Summary of the FHS Assessment Wrapper for the Home Energy Model

A technical explanation of the methodology

March 2026

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Contents

Background to the Home Energy Model: Future Homes Standard assessment

What is the Home Energy Model: Future Homes Standard assessment?

The Home Energy Model: Future Homes Standard assessment is a calculation methodology designed to assess compliance with the 2025 Future Homes Standard (FHS). It builds on the government's Home Energy Model, 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: FHS assessment technical documentation (e.g. this document)

What: This document is one of a suite of technical documents, which explain the approach to developing the standard assumptions and methodology used in the wrapper.

Audience: The technical documentation will be of interest to those who want to understand the justifications and evidence base behind the assumptions used in the model.

The Home Energy Model: Future Homes Standard assessment consultation and government response

What: The Home Energy Model: Future Homes Standard (FHS) assessment consultation sought views on the proposed methodology for demonstrating compliance with the FHS.

Audience: The consultation and response will be of interest to those who want to understand the proposed standardised assumptions around occupancy, energy demand etc. to be used when assessing compliance with the FHS, as well as the methodology for the calculation of the proposed FHS compliance metrics.

The Home Energy Model reference code

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

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.

Future Homes and Buildings Standards Government Response

What: The FHS consultation and response sets out the feedback received to the 2023 consultation on proposed Part L standards, and details the new regulations being introduced.

Audience: The consultation and response will be of interest to those wishing to understand the incoming standards for Building Regulations Part L.

Related Content

This document provides a summary of the wrapper for the FHS assessment. For a general summary of wrappers and how they relate to the core calculation, see HEM-TP-02 General summary of wrappers. For a general summary of the core calculation, see HEM-TP-01 General summary of core calculation.

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

src/hem.py

src/wrappers/future_homes_standard /future_homes_standard.py

src/wrappers/future_homes_standard /future_homes_standard_FEE.py

src/wrappers/future_homes_standard/future_homes_standard_notional.py

Methodology

1. Wrapper for the Future Homes Standard assessment

The energy performance requirements for new homes are set through Part L of the Building Regulations. A dwelling's compliance with these regulations may be determined using the Home Energy Model: FHS assessment. The Home Energy Model: FHS assessment is comprised of The Home Energy Model core engine and the FHS assessment wrapper. The assessment estimates the emissions and energy consumed by the dwelling under certain conditions and compares it to a benchmark notional dwelling.

The FHS wrapper itself consists of a methodology for pre-processing the input dwelling to apply the standardised assumptions for input to the HEM core engine and to generate the appropriate notional dwellings. The wrapper also post-processes the outputs from the core HEM engine, by applying a set of standardised factors to the energy consumption results, in order to produce the FHS compliance metrics.

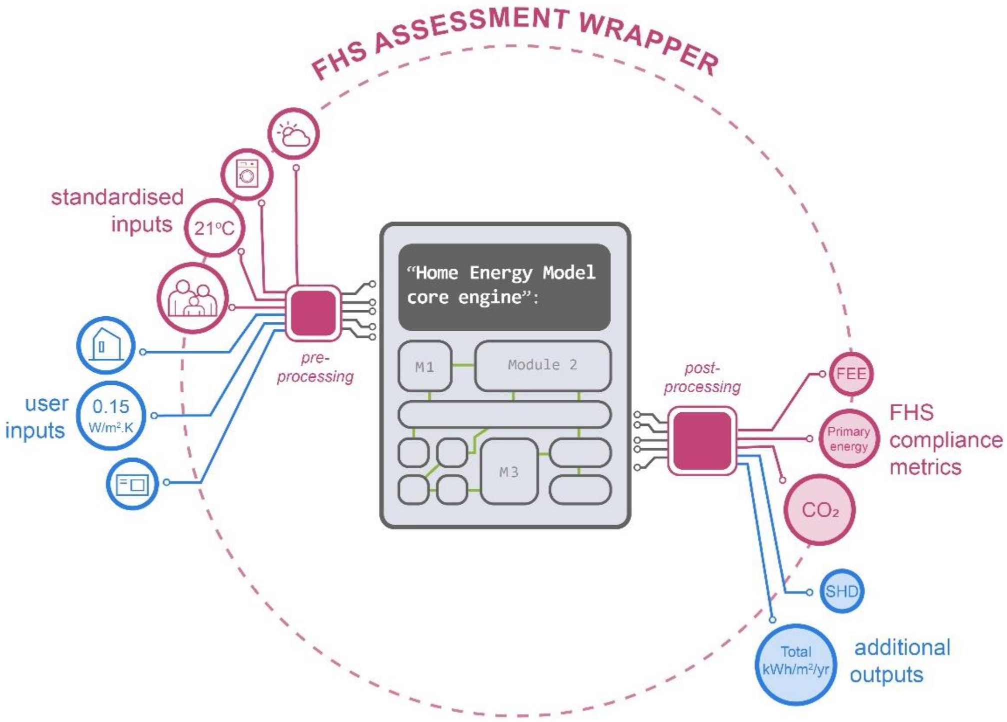

Figure 1 – Diagram of how the FHS assessment wrapper works with the Home Energy Model.

