SUSTAIN

Heat Pumps

Your Heat Pump Designs

Greener,

Smarter,

Better homes

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Sustain

We are a multi award winning renewables company specialising in installing the latest air source heat pumps and solar panels.

We are an accredited B-Corp balancing profit, purpose and the planet.

Design House

Our design team is led by John Luk, a Mechanical Engineer, CIBSE-affiliated system designer, and accredited "HeatGeek" Heating Master.

He is supported by a team of seasoned heating design professionals, retrofit coordinators, and an experienced senior management team.

SUSTAIN

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Heat Loss Report & System Design

Prepared for

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Summary

Your home's heat loss

Floor area

60 m²

Total heat loss

3.27 kW

Average heat load

54 W/m²

Proposed system design

HEAT PUMP

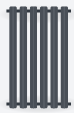
Vaillant aroTHERM Plus 3.5kW

Capacity at 45°C flow temp and -1.7 °C outdoor air temperature	4.43 kW
SCOP at 45°C	3.65

CYLINDER

150L Heat Pump Cylinder

Capacity	150 litres



RADIATORS

4 Radiator changes

4 replaced, 0 additional, 2 retained

Performance comparison

Annual CO2 savings

1.6 to 2.2 tonnes

Annual running cost savings

-£30 to £301 per year

Heat loss report

This section presents the results of our detailed heat loss calculations for your home. 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 home 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 home warm, the heat pump needs to deliver heat to the emitters (by which we just mean radiators and underfloor heating) as quickly as your home 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 home 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 home 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 home 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!

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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.

Design outdoor air temperature For the design outdoor temperature we use the "99th percentile" temperature. That means that the outdoor temperature in the area only falls below this temperature 1% of the time.	-1.7 °C
Design ground temperature The ground temperature is used in calculating the heat loss through the floor. It's the average temperature in the surrounding area across the year, because the ground temperature stays very constant through the year.	10.1 °C
Heating degree days Heating degree days are a measure of how much heating the home needs over the whole year based on the typical temperature profile for it's location.	2254 °C days
Indoor temperature The indoor temperature set point that the system needs to be able to maintain in each room. The value used in each room is shown in the room by room breakdown section.	16 °C to 22 °C depending on the room
Intermittent heating Heating a home up from cold requires more power than just maintaining a temperature. For intermittently occupied homes like holiday homes you might slightly oversize the system to allow it to warm up the home more quickly when it's needed. For a home that is occupied normally this would just result in the system cycling, thus reducing efficiency.	No: assume property is occupied all winter
Exposed location Properties very exposed to the wind will lose heat more quickly than typical so we would size the system to account for this.	No: property is not in an exposed location such as on the coast
MVHR Mechanical ventilation with heat recovery systems capture heat from exhaust air and use it to pre-heat incoming air. They therefore reduce heat loss due to ventilation compared to standard mechanical ventilation systems (like bathroom fans + air vents) because they recycle some of the heat.	No: a ventilation system with heat recovery is not present

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.

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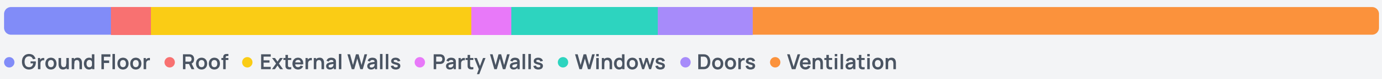
HEAT LOSS

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 3269 W



	U-VALUE* (W/m²K)	AREA	HEAT LOSS	ANNUAL ENERGY
Ground Floor 1. Solid floor. No insulation.	0.88 — 0.94	29.8 m²	259 W	651 kWh
Intermediate Floor/Ceiling 1. Intermediate floor. no insulation.	1.41 — 1.73	60.1 m²	0 W	0 kWh
Roof 1. Pitched, 250mm insulation at joists, felted	0.15	30.3 m²	92 W	209 kWh
External Wall 1. Filled Cavity. Brick and Standard Block (100mm). Plaster	0.45	83.0 m²	780 W	2,141 kWh
Internal Wall 1. Block - 100mm standard aerated block, plaster. 126mm.	1.06	82.9 m²	-0 W	-0 kWh
Party Wall 1. MCS default party wall	0.50	18.2 m²	70 W	193 kWh
Window 1. Double Glazed, Wood/PVC frame	2.80	5.9 m²	347 W	953 kWh
Door 1. Wooden door. 50% double glazing.	2.80	3.5 m²	209 W	574 kWh

	ACH**	VOLUME	HEAT LOSS	ANNUAL ENERGY
Ventilation	1	52 m³	342 W	939 kWh
Ventilation	2	52 m³	706 W	1,940 kWh
Ventilation	1.5	41 m³	465 W	1,107 kWh

Total	3,269 W	8,706 kWh

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

****ACH:** air changes per hour

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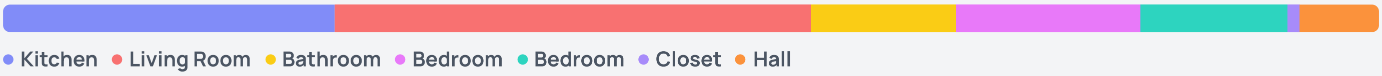
HEAT LOSS

Heat loss by room

This section shows the heat loss from each room in the property. These results are used to design the radiators for the new system.

