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NCFC SWIMMING POOL BUILDING

Energy Statement

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Energy Statement

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NCFC SWIMMING POOL BUILDING
Energy Statement

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Revision and Date	Amendment Details	Revision Prepared By	Revision Approved By

EXECUTIVE SUMMARY

Create Consulting Engineers Ltd has been appointed to provide an Energy Statement to support the forthcoming planning application for a proposed swimming pool building located in the Norwich City Football Club Colney training centre, Hethersett Lane, Norwich. This report has been developed to detail the energy strategy for the development and demonstrates how it relates to the following guidance documents:

- Greater Norwich Development Partnership (GNDP), Joint Core Strategy for Broadland, Norwich and South Norfolk, Adopted March 2011, amendments adopted January 2014.

The proposed development provides 387m² GIA (440m² GEA) of sports facilities including swimming pool area, changing and showering facilities and storage space located within the Colney training centre to the West of the A47 on the Western side of Norwich.

The strategy aims to reduce energy demands by incorporating suitable passive design measures to provide a highly efficient building fabric and efficient space heating system. The proposed building fabric as well as the building services systems providing space heating and cooling will reduce the Building Emission Rate (BER) over the Target Emission Rate (TER) by over 10%. This figure will be revised at the detailed design stage when the building services design is fully developed. The design will be progressed prioritising energy efficiency of the building fabric and services.

A feasibility study has been undertaken to establish the most suitable renewable technology for integration within the proposed development. Photovoltaic (PV) panels have been deemed the most viable and practical renewable technology to be incorporated in the building design along the specified VRF system. If feasible, a PV array for the site is initially proposed however, it is deemed that this is not required in order to achieve 10% Low-Zero Carbon (LZC) energy contribution and that this can be satisfied by an Air Source Heat Pump (ASHP) system alone.

An optimised PV system size will be considered to maximise the roof space and make the installation financially viable. The addition of the proposed PV system would further reduce carbon emissions helping the building achieve a total CO_2 emissions further reduction over Part L 2013.

1.0 INTRODUCTION

1.1 Create Consulting Engineers Ltd was instructed by Norwich City Football Club to prepare an Energy Statement for the proposed Swimming Pool Building at their Colney training centre providing approximately 387m² of floor space.

Site Location and Description

1.2 The land is currently a part of the Colney training centre car park, this training centre is located to the West of the A47 near the Norfolk and Norwich Hospital in Norwich. The training centre has rural land on all sides, the town of Little Melton to the Northwest and the city of Norwich to the East. Please refer to figure 1.1 below for the Site Location Plan.

Figure 1.1: Site Location Plan

Objectives

1.3 The objectives of this report are to:

- Demonstrate how the proposed development will meet the policy requirements of the Joint Core Strategy for Broadland, Norwich and South Norfolk.
- Identify the most suitable passive and energy efficient design approach for the scheme, the feasibility of LZC technologies and operational Best Practice; and
- Identify the drivers relating to an energy efficient design over and above minimum compliance with current Building Regulations and other appropriate regional and national policies.

Constraints and Assumptions

1.4 This report is based on minimum fabric specification and a concept Mechanical, Electrical and Public Health (MEP) strategy prepared by Create Consulting Engineers. A detailed MEP design will follow at a later stage and will inform further energy assessments carried out to support Building Regulations submission.

1.5 Create Consulting Engineers Ltd has endeavoured to assess all information provided to them during this assessment. Should additional information become available, which may affect the opinions expressed in this report, Create Consulting Engineers Ltd reserves the right to review this information and, if warranted, to modify the opinions presented in the report accordingly.

2.0 CURRENT AND FUTURE PLANNING POLICIES/GOOD PRACTICE REVIEW AND PROJECT REQUIREMENTS

National Planning Policy Framework (Feb 2019)

2.1 The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The ministerial foreword of this NPPF highlights that 'the purpose of planning is to contribute to the achievement of sustainable development' and that at the heart of the framework is a presumption in favour of sustainable development.

2.2 Sustainable development is defined in the NPPF as comprising developments "meeting the needs of the present without compromising the ability of future generations to meet their own needs" in line with the definition of the Brundtland Commission ('Our Common Future', 1987). The NPPF also refers to the three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways – an economic objective, a social objective and an environmental objective.

GNDP Joint Core Strategy (Adopted March 2011, amendments adopted January 2014)

2.3 The policies within the GNDP Joint Core Strategy that are relevant to energy conservation issues are:

Policy 3: Energy and Water

> *"All development proposals of a minimum of 10 dwellings or 1,000m^2 of non-residential floorspace will be required (a) to include sources of 'decentralised and renewable or low carbon energy' (as defined in the glossary) providing at least 10% of the scheme's expected energy requirements and (b) to demonstrate through the Design and Access Statement for the scheme whether or not there is viable and practicable scope for exceeding that minimum percentage provision".*

Decentralised and Renewable of Low-carbon energy sources

> *"Sources of energy that are renewable or low-carbon (or a combination of these) and locally based (on-site or near-site, but not remote off-site), usually on a relatively small scale. Decentralised energy is a broad term used to denote a diverse range of technologies, including micro-renewables, which can locally serve an individual building, development or wider community and includes heating and cooling energy."*

Building Regulations Approved Document Part L: 2013

2.4 Part L of the current Building Regulations consider the reduction of carbon emissions in new and existing buildings. The proposals for the site consist of the creation of new non-domestic areas. The new non-domestic areas fall under Part L2A of the Building Regulations (Conservation of fuel and power in new buildings other than dwellings).

