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Heat Loss Report & System Design

Prepared for

[redacted]

Prepared by

E.on
E.ON Energy Installation Services Ltd
saleshometech@eonenergy.com
0345 3665981

E.ON Energy Installation Services Ltd, Westwood Business Park, Westwood Way, Coventry CV4 8LG, UK, 0345 3665981

Summary

Your property's heat loss

Floor area	Total heat loss	Average heat load
130 m^2	3.91 kW	30 W/m^2

Proposed system design

HEAT PUMP

Vaillant aroTHERM plus 5kW

Capacity at 50°C flow temp and -1.7 °C outdoor air temperature	6.12 kW
SCOP at 50°C	3.41

CYLINDER

Vaillant uniSTOR

Capacity	250 litres

EMITTERS

2 new radiators

2 replaced, 0 additional, 10 retained

Performance comparison

Annual CO2 savings	Estimated annual running cost savings
2.2 to 3.2 tonnes	-£95 to -£49 per year

Heat loss report

This section presents the results of our detailed heat loss calculations for your property. The overall heat loss determines how big your heating system needs to be, and the room-by-room breakdown allows us to size the emitters (radiators and underfloor heating) correctly to keep each room warm on a cold day.

Introduction

How quickly your property loses heat depends on how big it is, the materials it is made from, and how air tight it is. Our detailed heat loss survey captured all this information and we have laid it out in this report so you can understand how and why we produce our recommendations. There are several key questions that we're looking to answer as we go through this process for you:

Are the heat pump and radiators big enough?

To keep your property warm, the heat pump needs to deliver heat to the emitters (by which we just mean radiators and underfloor heating) as quickly as your property loses it, and in turn the emitters need to deliver that heat as quickly as each room loses it.

We cannot rely on the fact that your existing radiators keep your property warm with your existing heating system, because heat pumps typically work at a much lower flow temperature than fossil-fuel boilers.

Whilst heat pumps are capable of making very hot water, they work most efficiently when generating low-temperature heat, typically between 35-50C. Gas boilers have traditionally been set up to generate high-temperature heat, with water temperatures of 70-80C (although they also work more efficiently at lower temperatures!).

A lower flow temperature, while more efficient, does mean the heat output from each radiator will be reduced. We use the heat loss survey to calculate how that reduced output compares to the room's demand for heat and then determine which (if any) radiators need replacing. In this way we ensure your new system will run efficiently with a low flow temperature, while still keeping you warm on cold days.

Is the heat pump too big?

This strikes many as a funny question, but we do not want to "oversize" your heat pump. While we design your heating system to ensure it keeps your property warm on cold days, most of the time it isn't that cold! On milder days, your house loses heat more slowly so the heat pump will need to provide less heat.

Heat pumps have to be sized quite precisely, as opposed to the majority of gas or oil boilers which are typically far more powerful than is actually needed for the property. If heat pumps turn on and off all the time, it can be really inefficient and unnecessarily increase energy bills. So we want to choose a model that can keep your property warm on a cold day, but "modulate down" to keep running efficiently on milder days.

We hope this all makes sense! Please do give the report a thorough read through and let us know if you have any questions – we're more than happy to explain what bits mean in more detail if you would like!

HEAT LOSS

Calculation conditions

When calculating the property's heat loss we design to certain conditions. This section shows the conditions used for this property.

Indoor & outdoor

Design outdoor air temperature

-1.7 °C

The "99th percentile" temperature for the area — the outdoor temperature only falls below this 1% of the time.

Indoor temperature

18 °C to 21 °C

The set point the system needs to maintain. The value used in each room is shown in the room by room section.

Design ground temperature

10.2 °C

Average ground temperature across the year, used to calculate heat loss through floors.

Ventilation & infiltration

Air permeability

10.0 $m^3/hr/m^2$ at 50 Pa

Source: Estimated from survey data

A measure of how much air leaks through the building fabric, expressed as the volume of air per hour per square metre of exposed surface area at a reference pressure of 50 Pa. This value is the starting point for calculating the ventilation heat loss in each room.

Shielding

Normal

An adjustment to account for how exposed the property is to the wind. Properties in sheltered locations lose less heat through ventilation than those in exposed locations.

All calculations have been done in compliance with BS EN12831 (UK National Annex) and comply with the standards laid out in the Microgeneration Certification Scheme.

HEAT LOSS

Heat loss by element

This section shows the heat loss through each element in the property. They give you a sense of which parts of the property fabric lose the most heat, and may indicate areas where insulating could have a significant impact on the heat loss.

Total heat loss 3.91 kW

Ground Floor · Intermediate Floor/Ceiling · Roof · External Wall · Party Wall · Window · Door · Ventilation

	U-VALUE* (W/m²K)	AREA	HEAT LOSS
Ground Floor 1. Suspended floor. 100mm insulation. 2. Solid floor. 140mm insulation.	0.16 — 0.29	73.7 m²	223 W
Intermediate Floor/Ceiling • Intermediate floor. no insulation.	1.41 — 1.73	122.9 m²	146 W
Roof • Pitched, 150mm insulation at joists, felted	0.23	62.6 m²	315 W
External Wall 1. Render. Double Brick 228mm. External Insulation. 2. Filled Cavity. Brick and Standard Block (100mm). Plaster	0.25 — 0.45	108.2 m²	663 W
Internal Wall • Brick - single layer, plaster. 129mm	1.82	252.1 m²	0 W
Party Wall • MCS default party wall	0.50	32.2 m²	92 W
Window • High performance windows - U value 2 W/m2K	2.00 — 2.30	19.9 m²	894 W
Door • High performance door - U value 2.0 W/m2K	2.00	8.4 m²	383 W

	ACH**	VOLUME	HEAT LOSS
Ventilation	0.21 — 0.80	316 m³	1,197 W
Total			3.91 kW

*** U-Value:** the thermal conductivity of the element.

ACH: air changes per hour

HEAT LOSS

Heat loss by room

This section shows the heat loss from each room in the property. These results are used to design the emitters (i.e. radiators or underfloor) for the new system.

Total heat loss

3.92 kW

Bath/Shower · Dining · Dining · Hall/Landing · Kitchen · Living/Lounge · Bath/Shower · Bedroom 1 · Bedroom 2 · Bedroom 3 · Bedroom 4 · Hall/Landing

	ROOM TEMP	ACH*	FLOOR AREA	VOLUME	HEAT LOSS	HEAT LOSS PER UNIT AREA
Bath/Shower	21 °C	0.8	3.1 m²	7 m³	160 W	51 W/m²
Dining	21 °C	0.7	9.5 m²	23 m³	347 W	37 W/m²
Dining	21 °C	0.7	7.4 m²	21 m³	455 W	62 W/m²
Hall/Landing	21 °C	0.3	8.9 m²	21 m³	193 W	22 W/m²
Kitchen	21 °C	0.5	17.6 m²	42 m³	477 W	27 W/m²
Living/Lounge	21 °C	0.5	24.9 m²	60 m³	756 W	30 W/m²
Store	18 °C	0.6	2.3 m²	5 m³	-2 W	-1 W/m²
Bath/Shower	21 °C	0.5	4.5 m²	11 m³	183 W	40 W/m²
Bedroom 1	20 °C	0.5	10.5 m²	25 m³	323 W	31 W/m²
Bedroom 2	20 °C	0.5	12.9 m²	31 m³	380 W	30 W/m²
Bedroom 3	20 °C	0.5	9.8 m²	23 m³	233 W	24 W/m²
Bedroom 4	20 °C	0.6	11.9 m²	29 m³	354 W	30 W/m²
Hall/Landing	20 °C	0.2	7.0 m²	17 m³	56 W	8 W/m²

