Amazon Data Services Irelands Limited

BAT Rerence REF-Energy Efficiency

Attachment-4-7-2

Prepared by AWN Consulting

Licence Application Ref: LA007495

ASSESSMENT OF COMPLIANCE WITH REFERENCE DOCUMENT (REF) ON BEST AVAILABLE TECHNIQUES FOR ENERGY EFFICIENCY, FEBRUARY 2009

The full and complete REF is available at the EIPPC Bureau website: http://eippcb.jrc.ec.europa.eu/reference/

<u>SCOPE OF BEST AVAILABLE TECHNIQUES (BAT)</u>

The *particular processes and activities at the installation that may have particular relevance with regard to the scope of the conclusions on BAT from the Energy Efficiency reference document (BREF) are:*

- Emergency generators
- Cooling systems – heating, ventilation, air conditioning
- Lighting
- Electrical power supply from mains
- IT hardware and associated equipment

Due to the Class of Activity being applied for it is the EPA's expectation that an applicant has regard to these Horizontal BAT Conclusions for Energy Efficiency**.**

Conclusions on 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). 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).	**Applicable -** Energy management forms an integral part of the installation's management. Measures are in place to minimise energy use as far as possible. A Building Management System (BMS)and an Electrical Power	ENEMS will be in place 12 months after commencement of IE Licence

d. Implementation and operation of procedures paying particular attention to: • Structure and responsibility • Training, awareness and competence (see BAT 13) • Communication • Employee Involvement • Documentation • Effective control of processes (see BAT 14) • Maintenance (see BAT 15) • Emergency preparedness and response • 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: • Monitoring and measurement (see BAT 16) • Corrective and preventive action • Maintenance of records • Independent (where practical) 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.	Management System (EPMS) are in place to track the operation of all critical sub-units and report back on energy efficiency of each section An Environmental Management System (EMS) is currently being developed for the ADSIL facilities and will be reviewed to ensure it includes the requirements of this BREF and the requirements of the facility's IE Licence, once granted. The EMS will outline the management of the site's environmental program and will be broadly in line with the principals of ISO14001; however, it will not be accredited. Electrical performance monitoring in respect of Power Usage Effectiveness (PuE) of the site is undertaken on a continuous basis. PUE is an indicator for measuring the energy efficiency of a data centre. PuE is measured as a ratio of total amount of energy used by a computer data center facility to the energy delivered to computing equipment. An ideal PUE is 1.0. Anything that isn't considered a computing device in a data center (i.e. lighting, cooling, etc.) falls into the category of facility energy consumption. An energy efficiency management system (ENEMS) will be developed that will set out the energy targets for the facility and will define the facility's energy policy. Responsibility for the consumption of energy and utilities will be allocated to	

	the Data Centre Engineering Operations (DCEO) Chief Engineer for the facility, and this responsibility will be set out in the EMS. The overall electrical energy for the facility is controlled and monitored to achieve the energy efficiency and power use effectiveness goals.	
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** – Energy management forms an integral part of the installation's management. Measures are in place to minimise energy use as far as possible. ADSIL is committed to continually improving their energy efficiency and reducing their carbon footprint. The ENEMS will set out the energy targets for the specific facility on an annual basis along with the responsible party; and targets will be assessed at the end of each year and reported in the AER for the facility. Energy efficiency learnings and weekly metrics are continuously shared between sister facilities in Ireland and worldwide.	ENEMS will be in place 12 months after commencement of IE Licence
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 relevant EPA guidance Article 8 of the European	Will be undertaken as described in

	Energy Efficiency Directive to identify further opportunities for energy efficiency improvement as part of facility management systems. ADSIL currently undertake Energy Efficiency audits, in the context of Article 8, every 4 years for a sample of their facilities in Ireland. The next compliance deadline is in 2023. The sites are selected randomly for auditing.	EPA guidance Article 8 of the European Energy Efficiency Directive.
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: • 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) • ensuring insulation is optimised, e.g. see Sections 3.1.7, 3.2.11 and 3.11.3.7 • 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 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)	**Applicable.** ADSIL will ensure that the energy audits meet the requirements of this BAT . The results of these audits will be reported in the relevant facility's Annual Environmental Report (AER) as required.	Will be undertaken as described
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** – An energy efficiency management system (ENEMS) will be developed that will set out the energy targets for the facility and will define the facility's energy policy.. The facility performance and equipment will be continually monitored an Electrical Power Management System (EPMS) and a system will be in place to optimise performance. The EPMS	ENEMS be place 12 months after commencement of IE Licence