2.5 The overall structure of compliance with the 2013 Building Regulations includes five criteria to comply with for all new non-domestic buildings:

- **Criterion 1** – The Building Emission Rate (BER) should be better than the Target Emission Rate (TER);
- **Criterion 2** - Limit on design flexibility;
- **Criterion 3** - Limiting effects of heat gain in summer;
- **Criterion 4** - Commissioning and air-tightness; and
- **Criterion 5** - Efficient operation of buildings.

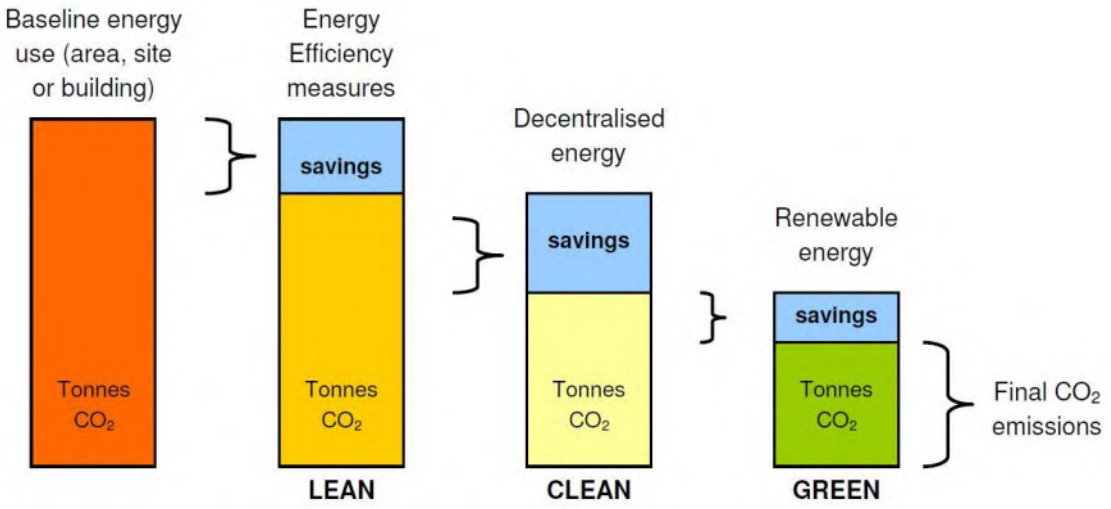
2.6 The new Building Regulations came into force on 6th April 2014. The Part L 2013 specifications for non-domestic buildings have been strengthened to deliver 9% carbon dioxide savings across the new non-domestic mix relative to Part L 2010.

2.7 The detailed energy strategy for the scheme will be developed to ensure the scheme meets the relevant requirements of the Building Regulations.

3.0 ENERGY EFFICIENCY STRATEGY

Introduction

3.1 The proposed energy strategy has, as its first priority, minimised energy consumption through the performance of the building envelope and services. The following section details the energy efficiency features of the development. The hierarchy set out within the London Plan has been followed.



3.2 This analysis includes:

- Building Regulations Approved Document ADL2A (2013) initial compliance assessment, identifying the potential for the design to comply with and exceed Building Regulations requirements; and
- An energy demand assessment of the proposed scheme contained within this document provides carbon dioxide emissions estimates from the analysis of passive energy efficiency enhancements and Low and Zero Carbon potential. This will utilise Building Regulations 2013 carbon dioxide factors.

3.3 In further detail, the energy efficiency strategy of the scheme has been achieved by incorporating the following design and technology features:

Energy Efficiency Features Proposed

<u>Physical Form and Orientation of the Building</u>

3.4 While the orientation of the development has been driven by the constraints of the surrounding infrastructure, the individual orientation of the swimming pool building has been optimised in order to provide a balance of thermal control, both from within and outside of the building.

3.5 Passive solar design involves adapting the internal layout and glazing to best respond to the local climate and annual sun path, with the aim of reducing energy demands and improving occupant comfort through the use of heat and light from the sun. The swimming pool area accommodates windows where possible permitting maximum daylight penetration into the new building.

3.6 Good levels of natural daylight will be achieved for the majority of the scheme. This will reduce reliance on artificial lighting and thus limit energy consumption.

Overheating

3.7 The glazing proposed will have a medium g-value (solar thermal transmittance) to limit solar gains during summer months but to allow for adequate heat gains to reduce the need for space heating during colder periods of the year.

3.8 An effective ventilation system has been proposed for the swimming pool area providing fresh air via mechanical ventilation with heat recovery including inlet and exhaust louvers.

3.9 The initial cooling strategy proposed for the building is via highly efficient VRF units that will be designed to offer sufficient level of comfort cooling to the inlet air of the ventilation system to the main swimming pool space.

Building Envelope Specification and Thermal Performance

3.10 Building fabric thermal transmittance is measured by the U-value of each building element in Watts/m²/K. The U-value describes how well a building element conducts heat. It measures the rate of heat transfer through a building element over a given area, under standardised conditions: the lower the U-value, the better the insulating ability. Table 3.1 below details the proposed U-values for the Swimming Pool building at the Colney Training Centre development, in relation to Building Regulations minimum standards.

