Passivhaus Trust

PASSIVHAUS COMPARED TO THE PROPOSED FHS 2025

PHT Position Paper
March 2025

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Diespeker Wharf, 38 Graham Street, London N1 8JX
passivhaustrust.org.uk
info@passivhaustrust.org.uk

> *"I was working as a physicist. I read that the construction industry had experimented with adding insulation to new buildings and that energy consumption had failed to reduce. This offended me – it was counter to the basic laws of physics. I knew that they must be doing something wrong. So I made it my mission to find out what, and to establish what was needed to do it right."*
>
> — Prof. Dr. Wolfgang Feist

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Author:
Rachel Mitchell Passivhaus Trust

Technical review:
Jon Bootland Passivhaus Trust
Sarah Lewis Passivhaus Trust
Nick Grant Elemental Solutions

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EXECUTIVE SUMMARY

Two options are currently being considered for the proposed Future Homes Standard 2025 (FHS), both of which are based on the fabric parameters currently used in Approved Document L Volume 1: Dwellings (2021). One option could have photovoltaics (**FHS PV**), while in the second option, the PV is omitted (**FHS no PV**). The omission of PV will have an impact on energy use, cost, and CO_2 emissions, and this has been raised as a concern.

Calculations show:

1. Without PVs, **a new Future Homes Standard home will cost more to run each year** than an existing Part L 2021 home, approximately £340 more for a typical end terrace and £130 more for a typical flat.
2. **PVs will not be feasible for many homes**, especially for apartments/ flats. These homes will not contribute to the Government's energy generation targets and will in fact exacerbate the peak load problems for the grid, because of their higher heating demand.
3. **Investment in fabric improvements to a Passivhaus equivalent standard would reduce heating bills (and CO_2 emissions)** down to the same level as a home built to the Future Homes Standard with PVs, and **reduce the peak load** on the grid by reducing heating demand at a time (winter) when PV generation is low.
4. **Building to the Passivhaus Classic standard will cost no more** than Future Homes Standard with PV.
5. Investment in fabric improvements would bring **other benefits to occupants**, including better quality components, comfort and health as well as protection against damp and mould.

Therefore, our recommendations are that:

- Future Homes Standard dwellings should cost no more to heat than those built under the existing Building Regulations, which requires either the installation of photovoltaics or improvements to fabric performance to Passivhaus equivalent levels.
- Passivhaus Classic should be deemed to comply with Approved Document L Conservation of fuel and power when the Future Homes Standard (2025) is introduced.

The proposed new FHS standards are compared to Passivhaus Classic (no renewables), which is shown by modelling to perform near to FHS PV and better than FHS no PV in terms of:

1. Space heating demand
2. Carbon dioxide emissions
3. Running costs (regulated energy)
4. Certainty of performance
5. Comfort and health benefits

Using both an end of terrace and a block of flats as reference buildings, we have modelled FHS PV and FHS no PV against Passivhaus Classic (PH), using PHPP 10 (the Passivhaus Planning Package) to compare the three standards. Appendix 1 gives the specification for each option. We report on space heating demand, regulated energy demand, carbon emissions and running costs.

In our calculations, **FHS PV** and **FHS no PV** have a significantly higher space heating demand than expected. Erroneous predictions of low energy demand can drive decisions to allow direct electric heating in flats, which may lead to much higher energy costs than expected for occupants or to the prioritization of photovoltaics over building fabric, which may result in an inability to provide sufficient heat for occupant comfort.

A Passivhaus Classic building would have lower space heating demand than both FHS PV and FHS no PV.

Investing in the building fabric locks the energy reductions into the lifetime of the building. Relying on renewable energy generation, which can degrade over time, means that there is no guarantee they will maintain the electrical demand offset needed to maintain lower bills.

In addition, certifying a building to the Passivhaus Classic standard will deliver the following benefits compared to the two proposed options. See *Passivhaus Benefits* (Passivhaus Trust, 2021)[1] for more details.

