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GENT FAIRHEAD & CO LIMITED
RIVENHALL IWMF
GREENHOUSE GAS ASSESSMENT

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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. The assessment considers the direct greenhouse gas emissions from the proposed power generating activities at the Rivenhall IWMF (the Installation) and considers these in relation to other forms of power generation in the UK.

The Installation will generate power from two sources:

(1) The incineration of waste in the CHP Plant; and

(2) The combustion of biogas generated from anaerobic digestion (AD) of waste.

In this report, we have examined the amount of greenhouse gas released through the incineration of waste and the combustion of biogas from the anaerobic digestion of organic waste. We have calculated emissions of CO_2, and we have presented the quantities of 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, we have calculated the net change in carbon dioxide emissions as a result of using waste to generate electricity rather than generating it by conventional means (based on the average UK power mix). For the purpose of this report, the power from renewable sources has been assumed to displace the same power as that generated by conventional means.

This report does not consider the equivalent emissions of carbon dioxide from the power consumed by the Installation other than that consumed by the CHP plant and the AD plant and indirect carbon dioxide emissions associated with the operation of the installation.

2 ASSUMPTIONS

2.1 CHP Plant

For the purposes of this assessment the following assumptions have been applied to the CHP Plant:

(1) The facility has a maximum capacity of 595,000 tonnes per annum.

(2) The facility will have a maximum availability of 8,150 hours operation.

(3) The facility will generate up to 49 MWe with a parasitic load of 5.5MWe.

(4) The composition of the RDF combusted in the facility as follows:

- The composition of combustible C&I waste, contains 35% carbon by weight; and
- 64% of the carbon content of the incoming waste is biodegradable, as defined by the Government in the legislation for the Landfill Allowance Trading Scheme.

(5) Nitrous oxide is emitted at a concentration of 10 mg/m^3.

(6) The facility will be in start-up and shut down for 170 hours per annum.

(7) During periods when the facility is not available, the parasitic load will be 20% of the operational load. Therefore, the facility will have a non-availability of 590 hours per annum with a parasitic load of 1.1MW.

(8) The volumetric flow of flue gases from the CHP Plant is 184,902 Nm^3/hr.

(9) The facility will have 10 start-ups and shut-downs per annum. Each start-up will take 16 hours, and each period of shut-down will take 1 hour. Therefore, the auxiliary burners will be in operation for 170 hours per annum.

(10) The burners will operate at 60% of the maximum continuous rating of the thermal capacity of the facility. Therefore, the burner capacity will be approximately 96MW.

(11) As stated in Environment Agency Guidance Note H1 (h) the combustion of heavy fuel has emissions of 0.26 t CO_2/MWh.

2.2 AD Plant

For the purposes of this assessment, the following assumptions have been applied to the operation of the AD plant:

(1) The facility will generate up to 1MWe with a parasitic load of 0.2MWe.

(2) The facility will be available to operate for 8,352 hours per annum. During periods when the facility is not available the facility will operate at 20% of the parasitic load.

(3) The power generated by the AD plant is considered to be generated from Renewable Sources. As stated in Environment Agency guidance note H1 Annex H – Global Warming Potential, 'carbon dioxide released from the conversion of renewable sources, a factor of zero should be assigned'. The guidance explains that renewable non-fossil energy sources include biomass, landfill gas, sewage treatment plant gas and biogas.

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 installation.

Table 3.1 - UK Electricity Supply Characteristics[1]

Energy source	Proportion of UK supply (%)	Carbon emissions during operation (gCO_2/kWh)
Coal	17.0	910
Natural gas	32.3	390
Nuclear	23.7	0
Renewables	24.3	0
Other	2.5	590

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. 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 Rivenhall IWMF 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 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 is equivalent to 380 g/kWh.

We have made the following assumptions regarding the energy outputs from the installation.

- The CHP Plant will generate up to 49 MW of electricity with a net output of 5.5MW, giving a gross and net electrical efficiency of 26.0% and 22.8% respectively.
- The AD facility will generated up to 1 MW of electricity with a net output of 0.8 MW, assuming 8,352 hours operation.
- For the purposes of this greenhouse gas assessment there will be no heat export from the CHP Plant or the AD plant. It should be noted that the CHP Plant will supply heat to the Pulp Plant. If this heat export was included within the assessment it would lead to a more thermally efficient process, and therefore a more favourable assessment.

[1] Department of Energy and Climate Change. Fuel Mix Disclosure data table (01 April 2015 to 31 March 2016)

On this basis:

- The CHP Plant will generate approximately 399,000 MWh of power per annum. Of this power approximately 348,000 MWh per annum will be available for export. This will displace a total of approximately 135,700 tonnes of carbon dioxide equivalent.
- The AD facility will export approximately 6,680 MWh of power per annum and this will displace a total of approximately 2,600 tonnes of carbon dioxide equivalent.
- In total the installation will export approximately 354,680 MWh of power per annum. This will displace up to approximately 138,300 tonnes of carbon dioxide.