***ACH:** air changes per hour

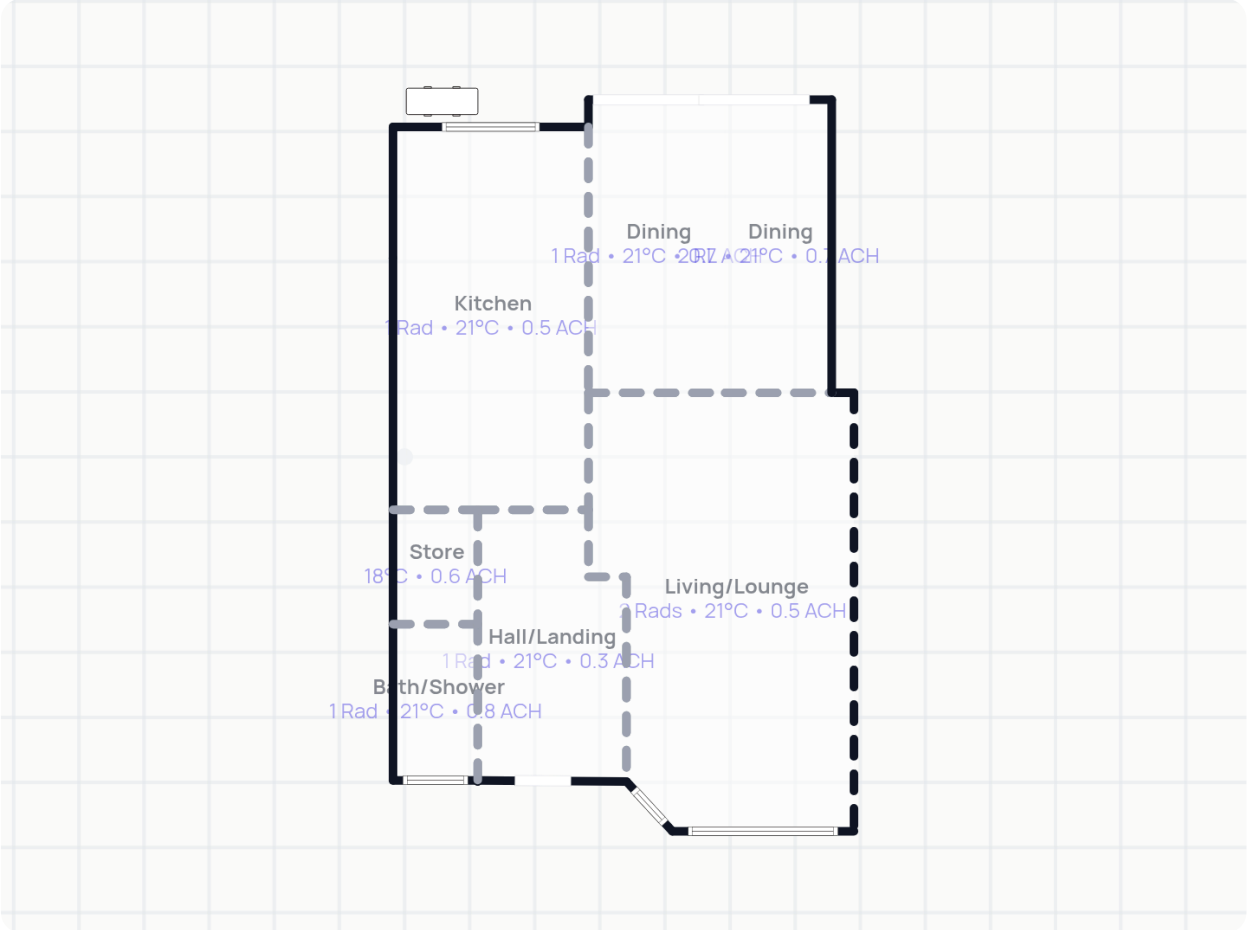
HEAT LOSS BY FLOOR

Ground floor

Heat loss by room

2386 W

Living/Lounge • Kitchen • Hall/Landing • Bath/Shower • Dining • Dining



Rads: number of radiators

UFH: underfloor heating in room

°C: room temperature

ACH: air changes per hour

W: number of windows

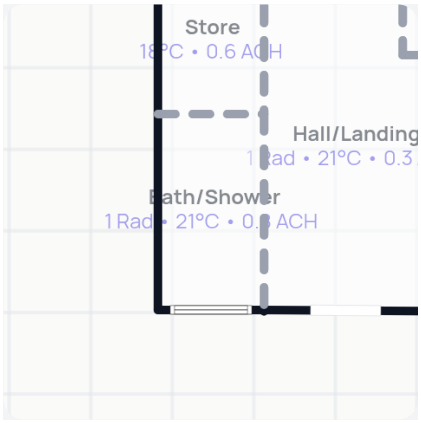
D: number of doors

HEAT LOSS BY ROOM

Bath/Shower

Total heat loss	Room temp	Air changes per hour
160 W	21 °C	0.8

Floor area	Average height	Volume
3.1 m²	2.4 m	7.4 m³



Heat loss by element

160 W

Ground Floor · External Walls · Internal Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.2 °C	0.23 W/m²K	3.1 m²	8 W
Intermediate Ceiling	21.0 °C	1.73 W/m²K	3.1 m²	0 W
External Walls	-1.7 °C	0.25 W/m²K	7.9 m²	45 W
Internal Walls 1	21.0 °C	1.82 W/m²K	5.8 m²	0 W
Internal Walls 2	18.0 °C	1.82 W/m²K	3.1 m²	17 W
Windows	-1.7 °C	2.00 W/m²K	1.0 m²	45 W
Ventilation	-1.7 °C			45 W

Heat loss per m² — 51 W/m²

Emitter performance

160 W (100%) of 160 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 11 (K1) 600 x 400 mm	160 W	100 %

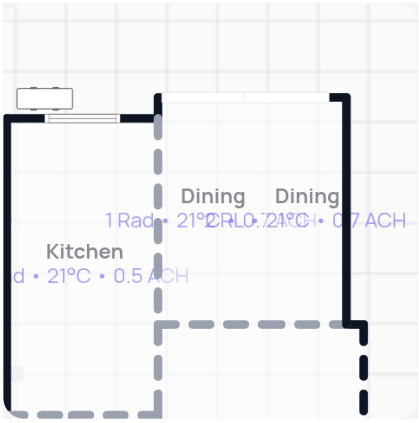
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Dining

Total heat loss	Room temp	Air changes per hour
347 W	21 °C	0.7

Floor area	Average height	Volume
9.5 m²	2.4 m	22.8 m³



Heat loss by element

347 W

Ground Floor · Intermediate Ceiling · External Walls · External doors · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.2 °C	0.16 W/m²K	9.5 m²	17 W
Intermediate Ceiling	18.0 °C	1.73 W/m²K	9.5 m²	49 W
External Walls	-1.7 °C	0.25 W/m²K	2.7 m²	15 W
Internal Walls	21.0 °C	1.82 W/m²K	25.6 m²	0 W
External doors	-1.7 °C	2.00 W/m²K	3.4 m²	153 W
Ventilation	-1.7 °C			113 W

