Scotland NCM Software Validation
DSM and FI-SBEM
Validation Guidance Document

April 2023

Version log

Version	Date	Notes
1	April 2023	Version 1 of the new Scottish Government NCM software validation process

Content

1. Introduction

New (Section 6) Energy Standards within the Scottish Building Regulations, which are applicable to non-domestic buildings, came into force on 1 February 2023.

This document is written for software vendors. It describes the methodology and procedures required for the validation of third party commercial Dynamic Simulation Modelling (DSM) and Front Interface Simplified Building Energy Modelling (FI-SBEM) software packages for the specific purposes of Building Regulation (Section 6) compliance assessment, Energy Performance Certificate (EPC) calculation and Section 63 Action Plan generation in Scotland. The process is similar to the approach already adopted in England and Wales with the validation tests tailored to the Scottish requirements.

DSM software validation is required following amendments to the core methodology (Scottish National Calculation Methodology (NCM)). A DSM validation may also be required where a vendor makes changes to the relevant calculation engines in their software.

FI-SBEM validation is required following amendments to the core methodology (Scottish NCM).

It is expected that the software vendor will produce similar software for England. Hence, to streamline the process, for each software version update, software vendors must obtain prior validation and approval in England as a pre-requisite to submitting for validation in Scotland. This reduces the extent of validation necessary for Scotland.

In the event that prior validation is not to be sought for England, vendors are requested to make early contact with the Scottish Government Building Standard Division to discuss the additional validation process that would be needed in such a situation.

The Scottish Government is the sole point of contact for all software validation enquiries relating to the Scottish NCM software validation. Queries should be directed to buildingstandards@gov.scot. Queries received which relate to validation of software for the purposes of EPC or Action Plan production will be shared with the relevant Scottish Government policy lead.

The Scottish Government may redirect enquiries to the validation scheme operator.

2. Software Submission Requirements

The software validation process involves three key parties: (1) The software vendor, (2) the Scottish Government, and the (3) validation scheme operator. The interactions of these parties and the processes leading to software approval are summarised in Figure 1.

Figure 1: Process map of the validation process
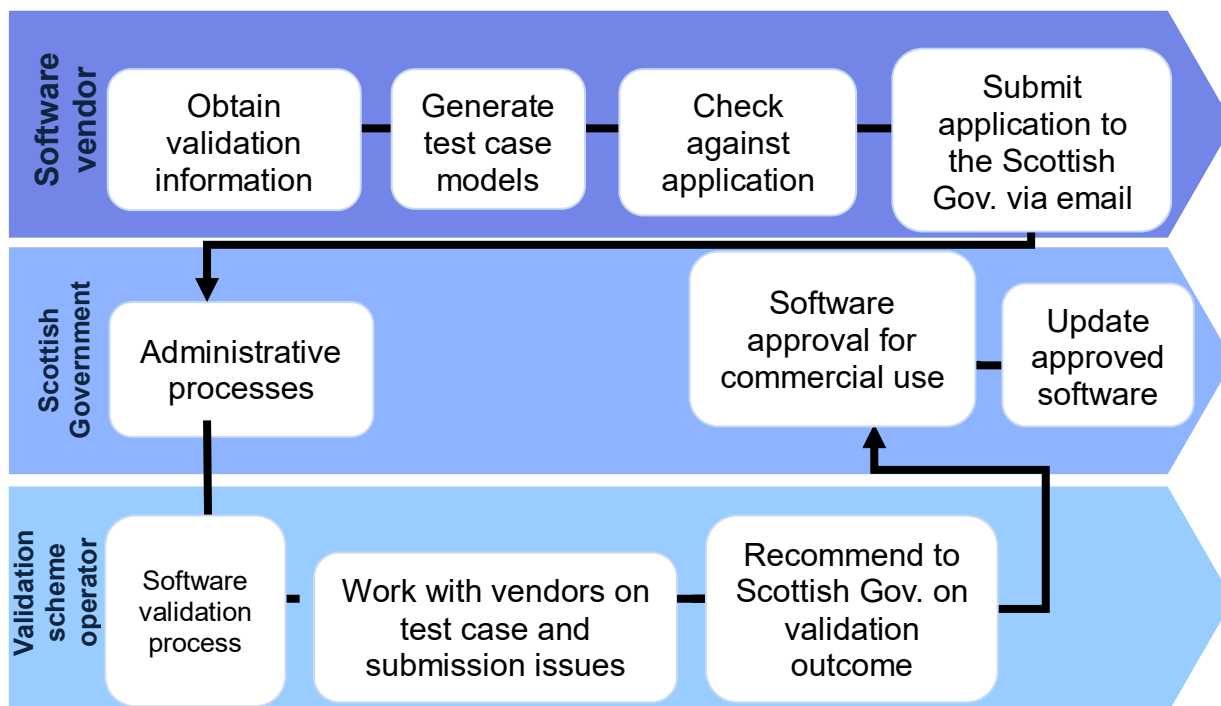
Overview

