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Indaver Ireland Limited

IE Licence Review Application

Reference Document on Best Available Techniques for Energy Efficiency, February 2009

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1. Introduction

This report has been prepared for the purposes of Section 4.7 of an Industrial Emissions Licence (IE) Review application submitted by Indaver Ireland for their site at Carranstown, Duleek, County Meath. This report, which applies to IE Licence W0167-03, consists of a review of the licensed activities on site and the proposed activities to which the licence review relates in the context of any applicable Best Available Techniques (BAT).

The Industrial Emissions Directive 2010/75/EU (IED) and the European Union (Industrial Emissions) Regulations 2013 (SI 138 of 2013) define BAT, BAT Reference Document (BREF) and BAT Conclusions (BATC) as follows:

The Industrial Emissions Directive defines Best Available Techniques as follows:

'best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:

(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;

(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole;

The Industrial Emissions Directive definition of BAT Reference Document is as follows:

"(11) 'BAT reference document' means a document, resulting from the exchange of information organised pursuant to Article 13, drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques, giving special consideration to the criteria listed in Annex III;"

SI 138 of 2013 has a similar definition.

The Industrial Emissions Directive and SI 138 of 2013 have the same definition of BAT conclusions, as follows:

'BAT conclusions' means a document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures;

The Industrial Emissions Directive 2010/75/EU replaced seven existing directives including the Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC).

- Historically, the BREF process for the IPPC Directive produced guidance documents that member states had to have regard to when permitting (licensing) installations.
- However, the IED has made BAT conclusions mandatory in the permitting process (Article 14(3) of the IED).

Where BAT conclusions are available for any new installations, they are expected to achieve the associated standard before commencement of operations.

For existing installations, the IED provides that where a Commission Implementing Decision on BAT conclusions is published, within four years (relating to the main activity of the installation), the Environmental Protection Agency (EPA) should undertake that 'all permit/licence conditions for the installation concerned are reconsidered, where necessary updated' and 'ensure compliance with the BAT'.

The European IPPC Bureau (EIPPCB) organises and co-ordinates the exchange of information between Member States and the industries concerned on Best Available Techniques (BAT), as set forth in Article 13 of the IED. The EIPPCB produces BAT reference documents (BREF) and BAT conclusions.

2. Activity

As per W0167-03 the facility is currently licensed to carry out the following activities as outlined in the First Schedule of the Environmental Protection Agency (EPA) Act 1992, as amended:

11.3: Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants –

(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour,

(b) for hazardous wate with a capacity exceeding 10 tonnes per day.

Following implementation of the proposed development, which includes an increase in the amount of waste being accepted at the facility and the construction of a hydrogen generation unit, two new activities as outlined in the First Schedule of the EPA Act 1992, as amended, will be carried out:

5.13 (a) The production of inorganic chemicals, such as gases, such as ammonia, chlorine or hydrogen chloride, fluorine, or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride (production means the production on an industrial scale by chemical or biological processing);

11.6 Temporary storage of hazardous waste, (other than waste referred to in paragraph 11.5) pending any of the activities referred to in paragraph 11.2, 11.3, 11.5 or 11.7 with a total capacity exceeding 50 tonnes, other than temporary storage, pending collection, on the site where the waste is generated.

3. BAT/BREF Assessments

A review of the European Commission Integrated Pollution Prevention and Control *Reference Document on Best Available Techniques on Energy Efficiency February 2019* is presented in the table below.

Table 1: Review of European Commission Integrated Pollution Prevention and Control Reference Document on Best Available Techniques on Energy Efficiency