Heat loss per m² — 37 W/m²

Emitter performance

721 W (208%) of 347 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 600 x 1000 mm	721 W	208 %

***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Dining

Total heat loss	Room temp	Air changes per hour
455 W	21 °C	0.7

Floor area	Average height	Volume
7.4 m²	2.8 m	20.7 m³

Heat loss by element

455 W

Ground Floor · Roof · External Walls · Rooflights · External doors · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.2 °C	0.22 W/m²K	7.4 m²	17 W
Roof	-1.7 °C	0.23 W/m²K	6.0 m²	31 W
External Walls	-1.7 °C	0.25 W/m²K	13.8 m²	78 W
Internal Walls	21.0 °C	1.82 W/m²K	17.2 m²	0 W
Rooflights	-1.7 °C	2.30 W/m²K	1.4 m²	73 W
External doors	-1.7 °C	2.00 W/m²K	3.4 m²	153 W
Ventilation	-1.7 °C			102 W

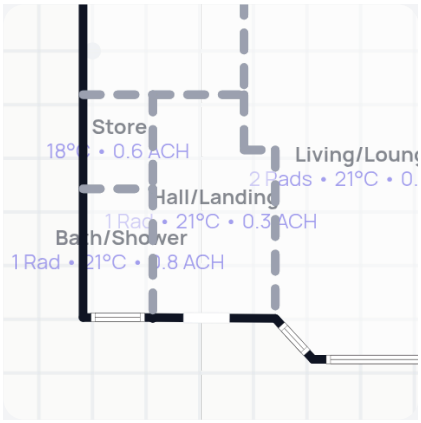
Heat loss per m² 62 W/m²

HEAT LOSS BY ROOM

Hall/Landing

Total heat loss	Room temp	Air changes per hour
193 W	21 °C	0.3

Floor area	Average height	Volume
8.9 m²	2.4 m	21.4 m³



Heat loss by element

193 W

Ground Floor · External Walls · Internal Walls · External doors · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.2 °C	0.16 W/m²K	8.9 m²	16 W
Intermediate Ceiling	21.0 °C	1.73 W/m²K	8.9 m²	0 W
External Walls	-1.7 °C	0.25 W/m²K	3.9 m²	22 W
Internal Walls 1	21.0 °C	1.82 W/m²K	21.2 m²	0 W
Internal Walls 2	18.0 °C	1.82 W/m²K	4.2 m²	23 W
External doors	-1.7 °C	2.00 W/m²K	1.7 m²	77 W
Ventilation	-1.7 °C			55 W

Heat loss per m² — 22 W/m²

Emitter performance

320 W (166%) of 193 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 11 (K1) 600 x 800 mm	320 W	166 %

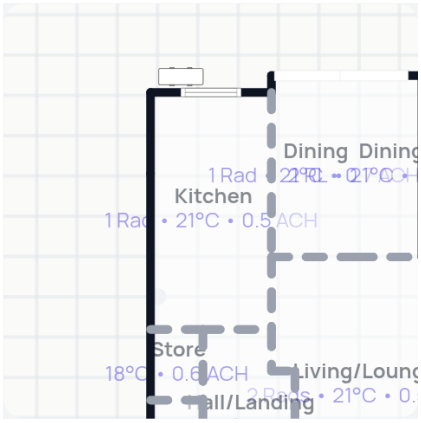
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Kitchen

Total heat loss	Room temp	Air changes per hour
477 W	21 °C	0.5

Floor area	Average height	Volume
17.6 m²	2.4 m	42.2 m³



Heat loss by element

477 W

Ground Floor · External Walls · Internal Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.2 °C	0.20 W/m²K	17.6 m²	37 W
Intermediate Ceiling	21.0 °C	1.73 W/m²K	17.6 m²	0 W
External Walls 1	-1.7 °C	0.45 W/m²K	14.1 m²	144 W
External Walls 2	-1.7 °C	0.25 W/m²K	5.2 m²	30 W
Internal Walls 1	18.0 °C	1.82 W/m²K	3.1 m²	17 W
Internal Walls 2	21.0 °C	1.82 W/m²K	18.2 m²	0 W
Windows	-1.7 °C	2.00 W/m²K	2.0 m²	89 W
Ventilation	-1.7 °C			160 W

Heat loss per m² — 27 W/m²

Emitter performance

505 W (106%) of 477 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 600 x 700 mm	505 W	106 %

***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Living/Lounge

Total heat loss	Room temp	Air changes per hour
756 W	21 °C	0.5

Floor area	Average height	Volume
24.9 m²	2.4 m	59.8 m³

Heat loss by element

756 W

Ground Floor · Intermediate Ceiling · External Walls · Party Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	-1.7 °C	0.21 W/m²K	24.9 m²	116 W
Intermediate Ceiling	18.0 °C	1.73 W/m²K	24.9 m²	129 W
External Walls	-1.7 °C	0.25 W/m²K	5.5 m²	31 W
Internal Walls	21.0 °C	1.82 W/m²K	24.7 m²	0 W
Party Walls	15.0 °C	0.50 W/m²K	16.2 m²	49 W
Windows	-1.7 °C	2.00 W/m²K	4.5 m²	204 W
Ventilation	-1.7 °C			226 W

Heat loss per m² — 30 W/m²

Emitter performance

740 W (98%) of 756 W at 50 °C

Radiator · Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 600 x 400 mm	286 W	38 %
Radiator		Type 11 (K1) 400 x 1600 mm	454 W	60 %

***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Store

Total heat loss	Room temp	Air changes per hour
-2 W	18 °C	0.6

Floor area	Average height	Volume
2.3 m²	2.4 m	5.5 m³

Heat loss by element

-2 W

Ground Floor · External Walls · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	-1.7 °C	0.29 W/m²K	2.3 m²	13 W
Intermediate Ceiling	18.0 °C	1.73 W/m²K	2.3 m²	0 W
External Walls	-1.7 °C	0.25 W/m²K	4.2 m²	21 W
Internal Walls	21.0 °C	1.82 W/m²K	10.4 m²	-57 W
Ventilation	-1.7 °C			21 W