The core part of the validation process requires the software packages to be tested for accuracy in implementing the National Calculation Methodology (NCM). A set of test cases for the two software types have been developed. It requires the software vendor to use their software to generate specified building models, populate with prescribed data, and calculate results.

Details of the DSM and FI-SBEM test cases are provided as follows in the validation information pack:

- The validation guidance documents specify the building models and data to implement in their software.
- iSBEM model files (*.nct) for the test cases. The software vendors need to run these files on the latest government iSBEM software to generate the Reference Outputs.

The vendor's own software test case outputs are compared to the corresponding sets of Reference Outputs, which should match within the stipulated tolerance levels (see Section 2.2 below).

It should be noted that whilst the validation process interrogates the entire DSM software, for FI-SBEM software class, the validation process only checks the software front-end interface to the SBEM engine, which third party vendors would have

developed to interface with and run the SBEM engine. The SBEM engine is locked and is maintained by BRE.

Software vendor: Software vendors obtain the validation information pack from the Scottish Government. Software vendors are required to check their own software outputs agree with the Reference Outputs. Software vendors also need to meet other pre-requisites to ensure that their software is in a good commercial state and fit-for-purpose. Prior approval in England will also be required. When these validation pre-requisites are met, the software vendor can submit a validation application to the Scottish Government. The Scottish Government is the initial point-of-contact for any validation application via the email address provided above.

Validation scheme operator: The Scottish Governments requests the scheme operator to validate the software. Further checks and assessments to those previously carried out by software vendors are carried out by the validation scheme operator during the validation process. As necessary, the scheme operator will engage with the software vendors on any issues identified. If a software passes the validation process, the scheme operator will recommend that the software is approved by the Scottish Government. If the software does not pass the validation process, the software vendor needs to retest and resubmit when ready.

Scottish Government: Upon receiving validation application from the software vendors, the Scottish Government will instruct the validation scheme operator to carry out the validation process. The Scottish Government will provide final approval of the validated software based on the recommendation provided by the validation scheme operator and issue the Approval Letter to the software vendors. The Scottish Government will update the software details on the approved software list.

2.1 Validation Information Pack

A validation information pack will be made available to software vendors, which comprises this guidance document, the associated test case Reference (*.nct) files, the validation submission pro-forma and any other relevant information. Software vendors will need to contact the Scottish Government for the latest validation information pack. Any updates to the validation information pack will be disseminated by the Scottish Government in the first instance, which can be subsequently requested if required.

2.2 Assessment Procedure

Test cases

Test cases 1 to 14 have been developed for Scotland and are described in detail in Appendix A. Test cases 1 to 8, which are based on the England test cases, and Test cases 9 to 11 will test various aspects of the implementation of the Scottish NCM for Section 6 compliance and EPC calculations as described in the 2022 NCM Modelling Guide for Non-domestic Buildings in Scotland[1]. Test cases 12 to 14 have been designed to test the implementation of the Section 63 Action Plan.

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[1] 2022 NCM Modelling Guide for Non-domestic Buildings in Scotland
URL: https://www.gov.scot/publications/non-domestic-buildings-national-calculation-methodology-modelling-guide-2022/

Software vendors should be familiar with the differences in application of the NCM for the purposes of demonstrating building regulations compliance (section 6) and for EPC/Action Plan production in Scotland

Software vendors will find it useful to interrogate the test cases *.nct files in detail, especially when developing and setting up the test cases using the vendor software, as well as checking various intermediate outputs and the final Section 6 calculations and EPC ratings. Software vendors will need to ensure the latest version of iSBEM is used to generate the relevant Reference Outputs.

