# Kronospan Low Carbon CHP Facility

## Appendix 9C

## Greenhouse Gas Emissions Assessment

**Prepared for: Kronospan**

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**DNS4-039**

## 1.0 INTRODUCTION

1.1.1 This appendix has been written in support of Chapter 9 of the Environmental Statement (ES) which supports the Development of National Significance (DNS) application for the Proposed Development. This appendix details the inputs, assumptions and calculations within the Greenhouse Gas (GHG) Emissions Assessment.

1.1.2 The planning application is seeking to install a new CHP Facility which would replace the normal operation of the K7 Biomass Plant and remove the requirement to build two of the gas engines which currently have planning consent and an EP to operate. In addition, as set out in Chapter 9 of the ES, the Site benefits from planning permission for an Orientated Strand Board (OSB) process which is not yet operational. GHG emissions associated with this project should be included in the future baseline for the Site.

1.1.3 Full details of the fuel strategy are set out in **ES Chapter 4.0 (Description of the Proposed Development)** and **ES Appendix 4A**. In summary the new CHP Facility would be fuelled by a mixture of material currently being used in the K7 Biomass Plant, process residues currently sold, on-site process residues, and additional forestry brash and grade C waste wood which would be imported. In addition, there would be an increase in site production which would result in additional process residues which would also be used as fuel for the CHP Facility.

## 2.0 SCOPE OF THE CALCULATION

2.1.1 The GHG emissions associated with the Proposed Development include the following:

**Construction:**

i) Indirect GHGs associated with the demolition of existing equipment and buildings needed to facilitate the development of the CHP Facility;
ii) Indirect GHGs associated with the transportation of waste material from site;
iii) Indirect GHGs associated with the construction of the CHP Facility; and
iv) Indirect GHGs associated with the transportation of construction materials to site.

**Operation:**

i) Direct GHGs from the combustion of biomass (existing process residues currently sold, biomass currently being used in the K7 Biomass Plant, on-site process residues, imported forestry brash for direct use in the CHP Facility, increase in import of grade C waste wood for direct use in the CHP Facility, and additional waste wood arising from an increase in site production);
ii) Direct GHGs from the combustion of diesel during start-up and shut-down;
iii) Indirect GHGs associated with the production of diesel used during start-up and shut-down (well-to-tank (WTT) emissions);
iv) Indirect GHGs associated with the production of flue gas treatment (FGT) reagents (lime and activated carbon);
v) Indirect GHGs associated with the transportation of diesel used during start-up and shut-down;
vi) Indirect GHGs associated with the transportation of biomass;
vii) Indirect GHGs associated with the transportation of FGT reagents;
viii) Indirect GHGs associated with the transportation of ash residues from the combustion process; and
ix) Indirect GHGs associated with the disposal / recycling of ash residues.

**Decommissioning:**

i) Indirect GHGs associated with the decommissioning of the CHP Facility; and
ii) Indirect GHGs associated with the transportation of materials from the site.

**Operation:**

2.1.2 The CHP Facility will produce heat and electricity which will replace the operation of the K7 Biomass Plant and on-site gas engines and as such will offset emissions from these sources.

2.1.3 The K7 Biomass Plant, which the CHP Facility will replace the normal operation of, will also include many of these sources of GHGs albeit it a lower amount given the smaller capacity. Therefore, the following have been considered:

i) Direct GHGs from the combustion of the additional biomass needed for the CHP Facility (existing process residues currently sold, imported forestry brash for direct use in the CHP Facility, increase in import of grade C waste wood for direct use in the CHP Facility, and additional waste wood arising from an increase in site production);

ii) Direct GHGs from the combustion of additional diesel used during start-up and shut-down of the CHP Facility compared to the K7 Biomass Plant;

iii) Indirect GHGs associated with the production of additional diesel (WTT emissions);

iv) Indirect GHGs associated with the production of FGT reagents for the CHP Plant, noting that the K7 Biomass Plant does not include any dosing system so does not use any FGT reagents;

v) Indirect GHGs associated with the transportation of the additional diesel;

vi) Indirect GHGs associated with the transportation of the additional biomass needed for the CHP Facility (imported forestry brash for direct use in the CHP Facility, increase in import of grade C waste wood for direct use in the CHP Facility, and vehicles resulting in the additional waste wood arising from an increase in site production);

vii) Indirect GHGs associated with the transportation of the FGT reagents;

viii) Indirect GHGs associated with the transportation of the additional ash residues produced by the CHP Facility compared to the K7 Biomass Plant;

ix) Indirect GHGs associated with the disposal / recycling of the additional ash residues produced by the CHP Facility compared to the K7 Biomass Plant; and

x) The offset of GHG emissions associated with the combustion of additional biomass in the CHP rather than natural gas in the on-site gas engines.