Total heat loss 3269 W



	ROOM TEMP	ACH*	FLOOR AREA	VOLUME	HEAT LOSS	HEAT LOSS PER UNIT AREA
Kitchen	18 °C	2	12.6 m^2	30 m^3	811 W	64 W/m^2
Living Room	21 °C	1.5	17.2 m^2	41 m^3	1,145 W	67 W/m^2
Bathroom	22 °C	2	4.3 m^2	10 m^3	332 W	78 W/m^2
Bedroom	18 °C	1	11.5 m^2	28 m^3	445 W	39 W/m^2
Bedroom	18 °C	1	8.9 m^2	22 m^3	357 W	40 W/m^2
Closet	16 °C	1	1.1 m^2	3 m^3	9 W	8 W/m^2
Hall	18 °C	2	4.6 m^2	11 m^3	170 W	37 W/m^2

***ACH:** air changes per hour

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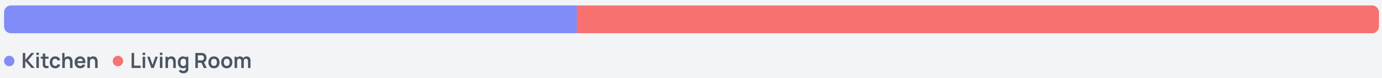
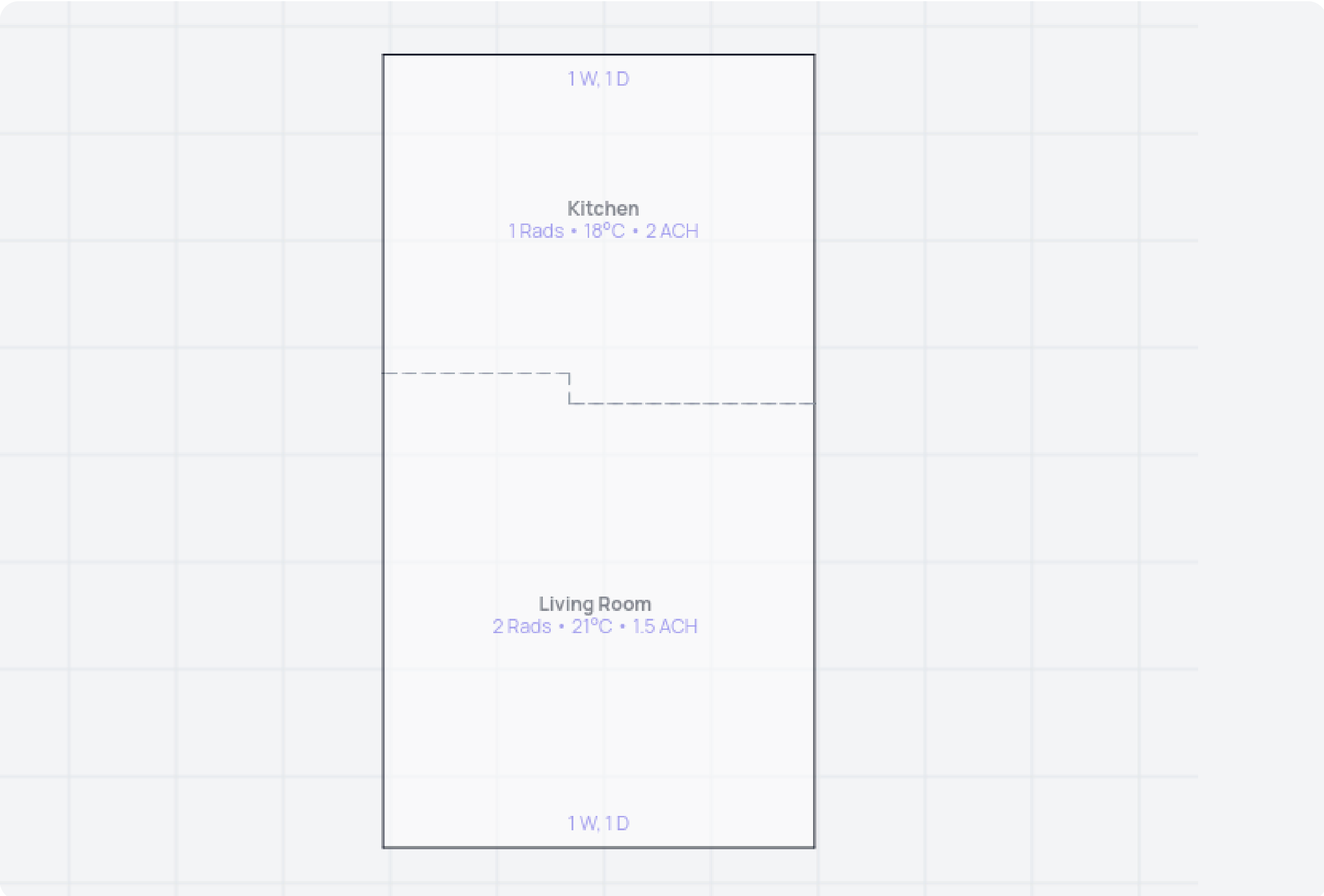
HEAT LOSS BY FLOOR

