Apatura Energy - P108 Currie – Wester Hermiston

Operational Energy Statement

Apatura Energy

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Executive Summary

A preliminary Operational Energy Assessment has been conducted by Cundall for the proposed Wester Hermiston Data Centre Campus in Edinburgh for Apatura Energy. The aim of this assessment is to estimate the in-use operational energy performance from the outset of the project.

Operational energy is an important component of the whole life carbon and overall greenhouse gas emissions associated with the running of a data centre facility. The data hall areas themselves are energy intensive, however this type of facility also presents significant opportunities for the harnessing of energy for reuse. The proposed Wester Hermiston Data Centre Campus will be designed to reduce its annual energy consumption, deliver energy in an environmentally friendly way, and minimise its annual carbon footprint as far as possible.

Power Use Effectiveness (PUE)

The Power Usage Effectiveness (PUE) is a metric used to determine the energy efficiency of a data centre by comparing the ratio of the total facility energy consumption to the energy used directly by the IT equipment – further details are included in Section 1.3.1. The target for the data hall area has been selected as 1.17 which is representative of a net zero aligned data centre building starting its operations in 2030 as per the UK NZCBS. This represents a high utilisation data centre, where more than 50% of the area is dedicated to IT equipment.

The Energy Use Intensity (EUI) target selected for the Office/Admin area is 106 kWh/m², which is representative of a net zero aligned office building with longer operating hours that is starting operations in 2030.

Operational Energy Summary

A summary of the estimated operational energy results associated with the three proposed data centre buildings as part of the Wester Hermiston development are summarised in the table below. Data centres 01 and 02 are the same size.

Element	DC01 & DC02	DC03
Data Hall energy intensity kWh/m² GIA	24,262	24,874
Office/Admin block energy intensity kWh/m² GIA	106	106
Whole Building energy intensity kWh/m² GIA	19,193	20,977

Summary of the energy intensity and carbon results for the Wester Hermiston Data Centre project

Next Steps

Reducing the Power Usage Effectiveness (PUE)

In order to reduce the PUE for the data halls and reduce carbon emissions, The Chartered Institute of Building Services Engineers (CIBSE) emphasises the importance of an energy strategy focused on efficient air management and high-performance energy systems. Effective use of cool air is a key enabler of saving energy linked to mechanical systems. Measures such as minimising air leakage can reduce fan power consumption while minimising the recirculation of hot air back into IT equipment allow set-points to be raised, reducing the energy associated with cooling systems.

The setpoints of the cooling cycle have the biggest effect on operational energy - increasing the setpoints leads to cooling equipment working at a higher efficiency for more hours using free cooling. Free cooling must be used wherever possible to achieve the energy efficiency targets.

Achieving the EUI target for office area

Cundall has proposed an Energy Use Intensity (EUI) target to support the data centre development in reducing their operational energy effectively for the office/admin area. This target is 106 kWh/m² GIA/year. To achieve this, following the industry-recognised Energy Hierarchy 'Be Lean', 'Be Clean', 'Be Green' is essential.

Contents

1.0 Introduction

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1.1 Net Zero Carbon Overview

1.1.1 A Climate Emergency

We are currently on a trajectory for at least a 3°C global temperature rise, well above the targets and aspirations of the Paris Agreement, which will have profound impacts on us all. It is therefore vital that we act now and act fast in the hope of alleviating the worst of the predicted outcomes. In order to achieve reductions of this scale, we need complete societal transformation to flatten the emission curves and allow our ecosystem to cope. Achieving net zero carbon must be at the heart of our response to this crisis. To this end, the UK Government has declared a climate emergency and amended the Climate Change Act to bring all greenhouse gas emissions to net zero by 2050, compared with the previous target of an 80% reduction from 1990 levels. This target is a challenge to every part of industry and society as a whole. More recently, a target to reduce emissions by 78% by 2035 has been announced.

1.1.2 Net Zero Carbon Buildings: A Framework Definition

In 2019, the UK Green Building Council set out their framework for 'Net Zero Carbon Buildings' (NZCB) as part of the World Green Building Council's Advancing Net Zero programme. This framework outlines their approach to make all new buildings net zero carbon by 2030, and all existing buildings by 2050. The framework sets a clear process for achieving NZCB as shown in Figure 1-1: UKGBC's .

As a framework, it is clear and concise but lacks the details of each stage. To address this, the UKGBC are currently developing operational energy and upfront embodied carbon intensity targets for a range of sectors. These targets are being developed using the 'Paris Proof' methodology, which establishes the likely capability of our electrical grid from zero carbon sources in 2050 and what demand reduction would be required to achieve a net zero economy as illustrated in Figure 1-22.

