AN AIR QUALITY FORECAST FOR IMPLEMENTATION OF THE NES-IPH IN CANTERBURY

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Abstract

The National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat (NES-IPH) have been introduced in New Zealand with the purpose of reducing greenhouse gas (GHG) emissions. Under the NES-IPH, high-emitting industrial sites using fossil fuels to provide process heat must gain a resource consent for discharges of greenhouse gases and establish an emissions reduction plan. The Canterbury Regional Council has committed to implement the NES-IPH in Canterbury as part of its Long-Term Plan development process.

This paper examines how the NES-IPH may affect industrial process heat in the Canterbury Region and forecasts changes in air quality. Approximately 45 sites in Canterbury have fossil-fuel powered process heat devices with a capacity exceeding 500 kW and could be required to decarbonise under the NES-IPH. An estimated 95% of these sites currently use coal for process heat. Approximately 90% of high-emitting industrial sites in Canterbury plan to transition to biomass, with the remaining 10% planning to electrify their process heat.

Implementing the NES-IPH provides opportunities for co-benefits in addition to reducing GHG emissions, for example, eliminating discharges of contaminants to air through conversion of fossil fuel-fired devices to electricity. Switching from sub-bituminous coal to biomass is expected to decrease NO_X and SO_X emissions but increase CO emissions. PM_{10} and $PM_{2.5}$ emissions could increase or decrease, depending on the firing configuration and particulate control devices used. Additional particulate removal devices may be required to mitigate PM emissions for some sites, especially within polluted airsheds.

Locally supplied biomass fuel to meet increasing demand will be critical for the transition in order to avoid an increase in emissions of GHGs and air pollutants from fuel transportation, which could impact the Region's ability to meet GHG emission targets for the transport sector, and air quality targets.

Keywords: Greenhouse Gases, Regulation, Biomass, Industrial Process Heat.

1. Introduction

In November 2022, changes were made to the New Zealand (NZ) Resource Management Act to enable regional and local authorities to consider the effects of greenhouse gas (GHG) emissions on climate change. These changes were made to support New Zealand's commitments under the Paris Agreement to keep the global average temperature well below 2 °C above pre-industrial levels.

Following on from these changes, the National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat (NES-IPH) were created by the New Zealand Ministry for the Environment (MfE) to support NZ councils in their decision-making regarding greenhouse gas emissions from industrial sites using fossil fuel process heat devices (MfE, 2024).

The NES-IPH came into force on 27 July 2023 and has significant opportunities to provide co-benefits along with the required greenhouse gas emission reductions, specifically for improved air quality. This paper examines how the NES-IPH may affect industrial process heat in the Canterbury Region and forecasts changes in air quality in the Region due to changes in fuel use. It also provides an overview of the commitment of the Canterbury Regional Council (CRC) to implement the NES-IPH and the National Policy Statement for Greenhouse Gas Emissions from Industrial Process Heat (NPS-IPH) as part of its Long-Term Plan (LTP) development process, and how the industrial process heat regulations may be enabled alongside broader outcomes for the Region.

2. Implementation of the NES-IPH

The NES-IPH definition of industrial process heat means thermal energy that is used:

- in industrial processes, including in manufacturing and in the processing of raw materials; or
- to grow plants or other photosynthesising organisms indoors; but
- does not include thermal energy used in the warming of spaces for people's comfort (for example, heating of commercial offices).

The NES-IPH aims to provide nationally consistent policies and requirements for reducing GHG emissions from industries using process heat by:

- prohibiting discharges of GHGs from new low to medium temperature coal boilers immediately and from existing coal boilers after 2037;
- requiring resource consents to be held for new and existing fossil fuel boilers that emit 500 tonnes and above of carbon dioxide equivalents (CO_2-e) per year, per site; and
- requiring resource consent applicants to prepare and implement GHG emission plans.

3. Process Heat Devices in Canterbury

The Regional Heat Demand Database created by the Energy Efficiency and Conservation Authority (EECA) identifies 82 sites in the Canterbury Region with a heating capacity greater than 500 kW (EECA, 2022). Depending on their operating hours, the 500 t CO_2-e per year emission threshold is likely to also be exceeded by some sites with heating capacities less than 500 kW, which are not included in the EECA database. However, the database provides an indication of the number of sites in Canterbury with a high heat demand. Of the 82 sites, 45 are likely to meet the definition of industrial process heat and be captured by the NES-IPH regulations. These 45 sites have a total annual process heat demand of 2,253 GWh. The process heat provided by various fuels is shown in Figure 1. 95% of the process heat for these sites is currently provided by coal combustion.