Building Element/Characteristic	Proposed values	Building Regulations Part L2A: 2013 maximum target values
Exterior walls - U value (W/m²K)	**0.22**	0.35
Floor - ground floor	**0.19**	0.25
Flat Roof - U value (W/m²K)	**0.15**	0.25
Windows - U value (W/m²K)	**1.5, g-value= approx. 0.4**	2.2
Doors to unheated areas - U value (W/m²K)	**2.2**	2.2
Design Air Permeability (m³/hr/m² @50Pa)	**5**	10

Table 3.1: Proposed building fabric performance for non-domestic buildings

Air Tightness and Ventilation Strategy

3.11 Air permeability is a measure of infiltration. It indicates how often the entire air quantity in a building is exchanged with outside air within 1 hour without any ventilation in place. Any air exchange with outside air is carrying heat energy away from the building, resulting in a higher heating load. Lower air permeability levels are desirable for conserving heat energy and, in the case of mechanical ventilation systems, for reducing fan power consumption. Infiltration is different from ventilation. Infiltration is essentially unwanted air exchanges through imperfections in the building fabric while ventilation is the air exchanges intended by the designer.

3.12 As detailed in Table 3.1, the air permeability of the proposed development has been assumed to be in the region of 5 m^3/m^2@50PA/hr for all non-domestic spaces.

3.13 The ventilation system proposed for the non-domestic areas is a mix of mechanical extract ventilation (in toilets) and Mechanical Ventilation with Heat Recovery (MVHR) (in swimming pool spaces). The MVHR proposed will have high efficiency, in the region of 80-85%, and low SFP (Specific Fan Power) to limit energy use. The exact make and model will be confirmed at detailed design stage.

Lighting and Appliances

3.14 Highly efficient lighting has been proposed for the scheme: > 120 luminaire lumens per circuit watts with occupancy sensing and/or daylight dimming controls (parasitic power ≤ 0.02 W/m^2).

3.15 Lighting will be designed in accordance with CIBSE (Chartered Institute of Building Service Engineers) Lighting Guide 4: Sports Lighting.

3.16 Unnecessary light spill will be reduced by avoiding the use of external decorative lighting; providing fittings only where they are required for security and maintenance purposes. External luminaires will be chosen to minimise sky glow and overspill and located to ensure that only the level of lighting that is required is achieved.

3.17 A simple building user guide on the operation and environmental performance of the building and systems will be developed for the occupant and non-technical building manager.

The Choice and Design of Building Systems and Plant

3.18 The building's Heating, Ventilation and Air Conditioning (HVAC) have not yet been fully designed. The system proposed as part of the initial MEP strategy will, however, optimise the efficiency of the plant by matching installed capacity to anticipated building demand. Items of equipment, which make up the development's mechanical building services installation, will

be specified to achieve high annual energy efficiency in operation and will be serviced regularly to maintain their performance.

3.19 The proposed method of supplying heating and cooling to majority of spaces will be via air source heat pumps (ASHP system). Space heating and cooling to the main swimming pool area will be provided by an Air Handling Unit (AHU) via floor level air distribution grilles. All other heated spaces, as well as the pool decking area, will be heated through Underfloor Heating systems (UFH). The heating efficiency of the proposed system will be in the region of 350% Seasonal Co-efficient of Performance (SCoP) greater than 3.5, and the cooling efficiency will exceed Seasonal Energy Efficiency Ratio (SEER) of 4.5.

3.20 Air Source Heat Pumps (ASHP) systems are a refined and more flexible development of the mature technology that has been applied in 'split' direct expansion (DX) and heat pump systems. As well as providing distributed, temperature-controlled room units, by applying reversible heat pump technology ASHP can simultaneously shift heating and cooling around the building, so reducing overall energy use.

3.21 The Co-efficient of Performance (CoP) is a measure of the electricity input to the system and the heat energy extracted. Several factors affect the CoP of a heat pump; the consistency of the heat source and the required output temperature. Heat pump efficiency is greatest when the required output temperature rise is lowest.

3.22 It is proposed that hot water will be provided by a hot water cylinder with an LTHW coil, the heat for this LTHW coil will be supplied by an ASHP, this will give a gross thermal efficiency of 350%.

Carbon Dioxide and Energy Reductions - Part L2A compliance

IES Thermal Modelling

3.23 IES VE Compliance v7.0.13.0 software has been used to carry out the modelling of the building. It uses National Calculation Methodology (NCM) and SBEM platform to demonstrate building compliance for non-residential buildings with Part L2A of the Building Regulations 2013. These calculations have been used to estimate the energy efficiency features required for Part L compliance, as well as to predict the annual building regulated energy demand, consumption and CO_2 emissions of the community areas.

3.24 The calculations determine a Building Emissions Rate or 'BER'. This value is compared to the energy requirements and emissions of a notional building of the same shape and dimensions which determines a compliant building (the Target Emission Rate or 'TER'). The BER must be equal to or less than the TER.

