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Consulting Engineers Limited

Portland Energy Recovery Facility

Powerfuel Portland Limited

Greenhouse Gas Assessment

ENGINEERING CONSULTING

Document approval

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1 Introduction

The aim of this report is to assess the impact of greenhouse gas emissions, as previously required by the Environment Agency for similar power generating activities. This assessment considers the direct greenhouse gas emissions from the Portland Energy Recovery Facility (the Facility) and considers these in relation to other forms of power generation in the UK.

In this report, an assessment of the amount of greenhouse gas released through the incineration of waste has been undertaken. The assessment calculates the quantity of emissions of CO_2 from the Facility and also other greenhouse gases released (for example N_2O) as a CO_2 equivalent.

Power generated through energy recovery from incoming waste displaces electricity that would have otherwise been sourced from conventional power stations. Therefore, the net change in carbon dioxide emissions has been calculated as a result of using waste to generate electricity rather than generating it by conventional means. For the purpose of this report, the power from renewable sources (biogenic carbon) has been assumed to displace the same power as that generated from the combustion of fossil fuels.

This report does not consider the release or avoidance of indirect carbon dioxide emissions associated with the operation of the Facility, as this is outside of the scope of the assessment required by the Environment Agency. However, it has been considered within the more detailed carbon assessment submitted in support of the planning application.

2 Assumptions

2.1 Facility

The combustion technology utilised at the Facility will use a moving grate. The Facility will be of a single stream design, with a nominal design capacity of approximately 22.8 tonnes of incoming waste per stream per hour, with a net calorific value (NCV) of 11 MJ/kg. Assuming an availability of 8,000 hours operation per annum, this equates to a nominal design capacity of 183,000 tonnes per annum. Assuming a higher availability (up to 8,760 hours per annum) and to allow for variations in the calorific value of the waste, the Facility will be capable of processing up to 202,000 tonnes per annum.

For the purposes of this assessment the following assumptions have been applied with regards the design of the Facility:

1. It will have a nominal design capacity of 183,000 tonnes per annum.
2. The annual availability will be 8,000 hours operation.
3. The boiler will have a total rated thermal capacity of approximately 70 MWth.
4. It will generate up to 18.1 MWe (design maximum) with a parasitic load of 2.9 MWe.
5. The composition of the incoming waste combusted in the Facility as follows:
    a. the waste contains 31% carbon by weight; and
    b. 68% of the carbon content of the incoming waste is biodegradable.
6. Ammonia will be used as a reagent in the SNCR system, which will result in emissions of nitrous oxide at a concentration of 8 mg/m^3.
7. There will be 10 start-ups and shutdowns per year. This is a conservative assumption. Each start-up will take 16 hours, and each period of shutdown will take 2 hours. Therefore, the auxiliary burners will be in operation for 180 hours per annum.
8. During periods it is not available, the parasitic load will be 20% of the operational load. Periods of non-availability are times when the Facility is neither operational nor in the process of start-up or shutdown, i.e. periods where the auxiliary burners are in operation. Therefore, the facility will have a non-availability of 330 hours per annum, during which the parasitic load will be 0.8 MW.
9. The volumetric flow of flue gases from the Facility is approximately 140,652 Nm^3/hr.
10. The auxiliary burners, which will be fired on gasoil, will operate at 70% of the maximum continuous rating of the thermal capacity of the facility. Therefore, the burner capacity will be approximately 49 MW.
11. As stated in Environment Agency Guidance Note H1, the combustion of gas oil has emissions of 0.25 t CO_2/MWh.

3 Displaced Power

Table 3-1 shows the energy sources for UK electricity generation, with their associated carbon intensities. It is important to consider which of these power sources would be displaced by the power generated by the Facility.

Table 3-1: UK Electricity Supply Characteristics[1]

Energy Source	Proportion of UK Supply (%)	Carbon Emissions During Operation (gCO_2/kWh)
Coal	5.20	920
Natural Gas	41.40	349
Nuclear	18.7	0
Renewables	32.8	0
Other	1.90	871

Current UK energy strategy uses nuclear power stations to operate as baseload stations run with a relatively constant output over a daily and annual basis. Power supplied from them is relatively low in cost and has the benefit of extremely low CO_2 emissions. Electricity generated from renewable energy is more expensive than non-renewable sources although, due to the benefit of very low greenhouse gas emissions, it is encouraged through government policies. For these reasons, the construction and operation of nuclear and renewable power stations would not be greatly influenced by that which would otherwise be generated by the installation.

It is most likely that the power displaced by the Facility would otherwise be generated by gas-fired combined cycle gas turbine (CCGT) power plants, or from coal fired power plants.

The DEFRA document 'Energy from Waste – A guide to the debate 2013' provides support for the use of CCGT as a comparator for electricity generated from the combustion of waste. Footnote 29 on Page 18 of the document states that:

'A gas fired power station (Combined Cycle Gas Turbine – CCGT) is the current standard comparator as this is the 'marginal' technology if you wanted to build a new power station.'

Therefore, for the purposes of this assessment it is assumed that power from the facility will displace power from a CCGT, and that the CO_2 emissions from a CCGT power station are equivalent to 349 g/kWh.

The following assumptions regarding the energy outputs from the installation have been made:

- The Facility will generate approximately 18.1 MW of electricity with a net output of 15.2 MW, giving a gross and net electrical efficiency of approximately 26.0% and 21.8% respectively.
- For the purposes of this greenhouse gas assessment, there will be no heat export from the Facility.

