# HILL BARTON ENERGY GENERATION PLANT ENVIRONMENTAL PERMIT APPLICATION

**Global Warming Potential Assessment**

Prepared for: Stuart Partners Limited

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# 1.0 INTRODUCTION

SLR Consulting Limited (SLR) have been instructed by Stuart Partners Limited (SPL) to prepare an Environmental Permit (EP) application for a proposed energy generation plant involving the gasification of Refuse Derived Fuel (RDF) at Hill Barton Business Park, Stuart Way, Clyst St. Mary, Exeter, EX5 1DR to be operated by Exeter Waste to Energy Limited (EWEL).

The proposed facility will process commercial, industrial and municipal refuse derived fuel (RDF) at a capacity of up to 87,000 tonnes per annum (tpa). The technology will be based on gasification comprising moving grate furnace, steam boiler and turbine generator to produce electricity and the potential to recover heat. Flue gases will be treated to minimise polluting emissions and solid residues will be transferred off-site for treatment and recovery or disposal.

A detailed description of the process is provided in the Best Available Techniques and Operating Techniques Document in Section 5 of this EP application.

The Environment Agency (EA) requires that new EP applications must include a risk assessment to assess the potential environmental impacts of emissions from the proposed activities. The requirements are described in EA guidance *'Risk assessments for your environmental permit'* last updated February 2020. For those sites which result in direct and/or indirect emissions to air that impact global warming, an assessment of impact of air emissions on global warming must be undertaken in accordance with the EA's *'Assess the impact of air emissions on global warming'* guidance published 1 February 2016.

The Hill Barton Energy Generation Plant has the potential to contribute to global warming as a result of direct and indirect emissions to air. As such, the purpose of this report is to provide an assessment of the global warming potential (GWP) associated with the direct and indirect emissions from the facility to support the EP application.

## 1.1 Scope of Assessment

The EA's guidance suggests the following steps are used to calculate the impact on global warming.

1. Identify your greenhouse gas emissions.

2. Work out the impact these emissions have on global warming.

3. Work out the impact of your 'process option' on global warming.

4. Add up the impacts from steps 2 and 3 for each of your current or proposed process options to give the total impact on global warming.

The objective of this assessment is to enable:

- techniques to be chosen that have the least impact on global warming; and
- to establish the best available techniques to control emissions with GWP.

The GWP assessment has been carried out in accordance with the EA's guidance and the H1 software tool.

# 2.0 IDENTIFY GREENHOUSE GAS EMISSIONS & IMPACTS

## 2.1 Sources

Table 1 summarises the sources of greenhouse gas emissions from the installation.

Direct emissions of greenhouse gases are produced by the combustion processes, primarily in the form of Carbon Dioxide ($CO_2$). In addition, emissions of Nitrous Oxide ($N_2O$) are also released from the combustion process and as a by-product from the Oxides of Nitrogen ($NO_x$) abatement process. Indirect emissions of greenhouse gases are also produced by the energy imported to supply ancillary equipment for start-up and periods when the facility is not generating electricity. This will primarily be in the form of $CO_2$ from combustion of fossil fuels to generate electricity.

**Table 1 Summary of Greenhouse Gas Emission Sources**

| Emission Type | Source of Greenhouse Gas | Key Influence on Emissions |
|---|---|---|
| Direct | Combustion of waste. Primarily as $CO_2$. | Waste |
| Direct | Combustion of ancillary fuels to support combustion (start-up & shutdown, low temperatures etc) or provide back-up for emergency generator. Primarily as $CO_2$. | Liquid Petroleum Gas (LPG) for ancillary support<br>Diesel for back-up generator |
| Direct | By-product of $NO_x$ abatement techniques. Primarily $N_2O$ emissions. | Combustion temperature and reagent dosing rate |
| Indirect | Imported energy (to supply ancillary aspects of the process such as fans, motors etc) with off-site release of combustion gases. Primarily as $CO_2$. | Electricity source |

### 2.1.1 Carbon Dioxide Sources

$CO_2$ will be released as a product of the combustion of waste in the Energy Generation Plant, as well as the combustion of ancillary fuels to support combustion. Indirectly, $CO_2$ will be released off-site in association with imported energy in the form of electricity to support ancillary aspects of the process.

