How to Use a Heat Pump: Maximise Efficiency & Savings

9th October 2024

8-9pm

OPEN eco HOMES

Cambridge Carbon Footprint

CAMBRIDGE RETROFIT HUB

G V Harrison — THE ROOF WINDOW EXPERTS —

Mole

KEYSTONE ARCHITECTURE & DESIGN

THE CAMBRIDGE Building Society

INCLUME

McCarthy Architectural Design
www.mccarthyarchitecturaldesign.co.uk

MR RIBA

LL

Ac

WRIGHT CHOICE

CFCI

CAMBRIDGE CITY COUNCIL

South Cambridgeshire District Council

Agenda

8:00 pm	Heat pump overview and operation – Fiona
	Impact of heating schedule and insulation – Nicola
	Smart heat pump controls – Henri
	1930’s solid wall bungalow - Gary
	Q & A
9:00 pm	Thanks and feedback

About Green Heat Coop

- Community energy social enterprise
  - Non-profit, co-operative company, based in Royston
  - Join as a member to support us in building a local green heating community (£10/year)

- What are we doing now?
  - Heat pump advice and home surveys
  - Consumer outreach and education
  - Community retrofit study of Royston & SG8 villages
- Please fill out our householder survey to help inform the retrofit study:
- www.greenheatcoop.co.uk/survey


Sustain-Ability


Heat pump open house

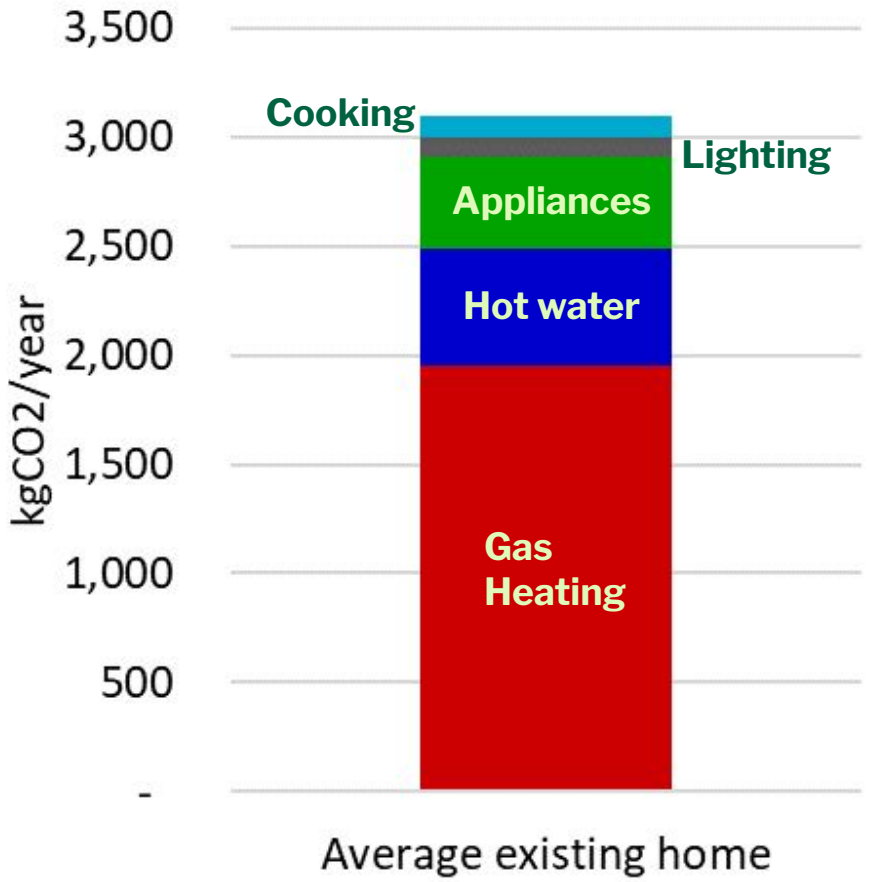
01763 788 774
hello@greenheatcoop.co.uk
www.greenheatcoop.co.uk

Heat Pump Overview

Fiona Hughes

Why get a heat pump?

- The biggest savings on your home's carbon emissions
  - 60% to 100% reduction
- More carbon savings than:
  - Solar PV – 12%
  - High efficiency boiler – 5%
  - Wall insulation – 30%
- Savings on running costs
  - £50 to £350 per year
- £7,500 off upfront cost from Boiler Upgrade Scheme



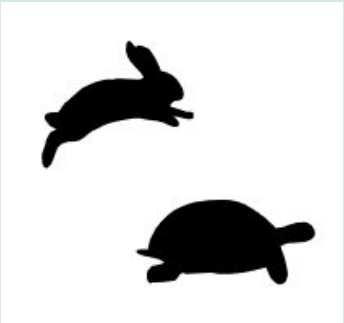
UK Housing: Fit for the Future?, CCC, 2019
https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/

How is a heat pump different from a boiler?

1. **Moving heat instead of making it**

- Heat pumps ***move heat*** from outside to inside using electricity.
- Efficiencies above 100%, typically 320% to 400%
- Compare with :
  - Boiler efficiencies of 75 – 90%
  - Electric heating efficiency of 100%

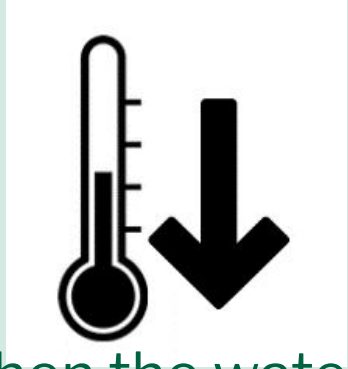
2. **Running slow and steady**



- Heat pumps work best when keeping your home at an even temperature.
- Different control method than you may be used to
- Set-back temperatures for overnight and when you're away

How is a heat pump different from a boiler?

3. **Low flow temperature**



- Most efficient when the water flowing to the radiators is 50°C or less.
- The whole heating system needs to work together to heat your home with low flow temperatures.
- This may mean making changes to the pipes or radiators.

4. **Hot water storage tank**

- Heat pumps are sized to match your home's heating demand, not your instant hot water demand.
- Typical size 5 to 10 kW
  - vs 18 to 35+ kW for boilers
- Heat pumps take longer to heat hot water - need a tank
  - Other solutions available if this is not possible.


Heat Geek


Vaillant

System design - Low flow temperature

Design flow temperature (°C)	35	40	45	50	55	60
Annual Efficiency = Seasonal Coefficient of Performance (SCOP)	405%	372%	338%	312%	285%	253%
% heat moved from outside	75%	73%	70%	68%	65%	60%
% heat from electricity	25%	27%	30%	32%	35%	40%
Typical running costs	£660	£700	£760	£810	£880	£970

- Flow temperature = how hot your radiators are
- Design condition is about -3 °C
- Need larger radiators to use lower flow temperatures

green heat

Operation for Performance and Cost Savings

Fiona Hughes

Two principles of heat pump operation

1. Radiators can deliver heat more quickly when they are hotter
2. Heat pumps are most efficient when radiators are cooler

For best performance:

- Replace heat as it leaves your home
- Longer run-time at lower flow temperature
- Steady indoor temperature = radiators as cool as possible
- Radiator valves open

green heat

Average house in mild weather

- Typical house
  - 8 kW heat loss at -3 °C
  - 4 kW heat loss at 10 °C

- 1 hour in mild weather – 4 kWh lost
- Need to replace 4 kWh to keep indoor temperature

