energy nz

EPS plastics

Energy and emissions pricing

EECA

DECARBONISATION PATHWAY

EPS PLASTICS

Energy pricing

Different energy sources vary in price and also have different responses to changes in market conditions. The four main energy sources applicable to EPS manufacturing in New Zealand are:

- Electricity
- Natural Gas
- Liquefied Petroleum Gas (LPG)
- Diesel

Electricity is the core energy supply to a manufacturing site, being critical to operation of all process systems, including those that actually use fuels as the source of thermal energy. Electricity itself can also be used to generate thermal energy for process heating, although this has typically been avoided in the past for anything other than small-scale heating due to the relatively high price of electrical energy compared to fossil fuels.

For smaller and some medium-sized electricity users, electricity pricing is simple and typically very stable. For medium and larger users, it is more complex and variable, but can be cheaper depending on how and when it is used. A general electrical energy price of **$0.20 /kWh** is used for comparison with other energy sources. When considering the cost of electricity, however, it is important to note that the conversion of electrical energy to useful thermal energy (steam) is nearly 100% efficient. For low-temperature applications where a heat pump can be used, it is even possible to deliver multiple units of thermal energy for each unit of electricity purchased.

Natural gas has been the default thermal fuel throughout most of the North Island for decades, due to its low cost, clean-burning characteristics and ready on-demand availability via pipeline. Its main limitation has historically been access to it — piped natural gas has never been supplied to the South Island, and does not extend to most remote parts of the North Island. Aside from occasional low-level price shocks, gas pricing is typically quite stable. An indicative base price of **$0.07 /kWh** ($20/GJ) has been used for comparison against other energy sources. Use of natural gas is subject to carbon costs and inefficiencies of combustion systems, although these are typically lower than with other fossil fuels.

LPG has many of the same characteristics as natural gas, with the key exception that it can be liquefied at a relatively low pressure and thereby transported readily without a pipeline network. The major historical disadvantage of LPG, making it undesirable if natural gas is available, is the significantly higher price. For comparison purposes, a typical price of **$0.135 /kWh** ($1 /L) is used. LPG has historically had very long-term-stable pricing compared to any common fossil fuel other than coal, with prices having typically been static for multiple years at a time. LPG is also subject to carbon costs and inefficiencies of use, increasing the net cost of it above the base price of the fuel itself.

Energy source	Typical energy cost ($ /kWh)
Electricity	$0.200
Natural gas	$0.070
LPG	$0.135
Diesel	$0.187

Table 1: Typical Energy Costs converted to common energy units ($ /kWh)

Aside from base pricing and efficiencies of use, a further consideration when comparing fuel costs is when they are used and at what rate. As the simplest examples, prices for LPG and diesel are unaffected by the time day or week that the fuel is used, as it is delivered in bulk. It also does not matter if loads are short and peaky or steady and consistent, as the energy infrastructure is all onsite from storage through to combustion. Natural gas is somewhat similar in that energy remains the same price regardless of when it is used, but users do pay for the maximum rate of fuel demand that is called from the transmission and distribution networks. Although it is a small fraction of total gas costs, this does mean that short and peaky loads will incur a higher cost per unit of energy than a steadier load would.

Electricity is the key exception to this pricing simplicity. For smaller and some medium-sized sites (and excluding essentially all electricity used for process heat), users typically pay a set price for energy use at any time. This situation is becoming less common, with simplified time-based pricing brackets (e.g. day/night or peak/off-peak pricing) often offering strong incentives to shift energy use to cheaper periods if possible. For moderate to larger users on time-of-use electricity pricing, energy prices are strongly determined by the time, day and month when the energy is used. Additionally, the large cost components of transmission and local network delivery are normally determined in large part by the maximum demand placed on the network, so short and peaky loads can have a substantially higher cost per unit of energy than a steady or off-peak demand. As a consequence, timing, sizing and planning should play a much larger part when considering electricity as a thermal energy source instead of fossil fuels.

Energy emissions intensity

Each energy source has its own carbon emission factor per unit of purchased energy, depending on the chemical composition (fuel) or generation source (electricity). These figures for the four key energy sources, from lowest to highest, are:

- **Electricity:** 0.100 kgCO2e/kWh (varies by year but is an indicative typical figure for the near future)
- **Natural gas:** 0.194 kgCO2e/kWh (Ministry for the Environment standard figure; Measuring emissions: a guide for organisations)
- **LPG:** 0.219 kgCO2e/kWh (MfE emission factor of 3.02 kgCO2e/kg, density of 0.536 kg/litre, and energy density of 7.38 kWh/litre)
- **Diesel:** 0.249 kgCO2e/kWh (MfE emission factor of 2.66 kgCO2e/litre, and energy den sity of 10.68 kWh/litre)

Efficiency of use also plays a key role in the rate of emissions, with fossil-fuelled thermal systems typically having an efficiency of 75 – 85%. Electricity used for high temperatures, in a resistance or electrode heater, is close to 100% efficient. In lower-temperature hot water applications where a heat pump can be used, the efficiency of electricity can easily reach 300 – 400% (i.e. 3 – 4 units of heat are delivered per unit of electrical input).

