Department for Education

Further Education Output Specification

Technical Annex 2H: Energy

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Document Control

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Summary

Technical Annex 2H provides the minimum requirements for energy regarding the performance of the buildings and grounds. Sustainability, carbon reduction and in use monitoring underpins the requirements. It is to be read in conjunction with the Generic Design Brief (GDB) the College-specific Brief (CSB).

Review Date

Review dates for this document shall be at 6-month intervals.

Who is this publication for?

This document is for technical professionals involved in the design and construction of college premises, as part of the Employer's Requirements of the DfE Construction Frameworks (the DfE Construction Framework 2021 and the Offsite Schools Framework (incorporating Modular and MMC delivery) (MMC)). It may also be used as the basis of similar documentation for other procurement routes using the Further Education Output Specification.

Uniclass Codes

This document captures Uniclass codes for the management of exchange of information. To access all codes and associated titles reference should be made to Uniclass 2015 | NBS (thenbs.com).

1. Introduction

1.1. Overview

1.1.1 This document is one of the Further Education Output Specification (FE-OS) Technical Annexes that forms part of the Generic Design Brief (GDB). [PM_10_20]

1.1.2 The definitions listed in the GDB shall apply to this Technical Annex and all other parts of the FE-OS. [PM_10_20]

1.1.3 This document shall be read in conjunction with the GDB and all other Technical Annexes as well as the College-specific Brief (CSB), including the College-specific Annexes. [PM_10_20]

1.1.4 This document sets out the required technical standards and performance criteria for external fabric. [PM_10_20]

1.1.5 The information exchange required at each stage of the design, build and completion process is detailed in the DfE's Exchange Information Requirements (EIR). [PM_10_20_28]

1.1.6 The requirements in this Technical Annex shall apply to all parts of the works; New or Refurbished. [PM_10_20]

1.2. Purpose

1.2.1 This document has been developed for New and Refurbished Buildings to:

a) support the delivery of the requirements stated in the GDB [PM_35_70]

b) ensure energy efficient colleges [PM_35_70]

c) set targets for regulated and unregulated energy use in colleges [PM_40_30_27]

d) detail the energy modelling requirements [PM_35_70]

e) provide detail for the Contractor to produce energy strategy and carbon reports [PM_35_70]

f) ensure that college energy use is managed [PM_35_70]

g) allow New and Refurbished Buildings' operational annual energy uses to be benchmarked. [PM_35_70]

1.3. New and Refurbished Buildings

1.3.1 This document gives guidance on the energy efficient design and regulation of the energy benchmarking, modelling requirements and monitoring of New and Refurbished Buildings. [PM_35_70]

1.3.2 The following definitions are used in respect of Building Regulations and stipulated in AD L with regards to energy modelling.

a) New Build - the construction of a New Building; [PM_35_70]

i) a new free-standing building on an existing site; work to a Building with a total floor area greater than 1000m²

ii) where the Work includes the construction of extensions to Existing Buildings with an extension floor area greater than 100m² and greater than 25% of the total floor area of the Existing Building.

b) Refurbishment - construction work comprising changes to external fabric thermal performance; opening up areas in the building envelope; or changes to fixed Building Services. [PM_35_70]

1.3.3 These definitions shall be applied in the context of AD L however, the definitions of Refurbishment, New Building and Retained buildings given in the Generic Design Brief shall also apply.

1.3.4 Section 6 describes the different approach required for Refurbished Buildings. For Refurbished Buildings:

a) the results of energy auditing and historic energy data for the Buildings shall be used [PM_30_10]

b) the results shall be used to compare the predicted energy performance with the actual energy performance of the Existing Building(s). [PM_80_10_60]

1.3.5 In respect of refurbished works, the required level of compliance with this Technical Annex is set out in the Refurbishment Scope of Works (RSoW). [PM_10_20]

1.3.6 All refurbishment works shall be assessed to identify where retrospective legislation may apply and works shall be carried out to comply. [Ac_10_70_70]

2. Energy Efficiency for Further Education Building Design

2.1. Overview

2.1.1 New colleges shall be designed to meet the relevant Regulated and Unregulated energy standards, including local planning policies and national regulations. [PM_10_20_82]

2.1.2 To meet Energy Use Intensity (EUI) targets, reduce energy consumption and reduce the operational cost of the development, colleges shall be designed in line with the energy efficiency hierarchy:

a) Be Lean - use less energy [PM_40_20_26]

b) Be Clean - use efficient energy supplies [PM_40_20_26]

c) Be Green - use renewable energy [PM_40_20_26]

d) Be Seen - monitor performance in use [PM_40_20_26]

2.1.3 To achieve Net Zero Carbon in operation the application of low energy, fossil fuel free buildings which respond to climate change shall be prioritised. [PM_10_20_82]

2.2. Be Lean - use less energy

2.2.1 Lowering or eliminating the energy demand of New Buildings shall reduce the size and capital cost of plant and equipment and help to reduce the cumulative stress applied to the national grid infrastructure. [PM_40_20_26]

2.2.2 The Contractor shall deliver a Fabric-First approach to meet (or exceed) the minimum DfE Fabric Energy Efficiency Standard (FEES) in Technical Annex 2C Section 2.2, Table 1: Construction Data Values and reduce the need for active equipment by exploiting passive opportunities presented by the Building and its immediate microclimate. [PM_40_20_26]