Heat loss per m² -1 W/m²

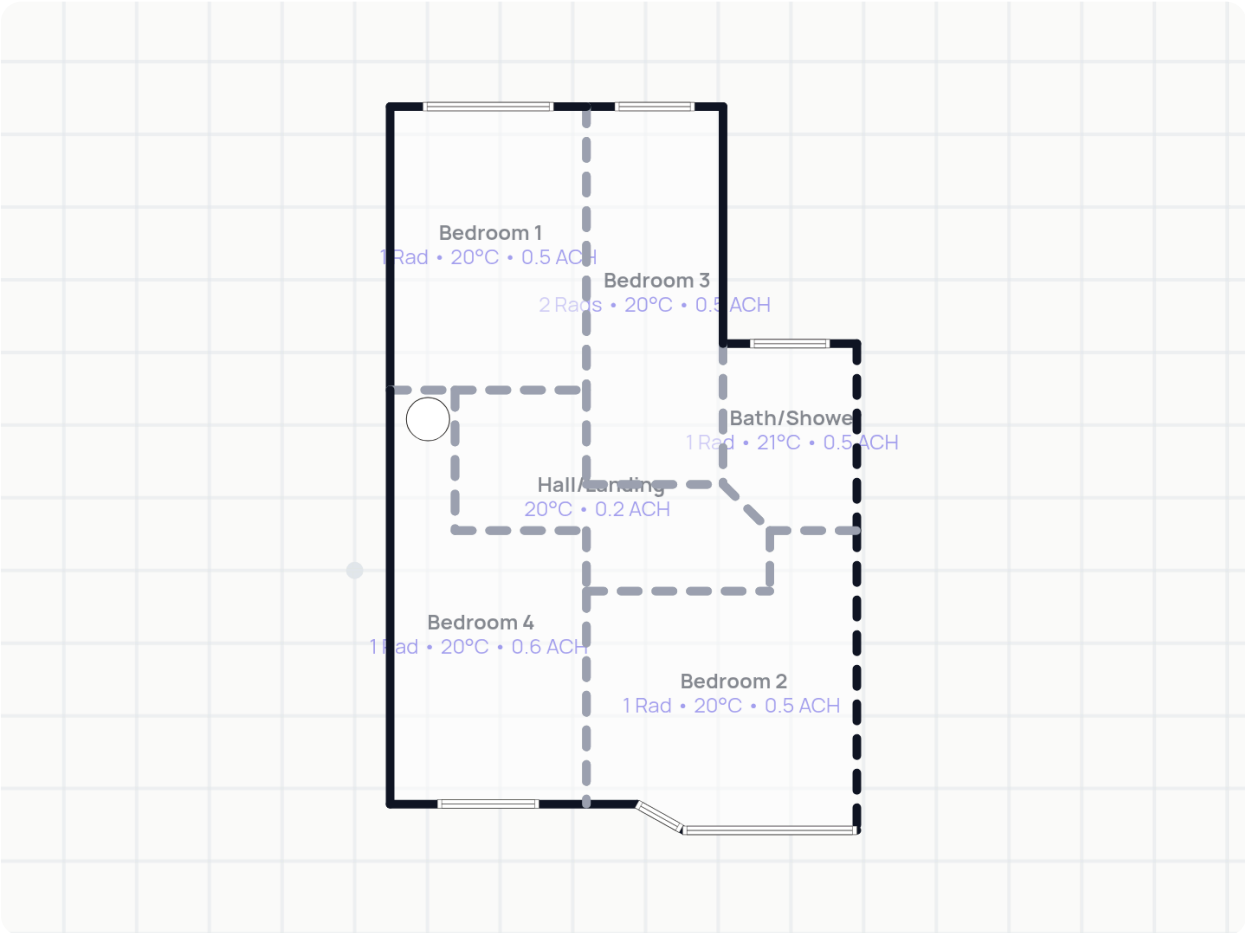
HEAT LOSS BY FLOOR

First floor

Heat loss by room

1529 W

Bath/Shower • Bedroom 3 • Bedroom 1 • Hall/Landing • Bedroom 2 • Bedroom 4



Rads: number of radiators

UFH: underfloor heating in room

°C: room temperature

ACH: air changes per hour

W: number of windows

D: number of doors

HEAT LOSS BY ROOM

Bath/Shower

Total heat loss	Room temp	Air changes per hour
183 W	21 °C	0.5

Floor area	Average height	Volume
4.5 m²	2.4 m	10.8 m³

Heat loss by element

183 W

Roof · External Walls · Internal Walls · Party Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	21.0 °C	1.41 W/m²K	4.5 m²	0 W
Roof	-1.7 °C	0.23 W/m²K	4.5 m²	24 W
External Walls	-1.7 °C	0.25 W/m²K	3.0 m²	17 W
Internal Walls	20.0 °C	1.82 W/m²K	9.7 m²	18 W
Party Walls	15.0 °C	0.50 W/m²K	6.2 m²	19 W
Windows	-1.7 °C	2.00 W/m²K	1.4 m²	65 W
Ventilation	-1.7 °C			41 W

Heat loss per m² — 40 W/m²

Emitter performance

432 W (236%) of 183 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 600 x 600 mm	432 W	236 %

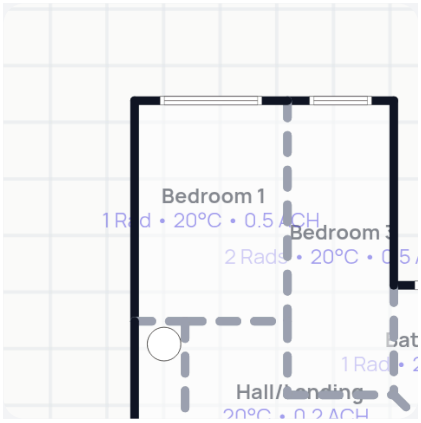
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Bedroom 1

Total heat loss	Room temp	Air changes per hour
323 W	20 °C	0.5

Floor area	Average height	Volume
10.5 m²	2.4 m	25.2 m³



Heat loss by element

323 W

Roof · External Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	20.0 °C	1.41 W/m²K	10.5 m²	0 W
Roof	-1.7 °C	0.23 W/m²K	10.5 m²	53 W
External Walls	-1.7 °C	0.25 W/m²K	13.5 m²	73 W
Internal Walls	20.0 °C	1.82 W/m²K	15.8 m²	0 W
Windows	-1.7 °C	2.00 W/m²K	2.3 m²	102 W
Ventilation	-1.7 °C			95 W

Heat loss per m² — 31 W/m²

Emitter performance

606 W (188%) of 323 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 600 x 800 mm	606 W	188 %

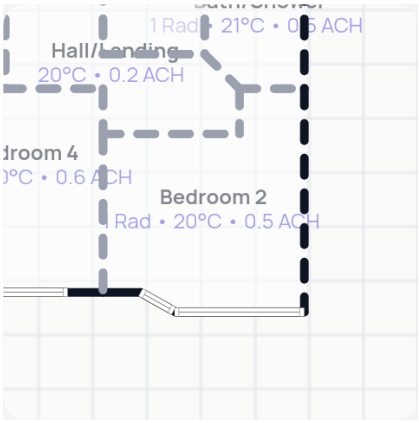
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Bedroom 2

Total heat loss	Room temp	Air changes per hour
380 W	20 °C	0.5

Floor area	Average height	Volume
12.9 m²	2.4 m	31.0 m³



Heat loss by element

380 W

Roof · External Walls · Party Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	21.0 °C	1.41 W/m²K	12.9 m²	-18 W
Roof	-1.7 °C	0.23 W/m²K	12.9 m²	64 W
External Walls	-1.7 °C	0.25 W/m²K	5.1 m²	28 W
Internal Walls 1	20.0 °C	1.82 W/m²K	15.1 m²	0 W
Internal Walls 2	21.0 °C	1.82 W/m²K	2.9 m²	-5 W
Party Walls	15.0 °C	0.50 W/m²K	9.9 m²	25 W
Windows	-1.7 °C	2.00 W/m²K	4.0 m²	175 W
Ventilation	-1.7 °C			112 W

