CAS-03463-R2W9C2 - Kronospan Low Carbon CHP Facility

Supporting Document 4

Heat and Power Plan

Prepared for

December 2025
DNS5-4-004

Document Control

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DNS4-004	December	VBT	JRS/RSF
DNS4-004 Rev 1			
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1.0 INTRODUCTION

1.1 Background

1.1.1 Kronospan Limited (the Applicant) are seeking consent for a Development of National Significance (DNS) from the Welsh Government for the development of a Low Carbon Combined Heat and Power (CHP) Facility and associated infrastructure (the Proposed Development) at the existing Kronospan Facility, in Chirk, North Wales (the Site).

1.1.2 The Low Carbon CHP Facility would have the capacity to generate up to 30 megawatts of electricity (MWe) and 125 megawatts of thermal energy (MWth), for use in the existing manufacturing processes at the existing Site, or up to 40 MW of electricity in power only mode. The proposed Low Carbon CHP Facility would be capable of processing up to 293,000 tonnes per annum (TPA) of fuel. To do so, it would predominately use on-site process wood residues (accounting for approximately 88.8% of the maximum throughput); the 'remainder' of the fuel would arise from:

- The import of forestry brash for direct use in the proposed Low Carbon CHP Facility.
- The import of Grade C waste wood for direct use in the proposed Low Carbon CHP Facility.
- Increased on-site production that would generate further on-site process wood residues for direct use in the proposed Low Carbon CHP Facility.

1.1.3 As such, the heat and power generated by the proposed Low Carbon CHP Facility would be renewable energy, helping the operations at the Site to decarbonise and also making a valuable contribution to meeting the Welsh Government's Net Zero commitments.

1.2 Objective

1.2.1 The proposed Low Carbon CHP Facility would supply heat and power to the existing manufacturing processes at the Site. On this basis, this CHP Heat and Power Plan has been produced to support the application for consent for a DNS from the Welsh Government.

1.2.2 This CHP Heat and Power Plan identifies the heat requirements of the Site and explains how the export of heat from the Low Carbon CHP Facility would be optimised to maximise the energy efficiency of the Site in accordance with the conditions of the Environmental Permit (which will need to be varied to allow for the operation of the Low Carbon CHP Facility) and Article 11 of the Industrial Emissions Directive (IED) (Directive 2010/75/EU), which requires regulators to ensure that regulated facilities use energy efficiently.

1.2.3 The CHP Heat and Power Plan also considers how the energy efficiency of the proposed Low Carbon CHP Plant relates to the relevant energy efficiency requirements of the Waste Incineration BREF which is applicable to the process.

1.2.4 An R1 calculation has been carried out to demonstrate whether the design of the Low Carbon CHP Plant is able to satisfy the R1 (Recovery) criteria within the Waste Framework Directive.

2.0 CONCLUSIONS

2.1 Technical Solution

- The Low Carbon CHP Facility would have a nominal design gross electrical output of 29.55 MWe and a net heat output of 49.1MWth, with a parasitic load of 3.1 MWe.
- However, the Low Carbon CHP Facility would have the capacity to generate up to 40 MWe in power only mode.
- The nominal capacity of the Low Carbon CHP Facility will be approximately 36.6 tonnes per hour of feedstock, with a nominal calorific value of 12.3 MJ/kg. The Low Carbon CHP Facility will have an estimated availability of around 7,884 hours. On this basis, the Low Carbon CHP Facility will have a nominal capacity of 288,819 tonnes per annum.
- Given the requirements of the onsite existing heat consumers, flexibility in terms of export temperatures and capacity, and the associated environmental benefits, it is proposed that steam extraction from the turbine will be sent to the heat user's heat exchangers for direct use in heat user's ongoing operations with the condensate being returned to the Low Carbon CHP Facility.
- This technology is well proven and highly efficient.

2.2 Energy Efficiency Measures

2.2.1 In order to qualify as technically feasible under the draft Article 14 guidance, the heat demand must be sufficient to achieve high efficiency cogeneration, equivalent to at least 10 % savings in primary energy usage compared to the separate generation of heat and power. With the average heat demand of 49.1 MWth, the Low Carbon CHP Facility achieves a Primary Energy Saving of 30.3 %, which is in excess of the technical feasibility threshold defined in the draft Article 14 guidance and would therefore be technically feasible to supply.

2.2.2 To be considered 'Good Quality' CHP under the CHPQA scheme, the quantity of heat exported to a heat network must be sufficient to achieve a Quality Index (QI) of at least 100 at the operational stage. The maximum QI score which could be achieved by the average heat demand of 49.1 MWth from the Low Carbon CHP Facility would be 85.9. On this basis, the average heat demand of 49.1 MWth from the Low Carbon CHP Facility would not qualify as Good Quality CHP. However, the efficiency criteria set out in the latest CHPQA guidance means that it is unlikely that any energy recovery facility will now achieve ‘Good Quality’ status.

