

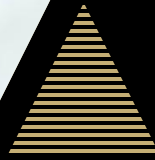
Energy Efficiency Analysis of a Small NHS Clinical Building in Wales

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GIG
CYMRU
NHS
WALES





Overview

- Background
- Aim & Objectives
- Research
- Methodology
- Results & Discussion
- Conclusion
- Recommendations



Background

- Green House Gases (GHG)
- Effecting public health
- Legally enforced Net Zero by 2050
- NHS Net Zero by 2040



Aim

Evaluate the technical and financial feasibility of replacing the existing gas boiler system with an ASHP in a small clinical building within a large health board in South Wales, with the goal of identifying opportunities to reduce operational costs and carbon emissions



Objectives

- Examine the building's existing infrastructure and thermal profile to determine suitability for an ASHP, whilst outlining a concept design for the proposed ASHP installation, tailored to the building's spatial constraints, heating demand, and operational requirements



Objectives

- Analyse installation and operational costs in comparison to the current gas boiler setup, including potential financial savings

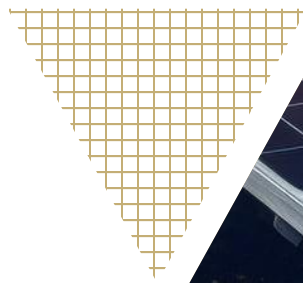


Objectives

- Determine whether findings can inform broader decarbonisation strategies across similar NHS properties



Research



Climate Change

- Higher Temperatures – 2 degree rise in 2018 (Fawzy *et al.*, 2020)
- Floods
- Droughts
- Wildfires
- Rising Sea Levels

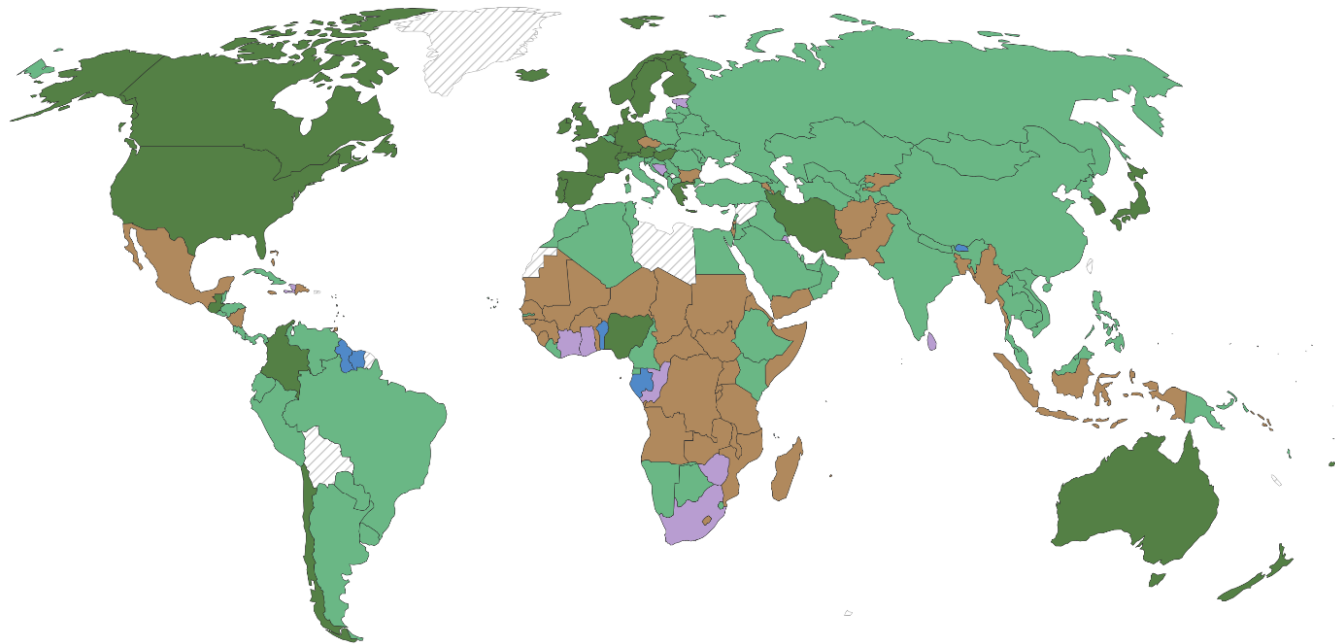


Climate Change

Status of net-zero carbon emissions targets

Our World
in Data

The inclusion criteria for net-zero commitments may vary from country to country. For example, the inclusion of international aviation emissions; or the acceptance of carbon offsets. To see the year for which countries have pledged to achieve net-zero, hover over the country in the interactive version of this chart.



■ Achieved (self-declared) ■ Pledged ■ In Law ■ In Policy Document ■ Proposed ■ No data