Imported: Ground Floor

Heat loss by room

1956 W





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

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HEAT LOSS BY ROOM

Kitchen

Total heat loss	Room temp	Air changes per hour
811 W	18 °C	2.0

Floor area	Average height	Volume
12.6 m²	2.4 m	30.0 m³

Heat loss by element

811 W

• Ground Floor • External Walls • Windows • Doors • Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.1 °C	0.94 W/m²K	12.6 m²	94 W
Intermediate Ceiling	18.0 °C	1.73 W/m²K	12.6 m²	0 W
External Walls	-1.7 °C	0.45 W/m²K	21.4 m²	190 W
Internal Walls	21.0 °C	1.06 W/m²K	10.3 m²	-33 W
Windows	-1.7 °C	2.80 W/m²K	1.3 m²	69 W
Doors	-1.7 °C	2.80 W/m²K	1.7 m²	96 W
Ventilation	-1.7 °C			395 W

Heat loss per m² 64 W/m²

Emitter performance

50% of 811 W at 45 °C

• Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Radiator		Type 21 (P+) 600 x 800 mm	405 W	405 W	811 W	50 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45 °C

HEAT LOSS BY ROOM

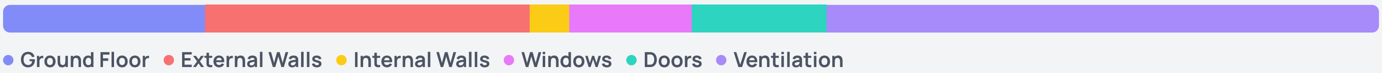
Living Room

Total heat loss	Room temp	Air changes per hour
1145 W	21 °C	1.5

Floor area	Average height	Volume
17.2 m²	2.4 m	40.9 m³

Heat loss by element

1,145 W



	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Ground Floor	10.1 °C	0.88 W/m²K	17.2 m²	165 W
Intermediate Ceiling	21.0 °C	1.73 W/m²K	17.2 m²	0 W
External Walls	-1.7 °C	0.45 W/m²K	26.7 m²	273 W
Internal Walls	18.0 °C	1.06 W/m²K	10.3 m²	33 W
Windows	-1.7 °C	2.80 W/m²K	1.5 m²	97 W
Doors	-1.7 °C	2.80 W/m²K	1.8 m²	113 W
Ventilation	-1.7 °C			465 W

Heat loss per m² 67 W/m²

Emitter performance

81% of 1145 W at 45 °C

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Radiator		Type 22 (K2) 600 x 600 mm	327 W	923 W	1145 W	29 %
Radiator		Type 21 (P+) 600 x 1400 mm	596 W	923 W	1145 W	52 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45 °C