2.2.3 The Gross Electrical Efficiency (NCV) will be 23.61 % with the proposed heat load of 49.1 MWth, which compares favourably with the BAT-AEELs for Gross Electrical Efficiency (20 – 35% for a new plant). The GEE will be 30.64% when calculated on a power-only basis (i.e. fully condensing mode without any heat export).

2.3 R1 Recovery Efficiency

2.3.1 The design of the Low Carbon CHP Facility has been assessed in accordance with the European Commission guidance for R1 facilities. The R1 efficiency of the Low Carbon CHP Facility has been calculated as 0.78 with fully condensing no heat case and 1.042 with design heat case. Both scenarios are above the threshold (0.65) for new incineration plants. Therefore, the design of the Low Carbon CHP Facility would achieve the R1 status and it would be classified as a recovery operation under the terms of the Waste Framework Directive.

3.0 DESCRIPTION OF THE CHP FACILITY TECHNOLOGY

3.1 The Low Carbon CHP Facility

3.1.1 The main activities associated with the Low Carbon CHP Facility will be the combustion of incoming on-site process residues and Grade C waste wood to raise steam and the generation of electricity in a steam turbine/generator.

3.1.2 The Low Carbon CHP Facility includes feedstock storage and handling, a boiler building, turbine building, service building, air cooled condenser (ACC), flue gas treatment facility, air pollution control (APC) reagent silos and residue silos, ash storage, water treatment, and a stack.

3.1.3 The Low Carbon CHP Facility would have a nominal design gross electrical output of 29.55 MWe and a net heat output of 49.1MWth, with a parasitic load of 3.1 MWe, to supply to onsite process plants. However, the Low Carbon CHP Facility would have the capacity to generate up to 40 MWe when no heat export on abnormal operational case.

3.1.4 The nominal capacity of the Low Carbon CHP Facility would be approximately 36.6 tonnes per hour of feedstock, with a nominal calorific value of 12.3 MJ/kg. The plant will have an estimated availability of around 7,884 hours. Therefore, the Low Carbon CHP Facility would have a nominal capacity of 288,819 tonnes per annum.

3.1.5 The Low Carbon CHP Facility would be capable of processing fuel with an NCV range of 11.2 - 17 MJ/kg. Assuming the lowest the realistic annual average NCV is 11.2 MJ/kg, then the Low Carbon CHP Facility wouldl have a maximum capacity of up to 317,186 tonnes per annum (again assuming 7,884 hours availability).

3.1.6 The Proposed Development would comprise the following key components:

- Feedstock storage and handling
- Boiler building
- Turbine building
- Service building
- Air Cooled Condenser (ACC)
- Flue gas treatment facility
- Air Pollution Control residue (APCr) and reagent silos

- Ash storage
- Water treatment
- Stack

3.2 Energy Recovery

3.2.1 The heat released by the combustion of the feedstocks would be recovered by means of a water tube boiler, which is integral to the furnace and will produce (in combination with superheaters) high pressure superheated steam at 92 bar(a) and 477°C. The steam from the boiler will then feed a high-efficiency steam turbine which will generate electricity. The turbine would have a series of extractions at different pressures that will be used for preheating air and water in the steam cycle.

3.2.2 The remainder of the steam left after the turbine would be condensed back to water to generate the pressure drop to drive the turbine. A fraction of the steam would condense at the exhaust of the turbine in the form of wet steam, However, the majority would be condensed and cooled using an air-cooled condenser. The condensed steam would be returned as feed water in a closed-circuit pipework system to the boiler.

3.2.3 Medium and low-pressure steam would be extracted from the turbine to pass through the heat user' heat exchangers. The volume of steam extracted will vary depending on the heat load requirements of the on-site heat users.

3.3 Details of Input Fuel

Table 3.1 – Expected Input Waste Characteristics

Parameter	Unit	Value
Nominal fuel throughput	TPA	288,819
Maximum fuel throughput	TPA	317,186
Proposed NCV	MJ/kg	12.30
Proposed GCV	MJ/kg	13.97

3.4 Heat Supply

3.4.1 The Low Carbon CHP Facility would have an electricity generating capacity of up to 40 MW. The proposed electrical system of the Low Carbon CHP Facility would include 11kV switchgear and transformers to enable it to connect to Kronospan's existing 11kV network.

3.4.2 It is proposed that electricity generated by the Low Carbon CHP Facility would be used to provide electricity to the on-site operations. Where on-site electricity demand is lower than electrical output, the excess power could be exported to the grid.