Carbon sensitivity

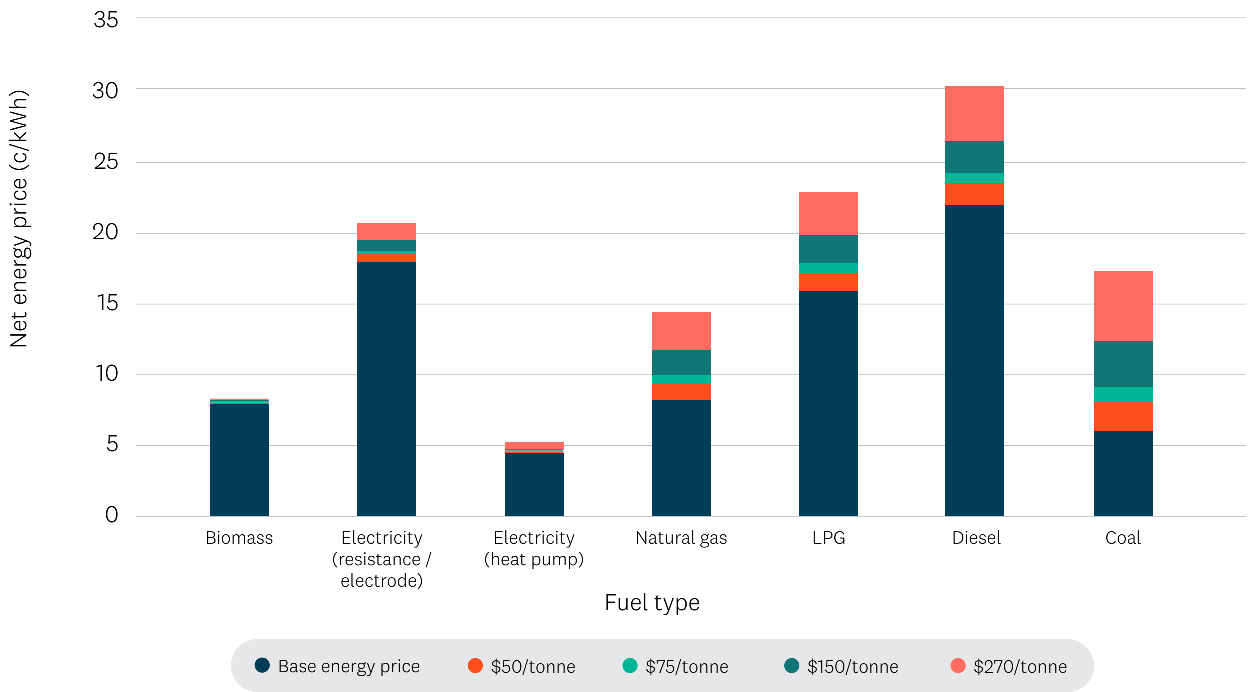
A range of carbon pricing scenarios can be examined to compare the effects of carbon pricing on each energy source. Carbon pricing in New Zealand is a market-based system where the total quantity of emission units is (mostly) capped, and pricing is established by supply and demand between market participants. It is therefore impossible to accurately predict future pricing, particularly as the market and its regulatory mechanisms are not yet mature. However, a range of fixed prices can be used to demonstrate different likely scenarios.

- **$50/tonne:** This should be considered a general indicator of possible minimum price in the near term if emissions markets slump. It is higher than the Government's current auction reserve price for NZUs ($30/tonne in 2022), but this figure is recommended to be revised significantly upward for all future years.
- **$75/tonne:** This is included as a reasonable expectation of normal pricing in the near-to-medium term. It is indicative of the generally stable NZU pricing in 2022. It is also the value used in the Climate Change Commission's (July 2022) scenario of minimum mitigation cost by 2030.

