Appendix 2.3: Carbon Assessment

This report was prepared to accompany the 2016 application. For details of the currently proposed development, please see Volume 1 of the ES.

Vismundi

BRITANIACREST RECYCLING

WEALDEN WORKS 3Rs FACILITY

CARBON ASSESSMENT

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Carbon Assessment

1. Introduction

1.1. This document provides a greenhouse gas assessment of the proposed facility, based on an estimate of its operational carbon footprint. Emissions from the proposed thermal treatment facility operating in electricity-only mode and potential combined heat & power (CHP) mode have been estimated. For comparison, the greenhouse gas emissions associated with emissions from landfilling of waste have been estimated.

1.2. A key driver in forcing waste producers and disposers to consider their waste management systems has been the Landfill Directive, which introduced a tax system to discourage the landfilling of wastes with methane producing potential. The reason for this is that methane is a powerful greenhouse gas that is released to the atmosphere as biodegradable wastes break down under anaerobic conditions in the landfill site.

1.3. Whereas in the recent past Government has been able to apply further mechanisms to the disposal of municipal wastes - such as the Landfill Allowance Trading Scheme (LATS) – which acted to drive local authorities away from using landfill and move the management of municipal waste up the waste management hierarchy, this did not apply to commercial and industrial wastes. The challenge with commercial and industrial wastes is that the same greenhouse gas mechanisms apply, but the only driver has been the Landfill Tax itself.

1.4. Avoidance of landfill can only be achieved by the adoption of materials recovery, recycling and energy recovery and these require infrastructure to be developed to enable them to be achieved. In the absence of such infrastructure, the avoidance of landfill and the reduction in greenhouse gases that accompany it will not be achieved. The purpose the Wealden 3Rs application is to provide such infrastructure that can be used for the treatment of wastes produced by business and commerce – currently not available through the facilities developed by the local authorities.

1.5. The purpose of the Wealden 3Rs development is, therefore, to both provide reliable and effective waste management and also to limit the amount of greenhouse gases arising from the disposal of the waste.

2. The Waste Management Hierarchy

2.1. The Waste Management Hierarchy is the fundamental principle of sustainable waste management laid down by the European Waste Framework Directive (2008/98/EC). The most effective management of greenhouse gas emissions from waste disposal is to limit the quantities of waste being disposed of in the first place. However, despite any source separation for recycling and reuse, the waste disposal system still requires the management and disposal of the residual waste stream – ie. a stream that is difficult or impossible to segregate at source, but will still contain some recyclable material, and in the absence of infrastructure to treat it, would be disposed of by landfill.

2.2. The objective of the Wealden 3Rs facility is to accept such wastes, extract for reuse or recycling the materials that can be effectively recovered and then recover the energy content of the residual material. It is anticipated that landfill disposal will be reduced to less than 5% by weight of the incoming waste stream – and even all residues from the energy recovery process will be recycled. As described in Chapter 4 of the accompanying Environmental Statement, an alternative technology assessment determined that the best arrangement for achieving this objective is a mechanical pre-treatment facility, followed by an energy recovery facility. It was then determined that the most reliable energy recovery technology under the circumstance would be moving grate combustion.

2.3. The proposal, then is for a facility that will accept the residual commercial & industrial waste stream, segregate out metals, some plastics and inert materials for recycling and thermally treat the remaining a proportion of the waste, dramatically reducing the waste volume, recovering the useful embodied energy within the materials and rendering the combustion residues inert in terms of greenhouse gas releases. The energy will be recovered in the energy from waste facility in the form of electricity exported to the grid. Whilst the plant will be built with the capability to export heat to local consumers, and thus potentially operating as a Combined Heat and Power (CHP) plant - no local demand for heat has been secured at present and initially the facility may generate electricity only. This may change if developments in the surrounding area allow heat customers to be secured.

2.4. Waste will be delivered from arisings in West Sussex and the southern counties of East Sussex, Surrey, and maybe Hampshire.