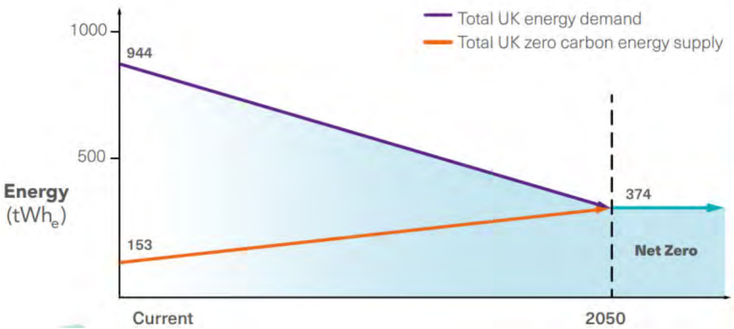

Figure 1-22: UKGBC's UK trajectory to a net zero economy

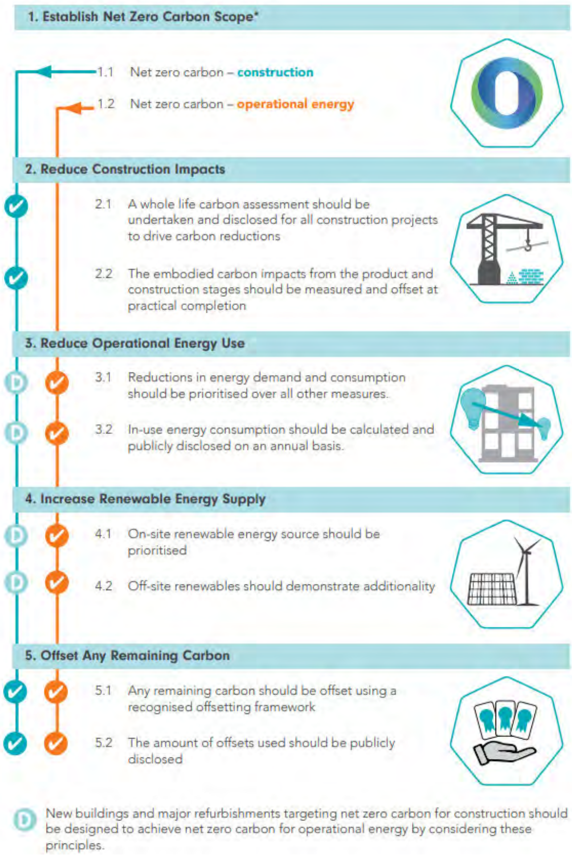

Figure 1-11: UKGBC's Net Zero Carbon Framework

1.1.3 RIBA 2030 Challenge

The Royal Institute of British Architects (RIBA) have set operational energy and whole life embodied carbon targets for domestic and non-domestic buildings as part of their '*2030 Challenge'*, using a similar methodology and stepped trajectory. These have been updated recently and generally align with the UKGBC energy intensity targets.

Figure 1-33 outlines the targets for office buildings.

RIBA 2030 Climate Challenge target metrics for non-domestic (new build offices)

RIBA Sustainable Outcome Metrics	Business as usual (new build, compliance approach)	2025 Targets	2030 Targets	Notes
Operational Energy $kWh/m^2/y$	130 $kWh/m^2/y$ DEC D (90)	< 75 $kWh/m^2/y$ DEC B (50) and/or NABERS Base build 5	< 55 $kWh/m^2/y$ DEC B (40) and/or NABERS Base build 6	Targets based on GIA. Figures include regulated & unregulated energy consumption irrespective of source (grid/renewables). 1. Use a 'Fabric First' approach 2. Minimise energy demand. Use efficient services and low carbon heat 3. Maximise onsite renewables
Embodied Carbon $kgCO_2e/m^2$	1400 $kgCO_2e/m^2$	< 970 $kgCO_2e/m^2$	< 750 $kgCO_2e/m^2$	Use RICS Whole Life Carbon (modules A1-A5, B1-B5, C1-C4 incl sequestration). Analysis should include minimum of 95% of cost, include substructure, superstructure, finishes, fixed FF&E, building services and associated refrigerant leakage. 1. Whole Life Carbon Analysis 2. Use circular economy strategies 3. Minimise offsetting, use UK schemes (CCC) BAU aligned with LETI band E; 2025 target aligned with LETI band C and 2030 target aligned with LETI band B.

Figure 1-33 RIBA 2030 Climate Challenge targets for non-domestic buildings

1.1.4 LETI's 'Climate Emergency Design Guide'

In order to understand the implications of these energy intensity targets at a building level, the London Energy Transformation Initiative (LETI) combined top-down modelling with bottom-up modelling. This has helped establish achievable building performance specifications to facilitate the zero-carbon operation of the buildings. For operational energy these align with the UKGBC and the RIBA 2030 challenge.

For embodied carbon, LETI have, however, focused on the upfront embodied carbon associated with the construction of the building, not the whole life embodied carbon as per RIBA. This aligns with the UKGBC framework which requires developments to report their upfront embodied carbon on practical completion, after meeting local carbon intensity targets, and offset all residual emissions.