	FHS 2025 PV	FHS 2025 no PV	Passivhaus Classic
TARGETS / LIMITS			
Energy use intensity	x	x	√
On site energy generation	√	x	x
Space heating demand	x	x	√
Cooling demand	x	x	√
ENERGY SUPPLY			
Low energy bills	√*	x	√
Lowest peak demand on the grid	x	x	√
COMFORT			
Summer comfort	?	?	√
Winter comfort	?	?	√
Good internal air quality	?	?	√
Protection against condensation and mould	?	?	√
Better quality components	x	x	√

**Dependent on PV being possible and / or the size of the array*

Table 1: *Benefits of certifying a building to the Passivhaus Classic standard*

1 *Passivhaus Benefits*, Passivhaus Trust (2021). Available online: https://pht.guide/benefits

PERFORMANCE PREDICTIONS

The performance gap between design and in-use energy performance is well documented and, conservatively, is found to result in a 60% increase[2] in space heating demand. While it is recognised that as part of the uplift to AD L 2021 and the FHS, photographic evidence is required to show that insulation measures are installed, windows are properly specified and building services perform as designed, there is, to date, no evidence that these measures will reduce the performance gap. Therefore, the same 60% performance gap that has previously been quoted for space heating demand in non-Passivhaus homes is included in the two FHS 2025 options, but not in Passivhaus Classic, which is shown by independent studies to have little or no performance gap[3].

The outputs from modelling (in PHPP) an end of terrace house and block of flats using the two FHS 2025 options and Passivhaus Classic are shown below. Note that for flats, it has been assumed that it has not been possible to install PVs on the FHS building because of roof space restrictions.

SPACE HEATING DEMAND

In both FHS options, the space heating demand is similar to AD L Vol 1: Dwellings 2021. Passivhaus Classic gives a much greater reduction in space heating demand compared to the FHS 2025 options, as the building fabric and services exceed the specification of the proposed Notional Building(s).