1.1 Compliance Metrics and the Notional Building

Part L sets the following performance targets for new homes:

• Target emission rate (TER)

• Target primary energy rate (TPER)

• Target fabric energy efficiency (TFEE)

These targets are set by assessing the energy performance of a theoretical dwelling of the same size, shape, orientation etc. (the notional dwelling) in HEM. The notional dwelling approach means that the exact values of the performance targets listed above will be unique to each dwelling (e.g. a flat will have different targets to a detached home).

These targets are compared against equivalent assessments of the actual building in HEM, which yield the following, corresponding compliance metrics:

• Dwelling emission rate (DER)

• Dwelling primary energy rate (DPER)

• Dwelling fabric energy efficiency (DFEE)

Further details on compliance with the FHS and the performance metrics may be found in Approved Document L Volume 1.

1.2 Simulations Used to Produce Compliance Metrics

To determine whether a dwelling complies with the Future Homes Standard (FHS) performance targets, the Home Energy Model runs four simulations, which assess the energy performance of the actual and notional building. These simulations consist of two sets of assumptions, the FHS standardisation assumptions (which apply to all runs) and the FHS Fabric Energy Efficiency (FEE) assumptions, each of which are applied to both the actual and notional dwelling.

The wrapper pre-processing creates the corresponding notional dwelling for the actual dwelling supplied, then applies the relevant assumptions for each simulation. Details of the pre-processing steps are explained in Section 2.

Each of the four simulations is then run independently through the HEM Core engine. The outputs from the core engine are postprocessed by the wrapper to calculate the corresponding FHS compliance metrics. For the simulations performed with the FHS assumptions these are the emissions rate (TER/DER) and primary energy rate (TPER/DER). For simulations performed with the FHS FEE assumptions, this is the fabric energy efficiency (TFEE/DFEE). The postprocessing and calculation of the metrics is described in detail in Section 3.

The simulations, assumptions and output metrics are summarised in Table 1. The complete HEM:FHS assessment process is visualised in Figure 2.

Name	Simulation	Outputs
Actual dwelling	The actual building with FHS standardisation assumptions	Dwelling emission rate (DER) Dwelling primary energy rate (DPER)
Notional dwelling	The notional building with FHS standardisation assumptions	Target emission rate (TER) Target primary energy rate (TPER)
Actual FEE dwelling	The actual building with FHS standardisation assumptions and Fabric Energy Efficiency (FEE) calculation assumptions.	Dwelling Fabric Energy Efficiency (DFEE)
Notional FEE dwelling[1]	The notional buildings with FHS standardisation assumptions and FEE calculation assumptions.	Target Fabric Energy Efficiency (TFEE)

Table 1: Summary of FHS Simulations. The FHS wrapper generates four simulations which are run through the HEM core engine: the actual dwelling, notional dwelling, actual FEE dwelling, and notional fee dwelling.