Energy and Climate
Intelligence Unit, 2023

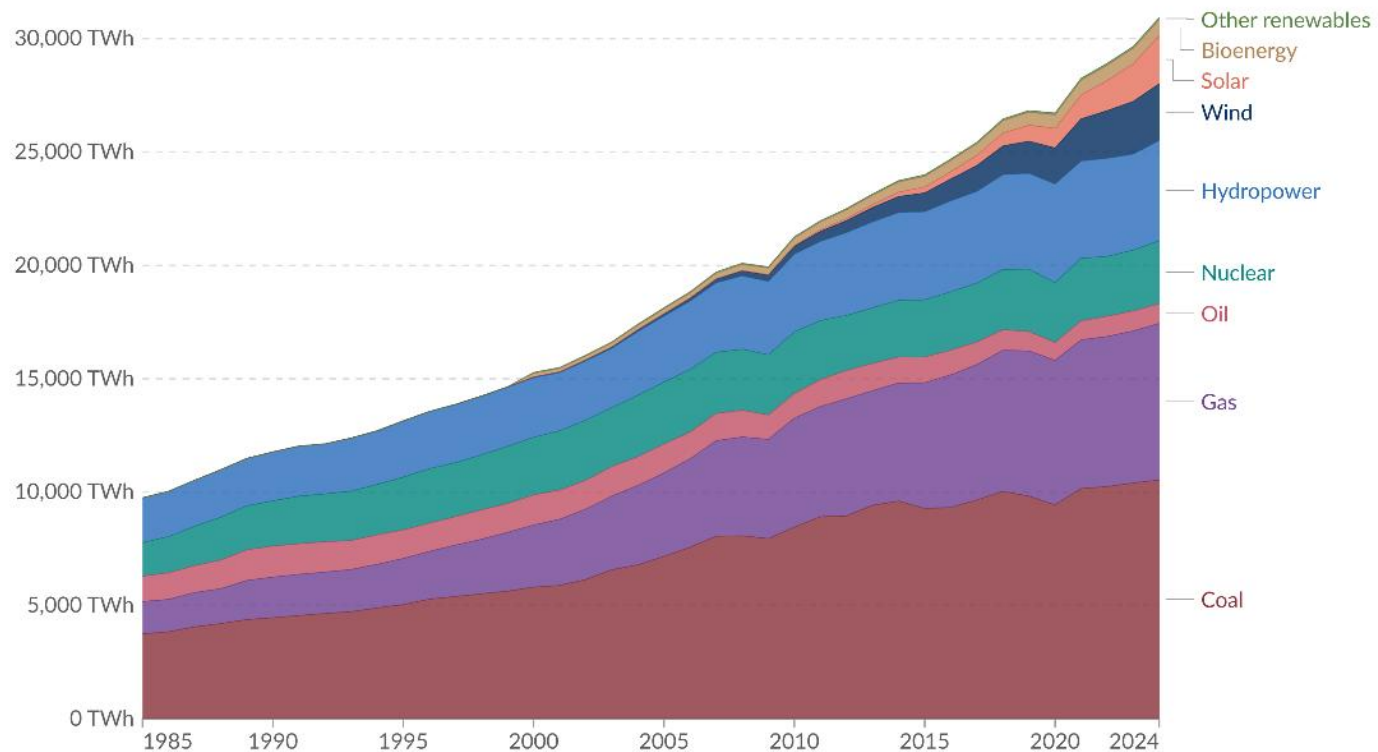
Building Services Impact

- Electricity

Energy Institute, 2025

Electricity production by source, World

Measured in terawatt-hours¹.



Building Services Impact

- Heating
- Fossil Fuels – coal, natural gas and oil
- Building Fabric

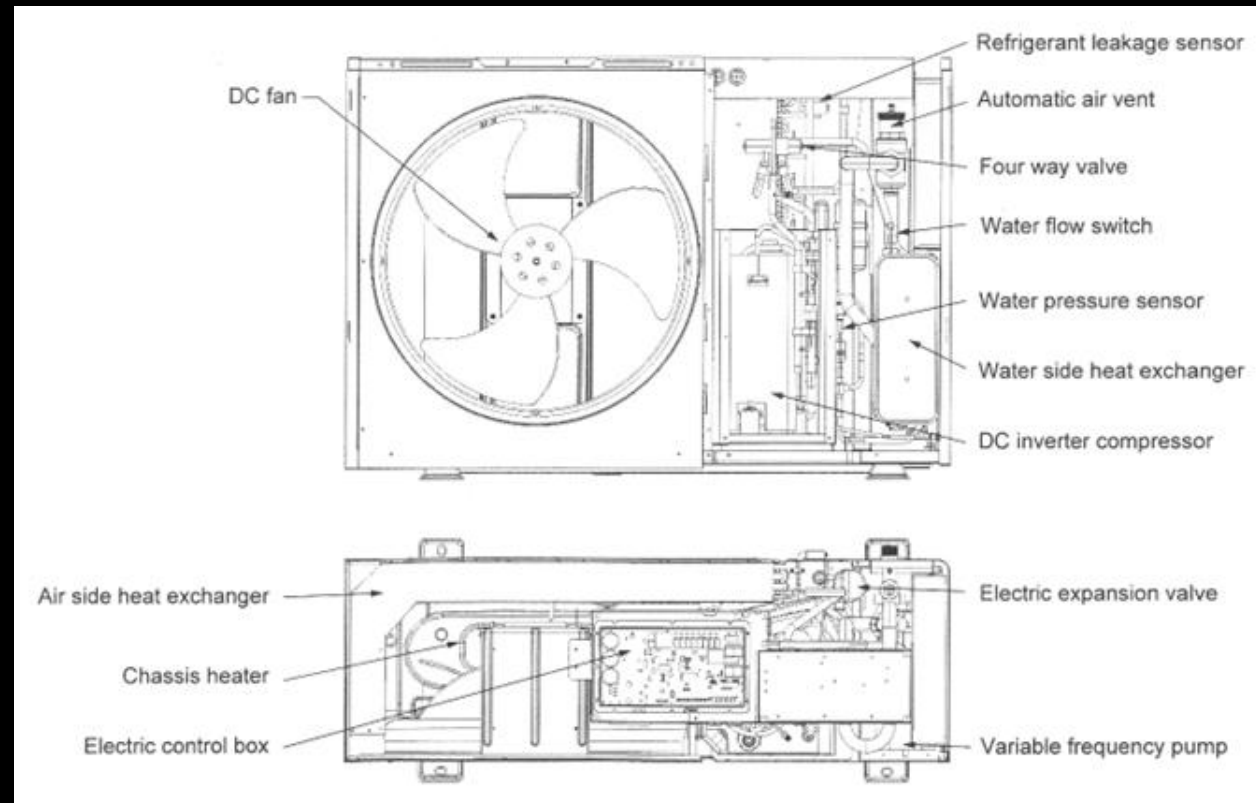


NHS Impact

- 217 trusts
- 1,228 hospitals
- Largest employer in Europe
- 4.5% of UK's total emissions in 2015 (Fifield *et al.*, 2018)