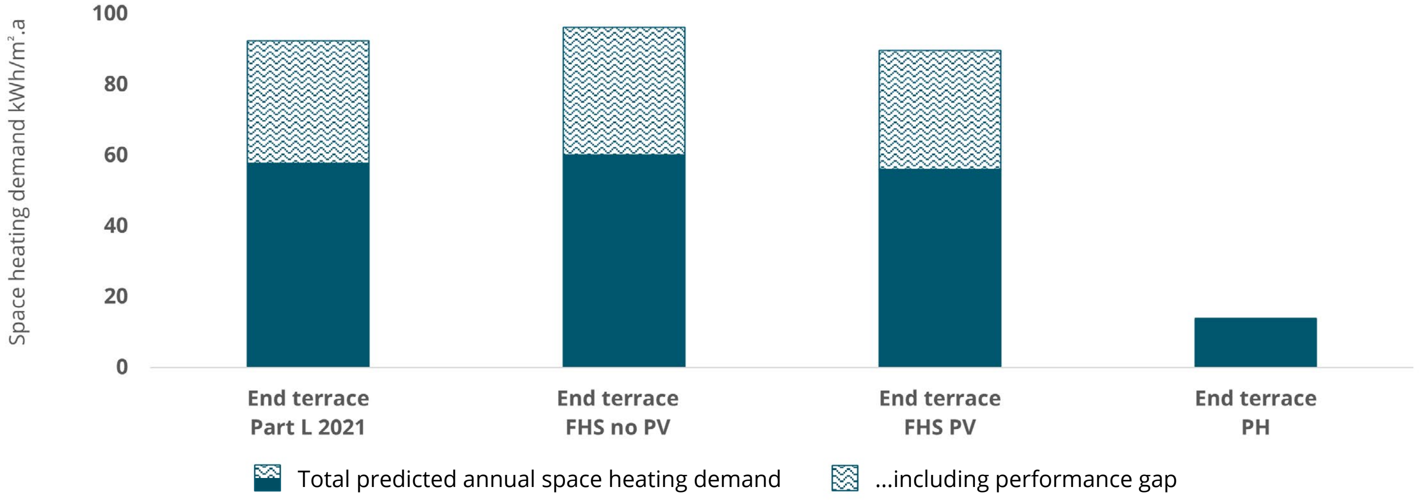

Figure 1: *Predicted space heating demand – end terrace house*

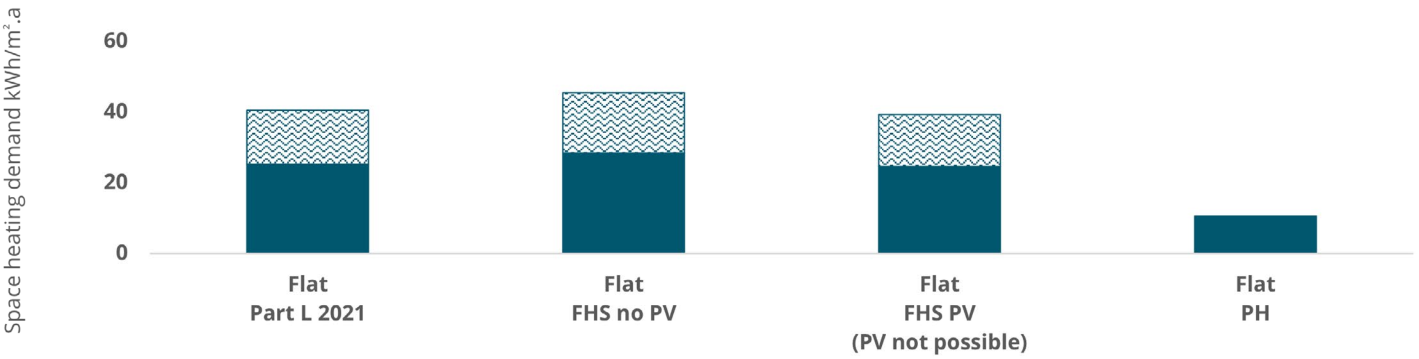

Figure 2: *Predicted space heating demand – flat*

2 See David Johnston et al., 'Quantifying the domestic building fabric "performance gap"', *Building Services Engineering Research & Technology* (2015) https://doi.org/10.1177/0143624415570344

3 See R. Mitchell and S. Natarajan, 'UK Passivhaus and the energy performance gap', *Energy and Buildings* (2020) https://doi.org/10.1016/j.enbuild.2020.110240; and D. Johnston, M. Siddall et al., 'Are the energy savings of the Passive House standard reliable? A review of the as-built thermal and space heating performance of Passive House dwellings from 1990 to 2018' *Energy Efficiency* (2020) https://doi.org/10.1007/s12053-020-09855-7

