UK Government

The Home Energy Model: Future Homes Standard assessment

Summary of responses received and Government response

Department for Energy Security and Net Zero (2026)

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Contents

Executive Summary

Introduction

This document presents the government's response to the Home Energy Model (HEM): Future Homes Standard (FHS) assessment consultation, which was launched on 13 December 2023 and closed on 27 March 2024.

Background

HEM is a calculation methodology designed to assess the energy performance of our homes. It will replace the Standard Assessment Procedure (SAP), which was first published in 1993.

The FHS is the latest iteration of Building Regulations Part L, covering energy performance. The FHS represents a significant milestone in the UK's pathway to net zero, requiring new build homes to be future-proofed with low carbon heating and world-leading levels of energy efficiency.

HEM and the FHS assessment 'wrapper' will together make up the HEM:FHS assessment. HEM is under development, and its first version will be implemented as an approved methodology for demonstrating compliance with the FHS in 2026. In addition, an updated SAP will be temporarily available for demonstrating compliance with the FHS. This will enable both systems to run on an interim basis, giving the house-building sector time to transition towards working solely with HEM in future.

What has been published?

This government response document is part of a wider set of publicly available material relating to the HEM: FHS. Depending on your interests, you may be interested in all or part of this response document, as well as one or more of the other publications within this package. The full list of publications is as follows:

The Home Energy Model: Future Homes Standard Government Response (this document)

What: This document sets out the government's response to the Home Energy Model: Future Homes Standard consultation, which explained the FHS wrapper and sought views on the approach taken.

Audience: This document will be of interest to those who want to understand the feedback received in response to the consultation and how the government is responding to it.

Please note that this government response does not cover the core Home Energy Model consultation which can be found on the GOV.UK website here.

This response also does not address EPC reform or the development of a Home Energy Model methodology for producing EPCs. The government consulted on proposals for improving EPCs, including the performance metrics they display between 4 December 2024 and 6 February. The outcome of the EPC consultation will feed into the development of a Home Energy Model methodology for producing EPCs and will be published in due course.

HEM reference code

What: The HEM methodology (both core and wrappers) has been published in full as an open-source repository of Python code, which can be found here: https://dev.azure.com/Sustenic/Home%20Energy%20Model%20Reference

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 HEM.

Home Energy Model technical documentation and validation reports

What: This consultation is accompanied by technical documents and validation reports, to be published here shortly after the response, which further detail the methodology, including any changes since the consultation, and further validation exercises that have been carried out.

Audience: The technical documentation will be of interest to those who want to understand the detail of how the FHS wrapper works and the data sources underpinning the methodology.

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.

Summary of stakeholder responses to the consultation proposals

This document sets out the Government's response to a consultation on the Home Energy Model: Future Homes Standard Assessment. The consultation was published on GOV.UK on 13 December 2023 and ran until 27 March 2024. We received a total of 62 individual responses from a wide range of organisations, trade bodies, industry professional, academics and individual members of the public. While not every individual point raised has been captured in this summary response publication, all the views that were shared with us have been taken into consideration.

A breakdown of the responses we received according to different stakeholder categories is provided in Table 1.

Table 1 - Consultation responses by type of organisation

Respondent type	Number of responses	Percentage of total (rounded)
Accreditation scheme/body	4	6.5%
Consultancy	9	14.5%
Energy network	5	8.1%
Energy regulator	1	1.6%
Environmental organisation	2	3.2%
Housebuilders	4	6.5%
Housing association	1	1.6%
Local Government	1	1.6%
Manufacturer	20	32.3%
Member of the public	2	3.2%
Other	1	1.6%
Research/academic organisation	3	4.8%
Trade association/body	9	14.5%
	62	**100%**

This Response document sets out a summary of the responses we received to the 31 consultation questions and outlines the Government's position on each issue. Where there are multiple questions related to one issue, a single response is provided in relation to all the relevant questions on that theme. Some questions received more responses than others.

Summary of the government response to stakeholder feedback

We are grateful for the valuable responses to the consultation from respondents across a diverse range of stakeholder groups. We would like to thank everyone who took the time to respond, some with detailed submissions and supporting evidence.

Since the consultation closed, government has continued to work closely with industry, assessment bodies and technical experts to refine and test the FHS wrapper. Through targeted workshops, technical deep-dives and open sessions, we have incorporated stakeholder feedback directly into improvements to the methodology. Additional modelling and validation work has strengthened the evidence base behind our conclusions. As a result, the final approach reflects several years of collaborative development, ensuring the requirements are well-understood, rigorously tested and aligned with industry expectations. In this response questions on similar topics are grouped under sub-headings. The evidence from respondents is summarised for each question in turn, and then a single government response is provided covering each group of questions.

We had several key reoccurring themes across the consultation:

Standardisation: Many responses highlighted how standardisation regarding assumptions (including energy consumption and occupancy) promoted a more accurate and fair approach to the model. However, some did note the potential oversimplification of real-world diversity in dwellings and subsequently their performance.

Complexity: A recurring point related to the complexity of the model, with many respondents recognising that the increased level of specificity offered by the HEM and its wrapper goes beyond SAP. While this greater detail enables more accurate and representative results, it also introduces additional inputs and expands several pre-existing ones, which some stakeholders felt added to the overall burden of assessment.

Accuracy for effort: Responses highlighted that the increased level of detail required in the model raised concerns about time pressures and resource demands. Many assessors were worried that the additional inputs could place further strain on workloads and potentially affect the quality of assessments, prompting questions about whether the extra detail was proportionate to the benefits. Within this response, we have sought to explain how the enhanced accuracy delivered by the model provides tangible value and supports more consistent, evidence-based outcomes.

Data-sourcing difficulties: Concerns around data-sourcing were raised, especially during early design stages where Mechanical & Electrical (M&E) plans are incomplete. We've sought to explain how this detail will be used and why it will improve the model.

Flexibility: Respondents generally agreed that accuracy and standardisation are important but stressed the need for flexibility to handle real-world variability and simplify complex requirements. Overall, the feedback highlights a balance between consistency and adaptability in the proposed approach, which we've highlighted in our response to questions below.

The Home Energy Model: Future Homes Standard assessment

The Future Homes Standard assessment wrapper for the Home Energy Model (Q1-2)

Question 1

What are your views on the choice of inputs that have been standardised vs left open as user inputs? Please explain your reasoning and provide any supporting evidence.

Summary of responses

We received 55 responses to this question. Twelve agreed with our approach on standardised vs user inputs in HEM:FHS assessment. Eight disagreed with our approach. Twelve respondents had mixed feelings towards the suggested approach, whilst three proposed changes not explicitly asked for within the question. A further 20 responses did not express a clear view or did not provide one.

Those in support of our approach agreed overall with the balance of standardised vs user input elements, acknowledging that certain elements need to be fixed to maintain accuracy and fairness. Respondents described the standardised inputs as both logical and helpful, allowing for easier comparison of different properties. These respondents also appreciated the uniformity the change will bring, along with increased ease of future updates. One response specifically highlighted the use of seeing evidence to support the methodology choices, which they felt was often overlooked in SAP.

Those opposed to our approach felt that the proposed structure was too complex and unnecessary for real-world application. They also felt the amount of user inputs were too high, leading to increased time pressure for assessors, in turn worrying it would cause them to sacrifice quality to complete as many assessments as SAP would have allowed in a similar timeframe. This is magnified by the belief that changing certain input values had a very minor or no effect on assessment results.

Respondents with mixed views recognised positives within the suggested approach, whilst highlighting potential risks or disadvantages. Examples given included:

- Accuracy is increased with more in-depth information but requires higher attention to detail and time allocation from assessors.
- Improved utility and ease of designing and modifying buildings.
- Standardised inputs provide a more uniform output of assessments but lessen the nuance of assessments.

Although unrelated to the specific question asked, one response did raise support for Actual Fabric Energy Efficiency (AFEE), mandatory fabric testing, and heat pump monitoring.

Question 2

What are your views on the ease of populating or sourcing data for those user inputs? Please explain your reasoning and provide any supporting evidence.

Summary of responses

We received 55 responses to this question. Six agreed with our approach on populating and sourcing data for user inputs in HEM:FHS model, whilst six disagreed with our approach. Twenty respondents had mixed feelings towards the suggested approach, whilst three suggested changes not mentioned within the question. Twenty respondents did not explicitly make their views clear or otherwise provide an answer.