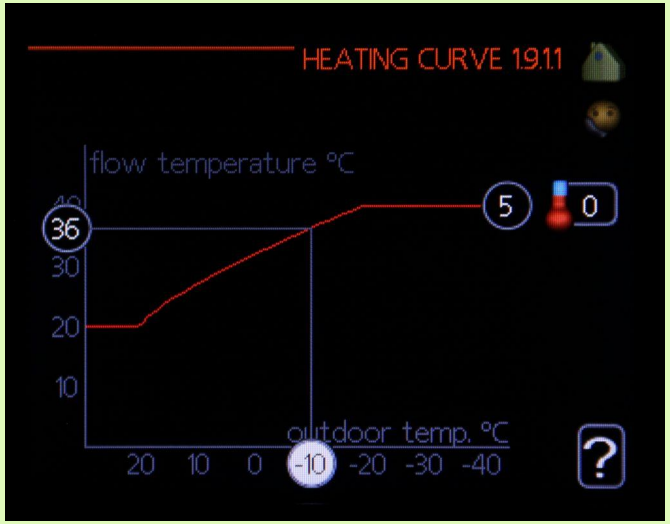
- Option 1: Heat pump runs at 4 kW for 1 hour
- Option 2: Heat pump runs at 8 kW for 30 minutes
- Same energy delivered, but more slowly in Option 1
- Slow heat delivery = cooler radiators = higher heat pump efficiency

Heat pump controls

Level One – Set it & forget it

- Weather compensation curve
- Hot water temperature

Daikin MMI



NIBE F1145

Level Two – Adjust as needed

- Weekly heating schedule
- Weekly hot water schedule

Daikin Madoka

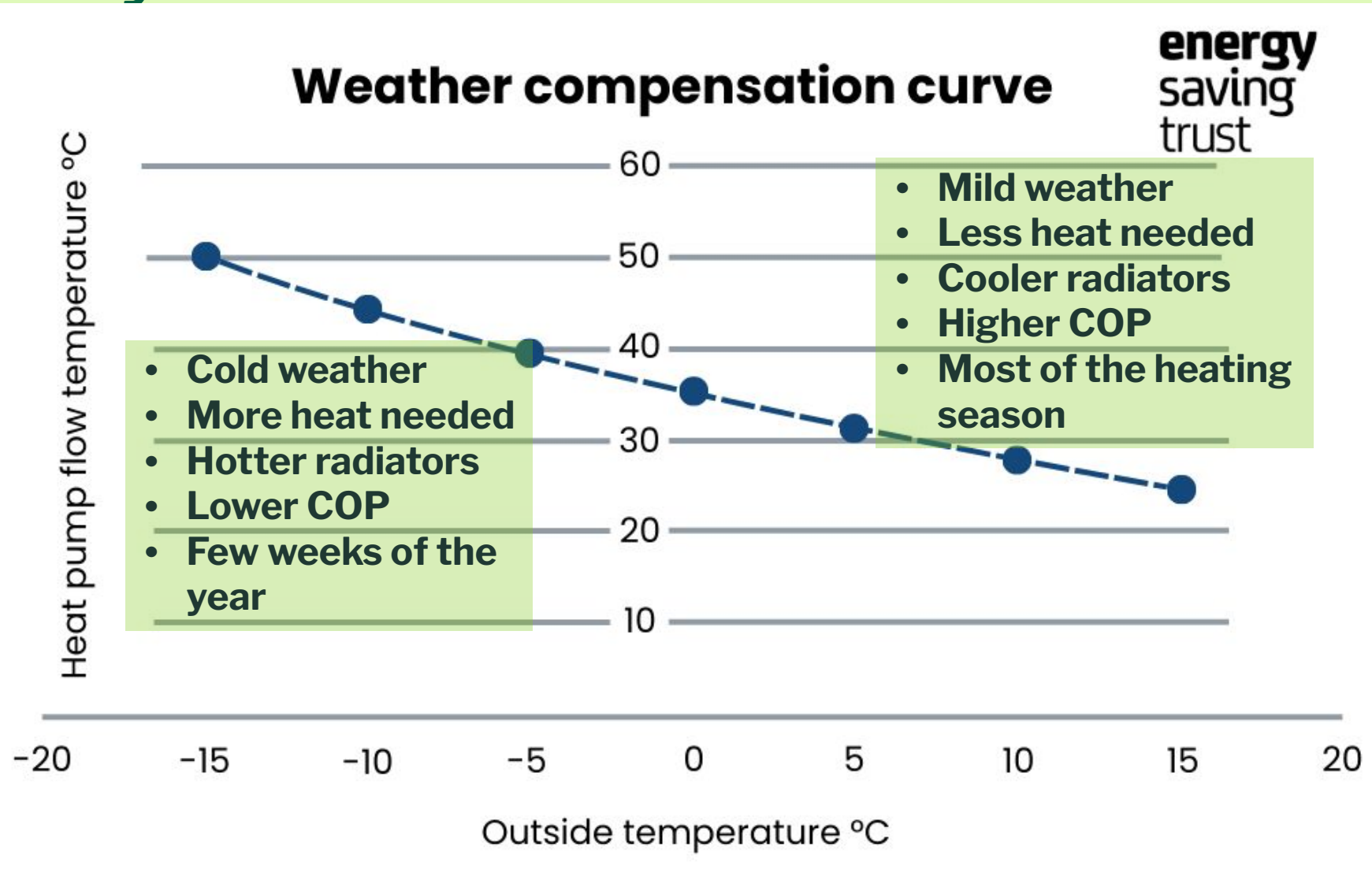
Vaillant SensoComfort

Weather compensation = radiators only as hot as they need to be

Get the weather compensation curve right, and your home will be comfortable in all weathers!

On/off thermostat:

Not recommended



Simple Troubleshooting

Issue	Suggestion
Is weather compensation activated?	• Check settings – some links below • Check with installer • Are rooms cold in the morning? Or all day? ☹️
Rooms too cold	• Open radiator valves in all rooms • Use set-back temperature • Check radiator temperatures - bleed or flush system • Raise weather compensation curve • Consider larger radiators
Rooms too hot	• Lower the temperature set-point • Partly close radiator valves • Lower weather compensation curve • Then may need to open radiator valves

Youtube instruction videos for popular heat pump models:

Daikin
Vaillant Arotherm Plus
Mitsubishi Ecodan
NIBE S Series

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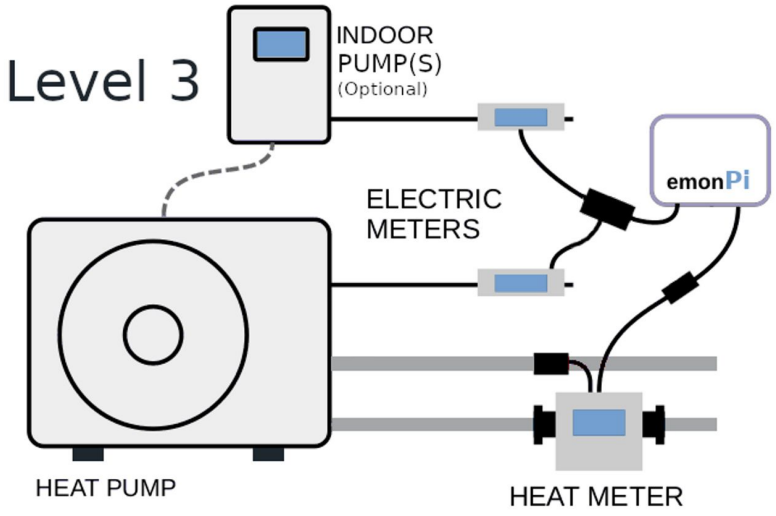
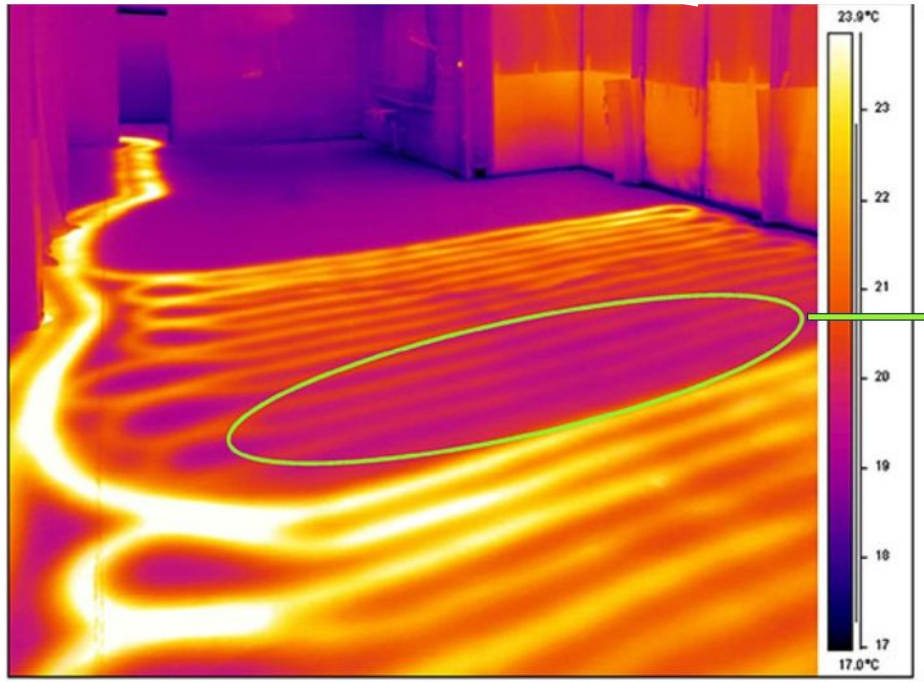
Further troubleshooting and monitoring

