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HT641 Net Zero M&E and PHPP Modelling Report

Building Services Assignment 2: 5017

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The UK Passive House Organisation



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Executive Summary

This report reviews the HT641 new-build dwelling and uses PHPP to assess its baseline and proposed low-energy performance. The baseline design includes an ASHP, but PHPP shows it does not meet Passivhaus-level performance, with a space heating demand of 77.4 kWh/m².a, heating load of 31.8 W/m², and airtightness of 4.74 ach @50Pa.

A Passivhaus-led strategy is proposed, including improved fabric performance, reduced thermal bridging, airtightness to 0.6 ach @50Pa, high-performance glazing, MVHR, optimised ASHP operation and PV. The proposed model reduces space heating demand to 21.6 kWh/m².a, giving an approximate 72% reduction.

Although the proposal does not fully meet the Passivhaus Classic target of 15 kWh/m².a, it provides a strong route towards Net Zero operation. The associated works are estimated at approximately £64,000, with annual space-heating savings of around £483/year based on Ofgem's April–June 2026 electricity rate.

1. Introduction



This report has been prepared for the HT641 scenario building, a new-build dwelling in Wales. The building is a four-bedroom, six-person house with a measured gross

internal floor area of 110m². The house is part of a wider technical feasibility study considering Net Zero Carbon Buildings for the Vale of Glamorgan Council.

This report will identify the existing proposed building services design, critically appraise the specification, model the building within an energy performance tool and propose design changes to meet a low-energy standard. PHPP has been used as the modelling tool because it allows the building's space heating demand, heating load, ventilation efficiency, primary energy demand and overheating risk to be tested consistently and transparently (Lewis 2026).

This report focuses on operational carbon, energy use, M&E performance, whole-life implications and cost considerations. It is not a full construction design package, and all values should be treated as feasibility design-stage information requiring specialist confirmation before construction.

2. Building Description and Assumptions

HT641 is a two-storey detached house designed for a six-person household. The ground floor plan indicates a lounge, kitchen/dining area, utility, WC/Shower room, hall and storage. The first floor includes four bedrooms, bathroom, landing and airing cupboard. The project drawings identify external wall build-up thicknesses of approximately 550mm, internal walls of 100mm and intermediate floors of 400mm.

Item	Assumption
Climate	Swansea Regional Climate Data
Building type	New-build four-bedroom, six-person dwelling for social housing
GIA/TFA	GIA: 110.4m ² / TFA: 101.94m ²
Occupancy	6 People
Baseline ventilation	Mechanical extract ventilation
Proposed ventilation	Balanced MVHR with heat recovery
Baseline heat source	ASHP with hot water cylinder
Proposed heat source	Optimised ASHP with low-temperature distribution and efficient DHW strategy
Renewable Energy	PV to be utilised

Table 1: Building Description and modelling assumptions

The treated floor area has been calculated using PHPP methodology, which includes only rooms within the thermal envelope and applies to specific allowances for areas

such as stairs, circulation and rooms with reduced head height (Passive House Institute n.d). This is important because PHPP performance metrics are expressed per square metre of TFA.

3. Selected Design Standard: Passivhaus Classic

Passivhaus Classic has been selected as the primary low-energy design standard for the improved HT641 specification. The standard is appropriate for new-build domestic housing because it combines a fabric-first approach with measurable energy and comfort criteria. The key targets are:

Criteria	Passivhaus Classic Target
Space heating demand	<15 kWh/m ² .a
Heating load	<10W/m ²
Airtightness	<0.6 air changes per house @50 Pa
PER demand	<60 kWh/m ² .a
Summer overheating	<10% of occupied house above 25°C
Ventilation	Typically, 30m ³ Per person

Table 2: Passivhaus Classic Performance Criteria

These criteria have been selected from the Passive House Institute headlines requirements summarised by the Passivhaus Trust (2025). The inclusion of both annual heating demand and peak heating load is useful because it can have a relatively low annual demand while still requiring a larger peak heating system if envelope performance, solar gains or ventilation losses are not properly balanced.

This standard is more suitable than a minimum compliance-only approach because it addresses real building performance. A dwelling can comply with building regulations while still having relatively high heating demand due to air leakage, thermal bridging, poor installation quality or inefficient ventilation. Passivhaus reduces this risk by requiring continuity of insulation, airtightness, verified ventilation design and PHPP modelling (BRE 2014; Lewis 2026).

It is recognised that the proposed PHPP model does not fully comply with all Passivhaus Classic targets, however the standard remains a useful benchmark

because it clearly identifies the performance gap and supports targeted design improvements.

4. Existing M&E and Fabric Specification

The baseline design represents a Building Regulations compliant new-build specification:

Element	Baseline Specification
Air Permeability	3.5 m ³ /m ² .h
Thermal Bridges	0.2W/mK
Window Frames	PVC Uf 1.4W/m ² K
Glazing	Double low-e glazing, Ug 1.120 W/m ² K
Ventilation	Mechanical Extract to wet rooms
Heat Recovery	N/A
Heating	Generic ASHP
ASHP SCOP	2.97

Table 3: Baseline M&E and fabric specification

The HT641 floor plan identifies a Vailant aroTHERM plus 5 KW ASHP and a Mixergy hot water cylinder as the baseline plant allowance. This demonstrates that the original specification already includes low-carbon heating and domestic hot water provision. However, the baseline PHPP model remains limited by its fabric and services assumptions, particularly air permeability, thermal bridging, extract-only ventilation, double glazing and generic ASHP performance.