Those in support of our approach agreed the information would be easy to gather. Those opposed to our approach highlighted various concerns, citing information sourcing issues, increased time to complete assessments, and a general lack of transparency around calculation methods and formulae. Other issues included:

- Shading challenges: Respondents noted that accurately assessing shading is particularly difficult at the design stage due to incomplete site plans. While site visits are standard for as-built and existing dwellings, providing detailed shading data before construction is often not feasible, so default values will be necessary.
- Heat emitters data is not currently required for the SAP methodology, leading to concerns that the data may be unattainable for assessments done before construction commences.
- Domestic hot water and space heating pipework presents potential hurdles, particularly during the design phase. Data may be unavailable as mechanical and electrical (M+E) designs are typically incomplete at this stage.

Respondents with mixed views acknowledged both the strengths and weaknesses identified by supporters and critics, noting that some information would be easy to gather, while also reiterating the challenges mentioned above.

Those who proposed further changes suggested window shading and object shading should be removed from the wrapper, and the introduction of a U-value calculator for fabric calculations.

Government response – Questions 1 - 2

The FHS assessment wrapper specifies inputs and outputs for HEM, when using the model in assessing whether a new home complies with the requirements of the FHS. Among the inputs are standardised assumptions relating to occupancy and energy demand. At the pre-processing stage, the wrapper standardises the following:

- Calculation period and timestep (set to one year and 0.5 hours respectively).
- Internal gains assumptions (metabolic, lighting, appliances, cooking).
- Space heating and cooling hours and setpoints.
- Cold water feed temperatures.
- Hot water draw-off events (pattern and total amount).
- Water heating hours (for non-instantaneous systems).

Some of these standardisations are fixed, while others allow for multiple standard values or are derived from other inputs. At the post-processing stage, the wrapper standardises emissions and primary energy factors applied to the predicted energy consumption.

In response to concerns about input complexity, we have undertaken a comprehensive simplification exercise. Inputs were triaged by the effort required to obtain them and their sensitivity within the model. Inputs that were difficult to provide and had little impact on results were assigned default values and removed as user inputs. More sensitive variables were converted to multiple-choice options, inferred from other inputs, or sourced from the HEM database. We have simplified the input requirements based on feedback as follows:

- Pipework lengths: Several responses and other stakeholder feedback raised that providing accurate data about water and space heating pipework lengths was challenging. We have mitigated this by inferring the estimated lengths in the wrapper, using a combination of inputs that are easier to provide (e.g. building dimensions, number of hot water tapping points).
- Heat emitters: Detailed technical parameters for radiators and other emitters are no longer required from the user. Instead, the user will select from a list of representative models provided within the HEM products database. These are intended to be used from design stage up to as-built. The new required user inputs are the type and dimensions of the radiators etc.
- Appliances: The wrapper is now less demanding on inputs for appliances. Microwaves and kettles are now included by default. Other inputs are restricted simply to a default or uninstalled input.

- Multiple choice options:
  - The reference pressure difference (test_pressure) can now be 4 or 50 Pa (for pulse/blower door test)
  - The solar absorption coefficient at the external surface (solar_absorption_coeff) is now set by selecting colour (light (0.3), intermediate (0.6) or dark (0.9))
  - The areal heat capacity (areal_heat_capacity) is now set by selecting between very light (50,000), light (75,000), medium (110,000), heavy (175,000), or very heavy (250,000)
  - The convective fraction for heating (frac_convective) is now set by selecting between "Air heating (convectors, fan coils etc.)" (0.95), "Free heating surface (radiators, radiant panels etc.)" (0.70), "Floor heating, low temperature radiant tube heaters, luminous heaters, wood stoves" (0.50), "Wall heating, radiant ceiling panels, accumulation stoves" (0.35), "Ceiling heating, radiant ceiling electric heating" (0.20)
- Defaulted inputs: The following inputs have been defaulted because they can be safely assumed for new builds, or because they make little material difference to the model:
  - Location of any heat batteries (heat_battery_location): defaulted to internal
  - Whether fuels are export capable (is_export_capable): defaulted to false for gas and true for electricity (but this can be overridden)
  - Location of hot water distribution pipework (location): defaulted to internal
  - Age of any electric batteries (battery_age): defaulted to 0 years old
  - Bath flowrate (flowrate): defaulted to 12 L/min
  - The initial vent position (vent_opening_ratio_init): defaulted to 1 (fully open)
- The reference pressure for an air terminal device (pressure_difference_ref): defaulted to 20 Pa.
  - The pitch of ground-slab elements (pitch): defaulted to 180° (flat)

Occupancy and energy demand

Occupancy (Q3-4)

Question 3

What are your views on the proposed standard occupancy assumption? Please explain your reasoning and provide any supporting evidence.

Summary of responses

We received 55 responses to this question. Twelve supported our approach on assumptions for standard occupancy, whilst 11 respondents disagreed with our suggestions. Four respondents had mixed feelings towards this approach, with a further nine proposing either ideas for new changes or raising questions about the approach. A further 19 did not express a clear view or did not provide one at all.

Those in agreement with our approach recognised it will improve accuracy, thanks in part to the move away from calculation based on floor area. Those in support also frequently mentioned that standard occupancy should be kept regularly updated based on the latest research to remain accurate. Similarly, those with mixed feelings largely supported the approach, on the condition that it would use updated research to ensure it remain correct and consistent.

Those respondents opposed to our suggested approach disagreed for varying reasons, including concerns that occupancy assumptions are too low and urged alignment with traditional household patterns and ventilation standards.

Responses raising new ideas and questions highlighted various points, such as:

- Suggesting that the proposed figures underestimate real-world occupancy, particularly for 4-bedroom homes.
- Questioning bespoke occupancy treatment for 1-bed homes and suggested clearer bedroom definitions to avoid misuse.
- Advocating for visible and customisable occupancy rates to enable more tailored property assessments.

Most of these responses still supported the underlying suggested approach presented.

Question 4

What are your views on the assumptions for metabolic gains? Please explain your reasoning and provide any supporting evidence.

Summary of Responses

We received 55 responses to this question. Twelve agreed with our approach on assumptions for metabolic gains (i.e. the heat generated by human occupants within a building**)** in HEM: FHS assessment, whilst two disagreed. Six had mixed feelings towards the suggested approach, whilst one person suggested changes not mentioned within the question. A further 34 respondents did not explicitly make their views clear or provided an answer unrelated to the question.

Those in support of our approach highlighted the need for a more robust and granular process but strongly suggested regular reviews and updated research to ensure accuracy. It was also suggested that the process be as flexible as possible, to allow for circumstances that may not be captured within the metabolic gains assumption.

Those in disagreement suggested that the proposal was complex and/or didn't accurately cover real-world scenarios or account for enough possible contingencies. For example, those with pets, or sedentary occupiers where metabolic emittance would be much lower.

Those with mixed opinions had no issue with the process, but felt the suggestions weren't meaningful enough to necessitate change.

One respondent suggested that latent heat should be included in the process, due to its effects on cooling loads and ventilation measures.

Responses supported using Time Use Survey data but warned against oversimplifying the link between occupancy and energy demand, noting it varies by household type and activity.

Government response – Questions 3 - 4

The FHS regulates the energy use and associated carbon emissions of a dwelling under a standardised pattern of use. The FHS is intended to reflect the designed use of the dwelling, but some account must be taken of real patterns of occupancy observed in the stock. A higher standard occupancy leads to increased modelled hot water use but, because occupants' activities provide heat gains into the space, to decreased space heating demand. For dwellings with heat pumps these effects tend to decrease the overall modelled coefficient of performance. In this sense, increasing assumed occupancy is a conservative adjustment.

The occupancy assumptions in the FHS wrapper have been retained from the consultation version. We believe that the English Housing Survey (EHS)-based analysis used to derive the standard occupancy remains the best available methodology. This approach reflects the best available evidence on average occupancy and provides a simple, consistent way to account for long-term uncertainty in how a dwelling will be used. Preliminary examination of subsequent EHS releases indicates only marginal changes to the distributions in more recent data, and so the existing assumptions have been retained. Typically, these assumptions remain fixed for the duration of each edition of the Building Regulations, to maintain consistency.

Some responses suggested that the assumed occupancy should be higher or lower than proposed, and there was a relatively even split of opinion on this. Neither suggestion was found to be supported by representative population data of comparable quality to the EHS and the other data used in the proposal. As in the consultation, the occupancy is standardised for all dwellings of the same size, with no facility for the assessor to report deviations from this. This continues to reflect the fact that the HEM:FHS assessment is a standardised assessment of the dwelling, almost always carried out before any occupants have taken up residence. Accounting for the variability and quirks of real occupancy is therefore out of scope.

Improvements have been made to the metabolic gains methodology to better reflect occupant activities within the home, using the ASHRAE method and the ONS study Time Use in the UK. Weighted average heat outputs were calculated and converted into Watts using NHS data and

EHS demographic data was used to account for typical proportions of adults and children in the household[1].

