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What you need to know before purchasing a heat pump

The webinar

- Introductions: Philip Haile, Transition Bath
- Webinar designed to provide general background information
- Please ask questions about the presentation as the webinar progresses, but avoid specific questions on your home
- Introduce yourselves, and your homes briefly – age, size – 2 sentences

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Why purchase a heat pump?

- 85% lower carbon emissions than gas boiler
- 85% lower carbon emissions than hydrogen boiler
- Similar running costs to gas boiler, but can be cheaper with time of use tariffs
- Will continue to become lower carbon as grid decarbonises
- Much bigger CO2 reduction than other measures e.g. insulating (3x to 8x), buying an EV (1.4x), installing solar PV (5x)

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Common misconceptions

- Heat pumps don’t work in historic buildings
- Heat pumps don’t work in the cold
- Heat pumps are a new technology
- Heat pumps don’t work if you don’t improve the fabric
- Heat pumps are noisy
- Heat pumps heat buildings slower than gas boilers
- Heat pumps can only provide lower flow temperatures
- Heat pumps are less efficient if you don’t improve the fabric
- Heat pumps are expensive to run and don’t provide a financial payback

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Introduction – why this service?

- Transition Bath is a charity which aims to make Bath more sustainable
- Heat pumps reduce a home's heating and hot water carbon emissions by 85%
- Transition Bath have been offering informal advice to homeowners on heat pumps for 3 years, and see a demand
- We feel that installers haven't been providing enough advice to homeowners, or involve them in the decision making

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Why do you need advice on purchasing heat pumps?

- Your home's heating system wasn't designed for a heat pump
- Your home's radiators and hot water cylinder wasn't designed for a heat pump
- It's important to design your heating system to run a heat pump as efficiently as possible; greater efficiency => lower running costs and lower carbon emissions
- A more complex set of choices than a gas boiler
- It's relatively new technology compared with a gas boiler
- Installers generally don't explain the choices to you

What does Transition Bath's Heat Pump Advisory Service Offer?

- Free education webinars
- Bespoke, independent advice for your home
- Heat loss survey and then heat pump specification for your home
- Recommended installers
- Checking of quotes
- Post installation snagging and tuning
- Our only objective is to decarbonise heating and hot water in homes; we are not aiming to make a profit

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What is covered in this presentation

- How do heat pumps work?
- Components of a heat pump: outdoor unit, hot water cylinder, radiators, pipework
- Temperature versus efficiency/cost/CO2, weather compensation
- Reducing flow temperatures and upsizing radiators
- Locating a heat pump, noise, planning permission
- Hot water cylinders
- Controls
- Time of day tariffs
- What homes are most suitable, thermal insulation improvements, historic homes
- Do you run them 24-7? Thermostatic radiator valves. Zoning
- How to go about getting quotes (discussion)? Installers versus energy companies
- Solar PV and batteries
- Etc.