Results of the Energy and CO_2 emissions estimation

3.25 The total CO_2 emissions has been estimated based on the results from the energy modelling for the proposed building. Please refer to Tables 3.2 and 3.3 below:

Research & Development Centre	Carbon Dioxide Emissions	
	Regulated (BR Part L)	
TER Part L 2013 of the Building Regulations Compliant Development	**68.1**	**$KgCO_2/M^2$/ annum**
Proposed design: energy efficiency features and efficient HVAC system	**60.5**	**$KgCO_2/M^2$/ annum**
Improvement over Part LA: 2013	**7.6**	**$KgCO_2/M^2$/ annum**
	11.1	**%**

Table 3.2: CO_2 emissions reductions achieved over BR compliant case

Energy use type	Energy demand kWh/m^2/ year	Energy demand kWh/year
Space heating	23.54	9,110
Cooling	0.28	108
Hot water	64.89	25,112
Auxiliary	18.07	6,993
Lighting	9.72	3,762
Total	**116.49**	**45,085**

Table 3.3: Energy consumption by end use

Conclusions

3.26 The proposed energy conservation measures and highly efficient heating and cooling system based on low carbon heat pumps will reduce the total CO_2 emissions for the building by 11.1% when compared to a Building Regulations compliant case.

3.27 To further reduce CO_2 emissions for the scheme, the proposed development will incorporate renewable technology. A feasibility study of different renewable systems to determine their suitability for the scheme is presented in Section 4 of this report.

4.0 LOW AND ZERO CARBON TECHNOLOGY

4.1 To follow the guidance in the adopted GNDP Joint Core Strategy Policy 3 Energy & Water, the proposed energy strategy will consider application of renewable energy sources.

4.2 ASHPs (VRF/VRV units) are considered the most suitable option for providing heating and cooling to the development. This strategy has been adopted after a consultation with the design team. Heat pumps are already a low carbon technology that has provided, along with passive design features, over 11% reduction in CO_2 emissions over the Building Regulations compliant case (please refer to section 3 of this report for details of the calculations).

4.3 A further feasibility study has been undertaken to establish the most economically viable renewable technology which provides the highest overall reduction in carbon dioxide emissions for the proposed development to meet the policy requirements. The renewable technologies reviewed in this study and their feasibility for the proposed development are summarised in Table 4.1 below.

Low and Zero Carbon Technology	Suitability for the proposed development
Photovoltaic panels	**YES**
Solar thermal panels	**NO**
Combined Heat and Power (CHP)	**NO**
Biomass boilers	**NO**
Wind turbines	**NO**

Table 4.1: Summary of suitability of LZC technology for the site.

4.4 Key parameters which have been considered when selecting appropriate combinations of technologies include:

- Opportunities of the site and energy demand of the development;
- Client's preference;
- Visual impact of the system;
- Practical implementation considerations;
- Maintenance requirements;
- Implications for internal arrangement and space allocation, infrastructure and site layout;
- Public acceptability;
- Deliverability;
- Potential funding opportunities;
- Management options; and
- Interactions of the technologies with one another.

Renewable Technology Feasibility Study

Photovoltaic (PV)	**Suitable**

4.5 Photovoltaic cells directly convert sunlight into electrical current using semiconductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. The location and positioning of PV cells is therefore critical to achieving acceptable performance. Exposure to sunlight causes electricity to flow through the cells. Mono-crystalline PV cells provide higher levels of electricity generating performance over other panel types. PV panels can be incorporated into a range of building designs and positions, provided they are located in a shade-free environment and facing as close to south as possible.

4.6 Photovoltaics are generally technically suitable for all types of developments. Their use can be limited due to their high capital cost. However, with the introduction of the Feed in Tariff, the high capital cost could be balanced with the running cost savings and the fixed tariff offered during a set period of time.

4.7 The following issues are considered in relation to the feasible integration of PV:

- Low maintenance;
- Simple installation;
- Self-cleaning if tilted at an angle of 10 degrees or more;
- Photovoltaic panels are typically straightforward to integrate into a building's services strategy and would not conflict with an ASHP installation;
- Performance output and emissions reduction is greater for PV over solar thermal systems for this arrangement, panel area and specific project loads;
- Access issues;
- Access hatch/ services termination; and
- Improved Return on Investment and payback periods due to Feed-In Tariffs.

4.8 Areas of PV modules vary between manufacturers, however, on average a 1 PV module covers an area of approximately 1.5m^2. PV panels are produced in various sizes with power outputs ranging from 0.165kWp to 0.32kWp per module. The most commonly used modules generate approximately 0.2-0.25kWp of electricity.

4.9 The available roof area suitable for locating the PV panels is constrained by the orientation and roof layout of the development and space required for other elements of plant such as fans, flues, roof lights, lift overruns etc. The roof area identified as suitable for installation of PV panels is the slightly sloping part of the roof facing southeast (please see the sketch below).