5. Critical Appraisal of the Existing Specification

The baseline specification has several positive features. The use of an ASHP removes the direct fossil fuel combustion from the dwelling, reducing operational carbon when compared with gas or oil heating. This also aligns with the Welsh Housing Quality Standard's emphasis on affordable warmth and minimal environmental impact (Welsh Government 2024). The dwelling is also compact and designed around Welsh Housing space requirements, additionally, plant location, maintenance zones and duct routes have been considered at an early stage, which is essential for buildability and future maintenance.

However, the baseline specification is not sufficient for a Passivhaus or Net Zero-aligned outcome. The main weaknesses are as follows:

Ventilation heat loss: MEV extracts warm internal air without recovering heat. In an airtight, low-energy home, this creates avoidable heating demand. Replacing MEV with balanced MVHR is therefore one of the most important improvements. It's important to note that MVHR performance depends on good design, clear specification, suitable ducting, low noise and correct commissioning rather than simply selecting a unit (The Passivhaus Trust 2018).

Airtightness: The baseline PHPP model uses an N50 value of 4.74 ach at 50Pa. This is far above the Passivhaus standard of 0.6 ach at 50 Pa (Passivhaus Trust 2025). Air leakage increases heating demand, creates draughts, reduces comfort and can create moisture risks in the fabric (BRE 2014).

Thermal Bridging: The baseline PHPP model includes thermal bridges of 0.2W/mK, this exceeds the minimum Psi-value of 0.01 W/mK highlighted in the Passivhaus standards (Passivhaus Trust 2025). Thermal bridges at the ground floor perimeter, window reveals, roof-wall junctions and door thresholds can create additional heat loss and colder internal surface temperatures if they are not designed carefully (BSI 2017).

Glazing Performance: Double Glazing can meet regulatory requirements, but Passivhaus-level housing normally requires high-performing triple glazing or equivalent high-performance units, particularly for comfort near windows and reduction in heat load. The window specification should therefore consider whole-window U-values, frame performance, glazing performance, g-value and installation thermal bridging rather than just centre-pane value (Passivhaus Trust 2025; Rehau n.d).

Embodied Carbon: A move to very fabric high standards can add embodied carbon through additional insulation, glazing and services. This does not invalidate the fabric first approach, but it means specifications should favour lower-carbon materials where practical, avoid over-specification and consider whole-life carbon rather than operational carbon alone. It is important to consider both operational and embodied carbon to effectively consider the whole-life carbon (Sturgis 2017).

6. PHPP Modelling Results

Two PHPP models have been developed and reviewed: a baseline model and an improved Passivhaus-led model. The results are shown in the following table:

Metric	Baseline PHPP	Proposed PHPP	Passivhaus Target	Comment
Annual space heating demand (kWh/m ² .a)	77.4	21.6	<15	Major improvement but still above target
Heating load (W/m ²)	31.8	11.9	<10	Close to target but not fully compliant
Airtightness n50	4.74 ach	0.6 ach	<0.6 ach	Meets target
Overheating	1.4%	3.3%	<10%	Meets target
PER demand (kWh/m ² .a)	45.5	45.3	<60	Meets target

Table 4: Baseline and proposed model results

The PHPP model demonstrates that the biggest performance improvement comes from reducing thermal bridges, airtightness and ventilation heat loss. Space heating demand falls by approximately 55.8 kWh/m².a, equal to around a 72% reduction. This equates to an annual heating reduction of approximately 5685 kWh/year.

The proposed model still does not fully meet the Passivhaus Classic space heating target of ≤ 15 kWh/m².a or the heating load target of ≤ 10 W/m². However, it does meet the airtightness, overheating and PER demand targets. This shows that the proposal is not fully Passivhaus compliant, but it is a substantial improvement over the baseline and provides a credible route towards a low-energy, Net Zero-aligned dwelling.

7. Proposed Net Zero M&E and Fabric Strategy

7.1 Fabric-first improvements

The proposed design should maintain continuous insulation around the thermal envelope, with particular attention to junctions. External walls, roof and ground floor should be specified to achieve Passivhaus-level U-values where feasible.

7.2 Airtightness Strategy

Airtightness should be treated as a primary design package. The design should include a clearly marked airtightness line on all drawings. Key measures include:

- Continuous airtight layer to walls, roof and ground floor
- Taped sheathing board or membrane joints

- Airtight service penetrations using proprietary grommets
- Service voids to reduce penetrations through the airtight layer
- Airtight window and door tapes
- Pre-completion pressure testing with smoke testing to locate leakage paths

The target should be $n_{50} < 0.6$ ach at 50 Pa, matching the proposed PHPP model and the Passivhaus Classic airtightness criteria (Passivhaus Trust 2025). BRE (2014) and BSRIA (2025) both emphasise that airtightness is connected to energy use, comfort, indoor air quality and construction quality, so the strategy should be coordinated from design through site workmanship and final testing.

7.3 Thermal Bridging

Thermal bridging should be designed out by modelling junctions to identify the severity of thermal bridging.