This revised methodology to determine metabolic gains represents an improvement from that consulted on because:

- It now excludes gains from latent heat, which should not be included in the calculation.
- It separately accounts for the body surface areas of adults and children, rather than the previous assumption that all occupants had the same surface area.
- It better reflects when occupants are at home by using more accurate ONS activity data.
- It contains a more realistic mix of daytime activities in the home than the previous method of assuming all daytime activity was “quiet seated”.

Space heating and cooling (Q5-11)

Question 5

Do you think the FHS assessment wrapper should keep two thermal zones for all dwellings? Y/N. Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to question five, regarding thermal zone quantities in the FHS assessment wrapper. Eleven respondents agreed with the suggestion of keeping two thermal zones for all dwellings, stating that using two zones provides more flexibility and accuracy than one whilst preventing needless complexity if more were added. They also noted that it reflected a similarity to SAP, in terms of the work for assessors.

Ten responses disagreed with our approach whilst a further 11 presented more mixed sentiments. These responses were split between believing one zone was adequate for the wrapper, believing more than two were necessary, those who were entirely uncertain about the number of zones, and one response that suggested zoning does not work at all in relation to heat pumps. One of the responses stated that the suggested zoning approach may be less applicable because heating is often operated for longer periods at a relatively consistent temperature throughout the dwelling.

Those who believed one zone was appropriate stated increasing the number of zones would have little to no impact and put a higher strain on assessors. Others who argued for more than two zones suggested more zones would increase carbon saving potential. They also raised issues with open-plan living spaces, where a single internal space might partly belong in each of the two zones. Three responses proposed ideas not covered by the question, including having the number of zones be determined by occupants. A further 20 did not express a clear view or did not provide one at all.

[1] [Citation should point to HEM technical paper, once published]

Question 6

If the FHS assessment wrapper keeps two thermal zones, do you think we should introduce inter-zone heat transfer? Y/N. Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Thirteen respondents agreed, ten had mixed views and eight disagreed. Two respondents proposed changes. The remaining 22 did not express a clear view or did not provide one at all.

Those who agreed with our approach stated that introducing inter-zone heat transfer is positive for the following reasons:

- It significantly affects performance in mechanically ventilated homes, making modelling more accurate.
- It leads to more realistic modelling of thermal behaviour across zones.
- It better reflects real building physics, acknowledging how heat naturally moves between spaces.
- It helps prevent unrealistic insulation effects between zones, improving the credibility of simulation results.
- It helps prevent zoning being misused to reduce calculated heating demand in higher temperature zones.

Those with mixed views often echoed the above, while also noting limitations to the approach. Respondents noted that the inclusion of inter-zone heat transfer has an unclear methodology, would add complexity, have a limited impact, and would rely on occupancy or behavioural assumptions which could undermine the model. Additionally, some respondents argued that it should be assumed occupiers would keep doors closed, and that heating design guides and specifications already factor in room temperature differences and transfer.

Those who disagreed with our approach argued that the addition would have minimal accuracy impact on the overall result and increase model-run time alongside increasing the data-input burden.

Proposed changes included allowing radiator heat outputs to be updated in the model, due to issues with undersized radiators and incorporating multiple room-by-room modelling

Question 7

What are your views on heating setpoints for (a) one zone; (b) two zones without inter-zone heat transfer (i.e. the current assumptions given above); and (c) two zones with inter-zone heat transfer? Please provide reasoning and supporting evidence.

Summary of responses

We received 55 responses to this question. Nine supported our approach, on the basis it aligned with recent research that heating setpoints for each zone should be allowed.

Three disagreed with our approach. A common concern was that it would take away occupants' autonomy by removing the ability to model variations in comfort levels according to different preferences. Another respondent mentioned how some existing properties aren't kept to certain temperatures due to excessive fuel costs. One respondent proposed a change not mentioned within the question, whilst a further 25 responses did not express a clear view, or did not provide one at all.

The remaining 17 responses contained mixed views and most of these expressed concerns and/or potential solutions regarding the setpoints, including:

- Urging caution with high setpoints due to energy and carbon impacts, and suggested adapting temperatures to suit installed technologies.
- Noting that heating behaviour varies by system type and suggested inter-room heat transfer balances out overall energy use;
- Questioning the value of two zones with similar setpoints and suggesting real-world use should focus more on scheduling than temperature differences.

Question 8

What are your views on the assumptions for space heating hours? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Five respondents agreed with the assumptions for space heating hours, four offered mixed views, and eight disagreed. Twenty-six respondents proposed changes to the current assumptions. The remaining 12 responses were either unsure or not directly relevant to the question.

Of those that agreed, respondents stated that assumptions were an improvement on the current SAP model and acknowledged the need for standardised space heating hours in HEM and the positive additions for allowing setback temperature and continuous heating regimes.

Those with mixed views tended to agree that the assumptions were logical, while noting there were disadvantages. Respondents offered the following points of disagreement:

- The model uses broad assumptions that don't reflect real-world diversity in heating patterns, zoning, or user behaviour.
- Assumptions are based on outdated usage patterns and legacy gas boiler habits, not modern heat pump efficiency or post-pandemic home occupancy trends.

- Excessive heating hours for properties that may be well-insulated and operating intermittent heating.
- Lack of clarity for extending morning heating which may not align with typical routines.
- Overlapping heating schedules across zones could lead to unnecessary energy use and reduced system effectiveness.

Proposed changes to the assumptions included:

- Reflecting a broader range of housing types and heating systems, heating schedules being based on the most recent research and updated data, reflecting real-world usage patterns, including hybrid working and varied occupancy, with tailored zoning for different room types and times of day.
- Heat pump operation being supported with appropriate default patterns (e.g. continuous or setback heating), rather than legacy gas boiler assumptions.
- Accounting for Mechanical Ventilation with Heat Recovery (MHVR) systems as they typically reduce the need for primary heating.
- Building flexibility into heating schedules to support time-of-use tariffs and improve grid efficiency.
- Ensuring consistency and fairness, suggesting dual options for standardised vs. custom schedules and better alignment between FHS and EPC wrappers.

Question 9

What are your views on the ability to specify a control scheme (e.g. setback temperatures and "advanced start" periods) that works for the system being installed? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Fourteen agreed with our approach whilst eight disagreed. Nine respondents expressed mixed sentiments. A further 24 respondents did not express a clear view or provide a view at all.

Those in agreement with our approach supported the ability to specify control schemes but highlighted some important things to consider such as the need for clear, well-defined terminology to avoid ambiguity. There was also support for control features for intermittent heating, with the recommendation of modelling both intermittent and continuous strategies to capture worst-case impacts.

Those opposed to our approach mentioned that they felt occupant autonomy and comfort would be undermined, in addition to the control scheme likely being too complex. Multiple respondents felt that control schemes should not be fixed in the wrapper, as they are occupant-driven and could create a performance gap if misused for compliance.

Those with mixed views suggested they would:

- Support the use of control schemes if proven to be efficient, but suggested limits to guide appropriate use and avoid misuse.
- Support control schemes with safeguards, but heating assumptions should reflect heat pump functionality, not fossil fuel systems.
- Support setback for heat pumps but saw advanced start as unnecessary in most real-world use cases.

Question 10

What are your views on the treatment of the heating season vs non-heating season (months where the heating is assumed to be off regardless of the temperature)? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Seven respondents agreed with our approach to defining the heating season, while 21 disagreed. Four respondents offered mixed views, and five presented new options not mentioned within the question. A further 18 did not make their views clear or provided unrelated answers.

Those in support of our approach felt that a defined heating season provides clarity and consistency for assessments.

Those against our approach argued that a fixed season does not reflect real-world usage, as heating needs can vary significantly by household, region, and year. Some suggested that the model should allow for more flexibility or be based on actual weather data rather than fixed calendar months.

Respondents with mixed views acknowledged the value of standardisation but raised concerns about edge cases and the potential for misalignment with occupant behaviour.

Other suggestions included aligning the heating season with regional climate data, allowing user input for exceptional cases, and providing clearer guidance on how the season is determined within the model.

Question 11

What are your views on the proposed assumptions for the use of space cooling systems? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Two respondents agreed with the proposed assumptions, three disagreed and five offered mixed views. Twenty-one respondents proposed changes to the assumptions. The remaining 24 responses did not make their views clear.

Some respondents with mixed views agreed with elements of the assumptions such as the setpoint temperature and an undefined cooling system. Arguments against our approach included:

- Unrealistic assumptions about window opening, such as when it is hotter outside or cooling is active.
- The two-zone modelling approach over-extending limited data on cooling energy use.
- Cooling systems usage varying by type.