3.4.3 The Low Carbon CHP Facility would provide heat to the existing manufacturing process (MDF-1 and MDF-2) both in terms of superheated steam and the waste combustion gasses. In this regard, the Low Carbon CHP Facility would be highly efficient, unlike the majority of other large-scale biomass and waste combustion facilities which do not have heat users connected and therefore only generate electricity, with excess heat being lost to atmosphere.

3.4.4 Steam from the Low Carbon CHP Facility would be supplied to the existing wood panel plant, including a steam-to-steam generator and the existing MDF-1 and MDF-2 dryers for heating fresh air. The condensate will be returned to the deaerator.

4.0 ENERGY EFFICIENCY CALCULATIONS

4.1 Heat and Power Export

4.1.1 The heat and power export has been modelled across a range of load cases, and the results are presented in **Table 4.1**.

Table 4.1 – Heat and Power Export

Load Case	Heat Export at Turbine (MWth)	Gross Power Generated (MWe)	Net Power Exported (MWe)
1. No heat export	0.0	38.35	35.25
2. Proposed network heat load	49.07	29.55	26.45

4.2 CHPQA Quality Index

4.2.1 CHPQA is an energy efficiency best practice programme initiative by the UK Government. CHPQA aims to monitor, assess and improve the quality of CHP in the UK. In order to prove that a plant is a 'Good Quality' CHP plant, a QI of at least 105 must be achieved at the design, specification, tendering and approval stages. Under normal operating conditions (i.e. when the scheme is operational) the QI threshold drops to 100. The QI for CHP schemes is a function of their heat efficiency and power efficiency according to the following formula:

$$QI = X\eta_{power} + Y\eta_{heat}$$

where: η_{power} = *power efficiency; and*

η_{heat} = *heat efficiency.*

4.2.2 The power efficiency within the formula is calculated using the gross electrical output and is based on the gross calorific value of the input fuel. The heat efficiency is also based on the gross calorific value of the input fuel. The coefficients X and Y are defined by CHPQA based on the total gross electrical capacity of the scheme and the fuel / technology type used.

4.2.3 In March 2021, the UK Government released a revised CHPQA Standard Issue 8. This is applicable in Wales. The document sets out revisions to the design and implementation of the CHPQA scheme. These revisions are intended to ensure schemes which receive UK Government support are supplying significant quantities of heat and delivering intended energy savings. The following X and Y coefficients apply to the Low Carbon CHP Facility:

- X value = 214; and
- Y value = 120.

4.2.4 The QI and efficiency values (based on a gross calorific value of 13.97 MJ/kg) have been calculated in accordance with CHPQA methodology for various load cases and the results are presented in **Table 4.2**.

Table 4.2 – QI and Efficiency Calculations

Load Case	Gross Power Efficiency (%)	Heat Efficiency (%)	Overall Efficiency (%)	CHPQA QI
1. No heat export	26.98	-	26.98	57.73
2. Proposed network heat load	20.79	34.52	55.30	85.90

4.2.5 The results indicate that the Low Carbon CHP Facility will not achieve a QI score in excess of the 'Good Quality' CHP threshold (QI of 105 at the design stage) for the average heat load exported to the proposed heat network. The highly onerous efficiency criteria set out in the latest CHPQA guidance, most notably the underpinning requirement to achieve an overall efficiency (NCV basis) of at least 70%, means that none of the load cases considered will enable heat export from the Low Carbon CHP Facility to be considered Good Quality.

4.2.6 For reference, assuming the same Z ratio as set out in the preceding section, an average heat export of 83 MWth would be required for a heat network to achieve Good Quality status. It is clear that the design proposed for heat recovery is not capable of supplying this quantity of heat at the assumed conditions required by the local network.

4.3 BAT 20 of WI BREF

4.3.1 The Industrial Emissions Directive (IED), which was adopted on 7 January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector BREF become binding as BAT Conclusions. The WI BREF1 was published in 2019. This includes, as section 5, the BAT Conclusions.

4.3.2 BAT 20 states that the BAT-Associated Energy Efficiency Levels (referred to as BAT-AEELs) for Gross Electrical Efficiency for a waste incineration plant is 25-35%, this is applicable for the Low Carbon CHP Facility. The Gross Electrical Efficiency of the Low Carbon CHP Facility has been calculated in accordance with the requirements of BAT 20, refer to **Table 4.3**.

4.3.3 For the case of plants producing electricity using a condensing turbine, the gross electrical efficiency can be calculated. The formula for this calculation is stated in the BREF to be as follows:

$$Gross\ electrical\ efficiency\ \eta_e = \frac{W_e}{Q_{th}} \times \frac{Q_b}{Q_b - Q_i}$$

4.3.4 Where:

- W_e: electrical power generated, in MW;
- Q_b: thermal power produced by the boiler, in MW;
- Q_i: thermal power (as steam or hot water) that is used internally (e.g. for flue-gas reheating), in MW; and
- Q_{th}: thermal input to the thermal treatment units (e.g. furnaces), including the waste and auxiliary fuels that are used continuously (excluding for example for start-up), in MWth expressed as the lower heating value.