2.2.2 Passive design considerations

2.2.2.1 The following are some of the least complex and most cost-effective measures which shall be incorporated to help reach the EUI targets:

a) Site layout - optimise site layout and microclimate to minimise constraints and maximise opportunity across the site with respect to wind, noise, air pollution,

access to daylight, green infrastructure strategy, Sustainable Urban Drainage (SuDS) solutions and surrounding building context. [PM_35_70]

b) External Spaces - shall be considered in tandem with the internal environments, to maximise the opportunities for natural shading through vegetation, trees, green roofs and local permeable paving to reduce the heat island effect. [PM_35_70]

c) Optimise daylight - including dual aspect spaces, optimal cill heights and window sizes, resilient floor to ceiling heights, shallow floorplates, the use of lightwells and rooflights. [PM_35_70_20]

d) Control solar gain - optimise the size and depth of windows on each elevation to control and enhance the effect of solar gain; benefitting from the heat when required but not at the expense of overheating in the summer. [PM_35_70_20]

e) Optimise the use of shading - use shading devices and low g-value glazing to limit solar gains to areas which may be susceptible to overheating whilst limiting overshadowing of windows to areas that require daylight or which could benefit from solar gain. [PM_35_70_20]

f) Optimise the thermal envelope - an efficient thermal envelope is key to reducing the energy performance of the Building. New college buildings shall meet or exceed the DfE FEES. [PM_35_70_92]

g) Optimise insulation - one of the most cost-effective ways to make a building more energy efficient is by reducing the impact of external temperatures on the internal environment. [PM_35_70_92]

h) Eliminate thermal bridging - to prevent the loss of heat and to prevent the development of cold spots which can lead to condensation and mould. [PM_35_70_92]

i) Achieve a minimum airtightness of $3m^3$/hr/sq.m @ 50pa. Airtightness shall minimise the impacts of uncontrolled infiltration and control air entering and leaving the Building. [PM_35_70_03]

j) Optimise the use of thermal mass - which can help retain heat and reduce internal temperature fluctuations. [PM_35_70_92]

k) Use light coloured materials where possible to reduce the absorption of heat therefore reducing the likelihood of overheating. [PM_35_70_92]

l) Maximise the potential for natural ventilation - including openable windows, shallow floorplates, dual aspect units, designing in the ‘stack effect’ system where

pressure differences are used to draw air through a building and double façade where the inner façade has openings to release heat without occupants being exposed to external wind and noise. [PM_35_70_94]

m) Maximise the efficiency of heating infrastructure by increasing pipe and storage insulation and minimising the length of pipe runs. Pipes shall be sized to reduce pressure losses, whilst maintaining minimum flow velocities and to ensure the selection of efficient pumps and motors capable of variable flow solutions. [PM_35_70_36]

n) Maximise the capability and efficiency of installed systems through careful consideration of building zones and adjacencies. [PM_35_70_36]

2.2.3 Active system considerations

2.2.3.1 Once the passive design of the Building has been maximised, the required mechanical systems shall be optimised. The lower the energy demand of the Building, the easier it is to achieve Net Zero in use. [PM_40_30_52]

2.2.3.2 Active measures shall be designed to meet the needs of the College so that plant can run efficiently. Oversized plant shall be avoided to discourage inefficient use or unnecessary use of the equipment. [PM_40_30_52]

2.2.3.3 Where practical, Contractors shall include the following measures:

a) Include low emission and carbon dioxide efficient heating systems. [Ss_60_40_37]

b) Include heat recovery – collecting waste heat to pre-heat air or water increasing the efficiency of heating or hot water systems. [PM_40_30_52]

c) Maximise the use of passive cooling techniques and if mechanical cooling is required, minimise the operational requirement and use efficient systems. Reference should be made to Section 8.1 in Technical Annex 2F. [PM_10_20_90]

d) Select efficient ventilation systems with low total system pressure losses, high efficiency fans and motors and high ventilation efficiency within occupied zones. [Ss_65_40]

e) Maximise energy efficient lighting systems as defined in Technical Annex 2E. [PM_10_20_90]

f) Incorporate other energy efficient and energy saving equipment such as heating controls, individual controls, zoning, movement sensors, photo sensors, timers, metering, building management and monitoring systems. [PM_35_70]

2.2.3.4 Consideration shall be given to areas of the Building likely to need light, heat or ventilation. Activities that generate their own heat such as the use of ICT equipment shall be considered. [PM_40_30_52]

2.2.3.5 The Methodology for Overheating Risk Assessment (ORA) is defined in Technical Annex 2F and Building Bulletin 101: 'Guidelines on ventilation, thermal comfort and indoor air quality in schools' (BB101). [PM_10_20_90]

2.2.3.6 Technical Annex 2F takes precedence over BB101 for the application of weather files and existing buildings with respect to overheating requirements. [PM_10_20_90]

2.3. Be Clean - use efficient energy supplies

2.3.1 Having reduced the energy demand, the supply of clean and efficient energy shall maximise the efficiency of systems on site. [PM_40_20_26]

2.3.2 Where practical to do so Contractors shall deliver an entirely fossil fuel free building. [PM_40_20_26]

2.3.3 The Contractor shall meet (or exceed) minimum operational energy performance targets by maximising the energy efficiency of installed equipment and delivering fossil fuel free heat following the low carbon heat source hierarchy in Technical Annex 2F. [PM_10_20_90]

2.3.4 The feasibility of district heating shall be investigated. Calculations and analysis shall be included in the Energy Strategy Report. [Ss_60_40_84_22]

2.3.5 When determining whether it is feasible to connect to an existing district heating network, the following measures shall be considered, as appropriate.

a) The size of the development, and the heat load and energy demand throughout the year. [Ss_60_40_84_22]

b) The distance of the development to the nearest district heating network or proposed networks. [Ss_60_40_84_22]

c) The presence of physical barriers such as major roads or railway lines in making a connection to the network. [Ss_60_40_84_22]

d) The cost of connection and the impact this has on financial viability of the heat supply. [Ss_60_40_84_22]

2.3.6 When determining whether it is feasible to install an energy centre and establish a heating network, the following measures shall be considered, as appropriate.

a) The heat load and energy demand throughout the year and density of surrounding built environment. [Ss_60_40_84_22]

b) The proximity of and potential supply to any public sector estates and buildings with communal heating systems. [Ss_60_40_84_22]

c) The ability to secure agreements for the connection of nearby buildings or estates. [Ss_60_40_84_22]

