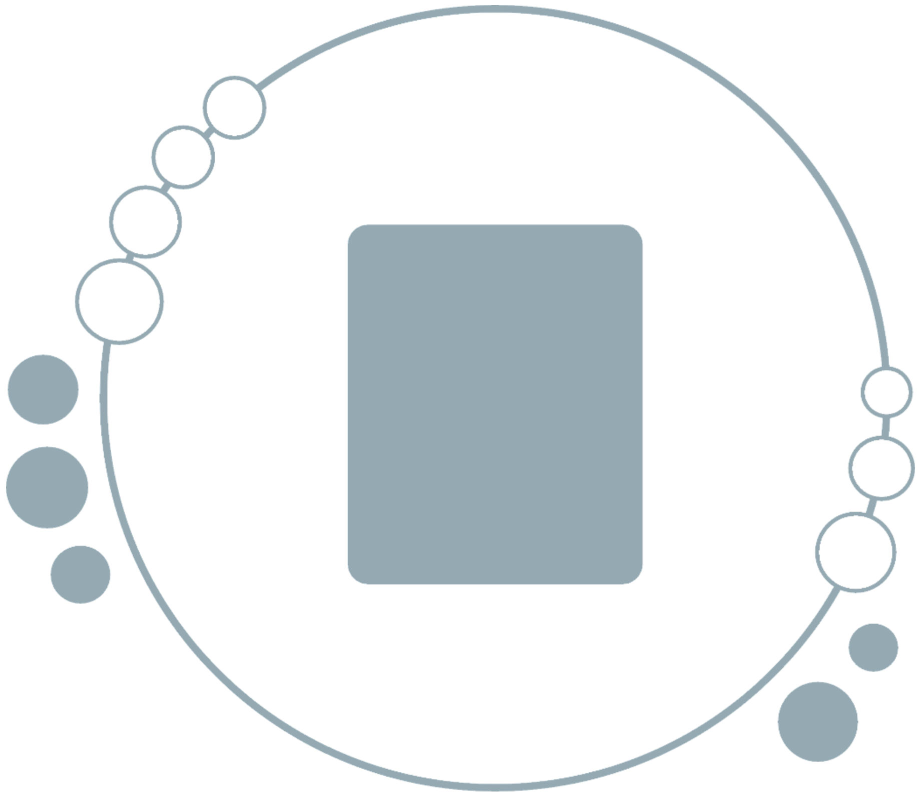

Calculating thermal mass within the Home Energy Model

A technical explanation of the methodology

October 2025

Acknowledgements

This methodology has been developed for the Department for Energy Security & Net Zero by a number of organisations and individuals, including Sustenic, Quidos, Scene Connect, City Science, Hoare Lea, Oxford Brookes University, University of Bath, 10-x, Building Research Establishment (BRE), AECOM, Kiwa Ltd., Loughborough University Enterprises Limited, Chris Martin and John Tebbit.

Quality assurance has been undertaken by a consortium led by Etude, including Levitt Bernstein, People Powered Retrofit, University of Strathclyde's Energy Systems Research Unit, Julie Godefroy Sustainability, and UCL.

.

Document reference: HEM-TP-07

Document version: v2.0

Issue date: October 2025

Home Energy Model version: HEM 1.0

Any enquiries regarding this publication should be sent to us at: homeenergymodel@energysecurity.gov.uk

Contents

Background to the Home Energy Model

What is the Home Energy Model?

The Home Energy Model (HEM) is a calculation methodology designed to assess the energy performance of homes, which will replace the government’s Standard Assessment Procedure (SAP).

Where can I find more information?

This document is part of a wider package of material relating to the Home Energy Model.

Home Energy Model technical documentation (e.g. this document)

What: This document is one of a suite of technical documents, which explain the calculation methodology in detail. New documents will be added, and the content amended, when necessary to ensure documentation is sufficiently comprehensive. This will usually, but not always, occur alongside the release of a new version of HEM.

Audience: The technical documentation will be of interest to those who want to understand the detail of how the Home Energy Model works and how different technologies are treated.

The Home Energy Model consultation and government response

What: The Home Energy Model consultation introduces the overhaul to the SAP methodology and sought views on the approach taken by the new Home Energy Model. The Home Energy Model consultation summarises the feedback to the consultation and the actions taken subsequently in development, ahead of the initial release of HEM.

Audience: The Home Energy Model consultation will be of interest to those seeking a general introduction to HEM and its role in government policy on domestic energy performance.

The Home Energy Model reference code

What: The full Python source code for the Home Energy Model core engine has been published as a Git repository. Note the reference code for official HEM wrappers is published separately.

Audience: The reference code will be of interest to those who want to understand how the model has been implemented in code, and those wishing to fully clarify their understanding of the new methodology. It will also be of interest to any potential contributors to the Home Energy Model or those wishing to use it within their own projects.

Related content

This paper sets out the methodology for calculating thermal mass within the Home Energy Model core engine.