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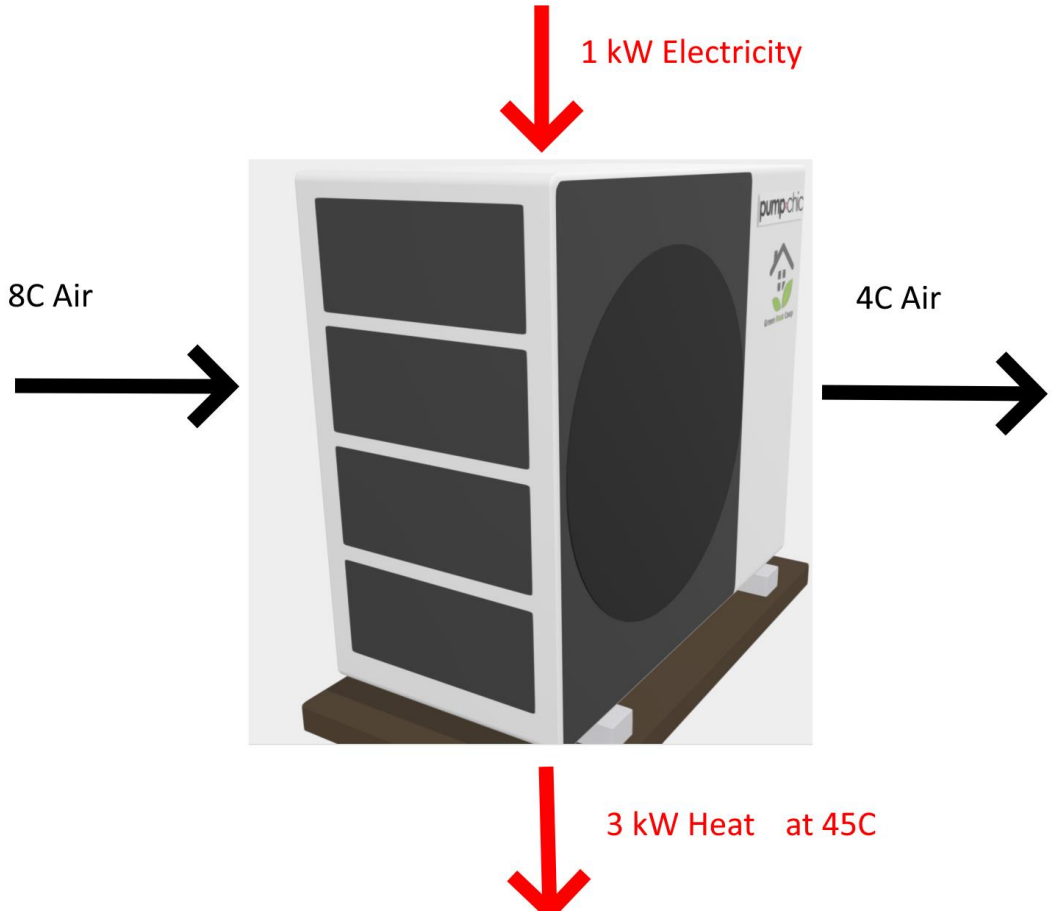
How do heat pumps work?

- Air source heat pumps extract heat from the air, using electricity, converts this extracted heat into hot water (similar mechanism to a fridge)
- 1 unit of electricity in, and 1.5 to 5.0 units of heat out depending on temperature (Coefficient of Performance (COP) = 1.5 to 5 or 150% to 500% efficiency
- Ground source heat pumps extract heat from the ground



Air source: mini-split/monobloc versus ground source

- Air source use electricity to extract heat from the outside air (or the ground) and convert it to higher temperature water, similar to a fridge but in reverse
- There is an ‘outdoor unit’ which extracts the heat from the air
- A cylinder to hold hot water is typically required inside, unless you don’t have a bath
- Otherwise the remainder of the system, pipework, radiators is similar to a gas boiler
- In operation, to be efficient they typically need to run for longer periods than gas boilers
- Mini-splits are rarely used, better if need cooling
- Ground source are expensive (£20K+), not that much more efficient, technically more difficult and attract a lower £5K grant

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Locating the heat pump - outside

- Outside space (gap behind, gap either side)
- Route for pipework from outside unit to cylinder
- If necessary can be a distance from the house, can be mounted on wall or flat roof
- Need to assess noise impact on neighbours – although modern heat pumps are very quiet
- Specific rules for listed buildings, conservation areas, World Heritage Sites

