Passivhaus Trust
The UK Passive House Organisation

Modelling existing dwellings in PHPP Periodic Heating

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PHT Author:
John Palmer, Passivhaus Trust

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What is the problem?

PHPP has been shown to be an accurate and effective tool for modelling energy use in low-energy buildings. However, for existing houses which have a relatively poor fabric performance, and thus utilize intermittent heating patterns, the average internal temperature needs to be adjusted to account for the unheated periods. The problem is determining this adjusted internal temperature as it will depend on the building's fabric performance and the time the heating system is switch on.

Why does this happen?

The primary reason for this discrepancy stems from the underlying assumption behind PHPP's modelling that the house will be maintained at a constant temperature of 20ºC during the heating period. In a typical existing dwelling in the UK, maintaining this constant internal temperature at all times would be prohibitively expensive due to the high heat loss rate. Thus, most existing buildings are heated periodically to suit the occupancy pattern of the residents. This means that the average internal temperature during the heating season can be significantly lower than 20ºC. This is borne out from historical monitoring data which suggests that the average internal temperature in UK homes is around 18ºC.[1]

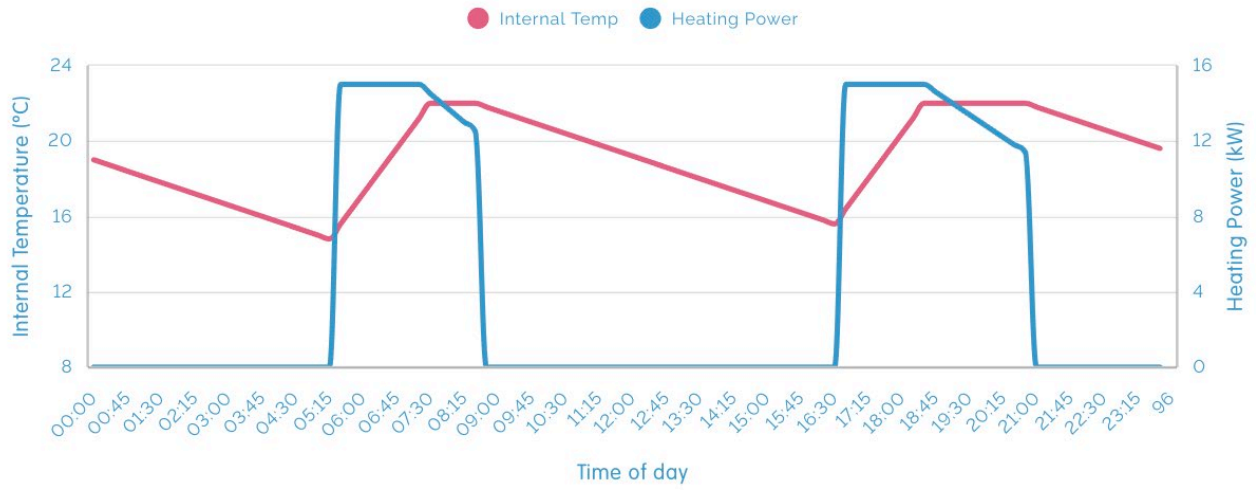

Figure 1 - Internal temperature and heating power in a typical UK dwelling

What is the solution?

Most Passivhaus designers are aware of this issue and thus will model existing buildings using a lower internal temperature for the heating season. However, this is an approximation as the actual average internal temperature will depend on the fabric characteristics of the building and also the occupancy patterns. An alternative approach is used by the UK's national Standard Assessment Procedure (SAP)[2] methodology which calculates the Heat Loss Coefficient (HLC) of the building and then uses that in conjunction with a daily heating/cooling cycle to calculate the average monthly internal temperature during the heating season. The Passivhaus Trust have therefore duplicated this methodology within an additional PHPP sheet to calculate a more representative monthly average internal temperatures for existing buildings and an overall average for the heating season. These temperatures can then be used in the PHPP heating demand calculation to achieve a more accurate indication of energy demand.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/274770/2_Mean_Household_Temperatures.pdf

[2] https://bregroup.com/sap/

What does this alternative methodology do to PHPP models?

Modelling a dwelling with an increasingly poor fabric performance using both the default temperature of 20ºC and the alternative average temperature obtained from the Mean Internal Temperature calculation reveals very close correlation at Passivhaus levels of fabric performance, but an increasing divergence in predicted energy demand as the fabric performance of the dwelling deteriorates. This is exactly what would be expected as the poorer the fabric performance, the lower the internal temperature will drop during periods when the house is unheated.