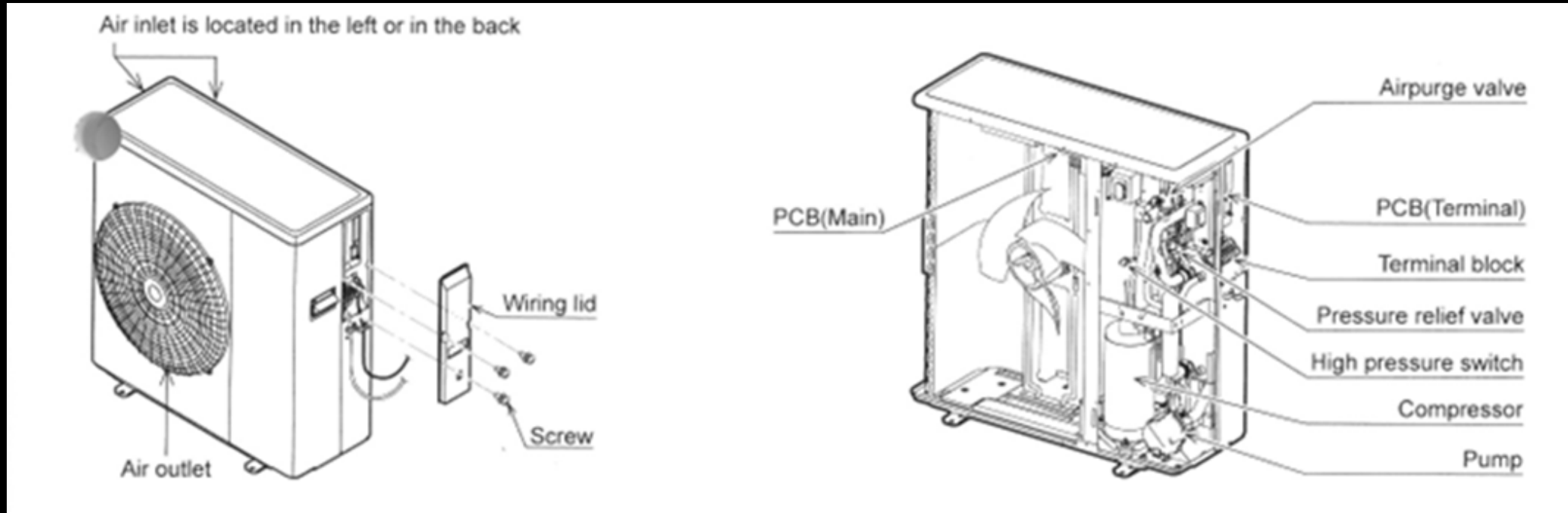


Heat Pumps



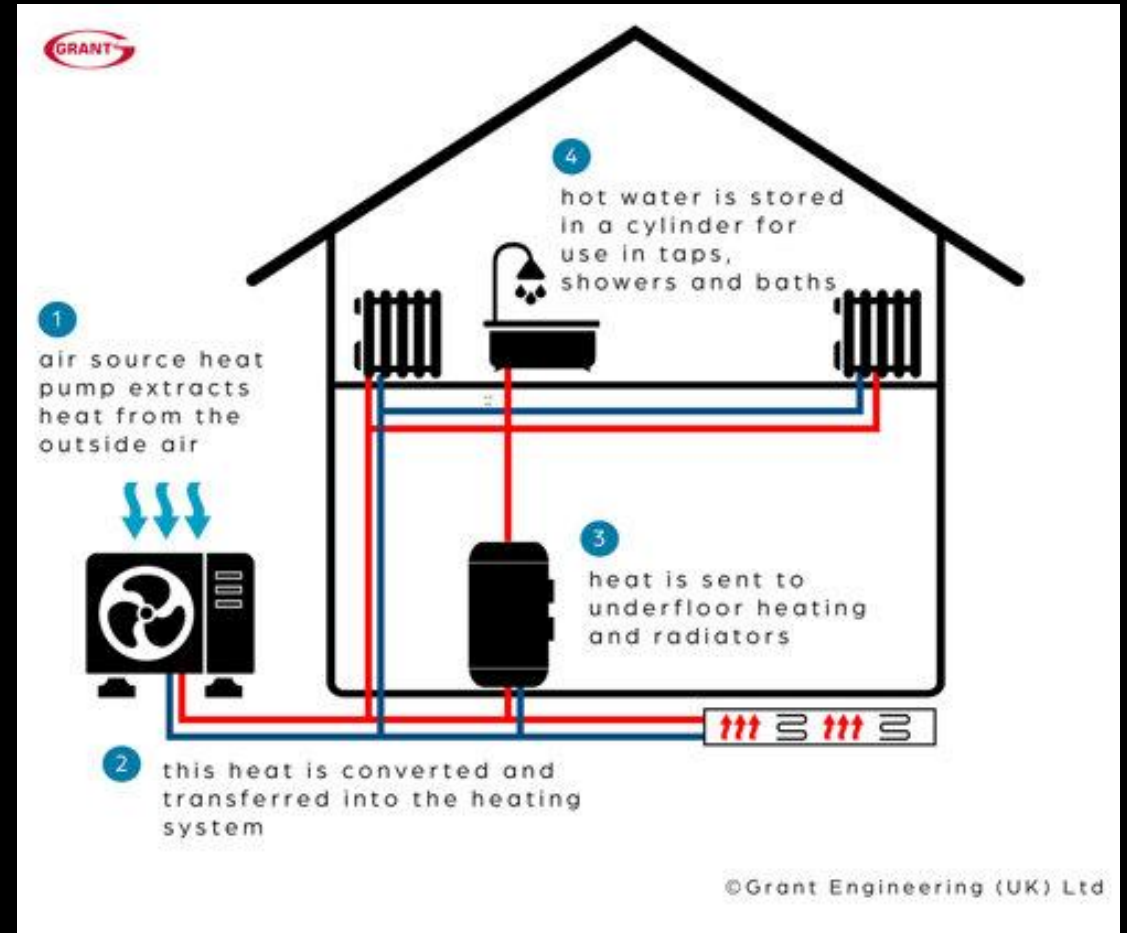
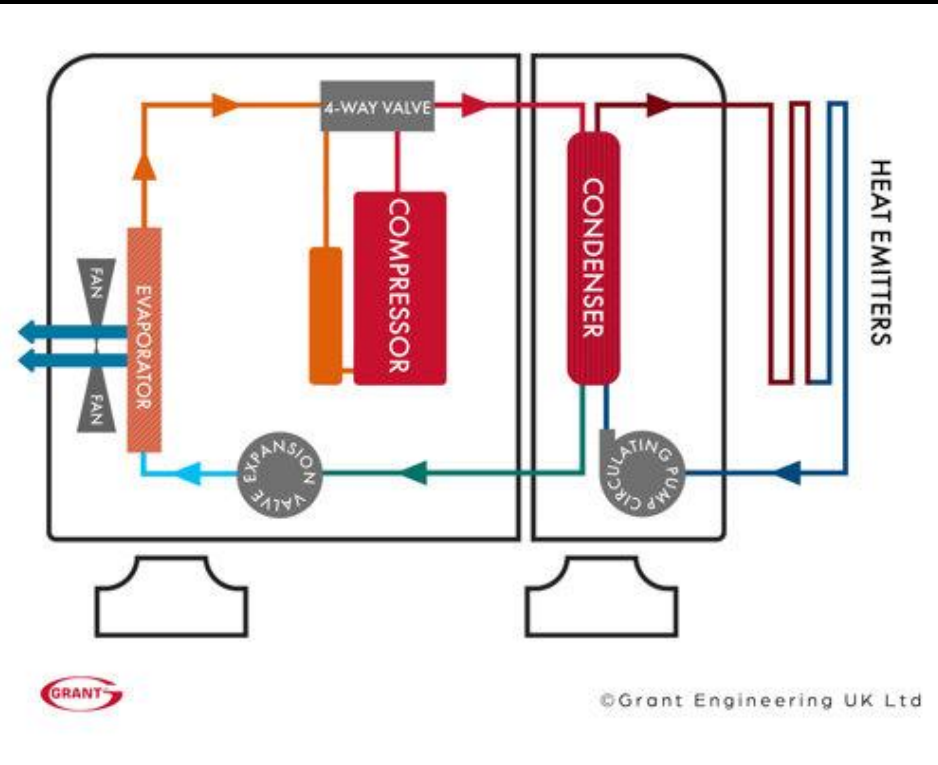
(Grant Engineering UK, 2024)

Heat Pumps



(Grant Engineering UK, 2024)