If there is a discrepancy between the details in the test case *.nct files and the corresponding test case description detailed in Appendix A, software vendors should use the information provided in Appendix A. Please feedback any discrepancy identified to the validation scheme operator either directly or via the Scottish Government support email provided in Section 1 above.

Reference Output

The Reference Output iSBEM test case models (*.nct files) are included in the validation information package for SBEM v6.1.e. Updates to the Reference Outputs have to be generated when new versions of the government software are released. This could be carried out either by the validation scheme operator or the software vendors. Currently, the approach is for the vendors to produce the Reference Outputs.

Acceptability threshold

The DSM vendor software will be required to produce EPC ratings for the test cases that match the corresponding Reference Output EPC rating band (A – G) for the Acceptability Threshold criterion to be met.

It is recognised that the Actual building's Building Emission Rate (BER) can differ between DSM and SBEM due to differences in the calculation engines. Therefore, whilst there may be difference in BERs, the vendor DSM software will need to be in the same EPC A-G rating band as that of the Reference Output for the corresponding test cases.

It is envisaged that further review of the vendor software through live assessment will be carried out in the event that the vendor software has not fully met this criterion and the outcome of passing this criterion will be evaluated on a case-by-case basis. For example, differences may cut across the EPC rating bands. The secondary checks, as described in the next sub-section, will supplement the validation process to capture discrepancies in the accuracy of the implementation of the Scottish NCM by the vendor software.

The FI-SBEM software will be required to both match the Reference output BER, EPC rating (numerical) as well as the EPC A-G rating band for the corresponding test cases to satisfy the Acceptability Threshold criterion.

Secondary Checks

The validation scheme operator will also apply a series of secondary checks on the Section 6 and EPC calculations. This will assess differences between vendor software test cases outputs and the Reference Outputs for output parameters for the Actual and Notional buildings in the *brukl.inp and as well as the details in the *epc.inp and *s63.inp files of the test cases. The intention is to identify parameters that have

demonstrated a 'significant' difference relative to the Reference Outputs to warrant further checks and discussion with the software vendors. There is no specific tolerance set that vendor software will need to meet for this assessment and issues arising will be evaluated on case-by-case basis.

Live Assessment

As there are a wide variety of calculation methodologies employed by DSM software, the energy demands calculated for Section 6 assessments can differ significantly between different software as well as the SBEM calculation methodology.

Therefore, when validating DSM software, differences in the test case outputs between the vendor software and the Reference Output, which is based on the SBEM calculation methodology, may require closer investigation through a live assessment session. This will enable the details of the different building physics calculation approach to be compared to understand the impact on output. It will also enable vendors to demonstrate how their software appropriately implements the Scottish NCM.

Live assessment applies to DSM validations, which will be requested as part of the validation process where required and conducted via a MS Teams meeting. Subsequent follow-up sessions may be required where necessary to support the validation process.

One of the main focuses of the live assessment is to ensure that the software correctly implements the Actual Building and the Notional Building sections of the Scottish NCM. Ahead of the live assessment, the validation scheme operator may provide the software vendor with a checklist of requirements to be tested to better facilitate the process.

During the live assessment, software vendors may be asked to create a simple model from scratch. This will demonstrate the software usability and help provide an indication on the quality and extent of software functionality detail provided in the user guide(s).

Typically, a simple model will be used during a live assessment session to examine various features of the Scottish NCM. For example, in Scotland, Section 6 compliance requires that the proposed building meets both the Target Emission Rate (TER) and the Target Delivered Energy Rate (TDER). The vendor will need to demonstrate how the TDER and the associated Building Delivered Energy Rate (BDER) are calculated and displayed to the user.

Software vendors will need to demonstrate the Section 63 Action Plan feature in their software and showcase how some of the triggers for Prescriptive Measures are implemented.

The live assessment may highlight discrepancies in the implementation of the Scottish NCM by the vendor software. If appropriate, these issues may be addressed by the software vendor as part of the validation process. If the issues encountered are substantive, a resubmission may be required.

2.3 Additional Requirements

The validation and approval in England require DSM and FI-SBEM software vendors to submit the relevant user guides (with the exception of bug-fix validations). These have been reviewed at a high-level to ensure they are sufficiently detailed in terms of software use and functionality.