- Laser temperature measurement
- Thermal camera
- Heat pump monitoring equipment from [Open Energy Monitor]
- See systems at [https://heatpumpmonitor.org/]





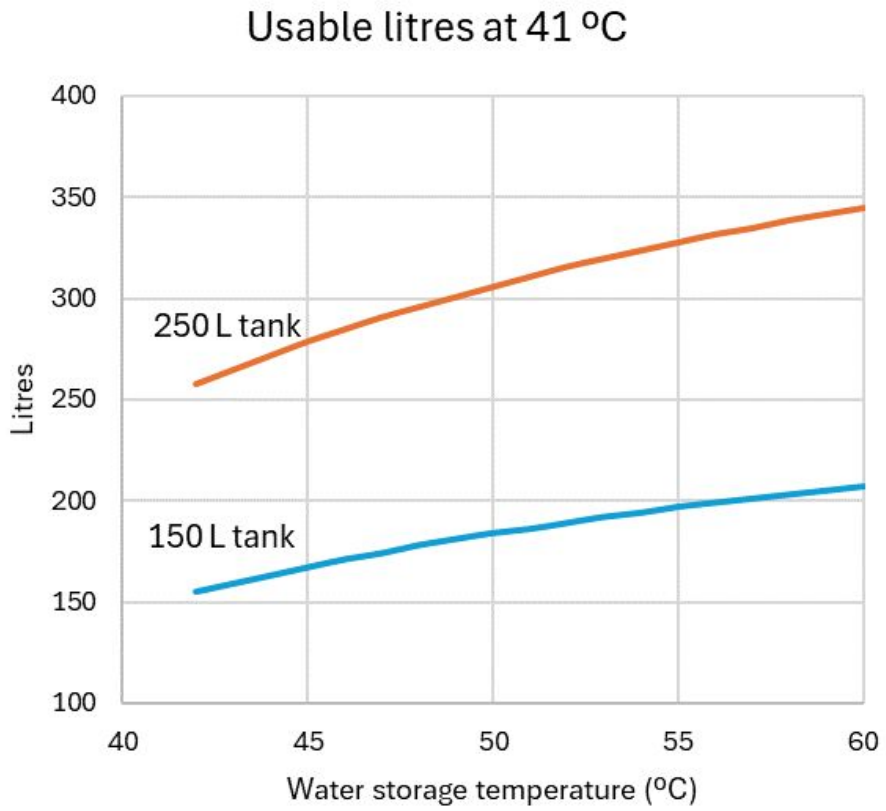
No need to dig up the floor to check heat flow – the camera reveals all.

In this case one heating circuit gets progressively cooler near the end - probably restricted hot water flow.

Image from Red Current

Lower hot water store temperature = Higher efficiency

- 60 °C not required!
  - Showers ~ 38 °C, washing dishes 40-43 °C
  - Legionella cycles (60 °C) can be run weekly
- Heat the tank only as often as needed
  - Full charges more efficient
  - Use time controls and match to your tariff
- Use “eco” mode if available
  - Vaillant Arotherm Plus, Mitsubishi Ecodan
- Can store hotter to get more from 1 tank
  - Consider low flow taps and showers

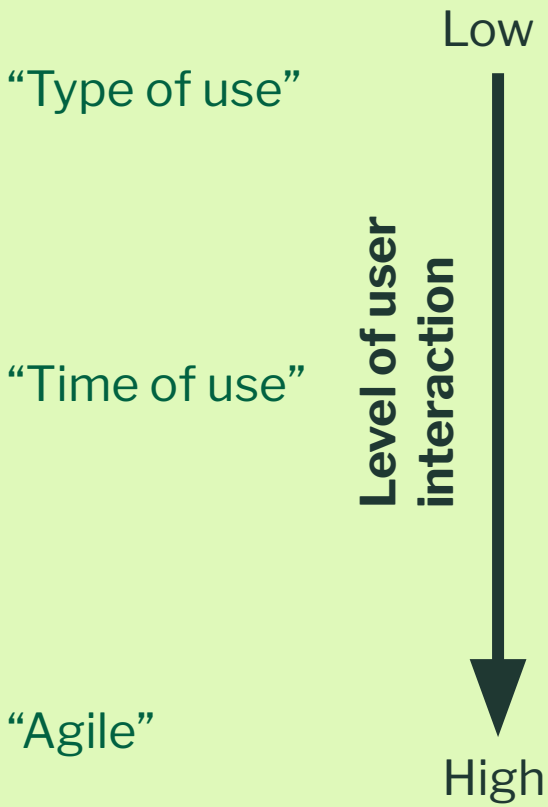


Weekly schedule and set-back

- Slow and steady operation
- “Set-back” temperature overnight
  - Up to 3 °C below daytime temperature
- More on this from Nicola in a few minutes

Choosing the right tariff

- Save 10% to 35% on electricity with smart tariffs:



Heat pump	EV	Solar / battery
OVO Heat Pump Plus	OVO Charge Anytime	Any Smart Export Guarantee
Octopus Cosy	Octopus Go	Octopus Flux
EDF Heat Pump Tracker	EON NextDrive	EON Next Export
	EDF Evolve & GoElectric	
Octopus Agile	Octopus Agile	Octopus Agile

- With multiple systems, best tariff will depend on how much you heat home vs drive car vs export solar power

green heat

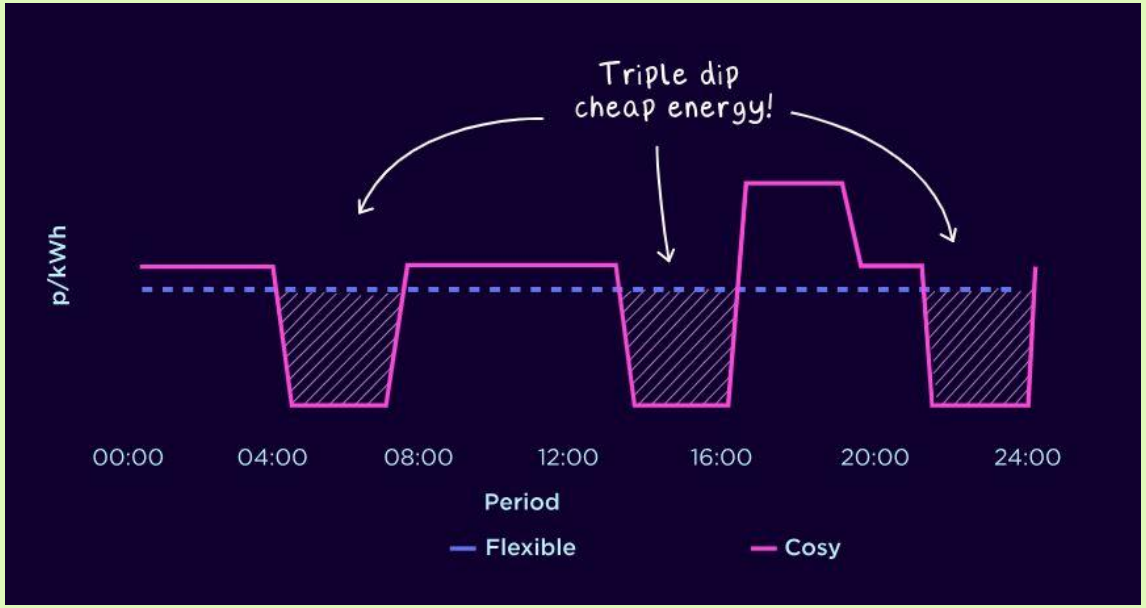
Popular heat pump tariffs

Octopus Cosy

- Any heat pump
- 3 cheap periods, 50% less, 12.6 p/kW)
- 1 peak period, 45% more, 37.4 p/kWh
- Costs apply to all electricity used
- Savings depend on shifting demand
- 10-20% savings typical

OVO Heat Pump Plus

- Vaillant Arotherm Plus (so far)
- Heat pump electricity 39% cheaper, 15 p/kWh
- Other electricity at standard rate (24.5 p/kWh)



Impact of Heating Schedule and Home Insulation

Nicola Terry

Heating patterns

Common pattern – morning and evening only.