Respondents proposed the following changes to assumptions:

- Both integrating space cooling considerations with Part O and conversely, separating the completion of the HEM:FHS tool from Part O calculations to reduce dependability.
- Enabling daytime cooling in secondary zones to mirror heating schedules.
- Expanding cooling options beyond air conditioning to incorporate both active and passive cooling methods and features.
- Shifting cooling profiles to reflect real occupancy patterns,
- Improving the alignment between AD-L and AD-P assessments, such as regarding window opening behaviour.
- Providing clear guidance on free area calculations and window restrictors.
- Reassessing temperature assumptions.
- Testing hourly models across different dwelling types.

Government response – Questions 5 – 11

We have followed the feedback in response to these questions, prioritising ease and consistency of user inputs while ensuring modelling assumptions reflect realistic averages and authoritative data sources. This is to ensure that HEM:FHS produces realistic assessments of the thermal performance of buildings without pursuing an unnecessary level of customisation which would complicate the assessment process unnecessarily.

After reviewing feedback, we have decided to move to a single thermal zone model for the FHS assessment. This single zone now uses a single temperature setpoint profile based on the control type. This decision is based on the following key points:

- Simplification of assessment inputs: Moving to one thermal zone significantly reduces the number of geometry inputs that assessors need to provide. This, together with other input simplifications, helps address concerns about the complexity of, and time required for, assessments.
- Minimal impact on compliance metrics: When an average temperature is used for the single zone, there is no observed difference in compliance metrics compared to using two zones with slightly different temperatures.

While some respondents raised concerns about flexibility and the diversity of real-world homes, technical analysis indicates that a single-zone approach is robust for the majority of UK dwellings. The inclusion of inter-zone heat transfer, which some respondents supported, would have had a similar effect in bringing the two zone temperatures closer together, without the corresponding simplification of the inputs. This option was therefore not pursued.

With the transition to a single thermal zone, one overall setpoint temperature profile is now required for the calculation. To generate this, an area weighted mean setpoint temperature profile is generated by using the living area and rest of dwelling area. The target setpoint temperatures and heating hours for each floor area have been retained from the consultation version; that is, the underlying profile assumptions have not changed, but the area weighting will produce bespoke final profiles for each dwelling.

Based on feedback, we have decided to simplify the space heating control options to either *temperature control* or *separate time and temperature control*. The setback temperatures and advanced start periods are no longer offered as user inputs and have been integrated as part of these main control types. Separate temperature control means both living and non-living areas follow the same time schedule (but setpoints will differ, as above). Separate time and temperature control has distinct weekday schedule for both areas, and a fixed 2-hour advance start applied to each area, which allows pre-heating before occupancy. Outside the core heating hours, the setback temperature of 18°C has been retained for both control setups.

In response to feedback we have retained the logic of not enforcing a heating season, where the heating is assumed to be off regardless of the temperature. This approach produces a more realistic profile of heating intermittency during shoulder seasons and one-off heating events.

For cooling, a set point of 24°C with a fixed time-of-day cooling schedule has been maintained. This is the central figure in the range 23-25°C given for habitable rooms in CIBSE Guide A. Some responses requested further cooling system options, but given the relative rarity of active cooling systems in the UK and evidence as to how they are used in practice is sparse, we have decided to retain a single standard profile in HEM:FHS.

Domestic hot water (Q12-16)

Question 12

What are your views on the assumptions for the volume of hot water demand? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question, with eight respondents agreeing, nine disagreeing, three providing mixed responses. The remaining 35 responses did not make their views clear.

Key actions and comments that were presented in the responses included calls for a review of the FHS wrapper assumptions in terms of volume of hot water demand against Approved Document G, with a comparison showing the volume of hot water associated with different use cases. Additionally, there were comments that the volume of hot water demand associated with showers and baths should be reviewed. Studies quoted in the consultation responses suggest 4-7 showers per person per week, with only a small proportion of people having baths.

There were suggestions that the impact of the use of electric showers and/or the absence of a bath on the calculation of the volume of hot water demand should be analysed and explained clearly in the documentation.

There appears to be confusion around how the pipework distribution losses are calculated in HEM. It was noted that clarification on this point, including any updates, would be beneficial to stakeholders. It was also noted that the fittings assumed in the Notional Building should be reviewed to ensure they are compliant with Part G standards.

Many responses noted the impact of HEM on hot water system sizing. For example, respondents noted that lower storage temperatures, common with heat pumps, often necessitate larger storage tanks to store equivalent energy. They suggested that the current HEM model does not effectively account for this, and further clarification in the government response is needed.

Finally, an error was identified in HEMFHS-TP-03 Table 1, where the shower flow rate is incorrectly listed as 8 litres per second. This should be to 8 litres per minute.

Question 13

What are your views on the pseudo-randomly generated hot water use schedule, including the algorithm generating it? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question, with six respondents agreeing, ten disagreeing, and six mixed responses. The remaining 33 responses did not give clear views.

Some respondents questioned the assumption that the system cannot supply two showers or baths simultaneously. This assumption, which results in concurrent shower demands being stretched into different consecutive timeslots (as noted on page 8 of HEM:FHS-TP-03), appears to be based on combi boiler technology. However, many believe that the presence of a hot water cylinder (likely in most FHS-compliant homes) would support simultaneous usage, and therefore the schedule should reflect this capability.

Concerns were also raised about the frequency of events, particularly showers and baths. Respondents cited published studies suggesting that individuals typically take between four and seven showers per week, with only a small proportion of people regularly taking baths, often limited to children. This suggests that the current assumptions may not accurately reflect real-world behaviour.

The pseudo-randomisation approach drew criticism. One concern is that it leads to unrealistic patterns, such as multiple days without showering followed by clusters of events, as illustrated in figure 4 of the consultation document. Respondents recommended reviewing this for plausibility against actual water use profiles and considering the consistency of performance evaluation.

Additionally, the impact of electric showers and the absence of baths on usage frequency should be analysed and clearly explained. There was also a request for clarification on whether the seed used to generate the schedule is locked to the dwelling being modelled in HEM, ensuring that subsequent runs of the code produce consistent results.

Finally, some respondents expressed concern about the complexity of the approach. They noted that the methodology was not well understood and that there was a perceived lack of clarity around the source data used to inform the schedule.

Question 14

What are your views on the proposed hot water / mixed water temperature assumptions? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to the question. Of these responses, six agreed, three disagreed, and 32 responses did not give clear views. A further 14 responses proposed changes.

Of these 14 responses:

- Four responses requested provisions for heat batteries for hot water and said that setting fixed supply temperatures and set points would limit deployment of innovative technologies such as Solar thermal, PV diverters, and enhanced insulation.
- Some responses felt that the assumptions were inconsistent with actual use. Two responses felt that the assumptions were also inconsistent with Approved Document Part G.
- Several responses mentioned Legionella bacteria. A few of these responses specified their support for industry practice of raising stored water temperature to 60 degrees once a week, with the intention of providing protection against legionella whilst not decreasing the efficiency of heat pump systems or increasing costs for consumers.
- A few responses suggested allowing for multiple / different stored water temperatures, reflective of cylinder sizes, volume of water, levels of blending, including one response suggesting the state of charge or multiple temperature measures.
- Six responses stated that assumptions should be based on the latest research without providing any further information or views.

- Three responses disagreed with the assumptions, stating the information required was overly complicated and assumptions should be revisited.

Question 15

What are your views on the assumptions for water heating hours? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Four agreed with our approach on the assumptions for water heating hours in HEM/HEM:FHS assessment. Eleven respondents expressed disagreement with our approach. One response gave mixed views and eight proposed changes. The remaining 31 did not express directly actionable views.

Those who disagreed with our proposed approach regarding the first assumption, that cylinder heating and instantaneous water heating is available throughout the day, suggested that the assumption was not representative of many use cases, especially those utilising heat batteries or other technologies which are scheduled to provide heat to the household only at scheduled times.

Those who disagreed with our proposed approach to the second assumption, that hot water cylinders run an overnight legionella cycle where the 60°C setpoint is maintained from midnight to 7am, suggested that the assumption was not aligned with industry practice or requirements from the HSE, MCS building regulations. Respondents suggested that the assumed frequency of cycling be reduced with many respondents proposing the cycle be weekly not daily.

Several respondents across the housebuilding, consulting and accreditation sectors suggested that the assumptions should be based on latest research, though it was unclear if the respondents felt that the assumptions in question were not already based on latest research and/or were proposing that the assumptions be updated to align with future or ongoing research.

Question 16

What are your views on the cold-water feed temperature assumptions? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Seven agreed with our approach on the cold-water feed temperature assumptions. Two disagreed with our approach, 13 respondents suggested proposed changes in their response and the remaining 33 responses did not provide specific views.