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
4.2.1. Energy Efficiency Management			
BAT 1	BAT is to implement and adhere to an energy efficiency management system (ENEMS) that incorporates, as appropriate to the local circumstances, all of the following features (see Section 2.1. The letters (a), (b), etc. below, correspond those in Section 2.1): a) commitment of top management (commitment of the top management is regarded as a precondition for the successful application of energy efficiency management) b) definition of an energy efficiency policy for the installation by top management c) planning and establishing objectives and targets (see BAT 2, 3 and 8) d) implementation and operation of procedures paying particular attention to: i. structure and responsibility ii. training, awareness and competence (see BAT 13) iii. communication iv. employee involvement v. documentation vi. effective control of processes (see BAT 14) vii. maintenance (see BAT 15) viii. emergency preparedness and response ix. safeguarding compliance with energy efficiency-related legislation and agreements (where such agreements exist). e) benchmarking: the identification and assessment of energy efficiency indicators over time (see BAT 8), and the systematic and regular comparisons with sector, national or regional benchmarks for energy efficiency, where verified data are available (see Sections 2.1(e), 2.16 and BAT 9) f) checking performance and taking corrective action paying particular attention to: i. monitoring and measurement (see BAT 16) ii. corrective and preventive action iii. maintenance of records	Applicable – The existing facility operates accordance with an Environmental Management System (EMS) which is certified (ISO 14001) and is updated annually in accordance with the IE licence requirements. This sets out annual targets including targets for energy efficiency. The process is controlled by the distributed control system (DCS) which allows for fine tuning of the process and the monitoring of all process parameters in order to optimise efficiency. Section 9 of this licence application provides a summary of the energy efficiency measures incorporated into the design of the facility. Every 4 years the company is required to complete an energy audit under SI 426 (2014 or as amended).	In place. One of the main drivers of the proposed development is to improve the energy efficiency and sustainability. The hydrogen generation unit (HGU) will be utilised when the electricity produced by the facility is not required by the electricity grid, this power is currently wasted and with the provision of the HGU, a useful and carbon free fuel in the form of hydrogen gas can be produced. The hydrogen generation unit will use 10MW of electricity (for approx. 1,000 hrs) that would otherwise be wasted to produce approximately 160 tonnes of hydrogen annually using water as a feedstock. The proposed development will be incorporated into the EMS.

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	iv. independent (where practicable) internal auditing in order to determine whether or not the energy efficiency management system conforms to planned arrangements and has been properly implemented and maintained (see BAT 4 and 5) g) Review of the ENEMS and its continuing suitability, adequacy and effectiveness by top management For (h) and (i), see further features on an energy efficiency statement and external verification, below. h) when designing a new unit, taking into account the environmental impact from the eventual decommissioning of the unit i) k. development of energy efficient technologies, and to follow developments in energy efficiency techniques. The ENEMS may be achieved by ensuring these elements form part of existing management systems (such as an EMS) or by implementing a separate energy efficiency management system. Three further features are considered as supporting measures. Although these features have advantages, systems without them can be BAT. These three additional steps are: • (See Section 2.1(h)) preparation and publication (and possibly external validation) of a regular energy efficiency statement describing all the significant environmental aspects of the installation, allowing for year-by-year comparison against environmental objectives and targets as well as with sector benchmarks as appropriate. • (See Section 2.1(i)) having the management system and audit procedure examined and validated by an accredited certification body or an external ENEMS verifier. • (See Section 2.1, Applicability, 2) implementation and adherence to a nationally or internationally accepted voluntary system such as: o DS2403, IS 393, SS627750, VDI Richtlinie No. 46, etc. o (When including energy efficiency management in an EMS) EMAS and EN ISO 14001:1996. This voluntary step could give higher credibility to the ENEMS. However, non-standardised systems can be equally effective provided that they are properly designed and implemented.		