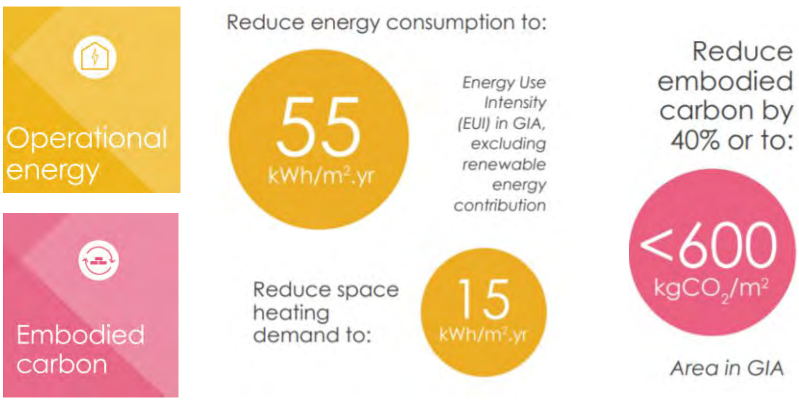

Figure 1-44 LETI Commercial Office Climate Emergency Design Guidance targets.

More recently, LETI has launched a Retrofit guide focusing on the residential sector, which is expected to be followed by guidance for non-domestic buildings in the near future.

1.1.5 UK Net Zero Carbon Building Standard (UK NZCBS)

The emerging UK Net Zero Carbon Building Standard has been developed by a wide range of stakeholders in the UK built environment industry. It creates a unified definition for 'Net Zero Carbon Aligned Buildings' in the UK, underpinned by an evidence-based reporting methodology.

The Standard sets out mandatory requirements for net zero carbon aligned buildings that could enable the UK real estate sector to stay true to the built environment's share of our national carbon and energy budgets. The mandatory requirements within the Standard are based on limits that have been derived from measured performance data, combined with expert professional experience on future performance trends in buildability, which have been compared against a complex model of the entire stock and future UK build-out rates.

Offsets may be used to complement, but not replace, the mandatory elements of the Standard, and may be used to achieve net zero carbon at the asset level.

The limits and targets set by this Standard are only applicable to completed works and fully operational buildings, thus no claim of conformity or alignment with this Standard can be made during the design and construction phases of a project.

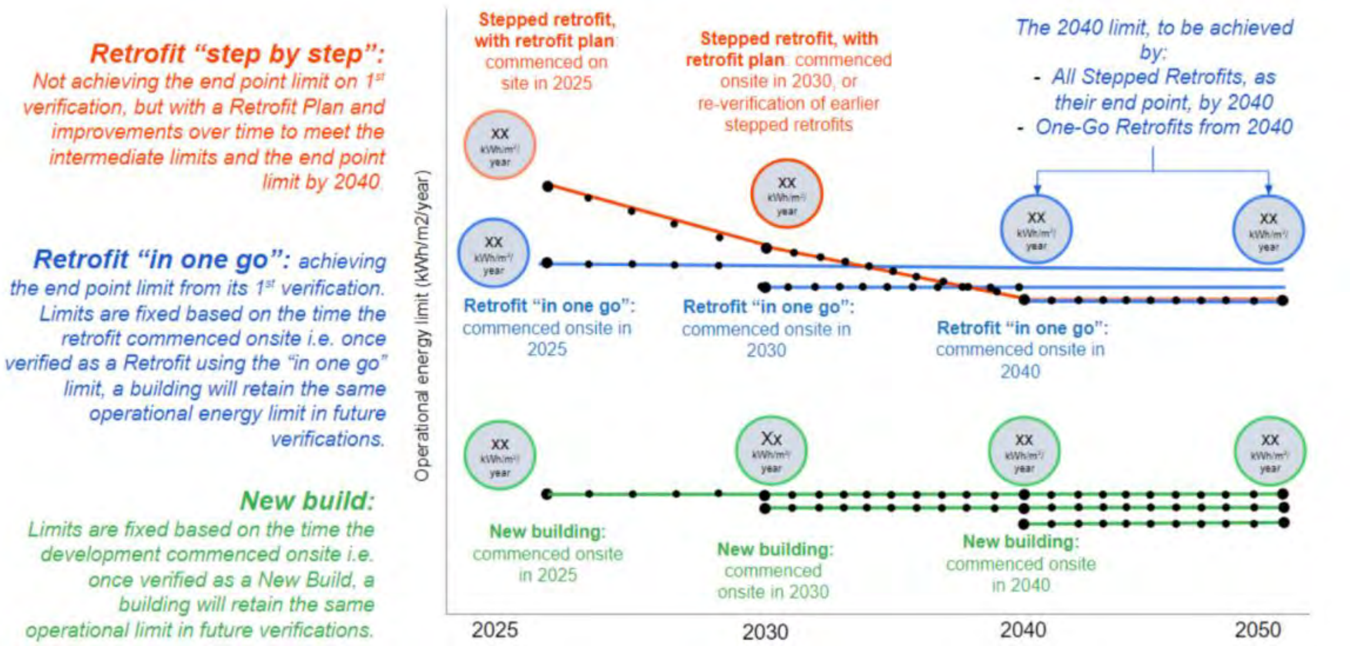

Figure 1-55 Approach taken in the UKNZCBS to operational energy limits

1.1.6 RICS Whole life carbon assessment for the built environment

As we strive to embed these targets into best practice design, we must ensure that they are not considered in isolation, but as part of a whole life carbon approach – addressing all impacts associated with the construction, operation and demolition of buildings and infrastructure.