Heat loss per m² — 30 W/m²

Emitter performance

587 W (154%) of 380 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 11 (K1) 600 x 1400 mm	587 W	154 %

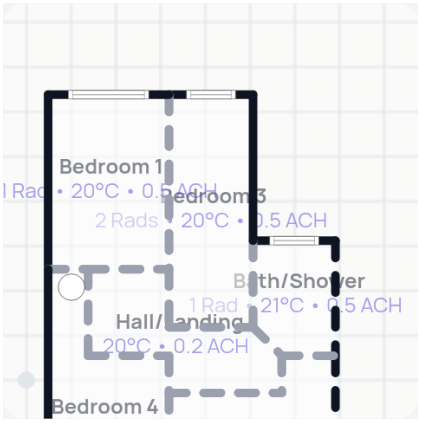
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Bedroom 3

Total heat loss	Room temp	Air changes per hour
233 W	20 °C	0.5

Floor area	Average height	Volume
9.8 m²	2.4 m	23.5 m³



Heat loss by element

233 W

Roof • External Walls • Windows • Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	21.0 °C	1.41 W/m²K	9.8 m²	-14 W
Roof	-1.7 °C	0.23 W/m²K	9.8 m²	49 W
External Walls	-1.7 °C	0.25 W/m²K	10.9 m²	59 W
Internal Walls 1	20.0 °C	1.82 W/m²K	17.0 m²	0 W
Internal Walls 2	21.0 °C	1.82 W/m²K	4.7 m²	-8 W
Windows	-1.7 °C	2.00 W/m²K	1.4 m²	62 W
Ventilation	-1.7 °C			85 W

Heat loss per m² — 24 W/m²

Emitter performance

671 W (288%) of 233 W at 50 °C

Radiator • Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 11 (K1) 600 x 600 mm	252 W	108 %
Radiator		Type 11 (K1) 600 x 1000 mm	419 W	180 %

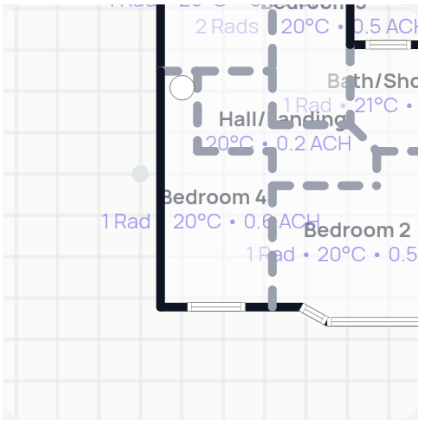
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Bedroom 4

Total heat loss	Room temp	Air changes per hour
354 W	20 °C	0.6

Floor area	Average height	Volume
11.9 m²	2.4 m	28.6 m³



Heat loss by element

354 W

Roof · External Walls · Windows · Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	20.0 °C	1.41 W/m²K	11.9 m²	0 W
Roof	-1.7 °C	0.23 W/m²K	11.9 m²	59 W
External Walls	-1.7 °C	0.25 W/m²K	18.3 m²	99 W
Internal Walls	20.0 °C	1.82 W/m²K	20.2 m²	0 W
Windows	-1.7 °C	2.00 W/m²K	1.8 m²	79 W
Ventilation	-1.7 °C			116 W

Heat loss per m² — 30 W/m²

Emitter performance

590 W (167%) of 354 W at 50 °C

Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	% DEMAND MET*
Radiator		Type 22 (K2) 500 x 900 mm	590 W	167 %

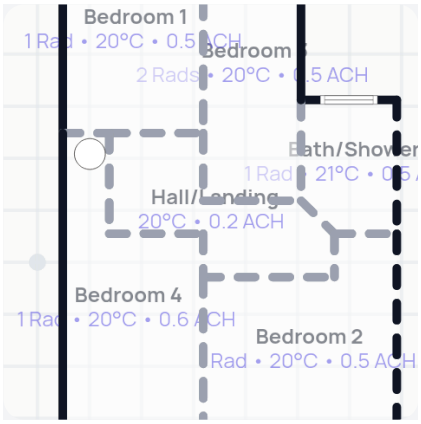
***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50 °C.

HEAT LOSS BY ROOM

Hall/Landing

Total heat loss	Room temp	Air changes per hour
56 W	20 °C	0.2

Floor area	Average height	Volume
7.0 m²	2.4 m	16.8 m³



Heat loss by element

56 W

Roof Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	20.0 °C	1.41 W/m²K	7.0 m²	0 W
Roof	-1.7 °C	0.23 W/m²K	7.0 m²	35 W
Internal Walls 1	20.0 °C	1.82 W/m²K	31.0 m²	0 W
Internal Walls 2	21.0 °C	1.82 W/m²K	2.2 m²	-4 W
Ventilation	-1.7 °C			25 W

Heat loss per m² 8 W/m²

HEAT LOSS

Ventilation heat loss breakdown

This section shows how much heat escapes with warm air leaving the building. This is calculated from the building's air permeability — how draughty it is overall — then distributed across rooms by their exposed surface area.

Whole home permeability

At 50 Pa
10.0 m³/hr/m²

At normal conditions
0.50 m³/hr/m²

This figure is estimated based on the following contribution from each part of the property (each at 50 Pa, in m³/hr/m²):

Structural Masonry	+ 7.0
Floor Sealed	+ 0.0
Doors & windows 100% draught-proofed	+ 2.0
Storeys 2 storeys	+ 1.0
Total	= 10.0

Calculation factors

Shielding — **Normal**

How exposed the property is to the wind. Sheltered locations lose less heat through ventilation than exposed ones.

Zone height — **Between 5m and 10m**

The building's total height across all floors, used to determine the shielding factor.

Shielding factor (50Pa to normal conditions conversion) — **0.05**

We multiply 50 Pa permeability by this factor to derive the value at normal conditions.

	EXPOSED AREA	INFILTRATION EX. VENTS	VENTS	INFILTRATION FROM VENTS	TOTAL INFILTRATION	VOLUME	ACH*
Living/Lounge	60 m²	30 m³/hr	–	–	30 m³/hr	60 m³	0.50 /hr
Kitchen	39 m²	19 m³/hr	–	–	19 m³/hr	42 m³	0.50 /hr
Hall/Landing	14 m²	7 m³/hr	–	–	7 m³/hr	21 m³	0.34 /hr
Bath/Shower	12 m²	6 m³/hr	–	–	6 m³/hr	7 m³	0.80 /hr
Store	6 m²	3 m³/hr	–	–	3 m³/hr	5 m³	0.59 /hr
Dining + Dining	57 m²	28 m³/hr	–	–	28 m³/hr	43 m³	0.66 /hr
Bath/Shower	9 m²	4 m³/hr	–	–	4 m³/hr	11 m³	0.50 /hr
Bedroom 3	22 m²	11 m³/hr	–	–	11 m³/hr	23 m³	0.50 /hr
Bedroom 1	26 m²	13 m³/hr	–	–	13 m³/hr	25 m³	0.52 /hr

	EXPOSED AREA	INFILTRATION EX. VENTS	VENTS	INFILTRATION FROM VENTS	TOTAL INFILTRATION	VOLUME	ACH*
Hall/Landing	7 m^2	4 m^3/hr	–	–	4 m^3/hr	17 m^3	0.21 /hr
Bedroom 2	22 m^2	11 m^3/hr	–	–	11 m^3/hr	31 m^3	0.50 /hr
Bedroom 4	32 m^2	16 m^3/hr	–	–	16 m^3/hr	29 m^3	0.56 /hr

***ACH:** the number of air changes per hour that the room sees. This is calculated based on the infiltration values.

System design

This section presents our proposed system design for the property. The design is based on the detailed room by room calculations in the previous section.