Junction	Risk	Proposed Response
Ground Floor to external Wall	Heat loss and cold internal surface	Continuous insulation below/around slab edge
Window Reveals	Cold bridging and condensation	Install windows within insulation zone with insulated cavity closers/reveals
Roof to wall	Discontinuous insulation	Link roof insulation to wall insulation without gaps
Door to threshold	Linear heat loss	Use insulated threshold and airtightness tapes
Service penetrations	Air leakage	Group and seal penetrations through airtight layer

Table 5: Thermal Bridge Junction Strategy

Thermal bridging is important because linear heat losses can undermine otherwise good U-values, particularly at repeated junctions such as window reveals and floor edges. For Passivhaus level design junctions should be modelled to design out potential thermal bridges (BSI 2017; Lewis 2026).

7.4 Windows & Doors

The proposed retrofit should replace existing windows and external doors to high-performance Passivhaus accredited units with triple glazing and insulated frames. To meet Passivhaus standards window and door performance must be $<0.80 \text{ W/M}^2\text{K}$ (Passivhaus Trust 2025).

Installation position is crucial as windows should be aligned within the insulation zones where possible, using structural brackets, insulated reveals and airtight tapes to reduce cold bridging (Insulated Render and Cladding Association, 2017).

The following frames and glazing should be used for HT641:

Element	Proposed Frame	Proposed Glazing
Windows	Enersign Primus 1194ws02	Triple low-E glazing 18mm Argon
PVC Doors	Enersign Primus 1194ws02	Triple low-E glazing 18mm Argon
Front Composite Door	Rehau Agila 11113cd03	Rehau Geneo PHZ 0180ed03

Table 6: Proposed window and door specification

7.5 Ventilation Strategy

MEV should be replaced with balanced MVHR. The proposed ventilation design should supply fresh air to living and sleeping rooms and extract from wet rooms such as the kitchen, bathroom, WC and utility. PHPP assumes six occupants and a recommended supply rate of $30 \text{ m}^3/\text{h}$ per person, giving a design supply rate of $180 \text{ m}^3/\text{h}$ (Passivhaus Trust, 2025).

Final room-by-room balancing should be completed by the MVHR designer. The ventilation specification must include duct sizing, acoustic limits, static pressure limits, commissioning results, filter access and handover requirements. This reflects Passivhaus Trust MVHR guidance, which stresses that MVHR performance is dependent on specification, ductwork, noise control and commissioning rather than only the heat recovery unit (Passivhaus Trust, 2018).

The Zehnder ComfoAir Q450 is a suitable example of a Passivhaus-certified MVHR unit, with certified heat recovery efficiency of 88% and specific electric power of 0.21 Wh/m^3 (Zehnder, 2026). This would be a significant improvement over extract-only ventilation because heat is recovered from extract air before it is discharged.

7.6 Heating and Domestic Hot Water

The ASHP should be retained, but it should be integrated into the low-energy design rather than treated as a standalone Net Zero solution. The proposed strategy is:

- Weather-compensated ASHP control.
- Low-temperature heat emitters or underfloor heating.
- Short, insulated heating and DHW pipe runs.
- Efficient hot water cylinder with good standing loss performance.
- Avoid unnecessary secondary circulation loops.
- Commissioned flow rates and design temperatures.

The WH-UD05JE5 is suitable for the HT641 proposed model for four main reasons. First, it is a 5-kW class air-to-water heat pump, which is appropriate for a very low-energy dwelling where the proposed PHPP heating load is 11.9 W/m². Across the 101.94 m² TFA, this gives an indicative peak space heating load of approximately 1.21 kW before any allowance for DHW recovery, system losses or design margin. A 5 kW ASHP therefore provides capacity for the reduced space heating demand while also supporting domestic hot water production, subject to final MCS heat loss and cylinder sizing checks.

7.7 Photovoltaics and Net Zero balance

To support Net Zero operational balance, the PHPP models include 18 PV panels generating 5245 kWh/a. However, PV does not remove the need to reduce demand first. The most robust Net Zero approach is therefore: reduce demand through fabric and airtightness, recover ventilation heat through MVHR, meet remaining heat demand efficiently with an ASHP and then offset electricity demand through PV. This approach also reduces the risk of oversizing renewable systems to compensate for avoidable heat loss (Passivhaus Trust 2025; Sturgis 2017).

8. Whole-Life Carbon and Cost Considerations

A Net Zero strategy should consider both operational and embodied carbon. The proposed improvements reduce operational energy, but some measures increase upfront embodied carbon, particularly triple glazing, additional insulation, PV panels and MVHR equipment. The design should therefore prioritise measures that provide long-term energy savings and comfort benefits without excessive material use. Whole-life carbon assessment requires designers to consider both the carbon emitted during the building phase and the carbon associated with materials, construction, maintenance and end-of-life scenarios (Sturgis 2017).

Measure	Capital Cost Effect	Operational Benefit	Comment
Airtightness Detailing	Low to Medium	High Benefit	Requires design coordination and site quality control
MVHR	Medium	Reduces ventilation heat loss	Needs commissioning and maintenance
Triple Glazing	Medium to high	Reduces heat loss and improves comfort	Best value when specified early
Thermal Bridge Detailing	Low to Medium	Reduces heat loss and mould risk	Mainly design coordination
PV array	High	Offsets electricity use	Output depends on roof orientation and shading
ASHP Optimisation	Low to Medium	Improves SCOP and comfort	Controls and commissioning are critical

Table 7: Whole-life carbon and cost considerations

8.1 Spon's-Based Cost Estimate for Associated Works

The following cost estimate has been prepared as an indicative feasibility-stage allowance for the proposed low-energy associated works. It uses the HT641 measured GIA of 110.4m² from the project floor plans and Spon's 2023 approximate estimating rates where available (AECOM 2023).