The amount of $CO_2$ released will depend on the carbon content of the fuel and the efficiency of combustion. As the purpose of waste to energy processes is to generate useable energy, high conversion rates of carbon in fuel to $CO_2$ are expected.

Each line will incorporate an auxiliary LPG-fired support burner in both the gasification and oxidisation units to enable temperature to be maintained at all times to comply with Industrial Emissions Directive (IED) requirements. For example, during start-up, shut down and abnormal operations such as feed chute blockage, the auxiliary, LPG-fired support burners will be used to maintain furnace temperatures within IED limits.

### 2.1.2 Nitrous Oxide Sources

Thermal waste treatment is a low contributor of emissions of $N_2O$ in terms of anthropogenic emissions and is not usually reported as a part of $NO_x$ estimation. However, it has a relatively high global warming potential and can form a small but significant component of overall global warming potential. The European Commission Joint Research Centre – Best Available Techniques Reference (BREF) document on Waste Incineration (December 2019)[1] describes that $N_2O$ can arise from:

- use of lower thermal treatment (combustion) temperatures - typically below 850°C; and
- the use of Selective Non-Catalytic Reduction (SNCR) for $NO_x$ reduction.

#### Thermal Treatment

Nitrous oxide ($N_2O$) can be emitted if there is insufficient oxygen and combustion takes place below 850°C. For municipal waste treatment, $N_2O$ emissions of 1 - 12 mg/Nm³ (for individual measurements) and averages of 1 -

[1] Section 2.5.9.1 of the December 2018 Final Draft BREF document on Waste Incineration.

2 mg/Nm³ are seen. For fluidised bed plants, lower temperatures together with the lack of air can mean $N_2O$ emission values ~10 mg/Nm³, with some values reported up to 100 mg/Nm³ and above.

**Selective Non-Catalytic Reduction**

Selective Non-Catalytic Reduction (SNCR) is commonly used for the abatement of NOx. In the SNCR process, ammonia ($NH_3$) or urea ($CO(NH_2)_2$) is injected into the furnace to reduce NOx emissions. SNCR promotes the formation of $N_2O$, dependent upon reagent dose rates and temperature. Values of 20 - 60 mg/m$^3$ have been measured, especially where low NOx values are sought ($N_2O$ increases when higher dose rates are used to secure lower NOx emission targets). The use of urea instead of ammonia can lead to higher $N_2O$ emissions, as much as 2 - 2.5 times higher. For the purposes of this assessment, a value of 20 mg/m$^3$ has been assumed.

**Combustion of LPG**

The combustion of LPG primarily releases CO. However, the quantity of pollutants released varied dependent on burner design, parameters and venting[2].

## 2.2 Process Options

The objective of this assessment is to demonstrate that BAT will be applied to control emissions with global warming potential. The EA's guidance requires that other process options are considered as part of this assessment. The key emissions of greenhouse gases from waste-to-energy processes are $CO_2$ and $N_2O$. Consideration has been given to other process options which may be available as alternatives to those proposed in this application, to identify any which could affect releases of greenhouse gases. This is summarised below.

### 2.2.1 Carbon Dioxide

The ultimate objective of any type of 'waste to energy' thermal treatment process is to convert the carbon content of waste into energy by combustion, whether that is by full conversion to heat and power on site, or partly off-site by the production of intermediate waste fuels for combustion elsewhere. If conversion technologies are chosen which achieve high burnout of carbon to maximise energy release, then the ultimate emissions of carbon dioxide would be similar per tonne of waste regardless of technology and whether the releases occur on-site or by intermediate fuels combusted off-site.

