FICHTNER
Consulting Engineers Limited

VIRIDOR
BEDDINGTON ERF
GREENHOUSE GAS ASSESSMENT

Fichtner Consulting Engineers Limited
Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW, United Kindom
t: +44 (0)161 476 0032 f: +44 (0)161 474 0618 www.fichtner.co.uk

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1 INTRODUCTION

The aim of this report is to assess the impact of greenhouse gas emissions from the proposed Beddington Energy Recovery Facility (ERF) and other forms of power generation.

All power plants that combust fuel result in the continuous release of combustion products, by far the largest constituent being carbon dioxide.

This report examines the amount of greenhouse gas released through the combustion of waste in the Beddington ERF. Emissions of CO_2 have been calculated, and other greenhouse gases released (for example N_2O) have been presented as a CO_2 equivalent.

Power generated through energy recovery from waste displaces electricity that would have otherwise been sourced from conventional power stations. 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) has been calculated.

1.1 Displaced Power

Table 1.1 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 ERF.

Table 1.1- UK electricity supply characteristics[1]

Energy source	Proportion of UK supply	Carbon emissions during operation
	%	gCO_2/kWh
Coal	28.9	910
Natural gas	44.2	400
Nuclear	17.3	0
Renewables	7.9	0
Other	1.7	620
Overall average		**450**

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 of the planned ERF.

It is most likely that the power displaced by the ERF would otherwise be generated by gas-fired combined cycle gas turbine (CCGT) power plants, or from coal fired power plants. Generation using CCGT technology is more thermally efficient and presently has a lower average cost per unit of electricity produced than coal-fired power plants. Economics of operation dictate that either coal or gas may be preferable at any particular time, which would affect the specific release of carbon dioxide.

[1] Department of Energy and Climate Change. Fuel Mix disclosure Table 1 April 2010 – 31 March 2011

The change in carbon dioxide emissions estimated for the Beddington ERF will conservatively be based on the UK ration of coal-fired to gas-fired generation. The proportion of coal-fired generation is 28.9 / (28.9 + 44.2) = 39.5%, which gives an average carbon intensity of 0.395*910 + 0.605*400 = 601 kg of CO_2 released per MWh of power generated.

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

- The ERF will generate up to 26.1 MW of electricity with a net output of 22.2 MW, giving a gross and net electrical efficiency of 27.9% and 23.7% respectively.
- There will be no heat export from the Beddington ERF for the basis of this greenhouse gas assessment. It should be noted that the facility is CHP ready for up to 20 MW of heat export, and that exporting heat would lead to a more thermally efficient process, and therefore a more favourable assessment.

On this basis:

- The plant will generate approximately 173,000 MWh of power per annum and this will displace a total of approximately 107,000 tonnes of carbon dioxide equivalent.

1.2 Emissions from the proposed Beddington ERF

The Beddington ERF will release carbon dioxide from the combustion of the carbon content of municipal solid waste (MSW) and commercial and industrial (C&I) waste. Carbon dioxide released from the combustion of materials containing carbon derived from fossil fuels 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 the commencement of feeding waste into the combustion chamber. In addition, these burners will be used to maintain the temperature within the boiler above 850°C, as required by WID. During shut-down, the auxiliary burners will be used to ensure complete burn-out of the waste. The combustion of fuel oil will release carbon dioxide.

Emissions from the Process

We have made the following assumptions regarding the waste feed.

- As stated in the supporting information, the plant will have a nominal design capacity of 35.22 tonnes/hour of waste with a net calorific value (NCV) of 9.8 GJ/tonne. At this design capacity and NCV and an annual utilisation of 7,800 hours the plant could incinerate approximately 275,000 tonnes per year. For the purposes of this greenhouse gas assessment, these operating conditions have been applied.
- Typical composition of combustible municipal and commercial and industrial waste contains 23.4% carbon by weight.
- 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.
- The ERF will generate up to 26.1 MW of electricity with a net output of 22.2 MW, giving a gross and net electrical efficiency of 27.9% and 23.7% respectively.
- Nitrous oxide is emitted a concentration of 6 mg/m^3.