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
4.2.2. Planning and Establishing Objectives and Targets			
4.2.2.1. Continuous Environmental Improvement			
BAT 2	BAT is to continuously minimise the environmental impact of an installation by planning actions and investments on an integrated basis and for the short, medium and long term, considering the cost-benefits and cross-media effects.	Applicable Continual improvement will be achieved through the implementation of the EMS and the setting of annual targets and objectives, in particular improved energy efficiency and reduced potential environmental impact. Indaver review their EMS every year and set up-to-date environmental goals to continually improve environmental performance.	In place The proposed development will be incorporated into the EMS
4.2.2.2. Identification of Energy Efficiency aspects of an installation and opportunities for energy savings			
BAT 3	BAT is to identify the aspects of an installation that influence energy efficiency by carrying out an audit. It is important that an audit is coherent with a systems approach (see BAT 7).	Applicable Energy audits will be carried out in accordance with SI 426/2014 (as amended) or as otherwise agreed with the Agency to identify further opportunities for energy efficiency improvement as part of facility management systems. The results of these audits are reported in the facility's AER.	In place The proposed development will be incorporated into the EMS
BAT 4	When carrying out an audit, BAT is to ensure that the audit identifies the following aspects (see Section 2.11): a) energy use and type in the installation and its component systems and processes b) energy-using equipment, and the type and quantity of energy used in the installation. c) possibilities to minimise energy use, such as: o controlling/reducing operating times, e.g., switching off when not in use (e.g., see Sections 3.6, 3.7, 3.8, 3.9, 3.11) o ensuring insulation is optimised, e.g., see Sections 3.1.7, 3.2.11 and 3.11.3.7 o optimising utilities, associated systems, processes and equipment (see Chapter 3) d) possibilities to use alternative sources or use of energy that is more efficient, in particular energy surplus from other processes and/or systems, see Section 3.3	Applicable Energy audits will be carried out in accordance with SI 426/2014 (as amended) or as otherwise agreed with the Agency to identify further opportunities for energy efficiency improvement as part of facility management systems. The results of these audits are reported in the facility's AER.	In place The proposed development will be incorporated into the EMS

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	e) possibilities to apply energy surplus to other processes and/or systems, see Section 3.3 f) possibilities to upgrade heat quality (see Section 3.3.2).		
BAT 5	BAT is to use appropriate tools or methodologies to assist with identifying and quantifying energy optimisation, such as: • energy models, databases and balances (see Section 2.15) • a technique such as pinch methodology (see Section 2.12) exergy or enthalpy analysis (see Section 2.13), or thermoeconomics (see Section 2.14) • estimates and calculations (see Sections 1.5 and 2.10.2).	Applicable A consumer list been developed to assist in identifying opportunities for energy optimisation. Energy balances are calculated from data collected. At the micro-level, specific unit operations such as heating, cooling, or lighting systems will be subject to energy efficiency assessment. This is an integral part of the Indaver continuous improvement approach.	In place
BAT 6	BAT is to identify opportunities to optimise energy recovery within the installation, between systems within the installation (see BAT 7) and/or with a third party (or parties), such as those described in Sections 3.2, 3.3 and 3.4.	Applicable Specific unit operations such as heating, cooling, or lighting systems are subject to energy efficiency assessment. It is in Indaver's best interest to optimise energy efficiency at the facility and improvements are consistently made to facilitate this where possible. Recent examples of efficient improvements at the facility include: • Reduced drum blowdown – this reduces heat losses from the process. • Reduced deaerator venting – Again this reduces heat loss from the cycle. • Increasing steam temperature to the steam turbine for maximum efficiency. • Optimise the use of the small bypass valve to avoid steam bypassing the turbine. • Reduced boiler pressure and boiler feed pump pressure thereby reducing house load.	In place
4.2.2.3. A Systems Approach to Energy Management			
BAT 7	BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example: • process units (see sector BREFs)	Applicable Each unit operation has been assessed for energy efficiency most notably process, heating, cooling, HVAC, motors/transformers, and lighting.	In place.