	monitor all critical equipment in real time and identify areas of inefficiencies on an ongoing basis. This information from the continuous monitoring undertaken by the EPMS will feed into the energy database in order to determine the efficiencies. There are energy databases and metrics for continuous improvement. Performance parameters will be in place and monitoring against the parameters will be used to ensure the facilities are operating efficiently.	
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** – throughout the design of the facility a systems approach was undertaken to optimise energy recovery. The fresh air ventilation system for the office area for Buildings E and F will be served using energy efficient Heat Recovery Units (HRU) which will recover the waste heat from the office spaces and re-use to pre-heat the air with the HRU. This will reduce the overall energy consumption for this system. Due to the infrequent use of the emergency generators, the practicalities of heat recovery from the combustion plant is limited. The Energy Statement for Buildings E and F describes how waste heat associated with the facility could be	In place

	utilised with a future district heating scheme developed by others. The cooling system design can be designed to accommodate heat recovery coils in the central ventilation plant. The heat recovery coils could generate hydraulic temperatures of between 20-30°C at the point of Recovery. The above provision could supply heat energy to a future district heating scheme developed by others external to the site boundary. It should be noted that in order to benefit from the above heat recovery that district heating infrastructure external to the site including plate heat exchangers, pumps and distribution networks would need to be developed by others.	
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)
• 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)
	Applicable – Throughout the design of the facility a systems approach was undertaken to optimise energy recovery.
	
	At design stage, each unit operation for the development has been assessed for energy efficiency most notably process, heating, cooling, heating, ventilation, Air Conditioning (AHUs), motors / transformers and lighting.
	
	Energy efficiency of all the critical systems (, servers, fans, etc) is monitored continuously by the EPMS
		In place

	and used to determine the overall efficiency of the site. Cooling systems have been considered in the Industrial Cooling Systems BREF (Attachment 4.7.4). The emergency generators (combustion plant) have been considered under the LCP BREF (Attachment 4.7.1). Motors, pumps and lighting are addressed below.	
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** –The ENEMS will include Key Performance Indicators (KPIs) for energy efficiency. The efficient use of energy will be monitored as part of the site's continuous improvement programme to ensure all staff on site actively participate in the programme. Key process monitoring will be carried out to monitor the plant performance including water usage, energy consumption (diesel and electricity), hours of operation and power generated. The energy monitoring via the BMS/EPMS will be accessible in real time so that future decisions on energy management/optimisation can be made on a fully informed basis.	ENEMS will be in place 12 months after commencement of IE Licence

	Electrical performance monitoring in respect of Power Usage Effectiveness (PuE) of the site will be undertaken on a continuous basis. PUE is an indicator for measuring the energy efficiency of a data centre. PuE is measured as a ratio of total amount of energy used by a computer data center facility to the energy delivered to computing equipment. An ideal PUE is 1.0. Anything that isn't considered a computing device in a data center (i.e. lighting, cooling, etc.) falls into the category of facility energy consumption.	
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 a part of the ENEMS and energy audits, benchmarking will be undertaken. The Sustainable Energy Authority of Ireland (SEAI) maintains benchmark records of energy performance broken down by sector which will be used as part of this benchmarking. Electrical performance monitoring in respect of Power Usage Effectiveness (PuE) of the site will be undertaken on a continuous basis. PUE is an indicator for measuring the energy efficiency of a data centre. PuE is measured as a ratio of total amount of energy used by a computer data center facility to the energy delivered to computing equipment. An ideal PUE is 1.0. Anything that isn't considered a computing device in a data center (i.e.	ENEMS will be in place 12 months after commencement of IE Licence