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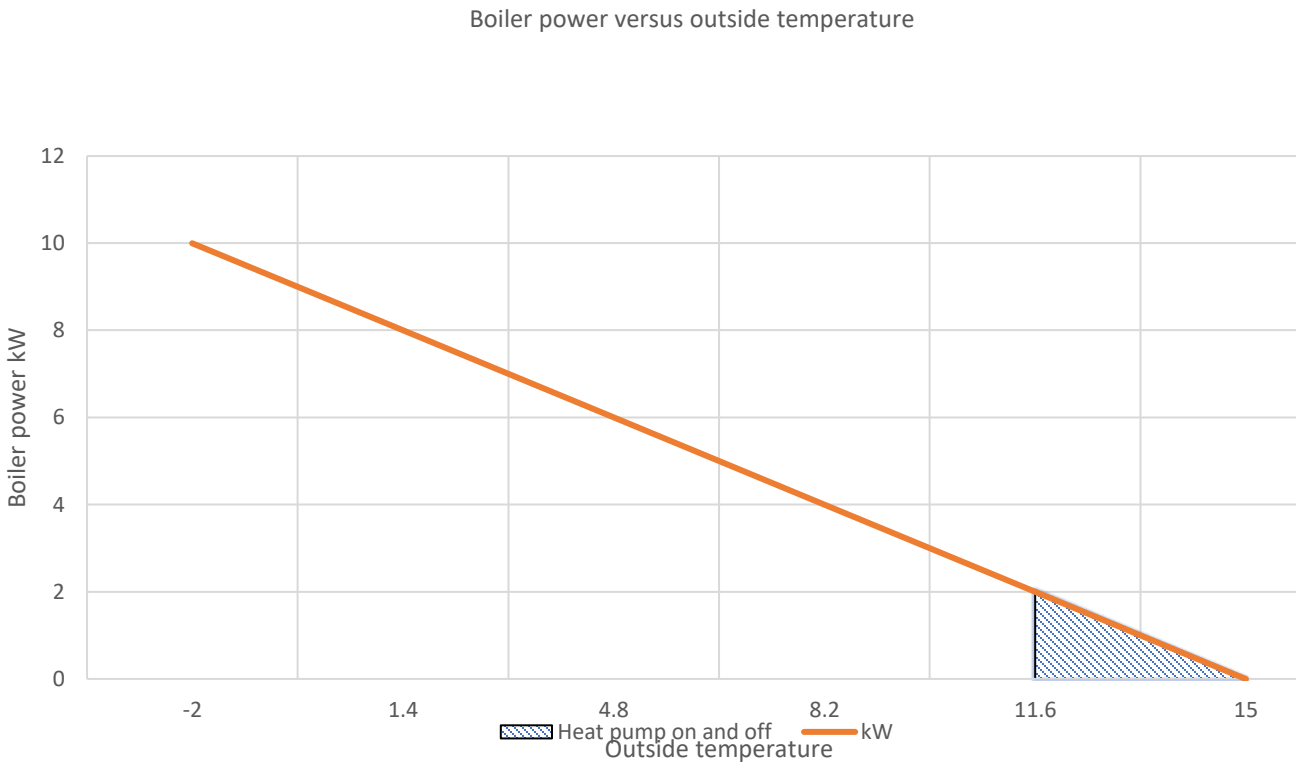
Locating the heat pump - indoors

- Most homes will need a new hot water cylinder as it needs a larger heat exchange coil than a gas boiler. Sometimes space is needed for a buffer tank
- If you don't have a cupboard or space to build a cupboard (typically if you currently have a combi-gas boiler) then you will need to find space for them (sometimes they can go in the roof or an outbuilding – but these aren't ideal locations)
- You will then need to think about where any new pipework might go from the outdoor unit to the existing central heating pipes, and to the cylinder
- Your existing gas boiler will be removed (replace gas hob)

How boiler heat output varies with outside temperature

- As the outside temperature gets colder your home linearly needs more heating
- Most heat pumps are ‘inverter driven’ so can vary the heat they generate dynamically rather than turning on and off. However they can’t typically ‘modulate down’ below 20% of their max. output, below this output in milder weather they will need to intermittently turn on and off
- Oversized heat pumps will have to turn and off more regularly in milder weather, which is generally inefficient