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	• heating systems such as: • steam (see Section 3.2) • hot water • cooling and vacuum (see the ICS BREF) • motor driven systems such as: • compressed air (see Section 3.7) • pumping (see Section 3.8) • lighting (see Section 3.10) • Drying, separation and concentration (see Section 3.11)	Operational control – the distributed control system (DCS) only turns on equipment as needed to optimise energy use. Where practical, equipment will be kept on standby until required. Variable speed drives are used where practical for conveyors, compressors, pumps. Selection of furnace technology has been made on the basis of efficient design. Waste heat generated from incineration will be re-used in the Waste Heat Boiler for electricity generation.	
4.2.2.4. Establishing and Reviewing Energy Efficiency Objectives and Indicators			
BAT 8	BAT is to establish energy efficiency indicators by carrying out all of the following: a) identifying suitable energy efficiency indicators for the installation, and where necessary, individual processes, systems and/or units, and measure their change over time or after the implementation of energy efficiency measures (see Sections 1.3 and 1.3.4) b) identifying and recording appropriate boundaries associated with the indicators (see Sections 1.3.5 and 1.5.1) c) identifying and recording factors that can cause variation in the energy efficiency of the relevant process, systems and/or units (see Sections 1.3.6 and 1.5.2).	Applicable As part of the energy auditing process, key energy efficiency indicators are developed and benchmarked against industry norms for similar industries.	In place The proposed development will be incorporated into the energy audits for the site.
4.2.2.5. Benchmarking			
BAT 9	BAT is to carry out systematic and regular comparisons with sector, national or regional benchmarks, where validated data are available.	Applicable As part of the energy auditing process, key energy efficiency indicators are developed and benchmarked against industry norms for other Indaver facilities.	In place The proposed development will be incorporated into the energy audits for the site.
4.2.3. Energy-Efficient Design (EED)			
BAT 10	BAT is to optimise energy efficiency when planning a new installation, unit or system or a significant upgrade (see Section 2.3) by considering all of the following:	Applicable Energy is recovered from the resulting flue gases in the furnace using a conventional steam boiler. The resulting steam is fed to a turbine and up to 21.5 megawatts of electricity (MWe) is	In place Energy efficiency has been incorporated into the overall design of the proposed

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	a) the energy efficient design (EED) should be initiated at the early stages of the conceptual design/basic design phase, even though the planned investments may not be well-defined. The EED should also be taken into account in the tendering process. b) the development and/or selection of energy efficient technologies (see Sections 2.1(k) and 2.3.1) c) additional data collection may need to be carried out as part of the design project or separately to supplement existing data or fill gaps in knowledge. d) the EED work should be carried out by an energy expert. e) the initial mapping of energy consumption should also address which parties in the project organisations influence the future energy consumption and should optimise the energy efficiency design of the future plant with them. For example, the staff in the (existing) installation who may be responsible for specifying design parameters.	generated. Approximately 2.5 MWe is consumed by the equipment in the plant and the other 19 MWe is then available for export to the national grid. The energy auditing process identifies ongoing energy saving improvements which are made year on year.	development and has been considered in procurement of equipment.
4.2.4. Increased Process Integration			
BAT 11	BAT is to seek to optimise the use of energy between more than one process or system (see Section 2.4), within the installation or with a third party.	Applicable Waste heat from the incineration process will be re-used for generating electricity.	In place
4.2.5. Maintaining the Impetus of Energy Efficiency Initiatives			
BAT 12	BAT is to maintain the impetus of the energy efficiency programme by using a variety of techniques, such as: a) implementing a specific energy efficiency management system (see Section 2.1 and BAT 1) b) accounting for energy usage based on real (metered) values, which places both the obligation and credit for energy efficiency on the user/bill payer (see Sections 2.5, 2.10.3 and 2.15.2) c) the creation of financial profit centres for energy efficiency (see Section 2.5) d. benchmarking (see Section 2.16 and BAT 9) d) a fresh look at existing management systems, such as using operational excellence (see Section 2.5) e) f. using change management techniques (also a feature of operational excellence, see Section 2.5).	Applicable Measures to optimise energy efficiency include. • Minimising flue gas heat losses • Ensuring the thermal conversion efficiency of the boiler is greater than 80% • Selecting a turbine suited to high energy efficiency and maximum expansion of steam to a very low pressure (0.1 bar, in vacuum) • Selecting low energy systems, such as the SNCR system for NOx abatement • Minimising the use of primary fuels by using energy produced onsite. • Sourcing secondary combustion air from the main process building where it is effectively pre-heated. • Installing variable speed drives on fans and pumps	In place Energy efficiency has been incorporated into the overall design of the proposed development,

