but they illustrate the relationship between the cost of electricity and the cost of emissions.

COAL VS ELECTRIC PRICE INDIFFERENCE
ELECTRICITY PRICES - EMISSION COSTS



The position of the lines reflects a particular set of costs; for plant, coal and capital. As those variables change so too will the break-even "indifference" line.

If the price of electricity is very low, then even a low emission price will make electric milk drying cheaper than using coal. But as the cost of electricity rises, so too must the cost of coal's emissions if electricity is to remain viable.

The graph shows that 8c/kWh electricity requires a CO_2 price of about $65/tonne for new investment to be directed into electric rather than coal powered milk drying.

The "replacement plant" line indicates that at 8c/kWh an extremely high CO_2 price would be required before Synlait or Fonterra would replace existing plant.

Synlait requires high temperature boilers to dry milk, many other situations will have economics that are more attractive, for instance heat pumps.

Over time, motorists, manufacturers, and households will do versions of the above analysis as they look to buy vehicles, plant, equipment and home appliances. Because the price of energy and emissions are only two of many variables the relationship will change over time, but as Synlait's choice shows, the cost of emissions has become a factor influencing investment decisions.

THE FINISH LINE: WHAT RETURNS CAN BE ANTICIPATED FROM INVESTING IN ELECTRICITY GENERATION IN NEW ZEALAND?

It is reasonable to be positive, but there are risks. The positive future looks thus:

- Electricity demand rises as motorists, manufacturers, and households switch from coal/oil/gas to electricity and economic growth is maintained.
- Investors and lenders are encouraged by low regulatory risks to provide the investment necessary to deliver increased electricity output.
- Electricity prices rise modestly to underpin returns.

A benign picture of a growth sector with investment opportunities and satisfactory returns.

However, there are risks:

- If government imposes distortionary policies or goals, such as "zero electricity sector emission by 2030", it will increase the risks for investors and hence required returns.
- Higher required investment returns will raise the cost of electricity, which means that stronger measures will be required to reduce CO_2 emissions.
- Leading to an increased potential for emission reductions to come from industrial closures, restrictions and declining economic activities.

Fortunately, the "benign picture" is simple and obvious. While the Update started by noting the experience of zealous and misdirected regulators in other countries, there is no reason to anticipate those errors being made in New Zealand.

COMPARING POWER BILLS

We asked friends and relatives in a number of cities to send us copies of their most recent electricity bills. They make interesting reading, if only to illustrate the range of outcomes possible. Some of the price differences reflect different fuel costs, but many are due to regulatory differences.

Wellington: Grey Power Electricity
31 days 660kWh $164.06 (pre GST) 24.9cents/kWh

	Cost	Cents/kWh
Energy	$53.61	8.1
Distribution	$81.03	12.3
Retail & metering	$28.68	4.3
Govt levy	$0.72	0.1
GST	$24.61	3.7

Melbourne: Citipower (exchange rate NZ$/A$ 0.90)
74 days 1,641kWh $373.12 (pre GST) 22.7cents/kWh

	Cost	Cents/kWh
Everything	$373.12	22.7
GST	$37.31	2.3

San Francisco (PG&E) (exchange rate NZ$/US$ 0.70)
34 days 759kWh $301.72 39.8cents/kWh

	Cost	Cents/kWh
Energy	$116.89	15.4
Distribution	$128.20	16.9
Govt levy	$56.63	7.5

New York (Consolidated Edison) (exchange rate NZ$/US$ 0.70)
32 days 259kWh $108.69 42.0cents/kWh

	Cost	Cents/kWh
Energy	$35.33	13.6
Distribution	$43.69	16.9
Retailer costs	$27.27	10.5
Clean energy levy	$2.51	1.0
Tax	$9.69	3.7

Berlin: LichtBlick (exchange rate NZ$/Euro 0.58)
365 days* 2,036kWh €955.57 (pre GST) 46.9cents/kWh

	Cost	Cents/kWh
Energy	$458.05	22.5
Distribution	$57.52	2.8
Metering	$14.41	0.7
Renewable & other levies	$425.59	20.9
VAT	$181.55	8.9

* Consumption and cost is assessed annually and billed monthly

Surrey, England: Co-op Energy (Exchange rate NZ$/GBP 0.52)
129 days 1,619kWh $552.08 (pre VAT) 34.1cents/kWh

	Cost	Cents/kWh
Energy	$451.70	27.9
Distribution	$100.38	6.2
VAT	$25.97	1.6


NEW YORK
Infratil