An additional review is needed to check whether the relevant user guides are suitable for implementation in Scotland. Software vendors should provide the user guide and accompany this with details of where the user guide describes the difference between the building regulations (section 6) compliance and EPC calculations in England and Scotland. Details on the Section 63 Action Plan should also be highlighted. These details could be provided through appropriate annotations within the copy of the user guide and/or a separate note. This should be included in the submission for Full Validation and Major and Minor Revalidation.

2.4 Parameters Not Covered

Whilst every effort is made to cover all of the elements of the Scottish NCM during software validation, there will inevitably be certain elements that cannot be accommodated in this process. Where there are components in the candidate software that are not governed by the Scottish NCM methodology, they will not be included in the validation process.

As elsewhere in the UK, there are a number of cases where the Scottish NCM modelling guide does not define certain calculations employed in DSM software. These include modelling of daylight availability for use in predicting lighting energy and renewable/low carbon technologies (e.g. SBEM and DSMs have slightly different ways to predict wind energy). In addition, variations inevitably exist within the core calculation engines used in each DSM software. For example, modelling solar gain through glazing systems and the storage effects of thermal mass will differ between each DSM software. Hence, none of the above will be evaluated directly during the validation process.

Furthermore, default values not included in the Scottish NCM Modelling Guide will not be included in the validation process. This includes the following parameters:

- The inference of HVAC system default efficiency
- The use of the SBEM construction library
- The use of the SBEM construction inference procedure library
- The use of lighting type load inference
- Glazing properties: surface to area ratio
- Glazing properties: window aspect ratio
- The use of 'Transpired Solar Collector'
- The use of 'additional thermal bridges' input
- No checks on the use of local and global psi values for thermal bridging

The above list of exclusions is the same as in the English and Welsh validation process.

3. Application Submission

All validation submissions must include a completed validation submission pro-forma with the following information:

- Type of software class and validation type (DSM; FI-SBEM)
- Company name, phone number, email address
- Software package name and version number being submitted, up to 3 decimal places (e.g. v1.1.2.3)
- SBEM version compatibility

Software vendors must also submit the relevant user guide(s) - annotated copy of the guide(s), with a cover note if applicable, for review, highlighting where the details for Scotland differ from that of England.

3.1 Software Submission

The software vendor will need to package up their submission based on instruction provided in the validation submission pro-forma. Vendors will be required to submit their validation application by emailing the Scottish Government and attach their validation pack. The email address is provided in Section 1. Following this, the application will be processed by the validation scheme operator.

3.2 Validation Management

All validation applications will be dealt with promptly and as efficiently as possible. The following timescales can be expected:

- DSM re-validation: Up to 8 working days are required from the date of submission.
- FI-SBEM re-validation: Up to 6 working days are required from the date of submission.

Vendors may need to clarify or respond to issues identified through the validation process. If so, there may be an associated delay to the validation time. If changes identified will take a significant amount of time to address, it will likely lead to the software vendor needing to resubmit their software for validation.

4. Following Software Recommendation

At the end of the validation process, the scheme operator will issue a Validation Report to the Scottish Government. It will provide results from the validation process and a recommendation to either defer or approve the software. The Validation Report will be provided by the Scottish Government to the software vendor alongside the software approval decision.

If the software approval is deferred, the software vendor will be provided with the reasons for this decision which will be included in the Validation Report. The Scottish Government cannot guarantee that it will be possible to resubmit software that does not initially meet the required standards.

For software which successfully satisfy the validation requirements, the software vendor will be contacted to proceed with the necessary software version control management procedures. The related details will be included in the Validation Report for record. The Scottish Government will issue an Approval Letter to the software vendor to notify that their software has been approved.

Appendix A: Test Cases

This Appendix provides the details of the Scotland software validation test cases. To stream-line the validation process for Scotland, the set of test cases used for England (under their 2021 NCM) will be adopted and tailored for use in Scotland. Software vendors will need to run test cases using their software under the Scotland Section 6 and EPC calculations. The details of the test cases are as described below.

There are two parts to the validation test cases:

- Part 1: Test cases 1 – 11 are for testing the software implementation of the Scotland Section 6 and EPC calculations.