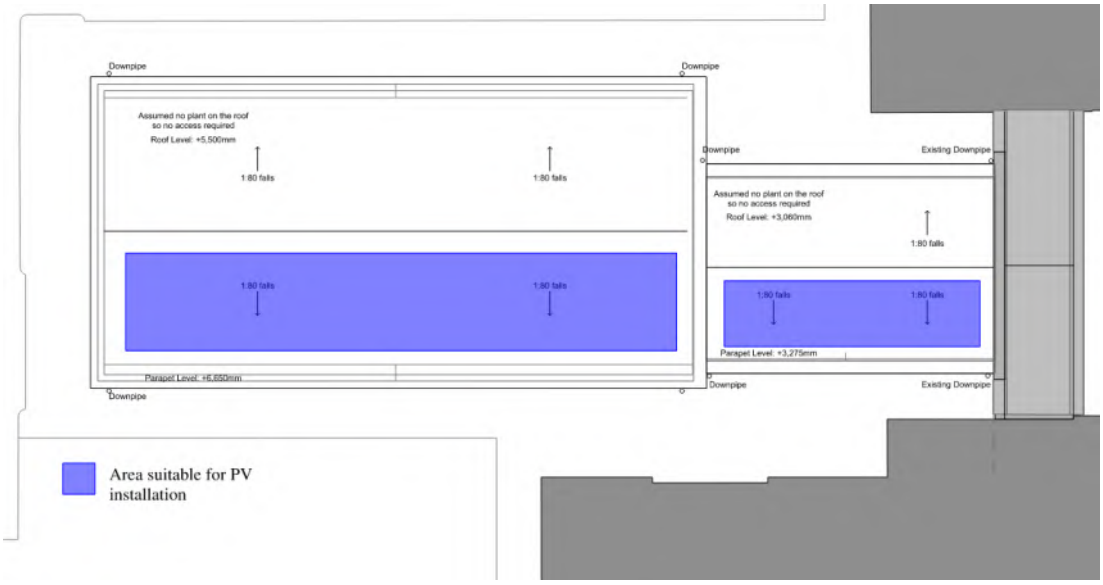


Figure 4.1: Potential PV panels positions on flat roofs

4.10 Additionally, a deduction for access, man safe systems and services terminations should be included. As a 'rule of thumb' a usable roof area is 25% of the available roof area for the unit.

4.11 It has been estimated that the 10% LZC energy contribution required to comply with planning policy is achieved by the introduction of the VRF Air Source Heat Pump system. A building regulations compliant design would use approximately 134.56Wh/m^2/annum. Once the ASHP system is introduced, this drops to 116.49 kWh/m^2/annum.

Research & Development Centre	Energy Consumption	
	Regulated (BR Part L)	
Baseline: Part L 2013 of the Building Regulations Compliant Development	134.56	**kWh/m^2/annum**
Proposed design: energy efficiency features and efficient HVAC system (heat pump)	116.49	**kWh/m^2/annum**
Improvement over Part L2A: 2013 (after "Clean" measures)	18.07	**kWh/m^2/annum**
	13.42	**%**
Energy contribution by 8kWp PV mounted horizontally	4.33	**kWh/m^2/annum**
Total Improvement over Part L2A: 2013 (after "Clean & Green" measures)	18.07+4.33 = 22.4	**kWh/m^2/annum**
	16.6%	**%**

Table 4.2: Calculations of LZC systems needed to meet the planning policy target

4.12 As it is anticipated that no PV will be required to meet the local policy target, the final decision regarding the amount of PV to be installed will rest with the client.

4.13 The assessed building has a potential to fit approximately 8kWp of PV panels if the suitable part of the roof is fully utilised. The actual size of the PV system that will be fitted on the roof will be confirmed at detailed design stage, taking into account the final HVAC system specification and the Client's preference on the maximum desired PV system.

4.14 A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the whole scheme to meet and exceed the planning policy target of 10% low-carbon and/or renewable energy contribution.

Other Technologies Considered in the Study

Solar Thermal Hot Water Panels	**Not Suitable**

4.15 Solar hot water systems (SHW) use the energy radiated by the sun and convert it into useful heat in the form of hot water.

4.16 Heat is transferred and stored in a central thermal store. The solar panel system would ideally supply approximately 45-55% of the developments hot water requirement; the remainder of energy required for domestic hot water would be supplied by the gas boilers.

4.17 Solar thermal panels are ideal for dwellings or other buildings with a steady hot water demand.

4.18 The roof of the building is almost flat, and therefore the collectors would have to be mounted on frames tilted at least 30 degrees facing south, south-west or south-east leading to an optimum hot water output. This would result in higher visual impact of the system.

4.19 A SHW could be utilized in the building, however, the installation of the collectors and their connection to a central hot water storage tank will be more complex than installation of PV panels.

4.20 For these reasons a solar hot water system is not recommended for the site.

Gas CHP (Combined Heat and Power)	**Not Suitable**

4.21 A conventionally fuelled CHP system would utilise a prime mover such as a diesel engine or gas turbine to drive an electrical generator. The heat generated by the prime mover during this process would be utilised in a community heating network.

4.22 Gas CHP systems are energy efficient and considered as low carbon technologies. For CHP to be viable, it must run almost continuously and thus requires a permanent heat demand (hence its suitability for swimming pools, hospitals etc.).

4.23 The building does not have enough continuous demand for heat (usually the hot water requirement) throughout the year to use the heat generated by a CHP. The majority of the building requires the provision of heating and cooling, and therefore a heat pump system is proposed as the main system to serve the occupied areas. The remaining areas requiring heating only have a minimal heating load which will not be able to use all the thermal energy (waste heat) generated by the CHP engine.

4.24 It is, therefore, not recommended that gas fired-CHP be considered for this site.

Bio-fuels	**Not Suitable**

4.25 Bio-fuels have the potential to contribute to the reduction of CO_2 emissions of various developments by using this fuel within a boiler or CHP plant. Biofuels are considered to have low or zero CO_2 intensities as theoretically the CO_2 released when these fuels are combusted is no greater than the CO_2 that has been absorbed from the atmosphere when the plants grew.