CARBON EMISSIONS

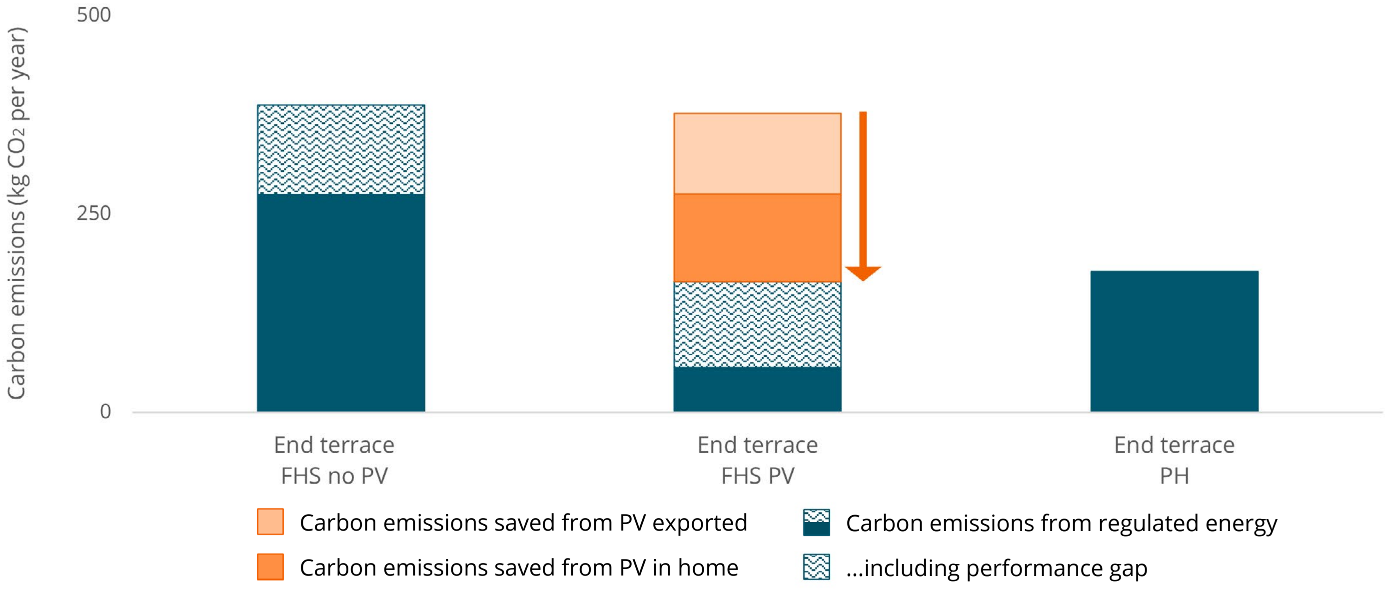

Figure 3: *Predicted carbon emissions for end terrace house*

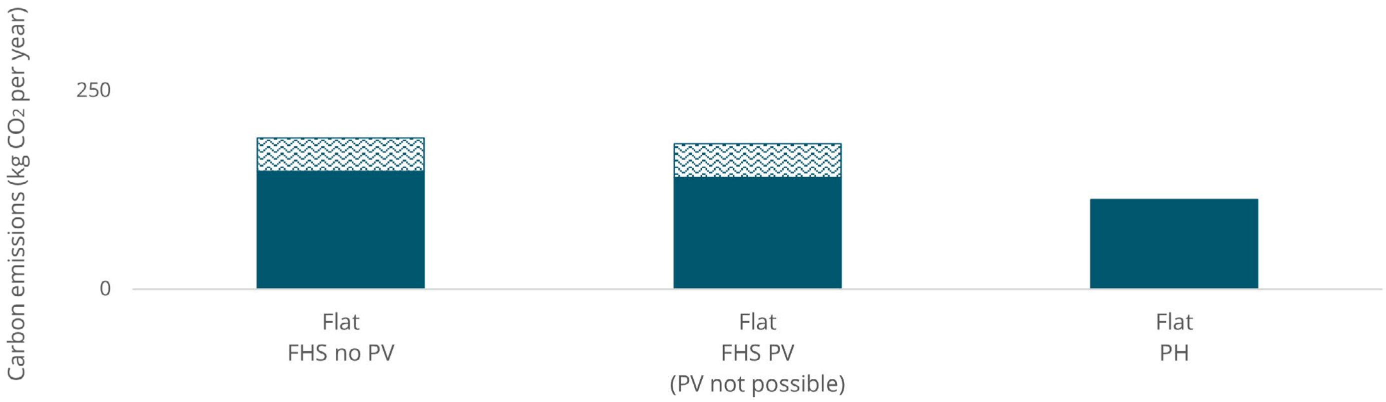

Figure 4: *Predicted carbon emissions for flat*

As no photovoltaics are installed on the FHS no PV, this has the greatest predicted carbon emissions. The reduction in emissions in FHS PV is wholly down to the installation of the PV array, which is estimated to be viable for only 40% of new buildings. In the case of a flat, where it is assumed no PV installation is possible, the second FHS option has, in practical terms, no reduction in carbon emissions (a negligible saving is indicated due to minor differences in specification - see Appendix 1).

As demonstrated by the modelling, Passivhaus Classic will deliver very similar or lower carbon emissions than FHS PV, but without the addition of photovoltaics. This means the emission reductions are locked in for the lifetime of the building. PV can be added in the future or as an add on if extra funds are available.

REGULATED ENERGY COSTS

The FHS no PV option will cost more to run than a home constructed to current 2021 building regulations, and we estimate this to be over £340 more for an end terrace and £130 more for a flat at today's energy prices. The FHS PV and Passivhaus classic are predicted to cost the same to run for the end terrace model. When a flat is considered, or any instance when PV will not be installed, the cost difference between Passivhaus classic and FHS is much greater, with Passivhaus costing between £380 and £150 less to run.