	lighting, cooling, etc.) falls into the category of facility energy consumption. Comparisons are also made to ADSIL's sister facilities in Ireland and Europe, particularly with respect to PUE.	
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: 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.	**Applicable** – the data storage facility buildings have been designed using energy efficient design (EED). EED has been incorporated into the electrical, mechanical and process design elements. The EED was carried out by an energy expert. New equipment will be evaluated as per documented procedures for energy performance prior to purchase. Mapping of energy consumption across data servers and the cooling/heating systems has been undertaken to optimise efficiency and provide a clear understanding for future developments on the site. This process included identifying which elements in any new ADSIL project are critical for influencing energy use at any new data storage facility. It is proposed to install an array of photovoltaic panels on the roof of the proposed data storage facility buildings, Buildings E and F, to generate electricity to feed back into the electrical supply for the building,	In place and ongoing

	serving lighting, office area general services and office IT 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** – energy supplied from the mains for the operation of the server hardware and associated ancillary equipment produces heat which must be managed by use of the roof mounted cooling plant..The waste heat from the data storage facilities will be removed continually by motorised fans in the AHU system. The cooling system design can be designed to accommodate heat recovery coils in the central ventilation plant. The above provision could supply heat energy to a future district heating scheme developed by others external to the site boundary. It should be noted that in order to benefit from the above heat recovery that district heating infrastructure external to the site including plate heat exchangers, pumps and distribution networks would need to be developed by others. Office air conditioning is provided by a Variable Refrigerant Flow (VRF) system which allows varying degrees of cooling across the office and support spaces thereby reducing energy consumption. High efficiency unit are used to minimise the electrical power demand.	In place and ongoing

	Waste heat from the office spaces is re-used within the development as part of the fresh air ventilation system. Energy efficient Heat Recover Units recover the waste heat and use it to pre-heat the incoming air thereby reducing the overall energy consumption of the heating system.	
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) e. A fresh look at existing management systems, such as using operational excellence (see Section 2.5) f. Using change management techniques (also a feature of operational excellence, see Section 2.5)	**Applicable** – a number of these measures were included in the design of the facility and have been addressed above including management systems, real time monitoring of energy usage, benchmarking, etc. Recording of energy use will be part of the EMS. Critical plant performance and equipment will be continually monitored by the EPMS and a system will be in place to optimise performance. ADSIL's parent company is also involved in a number of energy efficiency schemes and has pledged to be net zero carbon by 2040. ADSIL is committed to operational excellence and is constantly working to improve energy efficiencies. ADSIL's parent company has already been successful in increasing the energy efficiency of its facilities and equipment, for instance by using more efficient evaporative cooling in certain data centres instead of traditional air conditioning. A study by 451 Research	In place and ongoing

	found that ADSIL's infrastructure is 5 times more energy efficient that the average European enterprise data centre surveyed. https://blog.aboutamazon.eu/aws/eu-businesses-that-move-to-aws-cloud-improve-energy-efficiency-and-reduce-carbon-emissions	
4.2.6 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	**Applicable** – these techniques will be applied relative to the sector, nature, scale, and complexity of the installation. The design engineering team includes an energy team who are responsible for energy strategy, policy and innovation. All staff employed to work at the data storage facilities will be appropriately experienced Engineering Operations Technicians (EOT) and will be supervised by the Chief Engineer for each facility. ADSIL shares learnings and resources between its different data storage facilities including sharing the findings of energy audits for future learnings across all clusters. All investigations and reporting are completed by a suitably qualified consultant with experience in the relevant area. Specialist functions, audits, calibration or testing that cannot be carried out by the EOTs will be undertaken by suitably	In place and ongoing

	qualified contractors as and when required.	
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. Documenting or recording these parameters (see Sections 2.1(d)(vi), 2.5, 2.10 and 2.15)	**Applicable** – these techniques are applied relative to the sector, nature, scale and complexity of the installation. The facility is operated in accordance with a number of SOPs which address energy efficiency. An ENEMS will be developed which will outline how the use of energy will be minimised. Site maintenance and housekeeping systems have been developed for the installation and relevant plant will be included within a preventative maintenance schedule. This is managed by an Enterprise Asset Management System which is administered by a dedicated Asset Management Team. The EAM system records every piece of plant and equipment at each ADSIL site – each item is individually logged in the EAM system along with the PM requirements and frequency of maintenance required – an automatic update is sent to DCEO when maintenance is required. Training programmes are in place to ensure that operational and maintenance staff are aware of relevant procedures for ensuring energy efficiency.	ENEMS will be in place 12 months after commencement of IE Licence