2.3.7 Where practical, developments generating energy or waste heat shall maximise long term carbon dioxide savings by feeding the decentralised energy network with low or zero carbon hot water. [PM_40_20_26]

2.3.8 Information about existing and planned heat networks across the UK can be found at the Department for Business, Energy & Industrial Strategy website. See https://www.gov.uk/guidance/heat-networks-delivery-support. A check shall also be done with the Local Authority Heat Map. [Ss_60_40_84_22]

2.4. Be Green - use renewable energy

2.4.1 Renewable technology performance standards e.g., for PV installations defined within Technical Annex 2G shall be met or exceeded to generate energy through the application of on-site renewables. [PM_10_20_90]

2.4.2 The Project shall implement a green infrastructure strategy to increase biodiversity, improve surface water run-off, provide comfortable outdoor environments, and use building and/or ground level local green infrastructure to improve internal environments and mitigate overheating. [PM_40_20_85]

2.4.3 Reference shall be made to Technical Annex 2F for the hierarchy of heat generating systems including Low or Zero Carbon Technologies. [PM_10_20_90]

2.4.4 Where a college site meets all the requirements of the Output Specification but site-specific items or project constraints mean that it is not possible to achieve Net Zero Carbon in Operation using on-site renewables, a clear roadmap towards 2050 shall be provided for the Employer in response to Annex SS6 of the College-specific Brief (CSB). [PM_40_20_85]

2.5. Be Seen - performance in use

2.5.1 The Contractor shall meet (or exceed) minimum standards defined within this Technical Annex and Technical Annexes 2I and 2K, including commissioning the Building, supporting and empowering the end users with training and robust handover protocols to

meet or exceed minimum requirements for monitoring, verifying and reporting energy performance in use. [PM_10_20_90]

2.5.2 The Contractor shall provide the end user with clear metering and monitoring protocols as described within Section 5 and Technical Annexes 2I and 2K to ensure that the College can easily manage and understand their energy in use, as well as to drive good behaviours to support the operational energy performance. [PM_10_20_90]

2.5.3 Refer to Section 5: Monitoring in Use for further details. [PM_10_20_90]

2.6. Other Considerations

2.6.1 All European Standards are to apply until replaced with new UK equivalent or updated standards. [PM_10_20_82]

2.6.2 Where local planning policies require specific environmental certification, these elements shall be funded as a project abnormal and included within the CSB. [PM_10_20]

3. Energy and Net Zero Carbon

3.1. Design Benchmarks

3.1.1 During the design stage, the Contractor shall predict the total energy consumption of the Building(s) that comprise the Works. [PM_40_30_27]

3.1.2 In order to monitor performance in use, 15 minute data to iSERV as described in Section 5 shall be provided. [PM_10_20_82]

3.1.3 The Contractor shall prove that the design can meet the energy targets through energy modelling using the methodology defined in CIBSE TM54, as detailed in Section 4. [PM_40_30_27]

3.2. New Buildings

3.2.1 DfE Fabric Energy Efficiency Standards

3.2.1.1 New Building(s) shall be designed to the Fabric First principle. [PM_40_20]

3.2.1.2 The minimum requirements associated with External Fabric are defined within Technical Annex 2C: Section 2.2, Table 1. [PM_10_20_90]

3.2.2 Energy Use Intensity Targets

3.2.2.1 To meet the EUI Targets, the energy model shall have energy end use for college per m^2 of GIFA (kWh/m2) excluding unheated areas (transition spaces). [PM_40_20]

3.2.2.2 The following EUI values define the minimum standards for New Building(s) and shall be achieved before the application of renewable technology. [PM_40_20]

Educational Building Type	Energy Use Intensity (minimum)	Units
Secondary School (with 6th Form) and FE College	67*	kWh/m²

Table 1 Energy Use Intensity Targets

* Note: Allow 2 kWh/m² for building related services

3.2.2.3 The breakdown below provides an indication of how to achieve the overall EUI targets, by end use system. [PM_40_30_27]

Parameter	Value	Units
Heating	8	kWh/m²
Hot water	5	kWh/m²
Internal lighting	8	kWh/m²
Fans and pumps	5	kWh/m²
Cooling	0	kWh/m²
Lifts	1	kWh/m²
Building related services	2	kWh/m²
External lighting	6	kWh/m²
Small power (Low Tech) *	10	kWh/m²
Small power (Med Tech) *	15	kWh/m²
Small power (High Tech) *	25	kWh/m²
Server room	0	kWh/m²
Catering	7	kWh/m²
ICT equipment	*Included within Small Power*	*Included within Small Power*

Table 2 End Use Energy Benchmarks

*College (targets shall be variable depending upon extent of curriculum delivery - as noted for FF&E Power) see Guidance for Low, Medium and High Tech definition. For Example: Low (academic curriculum), Medium (low to medium energy use in vocational training), High (high energy use in vocational training).

3.2.3 Net Zero Carbon in Operation

3.2.3.1 Technical Annex 2J sets out the DfE standards with respect to the definitions and requirements for Net Zero carbon in operation. [PM_10_20_90]

3.2.4 Operational energy and Equipment

3.2.4.1 Technical Annex 2J sets out the DfE standards with respect to legacy equipment and TM54 assessment assumptions. [PM_10_20_90]

3.3. Existing Buildings

3.3.1 The existing estate plays a critical role in delivering energy and carbon reduction across the national college estate by 2050. [PM_40_20_26]

3.3.2 The extent of the Works shall determine the level of intervention which can be made in any Existing Building. [PM_40_20_26]

3.3.3 The Contractor shall maximise opportunity to reduce energy demand across Existing Buildings where appropriate. [PM_40_20_26]

3.3.2 Energy Reduction Targets

3.3.2.1 Energy Benchmarks are critical for Existing Buildings, and the first step to zero-carbon for Existing Buildings shall be a reduction in energy demand. [PM_40_20_26]

3.3.2.2 The following measures set out the requirements for energy consumption reductions based on the information from energy audits, surveys and operational meter data. [PM_40_20_26]