Heat Pumps

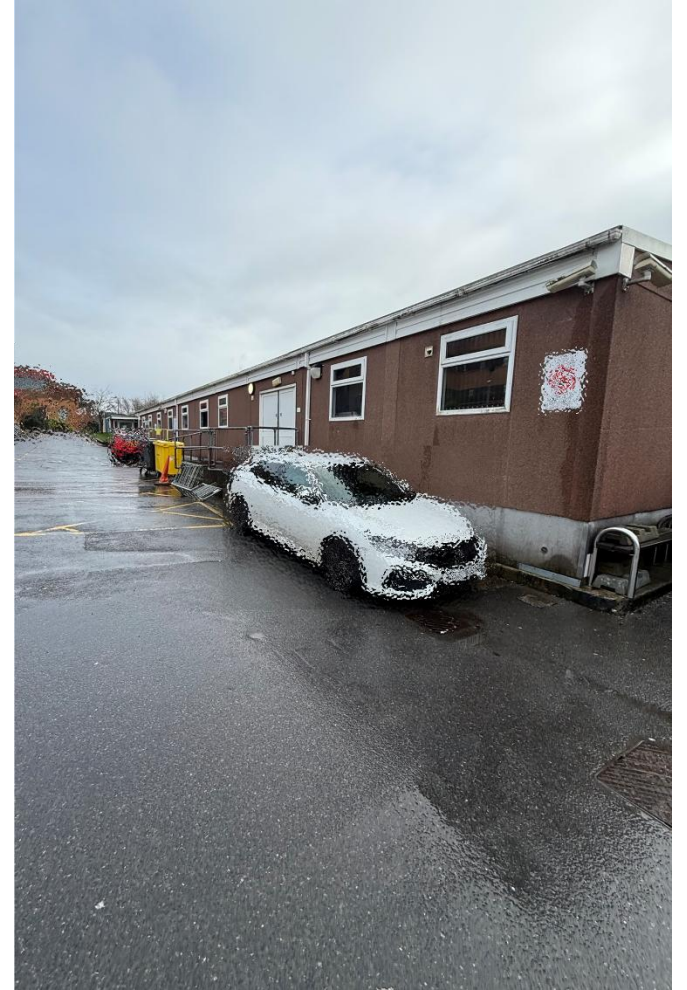


(Grant Engineering UK, 2020)

Methodology



Building J



Building J



Method 1 – Room-by-Room Heat Loss Calculation



Worksheet A – Heat Losses

Stage 1 - Job information
Room 1.1 Job 1.2 Page 1.3 of 1.4

Stage 2 - Design temperatures
Design room temp. 2.1
Outside design temp. 2.2
Design temp. difference 2.3
Ground reference temp. 2.4

Stage 3 - Ventilation heat loss

No. of air changes per hour	Length (m)	Width (m)	Height (m)	Room volume	Amount of air heated per hour	W/m ² - Air change factor	°C - Design temp. difference	Watts - Heat loss
3.1	3.2	3.3	3.4		3.5	3.6	3.7	3.8
No. of open flues and chimneys 3.9					3.10	3.11	3.12	3.13

Stage 4 - Fabric heat loss

Thermal bridging addition 4.1

	Length (m)	Width (m)	Height (m)	Area (m ²)	U-value (W/m ² K)	
External wall (gross area) (length outside × height)	4.2		4.3	4.4		
Glazing	4.5	4.6	4.7	4.8	4.9	4.10
External doors	4.11	4.12	4.13	4.14	4.15	4.16
Net area of external wall (glazing and door areas subtracted)				4.17	4.18	4.19
Ceiling or roof (gross area)	4.21	4.22		4.23		
Roof glazing	4.24	4.25		4.26	4.27	4.28
Net area of ceiling or roof (glazing area subtracted)				4.30	4.31	4.32
Internal wall 1	4.x1		4.x2	4.x3	4.x4	4.x5
Internal wall 2	4.x1		4.x2	4.x3	4.x4	4.x5
Party wall	4.x1		4.x2	4.x3	4.x4	4.x5
Other 1	4.x1		4.x2	4.x3	4.x4	4.x5
Other 2	4.x1		4.x2	4.x3	4.x4	4.x5
Other 3	4.x1		4.x2	4.x3	4.x4	4.x5
Floor (gross area)	4.34	4.35		4.36	4.37	4.38

Stage 5 - Design heat loss & estimated annual energy usage for room

Reheat factor 5.4
Period of disuse 5.5
Building air permeability 5.6
Building mass 5.6

Factors if YES
High ceiling? 5.2
Intermittent heating? 5.7

Reheat time
Reheat factor
Heat-up power

Reheat time	Reheat factor	Heat-up power
0.5 hour	5.x1	5.x2
1 hour	5.x1	5.x2
2 hour	5.x1	5.x2
3 hour	5.x1	5.x2
4 hour	5.x1	5.x2
5 hour	5.x1	5.x2