To understand how this methodology has been implemented in computer code, please see:

src/hem_core/space_heat_demand/building_element.py

Methodology

1. Thermal mass of building elements in main calculation

The thermal mass of building components is dealt with in the core heat balance equations, as described in BS EN ISO 52016-1:2017. In accordance with this standard, the areal heat capacity[1] (in J/(m2.K)) of each element is input along with one of 5 mass distribution classes describing in general terms the position of the mass (from internal to external) relative to the thermal resistance:

- Mass concentrated on internal side (I) – Construction with external thermal insulation (main mass component near inside surface), or equivalent
- Mass concentrated on external side (E) – Construction with internal thermal insulation (main mass component near outside surface), or equivalent
- Mass divided over internal and external side (IE) – Construction with thermal insulation in between two main mass components, or equivalent
- Mass equally distributed (D) – Uninsulated construction (e.g. solid or hollow bricks), heavy or lightweight concrete, or lightweight construction with negligible mass (e.g. steel sandwich panel), or equivalent
- Mass concentrated inside (M) – Construction with both internal and external insulation (main mass component concentrated near centre of construction), or equivalent

The standard also includes typical default values for areal heat capacity with a set of default construction type classes, varying from “very light” to “very heavy”. These construction types can be found in BS EN ISO 52016-1:2017 Table B.14. Table 1 below is a summary of the construction of these default classes.

Default class	Example of construction type
Very light	Light board or plastic
Light	5 to 10 cm lightweight brick/concrete
Medium	10 to 20 cm lightweight brick/concrete
Heavy	7 to 12 cm solid brick or heavyweight concrete
Very heavy	More than 12 cm solid brick or heavyweight concrete

Table 1 – Examples of construction type for each default class

Each opaque building element is modelled as five heat balance nodes (see HEM-TP-04 Space heating and cooling demand) and the areal heat capacity is distributed among these nodes

[1] Note: that the thermal mass includes the entire thickness of the building element. A monthly method such as the Standard Assessment Procedure would instead use the kappa value, which includes only the thickness of the construction active in thermal storage for the internal surface.

according to the mass distribution class (the procedure is described in BS EN ISO 52016-1:2017 section 6.5.7). The five nodes are then included in the overall heat flow network for the zone in the model. The heat balance equations for all the nodes in the zone are solved simultaneously using a linear algebra solver.

Thermal mass of transparent building elements is ignored.

The thermal mass is either distributed as a whole unit, or divided up in fractions of a half, a quarter or one-eighth. The distribution amongst the nodes is shown graphically below, where the thermal mass distribution is represented by the brown area.

Mass concentrated on internal side: I

	External	Inside			Internal
	Nodes				
Mass fraction/8	1	2	3	4	5
1					
2					
3					
4					
5					
6					
7					
8					

Figure 1 – Mass concentrated on internal side

Mass concentrated on external side: E

	External	Inside			Internal
	Nodes				
Mass fraction/8	1	2	3	4	5
1					
2					
3					
4					
5					
6					
7					
8					