3. Methodology and Assumptions

3.1. This assessment provides an estimate of the greenhouse gas emissions from the operational phase of the proposed 180,000 tpa capacity thermal treatment facility, against a baseline of greenhouse gas (GHG) emissions from landfilling of waste, which the current alternative. It therefore allows an assessment of the emissions reductions which would be achieved by the proposed facility against the current "business as usual" situation of landfilling the waste.

3.2. The majority of potential greenhouse gas emissions arise through the operational phase of the proposed development, rather than its construction, and therefore for the purposes of this assessment the operational phase only has been considered.

3.3. Due to the difficulty and time taken to develop heat networks, at this stage of the application process, customers for district heat distribution from the proposed facility have not been secured. The facility will, therefore, be built with the capability to export heat, but will initially operate in electricity generation mode. However, the nearby brickworks, has been identified as a potential future heat customer. The proposed North Horsham mixed use development also offers potential for heat use in the future.

3.4. Hence, this assessment has considered two scenarios for energy generation from the proposed thermal treatment facility: generation of electricity only, in which electricity sold displaces grid electricity production; and generation of electricity and heat in Combined Heat and Power (CHP) mode in which heat sold displaces on-site heat generation at potential local heat consumers' premises.

3.5. In assessing greenhouse gas emissions it is necessary to establish both the boundaries and the constituent elements of the assessment, which have been defined as follows:

3.5.1. **Process emissions** – greenhouse gas emissions from the waste treatment processes or from landfilling of the wastes which the new facility seeks to divert to energy generation. This may be through, for example, combustion of waste in the thermal treatment facility or through the release of methane from biodegradable wastes degrading in landfill sites. In addition this category includes any energy consumed in the combustion process, such as auxiliary fuels or electricity, and includes the energy consumed in bulking of waste at waste transfer stations (WTS).

3.5.2. **Avoided emissions** – emissions that are avoided by the production or recovery of useful products from the waste, which avoid the need to consume resources in the production of virgin materials and thereby release emissions to the atmosphere. For example, electricity recovered from the thermal treatment facility can avoid the need to consume fossil fuels directly in the production of this energy at power stations. Another example is recycling, in which re-use or recycling of the residues (*e.g.* bottom ash or ferrous metals) can avoid the need to consume resources in the replacement of such materials.

3.5.3. **Transportation** – this includes collection of waste and delivery to site alongside transportation of other key reagents and fuels required to support the operation of the facility. Transport emissions are also associated with disposal of residues from waste treatment. Transport of materials recycled is accounted for in the product life cycle analysis. Derived avoided emissions factors, and transport emissions for movement of materials to recycling are therefore not estimated separately in order to avoid double-counting. Staff transport for site workers is excluded, as such personal transport is outside the scope of this assessment.

3.6. Short-cycle (biogenic) and fossil (non-biogenic) carbon

3.6.1. To aid understanding of the assessment it is important to understand the distinction between short-cycle (or biogenic) carbon sources and those which are fossil (or non-biogenic) carbon sources. Essentially there are two types of carbon that are considered within greenhouse gas footprint assessments:

- Biogenic (short-cycle) carbon - the biogenic sources feed the short-term carbon cycle, which assumes such carbon was taken up recently by the biomass when it grew. If such materials are grown sustainably there is negligible or beneficial land use change and an equilibrium is reached between carbon taken up from and that released to the atmosphere; and

- Non-biogenic (fossil) carbon - fossil sources which feed the long-term carbon cycle, based on carbon which prior to combustion was stored underground for a long time and hence is regarded as a net addition to the atmosphere.