- Reduces heat demand to just when you want it.
- Increases heating power demand
- Need radiators to be HOT
- Heat pump is more efficient when supplying WARM
- *Aim to minimize electricity not heat*

Solution – use a setback temperature

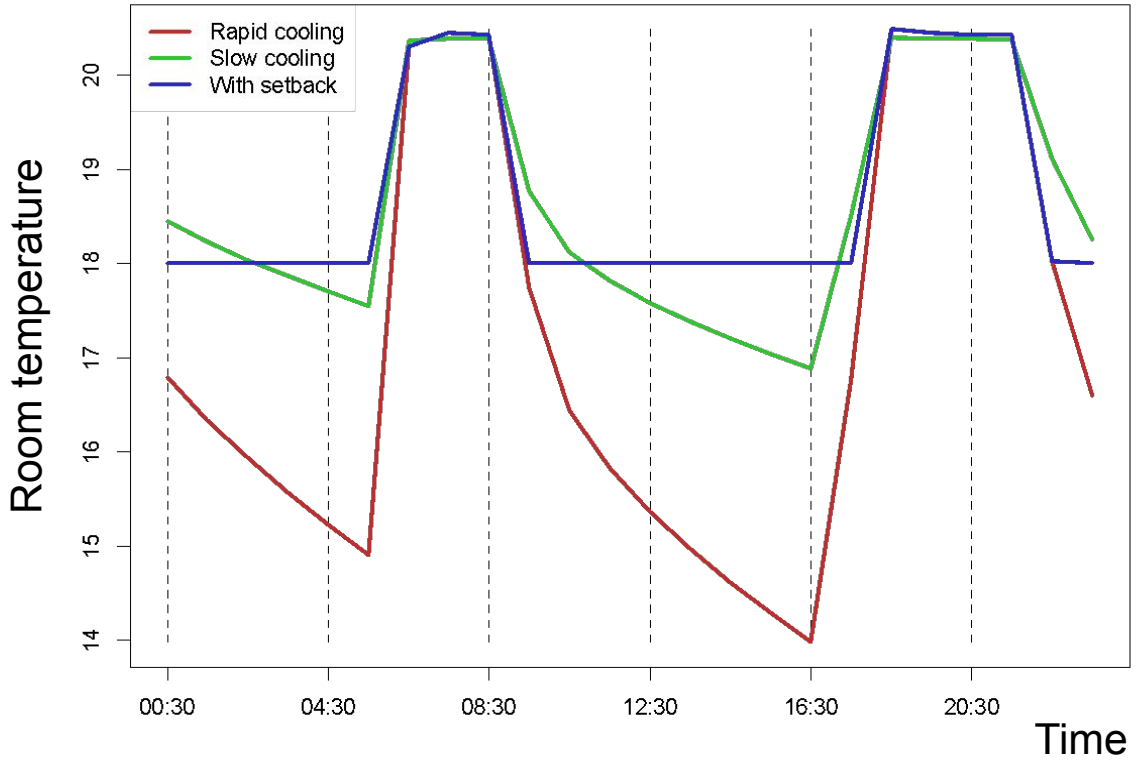
- Reduces peak power demand
- Increases heating demand

OR - install a smart heat pump controller

  - Homely or Passiv
  - HavenWise

0°C outside.

Terrace with filled cavity walls vs. Semi-detached with solid walls



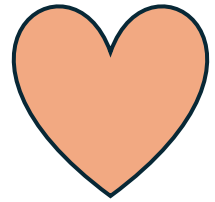
Increase in demand:

- 0-10% if heating all day
- 4-20% if heating twice per day
- Low figure for terrace with CWI
- High figure for detached with uninsulated solid walls.

Personal experience

- Installed heat pump (space only)
- Initially 20/17 °C
- Increase setback 20/19 °C
  - Heat and electricity demand up 10%
- Decreased nominal radiator temperature 55-> 52°C
  - Electricity demand back to where we started

Overall:



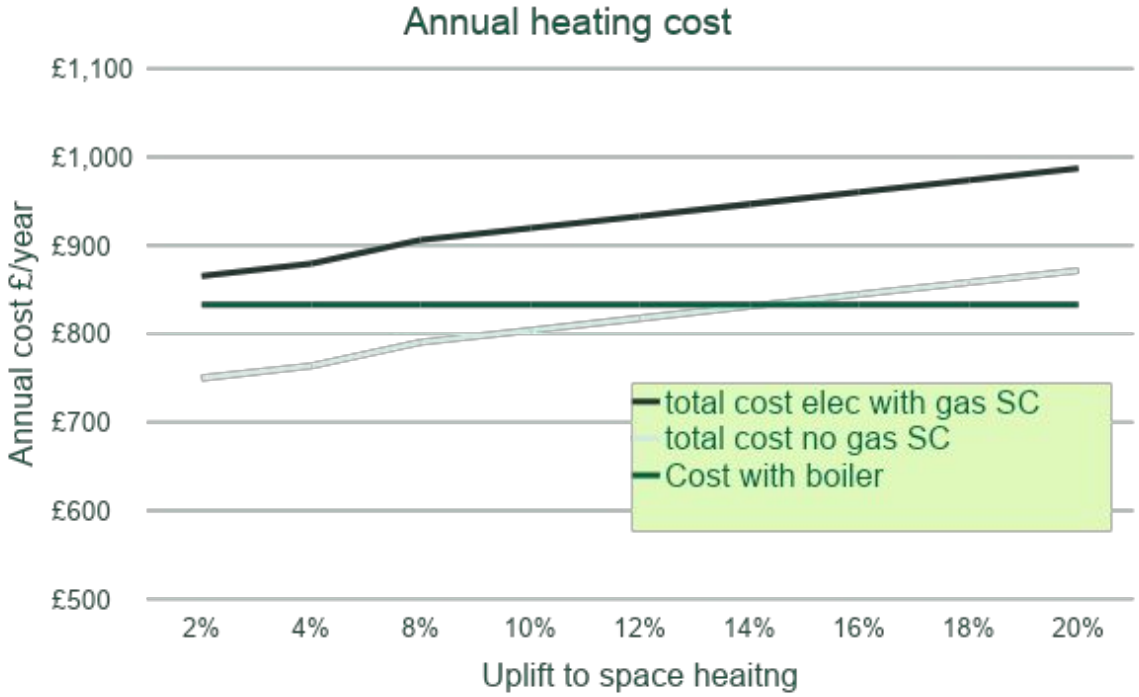
- No change in bill
- We are warmer overnight

You may find hot summer nights uncomfortable but being warm in winter is nice.

https://energy-surprises.blogspot.com/2022/04/performance-of-my-heat-pump.html

How much will my bills increase?