3.3.2.3 The following reduction shall be achieved for all Existing Buildings:

a) Heat Challenge

i) Heating reduction by 30%. [PM_35_70_36]
ii) Hot Water reduction by 10%. [PM_35_70_38]

b) Electrical Challenge

i) Internal lighting, fans and pumps, cooling reduction by 25%. [PM_35_70]

c) Safety and Security Challenge

i) Lifts, building related services, external lighting reduction by 3%. [PM_35_70]

d) College's Challenge (non-building)

i) Small power, server room, catering, ICT equip reduction by 5%. [PM_35_70]

3.3.3 Net Zero Carbon in Operation

3.3.3.1 Technical Annex 2J sets out the DfE standards with respect to the definitions and requirements for net zero carbon in operation. [PM_10_20_90]

3.3.4 Operational energy and Equipment

3.3.4.1 Technical Annex 2J sets out the DfE standards with respect to Legacy equipment and TM54 assessment assumptions. [PM_10_20_90]

3.3.4.2 Section 5 describes the requirements for monitoring performance in use. [PM_10_20_90]

4. Energy Baseline Models

4.1. The Modelling Process

4.1.1 Overview

4.1.1.1 Throughout the design process, thermal models shall be used to demonstrate compliance with relevant carbon emissions and energy performance requirements. [PM_30_30_86]

4.1.1.2 The development of both thermal and energy models for building design is required as an integral part of the design process for both New and Refurbished Buildings. [PM_30_30_86]

4.1.1.3 Modelling results shall be included in the Environmental Strategy Report as part of the DfE's EIR. [PM_10_20_28]

4.1.1.4 Modelling shall support a detailed understanding of the thermal performance and energy consumption of a building for a set of defined input criteria. [PM_30_30_86]

4.1.1.5 Energy models shall be subject to rigorous quality control procedures to reduce design errors. [PM_30_30_86]

4.1.1.6 During the early stages of design, information from thermal modelling shall inform an iterative process to evaluate the feasibility of design concepts. [PM_30_30_86]

4.1.1.7 During the later stages of design, models shall be used in the testing, fine-tuning and implementation of design features. [PM_30_30_86]

4.1.1.8 To evaluate if the design shall operate within the specified energy targets (see Section 3), the Contractor is required to develop a Concept Energy Model. The detailed requirement is set out in the DfE's EIR. [PM_10_20_28]

4.1.1.9 Once the project demonstrates that the concept model meets or betters the theoretical energy performance required, the Contractor shall create a Developed Energy Model. This requirement is set out in the DfE's EIR. [PM_10_20_28]

4.1.2 Calculation Methodology

4.1.2.1 Dynamic simulation models (DSM) shall be used for the Concept Energy Model and the Developed Energy Model which comply with CIBSE TM33 and be National Calculation Method (NCM) approved. [PM_30_30_86]

4.1.2.2 The Contractor shall ensure both models use the nearest CIBSE Test Reference Year (TRY) Weather file. [PM_30_30_98]

4.1.2.3 The Contractor shall design and construct the new facilities to meet or exceed the EUI Targets as a minimum requirement for all new Buildings, based on CIBSE TM54 assessment. [PM_10_20_90]

4.2. Concept Energy Model

4.2.1 Overview

4.2.1.1 The Concept Energy Model shall be used to evaluate the feasibility of New Building designs concerning energy. [PM_30_30_86]

4.2.1.2 The Concept Energy Model shall be produced in accordance with the information in the Employer's Requirements. [PM_30_30_86]

4.2.1.3 For Refurbished Buildings, an analysis of the energy performance of the Existing Building based on an energy audit shall replace the need for a Concept Energy Model. See Section 6. [PM_10_20_90]

4.2.1.4 The inputs to the Concept Energy Model for New Buildings shall comprise two types of design parameters:

a) 'Fixed' parameters using prescribed value in the model. [PM_30_30_86]

b) 'Flexible' parameters based on the Contractor's design specification, to permit a comparison between the energy and carbon performance of alternative design proposals. 'Flexible' parameters may also include a limitation to the range of input values that are permissible in the form of maximum or minimum values. [PM_30_30_86]

4.2.1.5 'Flexible' parameters are design elements that would be considered as a carbon saving measure under the 'Be Lean' stage of the energy hierarchy. [PM_30_30_86]

4.2.1.6 This approach is consistent with the objective of giving priority to energy efficiency at the concept design stage before considering low carbon heat or renewable technologies. [PM_40_20_26]

4.2.2 Fixed and Flexible Design Parameters

4.2.2.1 The following can be described as Fixed parameters:

a) College operational schedule (including opening hours and plant operating profile). [PM_40_30]

b) Room occupancy and internal gains. [PM_40_30]

c) Weather data. [PM_40_30]

d) Ventilation supply/extract rates and supply temperature. [PM_40_30]

e) HVAC system efficiencies. [PM_40_30]

f) Electrical lighting efficiency. [PM_40_30]

4.2.2.2 The following can be described as Flexible parameters:

a) Building geometry (form and orientation). [PM_40_30]

b) Shading elements. [PM_40_30]

c) Glazing ratio. [PM_40_30]

d) Thermal mass of building fabric. [PM_40_30]

e) HVAC system options. [PM_40_30]

f) HVAC system fuel. [PM_40_30]

g) Thermal transmittance (U-Value) of building fabric (with Limiting Values). [PM_40_30]

h) Building air permeability (with Limiting Values). [PM_40_30]

i) Glazing G-Value (with Limiting Values). [PM_40_30]

4.2.3 Design Parameters

4.2.3.1 The criteria in sections 4.2.4 to 4.2.8 shall be assumed ‘fixed’ unless stated otherwise. [PM_10_20_90]

4.2.4 Operational Hours

4.2.4.1 The operational hours are based on an NCM typical further education year and provide the details of HVAC operational hours throughout the year. See Tables 3 and 4. [PM_10_20_90]