2.1.4 In order to quantify the impact, an alternative future baseline, i.e. without the Proposed Development is required. The most likely route for biomass would be an alternative biomass facility where it would be used to produce electricity for export to the national grid. Therefore, the following have been considered:

i) Direct GHGs from the combustion of the additional biomass needed for the CHP Facility (existing process residues currently sold, imported forestry brash for direct use in the CHP Facility, increase in import of grade C waste wood for direct use in the CHP Facility) excluding the additional waste wood arising from an increase in site production as this is as a result of the development;

ii) Direct GHGs from the combustion of diesel used during start-up and shut-down associated an alternative biomass facility processing the additional biomass;

iii) Indirect GHGs associated with the production of the additional diesel (WTT emissions) needed for the start-up and shut-down of the alternative biomass facility processing the additional biomass;

iv) Indirect GHGs associated with the production of FGT reagents for the alternative biomass facility processing the additional biomass;

v) Indirect GHGs associated with the transportation of diesel required for start-up and shut-down of the alternative biomass facility processing the additional biomass;

vi) Indirect GHGs associated with the transportation of the additional biomass (imported forestry brash for direct use in the CHP Facility, increase in import of grade C waste wood for direct use in the CHP Facility, excluding the additional waste wood arising from an increase in site production as this is as a result of the development) to an alternative biomass facility;

vii) Indirect GHGs associated with the transportation of the biomass currently sold to an alternative biomass facility processing the additional biomass;

viii) Indirect GHGs associated with the transportation of the additional FGT reagents to an alternative biomass facility;

ix) Indirect GHGs associated with the transportation of the additional ash residues from an alternative biomass facility processing the additional biomass;

x) Indirect GHGs associated with the disposal / recycling of additional ash residues from an alternative biomass facility processing the additional biomass;

xi) The offset of GHG emissions associated with the combustion of additional biomass in the alternative biomass facility and this being exported to the national grid.

2.1.5 The quantity of ash generated, FGT reagents and diesel required, can be expressed on a per unit of biomass. Therefore, it has been assumed that the quantities would be same for the CHP Facility as an alternative biomass facility. In addition, in lieu of any specific information on the source of biomass, or the alternative biomass facility, it has been assumed that the distance from to the source to the site is similar and all transport of the additional materials would be using HGVs.

2.1.6 Therefore, the following parameters would not change as a result of the Proposed Development and as such have not been calculated:

i) Direct GHGs from the combustion of forestry brash, grade C waste wood and additional residues available from an increase in site production;

ii) Direct GHGs from the combustion of additional diesel required;

iii) Indirect GHGs associated with the transportation of additional diesel required;

iv) Indirect GHGs associated with the transportation of forestry brash and grade C waste wood;

v) Indirect GHGs associated with the transportation of additional ash residues; and

vi) Indirect GHGs associated with the disposal / recycling of additional ash residues.

2.1.7 As a result, the following have been calculated as these would result in a net change in GHG emissions as a result of the Proposed Development:

i) Direct GHGs from the combustion of residues from the increase in on-site production in the CHP Plant:

ii) Indirect GHGs associated with the production of FGT reagents required on-site based on the quantity of biomass combusted in the K7 Biomass Plant (which currently does not include a FGT system), which would be combusted in the CHP Facility;

iii) Indirect GHGs associated with the transportation of materials associated with the increased on-site production;

iv) Indirect GHGs associated with the transportation of the additional FGT reagents; and

v) Direct GHG emissions associated with the combustion natural gas in the on-site gas engines based on the change in gas use which would be offset.

i) Prevention of indirect GHGs associated with the transportation of existing on-site process residues currently sold off site; and

ii) Prevention of indirect GHG emissions savings associated with the electricity being produced from an alternative biomass facility processing the existing on-site process residues currently sold and this being exported to the national grid.

## 3.0 INPUTS

3.1.1 The following inputs have been used in the calculation of construction phase GHG emissions.

**Table 3.1 – Inputs – Construction Phase**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Total material to be removed from site (including gas turbines to be sold) | tonnes | 2,946 | Table 10.14 of ES – total volume – 1,352 m$^2$ Density – 2.13 Total weight – 2,946 |
| Quantity of steel – from demolition of gas turbines 1 and 2, redundant steelwork | tonnes | 635.5 | As set out in Table 10.14 of ES. All recycled |
| Construction waste - total | tonnes | 206 | As set out in Table 10.15 of ES. |
| % of construction waste recycled | % | 90 | As set out in Chapter 10 of the ES |
| % of construction waste landfilled | % | 10 | |
| Quantity of steel for CHP Facility | tonnes | 3,000 | Estimate based on similar sized projects |
| Quantity of concrete for CHP Facility | m$^3$ | 864 | Estimate based on footprint of CHP building, assuming 0.5 m depth |
| | tonnes | 2,074 | Calculated based on density of 2.4 t/m$^3$ |

3.1.2 The following inputs have been used in the calculation of operational phase GHG emissions.

**Table 3.2 – Inputs – Operational Phase**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Increase in on-site production as a result of CHP Facility | tpa | 8,222 | Estimate from Applicant |
| Quantity of biomass combusted in K7 Biomass Plant | tpa | 75,000 | Current operations |
| Quantity of biomass combusted in CHP Facility | tpa | 293,000 | Estimate from Applicant |
| Carbon content of biomass, as received | % | 34.3% | Estimate based on fuel specification |
| Biogenic carbon content of on-site produced residues | % | 90% | Estimate, appropriate for biomass with a waste content |
| Quantity of raw ammonia required per tonne of biomass | kg/tonne of biomass | 1.9 | Estimate from Applicant – delivered as raw ammonia and made up to 25% solution on site |
| Quantity of hydrated lime (Sorbacal) required per tonne of biomass | kg/tonne of biomass | 4.1 | Estimate from Applicant |
| Number of HGVs associated with the increase in on-site production | HGVs/year | 2,055 | Assumes delivery in 20 tonne HGVs and 20% of the new recycled material brought to site for production is unusable for manufacturing and combusted in the CHP |
| Distance travelled for additional biomass for increase in on-site production | km | 50 | Assumption, in lieu of any specific source |
| Change in on-site gas usage | GW | -385 | Estimation from Applicant, this includes the additional gas usage associated with OSB and one engine still running and other two only running for the CHP annual outage – i.e. based on 8,000 hours operation. |
| Quantity of on-site residues currently sold - bark | tpa | 54,188 | Current operations |
| Quantity of on-site residues currently sold – MDF rejects | tpa | 12,260 | Current operations |
| Quantity of on-site residues currently sold – wood dusts | tpa | 10,542 | Current operations |
| Payload of HGVs transporting residues currently sold | tonnes | 25 | Current operations |
| Distance travelled by residues currently sold - bark | km | 134 | 50% to Whitchurch (37.6 km) and 50% to Penrith (230 km). |
| Distance travelled by residues currently sold - MDF rejects | km | 218 | 75% to Carlisle (273 km) and 25% to Deeside (53 km). |
| Distance travelled by residues currently sold - wood dusts | km | 96 | 100% to Astley |
| NCV of residues currently sold | MJ/kg | 12.3 | Estimate |