4.26 However, there are a number of issues which must be considered with this type of fuel:

- Potential air quality impacts with combusting bio-fuels, in particular elevated NOx emissions and particulates and must be addressed.
- The relatively rapid degradation of biodiesel would require appropriately sized on-site storage tanks with regular fuel deliveries.
- Importantly, the actual bio-diesel CO_2 intensity cannot be guaranteed due to variations in fuel stock supply, demand, the energy input processing the fuel and CO_2 emissions due to growing, harvesting and processing the base fuel.
- Biofuel availability is currently uncertain due to unknown future supply and demand. Whilst an increase in demand for larger developments may stimulate the supply chain, availability could change with variation in demand. Transport is likely to have the most significant impact on the biofuel industry over emerging building demand.
- Socio-economic issues from growing and harvesting feedstock, with potential impacts on food production, particularly for biodiesel that is imported. Solid biofuels have a lesser impact in this area.
- On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area.
- Increased plant maintenance is generally required, adding to costs and plant down-time.

4.27 Consequently, biofuels for combustion within a boiler are not appropriate for the scheme.

Wind Turbines	Not Suitable

4.28 Although a wind turbine could be sized to meet the requirements of this development, there are numerous factors that would discount its suitability in this setting. The tower needed for the turbine would require a large amount of free space for the erecting and periodic maintenance of the turbine.

4.29 To be efficient, a wind turbine is generally used with wind speeds that average over the year at approximately 6m/s. In most locations of central England, a height of over 20m would be necessary to achieve that wind speed. A single large turbine is erected on a tower at this height. A metered connection is made to the grid and any surplus bought back by the Designated Network Operator (DNO) under agreement. A management company needs to be set up to maintain the turbine and manage energy distribution, charging and sale of any surpluses.

4.30 Although the site is mostly surrounded by arable land giving potentially a lot of available space for a wind turbine, a separate planning permission would be required for installation of this system, including consultation period involving local residents.

4.31 The size of the proposed development does not justify the long and complicated application process, as other low carbon and renewable technologies have been identified as feasible for the site.

4.32 Consequently, a wind turbine is not a suitable option for this development.

5.0 CONCLUSION

5.1 This report has been developed to detail the energy efficient features of the development and demonstrates how they relate to the relevant planning policy documents including the Greater Norwich Development Partnership Joint Core Strategy for Broadland, Norwich and South Norfolk.

5.2 The overriding objective in the formulation of the energy strategy for the scheme has been to maximise the viable reductions in total carbon dioxide emissions and low-zero carbon/renewable energy contribution within the framework of the local planning policy.

5.3 The energy strategy of the scheme has considered measures to adapt and mitigate effects of climate change leading to significant CO_2 emission reductions through the specification of energy efficiency systems and the use of LZC technologies.

5.4 A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the scheme to achieve an improvement over Part L 2013 of over 16.6% of annual energy usage once all Lean, Clean, Green measures are implemented.

5.5 It has been concluded that the requirements of the planning policies relating to energy conservation and carbon emissions reduction, as described in section 2 of this report, have been addressed and met.

6.0 DISCLAIMER

6.1 This report details information gathered from consultation with the design team and Norwich City Football Club. All information provided has been accepted in good faith as being accurate and representative of the proposed scheme at the time of review.

6.2 Create Consulting Engineers Ltd disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report.

6.3 The copyright of this report is vested in Create Consulting Engineers Ltd and Norwich City Football Club. The Client, or his appointed representatives, may copy the report for purposes in connection with the development described herein. It shall not be copied by any other party or used for any other purposes without the written consent of Create Consulting Engineers Ltd or Norwich City Football Club.

6.4 Create Consulting Engineers Ltd accepts no responsibility whatsoever to other parties to whom this report, or any part thereof, is made known. Any such other parties rely upon the report at their own risk.

APPENDICES

APPENDIX A

BRUKL – NOTIONAL / BASELINE

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

P21-2281 NCFC Colney Training Centre Swimming Pool - Notional

As designed

Date: Wed Aug 18 14:34:50 2021

Administrative information

Building Details

Address: Hethersett Lane, Colney, Norwich, NR4 7TS

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.6.b.0

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Create Consulting Engineers Ltd

Telephone number: 01603 877010

Address: Princes Street, Norwich, NR3 1AF

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	82.1
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	82.1
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	167.4
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.28	0.28	"XS000004_W0"
Floor	0.25	0.22	0.22	"XS000009_F"
Roof	0.25	0.18	0.18	"XS000004_C"
Windows***, roof windows, and rooflights	2.2	1.6	1.6	"XS000006_W0_O0"
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]

$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	10

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- Unheated

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- UFH from Boiler 0.82

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.81	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- AHU Warm Air - Boiler 0.82

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.81	2.5	-	3	-
Standard value	0.91*	N/A	N/A	1.6^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- Hot Water Cylinder - Boiler 0.82

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.81	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- SYST0001-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

2- SYST0010-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	0.001
Standard value	N/A	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Changing	0.3	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting

Zone name	Luminous efficacy [lm/W]			General lighting [W]
	Luminaire	Lamp	Display lamp	
Standard value	60	60	22	
Mech plant	27	-	-	381
Elec Plant	42	-	-	136
Store	12	-	-	114
Stairs	-	36	-	97
Basement	-	39	-	6134
Changing	-	18	-	619
Circulation	-	27	-	160
Control	58	-	-	90
Sauna	-	89	-	86
Showers	-	23	-	131
Pool Hall Decking	-	15	-	4711
Pool Hall	-	144	-	410