Indicative Spon's-Based Cost Estimate for Associated Works

HT641 proposed low-energy associated works – feasibility-stage estimate

Item	Quantity / basis	Spon's / cost basis	Rate used	Estimated cost
High-performance window allowance	24 m ² assumed opening area	Composite aluminium/timber window proxy rate from Spon's	£352.50/m ²	£8,460
External door allowance	2 nr assumed	Heavy-duty external door proxy rate from Spon's	£1,662.50/nr	£3,325
MVHR system allowance	110.4 m ² GIA	Residential ventilation proxy rate from Spon's	£56.50/m ²	£6,238
PV array	7.2 kWp, based on 18 × 400 W panels	Spon's 4 kWp solar PV rate scaled to 7.2 kWp	£19,890 item	£19,890
Airtightness layer / membrane allowance	205 m ² assumed envelope junction allowance	Self-adhesive membrane proxy rate from Spon's	£8.76/m ²	£1,796
Panasonic Aquarea J Series WH-UD05JE5 ASHP	1 nr	Specialist provisional sum; Spon's A&B does not provide a specific domestic ASHP rate	£8,500 item	£8,500
Thermal bridge improvement allowance	Item	Specialist provisional sum for insulated thresholds, junction closers and additional detailing	£2,000 item	£2,000
Airtightness testing and MVHR commissioning	Item	Specialist provisional sum	£1,900 item	£1,900
Works subtotal				£52,109
Main contractor preliminaries	12%	Spon's example preliminaries allowance	12%	£6,253
Design development / risk allowance	10%	Feasibility-stage contingency	10%	£5,836
Indicative total excluding VAT and professional fees				£64,198

Approximate rate against 110.4 m² GIA: £582/m²

Feasibility-stage estimate only. Excludes VAT and professional fees. Final costs subject to design development, contractor quotations, regional adjustment, inflation, and procurement route.

Figure 1: Indicative Spon's-based cost estimate for associated works. (AECOM 2023)

On this basis, the associated works are estimated at approximately £64,000 excluding VAT and professional fees. Using the measured GIA of 110.4m² this equates to approximately £582/m² additional build cost. This doesn't account for the omission of certain technologies like the existing ASHP proposal, double-glazing and existing PVC frames and isolated mechanical extraction. This figure should be described as an outline feasibility estimate only, all proposed interventions should be market-tested with supplier quotations at the next design stage.

8.2 Return on Investment Based on Energy Savings

A simple return on investment has been calculated using the PHPP space heating results and the Ofgem domestic electricity unit rate for 1 April to 30 June 2026 of 24.67p/kWh (Ofgem 2026). Standing charges have not been included as these are fixed daily charges.

Return on Investment Based on Energy Savings

HT641 proposed low-energy option – based on PHPP space heating results and Ofgem April–June 2026 electricity rate

Item	Calculation	Result
Baseline useful space heat	77.4×101.94	7,890 kWh/year
Proposed useful space heat	21.6×101.94	2,202 kWh/year
Useful heat reduction	$7,890 - 2,202$	5,688 kWh/year
Baseline electricity for heating	$7,890 \div \text{SCOP } 3.30$	2,391 kWh/year
Proposed electricity for heating	$2,202 \div \text{SCOP } 5.07$	434 kWh/year
Electricity saving	$2,391 - 434$	1,957 kWh/year
Annual cost saving	$1,957 \times \text{£}0.2467/\text{kWh}$	£483/year

ROI measure	Calculation	Result
Annual saving	$1,957 \text{ kWh} \times \text{£}0.2467/\text{kWh}$	£483/year
Simple payback	$\text{£}64,198 \div \text{£}483$	133 years
Simple annual ROI	$\text{£}483 \div \text{£}64,198 \times 100$	0.75% per year

Indicative annual energy saving: £483/year

Simple payback: 133 years

Based on Ofgem electricity unit rate of 24.67 p/kWh, including VAT, for 1 April to 30 June 2026. Standing charges excluded. Savings relate to space heating only and do not include comfort, carbon, PV self-consumption, maintenance, or future tariff changes.

Figure 2: Return on investment based on energy savings (Ofgem 2026)

9. Installation, Commissioning and Maintenance

The proposed systems require careful installation and commissioning. A high-performance design can fail operationally if details are not installed correctly. Key requirements include:

- Airtightness test before finishes are closed and again at completion.
- MVHR commissioning certificate with measured supply and extract rates.
- Acoustic testing or design evidence for bedrooms and living rooms.
- ASHP commissioning records, including flow temperature, weather compensation settings and cylinder settings.
- Thermal imaging during cold weather where possible.
- Home user guide explaining filters, controls, summer bypass, heating systems and maintenance.

Maintenance access must be retained for filters, MVHR unit. Hot water cylinder, ASHP controls and external ASHP clearances. The drawings must show plant zones protected through detailed design and not lost through construction coordination (Welsh Government 2026).