- Gas bill 11,500 kWh/year
  - Lower bills -> more savings
- Boiler efficiency 0.9
- HW 2 people = 1,800 kWh
- Heat pump SCOP
  - 3.1 (space)
  - 2.5 (HW)
- Gas and electricity price as per current price caps



- HP is cheaper if you come off gas and the heating demand uplift is less than 12%
- Can do better with specialist tariffs and flexibility on temperature
- Even better with a solar PV, battery to cover peak times, and/or higher SCOP

Smart Heat Pump Controls

Henri Castelyn

HavenWise

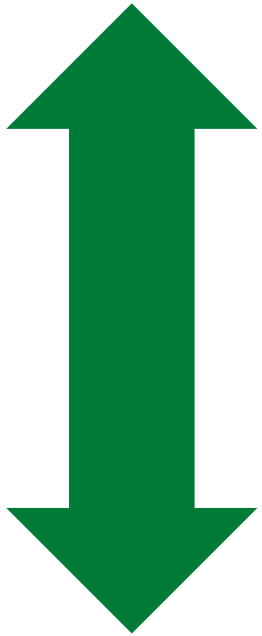
Get the most out of your heat pump

Two determinants of your heating and hot water bills

500%

150%

63 p/kWh



-8 p/kWh

So, what is the best setup for my home?

- Building characteristics
- Schedule
- Preferred temperature
- Weather
- Heat pump brand
- Tariff
- Solar PV & batteries

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Optimal control

Automatically

Predictive

24/7

Advanced mathematics

Built for heat pumps

Easy for the homeowner

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Easy for the homeowner

50% savings

So, what is the best setup for my home?

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- Weather
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- Tariff
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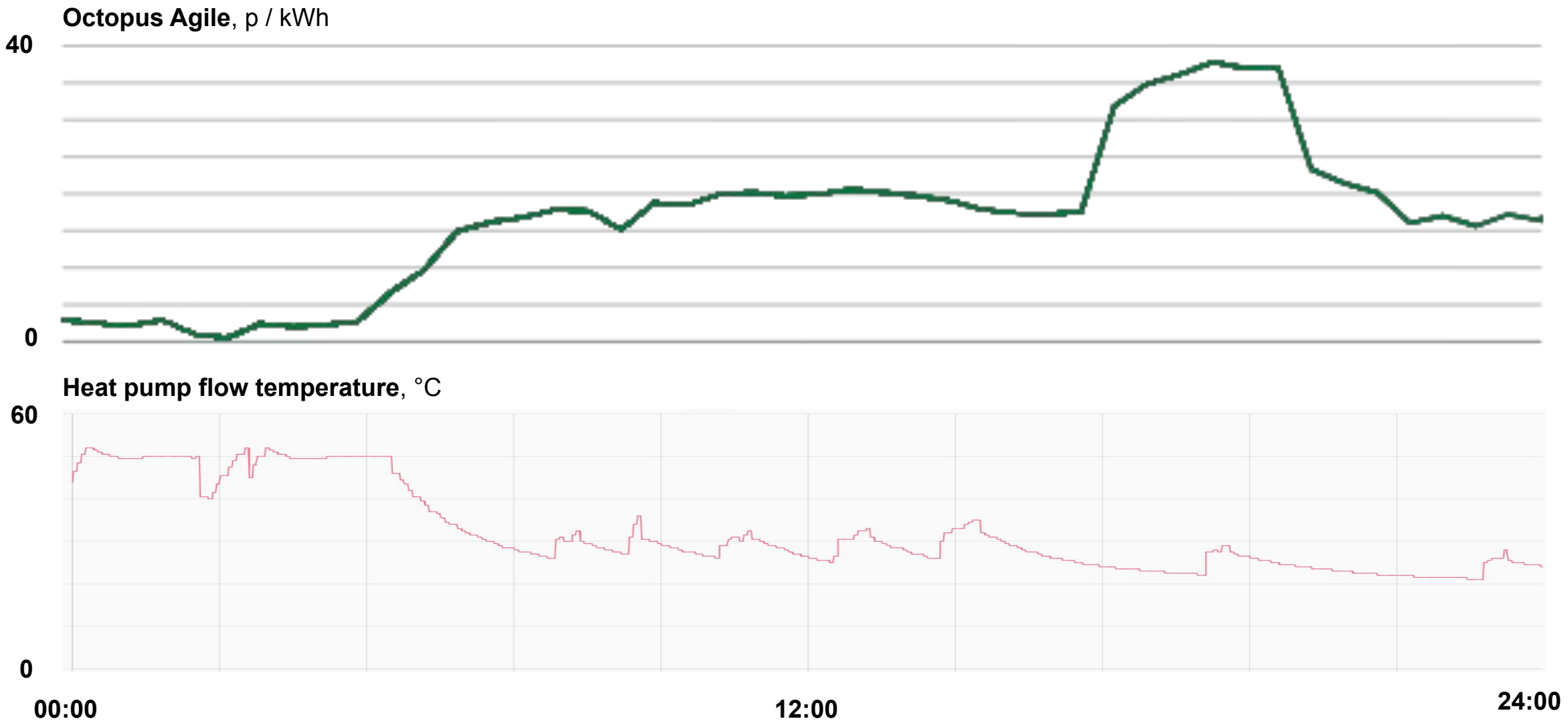
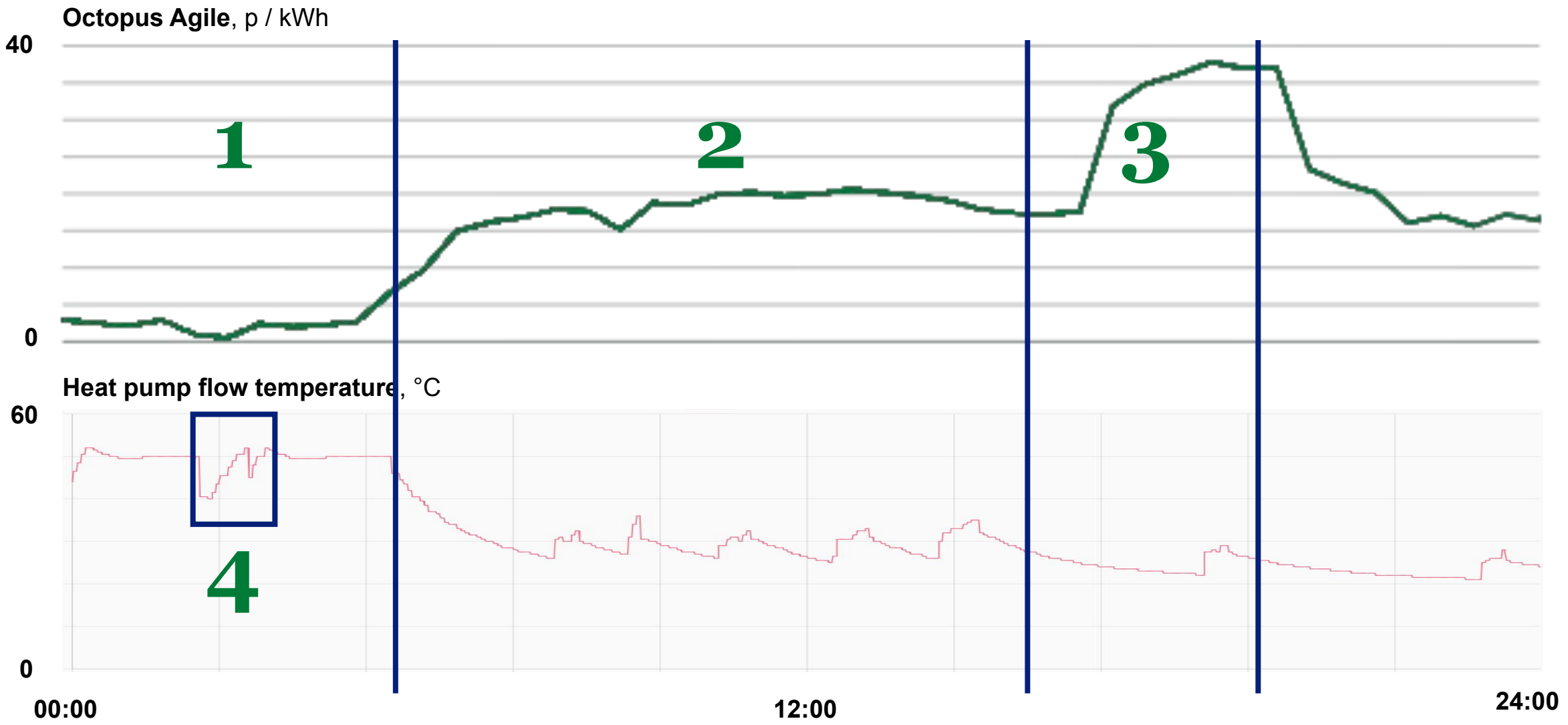
HavenWise