[1] *https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf*

4.3.5 Q_i is assumed to be zero as no thermal power is used internally. This means that $\frac{Q_b}{Q_b - Q_i}$ would be 1 for all the cases. The other parameters (W_e and Q_{th}) of the formula above for the Facility are set out **in Table 4.3**.

Table 4.3 – BAT 20 – Gross Electrical Efficiency

Item	Unit	1. No Heat Export	2. Proposed Network Heat Load
Annual Heat Export at Turbine	MW	-	49.07
Net Thermal input from waste, NCV (Qth)	MW	125.2	125.2
Gross Power Generation (MW)(We)	MW	38.35	29.55
Gross electrical efficiency, NCV (We/Qth)	%	30.64	23.61
BAT-AEEL Gross electrical efficiency (NCV)	%	25-35	25-35

4.3.6 The Environment Agency's BREF Implementation Plan states:

"BAT for these plants is to become CHP by connecting to a heat network or supplying a heat user direct where viable opportunities exist.

and

Existing plants will also be expected to demonstrate that they have maximised their GEE as far as possible and have minimised their parasitic heat and electrical loads."

4.3.7 MDF-1 and MDF-2 dryers will require heat and are heat user for the Low Carbon CHP Facility. In addition, as shown in **Table 4.3**, whilst the export of heat to the onsite dryers will reduce the electrical efficiency of the Low Carbon CHP Facility, the power only mode has a GEE of more than 25%. Taking this into consideration, the proposed export of heat from the Low Carbon CHP Facility is considered to represent BAT.

4.4 Primary Energy Saving

4.4.1 To be considered high-efficiency cogeneration, the scheme must achieve at least 10% savings in primary energy usage compared to the separate generation of heat and power. The Primary Energy Saving (PES) has been calculated in accordance with European Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015 Annex II part (b).

4.4.2 Efficiency reference values for the separate production of heat and electricity have been taken as 75% and 25% respectively as defined in Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015[2].

4.4.3 When operating in heat supply mode, the PES has been calculated in accordance with the draft Article 14 guidance3 and the results are presented in **Table 4.4**.

Table 4.4 – Primary Energy Saving (%)

	Primary Energy Saving (%)
The Low Carbon CHP Facility	30.28

4.4.4 The Low Carbon CHP Facility achieves a PES of 30.28%. This is more than the technical feasibility threshold defined in the draft Article 14 guidance. On this basis, the heat supply from the Low Carbon CHP Facility to the MDF-1 and MDF-2 dryers qualifies as a high-efficiency cogeneration operation when operating in CHP mode.

[2] *http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2402*
[3] *Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive, V0.9 April 2015*

5.0 R1 EFFICIENCY CALCULATIONS

5.1.1 In accordance with the Waste Framework Directive (WFD), incineration facilities which process non-hazardous residual waste (such as the Low Carbon CHP Facility) can be regarded as "Recovery" operations if the energy efficiency of the plant is greater than 0.65 (for plants permitted after January 2009). This is referred to as achieving "R1 status". In the UK, R1 status can only be formally granted by the relevant Competent Authority (for the Proposed Extension this will be the Environment Agency) when the facility has been in operation for more than 12 months. Plants which do not meet the energy efficiency criterion are classed as "Disposal" operations and therefore are considered as being equivalent to landfill in terms of the waste hierarchy.

5.1.2 The European Commission has published guidance titled '*Guidelines on the Interpretation of the R1 Energy Efficiency Formulae for Incineration Facilities Dedicated to the Processing of Municipal Solid Waste According to Annex II of Directive 2008/98/EC on Waste*'. Within the European Commission guidance, the formula to calculate the efficiency of a facility is explained as follows:

$$\text{Energy Efficiency} = \frac{\left(E_p - (E_f + E_i)\right)}{\left(0.97 \times (E_w + E_f)\right)}$$

5.1.3 Where:

- E_p means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (units of GJ/yr)
- E_f means annual energy input to the system from fuels contributing to the production of steam (units of GJ/yr)
- E_w means annual energy contained in the treated waste calculated using the net calorific value (NCV) of the waste (units of GJ/yr)
- E_i means annual energy imported excluding E_w and E_f (units of GJ/yr)
- 0.97 is a factor accounting for energy losses due to bottom ash and radiation.