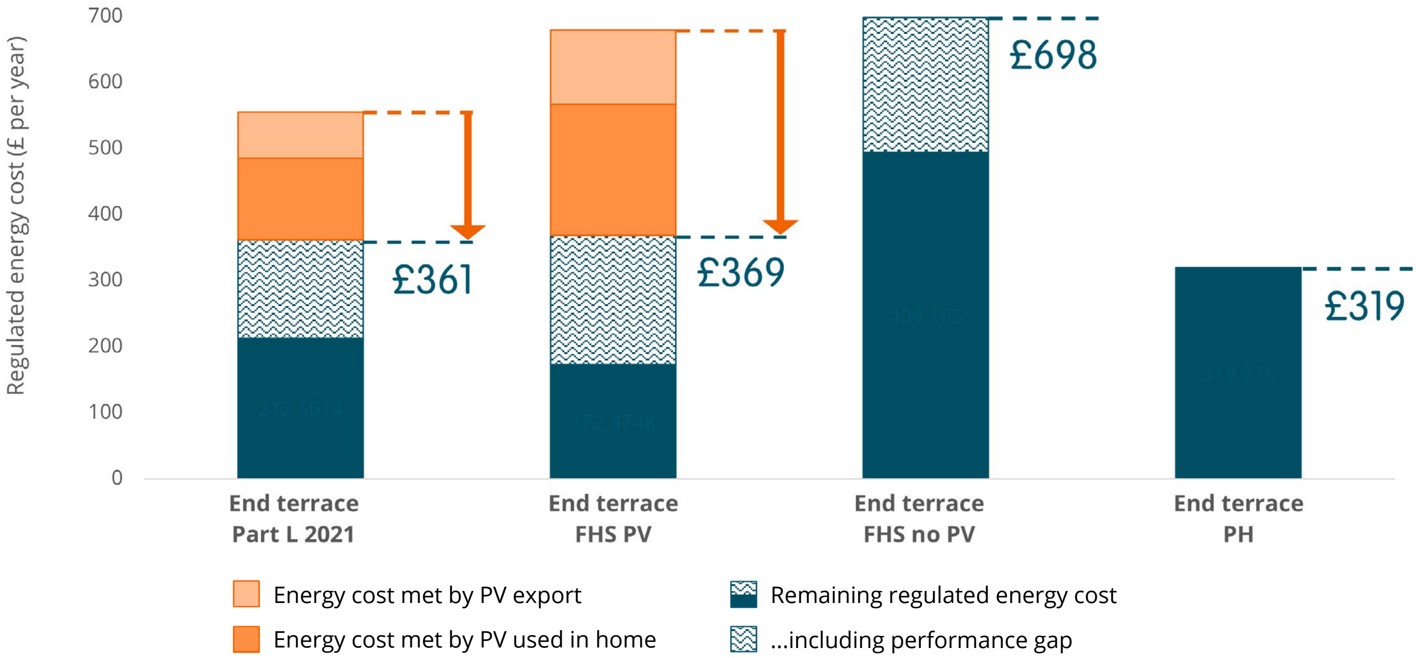

Figure 5: *Predicted regulated energy costs for end terrace house*

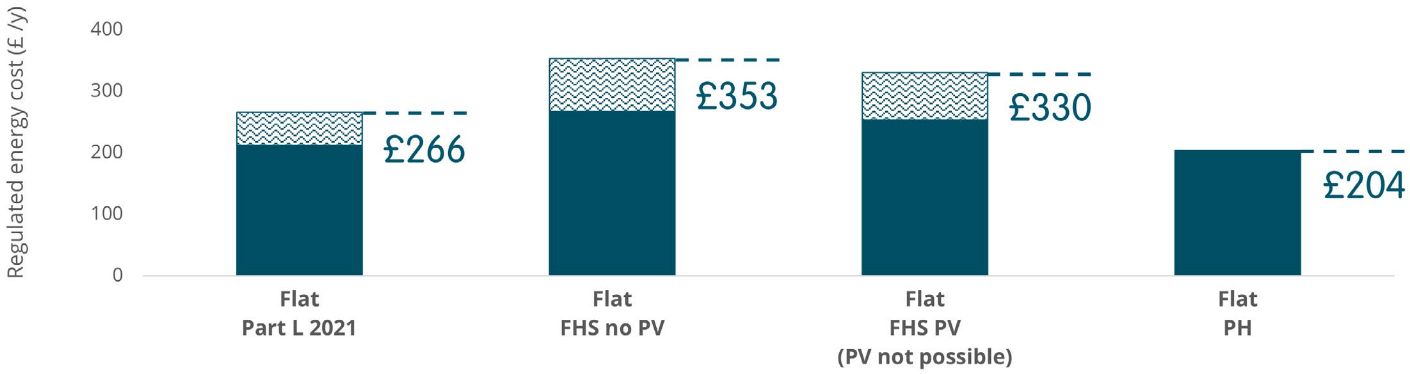

Figure 6: *Predicted regulated energy costs for flat*

FHS 2025 PV relies on photovoltaics to reduce the additional running costs that will arise from switching from gas to electricity. This philosophy works on building typologies with viable roof spaces; however, even if suitable, flats will have less roof area per dwelling, and there may be additional plant etc. located here, or the electricity generated will not be fed into each individual flat. The taller the building, the less energy will be generated (if any) for each dwelling; it will not be sufficient to offset costs in the same way. In addition, if direct electric heating is chosen and space heating demand is higher than predicted, energy costs will increase disproportionately for dwellings with a poorer building fabric.

This is not the case for Passivhaus Classic, which uses only the building fabric to reduce heating costs; these savings are locked in for the lifetime of the building.

CAPITAL COSTS

The main argument against improving building standards is capital costs, be that for the building fabric or the installation of additional technologies. The evidence suggests that there is a perception within the construction industry that building to higher energy standards will result in increased capital costs, which in turn reduces the viability of a scheme. However, it has been shown that in a well-planned, well-constructed low energy development, the capital cost uplift is minimal, and a wider uptake would further reduce these costs. Building typology is also important. As shown in Appendix 1, the insulation levels needed for a FHS 2025 flat and a Passivhaus Classic flat are similar, which means the cost uplift shown below will be less.

The table below gives an estimate of the difference in capital costs between FHS PV and Passivhaus Classic for an end terrace dwelling, against a baseline of FHS no PV.

	FHS PV	Passivhaus
Renewable energy: 2.68 kWp of PV	**£4,000 - £4,700**	–
Building fabric and MEP	–	**£4,500 - £5,600**

Table 2: *Comparison of capital cost differences between FHS 2025 PV and Passivhaus Classic*[4]

We can see that the estimated range in capital cost uplift to build a new dwelling to Passivhaus Classic overlaps with the cost range for adding a PV array to meet the proposed FHS 2025 with PV option and, as supply chains mature and volume is increased, these costs will likely reduce further.