Minimal energy bills, maximum comfort

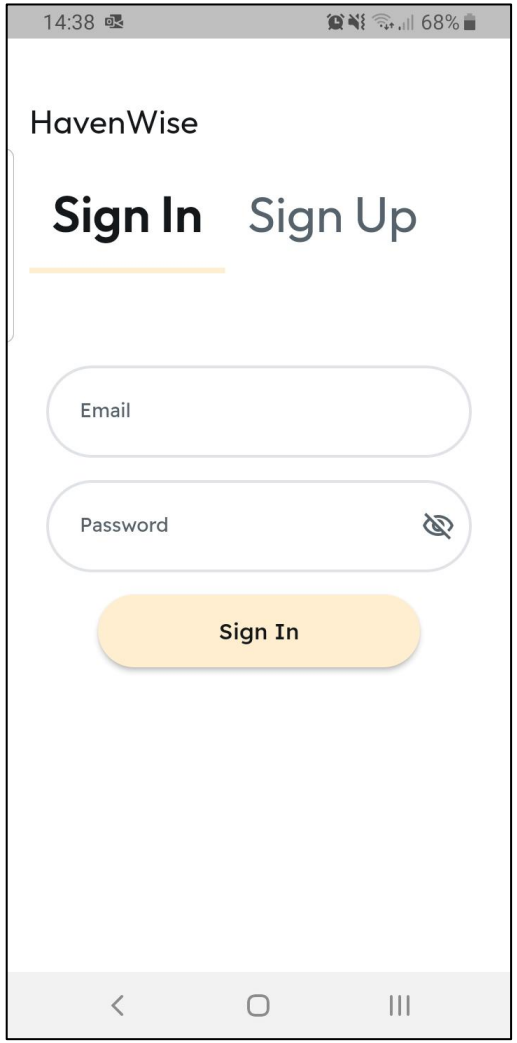
A real example from last Monday

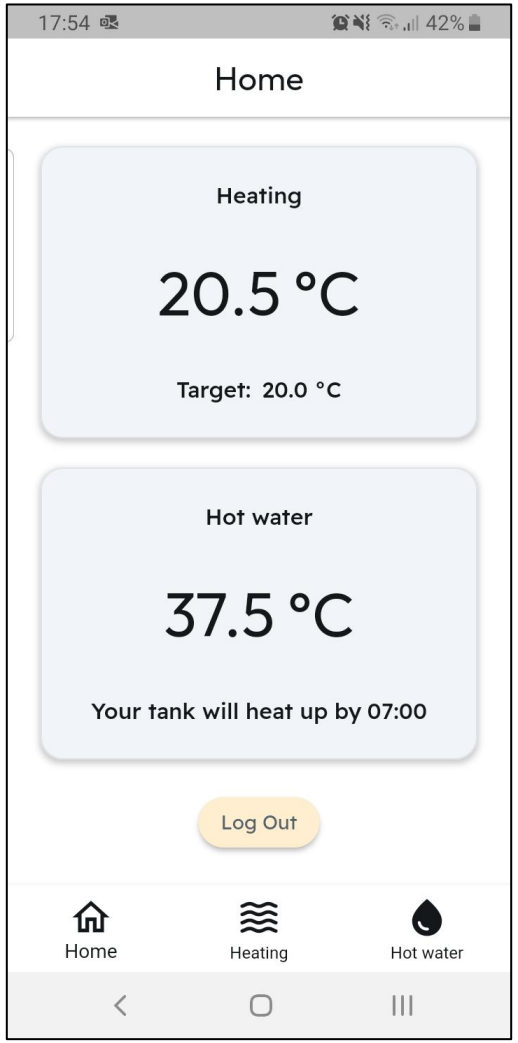


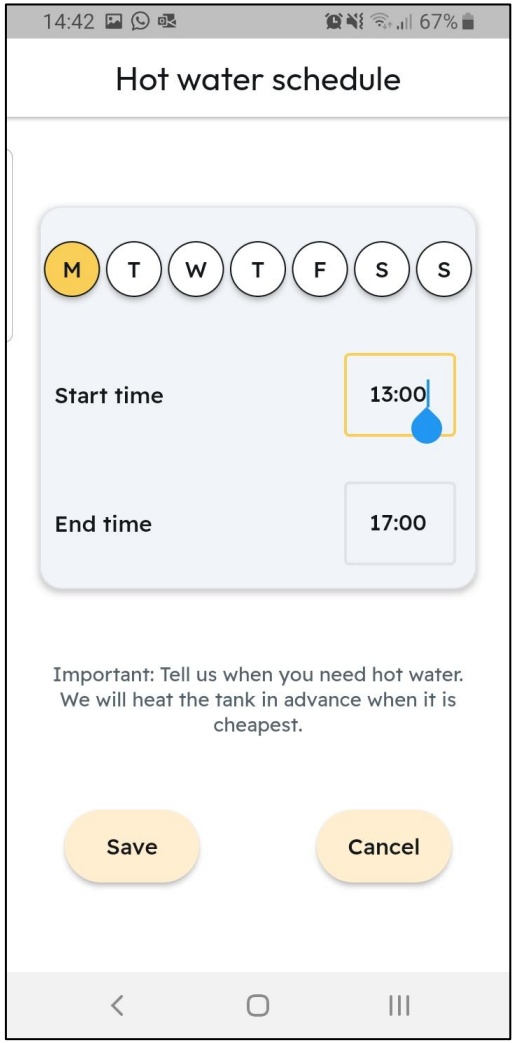
A real example from last Monday



Make it easy for homeowners







In summary, users benefit from reduced energy bills and easier control

Reduced energy bills: We make sure your heat pump works as efficient as possible and uses cheap electricity

Easy control: You get access to an easy-to-use app to turn your heat pump on / off and set schedules. No complex settings

No extra installation: We are a software-only solution. No expensive hardware and no installation time

Longer lifetime: We created safety mechanisms to reduce “cycling” of heat pump, ensuring it lasts longer

Support: We provide advice, explanation, and support to get the most of your heat pump

How to get started?