Proposed heat pump

Based on the property's design heat loss of 3.91kW and on all the attributes of the property that we know of at this stage, we would suggest the following heat pump.

Vaillant aroTHERM plus 5kW	
Capacity at 50 °C (-1.7 °C)	6.12 kW
SCOP at 50 °C	3.41
Flow temperature	50 °C

This heat pump covers **156 %** of the heating requirement at and above the design temperature of **-1.7 °C**. The heat pump will be run on weather compensation so the efficiency will be higher when the weather is milder.

MCS certificate number
[redacted]

Refrigerant
R290

Model number
[redacted]

Sound power
54 dB(A)

Width
1100 mm

Height
765 mm

Depth
450 mm

Weight
114 kg

Capacity (kW)

OUTSIDE TEMP	35°C	40°C	45°C	50°C	55°C
-5°C	6.3	6	5.6	5.5	5.4
-3°C	6.8	6.4	6.1	5.9	5.8
0°C	6.9	6.7	6.6	6.4	6.2
2°C	7.1	7	6.9	6.7	6.5

Seasonal Coefficient of Performance (SCOP)

SCOP is the average coefficient of performance over the heating season, accounting for the variation in outdoor temperature. Manufacturers have to test their equipment in standard conditions and report their SCOP performance data to be eligible for certification.

	35°	40°	45°	50°	55°
SCOP	4.48	4.13	3.77	3.41	3.06

Location

At rear of house under kitchen window. There is just enough clearance from vent to fir unit over to right and have 500mm clearance for maintenance.

- Mounting location: Ground
- Base to be built by: Use existing
- Condensate drain: Near drain or downpipe

SYSTEM DESIGN

Emitters

Emitters (i.e., radiators/fan coils/underfloor heating) are a vital part of the heating system. They take the heat produced by the heat source and distribute that heat around the property.

Based on the room by room heat loss results, we propose the following emitter design for the property. This design will ensure each room can be heated to its set point when it's -1.7 °C outside whilst maintaining high system efficiency.

Design conditions

- Flow temperature = 50 °C
- Temperature drop across the radiator (delta T) = 5 °C
- Mean radiator temperature = 47.5 °C

Emitter replacements

We propose replacing or adding emitters in the following rooms:

1. Living/Lounge
2. Dining

SYSTEM DESIGN

Current emitters in the property

ROOM	IMAGE	TYPE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% DEMAND MET*
Living/Lounge		Radiator	Type 22 (K2) 600 x 400 mm	286 W	740 W	756 W	98 %
		Radiator	Type 11 (K1) 400 x 1600 mm	454 W			
Kitchen		Radiator	Type 22 (K2) 600 x 700 mm	505 W	505 W	477 W	106 %
Hall/Landing		Radiator	Type 11 (K1) 600 x 800 mm	320 W	320 W	193 W	166 %
Bath/Shower		Radiator	Type 11 (K1) 600 x 400 mm	160 W	160 W	160 W	100 %
Store		–		0 W	0 W	-2 W	100 %
Dining + Dining		Radiator	Type 22 (K2) 600 x 1000 mm	721 W	721 W	802 W	90 %
		–		0 W			
Bath/Shower		Radiator	Type 22 (K2) 600 x 600 mm	432 W	432 W	183 W	236 %
Bedroom 3		Radiator	Type 11 (K1) 600 x 600 mm	252 W	671 W	233 W	288 %
		Radiator	Type 11 (K1) 600 x 1000 mm	419 W			
Bedroom 1		Radiator	Type 22 (K2) 600 x 800 mm	606 W	606 W	323 W	188 %
Hall/Landing		–		0 W	0 W	56 W	0 %
Bedroom 2		Radiator	Type 11 (K1) 600 x 1400 mm	587 W	587 W	380 W	154 %
Bedroom 4		Radiator	Type 22 (K2) 500 x 900 mm	590 W	590 W	354 W	167 %

***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50.0 °C.

SYSTEM DESIGN

Proposed emitter changes

ROOM	STATUS	IMAGE	TYPE	DETAILS	EMITTER OUTPUT	ROOM DEMAND	% DEMAND MET*
Living/Lounge	Keep		Radiator	Type 22 (K2) 600 x 400 mm	286 W	756 W	158 %
	Replacement		Radiator	Stelrad · Type 22 (K2) · White 450 x 1600 mm	905 W		
Kitchen	Keep		Radiator	Type 22 (K2) 600 x 700 mm	505 W	477 W	106 %
Hall/Landing	Keep		Radiator	Type 11 (K1) 600 x 800 mm	320 W	193 W	166 %
Bath/Shower	Keep		Radiator	Type 11 (K1) 600 x 400 mm	160 W	160 W	100 %
Store			–		0 W	-2 W	100 %
Dining + Dining	Replacement		Radiator	Stelrad · Type 33 (K3) · White 600 x 1000 mm	992 W	802 W	124 %
			–		0 W		
Bath/Shower	Keep		Radiator	Type 22 (K2) 600 x 600 mm	432 W	183 W	236 %
Bedroom 3	Keep		Radiator	Type 11 (K1) 600 x 600 mm	252 W	233 W	288 %
	Keep		Radiator	Type 11 (K1) 600 x 1000 mm	419 W		
Bedroom 1	Keep		Radiator	Type 22 (K2) 600 x 800 mm	606 W	323 W	188 %
Hall/Landing			–		0 W	56 W	0 %**
Bedroom 2	Keep		Radiator	Type 11 (K1) 600 x 1400 mm	587 W	380 W	154 %
Bedroom 4	Keep		Radiator	Type 22 (K2) 500 x 900 mm	590 W	354 W	167 %

***% demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 50.0 °C.

**** Accepting undersized emitters**

Please note that the emitters do not meet the room heat demand in all cases. This means that the following rooms will not reach their set point temperature at the design flow temperature. If you choose to go ahead, you are acknowledging that you are happy with the above. If that doesn't sound right please contact us before proceeding with the install.

Hall/Landing Covered by excess in hall below.

SYSTEM DESIGN

Hot water

The heat pump will provide **100%** of the hot water requirement. Heat pumps cannot create heat as quickly as combi boilers, so they can't heat up hot water instantaneously when you need it. Instead we install a cylinder which stores hot water so it's always ready when you need it.

Proposed cylinder model

We've selected the following hot water cylinder based on the number of bedrooms in the property.

Vaillant uniSTOR

Capacity	250 litres

Cylinder location

Loft, just in front and slightly to left of hatch. Customer will need to clear space and provide base as per structural report.

Hot water performance calculations

The calculation below shows how much electricity we expect the heat pump to use for providing hot water. The calculations are based on typical usage.