The most comprehensive framework for this is the Royal Institution of Chartered Surveyors' (RICS) "Whole life carbon assessment for the built environment", based on EN15978. It covers the material production, construction activities, building operation, maintenance and refurbishment, through to its deconstruction and re-use of materials. RICS places an emphasis on reuse, recycling and recovery at the end of life in accordance with the circular economy principles.

1.1.7 Science Based Targets (SBTs)

Science Based Targets (SBTs) is a global initiative coordinated by a group of organisations including CDP, the World Resources Institute (WRI) and WWF which encourages businesses to set carbon reduction targets in line with the latest climate science. This means setting individual carbon emissions targets based on limiting global temperature rises to 1.5 degrees centigrade in accordance with the ambitions of the Paris Climate Agreement.

They are currently consulting on what net zero carbon targets should look like for businesses and it is already clear that organisations will be required to take responsibility for not just the impacts of their own operations, but also for their 'value chain' emissions. This covers a raft of things including purchased goods and travel, but for an individual building it mostly means embodied carbon. More recently, SBT have launched their net zero carbon standard for businesses.

1.1.8 Carbon Risk Real Estate Monitor (CRREM)

The same principle of Science Based Targets is also now getting applied to the operation of buildings through the Carbon Risk Real Estate Monitor (CRREM). This is highlighted by the Institutional Investors Group on Climate Change (IIGCC)'s Net Zero Investment Framework as the main tool for assessing real estate, with its graphs forecasting stranded assets over the next thirty years.

The Carbon Risk Real Estate Monitor project (CRREM) is an EU-funded project which aims to support industry with assessing and tackling carbon-risk factors associated with their building stock. Key objectives of this exercise are to try to mitigate premature obsolescence and potential depreciation due to changing market expectations and legal regulations.

Through supporting industry to invest and address the energy efficiency of their properties, the aim of the tool is to help avoid assets becoming 'stranded' (i.e. identified as not meeting future energy efficiency standards and market expectations, or their energy upgrade is not deemed financially viable).

The tool plots annual targets relating to greenhouse gas emissions and energy use intensity up to 2050. Caution should, however, be applied when referencing the 2050 targets, where these are particularly onerous and not always deemed viable based on current market-available solutions. The performance targets outlined for the early 2040 period are generally deemed more appropriate and feasible at this point in time.

For a building or portfolio of buildings, you are now able to plot your performance against a science-based trajectory for that type of asset, and when it exceeds its 'carbon budget' it becomes stranded because it is no longer in line with the Paris Agreement. If this happens, the asset will potentially attract a 'brown discount' from investors and start losing value. Developers can avoid stranded assets by setting a programme of asset improvements to reduce energy consumption and remove fossil fuel, as shown in the following graph from CRREM of potential stranding events for a UK office building.

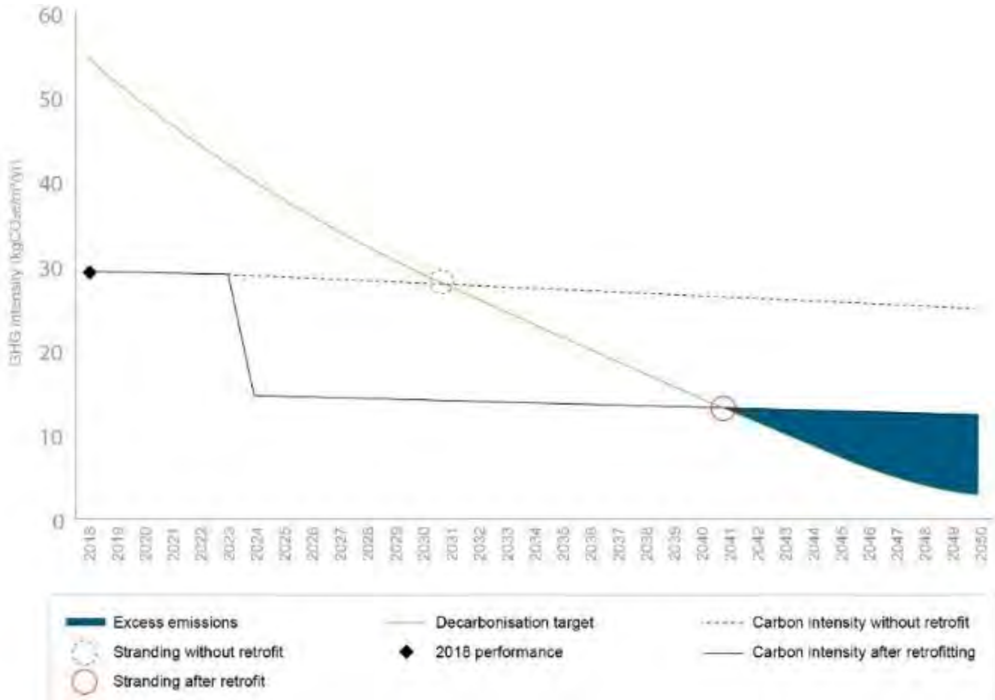

Figure 1-66 Example CRREM 1.5ºC scenario trajectory

1.1.9 Cundall Steps to Net Zero Carbon Buildings

Cundall have used their engineering knowledge to summarise the above guidance into the following approach:

Passive design optimisation

Façade design is key. Utilise the useful daylight index to ensure the best possible daylight for occupants, whilst limiting artificial lighting use, reducing glazing areas, glare, heat loss, cooling loads and improving views and occupancy comfort. This enables full or partial natural ventilation for a proportion of the year, supplemented by mechanical systems to provide heat recovery in winter and cooling in summer where required.