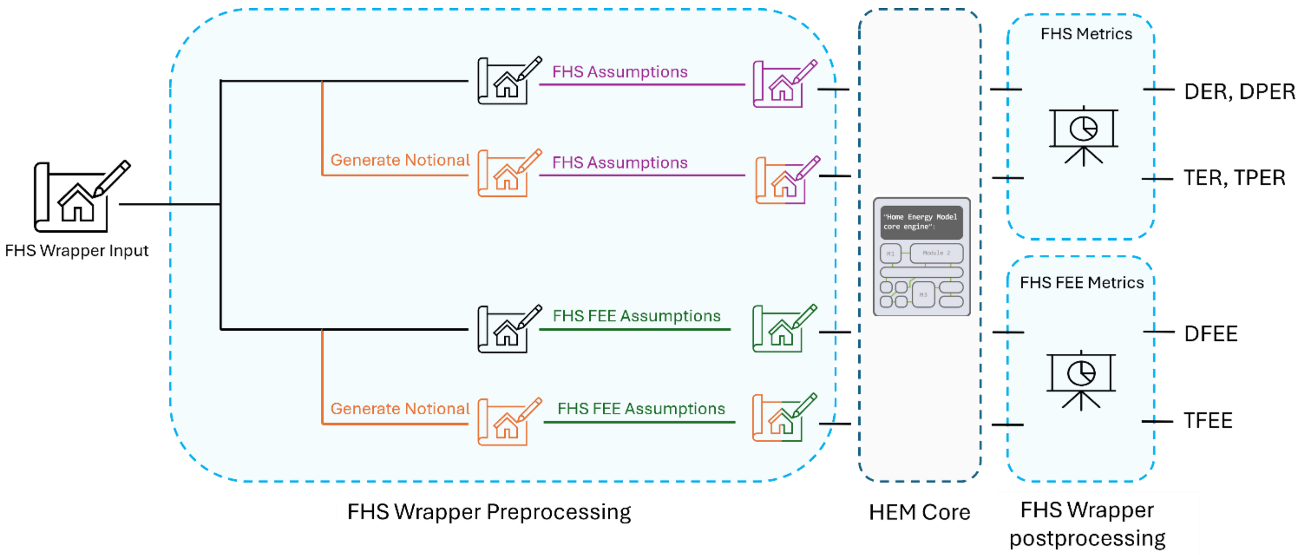

Figure 2: Summary of the FHS wrapper calculations. The FHS wrapper pre-processing produces 4 separate standardised input files for the HEM core. Each of these inputs is independently run through the HEM core engine. The FHS wrapper post-processing calculates the compliance metrics based on the outputs generated by the HEM core.

[1] FEE standardisations overwrite notional dwelling standardisations in the event that the two conflict. For example, the FEE heating system is always high-capacity direct electric heating, regardless of the actual or relevant notional system.

2. Pre-processing in the FHS Wrapper

2.1 Future Homes Standard Assumptions

The FHS assumptions standardise the following across all simulation runs:

- Calculation period and timestep for the simulation. These are set to one calendar year and 0.5 hours, respectively.
- Internal heat gains assumptions (metabolic, lighting, appliances, cooking) - see HEMFHS-TP-02 and HEMFHS-TP-05. Heat losses due to cold water and evaporation are described in HEMFHS-TP-07.
- Space heating and cooling hours and setpoints – see HEMFHS-TP-03.
- Cold water feed temperatures - see HEMFHS-TP-04.
- Hot water draw-off events (pattern and total amount) - see HEMFHS-TP-04.
- Water heating hours (for non-instantaneous systems) - see HEMFHS-TP-04.
- Energy consumption for non-heating purposes is modelled explicitly using demand schedules described in HEMFHS-TP-05.
- Opening and closing of windows and vents to modify air flow, and the operation of mechanical ventilation systems – see HEMFHS-TP-06.
- Intermittent shading of windows via curtains and blinds, which adjusts solar gains – see HEMFHS-TP-08.
- Weather data for the simulation, based on the dwelling's location – see HEMFHS-TP-10.
- Properties of fuels consumed in the dwelling are standardised at the post-processing stage – see HEMFHS-TP-09 and Section 3, below.

In some cases, this standardisation is the same for all dwellings, whereas in other cases there may be multiple standard values/profiles for the user to choose from, or the values/profiles are set depending on other user inputs. See the relevant technical papers for more details.

2.2 Future Homes Standard Notional Building and Fabric Energy Efficiency assumptions

The notional dwelling is created from the actual dwelling by applying additional standardisations which together reflect one representative way of meeting the Part L regulations for the dwelling being assessed.

To calculate the Fabric Energy Efficiency metric, additional pre-calculation standardisations are made. This provides additional standardisation of the heating system, cooling system (if applicable), ventilation system and removes any photovoltaic panels.

The notional dwelling specifications and FEE assumption specifications can be found in X.

3. FHS wrapper post-processing

3.1 HEM Core Outputs

During each simulation, the HEM core engine records series of data detailing the performance of the simulated dwelling in each timestep. The key intermediate quantities recorded by the core engine are summarised in Table 2[2]. These are then postprocessed by the FHS wrapper to produce the relevant compliance metrics.

Symbol	Output Name	Description
Q_i	Space Heat Demand	The energy required to heat the dwelling from the current operative temperature to the setpoint temperature in timestep i.
C_i	Cooling Demand	The energy required to cool the operative temperature to the setpoint temperature in timestep i, if active cooling is available.
U_i	Unmet Demand	The shortfall between the amount of energy demanded by a household for heating and cooling services and that delivered in timestep i.
$(E_j)_i$	Energy Consumption	The amount of energy from fuel type j consumed by the dwelling in timestep i.
$(G_j)_i$	Energy Generation	Self-generated amount of energy of fuel type j in timestep i.

Table 2: HEM core engine outputs.

[2] Note the notational convention that subscript i denotes the simulation timestep which runs from 1 to N over the course of the simulated year.