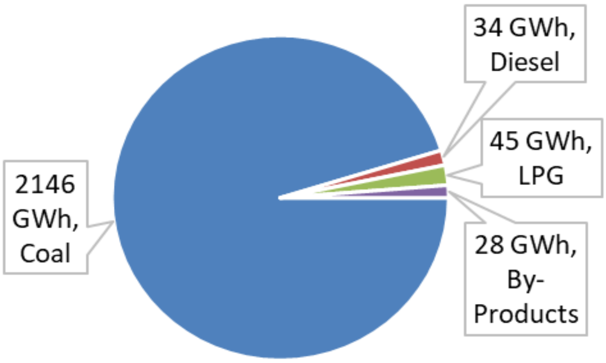

Figure 1: Process heat demand for sites with heat capacities ≥500 kW in Canterbury

The majority of the consumption of by-products is of wood waste at wood product manufacturing sites (25 GWh) and therefore can be excluded from further assessment when forecasting the effects of decarbonisation of process heat. The total process heat supplied by fossil fuels in Canterbury at sites with a capacity greater than 500 kW is therefore estimated to be 2,228 GWh.

4. Predicted Changes in Canterbury Process Heat Devices

The sites identified in Section 3 that consume fossil fuels for process heat are expected to require resource consents which will include an emissions plan with reduction targets. Any sites that burn coal and deliver process heat below 300°C will need to decarbonise by 2037. In 2021, DETA Consulting (DETA) interviewed 115 sites using process heat in the South Island about their decarbonisation plans (EECA and DETA, 2021). Approximately 90% of the sites in the Canterbury Region were planning to transition to biomass, and approximately 10% were planning to switch to electricity. DETA reported that electricity was less favoured due to supply/distribution costs and operating costs. Applying these indicated preferences of conversion to biomass and electricity, an additional 2,005 GWh of annual process heat demand could be supplied by biomass and 223 GWh by electricity when these sites decarbonise.

5. Forecasted Air Quality Effects

Emission of air pollutants from process heat devices vary depending on many factors including:

- The fuel type and properties;
- The type of heat device;
- Emission control devices; and
- Combustion parameters.

As shown in Section 3, approximately 95% of the sites in Canterbury that use fossil fuels for process heat are using coal, so this air quality forecast focuses on sites transitioning away from coal. Most coal used for process heat in New Zealand is either lignite or sub-bituminous coal (Eng, et al., 2008).

Particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), nitrogen oxides (NO_X), sulphur oxides (SO_X), and carbon monoxide (CO) are the air pollutants commonly considered for discharges of combustion products, thus emission factors for these pollutants have been compared. All emission factors were sourced from the Australian National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Combustion in Boilers (Australian Government, 2011). The NPI emission factors will not be representative of all process heat devices but provide an indication of the relative magnitude of emissions for different fuel types. The only NPI lignite emission factors are for briquettes and were not considered appropriate to use for New Zealand lignite. Therefore, emission factors for sub-bituminous coal and wood/bark were selected for comparison.

5.1. PM_{10} Emissions

Figure 2 summarises the NPI PM_{10} emission factors for wood/bark and sub-bituminous coal combustion in boilers, grouped by particulate control methods. An ash content of 5% was assumed for sub-bituminous coal (Eng, et al., 2008). The particulate control technologies compared, in order of decreasing PM_{10} emissions for wood/bark, are:

- uncontrolled;
- multicyclones with fly ash reinjection (MC, FAR),
- multicyclones without fly ash reinjection (MC);
- scrubber; and
- electrostatic precipitator (ESP).

For all control technologies, the emission factor for wood/bark is lower than the average emission factor for sub-bituminous coal, although some coal firing configurations have lower emission factors than wood/bark.