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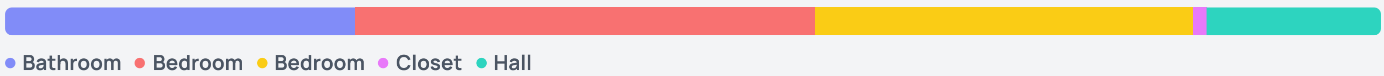
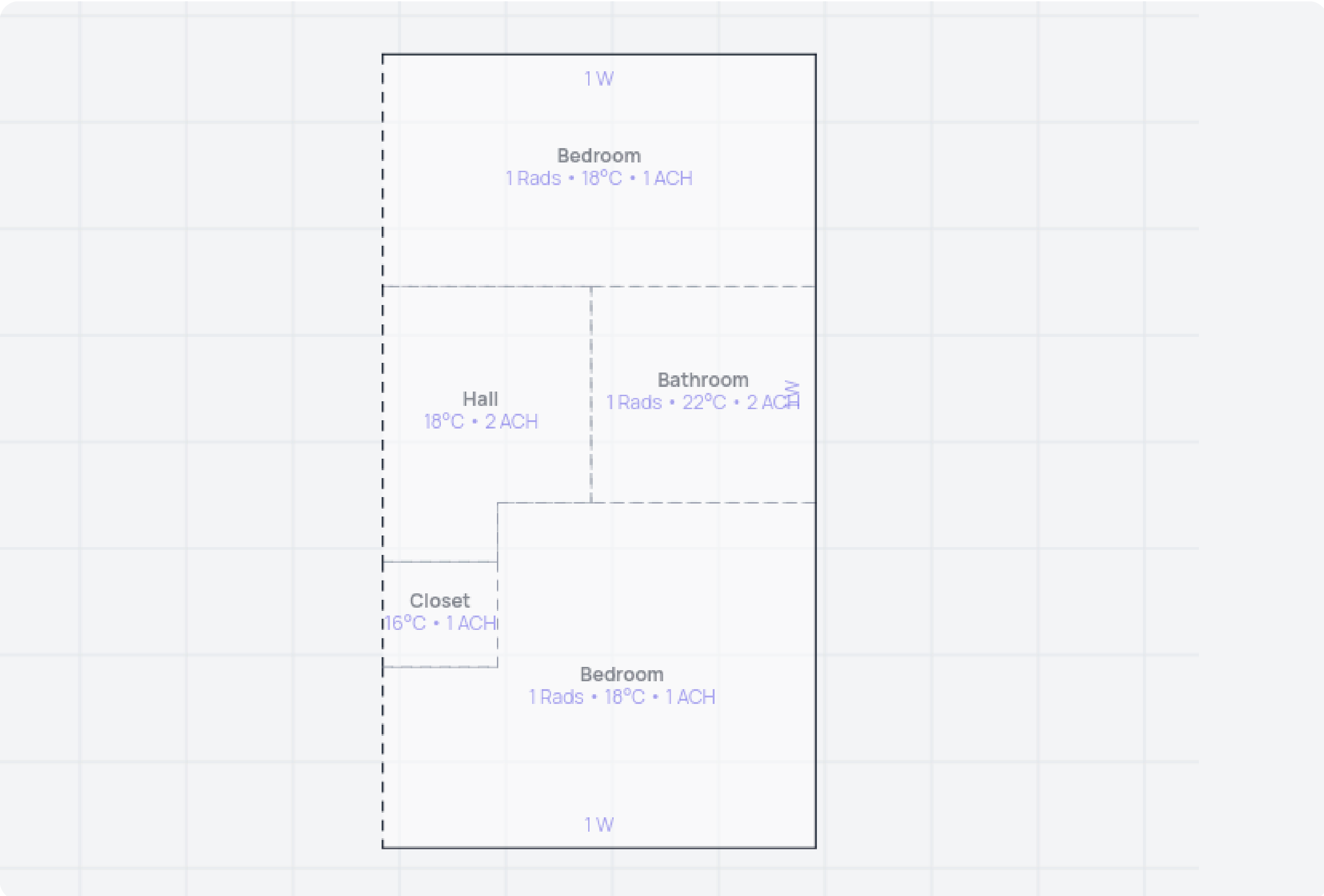
HEAT LOSS BY FLOOR

Imported: 1st Floor

Heat loss by room

1313 W





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

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HEAT LOSS BY ROOM

Bathroom

Total heat loss	Room temp	Air changes per hour
332 W	22 °C	2.0

Floor area	Average height	Volume
4.3 m²	2.4 m	10.5 m³

Heat loss by element

332 W

• Roof • External Walls • Internal Walls • Windows • Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	22.0 °C	1.41 W/m²K	4.3 m²	0 W
Roof	-1.7 °C	0.15 W/m²K	4.3 m²	15 W
External Walls	-1.7 °C	0.45 W/m²K	4.3 m²	46 W
Internal Walls	18.0 °C	1.06 W/m²K	15.3 m²	65 W
Windows	-1.7 °C	2.80 W/m²K	0.6 m²	41 W
Ventilation	-1.7 °C			165 W

Heat loss per m² 78 W/m²

Emitter performance

45% of 332 W at 45 °C

• Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Radiator		Towel rail - Straight chrome 1600 x 500 mm	150 W	150 W	332 W	45 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45 °C

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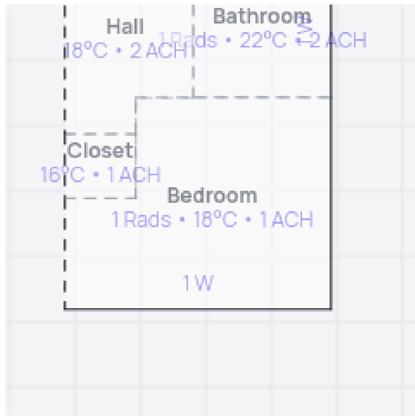
HEAT LOSS BY ROOM