Those in support of our approach suggested that the proposed assumptions were acceptable, explicitly agreed with the approach, or had no issues with the current method.

Those who disagreed with our approach suggested that the assumptions are overcomplicated, not user friendly, or that they prefer to use their own judgement rather than integrated assumptions.

Proposed changes to the assumptions included:

- Use of most recent research technical data
- Standardisation for New Homes
- Adjustment for Climate Change into data
- Integration of regional weather data
- Exclusion of header tanks

Government response – Questions 12 - 16

We have retained the approach of estimating total hot water demand and event frequency from the consultation, based on the original data sources. Some further refinements and error corrections have been made, as detailed in HEMFHS-TP-04. This methodology is based on a large and recent dataset, providing robust evidence to support these assumptions. While respondents highlighted that the assumption that hot water systems cannot supply more than one shower or bath simultaneously might not accurately reflect some new build dwellings, we have retained this assumption. Changing this would require a robust approach to assess system capability and would complicate the scheduling methodology without sufficient improvement to the energy performance assessment.

It was suggested by respondents that the estimated hot water demand from shower events, based on combi boiler data, disregarded the prevalence of electric showers in the UK stock, including alongside central heating systems. The demand estimation now accounts for this by increasing the number of shower events by 15% over the Connected Devices data – see HEMFHS-TP-04 Annex 1, Section 6.

The pseudo-random generation of hot water event schedules has been largely retained, with some minor refinements. This approach ensures that the hot water schedule captures plausible variations in hot water events and avoids the brittleness of a single schedule being used in all dwellings with the same broad characteristics. Representing unusual but plausible clusters in the schedule allows unmet demand from inadequate system sizing to be captured in the FHS metrics. While the method may generate schedules with unusual frequency of clusters, this does not impact the FHS metrics, provided that the hot water system is adequately sized for the dwelling. Some respondents requested information about the replicability of the methodology. As documented in HEMFHS-TP-04 FHS, the method uses a fixed seed to provide a consistent schedule for the same dwelling, so identical user inputs will produce the same schedule in every run.

The temperature schedule for hot water cylinders, which includes hot water being available throughout the day at temperatures between 52°C and 60°C, has been retained. Following revised guidance from HSE, the legionella cycle where the cylinder maintains a 60°C temperature now runs once a week rather than night; and from 1am until 2am, rather than midnight to 7am. This reduces overall hot water demand. Some respondents noted that this pattern is more in line with real practice. This revised assumption aligns more closely with the latest CIBSE Design Guidance for installation of heating systems.

Smart hot water tanks have been added to the core methodology, and the wrapper has been updated to assign a control schedule using a minimum and maximum state of charge that varies throughout the day. As recommended by several respondents, this control schedule allows HEM to represent the ability of these tanks to store water stratified at different temperatures and capture the efficiency benefits of doing so.

Assumptions around cold-water feed temperatures are unchanged from the consultation. Regional variations have not been incorporated due to lack of suitable supporting data, but this remains a possibility for future refinement.

Lighting, cooking, and appliances (Q17-20)

Question 17

What are your views on the proposed assumptions for lighting demand, time of use, and thermal gains availability? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Two agreed, three disagreed and three offered mixed views. Thirteen respondents proposed changes to the assumptions. The remaining 34 responses were either unclear, irrelevant or declared no view.

Those with mixed views, mostly agreed with the assumptions but found limitations or made suggestions to the assumptions.

Those who disagreed with our response argued that assumptions are both overcomplicated and outdated, particularly regarding lighting technology usage.

Proposed changes to the assumptions included:

- Further consideration of technological changes and demographic lighting trends, such as uptake of LED lighting which has no thermal gain.
- Thermal gains are building dependent so difficult to estimate.
- Further clarity required on changes to the SAP methodology to estimate actual heat gains.
- Inclusion of lighting types and fittings per zone.
- Consider shading effects on lighting demand.

- Allow user input to reflect property features and living circumstances.
- Align lighting demand with heating and building use.
- Use of more up to date research post-1990.

Question 18

What are your views on the proposed assumptions for cooking energy demand, time of use, and thermal gains availability? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Four respondents agreed, one disagreed and three offered mixed views. Eight respondents proposed changes to assumptions. The remaining 39 responses were either unsure or declared no view.

Respondents broadly agreed with the overall assumptions, with some noting the positive inclusion of new research on cooking energy demand.

Those with mixed views echoed the above while also noting limitations and proposing changes to the approach.

Those against our approach noted a lack of clarity regarding why these are assumptions are included in the HEM:FHS wrapper, when Building Regulations are only applicable to regulated energy. Respondents also questioned the acceptance of thermal gains, and lack of energy demand that is visible or used. Additionally, some responses disagreed with using a randomised approach for modelling cooking demand and highlighted that a reduction in the availability factor underestimates cooking heat gains.

Proposed changes to the assumptions included but were not limited to:

- Removing or standardising user inputs in wrappers to align with Building Regulations, which only cover regulated energy.
- Updating assumptions to reflect changes in occupancy and cooking patterns.
- Including new cooking appliances (such as air fryers) with varied heat transfer characteristics.
- Utilising recent time-use survey data to improve estimates of varied intra-day energy demand.
- Accounting for different energy consumption patterns on weekdays versus weekends and ensuring alignment between energy use data and assumed occupancy patterns.
- Considering the energy impact of mechanical extract ventilation during cooking.
- Treating thermal gains from cooking as a separate zone.

Question 19

What are your views on the assumptions for appliance energy demand, time of use, and thermal gains availability? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Three respondents agreed, five disagreed and three offered mixed views. Thirteen respondents proposed changes to the assumptions. The remaining thirty-one responses were either not directly relevant to the question or declared no specific view.

Respondents broadly agreed with the assumptions, with one noting that assumptions align with their existing data.

Some respondents with mixed views supported linking appliance demand to occupancy but raised concerns about thermal gains from additional appliances that are not part of regulated energy. Other concerns included unrealistic time of use assumptions and the dependency of appliance demand on floor area. Respondents also proposed suggestions.

Those against our approach included that assumptions were overcomplicated and opposed the dynamic modelling in Part O, and that the use of measured data may be distorted by outliers such as inefficient appliances or unusual user behaviour. The most common concerns were outdated research and questioning why energy from appliances is included in the FHS wrapper, when building regulations over cover regulated energy.

Proposed changes to the assumptions included but were not limited to:

- Excluding unregulated appliance energy from the FHS wrapper and focusing only on regulated energy.
- Allowing user input for built-in appliances, including reflecting the energy efficiency ratings for those appliances.
- Standardising or limiting user inputs in the wrapper to improve consistency.
- Modelling plug-in appliances based on common items per room, with allowances for less common devices.
- Making heat and moisture sources room-specific for more accurate modelling.
- Incorporating EV charging demand into property energy consumption.
- Basing assumptions and modelling on newer, post-occupancy research which accounts for varied living circumstances and energy flexibility.
- Recommending estimating net thermal losses in comparison to adjustment of availability factors.

Question 20

What are your views on the assumptions for cold water and evaporative losses? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Four respondents agreed, two disagreed and three proposed changes. The remaining 46 responses were either unsure or declared no specific view.

Of the four respondents that agreed, one noted that assumptions were reasonable due to their alignment with SAP 10.2.

Those who disagreed with our proposal argued that the assumptions are overcomplicated and that the system measures all the heat inside the home, meaning if the moisture stays indoors, the total heat in the home doesn’t change it shifts.

Proposed changes to the assumptions included:

- Capturing greater granularity in moisture loss, including contributions from occupants based on occupancy levels.
- Linking moisture loss data to heating and cooling energy calculations, using markers to flag risks of overheating or condensation.
- Lowering the default evaporation assumptions to better reflect realistic conditions.
- Accounting for the impact of laundry drying methods on evaporative losses.
- Recognising seasonal variation in evaporative losses, with higher losses occurring in winter.

Government response – Questions 17 - 20

The modelling of internal heat gains from unregulated (cooking and appliance) energy use is a longstanding component of Part L assessments using SAP. The improved detail of the HEM simulation means a more explicit approach to unregulated energy use is required, and this may have further uses in other HEM applications.

The new methodology for modelling lighting, cooking and appliance loads is explained in detail in HEMFHS-TP-05.

Lighting

The FHS wrapper calculates lighting energy use from the number of bulbs, their power and their efficacy. These inputs are used to generate a half hourly demand profile from monthly time of day shape and daylight factors. This approach has been retained because it is standardised, simple and technology agnostic, while still accounting for daylight and shading effects. Note that heat gains from lighting are power-dependent, hence efficient low-power bulbs produce much less heat gain, though gains are calculated in the same way for all lighting types.