This principle is confirmed in Item 51 of the EA's guidance 'How to comply with your environmental permit: additional guidance for: The Incineration of Waste (EPR 5.01, March 2009)' (EPR 5.01) states the following in relation to emissions of carbon dioxide:

'The global warming potential (GWP) of the installation will be derived mainly from the CO2 releases arising from the waste combustion. As it is the purpose of an incinerator to convert wastes into (primarily) water and CO2 attention should not focus upon these releases but upon the following: CO2 equivalent releases resulting from N2O releases. These can contribute in the order of 10% of the GWP, and may be minimised by appropriate selection and optimisation of SNCR reagent injection;'

For this reason, it is not considered necessary to consider releases from different conversion technologies as alternative process options for this assessment.

Item 50 of EPR 5.01 states the following:

'All measures that reduce fuel energy use also reduce the CO2 emissions. The selection, when possible, of raw materials with low organic matter content and fuels with low ratio of carbon content to calorific value reduces CO2 emissions. In this sector this is only relevant to the support fuels used. In general, natural gas will be the preferred option. If not available, low sulphur gas oil provides an alternative.'

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[2] Liquified Petroleum Gas Combustion https://www3.epa.gov/ttn/chief/ap42/ch01/final/c01s05.pdf

The Hill Barton Site proposes the use of LPG as an auxiliary fuel for start-up and shut down purposes. As diesel could potentially be used as an alternative process option, this aspect will be considered as part of this assessment.

Item 52 of EPR 5.01 states the following:

*'Improving installation energy efficiency (including recovery) will prevent CO2 release by other installations. This may be demonstrated by providing energy balance (Sankey) diagrams and quoting the net energy production per tonne of waste produced.'*

The Hill Barton Energy Generation Plant will be designed to achieve a high level of energy conversion. The BATOT document submitted in Section 5 of this application describes how the relevant energy efficiency techniques in S5.01 and 2019 BREF document on Waste Incineration have been taken into account. This includes (a) components selected to maximise in-process energy efficiency (b) process control systems to ensure than equipment operates as and when required, and (c) in-process measures to optimise plant efficiency.

As this aspect is covered in the BATOT document it is not considered further in this assessment.

Section 2.5.9 of the December 2019 Final Draft BREF document on Waste Incineration states:

*'There are essentially two ways of reducing greenhouse gas emissions:*

- *Increase the efficiency of energy recovery and supply…;*
- *Control $CO_2$ emissions using flue gas treatment.*

*Production of sodium carbonate by reacting $CO_2$ in the flue gases with NaOH [sodium hydroxide] is possible.'*

As identified above as measures proposed to achieve a high level of energy conversion are discussed with the BATOT document, this aspect is not considered further in this assessment.

Production of sodium carbonate by reacting $CO_2$ in the flue gases with NaOH has been ruled out from further assessment on the basis of it not being a well-established technique, issues associated with the use of significant volumes of NaOH and the release of $CO_2$ in NaOH production.

### 2.2.2 Nitrous Oxide

Item 51 of EPR 5.01 states that attention should focus on the following:

*'CO2 equivalent releases resulting from N2O releases. These can contribute in the order of 10% of the GWP, and may be minimised by appropriate selection and optimisation of SNCR reagent injection;'*

A SNCR system is proposed for the control of $NO_x$ emissions from the installation. An assessment of BAT for $NO_x$ abatement is presented in Appendix 04 to the BATOT in Section 5 of this application and concludes that this technique represents BAT for the installation. The impact of $NO_x$ emissions on global warming are covered in that $NO_x$ BAT assessment and therefore are not included in this report.

## 2.3 Impact of Emission Sources of Global Warming

Calculation of the global warming potential of direct and indirect emissions from the process is estimated using the H1 software tool and presented in Table 2 and Table 3 below.