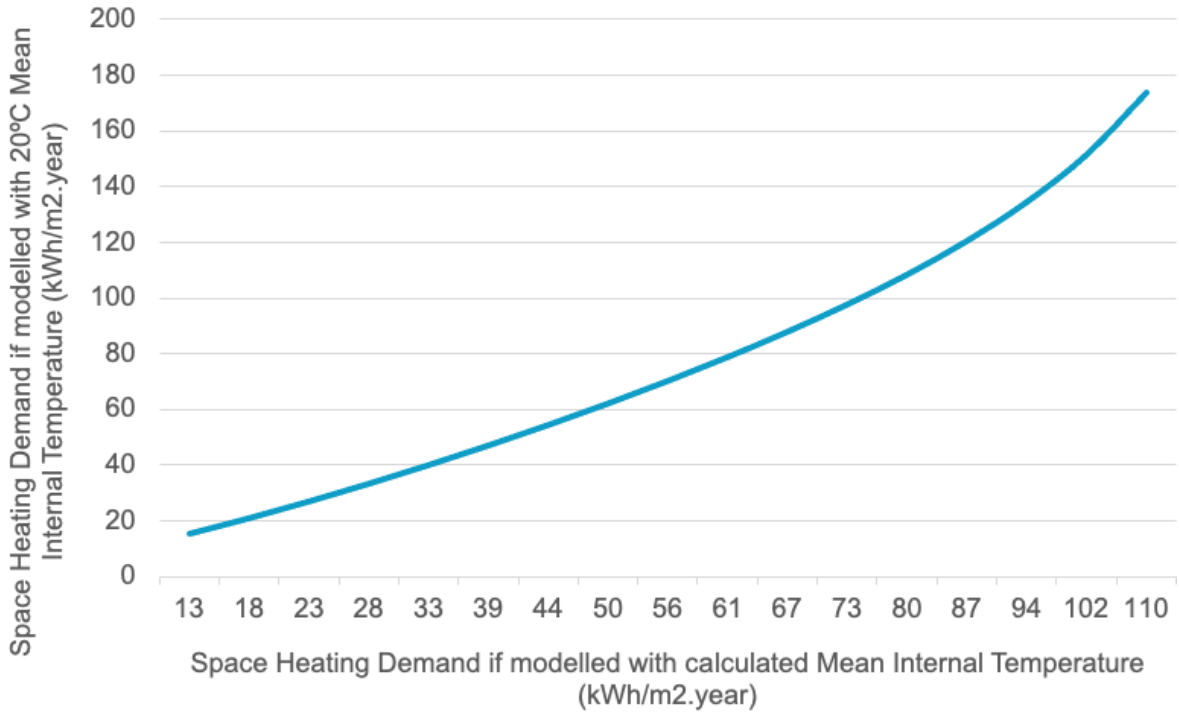

Figure 2 - Effect on space heating demand as fabric efficiency worsens and modelled with periodic heating

Does this match in-use data at scale?

This work was carried out as part of a wider UK stock model which provided archetype data for the UK's 28 million dwellings. Modelling these dwellings in an unmodified PHPP produced an average space heating demand of 130kWh/m^2.year whereas modelling using a calculated mean internal temperature and typical daily periodic heating pattern produced a result of 117kWh/m^2.year.

Consumption data for the UK indicates an average existing dwelling consumes around 10,000kWh[3] to support space heating demand and has a Treated Floor Area of 78m^2.[4] Assuming a typical efficiency for the gas boilers[5] providing space heating in the majority of UK homes, this equates to a space heating demand of 119kWh/m^2.year.

Whilst this a very large-scale calculation relying on a lot of data aggregation, it does seem to indicate that calculating an accurate mean internal temperature for homes which are periodically heated offers a far more appropriate prediction actual energy consumption for existing dwellings with relatively poor levels of fabric performance.

[3] See Passivhaus: The Route to Zero Carbon, Passivhaus Trust, March 2019, Appendix 2 for the derivation of this
[4] Treated Floor Area calculated as 85% of average UK Gross Internal Floor area of 92m^2 – see here https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725085/Floor_Space_in_English_Homes_main_report.pdf
[5] Assumed as being 85%