	The ENEMS will outline the key performance parameters will be applied relative to the sector, nature, scale, and complexity of the installation. PuE is continuously measured and discussed with senior management on a weekly basis.	
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 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.	**Applicable** – these techniques will be applied relative to the sector, nature, scale and complexity of the installation. A comprehensive preventative maintenance regime will be implemented at the facility by the maintenance team. This is managed by the Enterprise Asset Management System.	In place and ongoing
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** – these techniques will be applied relative to the sector, nature, scale and complexity of the installation. Operational procedures incorporating measures aimed at ensuring the installation operates efficiently and safely will be in place. The facility will be operated in accordance with these procedures as well as the planned ENEMS which outlines how the use of energy will be minimised. All relevant staff will be trained in the procedures.	ENEMS will be in place 12 months after commencement of IE Licence

	Electrical performance monitoring in respect of Power Usage Effectiveness (PuE) of the site will be undertaken on a continuous basis. PUE is an indicator for measuring the energy efficiency of a data centre. PuE is measured as a ratio of total amount of energy used by a computer data center facility to the energy delivered to computing equipment. An ideal PUE is 1.0. Anything that isn't considered a computing device in a data center (i.e. lighting, cooling, etc.) falls into the category of facility energy consumption. On-site electricity usage will be minimised as far as possible within the constraints of the process optimisation Key process monitoring will be carried out to monitor the plant performance including: water usage, energy consumption (diesel and electricity), hours of operation and power generated. Weekly metrics are gathered and compared for each site (fuel consumption/water consumption/ electrical demand). The plant performance and equipment will be continually monitored, and a system will be in place to optimise performance. The SOPs will be updated on a regular basis; the EMS will be updated annually in accordance with the requirements of the IE Licence.	
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, and those given in Table 4.1 (of the BREF document), including: • Advanced computer control of combustion conditions. • Reduced excess air. • Lowering exhaust gas temperatures • pre-heating of fuel gas. • pre-heating of combustion air.	**Applicable** – Opportunities to optimise energy efficiency will be included in the ENEMS. The combustion processes are monitored through the EPMS which alarms in the event of a malfunction. Any operation of the combustion plant is tracked manually and automatically via the EAM system. Additional measures are addressed in Attachment 4.7.1. BREF Large Combustion Plants. Additional measures are addressed in Attachment 4.7.1. BREF Large Combustion Plants. The containerised emergency generators will be pre-heated, and have engine jacket heaters, to ensure optimal start-up running conditions. Recuperative burners are not applicable to this site as combustion units are emergency back-up generators only. The fuel choice is restricted due to the type of units used (emergency back-up generators). However, their use is infrequent and under normal operating conditions will consist of regular testing only. Cogeneration is not applicable for the emergency back-up generators due to their infrequent use.	ENEMS will be in place 12 months after commencement of IE Licence
4.3.2 Steam Systems		

BAT 18. BAT for steam systems is to optimise the energy efficiency by using techniques such as: • Those specific to sectors given in vertical BREFs • Those given in Table 4.2 (of the BREF document).	**Not applicable** – No steam systems	N/A
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	**Not Applicable**	N/A
4.3.4 Cogeneration		
BAT 20. BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party).	**Not Applicable** – no viable cogeneration opportunities.	N/A
4.3.5 Electrical Power Supply		
BAT 21. 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 (listed below), according to applicability (see Section 3.5.1). a. Installing capacitors in the AC circuits to decrease the magnitude of reactive power. or lightly loaded motors. b. Minimising the operation of idling. c. Avoiding the operation of equipment above its rated voltage. d. When replacing motors, using energy efficient motors.	Applicable –all of the items listed in Table 4.3 have been incorporated into the design of the new facility where applicable. ADSIL continuously monitors the electricity usage of all plant and equipment against the power drawn from the grid to ensure all systems meet the specified efficiency threshold. Capacitors are installed in all AC circuits as per BAT 21. During normal operation conditions plant equipment idle time is minimised when non-operational and managed as part of the site wide BMS. No equipment is operated above its rated voltage.	In place

<table>
<tr>
<td></td>
<td>All motors are energy efficient motors as per BAT 24.