10. Conclusion and Recommendations

The HT641 baseline specification already moves away from fossil fuel heating by using an ASHP, but the PHPP results show that the design is not yet a true low-energy or Passivhaus-level dwelling. The baseline space heating demand of 77.4 kWh/m².a and heating load of 31.8 W/m² are primarily driven by ventilation heat loss, air leakage and fabric performance limitations.

The proposed Passivhaus-led design reduces annual space heating demand to 21.6 kWh/m².a and heating load to 11.9 W/m². Airtightness improves to 0.6 ach at 50 Pa, meeting the Passivhaus airtightness requirement, and PER demand remains below the Passivhaus Classic limit (Passivhaus Trust, 2025). Although the proposed design remains slightly above the Passivhaus Classic heating demand and heating load targets, it represents a substantial performance improvement and provides a credible route towards Net Zero operational housing.

The main recommendations are:

1. Adopt Passivhaus Classic as the benchmark standard for the HT641 improvement strategy.
2. Replace MEV with balanced MVHR, designed and commissioned to measured room-by-room airflow rates.
3. Target airtightness of $n_{50} \leq 0.6$ ach at 50 Pa through a coordinated airtightness strategy.
4. Improve glazing and installation detailing to reduce heat loss and improve comfort.
5. Replace generic thermal bridge allowances with project-specific junction detailing.
6. Retain the ASHP but optimise emitters, controls, pipework and DHW storage.
7. Add PV to move from low-energy performance towards an operational Net Zero balance.
8. Consider embodied carbon when selecting insulation, glazing, plant and PV systems.

Overall, the most effective strategy is not simply to add low-carbon plant. The dwelling should first be designed to need very little heat. Only then can the ASHP, MVHR and PV systems operate efficiently and economically over the building's life.

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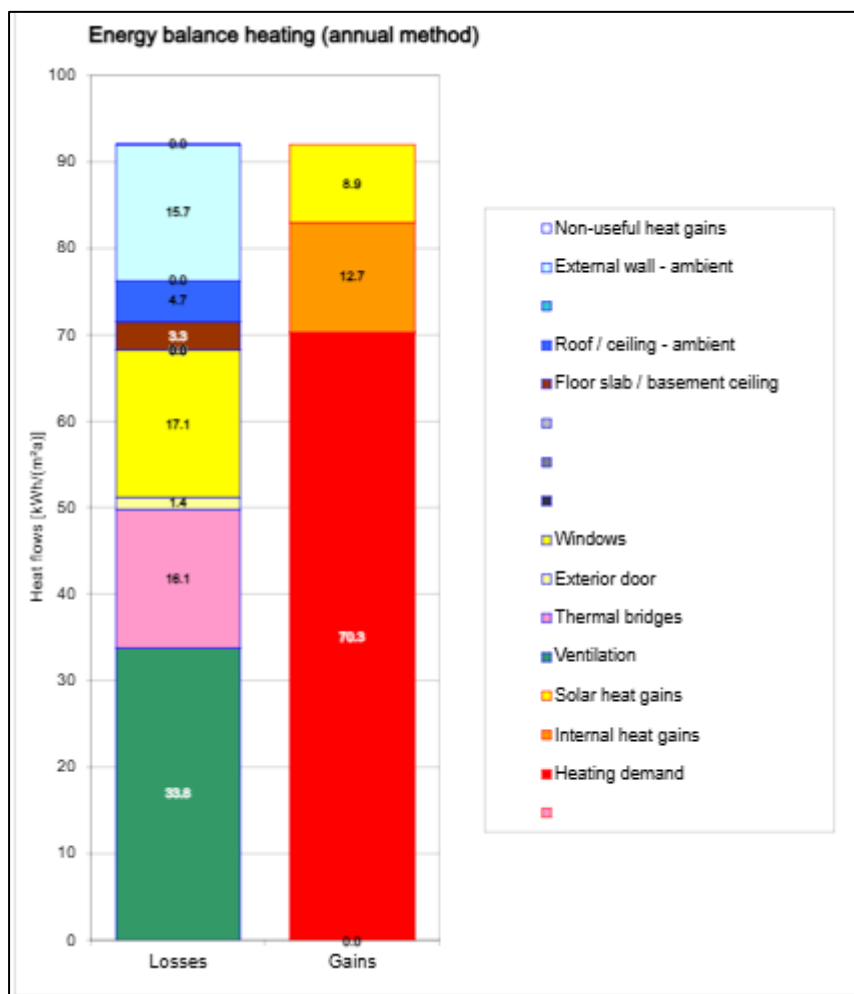
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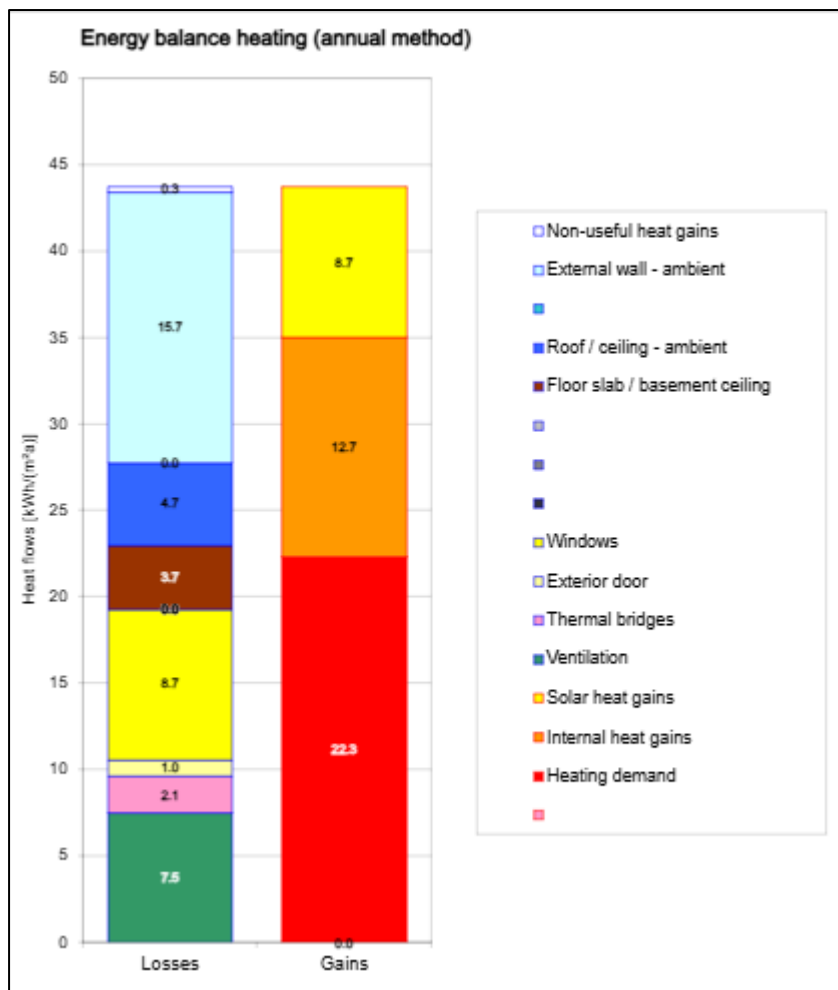
Appendices:

Appendix A: PHPP Model Data



Baseline PHPP Model

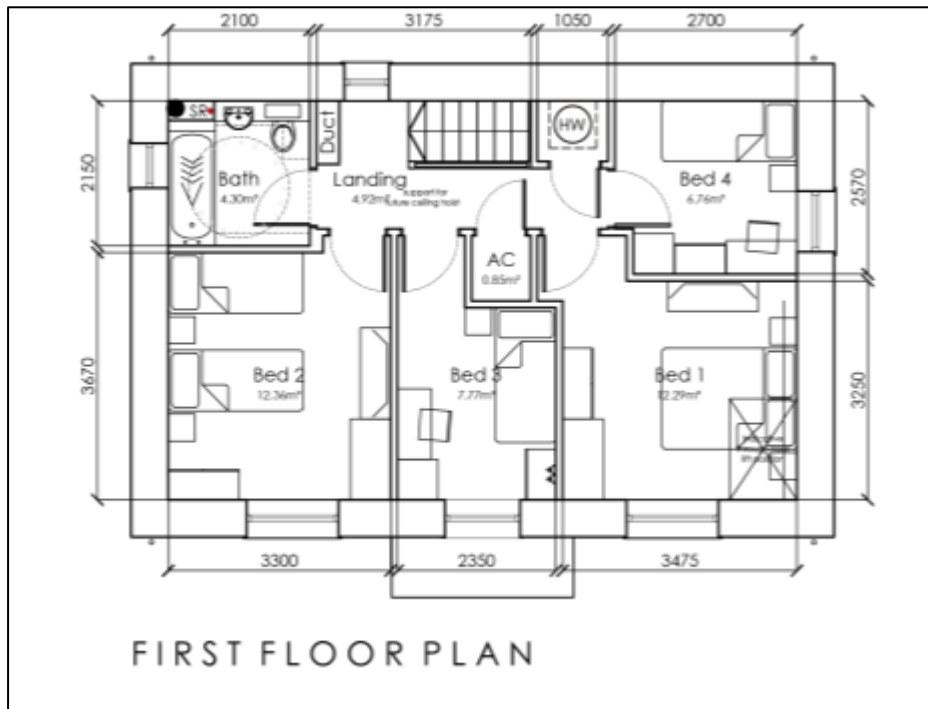
losses & gains for annual heating.