4.2.4.2 During times of the day/year when the College is closed, systems shall be set to the setback temperatures detailed in Table 7. [PM_10_20_82]

Timetable	Detail
Opening timetable - typical	07:00 – 17:00
Opening timetable - Community Courses and night classes	07:00 – 22:00
Dining timetable	12:00 – 14:00
Working week*	Monday – Friday

Table 3 Working Week

*During dates specified in Table 4 College/ Further Education Calendar

From (inclusive)	To (inclusive)	Status
January 01	January 08	Closed
January 9	March 19	Open
March 20	April 02	Closed
April 03	June 12	Open
June 13	September 25	Closed*
September 26	December 10	Open
December 11	December 31	Closed

Table 4 College Calendar

* Note: Staff shall be in during the holidays from June 13 to September 25

4.2.5 Construction Data

4.2.5.1 The minimum requirements associated with External Fabric are defined within Technical Annex 2C; Section 2.2, Table 1. [PM_10_20_90]

4.2.6 System Options

4.2.6.1 System types shall be entered on a room-by-room basis based on the requirements of the individual space as shown in Table 5. [PM_40_20]

Main System	Ventilation System	Cooling SSEER*	Heating SCoP** - Example Gas Boiler (B) Heat Pump (HP)	Auxiliary Energy - Per Volume Flowrate (W/l/s)	Notes
Heated and naturally ventilated	N/A	N/A	B=0.91 HP=2.5	N/A	Auxiliary energy, calculated for operational hours.
Heated and mechanically ventilated	Centralised balanced mechanical ventilation	N/A	B=0.91 HP=2.5	1.5+HR+Filter	Auxiliary energy, calculated for operational hours.
Heated and mechanically ventilated	Zonal supply system	N/A	B=0.91 HP=2.5	1.1	Auxiliary energy, calculated for operational hours.
Heated and mechanically ventilated	Zonal extract system	N/A	B=0.91 HP=2.5	0.5	Auxiliary energy, calculated for operational hours.
Heated and mechanically ventilated	Local extract	N/A	B=0.91 HP=2.5	0.3	Auxiliary energy, calculated for operational hours.
Fully air conditioned	Centralised balanced	2.6 - HP	B=0.91 HP=2.5	1.6+HR+Filter	Auxiliary energy, calculated for operational hours and

Main System	Ventilation System	Cooling SSEER*	Heating SCoP** - Example Gas Boiler (B) Heat Pump (HP)	Auxiliary Energy - Per Volume Flowrate (W/l/s)	Notes
	mechanical ventilation				using the greater of either floor area or flow rate.
Fully air conditioned	Zonal supply system	2.6 - HP	B=0.91 HP=2.5	1.1	Auxiliary energy, calculated for operational hours and using the greater of either floor area or flow rate.
Fully air conditioned	Zonal extract system	2.6 - HP	B=0.91 HP=2.5	0.5	Auxiliary energy, calculated for operational hours and using the greater of either floor area or flow rate.
Fully air conditioned	Local extract	N/A 2.6 – HP	B=0.91 HP=2.5	0.3	Auxiliary energy, calculated for operational hours and using the greater of either floor area or flow rate.
Changeover mixed mode	Natural ventilation		B=0.91 HP=2.5	N/A	Auxiliary energy, calculated for operational hours.

Main System	Ventilation System	Cooling SSEER*	Heating SCoP** - Example Gas Boiler (B) Heat Pump (HP)	Auxiliary Energy - Per Volume Flowrate (W/l/s)	Notes
Changeover mixed mode	Centralised balanced mechanical ventilation		B=0.91 HP=2.5	1.1	Auxiliary energy, calculated for operational hours.
Changeover mixed mode	Zonal supply system		B=0.91 HP=2.5	1.1	Auxiliary energy, calculated for operational hours.
Changeover mixed mode	Zonal extract system		B=0.91 HP=2.5	0.5	Auxiliary energy, calculated for operational hours.
Changeover mixed mode	Local extract		B=0.91 HP=2.5	0.3	Auxiliary energy, calculated for operational hours.

Table 5 System Option Types

(* and **) annotation to be clarified and updated to align with S21 November 2021 issue.

4.2.7 Room Data

4.2.7.1 The Contractor shall assign all the rooms from the list in Tables 6 and 7 below. [PM_40_30_70]

Parameter	Teaching Spaces – Typical Classroom	Teaching Spaces – Science Laboratories	Teaching Spaces – Food Technology Rooms	Teaching Spaces – Art and Design & Technology Rooms	Teaching Spaces – ICT Rich Teaching	Shared Areas – Atria	Shared Areas – Circulation Spaces	Shared Areas -Dining & Large spaces
Winter design temperature (°C)	20	20	20	20	20	17	17	20
Setback design temperature (°C)	5	5	5	5	5	5	5	5
Summertime design	25	25	25	25	25	25	25	25
Ventilation rate**	8 l/s/person	4 l/s/m²	2.5 l/s/m²	8 l/s/person	8 l/s/person	1.2 l/s/m²	1.2 l/s/m²	2.25 l/s/m²
Mechanical extract	N/A	Yes	Yes	Yes, depending on room use	N/A	N/A	N/A	Yes

Occupancy density	As College-specific SoA and ADS	As College-specific SoA and ADS	As College-specific SoA and ADS	As College-specific SoA and ADS	As College-specific SoA and ADS	N/A	N/A	As College - specific SoA and ADS
Sensible heat gains - Lighting (W/m²)	10	10	10	10	10	10	10	10
Sensible heat gains - People (W/person)	70	70	70	70	70	N/A	N/A	70
Sensible heat gains - ICT equipment (W/m²)	10	10	5	15 or higher depending on room use	19	N/A	N/A	N/A
Other equipment - to be added according to room use	N/A	Fume cupboards	Cookers	Machinery	N/A	N/A	N/A	Servery equipment