3.2 Regulated Energy Calculation

The wrapper post-processing extracts the regulated energy consumption (covering space heating, space cooling, hot water, ventilation, fans and pumps, and fixed lighting) for each fuel type from the corresponding energy consumption.

Symbol	Output Name	Description
$\left(E_j^{(R)}\right)_i$	Regulated Energy Consumption	The amount of energy consumed by regulated sources in the dwelling from fuel type j in timestep i.

Table 3: Regulated energy consumption.

3.2 Unmet Demand Accumulation

The core engine provides the unmet demand U_i for each timestep. The FHS wrapper only accumulates unmet demand in the case where the unmet demand has increased from the previous timestep. The annual unmet demand U is therefore given by:

$$U = \sum_{i=1}^{N} \max\left(U_i - U_{i-1}, 0\right) \tag{1}$$

where U_0 is by convention set equal to zero, ensuring that the first instance of unmet demand is always picked up. For convenience, we also define the reduced unmet demand:

$$U_i^{(r)} = \max\left(U_i - U_{i-1}, 0\right) \tag{2}$$

so that the annual unmet demand is given by the sum of the reduced unmet demand:

$$U = \sum_{i=1}^{N} U_i^{(r)} \tag{3}$$

The FHS wrapper applies a penalty for unmet demand to encourage well sized systems. Details on the calculation of this penalty are given in Section 3.4.

3.3 Fuel Factors

Fuel factors enable the conversion of the total energy consumption of a fuel to a corresponding primary energy usage or CO_2 equivalent emissions rate. For each fuel type, there are therefore two fuel factors defined:

- $(\kappa_{j,\mathrm{pri}})_i$ is the primary energy factor for fuel type j in timestep i.
- $(\kappa_{j,\mathrm{em}})_i$ is the emissions factor for fuel type j in timestep i.

In principle, the fuel factors may vary according to the timestep. However, the FHS assumes constant fuel factors that have no time dependence. Full details of the fuel factors used in the FHS wrapper may be found in HEMFHS-TP-09.

3.4 Primary Energy Rate (PER)

The FHS wrapper calculates the primary energy rate according to the following process:

1. For each fuel type j,

   a. Extract the regulated energy consumption $\left(E_j^{(R)}\right)_i$.

   b. Calculate the corresponding annual regulated primary energy consumption, $E_{j,\mathrm{pri}}^{(R)}$ according to:

$$E_{j,\mathrm{pri}}^{(R)} = \sum_{i=1}^{N} \left(\kappa_{j,\mathrm{pri}}\right)_i \left(E_j\right)_i \tag{4}$$

2. Calculate the annual reduction in primary energy consumption due to self-generation of electricity. This is given by:

$$\left(G_{\mathrm{elec,pri}}\right) = \sum_{i=1}^{N} \left(\kappa_{\mathrm{elec,pri}}\right)_i \left(G_{\mathrm{elec}}\right)_i \tag{5}$$

3. Calculate the primary energy rate penalty for unmet demand according to:

$$P_{\mathrm{pri}}^{(\mathrm{U})} = \sum_{i=1}^{N} \left(\kappa_{\mathrm{elec,pri}}\right)_i \; U_i^{(r)} \; . \tag{6}$$

4. The final metric is calculated by taking the floor area normalised sum of these terms:

$$PER = \frac{1}{F}\left(\sum_{j \in \mathrm{Fuel\ Type}} E_{j,\mathrm{pri}}^{(R)} - G_{\mathrm{elec,pri}} + \; P_{\mathrm{pri}}^{(\mathrm{U})} \right) \tag{7}$$

   where F is the total floor area.

3.5 Emission Rate (ER)

The calculation of the emissions rate proceeds as in Section 3.4, replacing each primary energy factor with the corresponding emissions factor. This results in the following overall expression:

$$ER = \frac{1}{F}\left(\sum_{j \in \text{Fuel Type}} E_{j,\text{em}}^{(\kappa)} - G_{\text{elec,em}} + P_{\text{em}}^{(\text{u})}\right) \tag{8}$$

Where:

- F is the total floor area
- $E_{j,\text{pri}}^{(\kappa)}$ is the annual emission rate for fuel type j
- $G_{\text{elec,em}}$ is the annual reduction in emission rate consumption due to self-generation of electricity
- $P_{\text{em}}^{(\text{u})}$ is the penalty applied to the emissions rate due to the unmet demand

3.6 Fabric Energy Efficiency (FEE)

The fabric energy efficiency is calculated according to the following equation:

$$FEE = \frac{Q + C}{F} \tag{99}$$

Where:

- F is the total floor area.
- Q is the total (annual) space heating demand, $Q = \sum_{i=1}^{N} Q_i$
- C is the total (annual) space cooling demand, $C = \sum_{i=1}^{N} C_i$

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