Figure 2 – Mass concentrated on external side

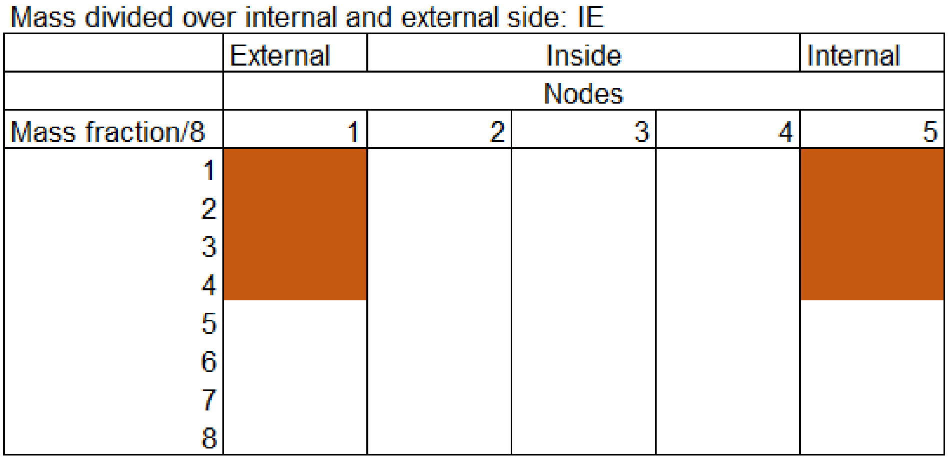

Figure 3 – Mass divided over internal and external side

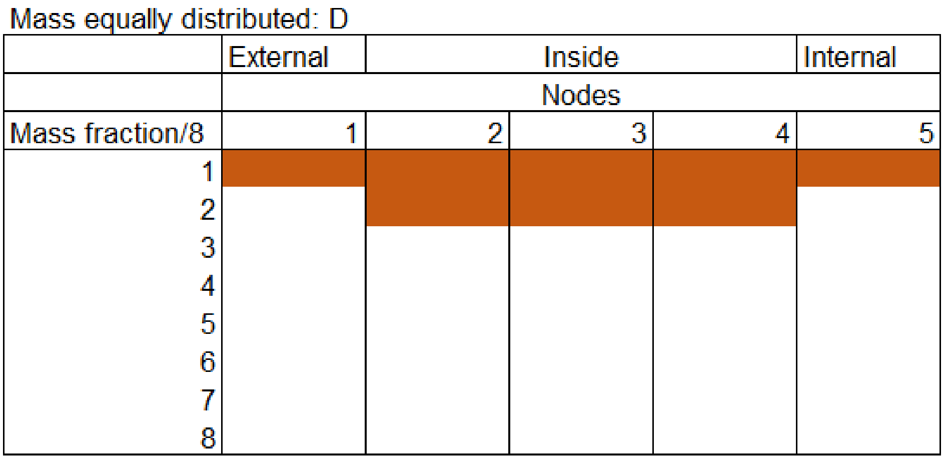

Figure 4 – Mass equally distributed

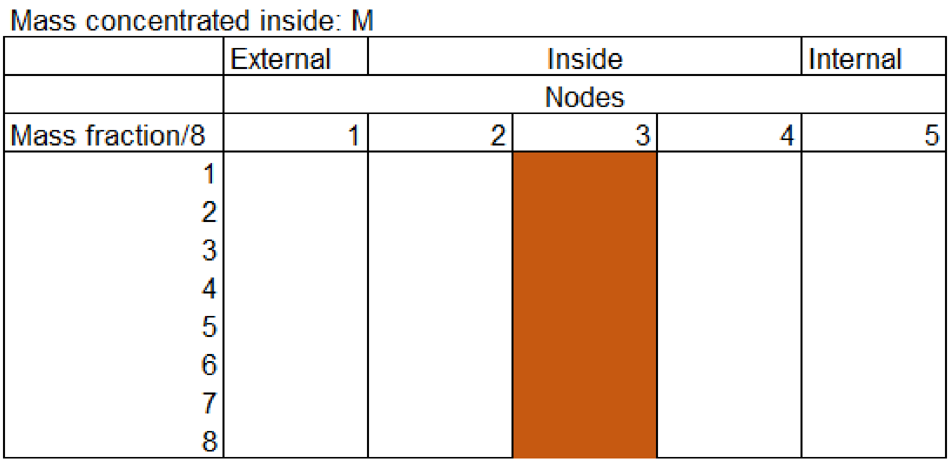

Figure 5 – Mass concentrated inside

2. Thermal mass of air and furniture in main calculation

The thermal mass of the air in the zone is assumed to be 10,000 J/K per m2 of zone floor area, as per the suggested default in BS EN ISO 52016-1:2017 Table B.17, which also assumes the presence of furniture.

3. Thermal mass of emitters and underfloor heating systems

The thermal mass of emitters and underfloor heating systems are captured in a separate manner from the building elements or the internal air. This thermal mass is not included in a heat balance node and instead is represented within the emitter model (see HEM-TP-16 Heat emitters), which is included within the zone heat flow network via the heating/cooling system. The emitter thermal mass is therefore still coupled to the zone's operative temperature (including when the heating is off) and has a similar overall effect as if it were treated as a fabric element.

In order to avoid double counting, the thermal mass of the proportion of a floor forming an underfloor heating emitter is excluded from the floor building element's thermal mass.

4. Static calculation for reporting

Although not used in the main heat balance calculation, for comparison purposes, a single heat capacity figure for the dwelling is also calculated. This is called the Heat Capacity Parameter (HCP) and is calculated by summing the heat capacity of all building elements in all zones and dividing by the total floor area. That is,

$$HCP = \frac{\sum heat\ capacities\ of\ building\ elements}{total\ floor\ area}$$

5. Limitations

The thermal mass distribution classes are an approximation of the thermal mass distribution in a real construction. They may be appropriate where there are simple layers, such as solid brick wall, cavity wall, solid wall internally insulated, or solid wall externally insulated. However, other constructions might not be so well represented. For example, a solid brick wall could be insulated internally using insulated plasterboard. In this case, the thermal mass of the plasterboard would not be represented in the internal node, if the wall is assigned to the mass distribution class "Mass concentrated on external side" or "E".

For some construction types, it is not obvious to which mass distribution class they should belong. This may in some cases lead to incorrect choices of mass distribution classes.

Future development

The selection of mass distribution class could be made easier with a tool that determines the most appropriate class. This might be included with a related tool such as a U-value calculator.

The mass distribution classes could be amended to better handle a wider range of construction types. Note this may involve a divergence from the standards, or for a request to BSI for the update of BS EN ISO 52016-1:2017.

This publication is available from: https://www.gov.uk/government/publications/home-energy-model-technical-documentation