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
		• Targets include reviewing in-house energy and resource usage by conducting electrical inspections and energy efficiency audits and establishing Key Performance Indicators (KPIs) for these resources.	
Maintaining Expertise			
BAT 13	BAT is to maintain expertise in energy efficiency and energy-using systems by using techniques such as: a) recruitment of skilled staff and/or training of staff. Training can be delivered by in-house staff, by external experts, by formal courses or by self-study/development (see Section 2.6) b) taking staff off-line periodically to perform fixed term/specific investigations (in their original installation or in others, see Section 2.5) c) sharing in-house resources between sites (see Section 2.5) d) use of appropriately skilled consultants for fixed term investigations (e.g. see Section 2.11) e) outsourcing specialist systems and/or functions (e.g. see Annex 7.12)	Applicable Facility is staffed by suitably skilled and qualified staff. All staff have received necessary training to complete their duties with additional training for energy management as required depending on their role. Energy audits completed under SI 426(2014) are chosen from registered of Energy Auditors on SEAI website.	In place
4.2.7. Effective Control of Processes			
BAT 14	BAT is to ensure that the effective control of processes is implemented by techniques such as: a) having systems in place to ensure that procedures are known, understood and complied with (see Sections 2.1(d)(vi) and 2.5) b) ensuring that the key performance parameters are identified, optimised for energy efficiency and monitored (see Sections 2.8 and 2.10) c) c. documenting or recording these parameters (see Sections 2.1(d)(vi), 2.5, 2.10 and 2.15).	Applicable The facility operates in accordance with site procedures. These account for energy efficiency principles where appropriate, and all staff are fully trained in these procedures. The process is controlled by the Distributed Control System which allows for fine tuning of the process and the monitoring of all process parameters in order to optimise efficiency.	In place The proposed development will be incorporated into the sites energy efficiency audits.
4.2.8. Maintenance			
BAT 15	BAT is to carry out maintenance at installations to optimise energy efficiency by applying all of the following: a) clearly allocating responsibility for the planning and execution of maintenance b) establishing a structured programme for maintenance based on technical descriptions of the equipment, norms, etc. as well as any equipment failures	Applicable A comprehensive preventative maintenance regime is implemented at the facility. This includes maintenance of all main process equipment.	In place The proposed development will be included in the preventative maintenance programme.

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	and consequences. Some maintenance activities may be best scheduled for plant shutdown periods. c) supporting the maintenance programme by appropriate record keeping systems and diagnostic testing d) identifying from routine maintenance, breakdowns and/or abnormalities possible losses in energy efficiency, or where energy efficiency could be improved. e) Identifying leaks, broken equipment, worn bearings, etc. that affect or control energy usage, and rectifying them at the earliest opportunity.	Appropriate records are kept and opportunities for energy efficiency improvements identified and communicated. Organisation matrix available where maintenance is clearly allocated.	
4.2.9. Monitoring and Measurement			
BAT 16	BAT is to establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of operations and activities that can have a significant impact on energy efficiency. Some suitable techniques are given in Section 2.10.	Applicable The facility operates in accordance with documented procedures. These account for energy efficiency principles where appropriate. Staff will be fully trained on the relevant procedures. Energy use monitoring is undertaken in order to demonstrate areas of greatest energy use. This is done under the facility's plant's control & management system.	In place The proposed development will be incorporated into the site's energy efficiency audits.
4.3. Best Available Techniques for Achieving Energy Efficiency in Energy-Using Systems, Processes, activities, or Equipment			
4.3.1. Combustion			
BAT 17	BAT is to optimise the energy efficiency of combustion by relevant techniques such as: • those specific to sectors given in vertical BREFs. • those given in Table 4.1 (of the BREF document).	Applicable The principal process at the facility is combustion. The thermal energy generated by burning the waste in the furnace is transformed into electricity using a conventional steam cycle. This consists of a boiler to generate steam, a steam turbine across which the steam is expanded to produce motive power and a condenser to condense the steam and dissipate the low-grade waste heat. The boiler operates within optimised steam parameters for electricity generation from waste incineration.	In place
4.3.2. Steam Systems			