Reduce operational energy demand and consumption

Prioritise fabric measures to drive down heating, cooling and lighting demand. Widen temperature set bands and allow occupants to adapt and control their own comfort by adjusting clothing, using fans and natural air flow. Review drivers of energy consumption to determine suitable alternate approaches that can be taken. Challenge conventional design practices and standards, recognising that the same solutions will result in the same energy intensive buildings and looking for alternative solutions. Utilise industry standards approaches like NABERS, Passivhaus and Design for Performance to embed energy savings at every stage and meet best practice energy intensity targets

Eliminate fossil fuels

Prioritise fifth-generation heat networks and electric heat pump technologies over fossil fuel technologies to supply affordable low carbon energy. When considered in conjunction with zero emission vehicles, this will significantly improve local air quality.

Provide onsite renewable energy and storage where possible

Supply all remaining energy from on-site technologies or off-site renewable certified energy sources.

Limit upfront embodied carbon

Consider all upfront carbon associated with the initial build and restrict carbon intensity to a maximum of $500kgCO_2/m^2$. This applies to all construction materials from extraction to installation, including the emissions associated with the construction works themselves. Use modular construction approaches, design for deconstruction using circular economy principles, and limit waste generated during construction.

Consider whole life carbon in conjunction with whole life costing

Measure all upfront and operational carbon emissions, including maintenance, fitouts, minor and major refurbishments, deconstruction and the reuse of building materials. All this must be considered over an extended design life allowing for durability and robustness.

Publicly disclose performance annually using an embodied carbon database

Use Gold Standard carbon offset schemes or equivalent to offset any residual emissions with the aim of reducing offsets over time through further onsite reductions. Publicly disclose all operational, embodied and whole-life carbon on an annual basis using an embodied carbon database like WRAP (Waste and Resources Action Programme) in the UK.

1.2 Development description

The proposed 77-acre site is located to the north of Heriot-Watt University, west of Hermiston and the City Bypass, and will connect to the Currie Substation to the south. The site lies within the green belt and is bordered by the canal and the M8 to the north. To the south, it is bounded by the A71 and a number of non-residential buildings. This technical note reports on the three data centre buildings proposed as part of the development.

DC01 and DC02 are identical buildings and therefore share the same characteristics for the purpose of this assessment. Each building has a Gross Internal Area (GIA) of 16,680 m² distributed across two levels. The current design intention is to install 48 MW of IT equipment capacity per building. Both buildings include a Front of House (FoH) area and data hall zones.

DC03 has a GIA of 11,442 m² across one level. The design intent provides for the installation of 36 MW of IT equipment capacity. Similar to the other facilities, DC03 incorporates both a FoH area and designated data hall zones.

Element	DC01 & DC02	DC03
Total Area (m²)	16,680	11,442
Data hall area (m²)	13,180	9,642
FoH area (m²)	3,500	1,800
IT equipment capacity (MW)	48	36