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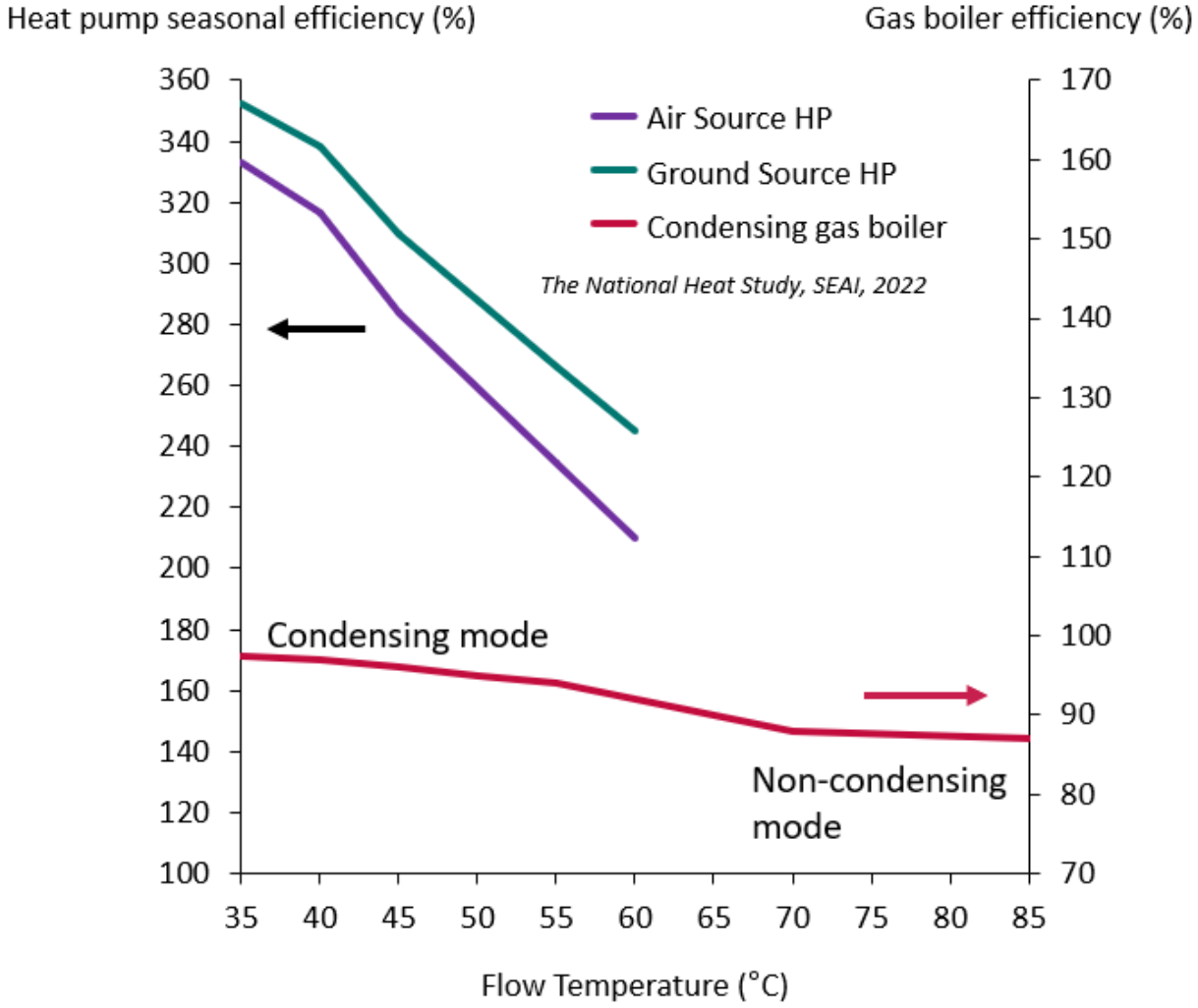
Why is ‘flow temperature’ important?

- The lower the flow temperature the more efficient the heat pump
- A heat pump running at 55C might be 240% efficient, but at 35C might be 330%
- Reduces electricity consumed for same heat, reducing CO2, and annual running costs e.g. from £1,500 at 55C to £1,000 at 35C
- Lower flow temperatures require larger radiators or underfloor heating