5.1.4 The formula within the European Commission guidance has been used to assess the energy efficiency of the Low Carbon CHP Facility. The calculation is based on the relevant design parameters for the Low Carbon CHP Facility. For the purposes of the calculations, the following assumptions have been made with regards to the design of the Low Carbon CHP Facility:

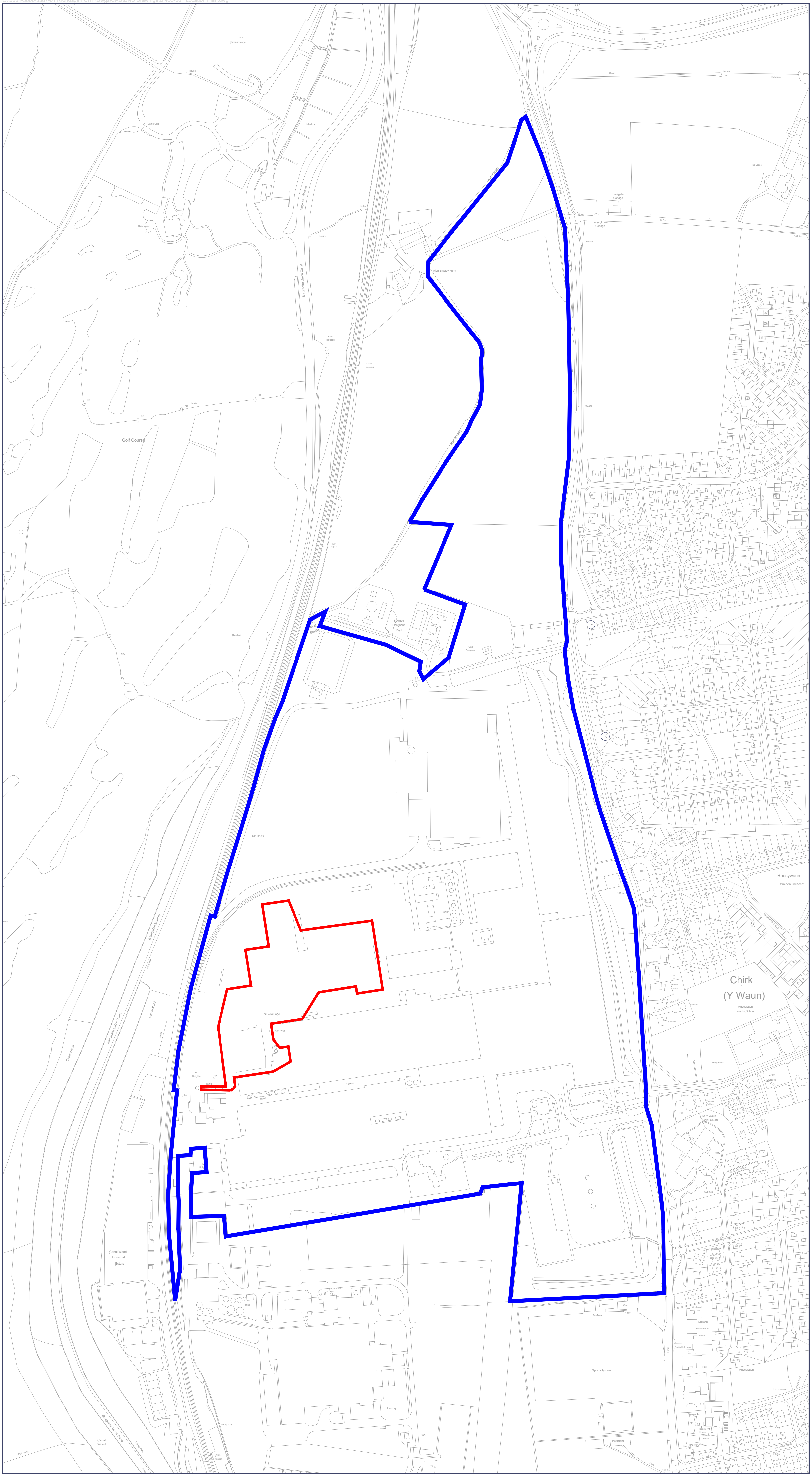
- One stream with an annual availability of 90.0 %, equating to 7,884 hours per annum.
- Fuel throughput of 36.63 tonnes per hour.
- Fuel processed will have an average NCV of 12.3 MJ/kg.
- The Low Carbon CHP Facility will generate 38.35 MW_e without any heat export, with a parasitic load of 3.1 MW_e.
- The Low Carbon CHP Facility is designed to generate 29.55 MW_e with heat export of 49.07 MW_{th}.
- During start-up and shutdown, the Low Carbon CHP Facility will consume a parasitic load of 3.1 MW_e.
- Electricity used during non-availability (i.e. excluding start-up and shutdown) will be 20% of the parasitic load.
- The auxiliary burners will have a capacity of 60% of the boiler thermal input.
- The average auxiliary burner consumption during start-up will be 50%[4] of the burner duty.
- There will be two start-up and shutdown events per year and each start-up and shutdown will use support fuel for a period of 16 hours and one hour respectively. 50% of the fuel used in the start-up will be used for steam production and therefore generate electricity.
- It has been assumed that no heat is exported from the Low Carbon CHP Facility. This assumption is judged to be conservative, as the export of heat will result in a higher efficiency.