TOTAL FOR ROOM 5.9

Heat emission (W/m²) (total loss per unit floor area) including down loss 5.10

Method 2 – PHPP Model



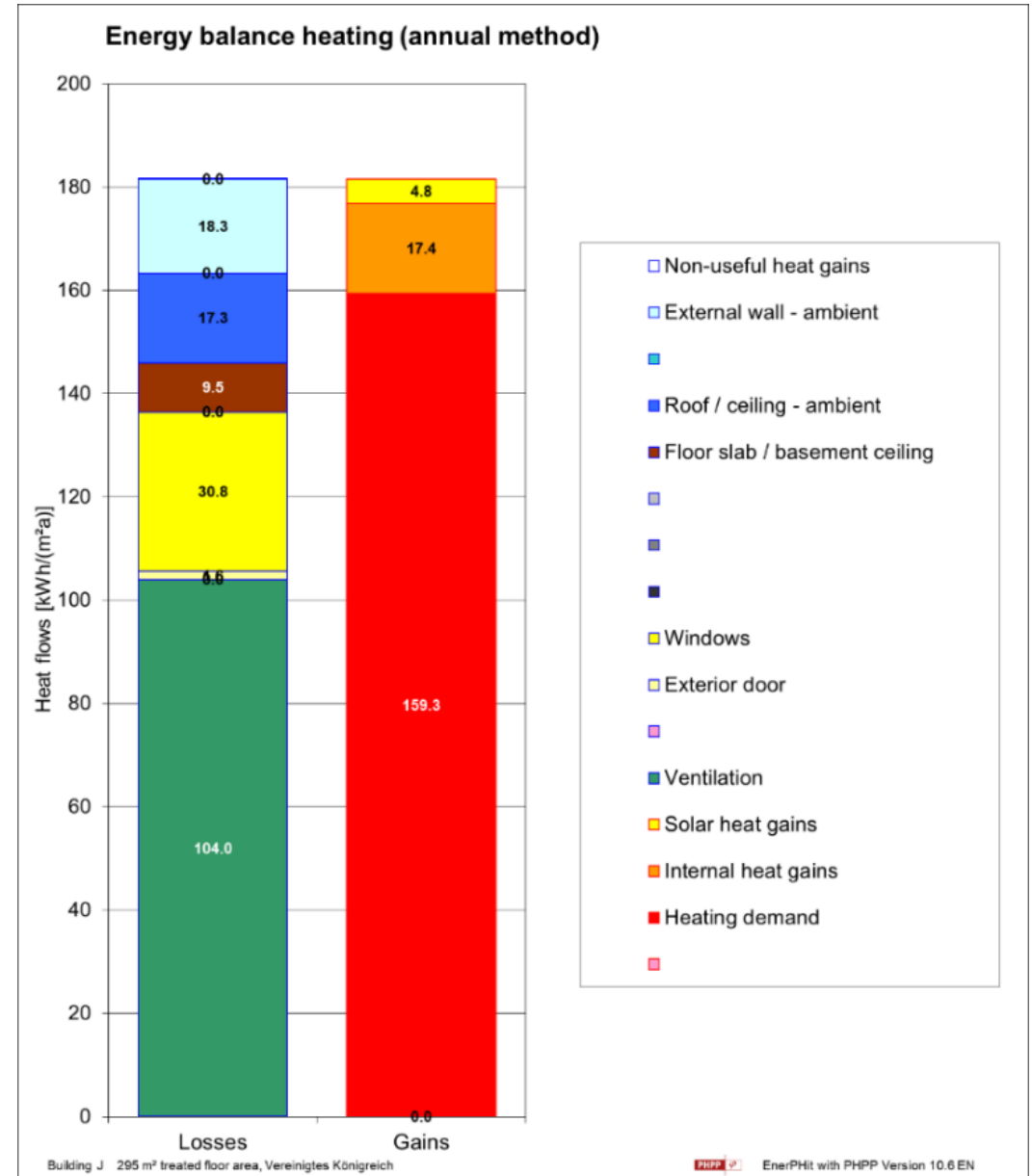
Results & Discussion



Method 1 Results – Room-by-Room Heat Loss

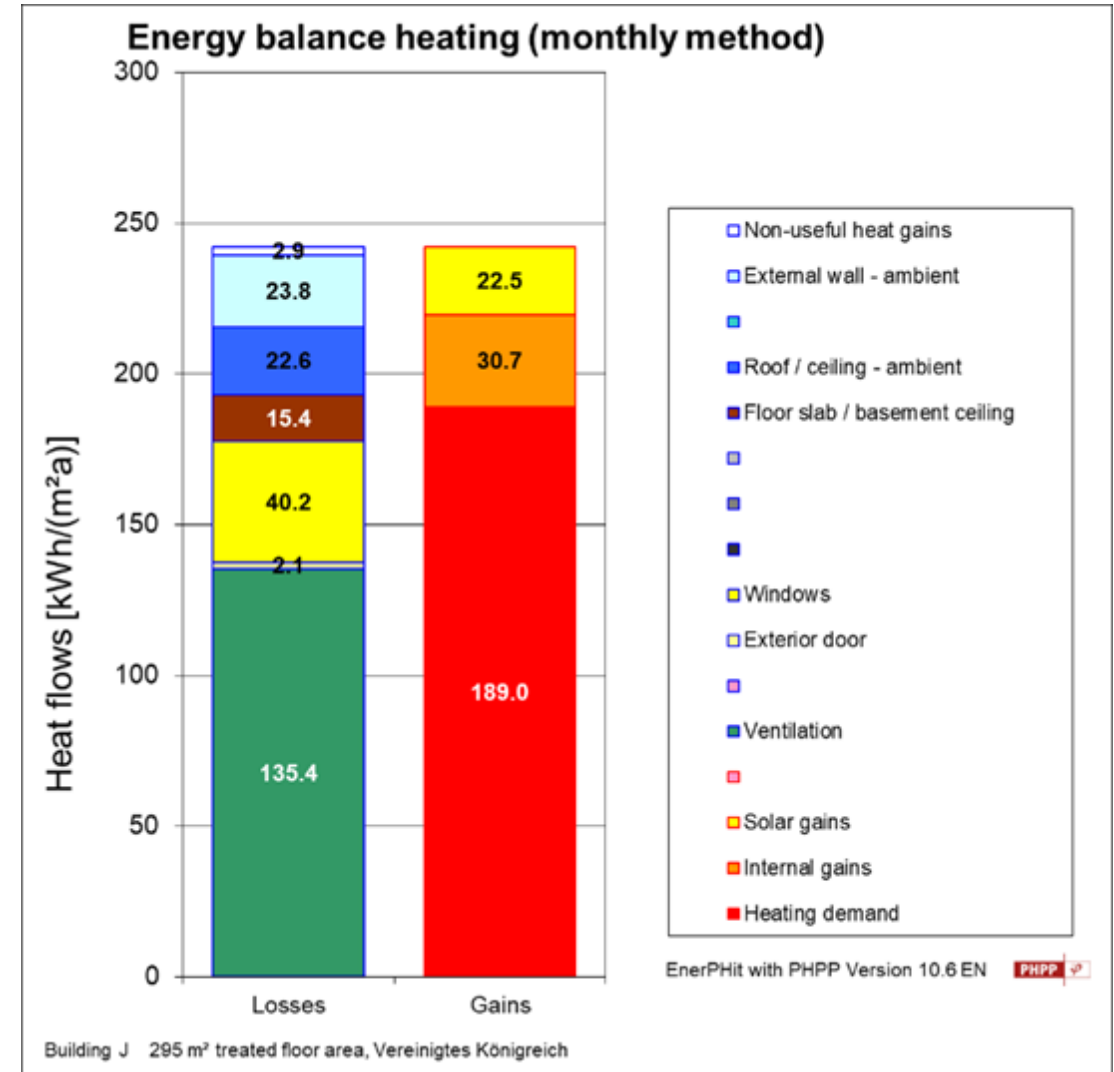
Total Heat Loss – Building J						
Room Reference	Room Name	AC H	Ventilation Heat Loss (kWh)	Fabric Heat Loss (kWh)	Oversize Factor	Total Heat Loss (kWh)
a)	Nursing Office	6	0.72	0.23	1.2	1.15
b)	Data Cupboard	1	0.03	0.02	1.2	0.06
c)	Staff Room	6	1.50	0.71	1.2	2.65
d)	Male Changing Room	6	0.25	0.08	1.2	0.40
e)	Female Changing Room	6	0.68	0.21	1.2	1.07
f)	WC	6	0.32	0.07	1.2	0.47
g)	Consulting	6	0.97	0.27	1.2	1.49
h)	WC	6	0.35	0.08	1.2	0.51
i)	Treatment Area	6	15.66	4.32	1.2	23.97
j)	Isolation Room	10	1.66	0.27	1.2	2.32
k)	Line Insertion Room	6	1.00	0.27	1.2	1.53
l)	Dirty Utility	6	0.61	0.08	1.2	0.82
m)	Water Treatment	4	1.36	0.28	1.2	1.97
n)	Store	6	1.60	0.64	1.2	2.69
o)	Workshop	6	1.52	0.75	1.2	2.72
p)	Cleaners Store	6	0.50	0.09	1.2	0.71
q)	Clean Utility	6	0.51	0.17	1.2	0.82
r)	Kitchen	6	0.51	0.12	1.2	0.75
s)	Disabled WC	6	0.46	0.08	1.2	0.66
t)	Waiting Area	6	1.96	0.44	1.2	2.88
u)	Corridor	6	0.43	0.06	1.2	0.58
			32.58	9.26		50.21

Method 2 Results – Energy Balance Heating (Annual)