3.6.2. The Intergovernmental Panel on Climate Change guidelines on greenhouse gas assessment and reporting stipulate that biogenic emissions of carbon should be dealt with in the assessment of emissions from waste as follows:

'Consistent with the 1996 Guidelines (IPCC, 1997), only CO_2 resulting from oxidation during incineration and open burning of carbon in waste of fossil origin (e.g. plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered net emissions and should be included in the national CO_2 emissions estimate. The CO_2 emissions from combustion of biomass materials (e.g. paper, food, and wood waste) contained in the waste are biogenic emissions and should not be included in national total emission estimates. However, if incineration of waste is used for energy purposes, both fossil and biogenic CO_2 should be estimated. Only fossil CO_2 should be included in national emissions under Energy Sector while biogenic CO_2 should be reported as an information item also in the Energy Sector.'

3.6.3. Biogenic emissions are considered to be from biomass sources and are therefore treated, like biomass renewables, as having a zero carbon emissions factor, but are reported separately as an information item.

4. Waste input

4.1. The waste input to the thermal treatment facility is assumed to be based on the capacity of the plant to treat approximately 180,000 tonnes per annum of commercial and industrial (C&I) waste. The additional 50,000 tonnes being recycled from the facilty will be ignored, as this would probably take place whether the thermal treatment facility was constructed or not.

4.2. The input waste composition is assumed to be as shown in Table 1:

Table 1

Waste stream components	Weight %
Paper	9.77
Cardboard	4.19
Plastic film	4.41
Dense plastics	5.22
Textiles	2.11
Misc. non-combustibles	6.12
Glass	8.13
Putrescibles	44.75
Ferrous metals	2.85
Non ferrous metals	2.61
Misc. combustibles	9.87
Total	**100**

5. Proposed Thermal Treatment Facility

5.1. The proposed thermal treatment facility will be located on the applicant site off Langhurstwood Road, Horsham , with the capacity to treat 180,000 tpa of residual C&I Waste.

5.2. **Process emissions**

5.2.1. Due to the oxidisation of non-biogenic carbon contained in the waste (for example, plastic waste) the process results in direct emissions of fossil greenhouse gases to the atmosphere. It is assumed that all of the fossil carbon is oxidised and released in the process, minus a small proportion of carbon which remains in bottom ash residues. Biogenic emissions from the process (e.g. from burning organic waste) have also been estimated, but are reported separately from the overall balance, as consistent with IPCC guidelines.

5.2.2. To ensure that the facility complies with the requirements of the Industrial Emissions Directive (2010/75/EU), a minimum temperature of 850°C must be maintained for at least 2 seconds when wastes are being burned. The proposed facility is therefore equipped with supplementary burners which are fueled with gas oil and GHG emissions have been estimated based on the estimated annual fuel consumption.

5.2.3. In addition to the CO_2 emissions there is potential for nitrous oxide (N_2O) to be emitted from waste combustion due to of operation of the abatement plant to control NOx emissions. The proposed facility will use urea as a reagent for NOx control, and a resultant N_2O concentration of 16 mg/m^3 of exhaust stack flow is assumed.

5.2.4. Under the Industrial Emissions Directive, carbon in ash must not exceed 3% w/w, so it is assumed that all combustion residues (both bottom ash and air pollution control residue) are inert with regard to GHG emissions. The non-oxidised carbon sequestered in incinerator bottom ash is estimated, as is the atmospheric carbon dioxide absorbed into bottom ash during the weathering period (assumed total absorption of CO_2 is equivalent to 1 % of the weight of dry bottom ash.

5.3. **Avoided emissions.**

5.3.1. It is assumed that 80 % of ferrous metals and 60 % of non-ferrous metals are recovered from the waste-stream at the processing facility. Materials recycling avoids emissions from the production of metals from virgin material that would otherwise have occurred.

5.3.2. It is also possible to avoid emissions through the recycling of the combustion residues (bottom ash minus metals) to the construction industry for use as aggregate, again avoiding the need to consume resources in the production of virgin materials. It is assumed that 100% of the bottom ash will be sold for use as aggregate.

5.3.3. The avoided emissions for each of the materials concerned are taken from Carbon Balances and Energy Impacts of the Management of UK Wastes, ERM (2006) and shown in Table 2.

