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Consulting Engineers Limited

Medway Energy Recovery Limited

Greenhouse Gas Assessment

ENGINEERING CONSULTING

Document approval

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1 Introduction

Medway Energy Recovery Limited is applying to the Environment Agency (EA) under the Environmental Permitting Regulations (EPRs) for an Environmental Permit (EP) to operate the MedwayOne Energy Hub (the Facility). The Facility will comprise a twin line waste incineration plant (the ERF) and associated infrastructure including battery storage and hydrogen production facilities, and will be located at Medway One, Kent.

1.1 Background

The aim of this report is to assess the impact of greenhouse gas emissions as a result of the operation of the Facility.

A quantitative assessment of direct greenhouse gas emissions from the operation of the Facility has been undertaken as required by the Environment Agency (EA) for power generating activities. Greenhouse gas emissions from the Facility have also been considered in relation to other forms of power generation in the UK. The assessment 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.

The EA guidance titled '*Assess the impact of air emissions on global warming*' requires an application for a bespoke environmental permit to identify:

- direct greenhouse gas emissions; and
- indirect greenhouse gas emissions (from heat or power imported to the site).

The application should then calculate the total carbon impact associated with the activity.

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 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 combusting incoming waste to generate electricity rather than generating electricity by conventional means (based on the average UK power mix).

2 Assumptions

2.1 The Facility

The Facility will use a moving grate as the combustion technology. The plant will be a twin-stream design. The main design assumptions are set out in Table 1.

Table 1: Assumptions

Parameter	Unit	Value
Operating hours	hours	8,000
Annual capacity	tpa	456,000
NCV	MJ/kg	10.5
Carbon content[(a)]	%	27.28
Percentage of carbon which is biogenic[(a)]	%	53.21
Electrical generation	MWe	49.9
Parasitic load	MWe	5
Thermal capacity (total)	MWth	166
Auxiliary burner fuel	-	Fuel oil
Auxiliary burner capacity (total)	MWth	107.9[(1)]
Start-up/shutdowns each year	-	8
Start-up/shutdown duration	hours	22
Start-up/shutdown periods each year	hours	176
Periods of non-availability each year	hours per annum	584
Parasitic load during periods of non-availability	MWe	1[(2)]
(1) Assumed to be 65% of the the thermal capacity *(2) Assumed to be 20% of operational parasitic load*		

In addition, for the purposes of this assessment, the following additional assumptions have been applied:

1. Nitrous oxide is emitted from the process at a rate of 4 kg/TJ waste[1].
2. As stated in Environment Agency Guidance Note H1, the combustion of fuel oil has emissions of 0.25 t CO_2eq/MWh.

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, Table 2.2: Default emissions factors for stationary combustion in the energy industries, Municipal Wastes (non-biomass fraction)

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[2]

Energy Source	Proportion of UK Supply (%)	Carbon Emissions During Operation (gCO_2/kWh)
Coal	3.4	945
Natural Gas	39.3	371
Nuclear	13.9	0
Renewables	40.8	0
Other	2.6	795

Current 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.

Wind and solar plants also have very low marginal operating costs and, in many cases, are supported by subsidies. This means that they will run when there is sufficient wind or sun, and their operation will be unaffected by the operation of the Facility. It is considered that the operation of the Facility will have little or no effect on how nuclear, wind or solar plants operate when taking into account market realities (such as the phase-out of nuclear plants and the generous subsidies often associated with the development of wind and solar plants).

Combined cycle gas turbines (CCGTs) are the primary flexible electricity source. Since wind and solar are intermittent, with the electricity supplied varying from essentially zero (on still nights) to more than 20.9 GW and 10 GW respectively for wind and solar (peak generation records to date at the time of writing), CCGTs supply a variable amount of power. However, records show that there are only very limited periods when CCGTs are not operational and providing power to the grid.

Gas engines, diesel engines and open cycle gas turbines also make a small contribution to the grid. These are mainly used to provide balancing services and to balance intermittent supplies. As they are more carbon intensive than CCGTs, it is more conservative to ignore these for the purposes of this assessment.

The DEFRA document 'Energy from Waste – A guide to the debate 2014' provides support for the use of CCGT as a comparator for electricity generated from the combustion of waste. Footnote 29 on Page 21 of the document states that:

> *'A gas fired power station (Combined Cycle Gas Turbine – CCGT) is a reasonable comparator as this is the most likely technology if you wanted to build a new power station today.'*

Therefore, for the purposes of this assessment it is assumed that power from the Facility will displace power which would otherwise be generated in a CCGT, and that the CO_2 emissions from a CCGT power station are equivalent to 371 g/kWh (refer to Table 3-1).