- Part 2: Test cases 12 – 14 are for testing the software implementation of the Scotland Section 63 Action Plan

Part 1

Test cases 1 – 11 are based on the use of 5 buildings, 6 HVAC systems, 3 hot water systems and 2 LZC technologies. All of the buildings are setup to generally emulate the England Notional Building. Several specification details to highlight are:

The location should be set to Glasgow.

The building fabric properties (U-values, thermal mass, glazing g-value/light transmittance/frame factors, etc) should remain to match those described in the England NCM modelling guide (2021) for the Notional Building.

A.1 Test Cases for Software Validation

The vendor software will need to generate results for all the 11 test cases listed below.

Table A.1: Test cases with details on type of building, HVAC and HWS systems and LZC type

Test case	Building type	HVAC system type[#]	HWS type[#]	LZC type	England test case no.
1	Office[##]	HVAC 1a	HWS 1		1
2	Office[##]	HVAC 2	HWS 2		2
3	Warehouse	HVAC 6	HWS 2		6
4	Hotel[###]	HVAC 2	HWS 3		9
5	Retail	HVAC 2	HWS 2		10
6	School	HVAC 1b	HWS 1		13
7	Office[##]	Ground floor HVAC 1a First floor: HAVC 2	HWS 2		18
8	Office[##]	HVAC 8	HWS 1		19
9	School	HVAC 9	HWS 2		New

| 10 | Warehouse | HVAC 6 | HWS 2 | LZC 1 | New |
| 11 | Warehouse | HVAC 6 | HWS 2 | LZC 2 | New |

\#   The stated HVAC system and HWS apply to all spaces

\#\#   The toilet activity in the Office building will have additional local mechanical extract of 10 ac/hr

\#\#\# The store room activity in the Hotel building will have no HVAC (i.e. only lighting)

A.2 Building Geometry

The following table and figures describe the test cases building geometries.

Table A.2: Summary of test case building types

Geometry	NCM Activity Building Type	Dimensions
Office	B1 Offices and workshop businesses	Figure A.1
Warehouse	B8 Storage or distribution	Figure A.2
Hotel	C1 Hotel	Figure A.3
Retail unit	A1/A2 Retail and financial/professional services	Figure A.4
School	D1 Non-residential institutions - Education	Figure A.5
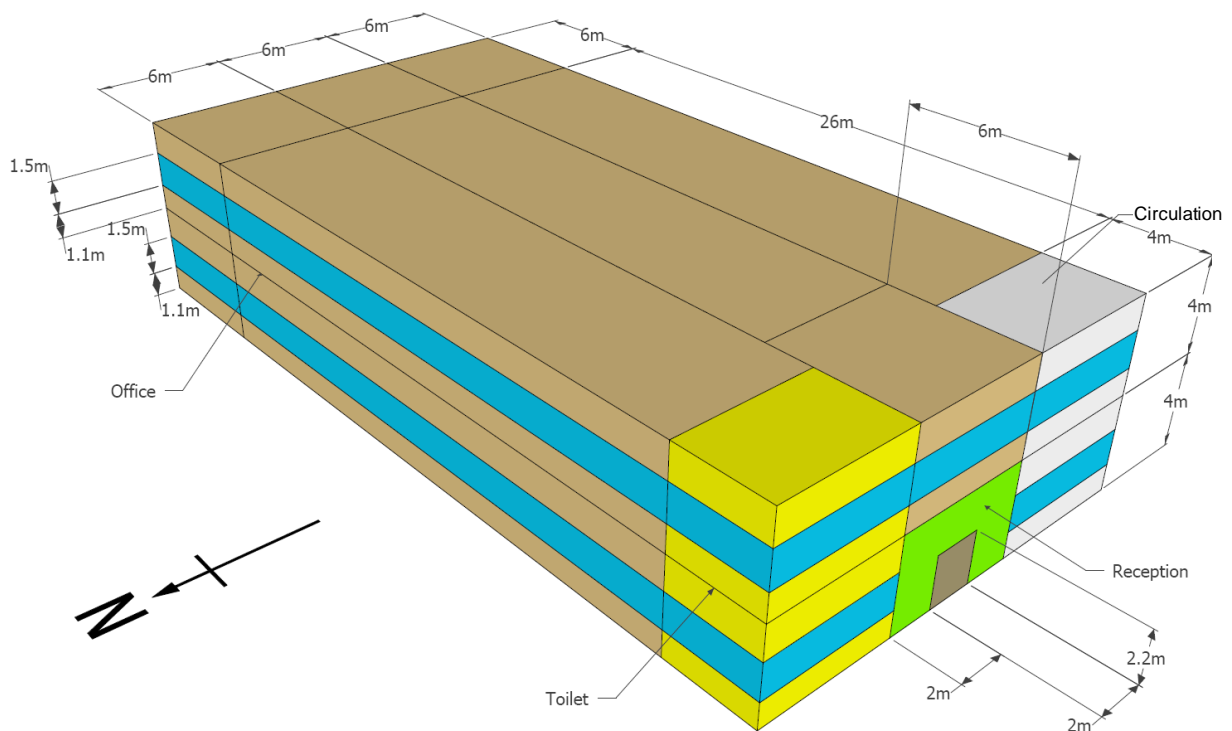
Figure A.1: Geometry for test case office building model