Bedroom

Total heat loss **445 W**	Room temp **18 °C**	Air changes per hour **1.0**
Floor area **11.5 m²**	Average height **2.4 m**	Volume **28.1 m³**



Heat loss by element

445 W

• Roof • External Walls • Party Walls • Windows • Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	18.0 °C	1.41 W/m²K	11.5 m²	0 W
Roof	-1.7 °C	0.15 W/m²K	11.5 m²	34 W
External Walls	-1.7 °C	0.45 W/m²K	16.5 m²	146 W
Internal Walls	22.0 °C	1.06 W/m²K	13.7 m²	-11 W
Party Walls	10.0 °C	0.50 W/m²K	4.1 m²	17 W
Windows	-1.7 °C	2.80 W/m²K	1.4 m²	76 W
Ventilation	-1.7 °C			184 W

Heat loss per m² — 39 W/m²

Emitter performance

89% of 445 W at 45 °C

• Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Radiator		Type 11 (K1) 600 x 1100 mm	397 W	397 W	445 W	89 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45 °C

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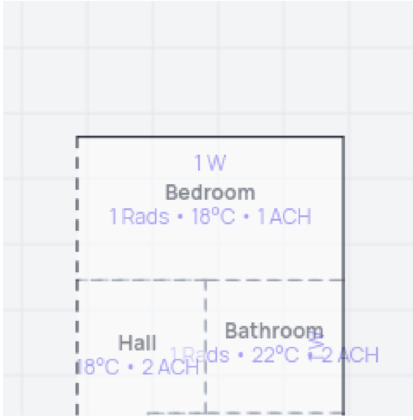
HEAT LOSS BY ROOM

Bedroom

Total heat loss	Room temp	Air changes per hour
357 W	18 °C	1.0

Floor area	Average height	Volume
8.9 m²	2.4 m	21.7 m³



Heat loss by element

357 W

• Roof • External Walls • Party Walls • Windows • Ventilation

	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	18.0 °C	1.41 W/m²K	8.9 m²	0 W
Roof	-1.7 °C	0.15 W/m²K	8.9 m²	26 W
External Walls	-1.7 °C	0.45 W/m²K	14.1 m²	125 W
Internal Walls	18.0 °C	1.06 W/m²K	9.9 m²	-22 W
Party Walls	10.0 °C	0.50 W/m²K	5.3 m²	21 W
Windows	-1.7 °C	2.80 W/m²K	1.2 m²	64 W
Ventilation	-1.7 °C			142 W

Heat loss per m² 40 W/m²

Emitter performance

81% of 357 W at 45 °C

• Radiator

EMITTER	IMAGE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Radiator		Type 11 (K1) 600 x 800 mm	289 W	289 W	357 W	81 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45 °C

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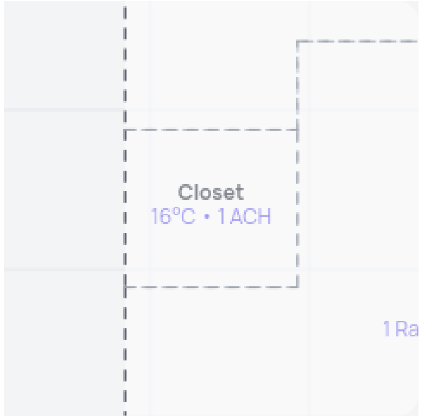
HEAT LOSS BY ROOM

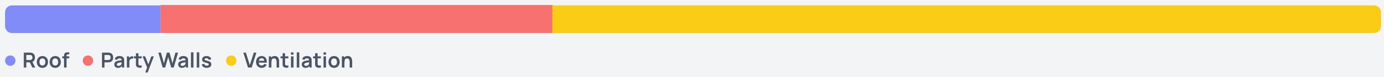
Closet



Total heat loss **9 W**	Room temp **16 °C**	Air changes per hour **1.0**
Floor area **1.1 m²**	Average height **2.4 m**	Volume **2.7 m³**

Heat loss by element

9 W



	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	16.0 °C	1.41 W/m²K	1.1 m²	0 W
Roof	-1.7 °C	0.15 W/m²K	1.1 m²	3 W
Internal Walls	18.0 °C	1.06 W/m²K	7.7 m²	-16 W
Party Walls	10.0 °C	0.50 W/m²K	2.4 m²	7 W
Ventilation	-1.7 °C			15 W

Heat loss per m² — 8 W/m²

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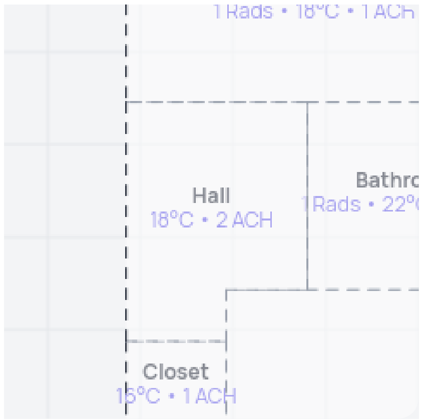
HEAT LOSS BY ROOM