CONCLUSION

As the building modelling shows, when FHS 2025 with or without PV is modelled against Passivhaus Classic, the Passivhaus will have lower space heating demand for both flats and terraces, and either similar or lower carbon emissions and running costs as well as additional comfort benefits; capital costs are shown to be similar. However, when FHS no PV is modelled against Passivhaus Classic, the Passivhaus will have lower space heating demand AND lower carbon emissions AND lower running costs, as well as additional comfort benefits.

Therefore, to ensure that occupants are protected from higher fuel bills, builders should be required to either install photovoltaics or improve fabric performance to Passivhaus equivalent levels of performance, and Passivhaus Classic should be deemed to comply with Approved Document L Conservation of fuel and power when the Future Homes Standard (2025) is introduced.

4 The estimate for cost of 2.68 kWp solar installation is derived from cost analysis by Arcadis for the Future Homes Hub - reference (5) below. To estimate the range in cost for fabric and MEP improvements to Passivhaus standard, we have examined analyses by Arcadis, AECOM, Currie & Brown, Ward Williams, and Baker Ruff Hannon. Trend analysis based on data from experienced Passivhaus project teams, alongside cost calculations by Currie & Brown and AECOM, indicates a cost uplift for Passivhaus construction of just 4% is achievable at scale (6). On a benchmark base cost of £114,290 for an end terrace home, as calculated in analysis by Arcadis for the Future Homes Hub (5), this indicates in the region of £4,500. The upper end of the range given is based on recent analyses by Currie & Brown for Wokingham Council (7) and by Ward Williams for Essex Climate Action Commission (8), which indicate a current estimated cost uplift over Part L 2021 of £11,300 - £14,000 for a semi-detached home built to a Passivhaus equivalent specification, including ASHP and PV. Discounting the cost of the ASHP which is the same in the FHS 2025 PV case as in Passivhaus Classic, and excluding the cost of the PV array (both according to Arcadis costings as above), leaves an estimated construction cost uplift of up to £5,600 for fabric and MEP. Costs for a semi-detached and for an end terrace house are assumed to be the same. See also *Future Homes Hub Contender Specifications for the FHS*, PHT (2023) https://pht.guide/FHHSpecifications.