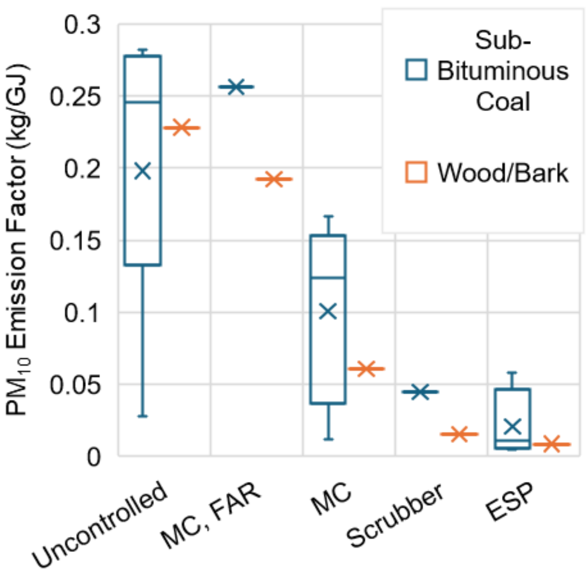

Figure 2: PM_{10} Emission Factors by Control Type

5.2. $PM_{2.5}$ Emissions

Figure 3 shows that the $PM_{2.5}$ emission factors for wood/bark are higher than the average sub-bituminous coal emission factors for uncontrolled discharges, and discharges treated by either multicyclones with fly ash reinjection or an electrostatic precipitator. For discharges treated by multicyclones or a scrubber, the wood/bark emission factors are lower than the average sub-bituminous coal emission factors.

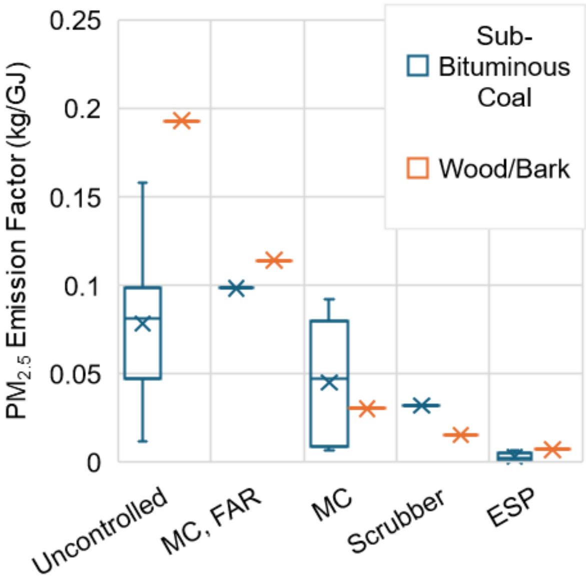

Figure 3: $PM_{2.5}$ Emission Factors by Control Type

5.3. NO_X Emissions

Figure 4 shows that the biomass NO_X emission factor is lower than any of the NO_X emission factors for sub-bituminous coal.

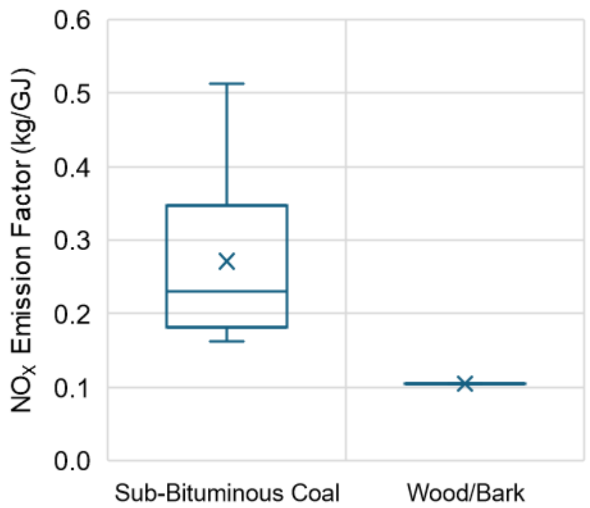

Figure 4: NOx Emission Factors

5.4. SO_X Emissions

Figure 5 shows that emissions of SO_X are generally significantly lower from biomass combustion than from sub-bituminous coal combustion. This is due to the lower fuel sulphur content of biomass. A conservative sulphur content of 1% was assumed for South Island sub-bituminous coal (New Zealand Petroleum & Minerals, 2024).