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Electrical efficiency of an alternative biomass facility | % | 35 | Estimate, based on a typical UK biomass facility excluding heat recovery. |

3.1.3 The GHG emission factors from DESNZ[1] presented in Table 3.3 have been used in to convert distance travelled and natural gas usage into kilo equivalents of carbon dioxide (kg$CO_2$e).

**Table 3.3 – Transport GHG emission factors**

| Parameter | Unit | Value |
|---|---|---|
| Emission factor for HGV (all diesel) Articulated (>3.5-33t) 100% laden | kg$CO_2$e/km | 0.93552 |
| Emission factor for HGV (all diesel) Articulated (>3.5-33t) 0% laden | kg$CO_2$e/km | 0.62775 |
| Emission factor for WTT - HGV (all diesel) Articulated (>3.5-33t) 100% laden | kg$CO_2$e/km | 0.22246 |
| Emission factor for WTT - HGV (all diesel) Articulated (>3.5-33t) 0% laden | kg$CO_2$e/km | 0.14831 |
| Emission factor for natural gas (gross CV) | kg$CO_2$e/kWh | 0.18296 |
| WTT natural gas (gross CV) | kg$CO_2$e/kWh | 0.03021 |

[1] DESNZ. (2025). *Greenhouse gas reporting: conversion factors 2025.* Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025. [Last Accessed 14 July 2025].

3.1.4 In order to determine the $kgCO_2e$ associated with the combustion of biomass allowing for emissions from nitrous oxide ($N_2O$) and methane ($CH_4$) factors from Table 2.2 of the 2006 IPCC Guidelines for National GHG Inventories for Stationary Combustion of Biomass[2] have been applied and the GHG potential factors from the IPPC Fourth Assessment[3]. In addition, in order to determine the $kgCO_2e$ associated with the production of FGT reagents emission factors from the carbon cloud database have been applied. To determine the $kgCO_2e$ associated with the production and recycling / disposal of concrete and steel used in construction of the CHP Facility emission factors from the DESNZ have been applied. The factors used in the calculations are set out in the following table.

**Table 3.4 – Standard GHG emission factors**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| $N_2O$ emissions | kg per TJ (net basis) | 4 | Table 2.2 of 2006 IPPC Guidelines for National GHG Inventories for stationary combustion of biomass |
| $CH_4$ emissions | kg per TJ (net basis) | 30 | |
| GHG Potential - $N_2O$ to $CO_2$ | kg $CO_2e$/kg $N_2O$ | 298.0 | IPCC Fourth Assessment report (2007) |
| GHG Potential - $CH_4$ to $CO_2$ | kg $CO_2e$/kg $CH_4$ | 25.0 | |
| Conversion from C to $CO_2$ | - | 3.6667 | Calculated from molecular mass |
| Ammonia production | $kgCO_2e$/kg | 1.69 | Carbon cloud database |
| Lime production | $kgCO_2e$/kg | 0.3 | |
| Activated carbon production | $kgCO_2e$/kg | 10 | |
| Materials use – metals | $kgCO_2e$/tonne | 3824.09335 | DESNZ GHG emission factors 2025 |
| Materials use – concrete | $kgCO_2e$/tonne | 118.79306 | |
| Closed loop recycling – metals | $kgCO_2e$/tonne | 1.00835 | |
| Closed loop recycling – concrete | $kgCO_2e$/tonne | 1.00835 | |
| Landfill – metals | $kgCO_2e$/tonne | 1.26338 | |
| Landfill – concrete | $kgCO_2e$/tonne | 1.26338 | |

[2] IPPC. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2.* Available at: *https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf*. [Last Accessed 14 July 2025].
[3] IPPC. (2007). *Fourth Assessment.* Available at: *https://www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf*. [Last Accessed 14 July 2025].

# 4.0 CALCULATIONS

### *Construction and demolition phase*

### *Indirect GHGs associated with the demolition of existing equipment and buildings needed to facilitate the development of the CHP Facility;*

4.1.1 In order to enable the construction of the CHP Facility existing infrastructure will need to be decommissioned and removed. The estimated quantities of materials associated with the demolition of the existing building and infrastructure are detailed in Chapter 10. It has been assumed that the gas turbines 1 and 2 would be re-used rather than recycled. The carbon intensity of the demolition of the existing equipment and building has been estimated using GHG factors from DESNZ for recycling / disposal of materials.