Table 6 Room Data 1

Parameter	Sports Swimming Pool - Halls	Sports - Changing Areas	Sports - Sports Hall	Food Preparation - Commercial Kitchen	Auxiliary - Admin Offices	Auxiliary - Store & Plant Rooms	Auxiliary - WC's & Sanitary Accommodation	Auxiliary - ICT Server Rooms
Winter design temperature (°C)	20	20	13	16	19	12	19	19[3]
Setback design temperature (°C)	15	5	5	5	5	5	5	10
Summertime design temperature (°C)[1]	25	25	25	26	25	N/A	15	22[3]
Ventilation rate[2]	4.5 l/s/m²	4.5 l/s/m²	12 l/s/person	30l/s/m²	12 l/s/person	0.3 l/s/m²	6l/s per WC/urinal	8 l/s/person[3]
Mechanical extract	Yes	Yes	N/A	Yes	N/A	N/A	Yes	N/A
Occupancy density	N/A	N/A	10m²/per person	10m²/per person	3 people	N/A	N/A	3 people

Sensible heat gains - Lighting (W/m^2)	10	10	10	10	10	10	10	10
Sensible heat gains - People (W/person)	N/A	N/A	90	70	70	N/A	N/A	N/A
Sensible heat gains - ICT equipment (W/m^2)	N/A	N/A	N/A	N/A	10	N/A	N/A	250
Other equipment - to be added according to room use	N/A	N/A	N/A	N/A	Photocopiers, etc.	N/A	N/A	N/A

Table 7 Room Data 2

1 Summertime design temperatures given shall only be applicable if the room is being cooled. The requirement for cooling shall be established with regards to thermal comfort, in line with Section 10 of Technical Annex 2F.

2 The area-based ventilation rates in l/s/m2 apply to spaces of 2.7m height or higher. The equivalent air change rate per hour (ach) can be calculated from ach = (l/s/m2 rate) x 3.6/ (Room height (m)). For spaces below 2.7m in height, the equivalent air change rate to a 2.7m high space shall be used.

3 See Technical Annex 2F for details of vent rate and temperatures required for server rooms. Out of hours, the temperature setback is 15°C in winter and the maximum summertime temperatures are as described in Technical Annex 2F section on Server Rooms.

4.2.8 Hot Water Requirement

4.2.8.1 The daily hot water consumption shall be a fixed parameter for the total Building capacity as follows:

a) College with shower use: 4 litres per person benchmark comparison. [PM_35_70_38]

4.2.8.2 The Concept Energy Model calculated end use energy consumption for hot water (in kWh) shall be compared to the energy targets detailed in Section 3. [PM_40_30_27]

4.2.8.3 The calculated energy consumption for hot water shall be equal or better than the energy targets. [PM_40_30_27]

4.2.8.4 The comparison shall be included in the Energy Strategy Report, as defined in DfE's EIR. [PM_10_20_28]

4.3. Developed Energy Model

4.3.1 The Developed Energy Model for the Works shall be a realistic representation of the final design of the Project. [PM_30_30_86]

4.3.2 The model shall accurately calculate the predicted regulated and unregulated energy loads of the College. [PM_30_30_86]

4.3.3 The model and analysis of the results shall be included in the updated Energy Strategy Report. [PM_40_20_26]

4.3.4 The model shall reflect the College-specific circumstances rather than the 'fixed' and 'flexible' input data required for the Concept Energy Model. [PM_30_30_86]

4.3.5 The anticipated annual energy end use figures shall be compared to the energy targets as detailed in Section 3. [PM_40_30_27]

4.3.6 The Contractor shall ensure that the model is consistent. [PM_30_30_86]

4.3.7 Energy consumption estimates shall be included for all regulated and unregulated loads in the model. [PM_30_30_86]

4.3.8 The model shall be designed to accurately predict the Building performance. [PM_30_30_86]

4.3.9 The model shall reflect the final design specifications including updated values such as:

a) predicted College use patterns [PM_40_30]

b) the final construction data [PM_40_30]

c) detailed HVAC system performance specifications [PM_40_30]

d) expected DHW and other unregulated energy consumptions [PM_40_30]

e) expected controls strategy [PM_40_30]

5. In Use Monitoring

5.1. Overview

5.1.1 A well designed, properly commissioned and fully functioning metering and monitoring system is fundamental to the monitoring and targeting process essential to energy management. [Ac_05_50_54]

5.1.2 The minimum metering requirement is defined in Technical Annex 2I. Sub-metering shall be enhanced where services solutions are more complex and as detailed in the CSB. [PM_10_20_90]

5.1.3 The Contractor is required to establish feedback mechanisms which are used to inform building managers whether the energy consumption is in line with the expectation set out at design stage. [PM_80_10_60]

5.1.4 The information collated from the energy meters shall allow continuous monitoring, benchmarking, and post occupancy Building Performance Evaluation against operational targets. [PM_80_10_60]

5.1.5 The metering and monitoring strategy shall reflect the size, complexity, and facilities management approach of the College. [Ac_05_50_54]

5.1.6 End use data shall be presented in a simple easy to understand format. [PM_10_20_82]

5.2. Continuous Monitoring

5.2.1 Contractors shall use the iSERV methodology to automatically monitor and report on the energy and water use of the College, or Buildings in the case of a project involving part of the College. The reporting of consumption and performance in use of the Buildings shall be carried out using the K2n system or similar system approved by the Employer. This requirement applies for any Building of over 500m². [Ac_05_50_54]

5.2.2 The Contractor shall complete the K2n, or similar approved services description spreadsheet, ensuring all component, system, sensor, and meter names relate to physical items or spaces where possible. [PM_35_10_60]

5.2.3 The Contractor shall provide the initial 15-month subscription and set up this service for the College or Building(s) and help the College to use the system to benchmark the performance of the College or Buildings during the 12 months post-handover. [PM_80_10_60]

5.2.4 The system shall be used to prove that all connected meters are calibrated correctly. [PM_10_20_82]

5.2.5 The Contractor shall remedy any faults in the metering system during commissioning and the defects period. [PM_10_20_82]