On this basis:

- The plant would export 647 kW of power per tonne of input waste;
- The carbon dioxide equivalent emissions would be 858 kg per tonne of input waste, of which 321 kg is derived from fossil fuels (309 kg CO_2 and 12 kg N_2O);
- The total carbon dioxide emissions from fossil fuels (excluding auxiliary fuels) will be 85,000 tonnes per tonnes per year.
- The total emission of nitrous oxide from the facility will be 3,300 tonnes per annum

Electricity Import

We have made the following assumptions regarding the electricity imported by the facility:

- The facility will have a parasitic load of 3.9 MW.
- The ERF will be available to operate for 7,800 hours per annum. During periods when the facility is not available the facility will operate at 20% of the parasitic load.

  The facility will be in start-up and shut down for 340 hours per annum with a parasitic load of 3.9MW. Therefore the facility will have a non-availability of 620 hours per annum with a parasitic load of 0.8 MW. On this basis:

  - during periods of start-up and shutdown the facility will have an electrical demand of approximately 1,350 MWh electricity; and
  - during periods of non-availability the facility will have an electrical demand of approximately 500 MWh electricity.

As stated in Environment Agency Guidance Note H1 (h) the import of electricity from public supply will have emissions of 0.166 t CO_2/MWh. Therefore the Beddington ERF facility is anticipated to release approximately 300 tonnes per year of carbon dioxide from the import of electricity.

Emissions from Auxiliary Firing

We have made the following assumptions regarding the incineration process, and the start-up and shut-down procedures.

- The ERF will have 10 start-ups and shut-downs per line per annum. Each start up will take 16 hours, and each period of shut-down will take 1 hour. The auxiliary burners will operate for 340 hours per annum.
- The burners operate at 60% of the maximum continuous rating of the incinerator capacity. Therefore the burner capacity will be approximately 57.5MW.
- The burners will use approximately 19,000 MWh of fuel oil per annum.
- As stated in Environment Agency Guidance Note H1 (h) the combustion of heavy fuel has emissions of 0.26 t CO_2/MWh.

On this basis there will be a total of approximately 5,000 tonnes per year of CO_2 equivalent from the combustion of fuel oil for auxiliary firing.

Summary

A total of 85,000 tonnes per year of CO_2 equivalent would be released from biogenic waste burned; 3,300 tonnes per year of CO_2 equivalent from nitrous oxide from the process; 300 tonnes per year of CO_2 equivalent from imported electricity; and approximately 5,000 per year of CO_2 equivalent from the combustion of fuel oil for auxiliary firing.

Therefore, it is predicted that approximately 93,600 tonnes per year of CO_2 equivalent would be released from the Beddington ERF.

2 CONCLUSIONS

Taking into consideration the information presented within this assessment, the following summary is provided.

Parameter	GWP (tonnes CO_2 equivalent)	
	Released	**Saving/offset**
CO_2 emissions from derived from fossil fuels(a)	85,000	
N_2O from the process (urea) (b)	3,300	
Indirect CO_2 emissions (imported electricity) (c)	300	
Direct CO_2 emissions (auxiliary fuel) (d)	5,000	
Total released (e=a+b+c+d)	**93,600**	
Energy recovered (electricity) (f)		107,000
Energy recovered (heat) (g)		-
Total offset (h=f+g)		**107,000**
Net GWP (j= e-h)	**(13,400)**	

The combustion of MSW and C&I waste in the Beddington ERF is predicted to be approximately 93,600 tonnes of carbon dioxide equivalent. The electricity generated by the Beddington ERF, assuming the electricity is generated from the typical UK coal/gas mix, would displace 107,000 tonnes of carbon dioxide equivalent.

Therefore, there will be a net reduction of approximately 13,4000 tonnes per year of carbon dioxide from the Beddington ERF compared to generating the equivalent power in a conventional power station.

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