Table 1-11 Proposed building areas and IT equipment capacity

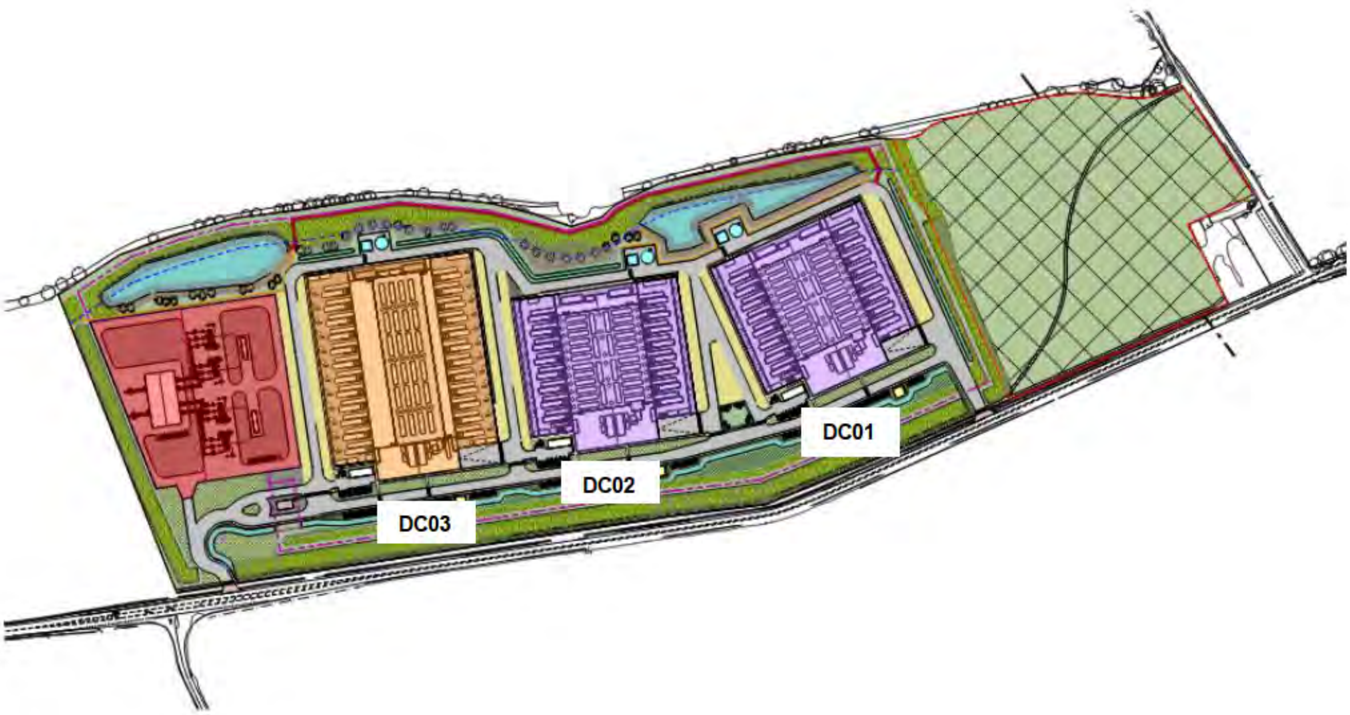

Figure 1-77 Proposed site plan

1.2.1 HVAC system description

The predominant cooling system for the three buildings is via air cooled chillers with free-cooling technology and variable speed compressors which provide chilled water to Computer Room Air Handler (CRAH) units serving the data halls. Air

Source Heat Pumps (ASHPs) will provide chilled water and low temperature hot water for cooling and heating respectively to the Front of House (FoH) office and admin areas via Fan Coil Units (FCUs). Ventilation for the FoH areas will be provided by dedicated air handling units (AHUs) and sized in line with the latest British Council lor Offices (BCO) design criteria.

1.2.2 Waste heat

The design intent is to enable for a future connection to capture waste heat from the main data centre IT systems and export the thermal energy through a heat recovery process which can potentially be transferred into a District Heating (DH) network in the future, where it can be redistributed.

There isn't currently a district heating network in the vicinity of the site, however, the Heriot-Watt university campus nearby has been identified by Edinburgh council as a future heat network development. Further details are included in Cundall's Energy Statement (document reference: ADC-CDL-XX-XX-T-SY-70220).

1.3 Energy Use Intensity (EUI) targets

The emerging UK Net Zero Carbon Building Standard has been used to set the Energy Use Intensity (EUI) targets for this project. The Standard has been developed by a wide range of stakeholders in the UK built environment industry. It creates a unified definition for the 'Net Zero carbon Aligned Buildings' in the UK, underpinned by an evidence-based methodology. The Standard sets out mandatory requirements for net zero carbon aligned buildings that could enable the UK real estate sector to stay true to the built environment's share of our national carbon and energy budgets. The mandatory requirements within the standard are based on limits that have been derived from measure performance data, combined with expert professional experience on future performance trends in buildability, which have been compared against a complex model of the entire stock and future UK build-out rates.

Offsets may be used to complement, but not to replace, the mandatory elements of the Standard, and may be used to achieve net zero carbon at the asset level.

1.3.1 Power Usage Effectiveness

Power Usage Effectiveness is a key performance metric used to evaluate the energy efficiency of a data centre by comparing the ratio of the total facility energy consumption to the energy used directly by the IT equipment. It is calculated as:

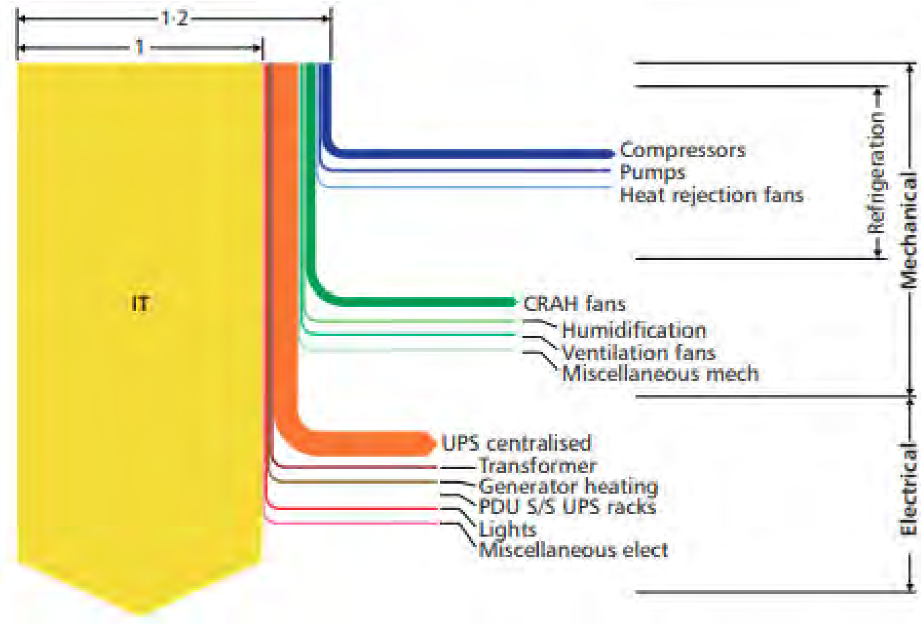

Figure 1-88 Example PUE: 1.2. (CIBSE KS18)

PUE = Total Facility Energy / IT Equipment Energy

A lower score is better and the lowest value a building can achieve is 1.0. A PUE of 1.0 represents ideal performance, where all consumed energy is dedicated solely to computer operations with no additional overhead energy for cooling, lighting or building services systems. A PUE provides an essential indicator of how effectively supporting systems are integrated to minimise non-IT energy use, enabling benchmarking. Current design focuses on achieving a PUE of less than 1.3, trending downwards as design improves.