Vaillant

MITSUBISHI ELECTRIC

SAMSUNG

DAIKIN

www.havenwise.co.uk

henri@havenwise.co.uk

07581 026213

Case Study: 1930's solid-walled bungalow

Gary Randall

Case study 1930’s solid wall bungalow

Underfloor insulation

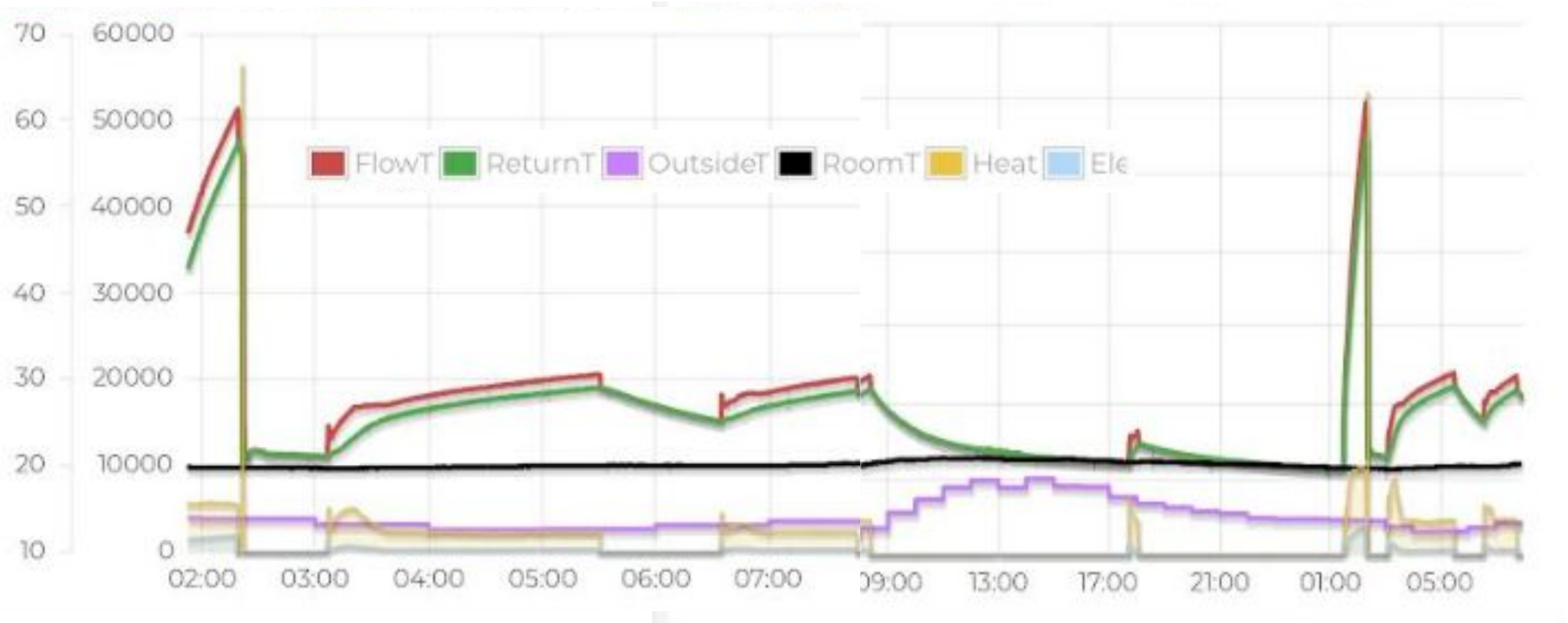





Solar, battery and EV

Heat pump

How we run our heat pump.

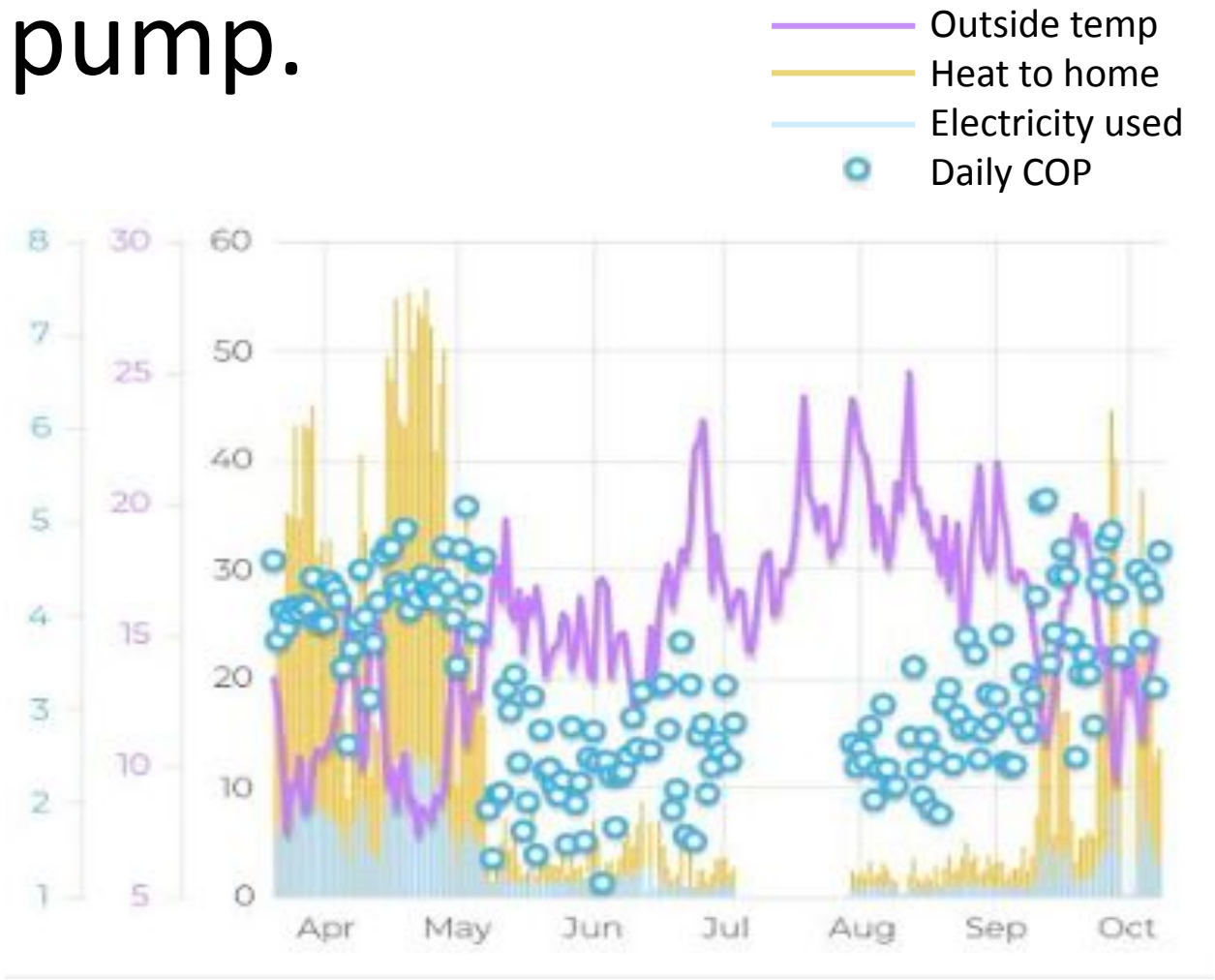


- Day time temperature – set to 19 º C but often higher
- Night time temperature – set to 18 ºC

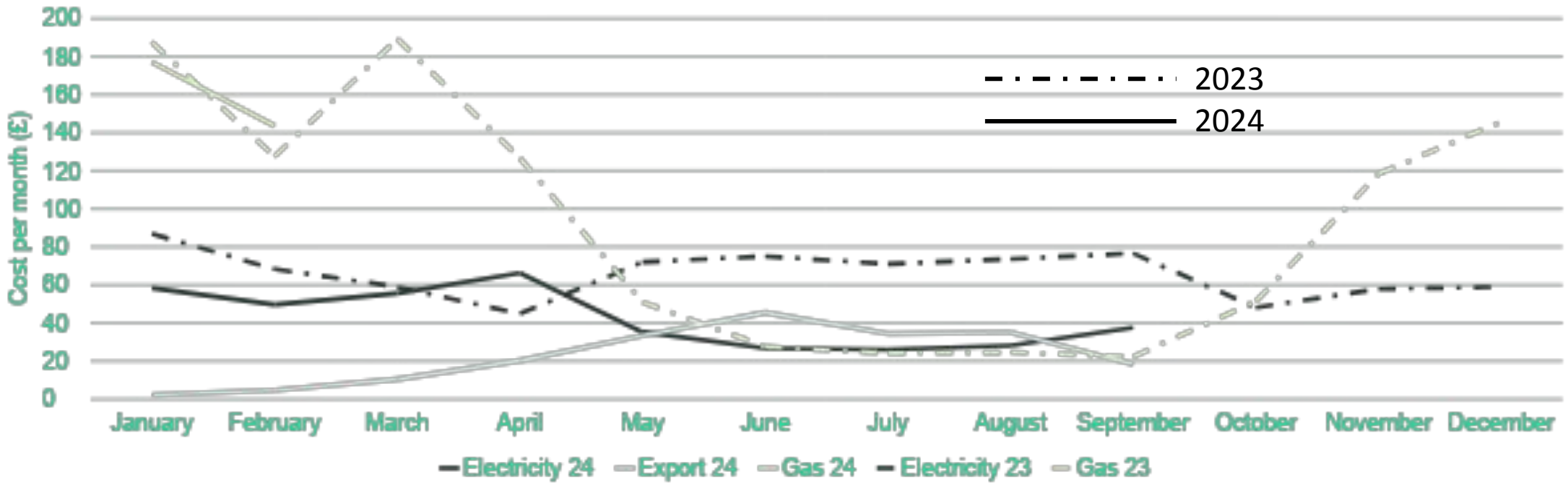
- Weather compensation
- Hot water heated once per day
- Tariff: Octopus Intelligent Go

How we run our heat pump.