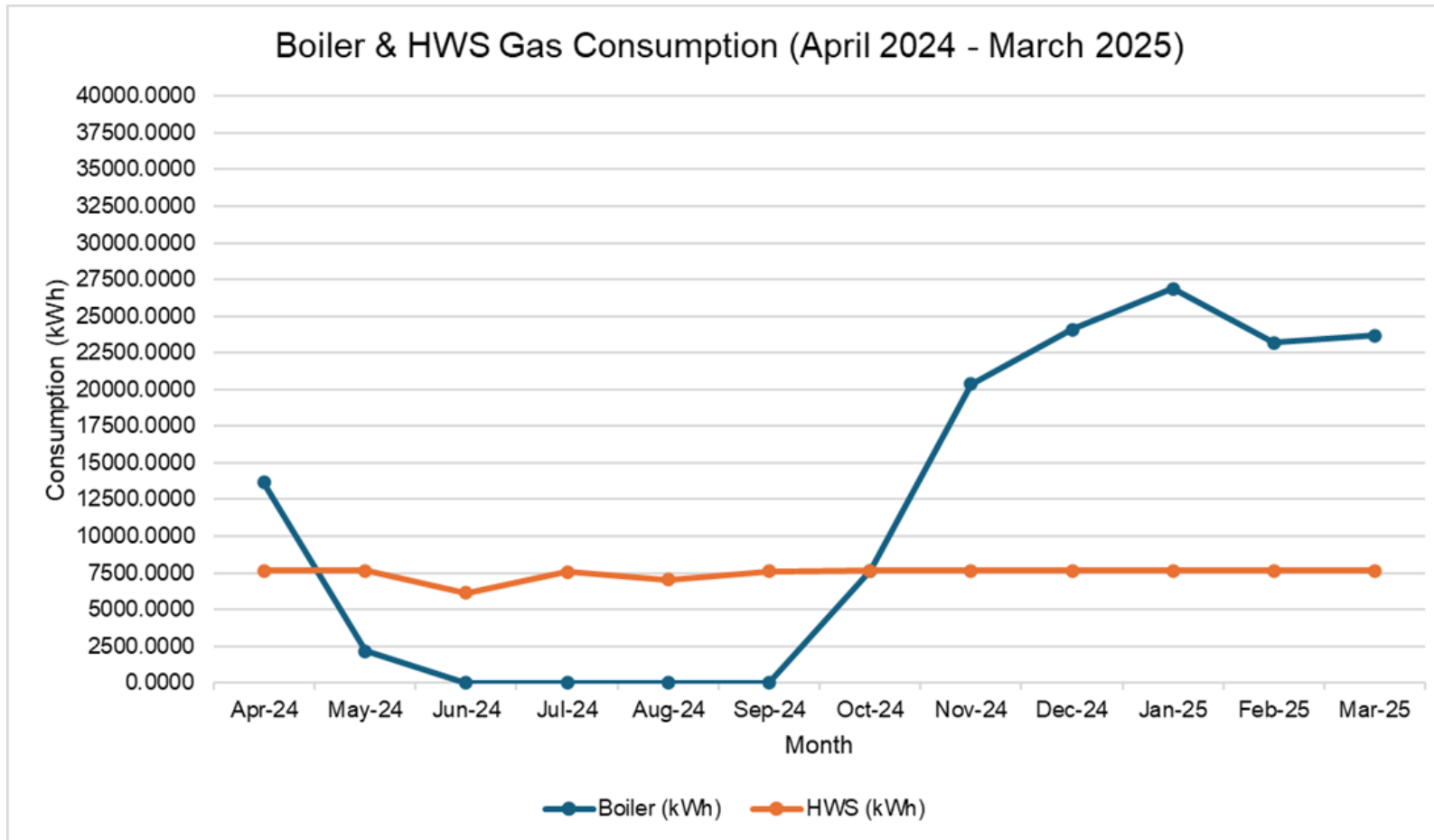


Method 2 Results

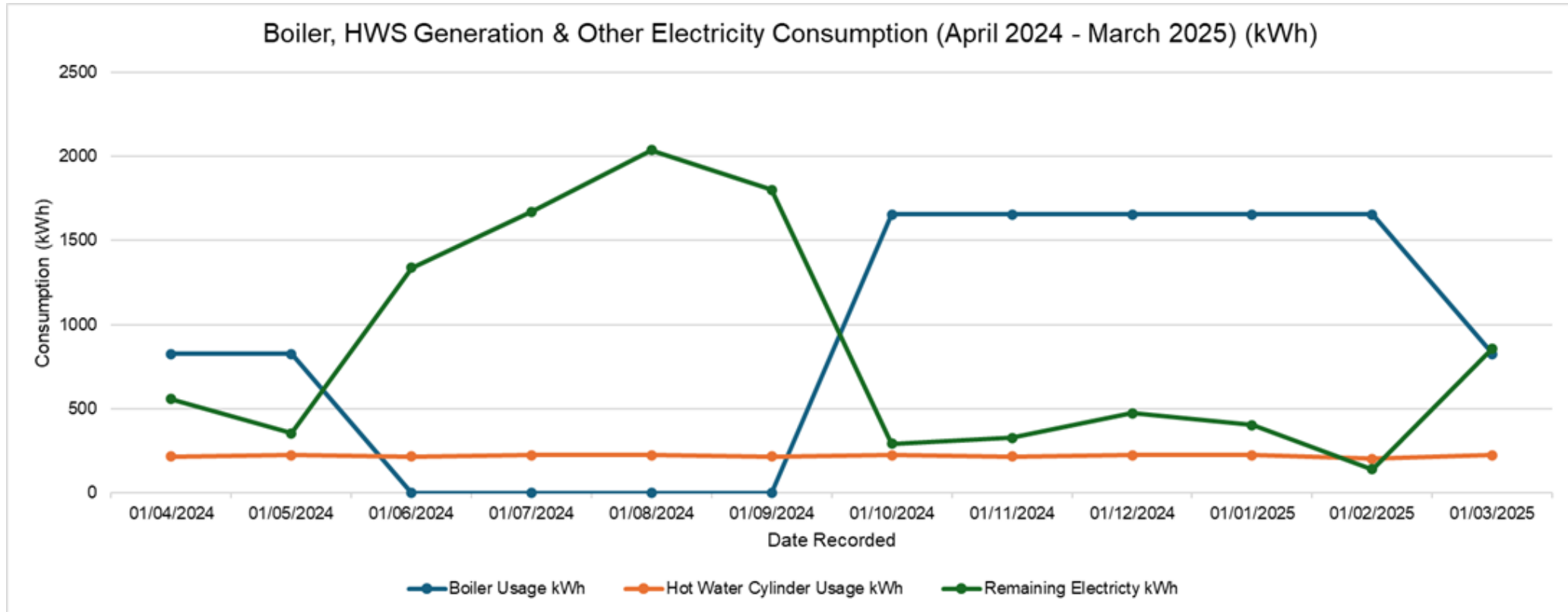
– Energy Balance Heating (Monthly)