Figure A.2: Geometry for test case warehouse building model

Figure A.3: Geometry for test case hotel building model
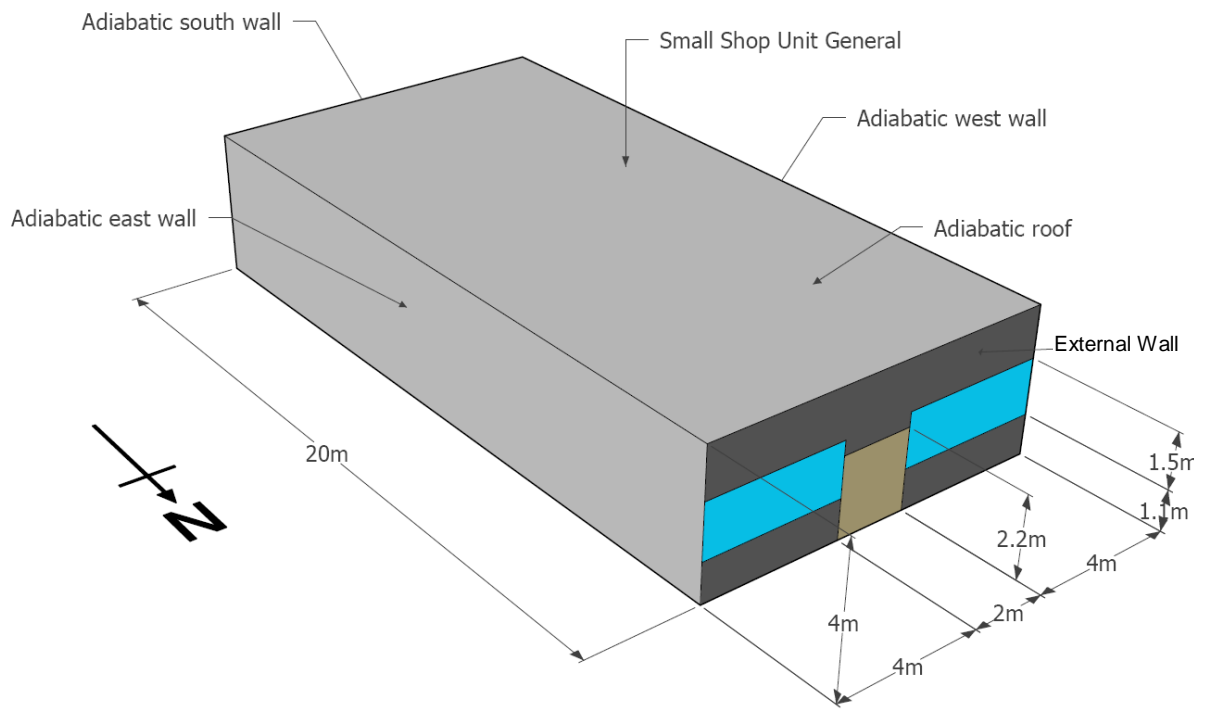
Figure A.4: Geometry for test case retail unit building model
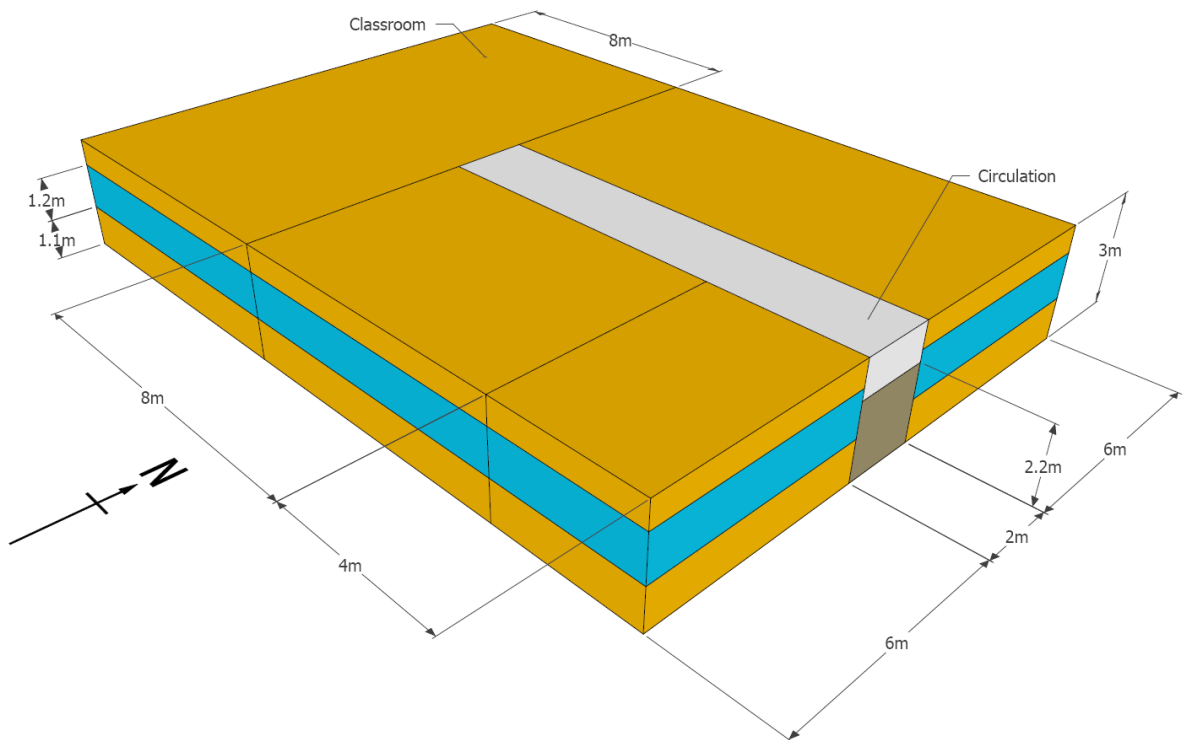
Figure A.5: Geometry for test case school building model