**Table 4.1 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Steel from GT 1 and 2 to be removed from site | tonnes | 2,310 | As set out in Table 10.14 of ES for re-use. |
| Steel to be removed from Site for recycling | tonnes | 635.5 | As set out in Table 10.14 of ES. |
| Construction waste to be removed from Site | tonnes | 206 | As set out in Table 10.15 of ES. |
| Proportion of steel recycled | % | 100 | As set out in Chapter 10 of the ES |
| Proportion of construction waste recycled | % | 90 | |
| Proportion of construction waste landfilled | % | 10 | |
| GHG intensity | | | |
| - Closed loop recycling – metals | $kgCO_2e$/tonne | 1.00835 | DESNZ GHG emission factors 2025 |
| - Closed loop recycling – concrete | $kgCO_2e$/tonne | 1.00835 | |
| - Landfill – metals | $kgCO_2e$/tonne | 1.26338 | |
| - Landfill – concrete | $kgCO_2e$/tonne | 1.26338 | |

**Table 4.2 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Recycling of demolished steel works | $tCO_2e$ | 0.6 | Calculated |
| Recycling and landfill of construction waste | $tCO_2e$ | 0.2 | Calculated |
| **Total** | **$tCO_2e$** | **0.8** | Calculated |

### *Indirect GHGs associated with the transportation of material from site*

4.1.2 The removal of demolition material from site would result in additional vehicle movements. The GHG emissions have been calculated applying the DESNZ factors assuming a fully laden trip from site, and an empty return trip, including WTT emissions.

**Table 4.3 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Steel from GT 1 and 2 to be removed from site | tonnes | 2,310 | As set out in Table 10.14 of ES for re-use. |
| Steel to be removed from Site | tonnes | 635.5 | As set out in Table 10.14 of ES. |
| Construction waste to be removed from Site | tonnes | 206 | As set out in Table 10.15 of ES. |
| Payload of vehicle | tonnes | 20 | From Applicant |
| No of vehicles | No. | 158 | Calculated total material to be removed divided by payload of vehicle |
| Distance travelled | km | 100 | Assumption, in lieu of any specific source |

**Table 4.4 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$** | **30** | Calculated |

### *Indirect GHGs associated with the construction of the CHP Facility*

4.1.3 In lieu of any lifecycle carbon assessment (LCA) for the CHP Facility, the GHG emissions imbodied within the construction materials have been estimated based on an estimate of the quantity of steel and concrete from a similar sized plant. The imbodied carbon intensity of the construction materials has been estimated using GHG factors from DESNZ for material use.

**Table 4.5 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of steel for CHP Facility | tonnes | 3,000 | Estimate based on similar sized projects |
| Quantity of concrete for CHP Facility | tonnes | 2,074 | Estimate based on footprint of CHP building, assuming 0.5 m depth |
| GHG intensity | | | |
| - Metals | $kgCO_2e$/tonne | 3824.09335 | DESNZ GHG emission factors 2025 |
| - Concrete | $kgCO_2e$/tonne | 118.79306 | |

**Table 4.6 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$** | **11,719** | Calculated |

### *Indirect GHGs associated with the transportation of construction materials to site*

4.1.4 The transportation of construction materials to site would result in additional vehicle movements. The GHG emissions have been calculated applying the DESNZ factors assuming a fully laden trip to site, and empty return trip, including WTT emissions.

**Table 4.7 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Steel for construction of CHP Facility | | | |
| - Quantity required | tonnes | 3,000 | Estimate based on similar sized projects |
| - Payload of vehicle | tonnes | 20 | From Applicant |
| - No of vehicles | No. | 150 | Calculated total steel required divided by payload of vehicle |
| - Distance travelled | km | 100 | Assumption, in lieu of any specific source |
| Concrete for construction of CHP Facility | | | |
| - Quantity required | tonnes | 2,074 | Estimate based on footprint of CHP building, assuming 0.5 m depth and density of 2.4 t/m$^3$ |
| - Payload of vehicle | tonnes | 32 | From Applicant |
| - No of vehicles | No. | 65 | Calculated total steel required divided by payload of vehicle |
| - Distance travelled | km | 100 | Assumption, in lieu of any specific source |

**Table 4.8 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$** | **42** | Calculated |

### *Operational phase*

4.1.5 As explained not all GHG emissions associated with the Proposed Development or Future Baseline have been calculated, the calculation of operational phase GHG emissions has focussed on the net change in GHG emissions from the Future Baseline scenario. This approach is considered appropriate as the significance of effect is determined based on the net change in GHG emissions from the Future Baseline in relation to the carbon budgets as set out in the ES chapter.

4.1.6 The calculated net change from the Future Baseline for the sources of GHG emissions identified are set out in the following sections:

### *Direct GHGs from the combustion of residues from the increase in on-site production in the CHP Facility*

4.1.7 The CHP Facility would facilitate an increase in on-site production and as a result additional residues would be created. These would not occur in the Baseline scenario. These residues would be combusted in the CHP Facility.

4.1.8 The carbon emissions associated with the direct combustion of these residues has been calculated by determining non-biogenic carbon available for combustion and applying the conversion of C to $CO_2$.

4.1.9 The carbon equivalent emissions of $N_2O$ and $CH_4$ associated with the direct combustion of residues has been calculated by determining the energy available in the on-site production residues and applying the emissions factors from IPPC Guidelines for National GHG Inventories for stationary combustion of biomass.