Hall

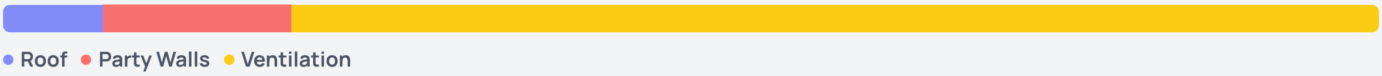


Total heat loss	Room temp	Air changes per hour
170 W	18 °C	2.0

Floor area	Average height	Volume
4.6 m²	2.4 m	11.2 m³

Heat loss by element

170 W



	OTHER SIDE TEMPERATURE	U-VALUE	AREA	HEAT LOSS
Intermediate Floor	18.0 °C	1.41 W/m²K	4.6 m²	0 W
Roof	-1.7 °C	0.15 W/m²K	4.6 m²	13 W
Internal Walls	16.0 °C	1.06 W/m²K	15.9 m²	-15 W
Party Walls	10.0 °C	0.50 W/m²K	6.3 m²	25 W
Ventilation	-1.7 °C			146 W

Heat loss per m² 37 W/m²

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 **3.3 kW** and on all the attributes of the property that we recorded during our site survey, we would suggest the following heat pump.

Vaillant aroTHERM Plus 3.5kW	
Capacity at 45 °C (-1.7 °C)	4.43 kW
SCOP at 45 °C	3.65
Flow temperature	45 °C

This heat pump covers **136 %** 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
KIWA 00016/021 HP

Refrigerant
R290

Model number
VWL 35 / 6 - 0010037211

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	4.2	4.1	4	3.9	3.8
-3°C	4.6	4.4	4.3	4.2	4
0°C	4.7	4.7	4.6	4.5	4.4
2°C	4.9	4.9	4.9	4.7	4.6

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	4.41	4.03	3.65	3.37	3.1

Location

- Mounting location: Ground
- Base to be built by:
- Condensate drain: Nearby drain or downpipe

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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 = 45 °C
- Temperature drop across the radiator (delta T) = 5 °C
- Mean radiator temperature = 42.5 °C

Emitter replacements

We propose replacing or adding emitters in the following rooms:

1. Kitchen
2. Living Room
3. Bedroom

SYSTEM DESIGN

Current emitters in the property

ROOM	IMAGE	TYPE	DETAILS	EMITTER OUTPUT	ROOM OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Kitchen		Radiator	Type 21 (P+) 600 x 800 mm	405 W	405 W	811 W	50 %
Living Room		Radiator	Type 22 (K2) 600 x 600 mm	327 W	923 W	1145 W	81 %
		Radiator	Type 21 (P+) 600 x 1400 mm	596 W			
Bathroom		Radiator	Towel rail - Straight chrome 1600 x 500 mm	150 W	150 W	332 W	45 %
Bedroom		Radiator	Type 11 (K1) 600 x 1100 mm	397 W	397 W	445 W	89 %
Bedroom		Radiator	Type 11 (K1) 600 x 800 mm	289 W	289 W	357 W	81 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45.0 °C

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SYSTEM DESIGN

Proposed emitter changes

ROOM	STATUS	IMAGE	TYPE	DETAILS	EMITTER OUTPUT	ROOM DEMAND	% HEAT DEMAND MET*
Kitchen	Replacement		Radiator	Type 33 (K3) 700 x 1000 mm	1001 W	811 W	123 %
Living Room	Keep		Radiator	Type 22 (K2) 600 x 600 mm	327 W	1145 W	95 %**
	Replacement		Radiator	Type 22 (K2) 600 x 1400 mm	764 W		
Bathroom	Keep		Radiator	Towel rail - Straight chrome 1600 x 500 mm	150 W	332 W	45 %**
Bedroom	Replacement		Radiator	Type 21 (P+) 600 x 1100 mm	557 W	445 W	125 %
Bedroom	Replacement		Radiator	Type 21 (P+) 600 x 800 mm	405 W	357 W	113 %

***% Heat demand met:** This is calculated for a day when the outdoor temperature is -1.7 °C and the flow temperature is 45.0 °C

**** Accepting undersized emitters**

Please note that the emitters do not meet the room heat demand in all cases. This means that when its cold outside the following rooms will not reach their set point 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.

Living Room Supplemented by additional kitchen radiator capacity

Bathroom Extractor not running continually, supported by adjacent bedrooms and heat rising from downstairs.