5.1.5 Taking the above into consideration, the R1 efficiency of the Low Carbon CHP Facility has been calculated as **0.78 with fully condensing no heat case and 1.042**

[4] *The average auxiliary burner duty during a full cold start is assumed to be 50%. The burners always have to start on low fire and ramp up slowly, following a predefined warm up curve to avoid damaging the boiler. This results in a duration of 16 hours for full cold start-up.*

with design heat case. Both scenarios are above the threshold for new incineration plants. Therefore, the Low Carbon CHP Facility will meet the definition of recovery with or without any heat export. A table setting out the calculation is presented in **Appendix** Error! Reference source not found..

Appendix A – Site Location and Layout Drawings



Application Boundary 25,992m²

Land Owned by Applicant

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Kronospan

Project

Kronospan Low Carbon Combined Heat and Power Facility

Drawing Title

Location Plan

Scale			Status
1:5000 @A3			--
Date		Drawn	Checked
December 2025		JD	BC
Dwg no			Rev
DNS3-001			

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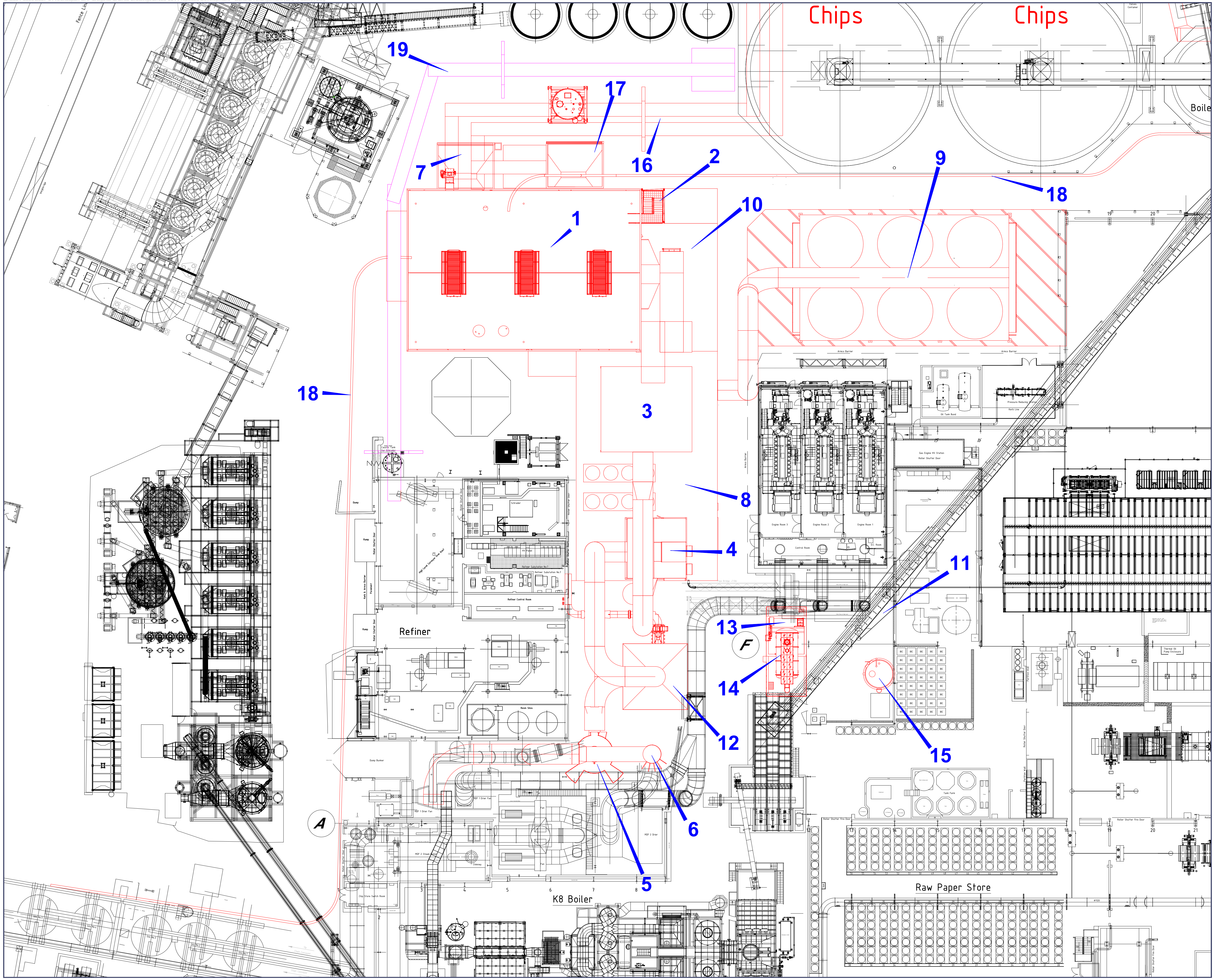