**Table 4.9 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| On-site production residues | | | |
| - Increase | tpa | 8,222 | Estimate from Applicant |
| - NCV | MJ/kg | 12.3 | Estimate |
| - Carbon content | % | 34.3% | Estimate based on fuel specification |
| - Biogenic carbon content | % | 90% | Estimate, appropriate for biomass with a waste content |
| Conversion factor C to $CO_2$ | - | 3.6667 | Calculated from molecular mass |
| $N_2O$ emissions | kg per TJ (net basis) | 4 | Table 2.2 of 2006 IPPC Guidelines for National GHG Inventories for stationary combustion of biomass |
| $CH_4$ emissions | kg per TJ (net basis) | 30 | |
| GHG Potential - $N_2O$ to $CO_2$ | kg $CO_2$e/kg $N_2O$ | 298.0 | |

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| GHG Potential - $CH_4$ to $CO_2$ | kg $CO_2$e/kg $CH_4$ | 25.0 | IPCC Fourth Assessment report (2007) |

**Table 4.10 – Calculation**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| $CO_2$ emissions | kg$CO_2$e/yr | 1,034 | Non-biogenic $CO_2$ only |
| $N_2O$ emissions | kg$CO_2$e/yr | 121 | - |
| CH4 emissions | kg$CO_2$e/yr | 76 | - |
| **Total** | **kg$CO_2$e/yr** | **1,230** | - |

### *Indirect GHGs associated with the production of FGT reagents required on-site based on the quantity of biomass combusted in the K7 Biomass Plant which would be combusted in the CHP Facility*

4.1.10 The quantity of FGT reagents required can be approximated based on the amount of biomass combusted. The CHP Facility includes a FGT system, and it is likely that any alternative biomass facility would also have an FGT system. However, the K7 Biomass Plant does not currently use any FGT reagents. As such the Proposed Development would require additional FGT reagents over the Baseline scenario. The additional reagents would be associated with the quantity of biomass currently combusted in the K7 Biomass Plant. As such the quantity of FGT regents required to combust the quantity of material currently combusted in the K7 Biomass Plant has been calculated. The carbon intensity of the production of the FGT reagents has been calculated by applying appropriate factors from the carbon cloud database.

**Table 4.11 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of biomass combusted in K7 Biomass Plant | tpa | 74,667 | Current operations |
| Quantity of biomass combusted in CHP Facility | tpa | 293,000 | Estimate from Applicant |
| Quantity of FGT reagents (ammonia) required for CHP Facility | tpa | 137 | Estimate from Applicant |
| Quantity of FGT reagents (Sorbacal) required for CHP Facility | tpa | 1,195 | Estimate from Applicant |
| Quantity of additional FGT reagents (ammonia) required for biomass combusted in K7 Biomass Plant | tpa | 142 | Calculated by factoring quantity required for CHP Facility |
| Quantity of additional FGT reagents (Sorbacal) required for | tpa | 306 | Calculated by factoring quantity required for CHP Facility |

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| biomass combusted in K7 Biomass Plant | | | |
| Carbon intensity of ammonia | $kgCO_2e/kg$ | 1.69 | Carbon cloud database |
| Carbon intensity of Sorbacal | $kgCO_2e/kg$ | 1.122 | Climateiq database for calcium hydroxide |

**Table 4.12 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Ammonia production | $tCO_2e/yr$ | 240 | Calculated |
| Sorbacal production | $tCO_2e/yr$ | 343 | Calculated |
| **Total** | **$tCO_2e/yr$** | **583** | Calculated |

### *Indirect GHGs associated with the transportation of materials associated with the increased on-site production*

4.1.11 The CHP Facility would facilitate an increase in on-site production which would result in additional vehicle movements transporting the raw material to site. These would not occur in the Baseline scenario. Therefore, the transportation associated with the additional raw material to site has been calculated. The GHG emissions have been calculated applying the DESNZ factors assuming a fully laden trip to site, and empty return trip, including WTT emissions.

**Table 4.13 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Number of vehicles associated with increase in on-site production residues | HGVs/yr | 2,055 | As set out in ES Appendix 4A. |
| Distance travelled | km | 50 | Assumption, in lieu of any specific source |

**Table 4.14 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e/yr$** | **199** | Calculated |

### *Indirect GHGs associated with the transportation of the additional FGT reagents*

4.1.12 As explained the Proposed Development would result in additional FGT reagents over the Baseline scenario. The additional reagents would be associated with the quantity of biomass currently combusted in the K7 Biomass Plant. As such the quantity of FGT regents required to combust the quantity of material currently combusted in the K7 Biomass Plant has been calculated. The GHG emissions associated with the transportation of these reagents have been calculated applying the DESNZ factors assuming a fully laden trip to site, and empty return trip, including WTT emissions.

**Table 4.15 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of additional FGT reagents (ammonia) required for biomass combusted in K7 Biomass Plant | tpa | 142 | Calculated by factoring quantity required for CHP Facility |
| Quantity of additional FGT reagents (Sorbacal) required for biomass combusted in K7 Biomass Plant | tpa | 306 | |
| Payload of vehicle - ammonia | tonnes | 28 | From Applicant – current deliveries |
| Payload of vehicle - Sorbacal | tonnes | 22 | |
| Distance travelled - ammonia | km | 65 | From Buxton as per existing deliveries |
| Distance travelled – Sorbacal | km | 125 | From Birkenhead as per existing deliveries |

**Table 4.16 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e/yr$** | **4.0** | Calculation |

### *Indirect GHGs associated with the transportation of the additional ash residues*

4.1.13 As explained the Proposed Development would result in additional ash residues over the Baseline scenario. The additional ash residues would be associated with the quantity of additional biomass combusted. As such the quantity of ash residues produced from the combustion of the additional biomass has been calculated. The GHG emissions associated with the transportation of these ash residues have been calculated applying the DESNZ factors assuming a fully laden trip to site, and empty return trip, including WTT emissions.