- Spring/autumn COP = 4.2
- Summer COP (hot water) = 3 - 3.5
- Overall COP so far = 3.9



Energy cost comparison



	January	February	March	April	May	June	July	August	September	October	November	December
Electricity 24	£58.40	£49.65	£55.57	£66.27	£35.30	£26.76	£26.02	£28.10	£37.55			
Export 24	£2.18	£4.77	£10.47	£20.25	£33.40	£45.47	£34.42	£35.21	£18.36			
Gas 24	£177.04	£143.65										
Electricity 23	£86.88	£68.36	£59.02	£44.88	£72.04	£75.10	£71.08	£73.63	£76.62	£48.11	£57.88	£59.06
Gas 23	£187.46	£127.52	£189.26	£126.69	£51.04	£27.60	£24.14	£24.59	£22.28	£51.40	£118.28	£145.72

Transition complete.

Your next steps

- Find out how you can get started with your retrofit
- Book another tour or talk
- Research our past case studies
- Book a training session and borrow a thermal imaging camera
- Use Transition Cambridge's personalised home energy advice tool
- Please complete the event feedback at the end of this talk

Can you help us?

Make a donation to help us run more Open Eco Homes tours:

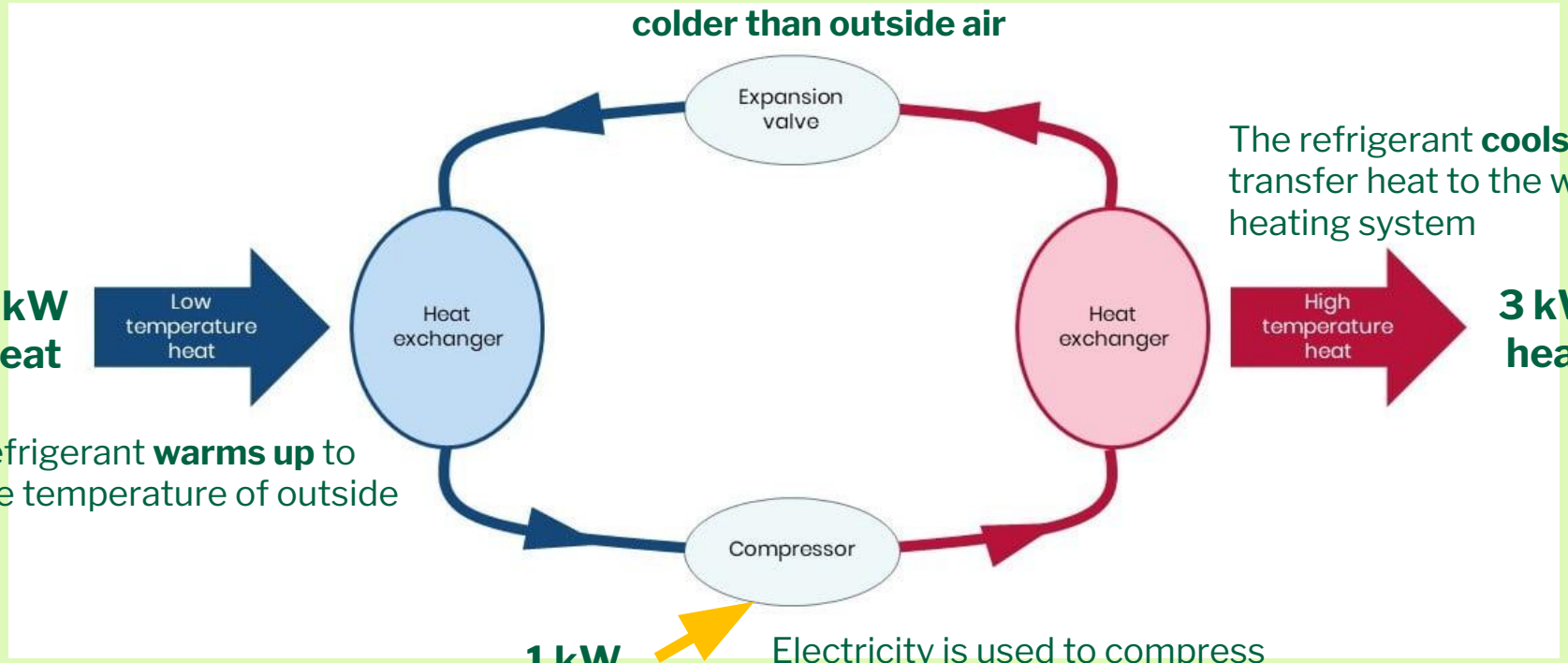
cambridgecarbonfootprint.org/donate

Share your experiences on social media: #OEH2024

Thank you for your support!

Heat pumps move heat instead of generating heat.

How does a heat pump work?



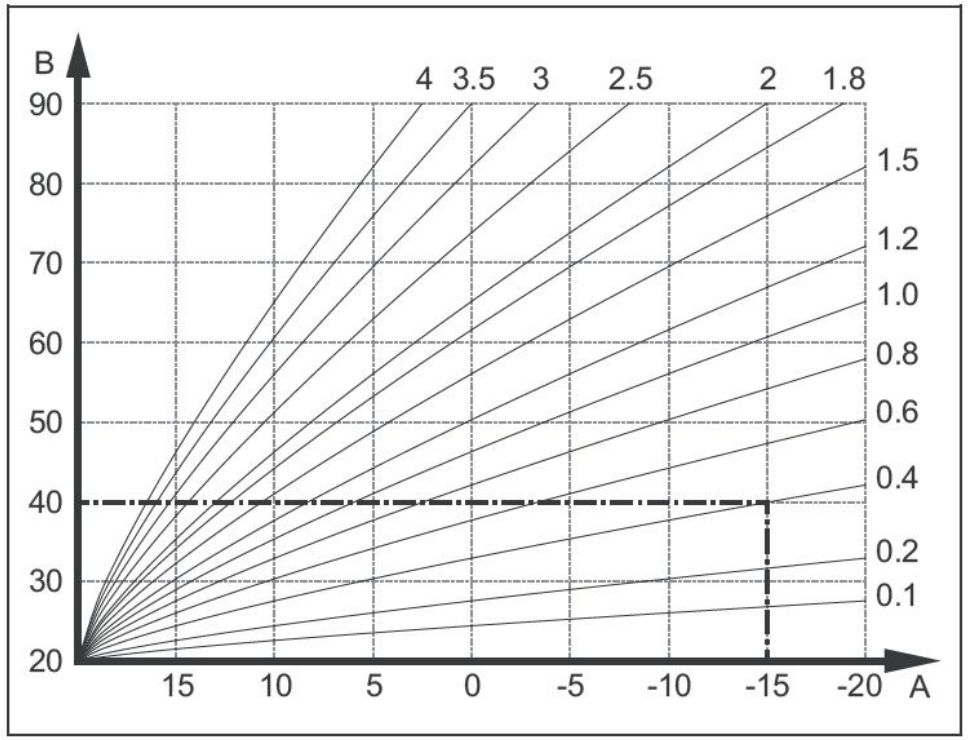
$$\text{Coefficient of performance} = \frac{heat\ from\ outside + electricity}{electricity}$$

Image from: https://energysavingtrust.org.uk/advice/in-depth-guide-to-heat-pumps/

How to set the curve

- Ideally set by installer during commissioning, but not always
- **What the curve should be** depends on your radiators and design flow temperature
- **How to set the curve** depends on your heating system and controller

1. Make sure **weather compensation is activated**
2. Start with all **radiator valves wide open**
3. **Choose curve** based on your system design, or educated guess
4. **Err on the low side** and tweak upwards after a few days if needed
5. **Once coldest rooms are OK**, turn down radiator valves **part way** where needed (e.g. bedrooms)



A Outside temperature °C B Target flow temperature °C

Youtube instruction videos for popular heat pump models:

Daikin
Vaillant Arotherm Plus
Mitsubishi Ecodan
NIBE S Series

Image from: Vaillant Arotherm Plus manual