Results – Recorded Gas



Results – Recorded Electricity





Results

GAS



£8,400.73 per year

£5,373.34 for the gas boilers

£3,027.39 for the hot water cylinder

ELECTRICITY



£1,982.73 per year

£965.76 for the gas boiler

£216.03 for the hot water cylinder

£800.93 for other electricity requirements

Results - ASHP



Max Heating Load $\times$ TFA = Total Peak Demand

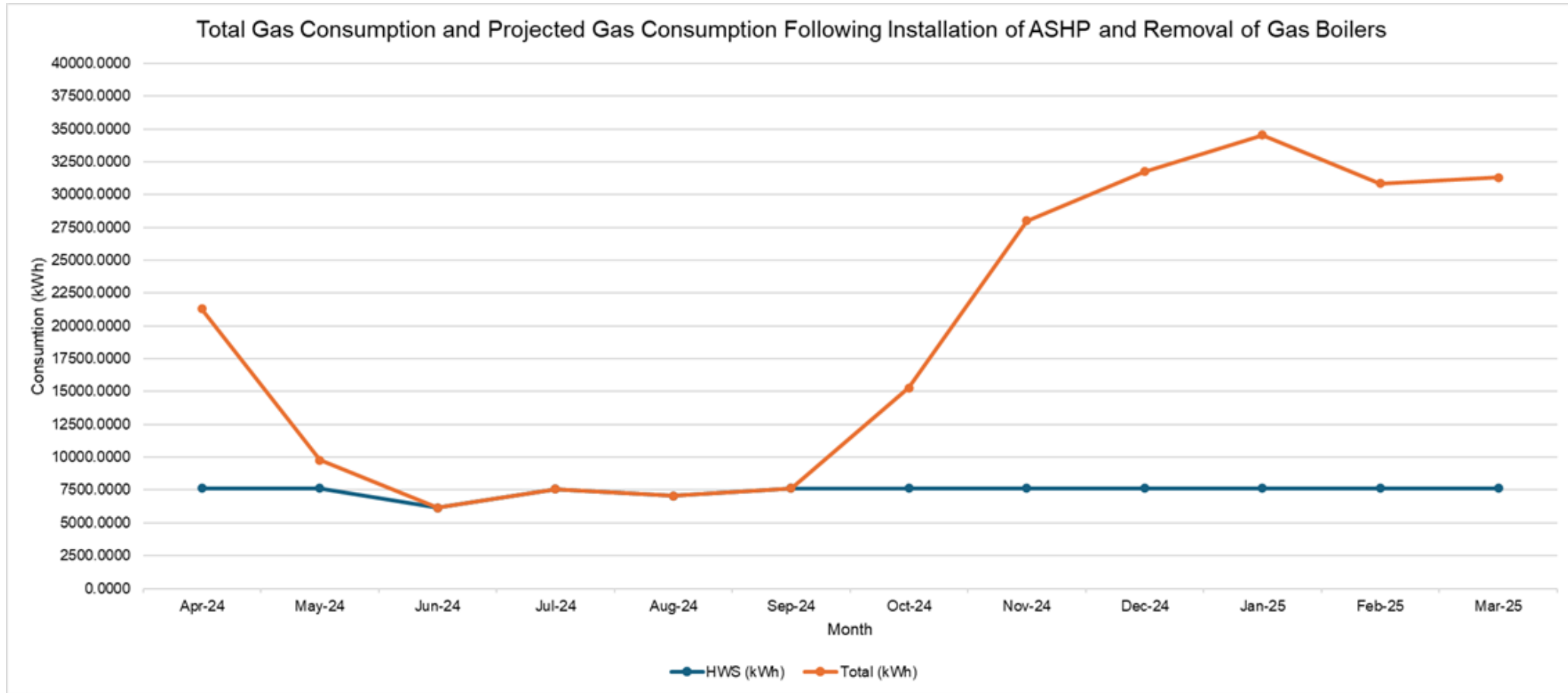
$$80 \text{ W/m}^2 \times 295.21 \text{ m}^2 = 23616.80$$

$$\frac{23616.8}{1000} = 23.6168 \text{ kW}$$

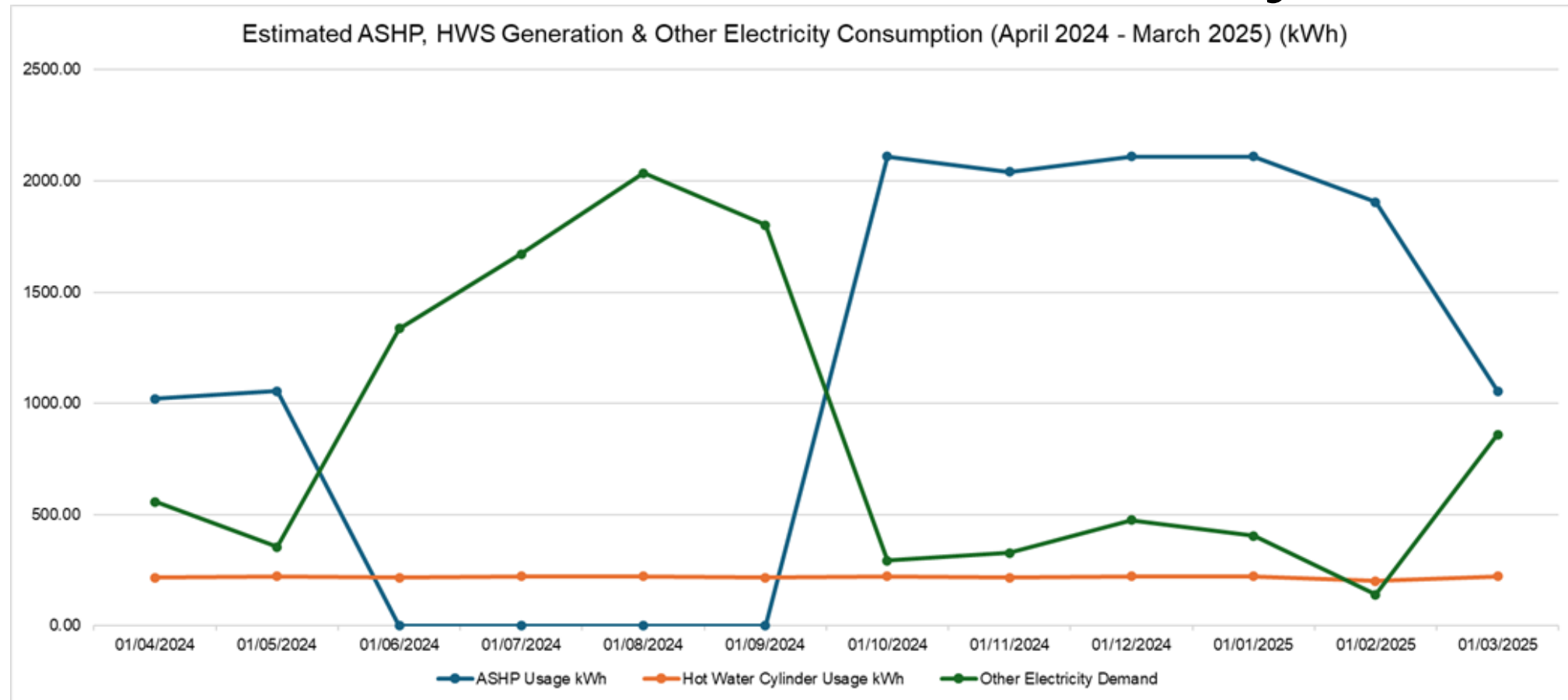
Equation 1 - Total Peak Demand of Building J (Feist et al., 2022)