**Table 4.17 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of additional ash residues produced | tpa | 33,348 | Estimate from Applicant |
| Payload of vehicle | tonnes | 20 | From Applicant – current exports |
| Distance travelled | km | 103 | To Skelmersdale as per existing exports |

**Table 4.18 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$/yr** | **332** | Calculation |

***The offset of GHG emissions associated with the combustion natural gas in the on-site gas engines based on the change in gas use***

4.1.14 The CHP Facility will replace the operation of the K7 Biomass Plant and XX gas engine resulting in a reduction in gas usage on-site and the resultant emissions of GHG emissions. The GHG emissions associated with the reduction in natural gas uses have been calculated applying the DESNZ factors for natural gas combustion and WTT emissions.

**Table 4.19 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Change in gas use | GW | -385.00 | From Applicant |

**Table 4.20 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$/yr** | **-82,070** | Calculation |

***Indirect GHGs associated with the transportation of existing on-site process residues currently sold***

4.1.15 Currently on-site process residues are sold and exported off-site. The GHG emissions associated with the transportation of the process residues currently sold have been calculated applying the DESNZ factors assuming a fully laden trip to site, and empty return trip, including WTT emissions.

**Table 4.21 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| On-site process residues currently sold – bark | tpa | 54,188 | Current operations |
| On-site process residues currently sold – MDF rejects | tpa | 12,260 | Current operations |
| On-site process residues currently sold – wood dusts | tpa | 10,542 | Current operations |
| Payload of vehicle | tonnes | 25 | Current operations |
| Distance travelled - bark | km | 134 | 50% to Whitchurch (37.6 km) and 50% to Penrith (230 km). |
| Distance travelled – MDF rejects | km | 218 | 75% to Carlisle (273 km) and 25% to Deeside (53 km). |
| Distance travelled – wood dusts | km | 96 | 100% to Astley |

**Table 4.22 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e/yr$** | **847** | Calculation |

***The offset of indirect GHG emissions associated with the electricity being produced from an alternative biomass facility processing the existing on-site process residues currently sold and this being exported to the national grid***

4.1.16 Currently on-site process residues are sold and exported off-site. It has been assumed that these would be combusted in an alternative biomass facility and used to generate electricity which would be exported to the national grid. Sending electricity to the grid offsets the carbon burden of producing electricity using other methods. In the case of a biomass facility, the displaced electricity would be the marginal source which is currently gas-fired power stations, for which the displacement factor is 0.375 t $CO_2e$/MWh. Electricity generated would be exported to the National Grid. DEFRAs ‘Energy from Waste – A Guide to the Debate 2014’ (specifically, footnote 29 on page 21) 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, the assessment of grid offset uses the current marginal technology as a comparator.

4.1.17 It is acknowledged that the UK government has set a target which will require the UK to bring all GHG emissions to net zero by 2050. Taking this into consideration, in the future, it is anticipated that the electricity which the residues currently sold could generate would displace other forms of power generation, including renewable energy power stations. However, at this stage the mix of future generation capacity additions to the grid that might be displaced by the project is uncertain, and the emissions intensity of future displaced generation cannot be accurately quantified. Therefore, for the purposes of this assessment, it has been assumed that the residues currently sold would be used in a biomass plant and displace a CCGTs as this is considered a reasonable comparator.

4.1.18 The effect of changing the grid offset displacement factor has been considered when assessing the lifetime impact of the GHG emissions where the effect of a gradually decarbonising grid has been considered.

**Table 4.23 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| On-site process residues currently sold | tpa | 76,991 | Current operations |
| Net CV of process residues currently sold | MJ/kg | 12.3 | Estimate |
| Assumed electrical efficiency of biomass facility | % | 35% | Standard assumption |
| CCGT emission factor | $gCO_2e/kWh$ | 375 | DESNZ fuel mix disclosure table 2024 |

**Table 4.24 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e/yr$** | **34,526** | |

### *Decommissioning*

#### *Indirect GHGs associated with the decommissioning of the CHP Facility*

4.1.19 Once the CHP Facility is no longer functional, it will be demolished and the material removed from the site. The GHG emissions associated with the removal of material used to construct the CHP Facility have been calculated using GHG factors from DESNZ for recycling / disposal of materials.

**Table 4.1 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of steel to be removed | tonnes | 2,310 | Steel used in construction of CHP Facility |
| Quantity of concrete to be removed | tonnes | 635.5 | Concrete used in construction of CHP Facility |
| Proportion of materials recycled | % | 90 | Assumption |
| Proportion of materials landfilled | % | 10 | Assumption |
| GHG intensity | | | |
| - Closed loop recycling – metals | $kgCO_2e$/tonne | 1.00835 | DESNZ GHG emission factors 2025 |
| - Closed loop recycling – concrete | $kgCO_2e$/tonne | 1.00835 | |
| - Landfill – metals | $kgCO_2e$/tonne | 1.26338 | |
| - Landfill – concrete | $kgCO_2e$/tonne | 1.26338 | |

**Table 4.2 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$** | **5** | Calculated |

### *Indirect GHGs associated with the transportation of materials from site*

4.1.20 The removal of material from site associated with decommissioning would result in additional vehicle movements. The GHG emissions have been calculated applying the DESNZ factors assuming a fully laden trip from site, and an empty return trip, including WTT emissions.