REFERENCES

1) *Passivhaus Benefits*, Passivhaus Trust (2021). Available online: https://pht.guide/benefits

2) David Johnston et al.,'Quantifying the domestic building fabric "performance gap"', *Building Services Engineering Research & Technology* (2015) https://doi.org/10.1177/0143624415570344

3) R. Mitchell and S. Natarajan, 'UK Passivhaus and the energy performance gap', *Energy and Buildings* (2020). https://doi.org/10.1016/j.enbuild.2020.110240

4) D. Johnston, M. Siddall et al., 'Are the energy savings of the Passive House standard reliable? A review of the as-built thermal and space heating performance of Passive House dwellings from 1990 to 2018' *Energy Efficiency* (2020). https://doi.org/10.1007/s12053-020-09855-7

5) *Ready for Zero: Evidence to inform the 2025 Future Homes Standard – Task Group Report*, Future Homes Hub (2023). Via futurehomes.org.uk: https://irp.cdn-website.com/bdbb2d99/files/uploaded/Ready for Zero - Evidence to inform the 2025 Future Homes Standard -Task Group Report FINAL- 280223- MID RES.pdf

6) *Passivhaus Construction Costs*, PHT (2019). https://pht.guide/costs

7) *Net Zero Policy – Technical Evidence Base*, Wokingham Council (2024). https://www.wokingham.gov.uk/sites/wokingham/files/2024-09/Wokingham%20-%20Net%20Zero%20Evidence%20Base%20Final%20Report.pdf

8) *Net Zero Carbon Viability and Toolkit Study*, Essex Climate Action Commission (2022). https://www.essexdesignguide.co.uk/media/2590/essex-net-zero-carbon-viability-study-final-report.pdf

9) *Future Homes Hub Contender Specifications for the FHS,* PHT (2023). https://pht.guide/FHHSpecifications.

10) *Passivhaus as an Alternative Means of Compliance to the FHS*, PHT (2024). https://pht.guide/FHSresponse

APPENDIX 1

Comparison of specifications

	FHS 2025 PV	FHS 2025 no PV	Passivhaus end terrace	Passivhaus flat
Wall U-value	0.18		0.13	0.18
Roof U-value plane	0.11		0.10	0.11
Floor U-value	0.13		0.10	0.13
Glazing	Double		Triple	
Window U-value / centre pane g-value	1.2/0.73		0.8/0.53	
Front door U-value	1.0		0.8	
Half glazed door U-value	1.2		0.8	
Air permeability q_{E50} (m³/hr.m²)	4.0	5.0	0.5*	
Ventilation	dMEV 0.15 W/(L.s)	Natural ventilation + extract fans	MVHR	
Heating emitter	Radiators 45ºC flow			
Heating	ASHP			
DHW	ASHP			
WWHR	Yes	No	Yes	
Shower flow rate	8 l/min			
PV philosophy	40% of roof area in plan	None		
PV installed (kWp)	2.8	0		
PV diverter	No			
Battery	No			
Lighting efficiency	120 lm/W			

** The Passivhaus airtightness criterion of 0.6 ACH has been approximated as equivalent to 0.5 m³/hr.m² air permeability in the modelling*

Table 3: *Summary of specifications for the notional building for FHS PV, FHS no PV, and certified Passivhaus Classic for end terrace house and for flat*

The Passivhaus Trust is an independent, non-profit organisation that provides leadership in the UK for the adoption of the Passivhaus standard and methodology.

Passivhaus is the leading international low energy design standard, backed with over 30 years of building performance evidence. It is a tried & tested solution that enables a meaningful transition to net-zero now. Over 65,000 buildings have been certified to this standard worldwide. The Trust promotes Passivhaus as a robust way of providing high standards of occupant comfort and health AND slashing energy use and carbon emissions from buildings in the UK.

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