A.3 HVAC System Types

Table A.3: Summary for HVAC system types

HVAC type	General description
HVAC 1a	**Natural ventilation with LTHW radiator heating** • Heat source - natural gas boiler with 88% seasonal efficiency
HVAC 1b	**Natural ventilation with LTHW radiator heating** • Heat source - air to water heat pump with scop of 2.64
HVAC 2	**Fan coil system** • Heat source - air to water heat pump with scop of 2.64 • Cooling source – air cooled chiller with SEER of 4.50 • AHU specific fan power of 1.8 W per l/s • FCU specific fan power of 0.3 W per l/s • Heat recovery with 70% sensible efficiency
HVAC 6	**Natural ventilation with multi-burner radiant heating** • Heat source – natural gas radiant heating with 86% seasonal efficiency (0.65 radiant fraction)

HVAC 8	**Fan coil system with district heating**
	• Heat source – District Heating with
	   ○ CO_2 factor 0.21kgCO$_2$/kWh
	   ○ PE factor 1.13kWh$_{pe}$/kWh
	• Heating generator seasonal efficiency 1.0
	• Heating system seasonal efficiency 0.929
	• Cooling source – air cooled chiller with SEER of 4.50
	• AHU specific fan power of 1.8 W per l/s
	• FCU specific fan power of 0.3 W per l/s
	• Heat recovery with 70% sensible efficiency

HVAC 9	**Mechanical ventilation with heat recovery with electric heating only** • Heat source – direct electric • AHU specific fan power of 1.8 W per l/s • Heat recovery with 70% sensible efficiency