The electrical load is supplied to the critical IT load via UPS (which have capacitors in them), the UPS also acts as power factor correction.</td>
<td></td>
</tr>
<tr>
<td>BAT 22.
BAT is to check the power supply for harmonics and apply filters if required (see Section 3.5.2)</td>
<td>Applicable – ADSIL check the power supply for harmonics and provide active harmonic input filters on UPS modules, no harmonic filters are required..</td>
<td>In place</td>
</tr>
<tr>
<td>BAT 23.
BAT is to optimise the power supply efficiency by using techniques such as those in Table 4.4 (of the BREF document), according to applicability.
<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</td>
<td>Applicable - At the design stage, 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.

The measures listed in Table 4.4 have been considers as part of the EED and there will be regular review to ensure that power supply efficiency measures are applied.

To reduce electrical losses between HV/MV/LV conversions, the Operator has (and will for future developments) installed low loss transformers. These comply with the Ecodesign directive 2009/125/EC as a minimum.</td>
<td>In place</td>
</tr>
<tr>
<td colspan="3">4.3.6 Electric motor driven sub-systems</td>
</tr>
</table>

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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 document), according to applicability 3. When the energy-using systems have been optimised, then optimise the remaining (non-optimised) motors according to Table 4.5 (of the BREF document) and criteria such as: • Prioritising the remaining motors running more than 2000 hrs per year for replacement with EEMs • 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. Items from Table 4.5 include: - Using energy efficient motors (EEM). - Proper motor sizing - Installing variable speed drives (VSD) - Installing high efficiency transmission/reducers - Use direct coupling where possible, synchronous belts or cogged V-belts in place of V belts and helical gears in place of worm gears. - Energy efficient motor repair (EEMR) or replacement with an EEM. - Rewinding: avoid rewinding and replace with an EEM or use a certified rewinding contractor (EEMR). - Power quality control - Integrate lubrication, adjustments and tuning into system operation and maintenance.	**Applicable** – Electric motors used for fans in the air handling units as well as for the assorted pumping systems onsite (not including the firewater pump which runs on diesel). All electrical motors have been selected based on EED and are typically will be controlled and monitored by the BMS, or by onboard controllers that alarm in case of a fault. The cooling systems employed for the data halls have been designed to be as efficient as possible. TheAHUs typically have high efficiency fans equipped with Variable Speed Drives (VSD) which are responsible for adjusting the exhaust fan speed based on the measured pressure differentials (for Buildings E and F, high efficiency electrically commutated EC direct drive fans will be used instead). The system is monitored and controlled by the BMS which monitors conditions and responds to reduce fan speeds and pump speed to maintain the operating point at the minimum necessary to meet the data storage room environmental conditions. Other electric motors include those associated with the assorted pumping systems onsite (fuel distribution, cooling water distribution, stormwater, mains water). These are typically Energy Efficient Motors (IE 3 rated or better) and will include VSDs were applicable/practical.	In Place

	All plant on site is subject to regular checks and preventative maintenance. Lubrication, adjustments and tuning will be incorporated into system operation and maintenance as per BAT.	
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, including the following. System design, installation or refurbishment techniques: - Overall system design, including multi-pressure systems - Upgrade compressor - Improve cooling, drying and filtering - Reduce frictional pressure losses (for example by increasing pipe diameter) - Improvement of drives (high efficiency motors) - Improvement of drives (speed control) - Use of sophisticated control systems - Recover waste heat for use in other functions - Use external cool air as intake - Storage of compressed air near highly-fluctuating uses System operation and maintenance techniques: - Optimise certain end use devices - Reduce air leaks - More frequent filter replacement - Optimise working pressure	**Applicable** – air compressors are used on sprinkler systems to prevent damage to equipment in electrical rooms due to leaks from sprinkler pipes.	In place
4.3.8 Pumping Systems		
BAT 26. 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), as summarised below. Design techniques: - Avoid oversizing when selecting pumps and replace oversized pumps - Match the correct choice of pump to the correct motor for the duty - Design of pipework system (see Distribution system, below)	**Applicable** – Pumps will be employed for the firewater main, water main, stormwater main (for delivery of stormwater from the new campus to the public stormwater drain south of the existing campus), fuel delivery system, and in the HVAC system (evaporative cooling water pumps).	In place