In calculating the Global Warming Potential of emissions, H1 indicates that a $CO_2$ emission factor of zero should be used for renewable energy sources such as waste to conform with convention to treat such emissions as carbon-neutral. Therefore, the carbon dioxide emissions from combustion of waste are not included in the assessment.

Direct emissions of carbon dioxide from use of LPG as auxiliary fuel for start-up and shutdown have been estimated based on information obtained from EWEL.

Indirect emissions of carbon dioxide from imported electricity from the public supply, used during periods when the plant itself is not generating, have been estimated

The plant will produce electricity to supply the plant's parasitic load with any excess is exported to the grid. The plant is expected to provide net 8.2 MWe for export in electricity only mode and 2.3MWe and 24.2MWth for export in CHP mode. The exported energy is considered to be $CO_2$ neutral and will displace $CO_2$ which would otherwise be generated from the public supply. This is presented in Table 2 and Table 3 as a negative emission which offsets the other GWP sources for the site.

Calculation of the global warming potential of $N_2O$ emissions from the process has been estimated assuming an emissions concentration of 20mg/m$^3$ and using the flow rates derived from the air quality modelling.

The following tables reproduce the estimation given by the H1 software tool.

**Table 2 Global Warming Potential of Emissions in Electricity Only Mode**

| Source | Release | Tonnes per annum | GWP tonnes $CO_2$ equivalent per annum |
|---|---|---|---|
| $CO_2$ from imported electricity | indirect | 7 | 7 |
| $CO_2$ from LPG combustion | direct | 138 | 138 |
| Nitrous oxide from combustion & SNCR | direct | 23 | 7,214.8 |
| Exported electrical energy | indirect | -25,092 | -25,092 |
| Total global warming potential | | | -17,732.2 |

**Table 3 Global Warming Potential of Emissions in CHP Mode**

| Source | Release | Tonnes per annum | GWP tonnes $CO_2$ equivalent per annum |
|---|---|---|---|
| $CO_2$ from imported electricity | indirect | 7 | 7 |
| $CO_2$ from LPG combustion | direct | 138 | 138 |
| Nitrous oxide from combustion & SNCR | direct | 23 | 7,214.8 |
| Exported electrical energy | indirect | -7,038 | -7,038 |
| Exported heat energy | indirect | -45,375 | -45,375 |
| Total global warming potential | | | -45,013.2 |

## 2.4 Comparison of Process Options

A comparison of alternative options for NOx control, including assessment of GWP, is provided elsewhere in Appendix 04 to the BATOT in Section 5 of this application and is therefore not repeated here.

# 3.0 CONCLUSIONS

Global Warming Potential emissions as carbon dioxide equivalents have been estimated for the proposed Hill Barton Energy Generation Plant in accordance with the Environment Agency's Horizontal Guidance Note, H1. The assessment was made using the H1 software tool, developed to support the H1 Guidance method.

Energy use information has been estimated from similar projects elsewhere and emissions of carbon dioxide and nitrous oxide have been estimated from information in the BREF notes.

This GWP assessment has only considered alternative process options for the combustion of auxiliary fuel, as:

- Alternative options for NOX abatement are covered in Appendix 05 to the BATOT in Section 5 of this application; and
- The generation of carbon dioxide from the burning of waste for energy recovery is assumed to be carbon-neutral.

H1 does not provide criteria for the determination of GWP significance. The total GWP per annum is estimated at -17,732.2 tonnes per annum carbon equivalent in electricity only mode or -45,013.2 in CHP mode.

For comparison, government figures indicate that the UK is responsible for releasing around 700-800 million tpa $CO_2$, the average household is responsible for around 25 tpa $CO_2$ and a 1km stretch of motorway generates around 3000 tpa as $CO_2$ [based on 70,000 vehicles per day at an average release rate of 120 g/km].

The assessment indicates that the GWP of the proposed installation is significantly positive.

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