4 EMISSIONS FROM THE IWMF

The CHP Plant will release carbon dioxide from the combustion of the carbon content of commercial and industrial (C&I) waste; and the combustion of biogas produced from the processing of organic waste within the AD facility.

4.1 CHP Plant

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

During start-up, auxiliary burners fired with fuel oil 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 shut-down, the auxiliary burners will be used to ensure complete burn-out of the waste. The combustion of natural gas will release carbon dioxide.

4.1.1 Emissions from the Process

The CHP Plant will export 585 kW of power per tonne of input waste.

The carbon dioxide equivalent emissions would be 1,283kg per tonne of input waste, of which 477 kg is derived from fossil fuels (approximately 462kg CO_2 and 15 kg N_2O).

The total carbon dioxide equivalent emissions from fossil fuels (excluding auxiliary fuels) will be approximately 284,100 tonnes per year (approximately 274,900 tonnes CO_2 and 9,200 tonnes N_2O).

4.1.2 Electricity Import

During periods of start-up and shutdown the CHP Plant will have an electrical demand of approximately 850 MWh electricity; and during periods of non-availability the facility will have an electrical demand of approximately 650 MWh electricity. Therefore the CHP Plant will consume approximately 1,500 MWh of electricity per annum.

As stated in Environment Agency Guidance Note H1 (h) the import of electricity from public supply should be assumed to have emissions of 0.166 t CO_2/MWh. Therefore the CHP Plant is anticipated to release approximately 600 tonnes per year of carbon dioxide equivalent from the import of electricity.

4.1.3 Emissions from Auxiliary Firing

The auxiliary burners will consume approximately 25,000 MWh of fuel oil per annum and there will be a total of approximately 6,200 tonnes per year of CO_2 equivalent from the combustion of fuel oil for auxiliary firing.

4.2 AD Facility

4.2.1 Emissions from the Process

Emissions from the combustion of biogas within the AD facility are considered to release approximately 0 tonnes per year of carbon dioxide equivalent.

4.2.2 Electricity Import

During periods of non-availability the facility will have an electrical demand of approximately 340 MWh electricity.

As stated in Environment Agency Guidance Note H1 (h) the import of electricity from public supply should be assumed to have emissions of 0.166 tCO_2/MWh. Therefore the AD facility is anticipated to release approximately 60 tonnes per year of carbon dioxide equivalent from the import of electricity.

4.2.3 Emissions from Firing of Fuel Oil

During normal operation of the AD facility there will be no emissions of carbon dioxide or equivalent from the AD facility. It is acknowledged that heat will be required by a package boiler for the start-up of the AD facility during commissioning. It is not expected that this boiler will be required to operate during normal operation and has therefore not been considered within this assessment.

4.3 Summary

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

- 274,900 tonnes per year of carbon dioxide equivalent would be released from the incineration of non-biogenic waste;
- 9,200 tonnes per year of carbon dioxide equivalent from nitrous oxide from the incineration process;
- 600 tonnes per year of carbon dioxide equivalent from imported electricity for the incineration facility;
- 6,200 tonnes per year of carbon dioxide equivalent from the combustion of fuel oil for auxiliary firing in the CHP Plant; and
- 60 tonnes per year of carbon dioxide equivalent from imported electricity for the AD facility.

Therefore, in total it is predicted that approximately 290,960tonnes per year of carbon dioxide equivalent would be released from the Installation.

5 CONCLUSIONS

The information presented within this assessment is summarised below.

	GWP (tonnes CO_2 equivalent)			
Process	**CHP Plant**		**AD Facility**	
Parameter	**Released**	**Saving / Offset**	**Released**	**Saving / Offset**
CO_2 emissions from derived from fossil fuels(a)	274,900		0	
N_2O from the process (urea) (b)	9,200		0	
Indirect CO_2 emissions (imported electricity) (c)	600		3	
Direct CO_2 emissions (auxiliary fuel) (d)	6,200		0	
Total released (e=a+b+c+d)	**290,900**		**60**	
Energy recovered (electricity) (f)		135,700		2,600
Energy recovered (heat) (g)		-		-
Total offset (h=f+g)		**135,700**		**2,600**
Net GWP (j= e-h)	**155,200**		**-2,340**	

To conclude, from the operation of the Rivenhall IWMF there will be an increase of approximately 152,860[2] tonnes per year of carbon dioxide equivalent from the generation of power from the incineration of MSW and C&I waste and processing of organic waste in the Rivenhall IWMF compared to generating the equivalent power in a conventional power station.

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, such as the export of treated residual waste overseas for disposal and treatment. Furthermore, no allowance has been made for the export of heat from the CHP Plant to the Pulp Plant.

[2] A WRATE assessment was completed for the original IWMF planning application which considered the holistic impact of the facility which included direct and indirect emissions (construction, transport, disposal of residues, etc.). This reported annual savings of greater than 120,000 tonnes of carbon dioxide emissions compared to existing waste management arrangements.

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