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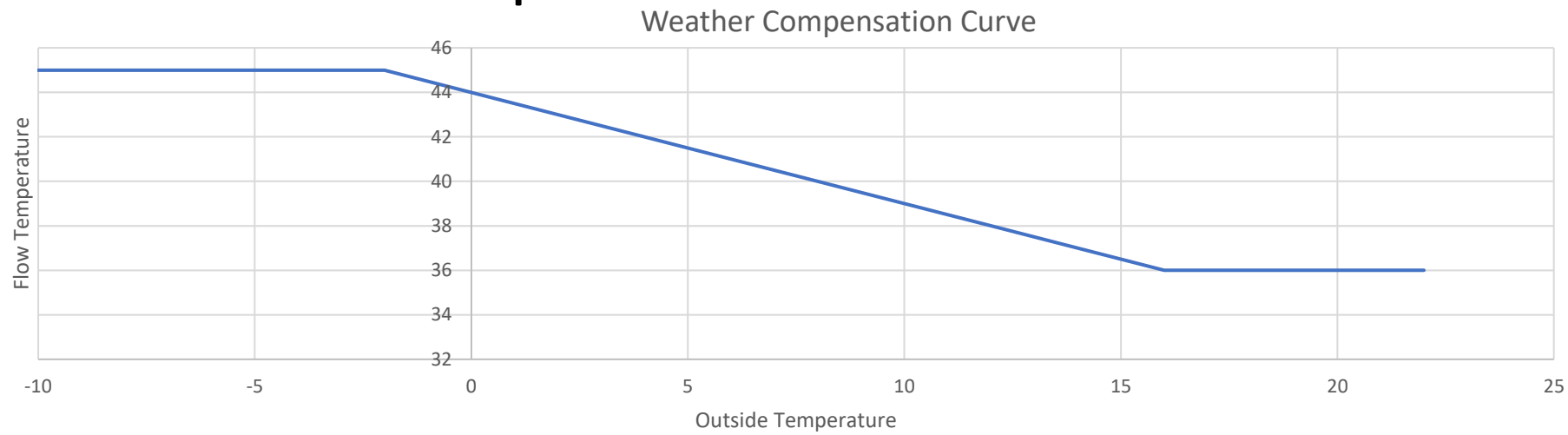
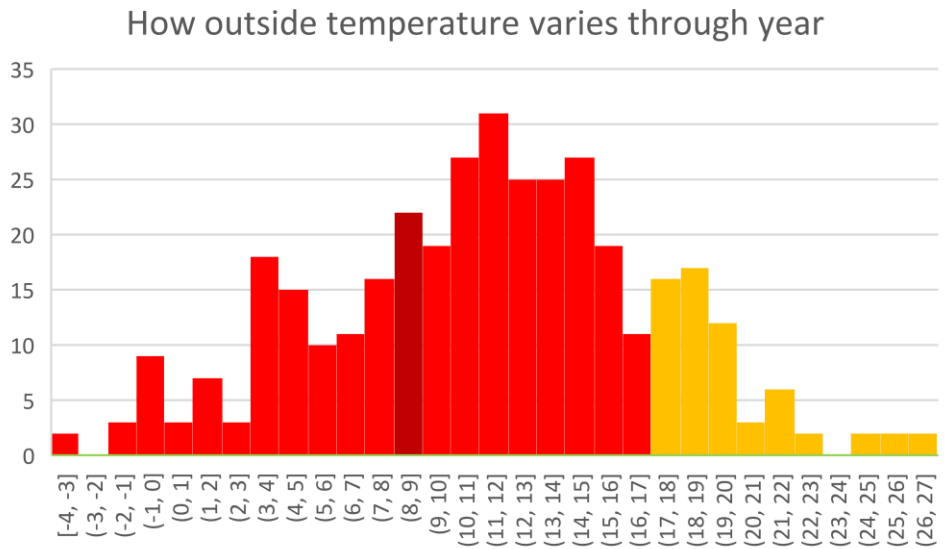
Weather compensation?



- Your installer will configure a ‘weather compensation’ curve for your heat pump
- This tells the heat pump what flow temperature to use for a given outside temperature
- Your flow temperature will increase automatically as it gets colder, the higher the temperature, the warmer the radiators, the more heat they put into the room
- Limited by the design flow temperature 45C in this example