Improved PHPP Model

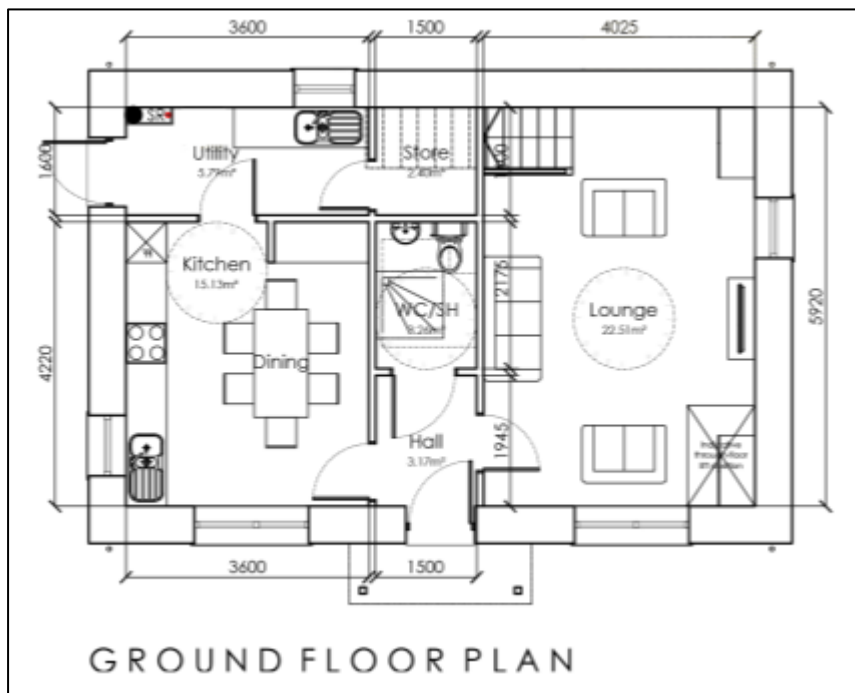
losses & gains for annual heating.

Appendix B: Project Site Plans



First Floor Layout

Plan



Ground Floor Layout

Plan

Appendix C: Product Data Sheets

3.2 WH-ADC0309J3E5 WH-UD05JE5

Item		Unit	Outdoor Unit		
Performance Test Condition			EN 14511		
			EN 14825		
Cooling Capacity		Condition (Ambient/Water)	A35W7		
		kW	4.50		
		BTU/h	15300		
		kcal/h	3870		
Cooling EER		W/W	3.00		
		kcal/hW	2.58		
Heating Capacity		Condition (Ambient/Water)	A7W35	A2W35	
		kW	5.00	4.20	
		BTU/h	17100	14300	
		kcal/h	4300	3810	
Heating COP		W/W	5.00	3.18	
		kcal/hW	4.30	2.73	
Heating Erp	Low Temperature Application (W35)		Warmer	Average	Colder
	Application	Climate			
	Pdesign	kW	4.0	5.0	3.0
	Tbivalent/TOL	°C	2 / 2	-10 / -10	-20 / -22
	SCOP/hs	(W/W)%	6.20 / 245	5.07 / 200	4.00 / 157
	Annual Consumption	kWh	862	2038	1848
	Class		A++	A++	A++
	Medium Temperature Application (W55)		Warmer	Average	Colder
	Application	Climate			
	Pdesign	kW	4.0	4.0	2.0
	Tbivalent/TOL	°C	2 / 2	-10 / -10	-20 / -22
	SCOP/hs	(W/W)%	4.20 / 165	3.47 / 136	2.83 / 110
	Annual Consumption	kWh	1274	2385	1740
	Class		A++	A++	A+
	DHW		Warmer	Average	Colder
	Application	Climate			
	COP/mwh	(W/W)%	3.88 / 155	3.30 / 132	2.48 / 99
	AEC	kWh	640	760	994
Noise Level		Condition (Ambient/Water)	A35W7	A7W35	A2W35
		dB (A)	Cooling: 48	Heating: 47	
		Power Level dB	Cooling: 64	Heating: 64 Heating: 55***	
Air Flow		m³/min (ft³/min)	Cooling: 39.6 (1400) Heating: 31.8 (1120)		
Refrigeration Control Device		Expansion Valve			
Refrigeration Oil		cm³	FW50S (450)		
Refrigerant		kg (oz)	R32, 0.90 (31.8) (Pre-charged) R32, 1.20 (42.4) (Maximum)		
F-GAS		GWP	675		
		CO ₂ eq (ton) (Precharged/Maximum)	0.608 / 0.810		
Dimension		Height	622 (24-1/2)		
		Width	824 (32-15/32)		
		Depth	298 (11-24/32)		
Net Weight		kg (lbs)	37 (82)		

Technical data	Unit	3.5kW	5kW	7kW	10kW (230V)	12kW (230V)	10kW (400V)	12kW (400V)
General								
Weight, ready for operation	kg	114		128	194		210	
Connection, heating circuit		G 1 1/4"						
Rated voltage		230 V (+10%/− 15%), 50 Hz, 1-/N/PE					400 V (+10%/−15%), 50 Hz, 3-/N/PE	
Rated current, maximum	A	14.3		15.0	23.3		15	
Fuse size	A	16			25		16	
Fuse type		Characteristic C, slow-blow, singlepole switching						
RCD type		Type B rated to 20kHz or greater and with a minimum trigger point of 150mA above 1kHz						
eBUS (2-core communication cable)	mm²	0.75						
Maximum length eBUS cable (polarity sensitive)	m	50						
IP rating		IP 15 B						
Fan power consumption	W	40					50	
Fan quantity		1					2	
Fan air flow, maximum	m³/h	2300					5100	
Heating pump, power consumption	W	2 - 50					3 - 87	
Heating circuit								
Heating water temperature, minimum/maximum	°C	20 - 75						
Basic length of the heating water pipe, maximum, between the outdoor unit and indoor unit	m	20						
Maximum static height difference between outdoor unit and the highest point in the heating system	m	18					13	
Minimum operating pressure	bar	3.0					2.5	
Maximum operating pressure	bar	20						
Minimum volume flow	l/h	400		540			995	
Maximum volume flow	l/h	860		1205			2065	
Water volume, in the outdoor unit	l	1.5		2.0			4.5	
Minimum open water volume	l	15		20			45	
Refrigerant circuit								
Fluid type		R290						
Fluid fill quantity	kg	0.6		0.9			1.3	
Refrigerant, Global Warming Potential (GWP)		3						
CO ₂ equivalent	t	0.0018		0.0027			0.0039	
Permissible operating pressure	bar				31.5			
Compressor type		Rotary piston					Scroll compressor	
Compressor oil type		Specific polyalkylene glycol (PAG)						
Compressor, control		Electronic						
Noise emissions, heating mode								
Sound power, EN 12102, EN 14511 LWA, A7/W35	dB(A)	48		49			51	
Sound power, EN 12102, EN 14511 LWA, A7/W55	dB(A)	48		49			51	
Efficiency								
Energy efficiency class 35°C	(A+++ to F)	A++			A+++			
Energy efficiency class 55°C	(A+++ to F)	A+			A++			
Combination with uniTOWER								
Energy efficiency class	(A+++ to F)	A+			A++			
Energy efficiency class, hot water	(A+ to F)	A			A			