Table 2: Emissions avoided through material recovery

Material	Avoided emissions (t CO_2/t)
Ferrous metals	0.705
Non-ferrous metals	12.30
Inert aggregate	0.0023

5.3.4. Electricity generated by the thermal treatment facility and exported to the grid displaces conventional grid electricity production, avoiding emissions that would have been associated with it. Similarly, any heat exported by the Facility to nearby consumers could avoid the need to generate heat from combustion of fuel or via electricity use at those premises.

5.3.5. The 3Rs Facility will be "CHP Ready", and if a heat network can be connected, it will be able to achieve much higher total efficiency operating in CHP mode - exporting both heat and electricity – than in pure generation mode. Although a heat study has been carried out and at least one potential future customer for exported heat has been identified, it is expected that initially the facility will export electricity only. Hence two scenarios are considered here:

- Electricity only
- CHP mode, generating electricity and heat

5.3.6. The electricity-only scenario is conservative in terms of GHG emission savings estimated, whilst the CHP scenario is more optimistic. In the electricity-only scenario, a thermal input of approximately 81.0 MW is assumed, with 21 MW recovered as electricity and exported to the grid at a net efficiency of 28.4 %.

5.3.7. In view of the uncertainty about potential demand for heat in CHP mode, the optimal position of a net efficiency of 75 % is assumed, with heat export at 60 % efficiency and electricity at 15 % of the same 81MW thermal input. This is equivalent to 51.60 MWth heat export and 12.90 MW electricity export.

6. Electricity and Heat Displaced – Greenhouse Gas Emissions Factors

6.1. Energy can be recovered in usable forms via heat or electricity. If processes result in the production of heat or electricity for export and use, this can avoid the need to take electricity from the national grid or to combust fossil fuels to produce heat. To enable a consistent assessment of the emissions avoided through the recovery of energy it is necessary to derive emissions factors that can be applied to every unit of heat or electricity captured and used.

6.2. Electricity exported is assumed to displace electricity drawn from the national grid. As the electricity in the grid is generated from coal, oil, gas, nuclear and renewables it is necessary to account for all these sources in the emissions factors. A GHG emission factor for the UK grid mix of electricity generation published by UK Government "Greenhous Gas Reporting – Conversion Factors 2016 is used to calculate the conventional electricity generation emissions avoided by production of electricity in a termal treatment facility of 0.41205 kgCO2e/kWh electricity generated.

7. Heat

7.1. In the CHP scenario, potential heat demand an overall emissions factor of 0.22963 kgCO2e/kWh heat displaced is used, taken from the boiler displaced data stated in 2016 Government GHG Conversion Factors for Company Reporting (September 2016). This is probably a conservative factor, as not all premises have central heating served by boilers.

8. Landfilling of Waste

8.1. It is assumed that all waste processed in the proposed thermal treatment facility would otherwise have been sent to landfill. Greenhouse gas emissions are released from a landfill site over time as the waste degrades. The avoided emissions from waste that would have been landfilled have been estimated using the greenhouse gas IPCC methodology stated in the "Intergovernmental Panel on Climate Change 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste". This method treats greenhouse gas emissions as if they are produced instantaneously after the waste has been landfilled. This approximation is reasonable for the purposes of this study, where the main focus is on the estimation of emissions from the 3Rs Facility. A proportion of landfill gas is assumed to be utilised for energy recovery via landfill gas engines. A proportion of carbon in waste sent to landfill is assumed to be sequestered and not to contribute to climate change through atmospheric release.