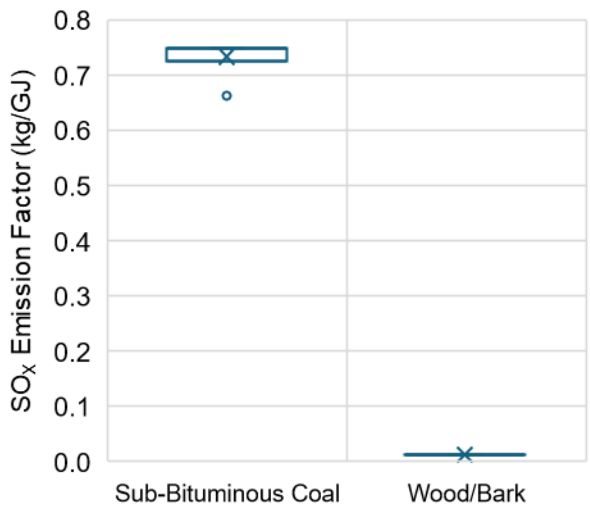

Figure 5: SO_X Emission Factors

5.5. CO Emissions

Figure 6 shows that emissions of CO are typically higher from combustion of biomass than sub-bituminous coal.

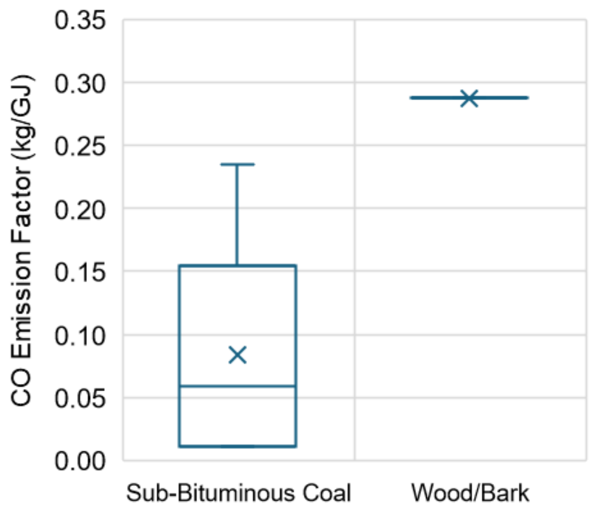

Figure 6: CO Emission Factors

5.6. Summary of Air Quality Effects

The data demonstrates that a transition to biomass makes reductions in NO_X emissions possible, and significant reductions in SO_X emissions will occur.

CO emissions are likely to increase. However, ambient CO concentrations do not typically exceed guideline values in Canterbury, and the contribution of a single site to ambient concentrations is typically at least an order of magnitude lower than the guideline values. Therefore, in most cases, an increase in CO emissions is unlikely to affect a site's ability to gain a resource consent.

There is potential for PM_{10} emissions to increase or decrease, depending on the firing configuration of the coal boiler that is being replaced, although on average a reduction is expected. PM_{10} concentrations in Canterbury sometimes exceed air quality guideline values, and as a result several areas within Canterbury have been gazetted as polluted airsheds (CRC, 2024). Mitigating PM_{10} emissions will be a key factor in gaining resource consents for discharges to air from biomass combustion.

$PM_{2.5}$ emissions may increase or decrease, depending on the existing coal firing configuration and particulate control devices used. Sites that are switching from coal to biomass may need to install secondary treatment emission control devices such as cyclones and electrostatic precipitators to mitigate PM_{10} and $PM_{2.5}$ emissions, especially if they are operating within a polluted airshed.

Sites that convert from fossil fuels to electricity will improve the local air quality by eliminating their discharges of contaminants to air.

6. Biomass Supply and Transportation

It is anticipated the Canterbury biomass market, or biomass markets of surrounding regions, may need to reposition to respond to future demands for industrial process heat.

Wood chip for fuel can be sourced from forest harvest or wood processing residues (Bioenergy Association, 2024). On average, radiata pines grown in New Zealand are harvested at 29 years (Eastland Wood Council, 2018). Biomass resources from forest residues are geographically dispersed and have low energy density, making them expensive to extract from source to market (Jack & Nielsen, 2008).

There are minor biomass and coal stocks available in Canterbury, however neither of these existing fuel sources meet the fuel demands of all industrial process heat activities occurring within the Region. In New Zealand, a large quantity of existing forestry potentially available to supply biomass for process heat is found in the middle and upper North Island (EECA, 2024). Large coal stocks are presently available from the West Coast and Southland Regions in the South Island (New Zealand Petroleum & Minerals, 2024). The South Island also presently has small volumes of forestry, which could be used for biomass supply.