Total electricity per year for hot water — 1,840 kWh

Annual demand

Volume per day	225 litres/day
Assumed mains water temp	10 °C
Storage temp	50 °C
Distribution efficiency	70 %
Heat demand per day	14.95 kWh
Days per year	365 days
Heat demand per year	5,458 kWh

Legionella cycles

Volume per cycle	250 litres
Tank starting temperature	50 °C
Legionella set point	60 °C
Distribution efficiency	70 %
Heat demand per cycle	4.15 kWh
Cycles per year	52
Heat provided by legionella cycles per year	216 kWh

Electricity consumption

Legionella cycle provided by	Heat pump
Heat energy provided by legionella cycle	216 kWh
Legionella cycle efficiency	170 %
Electricity consumption - legionella	127 kWh
Remaining heat demand	5,242 kWh
Hot water efficiency - normal operation	306 %
Electricity consumption - normal operation	1,713 kWh
Total electricity consumption	1,840 kWh
Overall efficiency	297 %

Reheat time — 1 h 57 min

Once depleted, it will take the cylinder **1 h 57 min** to fully reheat based on the following inputs:

Cylinder volume	250 litres

Mains water temp	10 °C
Hot water storage temp	50 °C
Heating power	5.97 kW

Sound assessment

Pass

To class as "permitted development" the heat pump design must comply with regulations regarding the sound level at a neighbour's nearest window/door. This section presents the results of the sound assessment we've conducted for the proposed heat pump and location, as set out in MCS 020a v1.0

This assessment accounts for:

- The sound level of the heat pump itself
- The influence of the space that it is in
- Any barriers between the heat pump and the assessment position

Results by position

Position 2	28.1 dB	Pass

SOUND ASSESSMENT

Position 2

Upstairs bedroom

Sound pressure level

Sound power level Vaillant aroTHERM plus 5kW V[redacted]	54 dB(A)
Reduction due to distance Reflective surfaces: three reflecting surfaces (Q=8) Distance (heat pump to assessment position): 5 m	15.9 dB(A)
Reduction due to barriers No line of sight, Solid brick/masonry wall or fence more than 18mm thick	10 dB(A)
Total	**28.1 dB(A)**

Result

Pass

Maximum allowed value	37 dB(A)
Final result at assessment position	**28.1 dB(A)**

Performance estimate

Predicting running costs with a heat pump is hard as it depends on a lot of factors, many of which are outside our control. But it's clearly really important that you're able to make an informed decision. So in this section we give you our best estimate of what the running costs and carbon savings will look like for the property if and when you switch to a heat pump.

We then provide an in-depth description of how we've calculated these figures in case you want to dig into the details. Please do ask us if anything doesn't make sense!

Summary

Bills

Current	£719 to £1,045
Proposed system	£768 to £1,140
Savings	-£95 to -£49

Carbon

Current	2.6 to 3.8 tonnes CO_2
Proposed system	0.4 to 0.6 tonnes CO_2
Savings	84%

PERFORMANCE ESTIMATE

Detailed results

The running costs and carbon emissions of a heating system depends on a few key factors, all of which are explained in (even) more detail further down this report:

1. **Your property's heating and hot water demand**
   This is how much heat your property needs for heating and hot water in the year irrespective of what heating system is used to provide it. It's surprisingly hard to put a definitive number on this because it depends on how often you have the heating on and at what temperature, how much hot water you use, and the weather outside.

   Given this uncertainty we have estimated this in 2 different ways to try and give you the best understanding:
   - **EPC** – Based on the heating and hot water demand from the property's EPC. This assumes the property hasn't changed since the EPC date and uses assumptions about the heating and hot water system that don't apply to a heat pump. If the property has changed since the last EPC or that EPC had errors, this might not be the best measure, but we have to include it.
   - **Heating Degree Days** – Based on the heat loss calculations we have done combined with "heating degree day" data which represents the typical annual weather pattern in the area.

2. **The efficiency of your system**
   The efficiency of your system describes how much heat your system makes from what you pay for (electricity/gas/oil), both in heating and when making hot water. This depends on the system design, install quality, and how you run the system. We've included two sets of numbers here. One using fixed efficiencies from MCS and another using the Manufacturer's tested values.

   The MCS estimate uses standard efficiency values, which are the same for all heat pumps and only depend on the flow temperature the system is designed at. They tend to be more conservative. Manufacturer's efficiencies use their test data at standard conditions. We've included both to give you a fair picture of what to expect.

3. **Energy prices**
   Heat pump running costs depend on the price of electricity, and the comparison with your old system depends on the price of mains gas. We've included numbers at the price cap to show what you might pay.

4. **Emission factors**
   Emission factors show how much carbon dioxide is emitted per unit of energy provided by a fuel. They are a measure of how "clean" a fuel is.

PERFORMANCE ESTIMATE

MCS031 Performance estimate

The table below shows a performance estimate in MCS's required table layout following the methodology laid out in MCS 031 Issue 4.0.

Heat Pump System Performance Estimate	
Your energy requirements	
Energy required for heating	**7,352** kWh
Demand to be supplied by the heat pump	**7,352** kWh
Energy required for hot water	**2,925** kWh
Demand to be supplied by the heat pump	**2,925** kWh
Your property	
Your postcode prefix	**DA**
Total property floorspace (not property footprint)	**130** m^2
Average watts per square metre Note: W/m2 is a measure of your property's thermal efficiency. 0-30W/m2 is very low heat loss and 120-150W/m2 is very high heat loss.	**30** W/m^2
Proposed system	
Heat pump capacity	**6.1** kW
Heat pump type	**ASHP**
Your system is proposed to provide:	**Space heat and hot water**
Your proposed heating system will be (select one):	**Upgraded radiators**
The proposed flow temperature will be	**50** °C
Performance	
The Seasonal Performance Factor is calculated to be:	**3.1**
Estimate of energy consumption of the proposed heat pump (or combined system where Hybrid). Note: you can convert these figures to approximate running costs.	**High: 4,501** kWh → **Low: 3,683** kWh
Important Note: This is not a detailed system design. It offers a reasonable estimate of likely performance and a description of the likely design. This estimate is based on a full heat loss survey and design.	
Applicable warning notes (from Table 2): None	

PERFORMANCE ESTIMATE

Results table - Manufacturer's efficiencies

This table shows a granular breakdown of the potential energy consumption and running costs of your heat pump, based on different estimates of your property's energy demand and different energy tariffs that you might choose. We are also using heat pump efficiencies (i.e. SCOP) based on the manufacturer's test data, which often shows higher efficiencies than MCS's fixed values.

Warning: In accordance with MCS standards you should treat any performance estimate that differs from the MCS031 calculations with caution. We have included it because we think it's helpful to show you how different estimates of your heating demand affect the overall performance, how the tariff you choose can affect the running costs of the system, and the potential efficiency of the heat pump based on the manufacturer's own test data.

If you have any questions about this, please do let us know and we'll be happy to talk you through it.

	BASED ON EPC		BASED ON HEAT LOSS CALCULATIONS AND HEATING DEGREE DAYS		BASED ON LAST YEARS CONSUMPTION
Bills	Existing (Mains gas)*	Heat pump (Electricity)	Existing (Mains gas)*	Heat pump (Electricity)	Unavailable
Price cap (24.67 p/kWh)	£719	£768 -£49	£1,045	£1,140 -£95	

* Based on an existing Mains gas price of 5.74 p/kWh

Carbon	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Totals	2,632 kg	423 kg 2,209 kg	3,825 kg	628 kg 3,197 kg	

Consumption	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Heating	8,966 kWh	2,156 kWh	11,557 kWh	2,779 kWh	
Hot Water	3,566 kWh	956 kWh	6,656 kWh	1,840 kWh	
Total	12,532 kWh	3,112 kWh	18,213 kWh	4,619 kWh	

Demand				Unavailable
Heating	7,352 kWh		9,477 kWh	
Hot Water	2,925 kWh		5,458 kWh	

Total	10,276 kWh	14,935 kWh

Efficiency	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Heating	82 %	341 %	82 %	341 %	
Hot water	82 %	306 %	82 %	297 %	

PERFORMANCE ESTIMATE

Inputs and assumptions

In each of the following sections, we break down how we've calculated the numbers that appear in the results table.