5.2.6 Further information on iSERV and K2n and the continuous monitoring requirements can be found at www.k2nenergy.com [PM_10]

5.3. Actual in Use Performance

5.3.1 The aim of iSERV is to encourage the construction industry to provide energy data by the end user so that:

a) an understanding of the performance gap between predicted and actual energy consumptions can be analysed and addressed [PM_80_10_60]

b) data can be gathered to illustrate the trends in energy efficiency and thereby create new benchmarks that are realistic and help deliver energy efficient buildings including colleges. [PM_80_10_60]

5.3.2 The meter, monitoring and data collection systems shall be proved as part of commissioning in accordance with Technical Annex 2I and the DfE's EIR. [PM_10_20_28]

5.3.3 Correctly commissioned meter, monitoring and data collection systems shall allow the predicted design energy use to be compared with the actual energy consumption of the Building. [PM_80_10_60]

5.3.4 The College shall be provided with the means to practice continual monitoring and benchmarking of energy and water consumption. Guidance shall be provided by the Building User Guide, handover training and monitoring support during the 12 months defects liability period. [PM_80_10_60]

5.3.5 Methods of metering, monitoring and data collection shall be detailed in the Operating and Maintenance manuals. [PM_10_20_82]

5.3.6 Energy and water consumption shall be monitored and consumption data reported. [PM_80_10_60]

5.3.7 All consumption associated with community use shall be reported as a separate data set. [PM_80_10_60]

5.3.8 All consumption associated with EV charging shall be reported as a separate data set. [PM_80_10_60]

5.3.9 At the end of the 12-month defects liability period, the Contractor shall upload the energy end use data to the Carbon Buzz website, http://www.carbonbuzz.org. [FI_30]

5.3.10 The Contractor can choose to anonymise the data on Carbon Buzz. All data and monitoring results shall be provided to the Employer in Excel spreadsheet format. [PM_10]

5.3.11 The Contractor shall use the iSERV methodology for energy reporting and building system optimisation and to compare the actual energy consumption. [PM_80_10_60]

5.3.12 This shall be carried out through the K2n database company or similar approved. [PM_10_20_90]

5.4. Requirement

5.4.1 Contractors shall supply 15-minute interval continuous monitoring and benchmarking data to the K2n national benchmarking database (or similar system approved by the Employer) on at least a monthly basis, and preferably on a daily basis, to enable automated reporting against DfE targets on a monthly basis and quarterly feedback from the Contractor to the College during the 12 months defect period. [Ac_05_50_54]

5.4.2 DfE and K2n have set up and developed the benchmarking database, based on the iSERV methodology, to establish realistic benchmarks and feedback in use for school and college buildings and have developed reporting formats for monthly reports to colleges and Contractors. [PM_10]

5.4.3 The reports shall help colleges manage their energy consumption and identify avoidable waste. [PM_35_10_60]

5.5. Monthly reports of achieved performance

5.5.1 Monthly continuous monitoring and benchmarking reports shall be provided to enable colleges to provide appropriate control over those energy consumers which they influence, helping the overall College energy targets to be achieved. [PM_80_10_60]

5.5.2 The K2n (or similar approved) reports shall be used to provide the feedback interface for the College users by means of the monthly reporting templates. [PM_80_10_60]

5.5.3 Contractors can choose to use other energy management reporting software to produce similar feedback reports for the College, where approved by the Employer. The Contractor shall provide continuous monitoring data to the DfE in an iSERV compatible format as described below. [PM_80_10_60]

5.5.4 After the first full year's report, subsequent monthly reports shall be set to report progress against a designated end of year month. This enables progress against contractual targets to be assessed as part of ongoing data collection and allow early corrective action to be taken if needed. [PM_80_10_60]

5.6. Data required

5.6.1 To participate in the wider community of Building Owners/Operators/Energy Managers providing data to K2n and the DfE, which enables up-to-date national benchmarks to be produced and maintained for DfE funded colleges and their systems, the DfE requires the Contractor to comply with the K2n data reporting standards. [PM_10_20_82]

5.6.2 To enable this to happen, the data from colleges shall be submitted in the K2n format or an alternative compatible format approved by the Employer. [FI_30]

5.6.3 This requires the Contractor to fully describe each College with the data requested in the fields marked in red in the K2n asset spreadsheet. [FI_30]

5.6.4 The Contractor shall request the latest DfE spreadsheet from K2n. The latest version can be obtained on request from info@k2nenergy. A completed spreadsheet for an example College shall also be provided. [PM_10]

5.6.5 The operational data required for the meters and sensors described in the asset spreadsheet shall be exported via a BEMS system, or directly from meters and sensors with the appropriate data collection and transmission facilities using the internet connection provided. See paragraph 4.6 in the GDB. [PM_10_20_90]

5.6.6 Manual transmission of the data to a dedicated email address can also be used to transmit the data to K2n. This shall be sent by midnight on the 1st of each month, including all data for the previous month, to enable inclusion in the automated reports which shall be sent to the Contractor and the Employer (and College if required). [FI_30]

5.6.7 The minimum environmental data required for occupied spaces is internal space temperature, carbon dioxide and outside temperature for each occupied space. This enables energy and building systems performance to be evaluated in order that further insights into the effectiveness of the Building Services HVAC systems can be provided to the College and Contractor and to inform systems commissioning and balancing. [FI_30]

5.6.8 Contractors can use this data to aid seasonal commissioning adjustments during the 12-month defects liability period. [FL_30]

5.6.9 Correlating the internal conditions with energy consumption enables the identification of avoidable energy use, building performance issues and sensors or meters that are likely

to be out of calibration. This is a powerful means of remote system diagnosis. [PM_80_10_60]

5.6.10 During the 7-day continuous ‘soak test’ period the BMS and all automatic controls and metering systems shall be fully operational, with data uploaded using the iSERV methodology to K2n. [PM_70_15_82]