The (PUE) target for the data centre has been selected as 1.17 for the data hall area which is representative of a net zero aligned data centre building starting its operations in 2030 as per the UKNZCBS. This represents a high utilisation data centre, where more than 50% of the area is dedicated to IT equipment.

The Energy Use Intensity (EUI) target selected for the Office/Admin area is 106 kWh/m², which is representative of a net zero aligned office building with longer operating hours that is starting operations in 2030.

Figure 1-99 shows the UK NZCBS limits for the PUE and EUI metrics that have been used in this assessment.

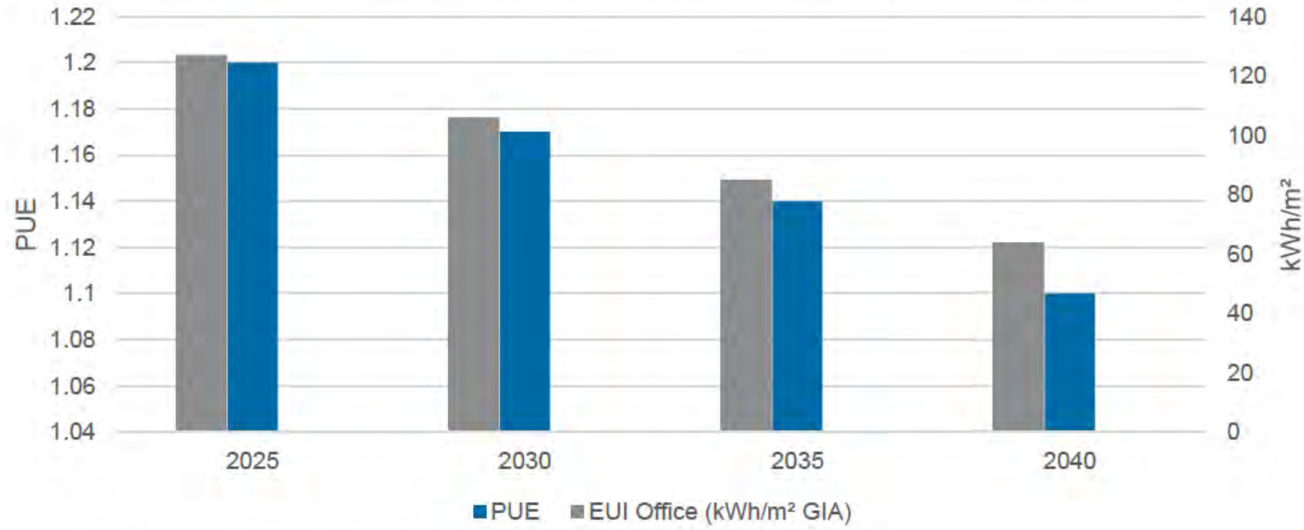

Figure 1-99 PUE and EUI targets from the UK NZCBS

1.4 Energy Strategy Approach

The proposed energy strategy for the Wester Hermiston Data Centre Campus project will adopt Cundall's "Steps to Net Zero Carbon" methodology, as seen in Figure 3 1, which provides a structured pathway to reducing both energy demand and emissions over the life of the development.

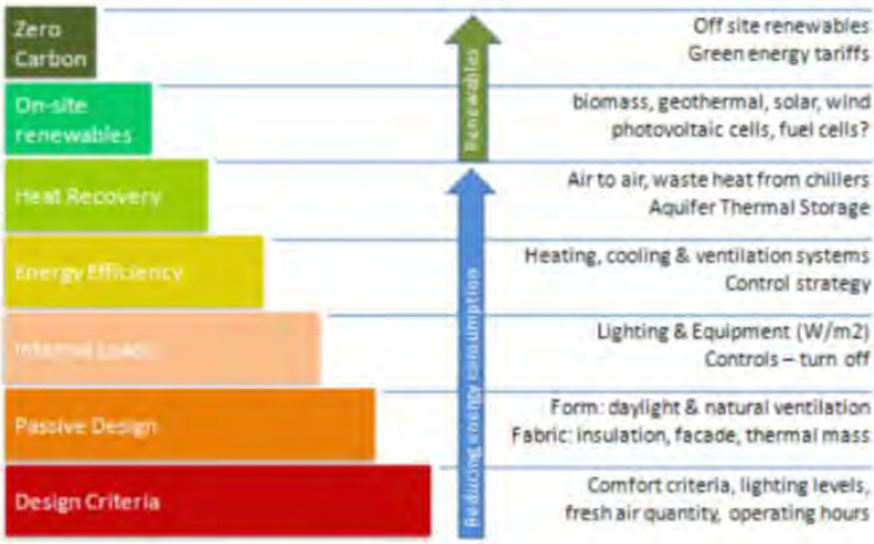

Figure 1-101010: Steps to low carbon methodology diagram

The "Steps to Net Zero Carbon" methodology aligns directly with the industry-recognised Energy Hierarchy "Be Lean", "Be Clean", "Be Green". Further details aligned with each of these key steps is included in Section 2.2.2.