Fuel source locality impacts the overall greenhouse gas footprint of an industrial process. While the NES-IPH does not account for greenhouse gas emissions associated with the transport of fuels, this should be considered by individual sites and within wider regional decarbonisation frameworks.

For example, switching a boiler located in South Canterbury from sub-bituminous coal sourced from Southland to wood chip sourced from the Tasman District could result in transport emissions (for either rail or trucking) increasing by a factor of 2 or more for both CO_2-e and air pollutants. This is due to coal having a higher energy density than wood chip, enabling it to be transported in lower volumes to meet the same energy demand.

However, an increase in fuel transport emissions from switching to biomass will typically be minor in comparison to the savings in greenhouse gas emissions from the heat device. Conversion from coal to biomass is anticipated to result in significant reductions (>90%) in the total operational CO_2-e emissions from transport and process heat. These conclusions exclude biogenic CO_2 emissions from biomass combustion which are considered to be neutral due to the CO_2 absorbed by the feedstock during its lifespan.

The above example demonstrates that if large scale transition from fossil fuels to biomass is adopted as the major decarbonisation pathway in the Canterbury Region, local land use conversions to forestry are likely required to respond to increased biomass demand, whilst enabling effective decarbonisation of process heat. This would avoid exacerbating air quality effects from transport emissions or partially transferring the source of greenhouse gas emissions from process heat to transport (while transport is yet to decarbonise).

Currently, increasing forestry to meet process heat demand has potential to encompass large areas of land. Assuming a median volume of woody residues of 88 m^3 per hectare of New Zealand plantation forest (Harvey & Visser, 2022), approximately 600 hectares of local forest may be required to supply a 15 MW boiler for one year.

Technology and innovation will be critical in both the biomass and transport industries to optimise fuel supply and reduce emissions. Notably, availability and demand of biomass may also be impacted by the New Zealand Emissions Trading Scheme (ETS), timber demand, and other industry demands such as pulp and paper.

Other energy alternatives for process heat, such as electricity, should be considered alongside further decarbonisation of freight, to ensure competing productive land uses can continue to be enabled within the Region. These complementary initiatives also provide an opportunity to concurrently improve air quality in the Region.

7. Regional Council Response

The Canterbury Regional Council has committed to implement the NES-IPH and NPS-IPH as part of its Long-Term Plan (LTP) development process on behalf of the New Zealand Government. The LTP sets out service priorities, work programmes and resource requirements such as expenditure and funding for a 10-year period across the Canterbury Region.

Implementation of the NES-IPH has included amendments to the Canterbury Air Regional Plan (CARP), which was made operative in 2017 to set out management of air pollution from home heating, industry and other sources like outdoor burning, dust, and odour in the Region.

The key challenges for regional councils will be implementing the NES-IPH consistently across New Zealand as well as integrating the NES-IPH with other environmental considerations, such as air quality objectives, commercial forestry, and transport, whilst enabling industrial sites to continue to generate the high-temperature process heat needed to support their businesses.

8. Conclusions

Approximately 45 known sites in Canterbury, with a total process heat demand of 2,228 GWh, are likely to be affected by the NES-IPH. Additional sites that have process heat demands less than 500 kW are also expected to be captured by this legislation. The majority (approximately 95%) of process heat demand for the 45 sites above 500 kW is currently supplied by coal. As sites decarbonise, approximately 90% of that process heat demand is predicted to be met by biomass, with the remainder supplied by electricity. Conversion of boilers from sub-bituminous coal to biomass is likely to, on average, decrease NO_X emissions, significantly decrease SO_X emissions, and increase CO emissions. PM_{10} and $PM_{2.5}$ emissions are likely to increase at some sites and decrease at others. As a result, some sites may need to install emission control devices such as cyclones and electrostatic precipitators to mitigate their PM_{10} and $PM_{2.5}$ emissions.

Sites switching from fossil fuels to electricity will eliminate their emissions of air pollutants from combustion and improve the local ambient air quality.

To contribute to national GHG reduction and air quality targets, successful implementation of the NES-IPH requires careful consideration from regional councils in a wider context. Land use planning for increased supply of alternative energy sources such as biomass is critical. This will avoid air quality impacts from increased transport emissions and facilitate achieving wider greenhouse gas reduction outcomes to support New Zealand's commitments under the Paris Agreement.

Revision of the CRC LTP provides an opportunity to implement the NES-IPH while enabling broader outcomes for improved air quality and reduced transport emissions due to effective land use planning.

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