8.2. Key parameters are:

- Degradable organic carbon content (DOC) – fraction of waste that is biodegradable carbon;
- Dissimilable DOC – fraction of DOC that mineralises to CO2 and or CH4. The remainder is assumed not to degrade to gaseous products under the landfill condition;
- Methane content of the landfill gas (the rest is assumed to be carbon dioxide)

8.3. For the purposes of this study it is assumed that:

- 60 % of landfill gas is CH_4 (the remainder is short-cycle CO_2);
- The CH_4 usable capture rate at landfill is 50 % of the methane after accounting for oxidization;
- CH4 oxidisation to CO_2 by microbes is not assumed in this assessment
- A landfill gas engine efficiency is 38 %

9. Transport.

9.1. Emissions from transport are associated with the collection of waste by refuse collection vehicles (RCVs), transfer of waste in bulk from WTS to the Facility, and disposal of combustion residues from the Facility. In addition, emissions associated with delivery of process inputs (for example, reagents used in APC and gas oil for supplementary burners) to the facility are also estimated. Normally, transport from a facility is a CO_2 burden, but in the case of the 3Rs Facility, the thermal treatment plant will be processing residual waste that is already permitted to be processed at the site. Hence the impact of the thermal treatment facility will be to reduce the number of vehicles leaving the site carrying material to landfill. If there are 45,000 tpa of residue, this results in a reduction of transport equivalent to: (180,000 – 45,000)/20 = 6,750 vehicle journeys to landfill each year. If it is assumed that the landfill used is Redhill ie 32 Km, the vehicle-kilometers saved is 216,000 per year.

9.2. Bottom ash is assumed to be processed in a facility, at a location equi-distant to the landfill.

9.3. APC residues are assumed to be disposed of at a specialist Treatment Centre, at a distance of approximately 250 km from the proposed 3Rs Facility.

9.4. Other thermal treatment facility process inputs are assumed to be delivered by road, from sources also at 32 km distance.

9.5. Therefore the net transport impact of the facility is:

- The distance for Bottom Ash transportation (netted off in the vehicle distance calculated in 9.1 above); plus
- The additional travel distance for disposal of the APC residues (approximately 5400 tpa), ie 270 vehicles per year at an additional distance of 218 Km – 58,860 Km per year.
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9.6. Therefore the impact of the 3R Facility is to reduce vehicle-Kilometers by 157,140 Km per year, and from the Department of Energy & Climate Change standard set of GHG conversion factors 2016 for all HGVs (diesel), the CO_2 conversion factor is 0.702022 per Km.

10. Results

10.1. The results of the assessment are shown in Table 3.

Table 3: Summary of estimated emissions (tCO_2 equivalent per annum)

Emissions Source	Proposed Facility Electricity only	Proposed Facility with CHP
Process	+50,955	+50,955
Transport	-110,315	-110,315
Avoided CO_2		
Displaced Electricity Generation	-69,224	-42,521
Displaced Heat Generation	0	-94,791
Materials Recovery	-37,684	-37,684
Landfill Diversion	-76,505	-76,505
Total	-242,773	-310,861

11. Conclusions

11.1. The assessment of the potential carbon footprint for the proposed 3Rs Facility shows that it performs well, providing an estimated reduction in greenhouse gas emissions of approximately 242,700 tonnes of CO_2 equivalent per annum operated in electricity-only generation mode, and 310,800 tonnes of CO_2 equivalent per annum if it is able to be extended to run in CHP mode. This saving with electricity generation alone is equivalent to the annual emissions from approximately 39,700 homes.

11.2. Emissions savings from avoided landfilling of waste amount to approximately 76,500 t CO_2e per annum, and further savings of 38,000 t CO_2e per annum are achieved through recovery and recycling of metals from combustion residue (bottom ash).

11.3. Whilst combustion of waste in the thermal treatment facility produces emissions of 51,000 tCO_2e per annum, these are balanced by emissions savings from displaced electricity generation from the grid mix of mainly conventional power stations of between 69,200 t CO_{2e} per annum.

11.4. Over the expected lifetime of the proposed facility (assumed to be 25 years) total GHG emissions savings from the EfW facility amount to at least 6.06 million tonnes of CO_2 equivalent compared to the current landfilling of the waste, and over 7 million tonnes of CO_2 equivalent if CHP is developed early in its operational life.

11.5. In summary, the proposed facility is anticipated to have a significant positive impact on greenhouse gas emissions within West Sussex compared to the existing commercial and industrial waste management arrangements.