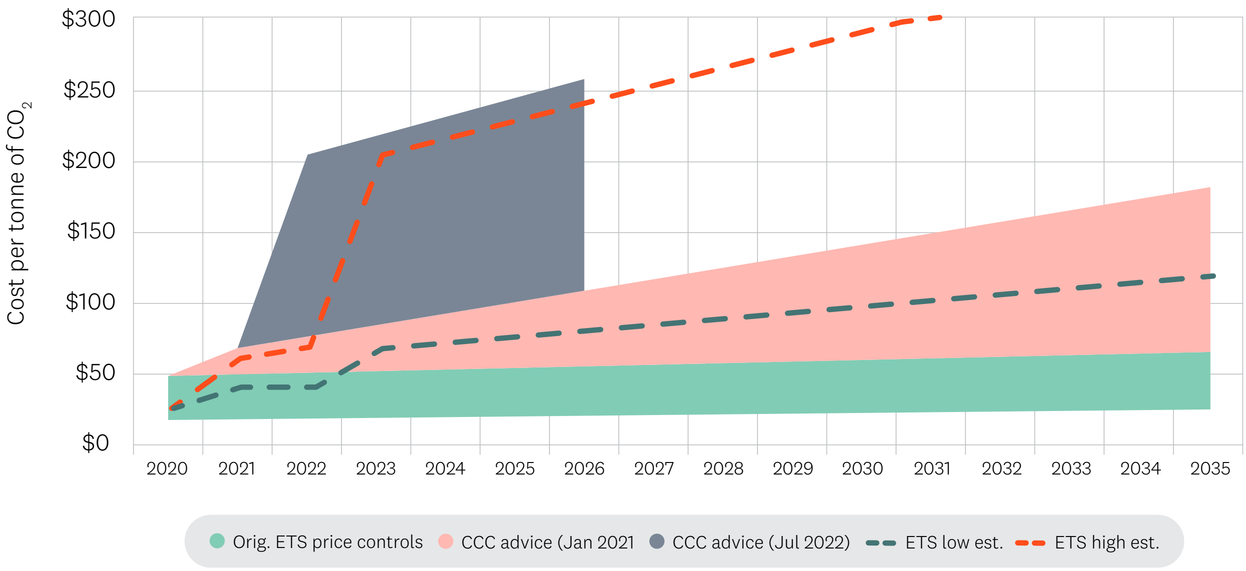
- **$150/tonne:** This scenario is included to illustrate the effect of a major increase in carbon pricing that could occur if, for example, major national or international government intervention took place as part of a concerted climate action programme. It is a reasonable mid-range estimate of likely medium-to-long-term pricing.
- **$270/tonne:** This is considered to be the current extreme scenario for carbon pricing, as it is the figure used in the Climate Change Commission's (July 2022) scenario of maximum mitigation cost by 2030. However, as there are many unforeseeable factors, including market dynamics and national/ international regulatory changes, it does not mean that this figure could not occur sooner or ultimately be exceeded.

The effect of each of each pricing scenario on net (delivered heat) pricing for each energy source is illustrated below, including biomass (wood) and coal for reference. A system efficiency of 85% has been allowed for liquid and gaseous fuels, and 400% for electric heat pump.

Net delivered heat energy price of different fuels



Carbon prices are projected to increase significantly over the next decade. The exact trajectory cannot be known yet, but price controls on the Emissions Trading Scheme (ETS) in NZ as of Dec 2022 are shown in the next graph for reference, along with the more ambitious trajectory advised to the Government from the Climate Change Commission (in July 2022). It is worth noting that a carbon price of "at least $250 per tonne" would be needed by 2050, per the Climate Change Commission's work.



The above information is also shown as a scatter plot for different fuels in the next graph, comparing the cost of delivered heat energy versus the associated carbon dioxide emissions from each source. This takes into account the typical conversion efficiency of different fuel sources, as indicated above, as well as typical fuel costs identified during the course of this study. This does not include future increases to the base price of each fuel, separate to carbon pricing impact. This information compares fuel energy operating costs only, and excludes any project capital costs or equipment maintenance costs.

For electricity, the carbon intensity is relatively low and is expected to decrease. The government has a target for 100% renewable energy that will decrease the carbon intensity, but only to a certain point due to the carbon dioxide emissions from existing geothermal power stations. The cost of electricity ultimately depends on an interaction of energy costs, fixed capacity charges and transmission and distribution charges. In addition, certain discounts may be possible for large bulk supplies such as continuous loads of the multi-MW scale. Multiple entries were added to the below graph for electricity, to illustrate these variations. Specific future costs must be investigated for each site and expected load profile in order to accurately model energy costs.

Net delivered heat energy price versus carbon intensity of different fuels