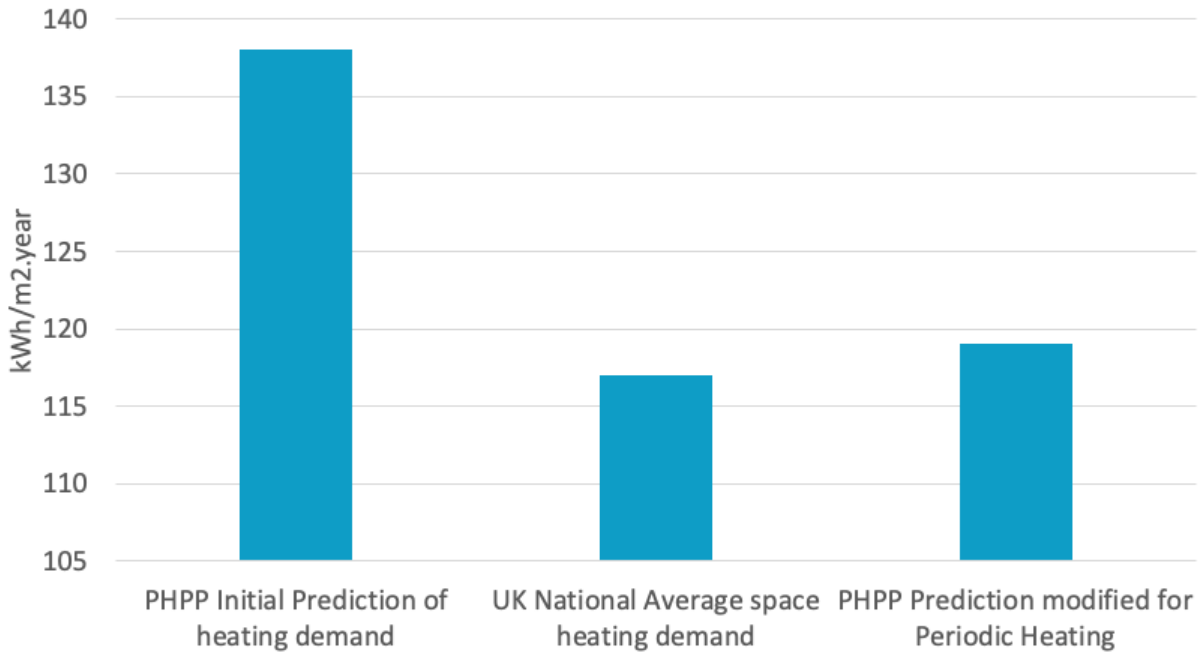

Figure 3 - Comparison of predicted average UK space heating demand against actual data with and without periodic heating modification to PHPP

What about for an individual dwelling?

To further test the periodic heating calculation, a PHPP model of an existing pre-retrofit building was used. The owners had also provided their gas bills, from which their actual gas usage for heating could be derived.

The results are shown below and demonstrate a very good correlation between the PHPP result when using an internal temperature derived from the periodic heating sheet – which suggested an average internal temperature of 16.6ºC.

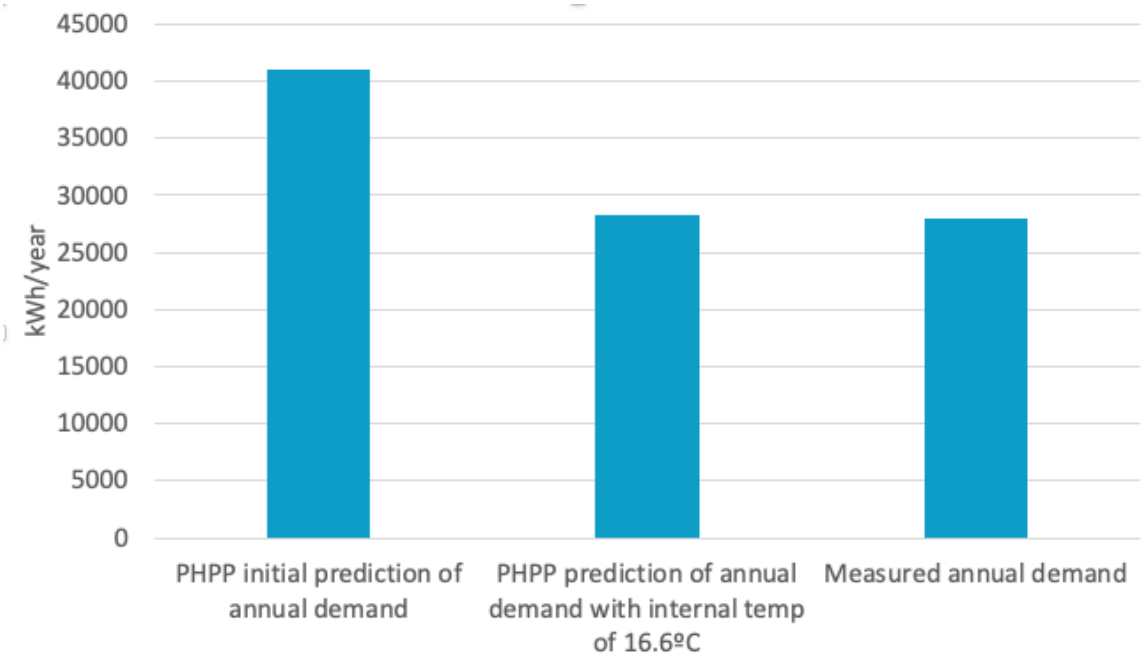

Figure 4 - Comparison of predicted annual heat demand for an individual dwelling with and without periodic heating modification

Why is this important and when should it be used?

Achieving an accurate prediction of space heating demand in non-Passivhaus buildings is particularly important when modelling retrofit scenarios as it will enable a more realistic prediction of the reductions in energy demand and energy costs from the initial baseline to the post-retrofitted home.

Download the Periodic Heating Tool

Download the Periodic Heating Tool together with instructions for use from the Passivhaus Trust website at https://pht.guide/PeriodicHeating.