Results – Theoretical Gas



Results – Theoretical Electricity



Results

GAS

£3,027.39 per year

Hot water cylinder only

ELECTRICITY

£2,217.47 per year

£1,200.51 for the ASHP

£216.03 for the hot water cylinder

£800.93 for other electricity requirements

Results - Costs

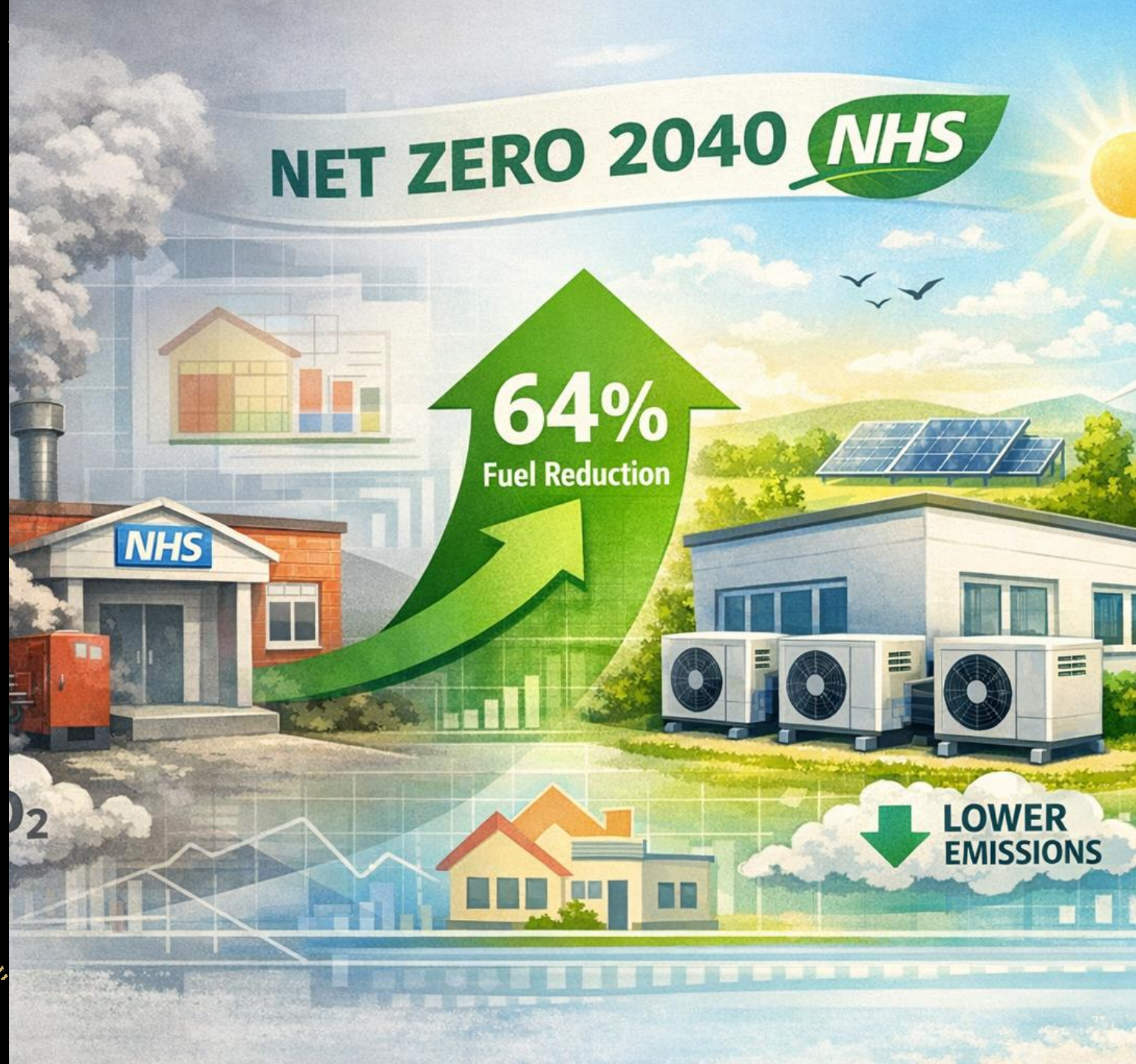
Estimated Savings on Gas Consumption				Estimated Savings on Electricity Consumption			Overall Savings
Month	Current Gas Cost	Estimated Gas Cost	Savings on Gas	Current Electricity Cost	Estimated Electricity Cost	Savings on Electricity	
Apr-24	£638.64	£229.13	£409.51	£90.32	£101.24	-£10.92	£398.59
May-24	£235.89	£184.07	£51.82	£91.55	£106.39	-£14.84	£36.98
Jun-24	£160.61	£160.61	£0.00	£115.77	£115.77	£0.00	£0.00
Jul-24	£192.69	£192.69	£0.00	£130.25	£130.25	£0.00	£0.00
Aug-24	£208.44	£208.44	£0.00	£183.24	£183.24	£0.00	£0.00
Sep-24	£301.26	£301.26	£0.00	£156.60	£156.60	£0.00	£0.00
Oct-24	£525.34	£262.74	£262.60	£187.46	£226.80	-£39.33	£223.27
Nov-24	£912.84	£248.84	£664.00	£197.60	£232.42	-£34.82	£629.18
Dec-24	£1,244.35	£299.40	£944.95	£232.21	£277.17	-£44.95	£900.00
Jan-25	£1,581.34	£349.81	£1,231.53	£213.15	£255.69	-£42.54	£1,188.99
Feb-25	£1,378.69	£341.41	£1,037.28	£225.21	£253.55	-£28.34	£1,008.94
Mar-25	£1,020.65	£248.99	£771.66	£159.37	£178.37	-£19.00	£752.66
	£8,400.73	£3,027.39	£5,373.34	£1,982.73	£2,217.47	-£234.75	£5,138.59

Conclusion

POOR ENERGY EFFICIENCY

HIGH KWH ASHP

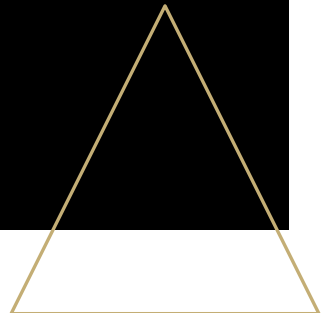
COST SAVINGS OF £5,138.59
PER YEAR





Recommendations

1. Improve airtightness
2. Install MVHR
3. Upgrade glazing
4. Enhance Insulation
5. Install ASHP alongside fabric improvements
6. Apply findings across the wider NHS estate



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Microsoft Copilot (2026)

Thank You

Any Questions?



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