Proposed Development - New

1 - Boiler Building
2 - Stair Tower
3 - Bag Filter
4 - ID Fan with Noise Enclosure
5 - Silencer
6 - Stack
7 - Ash Pit
8 - Turbine Building
9 - ACC. (on elevated steel structure)
10 - Service Building
11 - Water Treatment
12 - NOx. Catalyst
13 - Effluent Pit
14 - Ammonia Tank
15 - Lime Silo
16 - Feedstock Conveyor
17 - Backup Feedstock Loading
18 - Dust Blow Line into CHP

Proposed Development - Replacement

19 - Transportation System between Existing Chip Silos and Existing Refiner Building

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Drawing Title
Proposed Development - General Arrangement (CHP Facility)

Scale	Status
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December 2025	JD	BC

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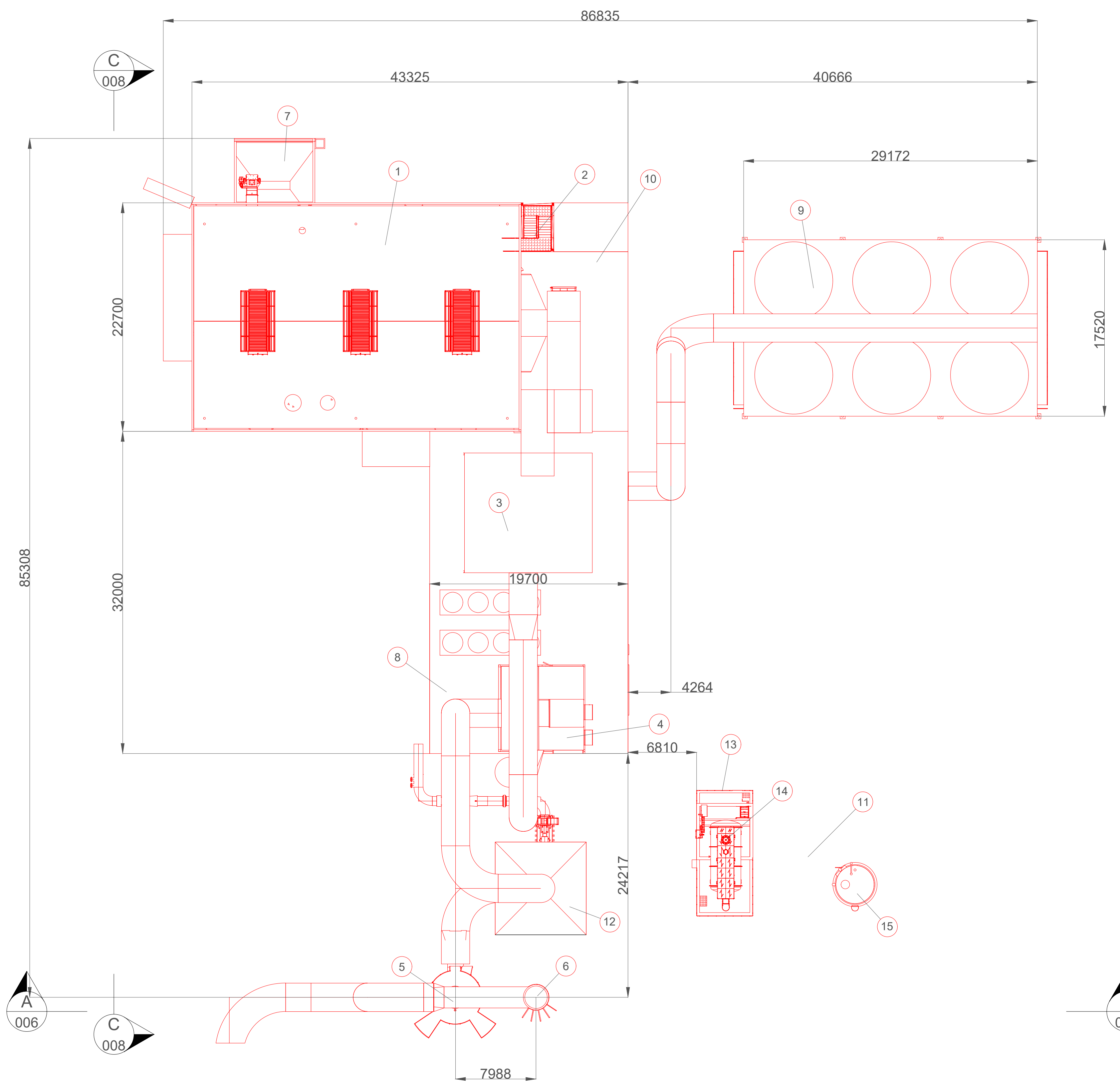

