Solar gains and shading within the Home Energy Model

A technical explanation of the methodology

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Acknowledgements

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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).

The Home Energy Model is still under development and its first version will be implemented alongside the Future Homes Standard (FHS) in 2025. We are publishing information about the model while it is still at a formative stage to enable industry to participate in the ongoing development process.

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 go into further detail on the methodology and the validation exercises that have been carried out. We intend to update and produce further technical documentation throughout the model development process.

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

What: The Home Energy Model consultation, which explains the overhaul to the SAP methodology and seeks views on the approach taken by the new Home Energy Model.

Audience: The Home Energy Model consultation will be of interest to those who want to understand the proposed changes to the SAP methodology and wider SAP landscape.

The Home Energy Model reference code

What: The full Python source code for the Home Energy Model and the Home Energy Model: FHS assessment has been published as a Git repository. This code is identical to that sitting behind the consultation tool. We are currently considering whether the open-source code could serve as the approved methodology for regulatory uses of the Home Energy Model.

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.

Related content

This paper sets out the methodology for accounting for solar gains and shading within the Home Energy Model core engine.

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

src/core/external_conditions.py

src/core/space_heat_demand/building_element.py

src/core/space_heat_demand/zone.py

Methodology

1. Solar irradiance

The method described in BS EN ISO 52010-1:2017 is used to calculate the diffuse and direct irradiance on each surface of the dwelling.

2. Heat transmitted through opaque elements

The direct irradiance incident on an opaque surface may be reduced by a shading factor from distant objects (e.g. neighbouring buildings) calculated as described in the section Distant shading below.

The amount of heat transmitted through opaque surfaces is taken into consideration using a solar absorption coefficient assigned to each external element, following the procedure described in BS EN ISO 52016-1:2017 section 6.5.6.

3. Solar gains through transparent elements

In the case of transparent elements, direct and diffuse solar irradiance may be reduced due to nearby objects (e.g. balconies, overhangs, fins, reveals) as described in the section Shading from nearby objects below. The direct irradiance may also be further reduced by distant shading objects (e.g. neighbouring buildings), as described in section 4.

The amount of heat gain from solar energy incident on transparent surfaces is taken into consideration via an input g-value, following the procedure described in BS EN ISO 52016-1:2017.

- The solar energy transmittance of non-scattering glazing for radiation perpendicular to the glazing (g-value) shall be calculated in accordance with ISO 9050.
- In practice, the total energy transmittance varies with respect to the angle of incidence of the solar radiation. To account for this, a fixed correction factor Fw (given in BS EN ISO 52016-1:2017 Annex B Table B.22) is applied to the g-value.

Solar gains are calculated for individual transparent elements, but then summed per zone for use in the core heat demand calculation.

The total solar gains are apportioned to the air node and to internal surfaces via convective and radiative fractions as given in BS EN ISO 52016-1:2017 Table B.11. PD CEN ISO/TR 52016-2:2017 section B.5 provides justifications for the choice of convective/radiative fractions.

4. Distant shading

Shading from distant objects (e.g. neighbouring buildings) applies to both opaque and transparent elements (as well as photovoltaics).

Distant shading only applies a reduction factor to direct irradiance.

The direct shading factor is derived by calculating the projected shadow on the shaded element following section F.3 of BS EN ISO 52016-1. It is derived from the geometrical dimensions of the shading object and the shaded element, the direct irradiance, and the position of the sun (altitude and azimuth).

Distant shading objects are represented as follows: the ground plane is split into segments, and shading objects surrounding the building are assigned to the relevant segments and described by their height and distance from the dwelling. They are represented as infinite shading elements, therefore there is no depth to the shading element.

The geometrical information of the shaded element needed is its height/length, width, area and the distance between the ground and the lowest edge of the element (base height).

5. Shading from nearby objects

Shading due to nearby objects (e.g. overhangs, fins, reveals) only applies to transparent elements.

Shading due to nearby objects is represented via

- a direct shading factor, applied to the direct solar irradiance
- a diffuse shading factor, applied to the diffuse solar irradiance

The direct shading factor is derived following the same methodology as for distant shading (F.3 of BS EN ISO 52016-1).

The diffuse shading factor is derived by calculating the proportion of sky that is obstructed by the shading object following procedures from PD CEN ISO/TR 52016-2:2017 annex F.6. The decision to include the diffuse shading factor from nearby objects was taken as part of the inter-model validation exercise.

Nearby shading objects can be attributed to each transparent element. The geometry of each nearby shading object is described by its depth and distance from the glazing. Horizontal shading elements are assumed to be infinitely wide, and vertical elements are assumed to be infinitely tall. Nearby shading objects do not apply to all transparent elements of a façade, they should be entered separately for each transparent element.

For shading due to nearby objects, the geometrical information of the shaded transparent element needed is the same as for distant shading: height/length, width, area and the distance between the ground and the lowest edge of the element (base height).

Future development

Three potential areas for improvements were noted:

- Near-by shading elements placed in front of transparent elements, such as balustrades and fixed or movable shutters cannot currently be modelled as nearby shading objects to transparent elements.
- Near-by shading objects such as overhangs and side fins are currently assumed to be infinitely wide or high respectively. Therefore nearby shading objects which only cover part of the width or height of a transparent element cannot be accurately modelled.
- The shading of diffuse radiation and the reflectance from distant shading objects are not currently accounted for.

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