Accounting for External Conditions within the Home Energy Model

A technical explanation of the methodology

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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

The heat loss and heat gains in buildings will be influenced by external factors including external temperature, wind speed and solar radiation.

This paper sets out the methodology for the use of external conditions 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/read_weather_file.py

src/read_CIBSE_weather_file.py

Methodology

The Home Energy Model (HEM) core engine requires data on the external conditions of a building. External conditions which the HEM engine requires include the external air temperatures, solar radiation, wind speed, and the latitude and the longitude of the building.

1. Weather Files

The consultation version of the Home Energy Model has been developed to accept two different types of weather file:

- EnergyPlus Weather Format (EPW) files
- CIBSE Test Reference Year (TRY) files

The EPW file format was chosen as it is easily and freely available for a large range of locations and is sufficiently rich to support the Home Energy Model's treatment of building physics. It is also used within comparable models, facilitating validation of HEM.

The CIBSE format can provide the same data, after some minor modifications which have been automated as part of the data ingestion process (see Table 1). This format was adopted to facilitate the use of the CIBSE Test Reference Year (TRY) scenario data, which offers projected future scenarios based on Met Office climate projections.

The Home Energy Model: FHS assessment consultation tool uses a set of CIBSE TRY files[1]. However, the weather data and format to be used in the 'live' version is still to be confirmed.

The data available in each weather file is shown in Table 1.

External Factor	EPW Weather File	CIBSE Weather File
External Air Temperature	Included in File	Included in File
Wind Speed	Included in File	In Knots, converted to m/s
Direct Beam Normal Radiation	Included in File	Inferred from Global Horizontal
Diffuse Irradiation (Horizontal)	Included in File	Included in File
Latitude	Included in File	Included in File
Longitude	Included in File	Included in File

Table 1 - Required external condition inputs for the HEM engine and their availability in the weather files.

[1] The specific scenario being used is the High (50th percentile) 2020s TRY (10 locations across England).

2. External Temperature

Hourly external air temperature is taken directly from the weather files.

External dry bulb air temperature has several purposes:

- Boundary condition in the fabric heat loss calculation for elements adjacent to the external environment.
- Source temperature for air source heat pumps.
- Supply temperature of the air flow element in a ventilation system.
- Used to determine the heating system flow and return temperatures when weather compensation is enabled.
- To determine the ductwork losses of mechanical ventilation systems.

3. Wind Speed

Wind speed is taken directly as hourly data from the EPW weather file. The wind speed is provided hourly in Knots within the CIBSE weather file, which is converted to m/s for use in the core HEM engine.

Wind speed is used to determine the infiltration rate adjusted by a wind speed factor.

4. Solar Radiation

Hourly data of direct beam normal radiation and diffuse irradiation (horizontal) is taken directly from the EPW weather file. Hourly diffuse irradiation (normal plane) is taken directly from the CIBSE weather file, but the direct beam normal radiation requires a conversion from the horizontal plane.

To determine the direct beam normal radiation, the direct beam on a horizontal plane is taken as the difference between the global and diffuse horizontal irradiation. The value is divided by the sine of the solar altitude to determine the direct beam normal radiation.

Solar radiation has several purposes:

- Solar radiation is used to calculate the incidence of solar gains through transparent elements of a dwelling.
- Solar radiation is used to determine the solar absorption for elements adjacent to the external environment.

- Total solar irradiance is used to determine the energy produced from a PV system.

For more information on how solar radiation is treated please see HEM-TP-08 Solar gains and shading.

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