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Basement	N/A	N/A
Control	N/A	N/A
Sauna	N/A	N/A
Pool Hall	NO (-55.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	697.1	697.1
External area [m^2]	1339.4	1339.4
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	10	5
Average conductance [W/K]	443.57	455.12
Average U-value [W/m^2K]	0.33	0.34
Alpha value* [%]	18.59	30.5

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
100	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	111.86	62.91
Cooling	1.07	0.56
Auxiliary	75.42	6.81
Lighting	82.5	20.49
Hot water	280.35	248.7
Equipment*	25.34	25.34
TOTAL**	**551.21**	**339.47**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	532.68	268.38
Primary energy* [kWh/m^2]	967.87	468.05
Total emissions [kg/m^2]	167.4	82.1

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	14.4	123.9	1.3	0	2.8	3.12	0	3.5	0
	Notional	42	41.3	4.8	0	1.4	2.43	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	65.7	315.8	25.2	0	4.4	0.72	0	0.81	0
	Notional	87.9	88.6	29.8	0	2.9	0.82	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	9176	102.8	3190.1	34.2	2295.4	0.8	0.84	0.81	2
	Notional	4435.4	233.2	1504.4	18	153.5	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.28	"XS000004_W0"
Floor	0.2	0.22	"XS000009_F"
Roof	0.15	0.18	"XS000004_C"
Windows, roof windows, and rooflights	1.5	1.6	"XS000006_W0_O0"
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	10

APPENDIX B

BRUKL – `LEAN` MEASURES

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

P21-2281 NCFC Colney Training Centre Swimming Pool - Lean

As designed

Date: Wed Aug 18 14:28:25 2021

Administrative information

Building Details

Address: Hethersett Lane, Colney, Norwich, NR4 7TS

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.6.b.0

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Create Consulting Engineers Ltd

Telephone number: 01603 877010

Address: Princes Street, Norwich, NR3 1AF

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	82.1
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	82.1
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	92.1
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.22	0.22	"XS000004_W0"
Floor	0.25	0.19	0.19	"XS000009_F"
Roof	0.25	0.15	0.15	"XS000004_C"
Windows***, roof windows, and rooflights	2.2	1.5	1.5	"XS000006_W0_O0"
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]

$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- Unheated

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- UFH from Boiler 0.92

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.92	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- AHU Warm Air - Boiler 0.92

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.92	3.5	-	1.5	0.75
Standard value	0.91*	N/A	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- Hot Water Cylinder - Boiler 0.92

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.92	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- SYST0001-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

2- SYST0009-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	0.001
Standard value	N/A	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Changing	0.3	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Mech plant	120	-	-	85
Elec Plant	120	-	-	47
Store	120	-	-	11
Stairs	-	120	-	14
Basement	-	120	-	1203
Changing	-	120	-	45
Circulation	-	120	-	18
Control	120	-	-	44
Sauna	-	120	-	32
Showers	-	120	-	13
Pool Hall Decking	-	120	-	304
Pool Hall	-	120	-	247

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Basement	N/A	N/A
Control	N/A	N/A
Sauna	N/A	N/A
Pool Hall	NO (-55.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	697.1	697.1
External area [m^2]	1339.4	1339.4
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	5
Average conductance [W/K]	380.46	455.12
Average U-value [W/m^2K]	0.28	0.34
Alpha value* [%]	21.67	30.5

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
100	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	79.99	62.91
Cooling	0.4	0.56
Auxiliary	30.58	6.81
Lighting	9.72	20.49
Hot water	246.84	248.7
Equipment*	25.34	25.34
TOTAL**	**367.53**	**339.47**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	287.96	268.38
Primary energy* [kWh/m^2]	526.27	468.05
Total emissions [kg/m^2]	92.1	82.1

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	29.6	23.9	2.6	0	2.8	3.12	0	3.5	0
	Notional	42	41.3	4.8	0	1.4	2.43	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	111.5	80.8	37.7	0	4.4	0.82	0	0.92	0
	Notional	87.9	88.6	29.8	0	2.9	0.82	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	5478	90.1	1973.6	12.8	865.1	0.77	1.95	0.92	3.5
	Notional	4435.4	233.2	1504.4	18	153.5	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.22	"XS000004_W0"
Floor	0.2	0.19	"XS000009_F"
Roof	0.15	0.15	"XS000004_C"
Windows, roof windows, and rooflights	1.5	1.5	"XS000006_W0_O0"
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

APPENDIX C

BRUKL – `CLEAN` MEASURES

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

P21-2281 NCFC Colney Training Centre Swimming Pool - Clean

As designed

Date: Fri Aug 20 10:26:47 2021

Administrative information

Building Details

Address: Hethersett Lane, Colney, Norwich, NR4 7TS

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.6.b.0

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Create Consulting Engineers Ltd

Telephone number: 01603 877010

Address: Princes Street, Norwich, NR3 1AF

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	68.1
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	68.1
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	60.5
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.22	0.22	"XS000004_W0"
Floor	0.25	0.19	0.19	"XS000009_F"
Roof	0.25	0.15	0.15	"XS000004_C"
Windows***, roof windows, and rooflights	2.2	1.5	1.5	"XS000006_W0_O0"
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]