Legend:

1) Boiler Building
2) Stair Tower
3) Bag Filter
4) ID Fan with Noise Enclosure
5) Silencer
6) Stack
7) Ash Pit
8) Turbine Building
9) ACC. (on elevated steel structure)
10) Service Building
11) Water Treatment
12) NOx. Catalyst
13) Effluent Pit
14) Ammonia Tank
15) Lime Silo

Notes:

Drawing shows proposed CHP Facility components to be provided by the CHP supplier only - for full details of all proposed CHP components, including feedstock storage and processing, please refer to Planning Drawings 1-6

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Drawing Title
Proposed Development - CHP Facility: Plan

Scale	Status
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Date	Drawn	Checked
December 2025	JD	BC

Dwg no	Rev
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Appendix B – Waste Framework Directive Energy Efficiency Calculation

Kronospan Low Carbon CHP Facility

Appendix B

Waste Framework Directive Energy Efficiency Calculation

Prepared for: Kronospan

December 2025

Parameters	Unit	Power Only	With Heat Export
Number of streams	-	1	1
Average through-life availability	%	90.00%	90.00%
Equivalent full load operating hours per year	h/y	7,884	7,884
Feed stock calculations			
Fuel throughput per boiler	tph	36.634	36.634
Fuel NCV	MJ/kg	12.30	12.30
Fuel throughput	t/y	288,819	288,819
Energy input	MW	125.16	125.16
Energy input	MWh/y	986,799	986,799
Energy input	GJ/y	3,552,477	3,552,477
Electricity exported			
Gross electricity production	MW	38.35	29.55
Gross electrical efficiency		30.64%	23.61%
Total electricity produced	MWh/y	302,371	232,964
Total electricity produced	GJ/y	1,088,535	838,672
Parasitic load	kW	3,100	3,100
Parasitic load	MWh/y	24,440	24,440
Parasitic load	GJ/y	87,985	87,985
Net electrical output	MW	35.3	26.4
Net electrical efficiency	%	28.16%	21.13%
Heat exported			
Heat exported	MWh/h	-	49.07
Heat efficiency	%	0.00%	39.20%
Heat exported	MWh/y	-	386,845
Heat exported	GJ/y	-	1,392,641
Heat used internally (a)			
Heat used internally	MWh/y	-	-
Heat used internally	GJ/y	-	-

Parameters	Unit	Power Only	With Heat Export
Total heat produced			
Total heat produced	MWh/y		386,845
Total heat produced	GJ/y		1,392,641
Fuel used			
Auxiliary burner capacity		60%	60%
Auxiliary burner capacity	MW	75.10	75.10
Average auxiliary burner duty during start-up	%	50%	50%
Number of start-ups per year	-	2	2
Start-up/ shutdown time using support fuel	hrs	17	17
Annual time for start-ups	hrs/y	34	34
Total auxiliary fuel consumed	MWh/y	1,277	1,277
Energy in auxiliary fuel consumed by start-up burners	GJ/y	4,596	4,596
Electricity imported			
Electricity consumption during start-up	kW	3,100	3,100
Electricity imported during start-up	MWh/y	105	105
Electricity imported during start-up	GJ/y	379	379
Electricity consumption during non-availability	kW	620	620
Electricity imported during non-availability	MWh/y	543	543
Electricity imported during non-availability	GJ/y	1,955	1,955
Electricity imported during start-up and non-availability	MWh/y	649	649
Electricity imported during start-up non-availability	GJ/y	2,335	2,335

Notes:

The input data is based on a single design point, a reduction factor of 0.95 has been used to include partial load operation, boiler fouling and high air temperature during the summer.

It is assumed that only 50% of fossil fuel used by the start-up burners generates steam and therefore only 50% of fuel energy is included as Ei (heat).

WFD Calculation	Unit	Power Only	With Heat Export
Ew	GJ/y	3,552,477	3,552,477
Ep (electricity)	GJ/y	2,688,682	2,071,519
Ep (heat)	GJ/y	-	1,531,906
Ep total (electricity + heat)	GJ/y	2,688,682	3,603,424
Ef (1)	GJ/y	2,298	2,298
Ei (electricity)	GJ/y	6,070	6,070
Ei (heat)(2)	GJ/y	2,298	2,298
Ei total (electricity + heat)	GJ/y	8,368	8,368
WFD ratio			
WFD ratio	-	0.7767	1.0419
Pass or fail?	-	pass	pass
Climate change factor			
Heating degree days		3,350	3,350
Old plant or new plant		New	New
Climate change factor	-	1.000	1.000
Adjusted WFD ratio	-	0.7767	1.0419
Pass or fail?	**-**	**pass**	**pass**