Radiators

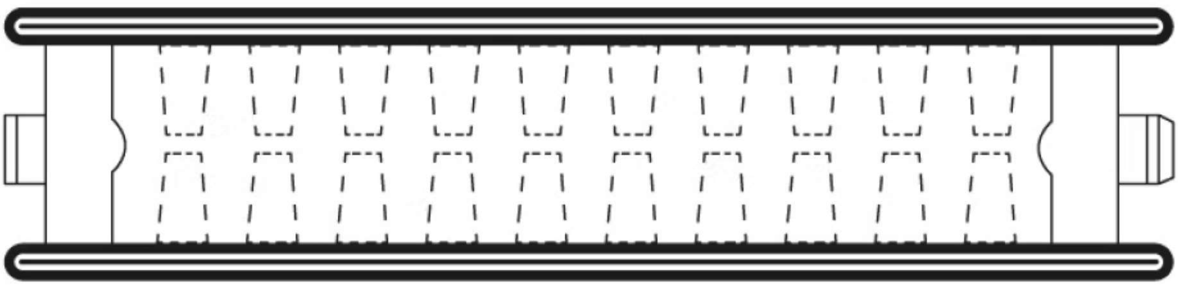
Where possible we aim to replace radiators with the same or similar width of the existing radiators. In most cases the thickness of the radiators is increased by either adding an additional panel or extra fins.

The radiator types used in this design are shown below for your reference.

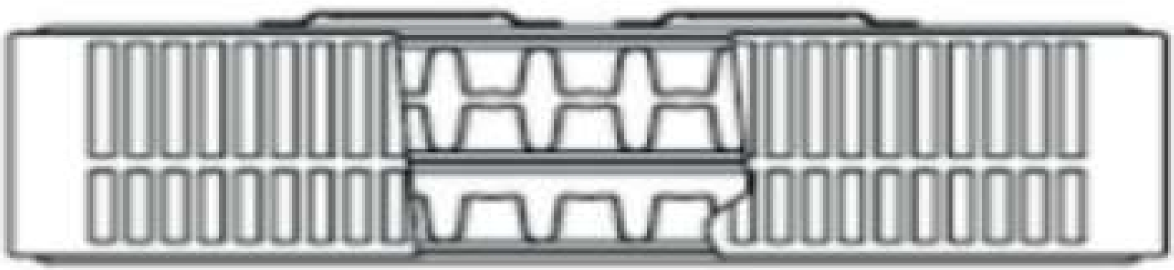
K1 one panel and one fin

P+ two panels, one fin

K2 two panels, two fins



K3 three panels, three fins



SUSTAIN

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.

150L Heat Pump Cylinder

Capacity	150 litres

Cylinder location

SUSTAIN

Hot water demand

The calculation below shows how much electricity we expect the heat pump to use for providing hot water, based on our assumptions about how much hot water people typically use in a year.

Total electricity per year for hot water — 1,121 kWh

Normal operation	1,056 kWh
Electricity per day	2.89 kWh
Heat energy per day	8.97 kWh
Volume per day	135 litres/day
Assumed mains water temp	10 °C
Storage temp	50 °C
Distribution efficiency	70 %
Heat pump sCOP (55 °C flow)	310 %

Legionella cycles	65 kWh
Electricity per cycle	2.49 kWh
Heat energy per cycle	2.49 kWh
Volume per cycle	150 litres
Tank starting temperature	50 °C
Legionella set point	60 °C
Distribution efficiency	70 %
Legionella cycle efficiency	100 %
Cycles per year	26

Reheat time — 1 h 41 min

Once depleted, it will take the cylinder **1 h 41 min** to fully reheat based on the following inputs:

Cylinder volume	150 litres
Mains water temp	10 °C
Hot water storage temp	50 °C
Heating power	4.17 kW

SUSTAIN

Sound assessment

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 required by those regulations.

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

Assessment position:

Sound pressure level

Sound power level Manufacturer’s data	54 dB(A)
Reduction due to distance Reflective surfaces: two reflecting surfaces (Q=4) Distance from heat pump to assessment position: 5 m	19 dB(A)
Barriers Between heat pump and assessment position: Visible Distance from heat pump to assessment position: 5 m	0 dB(A)
Total	**35 dB(A)**

Adjustment due to background noise

Background noise level	40 dB(A)
Difference Difference between background noise level and heat pump sound pressure level	5 dB(A)
Adjustment	1.2 dB(A)
Max of sound pressure level and background noise	**42 dB(A)**

Result

Pass

Maximum allowed value	42 dB(A)
Final result at assessment position	**42 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	£575 to £805
Proposed system	£356 to £835
Savings	-£30 to £301

Carbon

Current	1.9 to 2.7 tonnes CO_2
Proposed system	0.3 to 0.5 tonnes CO_2
Savings	83%

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 home's heating and hot water demand**
   This is how much heat your home 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 both at the price cap and with a heat pump tariff, to show the range of what you might pay depending on the tariff you are on. We've included more info on heat pump tariffs further down.