Heat energy required

To work out how much energy the property needs to keep it warm, we first have to work out how much heat is required. That might sound strange, but because different heating sources have wildly different efficiencies, this heat energy number will need to be divided by the system efficiency (see next section) to calculate the actual energy required.

	BASED ON EPC	BASED ON HEAT LOSS CALCULATIONS AND HEATING DEGREE DAYS	BASED ON LAST YEARS CONSUMPTION
	Certificate number: [redacted]	2255 degree days, 175 W/°C	Unavailable
Heating	7,352 kWh	9,477 kWh	
Hot water	2,925 kWh	5,458 kWh	
Total	10,276 kWh	14,935 kWh	

System efficiency

The efficiency of a heating system describes how much useful output (heat) you get per unit of what you pay for (electricity/gas/oil). A system's efficiency will often be different when it is doing space heating vs. when it's making hot water because the temperature that the system is heating the water to is often hotter in water heating cycles. We have used the following inputs when modelling the system.

Existing heating system

Existing heating system fuel:	Mains gas
Efficiency - space heating:	82%
Efficiency - hot water:	82%

Heat pump system

Type of system:	Air source heat pump
Model:	Vaillant aroTHERM plus 5kW
MCS certificate numbers:	[redacted]
Flow temperature - space heating:	50°C
Flow temperature - hot water:	55°C

	MCS SPF	MANUFACTURERS SCOP
Heating efficiency	310 %	341 %
Hot water efficiency	170 %	297 %

Energy prices

As the last few years have shown, energy prices are very hard to predict. In modelling bills we have used the current energy price cap. Energy tariffs can also vary by supplier and change over time, so we'd recommend not making your decision based purely on a specific tariff or running cost figure.

If you have solar (or are planning to install it), the electricity prices will also be lower because the heat pump will use some of the electricity that the solar is generating. This is especially true for hot water consumption because you can schedule the hot water to run in the middle of the day.

MAINS GAS

Existing price	5.74 p/kWh

ELECTRICITY

Price cap Price cap 1st April - 30th June 2026	24.67 p/kWh

Emission factors

We've used the emission factors from the government's SAP 2010 methodology. For mains gas this value is fixed but for electricity it is falling over time as the grid decarbonises. This means the system will get cleaner and cleaner. The value used here is based on a projected continued reduction in grid carbon intensity.

Mains gas

210 gCO2/kWh

Electricity

136 gCO2/kWh

Dependence of performance on flow temperature

How much electricity the heat pump will use to provide heating depends on the flow temperature that the system runs at. We have designed the system to run at 50°C when it's -1.7°C outside and we'll set it up to use weather compensation so it runs more efficiently at milder temperatures.

To demonstrate the importance of flow temperature, the table below shows how much electricity the system would consume to provide heating at a range of flow temperatures. This graph is based on the heat loss calculations and heating degree days based estimate, but the pattern would be similar for any of the inputs.

	35°	40°	45°	50°	55°
SCOP	4.48	4.13	3.77	3.41	3.06
Electricity consumed (kWh/year)	3334	3616	3962	4380	4881

PERFORMANCE ESTIMATE

MCS Key facts - Energy Performance Estimate

Predicting the heat demand of a building, and therefore the performance and running costs of heating systems, is difficult to predict with certainty due to the variables discussed here. These variables apply to all types of heating systems, although the efficiency of heat pumps is more sensitive to good system design and installation. For these reasons your estimate is given as guidance only and should not be considered as a guarantee.

Seasonal Coefficient of Performance:

MCS Seasonal Coefficient of Performance (SCoP) is derived from the EU ErP labelling requirements, and is a theoretical indication of the anticipated efficiency of a heat pump over a whole year using standard (i.e. not local) climate data for 3 locations in Europe. It is used to compare the relative performance of heat pumps under fixed conditions and indicates the units of total heat energy generated (output) for each unit of electricity consumed (input). As a guide, a heat pump with a MCS SCoP of 3 indicates that 3 kWh of heat energy would be generated for every 1 kWh of electrical energy it consumes over a 'standard' annual cycle.

Energy Performance Estimate

An Energy Performance Certificate (EPC) is produced in accordance with a methodology approved by the government. As with all such calculations, it relies on the accuracy of the information input. Some of this information, such as the insulating and air tightness properties of the building may have to be assumed and this can affect the final figures significantly leading to uncertainty especially with irregular or unusual buildings.

Identifying the uncertainties of energy predictions for heating systems

We have identified 3 key types of factor that can affect how much energy a heating system will consume and how much energy it will deliver into a property. These are 'Fixed', 'Variable' and 'Random'. Most factors are common to ALL heating systems regardless of the type (e.g oil, gas, solid fuel, heat pump etc.) although the degree of effect varies between different types of heating system as given in the following table.

The combined effect of these factors on energy consumption and the running costs makes overall predictions difficult however an accuracy ± 25-30% would not be unreasonable in many instances. Under some conditions even this could be exceeded (e.g. considerable opening of windows). Therefore it is advised that when making choices based on mainly financial criteria (e.g. payback based on capital cost versus net benefits such as fuel savings and financial incentives) this variability is taken into account as it could extend paybacks well beyond the period of any incentives received, intended occupancy period, finance agreement period etc.

'Fixed' which include:

Factor	Impact
Equipment Selection Performance figures (SCoP) from ErP data	System Efficiency
Energy Assessment via the EPC (e.g. assumptions as to fabric construction and levels of insulation; the variation in knowledge and experience of Energy Assessors)	Energy Required

'Variable' which are affected by the system design and include:

Factor	Impact
Accuracy of sizing of heat pump-i.e. closeness of unit output selection (kW) to demand heat requirement (kW)	System Efficiency
Design space and ambient (external) temperatures	Energy Required
Design flow / return water temperatures and weather compensation	System Efficiency
Type of Heat emitter (e.g. Under-floor; natural convector (e.g. radiator), fan convector etc.)	System Efficiency

'Random' which cannot be anticipated and include:

Factor	Impact
User behaviour:	
• Room temperature settings	Energy Required
• Hot water usage and temperature settings	Energy Required
• Occupancy patterns/times	Energy Required
• Changing the design HP flow temperatures	System Efficiency
• Ventilation (i.e. opening windows)	Energy Required
Annual climatic variations (i.e. warmer and colder years than average)	Energy Required

Key

The statement at the end of each item indicates the major factor affected as follows:

Energy Required: the heat energy output requirement of the system which directly impacts on running costs. This requirement exists regardless of the heating system chosen as it is the heat required to keep the space comfortable. Opening windows or increasing room temperatures will demand more heat output, which means more energy input but this would NOT directly affect the efficiency. Thus increased energy demand does NOT automatically mean reduced efficiency.

System Efficiency: the efficiency of the system has been directly affected and will therefore demand more input energy to achieve the same heat output thus increasing running costs. However, increased energy input does NOT necessarily mean lower system efficiency (see above).