6. Refurbished Buildings

6.1. Overview

6.1.1 The Contractor shall work with the College to limit energy end uses to the energy targets. [PM_40_30_27]

6.1.2 A strategy for reducing energy demands shall be established through energy audits and modelling, suggested minimum reduction targets have been given in Section 3. [PM_40_20_26]

6.1.3 Where refurbishment works are being undertaken to Existing Buildings, the energy demand reduction requirements noted in Section 3 shall be achieved and the overall DEC rating for the site shall be improved by two categories above the existing level where heavy refurbishment and one category above the existing level where medium refurbishment. An EPC shall be used if the existing building does not have a DEC. [PM_40_30_27]

6.1.4 In Refurbished Buildings, an Energy Audit takes the place of the Concept Energy Model and this is then used to produce an Energy Model. [PM_40_30_27]

6.2. Energy Audits Refurbished Buildings

6.2.1 The Contractor shall carry out an Energy Audit to assess the existing Building(s) included in the Works, including any external lighting, and detail the best methods to improve energy efficiency. [Ac_15_55_26]

6.2.2 The Energy Audit shall identify principal energy uses and compare the performance against the energy targets in Section 3. [Ac_15_55_26]

6.2.3 The Energy Audit assessment shall be based on actual college use patterns. It shall separate loads by supply so that the different costs and environmental impacts of the fuels can be established. [Ac_15_55_26]

6.2.4 Energy use data shall be obtained from:

a) information supplied to the Contractor by the Employer [FI_30]

b) occupant feedback on the performance of Building Services and existing energy monitoring [FI_30]

c) metered energy data. [FI_30]

6.2.5 An accurate Energy Model shall be built, with the data collected, as described in Section 6.3 to estimate the energy saving potential of the refurbishment. [PM_30_30_86]

6.3. Developed Energy Modelling for Refurbished Buildings

6.3.1 The model shall use actual data obtained through the Energy Audit and be a realistic representation of the existing College. [PM_30_30_86]

6.3.2 The model shall use actual existing data for values such as:

a) actual college use patterns [FI_30]

b) final construction data [FI_30]

c) actual HVAC system performance specifications [FI_30]

d) actual occupancy densities [FI_30]

e) actual DHW and other unregulated energy consumptions [FI_30]

f) installed controls strategy [FI_30]

6.3.3 The Contractor shall produce the Energy Model and check the results are in line with the metered energy use. [PM_30_30_86]

6.3.4 To understand the most effective methods for refurbishment, iterative improvements shall be modelled and the energy saving potential shall be assessed. [PM_30_30_86]

6.3.5 The improved predicted annual energy end use figures shall be compared to the existing energy use and the energy targets as detailed in Section 3. [PM_40_30_27]

7. Demonstrating Compliance

7.1. Overview

7.1.1 The Contractor shall demonstrate compliance with the Employer's Requirements by use of protocols detailed in the Contractor's Quality Assurance procedures capturing evidence of both coordinated design and its implementation into the construction of the College Building(s) with photographic evidence and/or third-party accreditation. [PM_70_15]

8. Reference Standards

8.1.1 In addition to DfE publications and the requirements set out within this Technical Annex and the GDB, the Contractor shall ensure that the design and installation is compliant with regulations and takes account of the following documents (or updated documents where relevant): [PM_10_20_90]

a) Approved Document L2A. [FI_70]

b) Approved Document L2B. [FI_70]

c) Non-Domestic Building Services Compliance Guide. [FI_70]

d) CIBSE TM57 ‘Integrated School Design’. [FI_70_85]

e) CIBSE Guides A, B, C, F, H, M. [FI_70]

f) BS EN ISO 13370 ‘Thermal performance of buildings’. [FI_70_85]

g) CIBSE TM54 ‘Evaluating operational energy performance of buildings at the design stage’. [FI_70_85]

h) CIBSE TM37 ‘Design for improved solar shading control’. [FI_70_85]

i) CIBSE TM52 ‘The limits of thermal comfort: avoiding overheating in European buildings’. [FI_70_85]

j) CIBSE AM10 ‘Natural Ventilation in Non-Domestic Buildings’. [FI_70_85]

k) CIBSE AM12 ‘Combined Heat and Power for Buildings’. [FI_70_85]

l) CIBSE AM13 ‘Mixed Mode Ventilation’. [FI_70_85]

m) CIBSE AM14 ‘Non-Domestic Hot Water Heating Systems’. [FI_70_85]

n) CIBSE TM39 ‘Building energy metering’. [FI_70_85]

o) ASHRAE ‘Handbook Fundamentals’. [FI_70_85]

p) ASHRAE 90.1 ‘Energy Standard for Buildings Except Low-Rise Residential Buildings’. [FI_70_85]

q) CIBSE TM46 ‘Energy Benchmarks’. [FI_70_85]

r) CIBSE TM38 ‘Renewable Energy Sources for Buildings’. [FI_70_85]

s) MHCLG ‘National calculation methodology modelling guide (for buildings other than dwellings in England and Wales)'. [FI_70]

t) SBEM Technical Manual. [FI_70_85]

u) CIBSE AM11 ‘Building Performance modelling’. [FI_70_85]

v) CIBSE Commissioning Codes. [FI_70_85]

w) BSRIA BG 8/2009 ‘Model Commissioning Plan’. [FI_70_85]

x) Carbon Trust ‘Monitoring and Targeting CTG077’. [FI_70]

y) BSRIA BG 54 ‘The soft landings framework’. [FI_70]

z) BSRIA BG 9 ‘Soft landings for Schools: Case Studies’. [FI_70]

aa) BSRIA BG 26/2011 ‘Building manuals and building user guides’. [FI_70]

bb) CIBSE TM31 ‘Building Logbook Toolkit’. [FI_70_85]

cc) CIBSE TM22 ‘Energy Assessment & Reporting Methodology'. [FI_70_85]

dd) Carbon Trust Schools CTV019 ‘Schools, learning to improve energy efficiency’. [FI_70]

ee) Government Soft Landings. [FI_70]

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