Control and maintenance techniques: - Control and regulation system - Shut down unnecessary pumps - Use of variable speed drives (VSDs) - Use of multiple pumps (staged cut in) - When the pumping flow is less than half the maximum single capacity - Regular maintenance Distribution system techniques: - Minimise the number of valves and bends commensurate with keeping ease of operation and maintenance - Avoiding using too many bends (especially tight bends) - Ensuring the pipework diameter is not too small (correct pipework diameter)	Typically pumps have been designed to their requirement; or when due for replacement will be: not oversized, matched correctly to the motor type, matched correctly to the pipe size. All pumps will be controlled by the BMS and monitored continuously to ensure they are operating efficiently. The majority of the pumps work on duty/standby: The main diesel supply system contains 3 no. pumps, all with VSDs, which operate on Duty/Duty/Standby. The pumps from the day tanks and the belly tanks to the generators all have VSDs. The pumps from the day tanks to the gens operate on duty/standby. Only 1 pump is needed from the belly tanks to the gens. The water main pumping system operates on duty/standby and both pumps have VSDs. The cooling water pumping system includes 3 pumps, all with VSDs, which operate on Duty/Duty/Standby. The firewater supply pumps work on duty/standby. These are diesel powered pumps. They do not require VSDs as they are only used for emergency supply of firewater. The stormwater pumps do not require VSDs as these are not process controlled pumping systems.	

	All pumps will be subject to regular checks and preventative maintenance. Water and fuel distribution pipelines have been matched with the appropriate pump size. Bends and other obstructions have been reduced where practicable. Whilst some 'dead legs' have been identified in the cooling water pipelines ADSIL is in the process of correcting these.	
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 those Table 4.8 (of the BREF document) according to applicability.	Applicable- HVAC systems are integral part of the data storage facilities as well as the ancillary office spaces. The ventilation system for the data halls will be an air-cooling system whereby fresh air is used to cool the space. The warm air is recirculated or exhausted to atmosphere subject to external ambient conditions. Adiabatic cooling is used as an alternative only during the peak cooling season. Further details are in Attachment 4.8.1 Operational Report. The cooling systems employed for the data halls have been designed to be as efficient as possible and this has been addressed in Attachment 4.7.4. The office air conditioning shall be served by a VRF refrigerant system. High efficiency units will be used to minimise electrical power demand.	In place

	Typically, the energy efficiency of a VRF system will exceed that of traditional air-cooled chillers by 15-25%. The fresh air ventilation system for the office area will be served using energy efficient Heat Recovery Units which will recover waste heat from the office spaces and re-use to pre-heat the air with the HRU. This will reduce the overall energy consumption for this system. Routine preventative maintenance activities will be undertaken to optimise systems and reduce energy losses	
4.3.10 Lighting		
BAT 28. BAT is to optimise artificial lighting systems by using the techniques such as those in Table 4.9 (of the BREF document) according to applicability	**Applicable -** External lighting will make use of high efficiency, low energy LED luminaires. The lighting design has been optimised to reduce glare, spillage or other light nuisance to adjacent sites and/or public roads. Artificial lighting both internal and external lighting are also an essential component of the security system, which is vital due to the sensitive nature of the site. Secondary external lighting in areas such as the generator compound will be operated via presence and daylight detection to minimize hours of operation and thus keep energy usage to a minimum.	In place

	Internal lighting shall be provided by high efficient, low energy LED luminaires combined with presence detection controls or local switching where appropriate. In older Buildings A and B, fluorescent tubes are being replaced with LED luminaires when replacement is required. The lighting design meets the illumination level requirements as outlined in EN 12464. LED luminaires are also to be used for the emergency lighting installation which is designed to comply with the requirements of EN 1838.	
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	**Not Applicable** – no drying, separation or concentration processes at the facility.	N/A