Cooking

Cooking demand is now modelled as event-based appliance use for oven, hobs, microwave and kettle. Microwaves and kettles are now assumed to be present in all dwellings. The wrapper now uses a standard hourly propensity profile for the year and scales it by occupancy schedules, so events only occur when the dwelling is occupied. The improved approach combines a top-down annual energy estimate with bottom-up event scheduling. This brings cooking more closely into line with the approach used to model hot water events (i.e. realistically intermittent demand).

Appliances

Inputs for individual appliances have been simplified to whether the appliances are installed or not. The appliances with the largest energy use events (such as washing machines and dryers) are now modelled as explicit demand events rather than as part of a smooth aggregate load curve, to increase accuracy. The remainder of smaller appliances are still modelled as an aggregate load. Appliance electricity use is a significant component of overall electricity use, and hence important both for heat gains and utilisation of PV and other microgeneration.

Cold water and Evaporative losses

Heat losses due to cold water and evaporation are dependent on occupancy levels, using the same occupancy profiles as for metabolic heat gains (see response to Questions 3 and 4) and replaces the fixed rate of loss used in the consultation version of HEM, which was inherited from SAP 10.2. The revised methodology is set out in HEMFHS-TP-07.

Weather assumptions (Q21)

Question 21

What are your views on the use of climate projections rather than historical averages for the weather assumptions within the model? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Fifteen respondents agreed, five disagreed and eight were mixed. Nine proposed changes to the use of climate projections, or provided suggestions indirectly related to the question, such as localised data. The remaining 18 responses were either unsure or did not express a clear view.

Those who agreed on the use of climate projections rather than historical averages, stated that climate projections better reflect evolving trends in weather in the context of a changing climate. Overall, many supporters also argued that project data should be localised, noting that it provides more accurate insights for specific regions.

Those with mixed views were divided between preferences for projected and localised data, compared to recent historical weather averages. Respondents which preferred historical averages, noted that projections could be overcomplicated and unreliable due to peak weather periods, required a high level of validation to ensure regions are all accurate and that warm weather assumptions may impact technology choices.

Those who disagreed, preferred the reliability of historical weather data. Respondents also noted concerns about data transparency for projected data and that warmer weather assumptions risk the under sizing of systems such as heat pumps, compromising heating performance in colder conditions.

Proposed changes included:

- Using both climate projections and historical data to balance future relevance with proven accuracy.
- Providing more clarity on the impact of using climate projections compared to historical averages.
- Incorporating local weather data to offer more tailored insights for specific regions.
- Avoiding relying solely on the compliance wrapper for heat pump specification and proposing a separate, heat pump–ready wrapper that includes on-site performance data.
- Using regional historic weather data as a more reliable alternative to projections that are difficult to validate.
- Limiting the number of weather zones used in the model to a maximum of three for simplicity.
- Using broader climate zones instead of detailed projections.
- Including data such as CIBSE's Design Summer Year (DSY) weather files in the model to better reflect peak summer conditions.

A frequent point was raised regarding the need for regular updates and model adjustments to maintain accuracy.

Government response – Question 21

Respondents had a range of views on the use of regionally varying weather data, as was used in the consultation version of HEM: FHS. A single standardised profile for England, fewer regional profiles, and significantly more profiles representing much higher spatial resolution, were all proposed as alternatives. In light of the simultaneous running of HEM: FHS and SAP 10.3, where the latter model retains the single standardised weather profile for England used in SAP 10.2, we have decided to use a single standardised weather file for England in HEM: FHS. This helps ensure consistency of outcomes across all FHS compliance assessments. We recognise that there is a trade-off in the accuracy of estimated energy consumption because of this standardisation, and that this can affect the apparent optimal sizing of heating systems. We will continue to explore the use of location-dependent weather in HEM assessments in the future, and to facilitate this for other uses of the model.

We recognise that there are mixed views on the use of climate projections compared to historical data, with projections viewed as better reflecting a changing climate but their validity being more uncertain. The consultation version of HEM: FHS used the CIBSE Test Reference Year weather data as the basis for its assessments. We have opted for HEM: FHS to use historical weather data sourced from climate.onebuilding.org. These data and the methodology used to produce them are open source, which helps to alleviate transparency issues raised by some respondents. The two datasets share underlying source data collected from weather stations and undergo equivalent averaging procedures to produce representative time series. Being historical, the forward-look made possible by the Met Office Climate Projections methodology is no longer available, but the effect of this change on assessment outcomes is small.

Responses consistently highlighted the importance of ensuring weather data is accurate, representative, and valid. To address this, the weather file has been selected by comparing the temperature, humidity, solar irradiance, and wind speed for each climate.onebuilding file against the average for England. Shortlisted weather files were subject to quality checks, such as ensuring all dates and expected data were present, and comparing a variety of summary statistics for each variable. Files were ruled out if they contained anomalous data. The most representative data file which passed the quality checks was selected for use in HEM:FHS.

In response to concerns raised outside of the consultation, about the quality of the solar data in the climate.onebuilding files, we have replaced the solar data in the original files (sourced from ERA5, the fifth generation reanalysis for global climate and weather from the European Centre for Medium-Range Weather Forecasts) with data from the Copernicus Atmosphere Monitoring Service (CAMS). Academic literature shows that the ERA5 data can under- or over-estimate direct solar radiation in response to cloud cover, and that CAMS more closely aligns with ground measurements. Although internal analysis showed that the switch to CAMS data had a minor impact on the FHS metrics, this modification should enable HEM: FHS to better reflect hourly variation in solar PV generation and solar gains.

FHS compliance metrics

Metrics (Q22-23)

Question 22

What are your views on the additional metrics produced by the FHS assessment wrapper (i.e. metrics produced in addition to the FHS compliance metrics)? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Six respondents supported the additional metrics, three had mixed views and two disagreed. Nine respondents proposed changes to the metrics. The remaining 35 responses did not express a clear view.

Those who supported the additional metrics highlighted their usefulness in:

- understanding the predicted breakdown of energy use, on-site generation potential, and areas for improvement in home design,
- conducting initial analysis for building fabric and air tightness, efficiency of heating and hot water systems, and on-site renewable energy, and
- compiling large-scale datasets at local, regional, and national levels, which could be valuable for other applications.

Some respondents raised concerns that the additional metrics:

- do not reflect the real usage of a building,
- increase calculation time and should therefore be minimised, and
- are standardised based on total floor area, potentially creating unintended bias in the produced data.

Other respondents suggested the following improvements:

- ensuring that assessors can extract all results and outputs as a dataset,
- including additional metrics such as an actual fabric energy efficiency measurement, a delivered energy metric, and an energy use intensity metric,
- testing the science behind the additional metrics, and
- making the additional metrics more flexible and customisable to individual situations.

Question 23

What are your suggestions for additional metrics (i.e. metrics produced in addition to the FHS compliance metrics) not currently produced by the FHS assessment wrapper? Please make suggestions, explaining your reasoning, and providing any supporting evidence.

Summary of responses

We received 55 responses to this question, with 32 responses offering thoughts on additional metrics, and two opposing the consideration of additional metrics. Twenty-one respondents did not provide any suggestions for additional metrics or improvements.

Respondents offered a wide range of suggestions for metrics that could enhance the FHS wrapper, reflecting a desire for more granular, performance-based, and user-relevant indicators. The most frequently mentioned themes were heat pump performance, data access and reporting, appliance-level energy use, annual and unmet energy use, and flexibility.

Heat pump performance was the most frequently raised topic, with 7 mentions out of 34 responses. Respondents proposed metrics such as average Coefficient of Performance (CoP) during space heating and hot water production to better reflect real-world efficiency and product stability.

The next most common theme with five out of 34 mentions, was data access and reporting. Many called for the ability to extract and customise reports from the FHS wrapper, including downloadable outputs and access to intermediate data points to support design flexibility and client reporting.

There were also suggestions which included metrics for annual energy use, unmet energy demand, and total consumption including appliances, cooking and EV charging. These would help assess affordability and system interactions more holistically.

Some respondents also recommended metrics that capture flexibility potential of homes, including load shifting, smart heating, and battery storage. Some supported the Smart Building Rating concept and proposed a ‘smart EPC’ to reflect smart meter and control installations.

Some respondents advocated for a new metric based on measured Heat Transfer Coefficients – an Actual Fabric Energy Efficiency (AFEE) metric) – allowing the FHS wrapper to reflect real-world performance and close the design performance gap.

The other metrics mentioned were carbon and cost metrics, to ensure that low-carbon does not equate to high-cost and environmental and comfort factors.