Vailant aroTHERM plus

5kW

Composite Doors AGILA

- 1 Dedicated transom allows for top light glazing and greater flexibility
- 2 Opening vent option using REHAU Tritec sash
- 3 Slimmer sightlines enabling narrower door openings such as small cottage doors and older properties
- 4 Suitable for standard 44mm door slabs
- 5 Mechanical joint option available on transom
- 6 Dual brush pile seal for enhanced weather performance

Feature	Specification
Profile depth	70mm
Maximum slab weight	100kg
Maximum door size	996 x 2105mm
Panel width	44mm
Further options	Dedicated low threshold options for Part M compliance
	Mechanical joint
	Dedicated frame and transom
Accreditations	See page 60



Rehau Agila

CERTIFICATE

Certified Passive House Component

Component-ID 0954vs03 valid until 31st December 2026

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**
Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
Product name: **ComfoAir Q450 HRV, Comfort Vent Q450 HRV**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate η_{HR} $\geq$ 75 %
Specific electric power $P_{el,spec}$ $\leq$ 0.45 Wh/m³
Leakage $<$ 3 %
Comfort Supply air temperature $\geq$ 16.5 °C at outdoor air temperature of -10 °C

Airflow range

70–345 m³/h

Heat recovery rate

η_{HR} = 88 %

Specific electric power

$P_{el,spec}$ = 0.21 Wh/m³

¹⁾ At an airflow of 89 m³/h, a heat recovery of η_{HR} = 94 % is reached.
Due to the frost protection strategy at outdoor temperatures of -15 °C the air flow rate is reduced to about 255 m³/h.

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

www.passivehouse.com

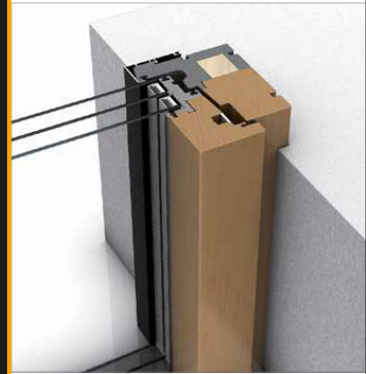
Zehnder ComfoAir

Q450

Certified aluminum-wood passive house windows **ENERSign®primus**

The **ENERSign®primus** wood-aluminum window with integral frame is the premium Passive House window with best insulation values, certified by the Passive House Institute in pH A class for cold climates with $U_w = 0.59 \text{ W / m}^2\text{K}$ according to EN 673.

- **Visible widths** of only 100 mm
- **Frame made of local woods** formed into a slim and elegant profile
- **High stability** due to 121 mm profile depth
- **Integral frame** (concealed sash)
- **Outer shell:** **ENER**foam insulation profil
- **Over-insulation** at window edge can create a "zero frame view" without thermal bridge or frame sight line
- **U-value** frame at the bottom, side, top: $U_f = 0.59 \text{ W / m}^2\text{K}$ according to EN 10077
- **Triple glazing:** $U_g = 0.531 \text{ W / m}^2\text{K}$ according to EN 673
- **Glass gap** filled with argon
- **Edge composite glass** with warm edge (Swisspacer Ultimate PU)
- **PSI glass** bottom, side and top: $PSI_g = 0.020 \text{ W / m}^2\text{K}$
- **Static glass gluing** with circumferentially air-tight gluing
- **3 sealing levels** (glare frame, sash, stop) for optimum sound, heat and leakage values
- **Window sash** with **ENERSafe** multipower: fully concealed fitting
- **Impermeability** to imperviousness and impact resistance to DIN 18055
- **Stress group C**
- **Increased burglar protection** and security by burglar resistant round mushroom-pin lock
- **Resistance class RC2** optional



ENERSign®primus

Leistungswerte

FIXED:

U-value window: **0.59** W/m²K
acc. EN 10077 (standard test size)
U-value frame: **0.58** W/m²K
acc. EN 10077
PSI-value glass: **0.019** W/mK

TURN-TILT:

U-value window: **0.61** W/m²K
acc. EN 10077 (standard test size)
U-value frame: **0.64** W/m²K
acc. EN 10077
PSI-value glass: **0.020** W/mK