On this basis:

- The Facility will generate approximately 144,800 MWh of power per annum. Of this power approximately 121,600 MWh per annum will be available for export. This will displace a total of approximately 42,400 tonnes of CO_2 equivalent per annum.

[1] Department for Business, Energy & Industrial Strategy. UK Fuel Mix Disclosure data table (01 April 2018 – 31 March 2019.)

4 Emissions from the EfW Facility

The Facility will release carbon dioxide from the combustion of the carbon content of the incoming waste and auxiliary fuels.

4.1 Facility

For the purposes of this assessment, carbon dioxide released from the combustion of gas oil used for auxiliary firing within the Facility is included as a global warming contributor.

During start-up, auxiliary burners will be used to raise the temperature within the boiler to 850°C before starting to feed waste into the combustion chamber, as required by the Industrial Emissions Directive (IED). These burners will also be used to maintain the temperature within the boiler above 850°C when needed, as required by the IED. During shutdown, the auxiliary burners will be used to ensure complete burn-out of the waste.

4.1.1 Emissions from the Incineration of Incoming Waste

The Facility will export approximately 666 kW of power per tonne of incoming waste.

The CO_2 equivalent emissions from the incineration of waste would be approximately 1,120 kg per tonne of incoming waste, of which approximately 358 kg per tonne of incoming waste will be from non-biogenic sources.

The total CO_2 equivalent emissions from fossil fuels (excluding auxiliary fuels) will be approximately 65,500 tonnes per year.

4.1.2 Emissions of Nitrous Oxide

The Facility will release approximately 11.3 tonnes of nitrous oxide per annum. Nitrous oxide has a GWP of 310 CO_2 equivalent. Nitrous oxide is produced when the free radical molecules derived from ammonia react with nitric oxide (NO) produced from the combustion of nitrogen-containing substances in the waste.

The emissions of nitrous oxide will be approximately 3,500 tonnes CO_2 equivalent per year.

4.1.3 Electricity Import

During periods of start-up and shutdown the Facility will have an electrical demand of approximately 522 MWh electricity; and during periods of non-availability the Facility will have an electrical demand of approximately 336 MWh electricity. On this basis, the Facility will consume approximately 858 MWh of electricity per annum.

As stated in Environment Agency Guidance Note H1, the import of electricity from public supply should be assumed to have emissions of 0.166 t CO_2/MWh. Therefore, the Facility is anticipated to release approximately 140 tonnes per year of carbon dioxide equivalent from the import of electricity.

4.1.4 Emissions from Auxiliary Firing

The auxiliary burners will consume approximately 8,800 MWh of gasoil per annum. This will be equivalent to a total of approximately 2,200 tonnes per year of CO_2 equivalent from the combustion of gas oil for auxiliary firing.

4.2 Summary

The operation of the power generating processes at the Facility will lead to the release of approximately:

- 65,500 tonnes per year of CO_2 equivalent would be released from the incineration of the non-biogenic component of the waste;
- 3,500 tonnes per year of CO_2 equivalent from nitrous oxide from the incineration of incoming waste;
- 140 tonnes per year of CO_2 equivalent from imported electricity for the incineration of incoming waste; and
- 2,200 tonnes per year of CO_2 equivalent from the combustion of gasoil for auxiliary firing in the Facility.

Therefore, in total it is predicted that approximately 71,340 tonnes per year of CO_2 equivalent will be released from the operation of the Facility.

5 Conclusions

The information presented within this assessment is summarised in Table 5-1 below.

Table 5-1: Greenhouse Gas Assessment Summary

	GWP (tonnes CO_2 equivalent)	
Process	**Facility**	
Parameter	**Released**	**Saving/Offset**
CO_2 emissions derived from fossil fuels (a)	65,500	
N_2O from the process (ammonia) (b)	3,500	
Indirect CO_2 emissions (imported electricity) (c)	140	
Direct CO_2 emissions (auxiliary fuel) (d)	2,200	
Total released (e=a+b+c+d)	**71,340**	
Energy recovered (electricity) (f)		42,400
Energy recovered (heat) (g)		-
Total offset (h=f+g)		**42,400**
Net GWP (j=e-h)	**28,940**	

To conclude, the operation of the Facility will result in a small increase (28,940 tonnes per annum) in the emissions of CO_2 released from the generation of power from the incineration of incoming waste within the Facility, compared to generating the equivalent power in a conventional power station.

However, it should be noted that this assessment methodology does not consider the avoidance of emissions from the disposal of the waste in a landfill, or from any other alternative methods of waste treatment.

A carbon assessment was carried out as part of the planning application. In addition to the combustion of the waste and the generation of power in a conventional power station, the carbon assessment also considered emissions from transport and the disposal of the waste within a landfill. The carbon assessment concluded that the operation of the Facility would represent a carbon benefit of 21,900 tonnes of CO_2 equivalent per annum compared to the disposal of the equivalent waste in a landfill.

Furthermore, the carbon assessment submitted in support of the planning application also considered the change in carbon emission if the Facility exported power to local heat users and also if the power generated by the Facility was exported to ships within the port. The assessment concluded that the export of heat to local users would result in a further saving of an additional 3,000 tonnes per annum of CO_2, and the export of power to ships within the harbour would result in a further saving of 4,500 to 5,500 tonnes per annum of CO_2.

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