Government response – Questions 22 - 23

The FHS assessment wrapper calculates the metrics required to assess compliance with the FHS. It also produces additional metrics and output data for further investigation and diagnostic purposes. This includes providing a breakdown of primary energy and emission across consumption, generation and unmet demand for each fuel type in each timestep.

The wrapper’s metric calculations supplement the reporting of the core engine, which produces a summary file for each simulation. Here, we have maintained reporting of the additional metrics from the consultation including annual space heating and cooling demand; annual energy use (both total and broken down by use case and fuel type); peak half hourly electricity draw; heat transfer coefficient and annual on-site electricity generation (both used on-site and exported). In response to consultation feedback, we have introduced reporting of the annual overall coefficient of performance (COP) for space heating and water heating (heat pump COP values are also recorded at multiple system boundaries). Additionally, the annual energy use reporting now includes a breakdown of appliance usage and includes energy storage.

The core calculation also produces further detailed results files, containing half-hourly timeseries results, for each simulation performed.

We recognise the importance of data access to users, which was reflected in consultation responses. The open sourcing of the FHS wrapper and HEM core engine provides direct access to results files for users and supports the development of custom post-processing scripts. The results and metrics are output as tables in comma separated value (.csv) format files or as JavaScript Object Notation (JSON) format files. These are common, standard file formats which allow users to extract data and produce further custom reporting. The precise means of accessing supplementary HEM outputs via the gov.uk interface for HEM and via commercial front-end software will be determined by these providers.

Fuel assumptions (emissions and primary energy) (Q24-26)

Question 24

What are your views on the methodological approach to define the emission factors and primary energy factors used within the Home Energy Model: FHS assessment? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Six respondents agreed with the methodological approach, ten disagreed, six had mixed views. The remaining 33 responses were either irrelevant, unclear or had no view.

Respondents who support the proposed approach, generally welcomed the move toward using up-to-date and standardised emissions and primary energy factors, particularly those drawn from the 2022 Government Greenhouse Gas Conversion Factors. They highlighted the benefits of consistency in reporting (coherence across government and industry emissions tracking), improved accuracy, and credibility. Some explicitly support the use of the most recent figures and recommended regular updates to maintain relevance.

Respondents with mixed views or concerns generally accepted the intent behind the methodology but raised concerns around its practicality, fairness, and technical robustness. Some highlighted that it should be adaptable to different living circumstances, not captured by standard assumptions. Several respondents argued that current factors reflect a long-term decarbonised future which doesn’t align with the 5–10-year timeframe in which decisions about heating systems are made.

Those who disagreed raised objections around the use of static, annualised factors for electricity. They argued that using a single annual carbon intensity or primary energy factor for electricity is inappropriate, as it ignores regional, seasonal, and intraday variations. This is seen as problematic given the increasing role of flexible technologies like heat batteries, thermal stores, and agile tariffs.

There were also some concerns around the methodology penalising flexibility and potentially undermining decarbonisation efforts, calls for dynamic modelling and recommendations to use half-hourly forecast data to better reflect real-time grid conditions and support technologies like demand shift and dynamic containment response.

Question 25

What are your views on the proposed emission and primary energy factors for electricity? Please explain your reasoning and provide any supporting evidence.

Summary of responses

We received 55 responses to this question with a broad spectrum of views. Twelve respondents expressed disagreement, eight respondents expressed agreement, five mixed responses, and the remaining 30 did no express a clear view or opinion.

There were several reoccurring themes across the responses

A total of nine respondents expressed concerns over the Primary Energy Factor, particularly criticising the use of a single annual value. They argued that this approach fails to reflect real-time variability in electricity generation and consumption, therefore undervaluing technologies like thermal stores, batteries, and time-of-use tariffs.

Grid decarbonisation was mentioned four times. Respondents acknowledged the importance of aligning emission factors with the UK's trajectory towards a greener grid and supported using forward-looking projections for this reason, especially given that FHS compliant homes will begin construction from 2027.

Time-varying factors were also mentioned four times, with a concern raised about the use of a single annualised value for emissions and primary energy. Respondents argued that this undermines the value of flexible technologies like batteries, thermal stores, and time-of-use tariffs. They advocated for half-hourly or dynamic modelling to better reflect real world grid conditions.

Solar PV treatment was mentioned three times, with respondents criticising the model for undervaluing on-site solar generation, particularly when exported to the grid. They argued that this contradicts policy goals around affordability and grid support.

Other themes mentioned were storage and flexibility, including the need to reward technologies that reduce grid strain and support decarbonisation. Some respondents questioned the logic of applying thermal conversion efficiencies to nuclear or imported electricity, suggesting these distort the model's outcomes.

Question 26

What are your views on the penalisation of energy shortfall and the energy shortfall factors? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question, with 11 respondents disagreeing, eight agreeing and ten having mixed views The remaining 26 respondents gave no answer at all or their response was unclear.

Of those that disagreed, respondents expressed concerns about fairness, realism, and unintended consequences of penalising energy shortfall. Respondents criticised the use of double electricity factors as ‘harsh’ or ‘unreasonable’, questioning why standard energy use factors aren’t applied instead. There were also concerns that penalisation could encourage assessors to manipulate inputs to pass assessments, undermining the integrity of the HEM model.

Some expressed that heating system sizing should remain with M&E experts, not energy assessors and some argued that the model doesn’t reflect real-life scenarios, such as the limited lifespan of PV panels or the impracticality of replacing broken systems.

Of those that agreed, respondents expressed support for penalisation, often with caveats or suggestions for refinement. Respondents expressed support on the grounds that it realistically models occupant behaviour, particularly the likelihood that residents will turn to portable electric or bottled gas appliances when primary heating systems fall short. Assigning unmet demand to electric heaters was seen as a practical way to prevent undersized systems from gaining artificial energy saving advantage. Penalisation was also viewed as a positive incentive for developers to construct better insulated, more energy efficient homes. Additionally, respondents advocated for more transparent and accurate assessments, and the separate reporting of unmet demand for space heating and domestic hot water to enable more targeted improvements.

The mixed views broadly supported the principle but questioned the implementation. These respondents asked for clearer guidance on how penalties are calculated, especially for heat pumps. Suggestions included rejecting calculations with frequent shortfalls or failing Part L compliance outright, rather than applying penalties. There was emphasis on ensuring the process isn’t exploitable, and that homeowners are informed of implications.

Government response – Questions 24 - 26

The methodology and assumed factors for emissions and primary energy of fuels have been retained from the consultation version of HEM. These can be viewed in Annex A of HEM FHS-TP-09, published alongside this document. These factors are expected to remain constant for the lifetime of the latest edition of Part L, as in previous editions. Note that other wrappers may adopt alternative numbers if these are found to be more appropriate to their respective use-cases.

Several respondents advocated for the adoption of more granular, varying factors for grid electricity, which would capture some real phenomena which are not recognised in a single average figure for emissions or primary energy. A robust methodology to produce a representation of a varying electricity grid, suitable for use in Part L compliance assessments, has not yet been produced, and work is ongoing in this area.

A number of responses to this consultation, as well as further submissions of analysis by stakeholders and additional work undertaken within the HEM project, have identified that penalisation of unmet demand in the consultation version of HEM:FHS was excessive and distorted compliance outcomes in undesirable ways. While the calculation of unmet demand and its role in the Part L compliance metrics have been largely retained, we have made two changes which greatly mitigate the unintended effects:

1. The penalisation factors (emissions and primary energy) for unmet demand are now equal to those of grid electricity (previously they were higher).
2. The accounting for unmet demand has been altered to reduce the sensitivity, which could create disproportionate impacts and potentially incentivise significant over-sizing of heating systems.

These changes have brought the treatment of unmet demand into line with the original intentions.

Validating the assumptions used in the FHS assessment wrapper

Validation against benchmark building energy models (Q27)

Question 27

What are your views on the inter-model validation work that has been carried out (i.e. against SAP 10.2, PHPP and ESP-r)? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Seven respondents shared positive views, five were mixed and 13 were negative. The remaining six responses were irrelevant, unclear, or ambivalent. Twenty-four respondents did not answer this question.

Those who shared positive views supported inter-model validation work, noting that testing the significance of differences caused by standardised inputs is important.

Those with mixed responses shared both positive and negative views. Respondents echoed that comparisons and cross-model insights are useful and supported the transparency and clarification provided by inter-model validation work. On the other hand, respondents stated that further development was required, with an expansion of validation scope through tools such as Building Information Modelling (BIM).

Those with negative views regarding the inter-validation work stated:

- An inaccuracy between comparing dynamic to static models, questioning the use of static models.
- Theoretical comparisons are inconclusive and need validation against real-world data.
- An insufficient comparison between SAP and HEM.