2.0

Operational Energy Summary

2.0 Operational Energy Summary

The predicted operational energy values have been calculated based on outline design information and reference data projects with comparable operational parameters.

2.1 Data Centre results summary

The table below shows the estimated operational energy by floor area for each building

Element	DC01 & DC02	DC03
Data Hall energy intensity kWh/m² GIA	24,262	24,874
Office/Admin block energy intensity kWh/m² GIA	106	106
Whole Building energy intensity kWh/m² GIA	19,193	20,977

Table 2-11 Summary of the energy intensity and carbon results for Apatura DC

NB. While data centre IT equipment loads will vary in response to the number and intensity of active processes, the default assumption is that the running IT load is flat over 24/7 basis and has been calculated on the assumption that the average data centre operates at 65% of the maximum design IT equipment capacity value according to the American Power Conversion[1].

2.2 Next steps

It should be noted that these figures are to be used as indicative figures for early-stage benchmarking and targets. A full operational energy assessment (CIBSE TM54) with more detailed information on building fabric performance, services, process loads, and operation is recommended to gain an improved insight into the performance of the bespoke design.

2.2.1 Reducing the Power Usage Effectiveness (PUE)

In order to reduce the PUE for the data halls and reduce carbon emissions, The Chartered Institute of Building Services Engineers (CIBSE) emphasises the importance of an energy strategy focused on efficient air management and high-performance energy systems. Effective use of cool air is a key enabler of saving energy linked to mechanical systems. Measures such as minimising air leakage can reduce fan power consumption while minimising the recirculation of hot air back into IT equipment allow set-points to be raised, reducing the energy associated with cooling systems.

The setpoints of the cooling cycle have the biggest effect on operational energy - increasing the setpoints leads to cooling equipment working at a higher efficiency for more hours using free cooling. Free cooling must be used wherever possible to achieve the energy efficiency targets.

2.2.2 Achieving the EUI targets

Cundall has proposed an Energy Use Intensity (EUI) target to support the data centre development in reducing their operational energy effectively for the office/admin area. This target is 106 kWh/m² GIA/year. To achieve this, following the industry-recognised Energy Hierarchy 'Be Lean', 'Be Clean', 'Be Green' is essential.

A summary of the key considerations associated with each part of the hierarchy is summarised in this section. The inclusion of these design considerations going forward will help to ensure the development operates as efficiently as possible, reducing the energy required for it to run.

[1] Neil Rasmussen, Electrical Efficiency Modeling for Data Centers

2.2.2.1 Reducing demand for energy (Be Lean)

High thermal efficiency across the building envelope and solar gain control

- Low U-values, low air permeability, and appropriate glazing areas and specifications will limit unwanted heat losses and gains due to the fabric. This 'fabric first' approach ensures energy demand is minimised prior to the application of any heating and cooling systems.

High efficiency heating and cooling systems

- The admin/office areas will be served via Air Source Heat Pumps (ASHPs), while free-cooling air-cooled chillers with variable speed compressors will be specified for the data hall areas.

Mechanical ventilation with heat recovery

- High efficiency Air Handling Units (AHUs) will be utilised to provide fresh air in the admin/office areas.

High efficiency lighting

- High efficacy LED luminaires, in combination with daylight and occupancy dimming will be utilised (where appropriate) to ensure lighting energy is kept to a minimum across the site.

2.2.2.2 Energy efficient systems (Be Clean)

District heating network

- The potential for the proposed development to export recovered waste heat from the data halls (that would otherwise be rejected) to a future district heating network (once available) has been investigated and will be further explored in subsequent project stages.

2.2.2.3 Low and Zero Carbon Generating Technologies (Be Green)

Air Source Heat Pumps (ASHPs)

- ASHPs will be specified for meeting the space and cooling demand of the admin and office areas within the proposed buildings.

On-site renewable energy generation

- The potential for incorporating rooftop solar Photovoltaics (PVs) above the admin and office areas of the proposed buildings will be further explored in subsequent project stages. This technology is considered a viable option for meeting a portion of the development's electricity demand. The feasibility and size of solar PV installation will be assessed as the project progresses, with the aim of maximising generation in line with local policy requirements.

2.2.2.4 Metering and monitoring

In addition, the operational energy analysis suggests that good management and control to the current design are required to meet the operational energy targets. If implemented in conjunction with effective monitoring and performance target reviews, these improvements would provide a potential route towards achieving net zero carbon for operational energy once the building is functional.

For operational energy data, a metering system should be in place which collects and reports energy consumption data. A data management system should be in place which allows for collection of five years' worth of half hourly data.

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ZERO CARBON DESIGN 2030