A.4 Hot Water System Types

Table A.4: Summary of hot water system types

HWS type	General description
HWS 1	**Fed from space heating system** • Storage with heat loss of 109.5 MJ/month or 1 kWh/day • Secondary circulation, loop length of 100m at 8 W/m heat loss, 30W pump power and time switch control.
HWS 2	**Electric resistance point-of-use** • 100% efficient, no storage

	Dedicated DHW heat pump
HWS 3	• Seasonal efficiency 3.20 • 1000 litre storage tank with 80mm thick factory fitted insulated • Secondary circulation, loop length of 160m at 10 W/m heat loss, 100W pump power.

A.5 Low or Zero Carbon Systems

Table A.5: Summary of LZC system types

Low or zero carbon systems	General description
LZC 1	**Photo-voltaic** • 1000m² of mono-crystalline silicon facing south inclined at 30º from horizontal
LZC 2	**Wind generators** • Suburban or industrial area • Swept area – horizontal axis, diameter 40m • 40m height, 400kW

Part 2

Part 2 uses Test case 6 (school model) from Part 1 as the base model, with further modifications for the three Section 63 Action Plan test cases.

- Test case 12 – to test trigger of roof insulation and lighting control prescriptive measures whilst others are suppressed due to conditions not being met
- Test case 13 - to test trigger of roof insulation, draught proofing and lighting control prescriptive measures whilst others are suppressed due to conditions not met
- Test case 14
    o to test trigger of draught proofing, heating control, boiler replacement and lamp replacement prescriptive measures
    o to test set up of alternative measures and impact of not overriding corresponding prescriptive measures

Table A.6: Specification for Test case 12

Item	General description
Fabric (trigger)	• Roof U-value at 1.5 W/m²/K • Pitch 20° Classrooms only • Loft access
Heating control (no trigger)	• None

HVAC 1b (no trigger)	• Direct electric heating • SCOP is 100%
Lighting (no trigger)	• Lamps luminous efficacy 25lm/cW
Lighting control (trigger)	• None
HWS 1 (no trigger)	• Fed from space heating system • Storage volume 200m^3 • 50mm insulation jacket

Table A.7: Specification for Test case 13

Item	General description
Fabric (trigger x 2)	• Air infiltration rate at 15m^3/h/m^2 • Roof U-value at 1.5 W/m^2/K • Pitch 20° • No loft access
Heating control (no trigger)	• None
HVAC 1b (no trigger)	• Boiler is < 15 years old • Boiler SCOP is 60%
Lighting (no trigger)	• T12 Fluorescent – halophosphate – low frequency ballast
Lighting control (trigger)	• Local manual switching all areas
HWS 1 (no trigger)	• Fed from space heating system • Storage volume 200m^3 • No insulation jacket present

Table A.8: Specification for Test case 14

Item	General description
Fabric (trigger)	• Air infiltration rate at 25m^3/h/m^2 • Roof U-value at 1.5 W/m^2/K • Pitch 0° • Loft access
Heating control (trigger)	• None
HVAC 1b (trigger)	• Boiler is > 15 years old • Boiler SCOP is 65%
Lighting (trigger)	• Tungsten/Halogen and Fluorescent - compact
Lighting control (no trigger)	• Local manual and photoelectric switching all areas

HWS 1 (no trigger)	• Fed from space heating system • Storage volume 1000m² • No insulation jacket present

Table A.9: Specification for Alternative Measures in Test case 14

Item	General description
Heating control	• <u>Do not</u> override Prescriptive Measure • Install Central Time Control, Optimum start/stop & Weather Compensation
HVAC 1b	• <u>Do not</u> override Prescriptive Measure – Boiler replacement • Replace boiler with direct electric heating • SCOP is 100%
Lighting	• <u>Do not</u> override Prescriptive Measure – lamp replacement • Install LED lighting – use option "Lighting chosen but calculation not carried out" • Lamps luminous efficacy 125lm/cW • Light output ratio 1
HWS 1	• <u>Do not</u> override Prescriptive Measure – insulation jacket • Install stand-alone water heat with no storage system
LZC	• PV • 20m², monocrystalline • South, 30° inclination, no overshading, strongly ventilated

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