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
BAT 18	BAT for steam systems is to optimise the energy efficiency by using techniques such as: a) those specific to sectors given in vertical BREFs. b) those given in Table 4.2 (of the BREF document).	Applicable The boiler outlet temperature for the existing facility is approximately 200°C and is considered BAT. Such a temperature is required for the evaporation of excess water in the process and the minimisation or avoidance of liquid effluent. The boiler consists of a number of empty passes and a final pass with tube bundles. The empty flue gas passes have been constructed from membrane walls without obstructions such as tube banks. The empty passes allow heat transfer from the flue gas to the evaporating water in the membrane walls mainly by radiation. There will be no tube bundles in this section of the boiler as the fly ash will be sticky, and would quickly deposit on, and foul the surfaces.	In place
4.3.3. Heat Recovery			
BAT 19	BAT is to maintain the efficiency of heat exchangers by both: a) monitoring the efficiency periodically, and b) preventing or removing fouling. c) See Section 3.3.1.1.	Applicable Steam cycle heat exchangers including waste heat boiler, condenser, and economiser. Processing temperatures and pressure are monitored continuously using the Automated Control System. This will provide an indication of possible fouling or damage to the heat transfer surfaces. Annual inspection of boiler tubes is undertaken during shut down. Boiler tubes are inspected for fouling or corrosion. Preventative maintenance is undertaken.	In place
4.3.4. Congregation			
BAT 20	BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party).	Applicable The facility uses waste heat from the furnace to generate steam from the steam boiler which is fed to a steam turbine for the generation of electricity.	In place
4.3.5. Electrical Power Supply			

<table>
<tr><th colspan="2">Best Available Techniques (BAT)</th><th>Applicability Assessment (describe how the technique applies or not to your installation)</th><th>State whether it is in place or state schedule for implementation</th></tr>
<tr><td>BAT 21</td><td>BAT is to increase the power factor according to the requirements of the local electricity distributor by using techniques such as those in Table 4.3, according to applicability (see Section 3.5.1).

Table 4.3: Electrical power factor correction techniques to improve energy efficiency.

<table><tr><th>Technique</th><th>Applicability</th></tr><tr><td>Installing capacitors in the AC circuits to decrease the magnitude of reactive power</td><td>All cases. Low cost and long lasting, but requires skilled application</td></tr><tr><td>Minimising the operation of idling or lightly loaded motors</td><td>All cases</td></tr><tr><td>Avoiding the operation of equipment above its rated voltage</td><td>All cases</td></tr><tr><td>When replacing motors, using energy efficient motors (see Section 3.6.1)</td><td>At time of replacement</td></tr></table></td><td>Applicable

Motors, Fans and Compressors are generally fitted with variable speed drives where practical to minimise losses. All equipment is operated within the rated voltages.</td><td>In place</td></tr>
<tr><td>BAT 22</td><td>BAT is to check the power supply for harmonics and apply filters if required (see Section 3.5.2).</td><td>Applicable

Energy monitoring is installed at the main incoming supply to the facility to monitor energy consumption and harmonic content.

Measures may be installed to filter harmonic content as required.</td><td>In place</td></tr>
<tr><td>BAT 23</td><td>BAT is to optimise the power supply efficiency by using techniques such as those in Table 4.4, according to applicability:</td><td>Applicable

Each unit operation has been assessed for energy efficiency and factors such as location of high electrical load items relative to supply connection point, sizing of electrical transformers etc have been incorporated into the design.

Measures listed in Table 4.4 have been incorporated and are set out in the design standards for the existing facility.</td><td>In place

Measures listed in Table 4.4 have been incorporated into the design standards for the proposed development.</td></tr>
</table>