It is acknowledged that the UK government has set a target which '*will require the UK to bring all greenhouse gas emissions to net zero by 2050*'. Taking this into consideration, in the future, it is anticipated that the power which the Facility will generate will displace other forms of power

[2] Department of Energy and Climate Change. UK Fuel Mix Disclosure data table (01 April 2022– 31 March 2023).

generation, including renewable energy power stations. However, at this stage, the mix of generation capacity which could be added in the future to the grid that could be displaced is uncertain (so the carbon intensity of future displaced generation cannot be accurately quantified). Therefore, it has been assumed that the Facility will displace a gas fired power station, as this is considered to be a reasonable comparator.

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

- The Facility will generate up to 49.9 MW of electricity with a net output of 44.9 MW, giving a gross and net electrical efficiency of 30.06% and 27.05% 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 399,200 MWh of power per annum. Of this power approximately 359,200 MWh per annum will be available for export. Therefore, on an annual basis, the power exported from the Facility will displace a total of approximately 133,600 tonnes of carbon dioxide equivalent which would otherwise be released from the combustion of natural gas.

4 Emissions from the Facility

The Facility will release emissions of carbon dioxide and their equivalents (other greenhouse gases such as nitrous oxide) from the combustion of waste. Furthermore, during periods when it is not generating power, the Facility will have a parasitic load which will require power to be imported from the grid.

In addition, 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). The 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. The combustion of auxiliary fuel will release carbon dioxide.

4.1 Emissions from the Incineration of Incoming Waste

The Facility will export 771 kW of power per tonne of incoming waste.

The carbon dioxide equivalent emissions from the incineration of waste would be 1,000 kg per tonne of incoming waste, of which 468 kg per tonne of incoming waste will be from non-biogenic sources.

The total carbon dioxide equivalent emissions from fossil fuels (excluding auxiliary fuels) will be approximately 213,400 tonnes per year.

4.2 Emissions of Nitrous Oxide

The Facility will release approximately 19.6 tonnes of nitrous oxide per annum. Nitrous oxide has a GWP of 310 carbon dioxide equivalent.

Therefore, the total carbon dioxide equivalent emissions from emissions of nitrous oxide will be approximately 5,900 tonnes per year.

4.3 Import of Electricity

During periods of start-up and shutdown the Facility will have an electrical demand of approximately 880 MWh electricity; and during periods of non-availability the Facility will have an electrical demand of approximately 584 MWh electricity. On this basis, the Facility will consume approximately 1,460 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 CO2/MWh. Therefore, the Facility is anticipated to release approximately 240 tonnes per year of carbon dioxide equivalent from the import of electricity.

4.4 Emissions from Auxiliary Firing

The auxiliary burners will consume approximately 19,000 MWh of fuel oil per annum. This will be equivalent to a total of approximately 4,800 tonnes per year of carbon dioxide equivalent from the combustion of fuel oil for auxiliary firing.

4.5 Summary

In summary, the operation of the Facility will lead to the release of approximately:

- 213,400 tonnes per year of carbon dioxide equivalent would be released from the incineration of the non-biogenic component of the waste;
- 5,900 tonnes per year of carbon dioxide equivalent from nitrous oxide from the incineration of incoming waste;
- 240 tonnes per year of carbon dioxide equivalent from imported electricity for the incineration of incoming waste; and
- 4,800 tonnes per year of carbon dioxide equivalent from the combustion of fuel oil for auxiliary firing in the Facility.

Therefore, in total it is predicted that approximately 229,411 tonnes per year of carbon dioxide equivalent would be released from the Facility.

5 Conclusions

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

Table 5-1: Greenhouse Gas Assessment Summary

	GWP (tonnes CO_2 equivalent)	
Process	**The Facility**	
Parameter	**Released**	**Saving/Offset**
CO_2 emissions derived from fossil fuels (a)	213,400	
N_2O from the process (ammonia) (b)	5,900	
Indirect CO_2 emissions (imported electricity) (c)	240	
Direct CO_2 emissions (auxiliary fuel) (d)	4,800	
Total released (e=a+b+c+d)	**224,340**	
Energy recovered (electricity) (f)		133,600
Energy recovered (heat) (g)		-
Total offset (h=f+g)		**133,600**
Net GWP (j=e-h)	**90,740**	

To conclude, the operation of the Facility will result in a small increase (90,740 tonnes per annum) in the emissions of carbon dioxide 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, which would both provide significant additional savings in carbon emissions.

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