**Table 4.3 – Process flow**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| Quantity of steel to be removed | tonnes | 2,310 | Steel used in construction of CHP Facility |
| Quantity of concrete to be removed | tonnes | 635.5 | Concrete used in construction of CHP Facility |
| Total material to be removed | Tonnes | 5,074 | Calculation |
| Payload of vehicle | tonnes | 20 | From Applicant |
| No of vehicles | No. | 254 | Calculated total material to be removed divided by payload of vehicle |
| Distance travelled | km | 100 | Assumption, in lieu of any specific source |

**Table 4.4 – Calculated GHG emissions**

| Parameter | Unit | Value | Justification |
|---|---|---|---|
| **Total** | **$tCO_2e$** | **49** | Calculated |

## 4.2 Summary

### *Construction and demolition*

4.2.1 The following table sets out the calculated GHG emissions associated with the demolition of the existing equipment and buildings needed to facilitate the development of the CHP Facility and the construction of the CHP Facility.

**Table 4.25 –GHG emissions (construction and demolition phase)**

| Parameter | Emissions ($tCO_2e$) | Savings ($tCO_2e$) |
|---|---|---|
| Indirect GHGs associated with the demolition of existing equipment and buildings needed to facilitate the development of the CHP Facility | 0.8 | |
| Indirect GHGs associated with the transportation of material from site | 30 | |
| Indirect GHGs associated with the construction of the CHP Facility | 11,719 | |
| Indirect GHGs associated with the transportation of construction materials to site | 42 | |
| **Total** | **11,791** | |

When annualised over the 40-year lifetime the GHG emissions associated with the construction and demolition phase is 295 $tCO_2e$/yr.

### *Operation*

4.2.2 The following tables sets out the calculated net GHG emissions associated with the Future Baseline and Do Something operational phase scenarios respectively.

**Table 4.26 – Net GHG emissions (operational phase) – Future Baseline**

| Parameter | Emissions ($tCO_2e$/yr) | Savings ($tCO_2e$/yr) |
|---|---|---|
| Indirect GHG emissions associated with the transportation of existing on-site process residues currently sold to an alternative electricity generation plant | 847 | |
| The offset of indirect GHG emissions associated with the electricity being produced from an alternative biomass facility processing the existing on-site process residues currently sold and this being exported to the national grid | | 34,526 |
| **Total** | | **33,526** |

**Table 4.27 – Net GHG emissions (operational phase) – Do Something**

| Parameter | Emissions ($tCO_2e/yr$) | Savings ($tCO_2e/yr$) |
|---|---|---|
| Direct GHGs from the combustion of residues from the increase in on-site production in the CHP Plant: | 1,230 | |
| Indirect GHGs associated with the production of FGT reagents required on-site based on the quantity of biomass combusted in the K7 Biomass Plant (which currently does not include a FGT system), which would be combusted in the CHP Facility; | 583 | |
| Indirect GHGs associated with the transportation of materials associated with the increased on-site production; | 199 | |
| Indirect GHGs associated with the transportation of the additional FGT reagents | 4 | |
| Indirect GHGs associated with the transportation of the additional bottom ash | 332 | |
| Indirect GHGs associated with the combustion natural gas in the on-site gas engines based on the change in gas use | | 82,070 |
| **Total** | | **79,722** |

The impact of the operational phase of the Proposed Development has been calculated as the difference between the Future Baseline and Do Something scenario as set out in the following table. As shown the Proposed Development results in an annual saving of ~46,000 $tCO_2e$. Over the proposed 40 year lifetime of the CHP Facility this would equate to savings of ~1,842,000 $tCO_2e$.

**Table 4.28 – Net GHG emissions – Do Something**

| Parameter | Emissions ($tCO_2e/yr$) | Savings ($tCO_2e/yr$) |
|---|---|---|
| Future Baseline | | 33,426 |
| Do Something | | 79,722 |
| Proposed Development (net change) | | 46,043 |

### *Decommissioning*

4.2.3 The following table sets out the calculated GHG emissions associated with the decommissioning of the CHP Facility.

**Table 4.29 –GHG emissions (decommissioning phase)**

| Parameter | Emissions ($tCO_2e$) | Savings ($tCO_2e$) |
|---|---|---|
| Indirect GHGs associated with the demolition of the CHP Facility | 5 | |
| Indirect GHGs associated with the transportation of materials from site | 49 | |
| **Total** | **54** | |

When annualised over the 40-year lifetime the GHG emissions associated with the decommissioning phase is 1.4 $tCO_2e/yr$.

### *Total*

4.2.4 The following table sets out a summary of the emission from each phase.

**Table 4.29 –GHG emissions - annualised**

| Parameter | Emissions ($tCO_2e/yr$) | Savings ($tCO_2e/yr$) |
|---|---|---|
| Construction and demolition | 295 | |
| Operation | | 46,043 |
| Decommissioning | 1 | |
| **Total** | | **45,747** |

## 4.3 Lifetime analysis

4.3.1 The GHGs emissions saving in the Baseline operational phase scenario are based on the existing on-site process residues currently sold being used to generate electricity and this displacing electricity generated by a CCGT. Two alternative future baseline marginal power sources have been established using the DESNZ publication "Green Book supplementary guidance: valuation of energy use and GHG emissions for appraisal".