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	<table><tr><th>Technique</th><th>Applicability</th><th>Section in this document</th></tr><tr><td>Ensure power cables have the correct dimensions for the power demand</td><td>When the equipment is not in use, e.g. at shutdown or when locating or relocating equipment</td><td>3.5.3</td></tr><tr><td>Keep online transformer(s) operating at a load above 40 – 50 % of the rated power</td><td>□ for existing plants: when the present load factor is below 40 %, and there is more than one transformer □ on replacement, use a low loss transformer and with a loading of 40 – 75 %</td><td>3.5.4</td></tr><tr><td>Use high efficiency/low loss transformers</td><td>At time of replacement, or where there is a lifetime cost benefit</td><td>3.5.4</td></tr><tr><td>Place equipment with a high current demand as close as possible to the power source (e.g. transformer)</td><td>When locating or relocating equipment</td><td>3.5.4</td></tr></table> **Table 4.4: Electrical power supply techniques to improve energy efficiency**		
4.3.6. Electric Motor Driven Dub-Systems			
BAT 24	BAT is to optimise electric motors in the following order (see Section 3.6): 1. optimise the entire system the motor(s) is part of (e.g. cooling system, see Section 1.5.1) 2. then optimise the motor(s) in the system according to the newly determined load requirements, by applying one or more of the techniques in Table 4.5 (of the BREF), according to applicability. 3. when the energy-using systems have been optimised, then optimise the remaining (non-optimized) motors according to Table 4.5 and criteria such as: i. prioritising the remaining motors running more than 2000 hrs per year for replacement with EEMs ii. electric motors driving a variable load operating at less than 50 % of capacity more than 20 % of their operating time and operating for more than 2000 hours a year should be considered for equipping with variable speed drives.	Applicable Electric motors used in the main waste handling facility include those used in the compressors, HVAC systems, pumps, fans, etc. Energy efficient electric motors are used throughout the facility and are sized accordingly. Motors are fitted with variable speed drives to minimise losses where practical. Direct coupling employed for electric motors.	In place Where practical, the measures listed in Table 4.5 have been incorporated for the proposed development.
4.3.7. Compressed Air Systems (CAS)			
BAT 25	BAT is to optimise compressed air systems (CAS) using the techniques such as those in Table 4.6 (of the BREF document), according to applicability:	Applicable Currently compressors on site have variable speed drives where practical to minimise losses and optimise for energy efficiency.	In place The proposed hydrogen generation unit will require

<table>
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<tr><th>Technique</th><th>Applicability</th><th>Section in this document</th></tr>
<tr><td colspan="3">SYSTEM DESIGN, INSTALLATION or REFURBISHMENT</td></tr>
<tr><td>Overall system design, including multi-pressure systems</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Upgrade compressor</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Improve cooling, drying and filtering</td><td>This does not include more frequent filter replacement (see below)</td><td>3.7.1</td></tr>
<tr><td>Reduce frictional pressure losses (for example by increasing pipe diameter)</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Improvement of drives (high efficiency motors)</td><td>Most cost effective in small (<10 kW) systems</td><td>3.7.2, 3.7.3, 3.6.4</td></tr>
<tr><td>Improvement of drives (speed control)</td><td>Applicable to variable load systems. In multi-machine installations, only one machine should be fitted with a variable speed drive</td><td>3.7.2</td></tr>
<tr><td>Use of sophisticated control systems</td><td></td><td>3.7.4</td></tr>
<tr><td>Recover waste heat for use in other functions</td><td>Note that the gain is in terms of energy, not of electricity consumption, since electricity is converted to useful heat</td><td>3.7.5</td></tr>
<tr><td>Use external cool air as intake</td><td>Where access exists</td><td>3.7.8</td></tr>
<tr><td>Storage of compressed air near highly-fluctuating uses</td><td>All cases</td><td>3.7.10</td></tr>
<tr><td colspan="3">SYSTEM OPERATION and MAINTENANCE</td></tr>
<tr><td>Optimise certain end use devices</td><td>All cases</td><td>3.7.1</td></tr>
<tr><td>Reduce air leaks</td><td>All cases. Largest potential gain</td><td>3.7.6</td></tr>
<tr><td>More frequent filter replacement</td><td>Review in all cases</td><td>3.7.7</td></tr>
<tr><td>Optimise working pressure</td><td>All cases</td><td>3.7.9</td></tr>
</table>
Table 4.6: Compressed air system techniques to improve energy efficiency
</td><td>All compressors are high energy efficiency units with sizing of pipework optimised to minimise losses due to friction etc, as listed in table 4.6.

In the event of replacements or upgrades, high efficiency systems will also be used in compliance with BAT.</td><td>installation of a compressor to compress the hydrogen gas from the gas holder pressure of 0.02 bar up to the pressure required in the on-site storage tank for mobile hydrogen of 350 bar or to supply the above ground installation (AGI) feeding into the natural gas distribution pipeline.

The proposed development will contain all new plant and as such high efficiency equipment will be selected.</td></tr>
<tr><td>BAT 26</td><td>BAT is to optimise pumping systems by using the techniques in Table 4.7 (of the BREF document), according to applicability (see Section 3.8):</td><td>Applicable

Pumps are required across the site and include the following main pumping systems:
• Feed water pumps (boiler feed – from the feed water tank to the boiler drum);
• Condensate pumps (pumping water from the condensate tank to the condensate flash tank); and
• Process water pumps.