- Testing limitations of HEM restrict the validation scope.
- PHPP comparison not robust due to differing inputs and modelling approaches.
- HEM underestimates energy demand versus PHPP, requiring better alignment.
- Hot water figures differ significantly from SAP10 without clear justification.

Lack of clarity on impact of standardised heating hours.

Validation against real-world case studies (Q28)

Question 28

What are your views on the monitoring data case study validation work that has been carried out? Please explain your reasoning and provide any supporting evidence.

Summary of responses

We received 55 responses to this question. Seven responses were supportive, 16 were constructive and four were critical. Twenty-eight respondents did not answer this question.

Of the supportive responses, respondents welcomed the use of real-world homes for validation and emphasised the importance of representativeness in case studies. They praised the transparency of the process and highlighted the role of case studies in establishing high industry confidence.

The constructive responses supported the validation work but offered suggestions for improvement or raised nuanced concerns. Key recommendations included expanding the sample size, incorporating diverse building types, integrating onsite measurement tools like SMETERs, and establishing error margins to enhance model transparency. Respondents also called for greater clarity on assumptions and measurement methods and highlighted the need for more detailed data on ventilation systems and calibration outcomes.

Critical responses expressed concerns about the validity and realism of the validation work. Some felt the focus on new builds was misplaced, arguing that existing housing stock should be prioritised. Others criticised the sample selection and zoning assumptions as unrepresentative and questioned the accuracy of uncalibrated HEM results.

Future Validation (Q29)

Question 29

What suggestions do you have for further validation exercises that could be undertaken to refine the Home Energy Model: FHS assessment? Please make suggestions, explaining your reasoning, and providing any supporting evidence.

Summary of responses

We received 55 responses to this question. Twenty-six respondents provided suggestions for further validation exercises, while the remaining five responses were either ambivalent or irrelevant. Twenty-four respondents did not answer the question.

The following suggestions for further validation were made:

- using post-completion and post-occupancy data, such as data from energy bills or smart meters,
- using data from retrofit installations or retrofit organisations,
- conducting validation exercises specifically focussed on individual heat sources, such as underfloor heating and heat pump performance,
- implementing a long-term performance monitoring programme where homes assessed with the HEM are monitored over an extended period, potentially including the use of sensors and monitors to capture real-time, longitudinal data,
- validation of time-of-use technologies,
- expanding the number of case studies and properties to cover a range of different building types and ages,
- carrying out additional real-life checks on new builds, including flats and large dwellings,
- validation against more representative dwellings and those already being built to the potential FHS,
- using more onsite performance measurements,
- using more representative UK occupancy levels, taking remote working into account,
- involving industry to conduct stress testing and validation, and
- additional validation on infiltration and ventilation.

Government response – Questions 27-29

HEM has undergone further extensive quality assurance and validation to ensure its suitability for simulating residential energy use. These exercises complement the previous validation work published alongside the consultation. We have refreshed and extended the analysis where HEM's methodology has changed since the consultation and have sought to address weaknesses in the testing highlighted in consultation responses. Some key new work is summarised below.

We have undertaken two connected exercises to assess the HEM core engine's modelling of the underlying building physics. These have been performed on simplified dwellings to isolate specific physical processes and to provide a bottom-up assessment of the core engine.

Respondents highlighted the need for further testing of HEM's approach to infiltration and ventilation, which is necessary given the substantial changes in this area since the consultation. We have therefore performed an extensive comparison with the Environmental

Systems Performance – Research (ESPr) building simulation model. This compared the two dynamic energy models across a series of scenarios of increasing complexity, designed to isolate specific aspects of infiltration and ventilation modelling. This testing shows both improved alignment and increased realism across a range of scenarios, increasing confidence in the modelling of infiltration and ventilation.

Some consultation responses suggested further testing for specific heat sources. We have conducted a review of the performance of HEM's modelling of air source heat pumps. We have compared HEM's predictions to prior testing of the EN 15316-4-2 formulae and known trends in heat pump performance. This work is complementary to earlier lab testing of heat pumps published alongside the consultation.

HEM: FHS's outputs have been tested across a wide range of new-build dwelling archetypes, with particular emphasis on dwellings close to the compliance boundary. In response to feedback, we have extended the set of archetypes to give better representation of the expected new-build dwelling stock. We have refreshed and performed more detailed inter-model comparisons with the Passive House Planning Package (PHPP), focusing on these new-build archetypes, and supplemented this with a sensitivity analysis of HEM: FHS outputs. These tests enable understanding of how HEM: FHS performs when wrapper assumptions are applied and as dwelling complexity increases.

These exercises represent a layered approach to validation, building from a baseline assessment of the HEM's handling of building physics, before introducing specific technologies and the FHS wrapper's assumptions. The updated analysis demonstrates that HEM is a valid building physics engine, which performs appropriately when used for assessing compliance for the FHS. We intend to publish further details of these and future validation exercises in the coming months.

Effective validation of HEM is necessarily an ongoing process. We will continue undertaking quality assurance and validation tests to strengthen model assurance and broaden the scope of tested scenarios. We agree with respondents that further testing against real world data is necessary to increase confidence in HEM. We intend to proceed with further studies comparing HEM with real-world data and we will continue to assess how best to make use of onsite performance measurements to validate HEM. We further hope that the open-sourcing of version 1.0.0 of the HEM core engine and FHS wrapper will enable industry and academic partners to actively contribute to ongoing validation and quality assurance of HEM:FHS.

Equality Act 2010 (Q30)

Question 30

What are your views on the equality considerations of these assumptions and their evidence base? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Five respondents believed that the assumptions would have no impact on groups with protected characteristics. Two respondents expressed concerns about the assumption of homogeneity, despite comfort not being the same for everyone and people using their homes differently. The remaining 48 either gave an unclear answer or no answer at all.

Government response – Question 30

We recognise the importance of ensuring that all policy changes, including technical modelling reforms, are assessed for their potential impact on individuals with protected characteristics under the Equality Act 2010.

We acknowledge that the way energy is used in homes can vary significantly across different groups—for example, older people or disabled individuals may occupy their homes for longer periods or require higher baseline temperatures. These usage patterns could influence how model outputs are interpreted or applied in policy and regulatory contexts.

To ensure that the modelling ecosystem does not inadvertently disadvantage any group, a Public Sector Equality Duty (PSED) review has been undertaken. This review considered the potential for indirect impacts and confirmed that the current design of HEM: FHS is unlikely to result in discriminatory outcomes as the assumptions are standardised, evidence-based, and applied consistently across all dwellings. Nonetheless, we recognise that some groups may have specific needs that fall outside standard assumptions.

The model has been validated against a limited set of real-world homes, and to ensure continued fairness, the next phase will expand this to a broader range of home archetypes, including those more commonly occupied by vulnerable groups.

Environmental Principles Policy Statement (Q31)

Question 31

What are your views on the possible environmental impacts of the Home Energy Model: FHS assessment itself? Please provide your reasoning and any supporting evidence.

Summary of responses

We received 55 responses to this question. Three respondents assessed the potential environmental impacts as positive, three assessed there to be no impact, and one expressed concern over negative impacts. One proposed changes and the remaining 47 did not provide a relevant answer to the question or did not answer at all.

Those expecting positive impacts highlighted the following:

- the model's improved energy modelling benefits the government's environmental commitments,
- the model ensures future housing is delivered that is net zero ready and can respond to climate change, and
- the model's indirect impact through enabling a reduction in CO2 emissions through Part L of the Building Regulations, also known as FHS.

One respondent raised the concern that the model masks a performance gap regarding actual fabric energy efficiency by not interacting with onsite measurements, which could have an environmental impact.

Government response – Question 31

The government is committed to advancing environmentally sustainable, net-zero practices. We acknowledge that most respondents agree that HEM: FHS has a minimal environmental impact as an individual wrapper but will contribute towards ensuring new build homes meet higher environmentally positive standards. As a wrapper, its primary function is to simulate building energy use with greater accuracy, enabling more informed policy and regulatory decisions that aid the UK's net-zero objectives. This approach seeks to negate biases towards specific technologies or systems and ensure more precise outputs. While the HEM: FHS wrapper itself has a negligible environmental footprint, its broader contribution to decarbonisation through enhanced modelling makes it a key enabler of other policies, which are expected to deliver a net positive environmental impact

Next steps

The government is continuing to work to develop and assess options for refining the detail of the methodology and model, including its assumptions, building on the positions set out here and informed by the responses to the consultation.

We look forward to continuing engagement with interested stakeholders throughout model development. We endeavour to engage with, and impact, industry feedback on HEM:FHS's ease of use and effectiveness in delivering BREL compliance work, and any further validation work we undertake. We want to ensure the model is fit for purpose in delivering industry expectations.

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