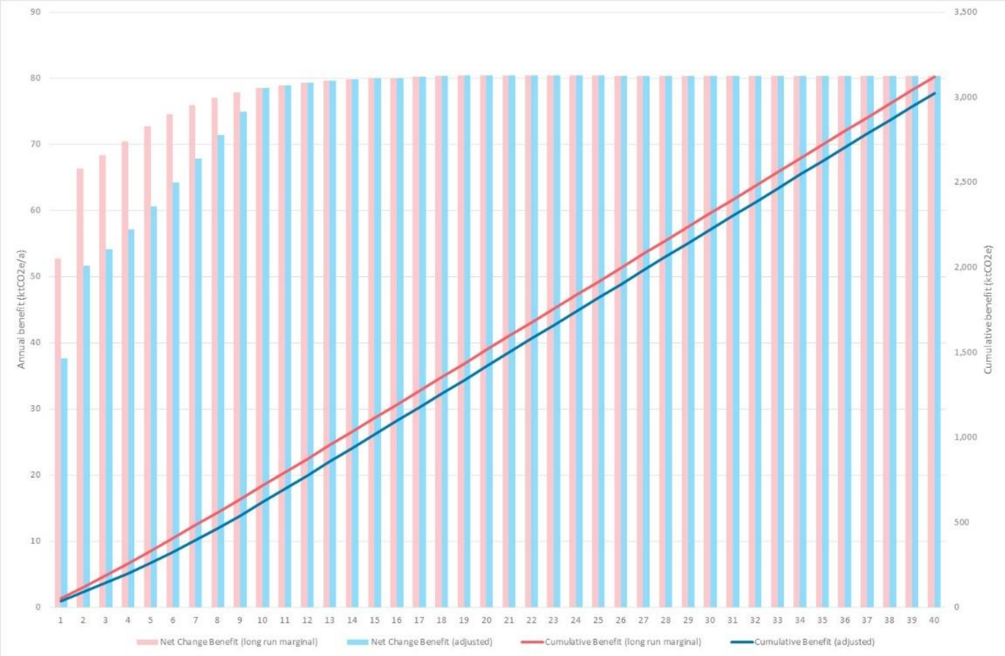
4.3.2 The first assumes that the long run marginal emission factors, generation-based, should be used.

4.3.3 The second assumes that the power displaced will decarbonise less quickly than the long run marginal emissions factor because, as explained earlier, power generated from a biomass facility operating at baseload will not displace other renewable power sources such as wind and solar until there is an excess of such power on the grid. The long run marginal emissions factor for 2024 is 0.210 $tCO_2e/MWh$, but it is considered that the current power source being displaced by biomass facilities remains CCGT with an emissions factor of 0.375 $tCO_2e/MWh$. Therefore, an alternative future baseline displacement factor curve has been calculated, as follows:

i) For 2024, the CCGT figure has been used.
ii) For 2035 and later, the DESNZ figure has been used.
iii) Between these two dates, the displacement factor has been gradually reduced, coming closer to the DESNZ figure.

4.3.4 Using the long run marginal figures for grid displacement, the cumulative benefit of the Development during the operational phase is predicted to be 3,133,208 t$CO_2$e, or an average of 78,330 t$CO_2$e/a, compared to the baseline scenario. Using the adjusted figures for grid displacement, the cumulative benefit of the Development during the operational phase is predicted to be 3,036,585 t$CO_2$e, or an average of 75,915 t$CO_2$e/a, compared to the baseline scenario. The benefit per year is shown in the figure below. The pink shows the annual progression based on the long run marginal figures for grid displacement and the blue the progression based on the adjusted figures. As shown the benefit from the year 2035 onwards is the same as the displacement factor aligns from this year. There is a greater annual benefit in the first few years using the marginal figures. However, as explained the electricity network has not currently decarbonised as projected and as such the comparison using the adjusted grid displacement figures is more appropriate. The benefit of the development is lower when the long run marginal emission factor is used as this provides a greater benefit to the power produced by on-site residues sold offsite than using the adjusted factor. As such as a conservative and more realistic assumption the adjusted factor has been used as the basis of the results presented in the ES chapter.

4.3.5 Allowing for the GHG emissions associated with the construction and decommissioning phases, the cumulative benefit of the Development during the operational phase is predicted to be 3,121,362 t$CO_2$e, or an average of 78,034 t$CO_2$e/a, compared to the baseline scenario. Using the adjusted figures for grid displacement, the cumulative benefit of the Development during the operational phase is predicted to be 3,024,740 t$CO_2$e, or an average of 75,618 t$CO_2$e/a, compared to the baseline scenario. Including the construction and decommissioning phases results in a 0.4% reduction in the benefit of the Development just considering operational phase emissions – i.e. a marginal change.


Annual benefit (ktCO2e/a)
Cumulative benefit (ktCO2e)
0
10
20
30
40
50
60
70
80
90
0
500
1,000
1,500
2,000
2,500
3,000
3,500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Net Change Benefit (long run marginal)
Net Change Benefit (adjusted)
Cumulative Benefit (long run marginal)
Cumulative Benefit (adjusted)