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.

SUSTAIN

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	**6,485** kWh
Demand to be supplied by the heat pump	**6,485** kWh
Energy required for hot water	**1,859** kWh
Demand to be supplied by the heat pump	**1,859** kWh
Your property	
Your postcode prefix	**CO**
Total property floorspace (not property footprint)	**60** m^2
Average watts per square metre	**54** W/m^2
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.	
Proposed system	
Heat pump capacity	**4.4** 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	**45** °C
Performance	
The Seasonal Performance Factor is calculated to be:	**3.4**
Estimate of energy consumption of the proposed heat pump (or combined system where Hybrid).	**High: 3,301** kW → **Low: 2,701** kW
Note: you can convert these figures to approximate running costs.	
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.	

PERFORMANCE ESTIMATE

Results table - Manufacturer's efficiencies

The table below shows running cost and carbon savings estimates based on efficiencies from manufacturer's test data, which often shows higher efficiencies than MCS's fixed values.

	BASED ON EPC		BASED ON HEAT LOSS CALCULATIONS AND HEATING DEGREE DAYS		BASED ON LAST YEARS CONSUMPTION
Demand					Unavailable
Heating	6,485 kWh		8,410 kWh		
Hot Water	1,859 kWh		3,275 kWh		
Total	8,344 kWh		11,685 kWh		
Efficiency	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Heating	92 %	365 %	92 %	365 %	
Hot water	92 %	310 %	92 %	310 %	
Consumption	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Heating	7,049 kWh	1,777 kWh	9,141 kWh	2,304 kWh	
Hot Water	2,021 kWh	600 kWh	3,560 kWh	1,056 kWh	
Total	9,070 kWh	2,376 kWh	12,701 kWh	3,361 kWh	
Bills	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Price cap (24.86 p/kWh)	£575	£591 -£16	£805	£835 -£30	
OVO Heat Pump Plus (15 p/kWh)	£575	£356 £219	£805	£504 £301	

Octopus Agile (17 p/kWh)	£575	£404 £171	£805	£571 £234	

Carbon	Existing (Mains gas)	Heat pump (Electricity)	Existing (Mains gas)	Heat pump (Electricity)	Unavailable
Totals	1,905 kg	323 kg 1,582 kg	2,667 kg	457 kg 2,210 kg	

SUSTAIN

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: 0511-3021-7201-0752-0204	2254 degree days, 155 W/°C	Unavailable
Heating	6,485 kWh	8,410 kWh	
Hot water	1,859 kWh	3,275 kWh	
Total	8,344 kWh	11,685 kWh	

SUSTAIN

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:	92%
Efficiency - hot water:	92%

Heat pump system

Type of system:	Air source heat pump
Model:	Vaillant aroTHERM Plus 3.5kW
MCS certificate numbers:	KIWA 00016/021 HP
Flow temperature - space heating:	45°C
Flow temperature - hot water:	55°C

	MCS SPF	MANUFACTURERS SCOP
Heating efficiency	340 %	365 %
Hot water efficiency	170 %	310 %

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 and also shown you a few different heat pump tariff options.

There are an increasing number of heat pump tariffs that give you access to cheaper electricity. These fall into two categories: **type of use** and **time of use**.

Type of use heat pump tariffs detect how much electricity the heat pump is using, and charge you a lower rate for that electricity.

Time of use tariffs charge you different amounts depending on when you use the electricity. So you can set the hot water heating schedule (and to a lesser extent the space heating schedule) to make use of lower prices.

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	Unit price
Price cap	6.34 p/kWh

Electricity	Unit price
Price cap	24.86 p/kWh
OVO Heat Pump Plus*	15 p/kWh
Octopus Agile last winter average**	17 p/kWh

*Currently only available for Vaillant, Viessmann and Mitsubishi heat pumps
**Octopus Agile avg. Dec 2023 - Feb 2024

You may want to check out some of these heat pump tariffs (we haven't vetted these):

Type of use:

- OVO heat pump plus: 15p/kWh. Vaillant, Viessmann and Mitsubishi heat pumps only currently.

Time of use:

- EDF: 10p/kWh off from 4-7am and from 1-4pm
- Octopus Cosy: Cheaper pricing 4am-7am and 1-4pm. Peak pricing 4pm -7pm
- Octopus Agile: Half-hourly pricing which tracks the wholesale price. Goes both very high and negative.

Emission factors

We've used the emission factors from the government's SAP 2010 methodology. For 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.

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 45°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	4.41	4.03	3.65	3.37	3.1
Electricity consumed (kWh/year)	2650	2900	3201	3467	3769

SUSTAIN

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 home. 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).

Questions

Get in touch with us to accept the proposal or ask any questions.

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