The pumping systems are designed for energy efficiency. These are sized correctly and are fit for purpose. The design, operation and control, generation and distribution of the pumping systems employs and will employ the techniques outlined in Table 4.7.</td><td>In place</td></tr>
</table>

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
		Pumps have variable speed drives where practical to minimise losses and be optimised for energy efficiency. The pumping systems are controlled using the Distributed Control System.	
4.3.9. Heating, Ventilation, and Air Conditioning (HVAC) Systems			
BAT 27	BAT is to optimise heating, ventilation and air conditioning systems by using techniques such as: • for ventilation, space heating and cooling, techniques in Table 4.8 (of the BREF document) according to applicability. • for heating, see Sections 3.2 and 3.3.1, and BAT 18 and 19 • for pumping, see Section 3.8 and BAT 26 • for cooling, chilling and heat exchangers, see the ICS BREF, as well as Section 3.3 and BAT 19.	Applicable HVAC systems in the main waste processing building include electrical room cooling, turbine hall extract, compressor room (cooling or ventilation as required). The HVAC systems are designed for energy efficiency. These are sized correctly and are fit for purpose. The design, operation and control, generation and distribution of the pumping systems employs the techniques outlined in Table 4.8. High efficiency HVAC units have been installed, and motors have variable speed drives where practical to minimise losses and be optimised for energy efficiency. Maintenance of the pumping systems and optimisation has been undertaken once the facility is operational. The HVAC pumping systems are controlled using the Automated Control System.	In place
4.3.10. Lighting			
BAT 28	BAT is to optimise artificial lighting systems by using the techniques such as those in Table 4.9 according to applicability (see Section 3.10):	Applicable The buildings are designed to maximise the use of natural light minimising artificial lighting. All measures listed in Table 4.9 have been incorporated.	In place Intelligent lighting and power systems, including high efficiency LED lighting included as part of design of the proposed development.

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	<table><tr><th>Technique</th><th>Applicability</th></tr><tr><td colspan="2">ANALYSIS and DESIGN OF LIGHTING REQUIREMENTS</td></tr><tr><td>Identify illumination requirements in terms of both intensity and spectral content required for the intended task</td><td>All cases</td></tr><tr><td>Plan space and activities in order to optimise the use of natural light</td><td>Where this can be achieved by normal operational or maintenance rearrangements, consider in all cases. If structural changes, e.g. building work, is required, new or upgraded installations</td></tr><tr><td>Selection of fixtures and lamps according to specific requirements for the intended use</td><td>Cost benefit on lifetime basis</td></tr><tr><td colspan="2">OPERATION, CONTROL, and MAINTENANCE</td></tr><tr><td>Use of lighting management control systems including occupancy sensors, timers, etc.</td><td>All cases</td></tr><tr><td>Train building occupants to utilise lighting equipment in the most efficient manner</td><td>All cases</td></tr></table> **Table 4.9: Lighting system techniques to improve energy efficiency**		
4.3.11. Drying, Separation and Concentration Processes			
BAT 29	BAT is to optimise drying, separation and concentration processes by using techniques such as those in Table 4.10 (of the BREF document) according to applicability, and to seek opportunities to use mechanical separation in conjunction with thermal processes: For drying these include: • DESIGN – Select the optimum separation technology or combination of techniques (below) to meet the specific process equipment. • OPERATION – Use of surplus heat from other processes – Use a combination of techniques. – Mechanical processes, e.g., filtration, membrane filtration – Thermal processes, e.g., directly heated dryers, indirectly heated dryers, multiple effect. – Direct drying – Superheated steam – Heat recovery (including MVR and heat pumps) – Optimise insulation of the drying system	Applicable Instrument air and plant air to be dried following air compression. Regenerative desiccant drying techniques are used. No thermal drying.	In place

Best Available Techniques (BAT)		Applicability Assessment (describe how the technique applies or not to your installation)	State whether it is in place or state schedule for implementation
	– Radiation processes e.g. infrared (IR), high frequency (HF), microwave (MW) • CONTROL – Process automation in thermal drying processes		