$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- Unheated

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- UFH from ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

3- AHU Warm Air - ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	4.5	-	0.8	0.75
Standard value	2.5*	N/A	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- Hot Water Cylinder

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- SYST0001-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

2- SYST0003-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	0
Standard value	N/A	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Changing	0.3	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Mech plant	120	-	-	85
Elec Plant	120	-	-	47
Store	120	-	-	11
Stairs	-	120	-	14
Basement	-	120	-	1203
Changing	-	120	-	45
Circulation	-	120	-	18
Control	120	-	-	44
Sauna	-	120	-	32
Showers	-	120	-	13
Pool Hall Decking	-	120	-	304
Pool Hall	-	120	-	247

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Basement	N/A	N/A
Control	N/A	N/A
Sauna	N/A	N/A
Pool Hall	NO (-55.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	697.1	697.1
External area [m^2]	1339.4	1339.4
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	5
Average conductance [W/K]	380.46	455.12
Average U-value [W/m^2K]	0.28	0.34
Alpha value* [%]	21.67	30.5

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
100	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	23.54	22.87
Cooling	0.28	0.56
Auxiliary	18.07	6.81
Lighting	9.72	20.49
Hot water	64.89	83.83
Equipment*	25.34	25.34
TOTAL**	**116.49**	**134.56**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	287.96	268.38
Primary energy* [kWh/m^2]	357.63	402.79
Total emissions [kg/m^2]	60.5	68.1

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	29.6	23.9	2.6	0	2.8	3.12	0	3.5	0
	Notional	42	41.3	4.8	0	1.4	2.43	0	----	----
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	111.5	80.8	9.9	0	4.4	3.12	0	3.5	0
	Notional	87.9	88.6	10.1	0	2.9	2.43	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	5478	90.1	566.3	8.9	465.8	2.69	2.81	3.5	4.5
	Notional	4435.4	233.2	507	18	153.5	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.22	"XS000004_W0"
Floor	0.2	0.19	"XS000009_F"
Roof	0.15	0.15	"XS000004_C"
Windows, roof windows, and rooflights	1.5	1.5	"XS000006_W0_O0"
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

APPENDIX D

BRUKL – `GREEN` MEASURES

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

P21-2281 NCFC Colney Training Centre Swimming Pool - Green

As designed

Date: Fri Aug 20 10:35:09 2021

Administrative information

Building Details

Address: Hethersett Lane, Colney, Norwich, NR4 7TS

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.6.b.0

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Create Consulting Engineers Ltd

Telephone number: 01603 877010

Address: Princes Street, Norwich, NR3 1AF

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	68.1
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	68.1
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	64
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.22	0.22	"XS000004_W0"
Floor	0.25	0.19	0.19	"XS000009_F"
Roof	0.25	0.15	0.15	"XS000004_C"
Windows***, roof windows, and rooflights	2.2	1.5	1.5	"XS000006_W0_O0"
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- Unheated

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- UFH from ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

3- AHU Warm Air - ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	3.5	-	1.5	0.75
Standard value	2.5*	N/A	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- Hot Water Cylinder

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.5	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- SYST0001-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

2- SYST0003-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	0.001
Standard value	N/A	N/A

3- SYST0000-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Changing	0.3	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting

Zone name	Luminous efficacy [lm/W]			General lighting [W]
	Luminaire	Lamp	Display lamp	
Standard value	60	60	22	
Mech plant	120	-	-	85
Elec Plant	120	-	-	47
Store	120	-	-	11
Stairs	-	120	-	14
Basement	-	120	-	1203
Changing	-	120	-	45
Circulation	-	120	-	18
Control	120	-	-	44
Sauna	-	120	-	32
Showers	-	120	-	13
Pool Hall Decking	-	120	-	304
Pool Hall	-	120	-	247

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Basement	N/A	N/A
Control	N/A	N/A
Sauna	N/A	N/A
Pool Hall	NO (-55.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	697.1	697.1
External area [m^2]	1339.4	1339.4
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	5
Average conductance [W/K]	380.46	455.12
Average U-value [W/m^2K]	0.28	0.34
Alpha value* [%]	21.67	30.5

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
100	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	22.06	22.87
Cooling	0.4	0.56
Auxiliary	30.58	6.81
Lighting	9.72	20.49
Hot water	64.89	83.83
Equipment*	25.34	25.34
TOTAL**	**127.65**	**134.56**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	4.33	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	287.96	268.38
Primary energy* [kWh/m^2]	391.9	402.79
Total emissions [kg/m^2]	64	68.1

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	29.6	23.9	2.6	0	2.8	3.12	0	3.5	0
	Notional	42	41.3	4.8	0	1.4	2.43	0	----	----
[ST] Central heating using water: floor heating, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	111.5	80.8	9.9	0	4.4	3.12	0	3.5	0
	Notional	87.9	88.6	10.1	0	2.9	2.43	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	5478	90.1	519.2	12.8	865.1	2.93	1.95	3.5	3.5
	Notional	4435.4	233.2	507	18	153.5	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.22	"XS000004_W0"
Floor	0.2	0.19	"XS000009_F"
Roof	0.15	0.15	"XS000004_C"
Windows, roof windows, and rooflights	1.5	1.5	"XS000006_W0_O0"
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5