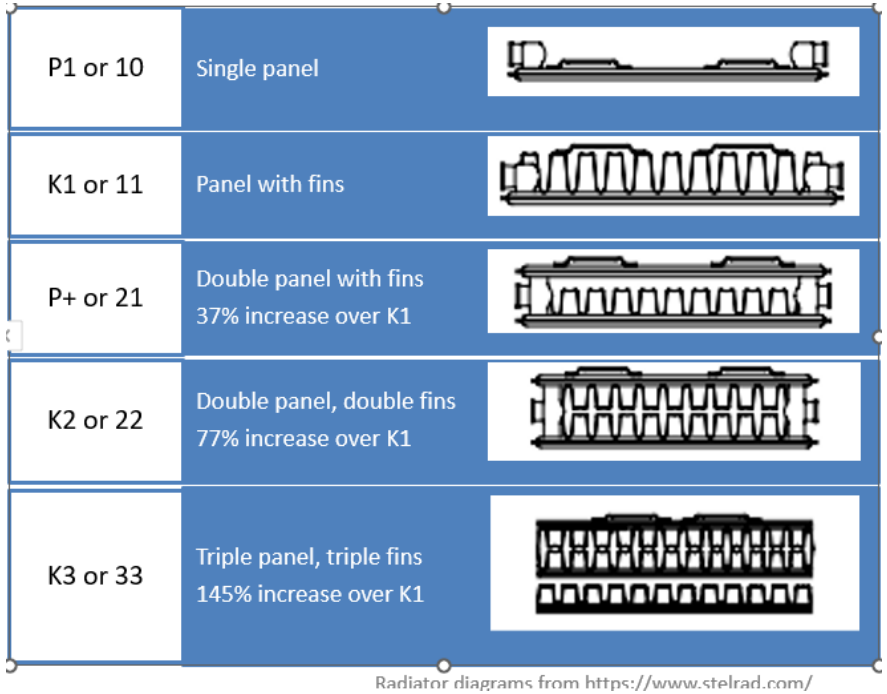
The difference between SCOP and COP

- The coefficient of performance (COP) is a measure of the efficiency at a single outside temperature and flow temperature e.g. a COP (7C/35C) is the efficiency of a heat pump at 7C outside temperature and 35C flow temperature
- The Seasonal Coefficient of Performance (SCOP) tries to represent the average efficiency over a range of outside temperatures for your region. Typical average Bath winter temperatures at 8C



Larger radiators, greater efficiency, lower flow temperatures

- So its important to have a discussion with your installer about their proposed flow temperature and weigh off the additional costs and practicality of larger radiators versus running costs savings
- Octopus for example are offering free heat pump installation but at a flow temperature of 75C which might be 160% efficient versus 330% efficient if you pay for larger radiators, but may save you £750 per year in running costs, so £7,500 over 10 years



Radiator diagrams from https://www.stelrad.com/

- Larger radiators: might just mean thicker radiators
- Cast iron ‘heritage’, or designer radiators often have low output for their size
- In most homes not all radiators will need upgrading, typically 40% to 60% as were probably originally sized before double glazing, thicker loft insulation and cavity wall insulation
- To save costs ask your installer to move existing larger radiators upstairs when they are being replaced

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Underfloor heating (UHF)

- Underfloor heating can be the best way of providing heat from an air source heat pump as flow temperatures can be as low as 30C, and efficiencies/SCOP up to 500%
- However, if only downstairs then may have to run upstairs radiators at a higher temperature reducing the benefit
- Need to ensure the installer doesn’t just rely on UHF’s blender circuit to blend higher flow temperature down

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Cost of heat pump at different flow temperatures

Flow temperature C	35	45	55	65 (Octopus)
Radiator cost	£2,190	£1,130	£730	£0
Total installation cost (net of grant)	£7,200	£6,600	£6,700	£0
Annual running costs	£720	£880	£1,060	£1,220
Annualised running and install costs (20 years)	£1,085	£1,215	£1,395	£1,225

As a purchaser you need to make a decision about how efficient/large you want your radiators. However the lowest flow temperatures may be limited by existing pipework. You can save costs

Running Costs and CO2

- Heat pumps are 4 times more efficient, but electricity costs 4 times more than gas so costs are about the same. Can save on £100/year gas standing charge
- But CO2 85% less:

Type	Efficiency	Relative efficiency	Tariff pence/kwh	Cost per kWh heat	Annual Running Cost	Annual CO2 kg	Relative CO2
Gas boiler	80%	100%	£0.07	£0.09	£980	2375	100%
Octopus high temperature heat pump	180%	225%	£0.15	£0.08	£930	756	32%
Efficient heat pump, larger radiators	350%	438%	£0.30	£0.09	£960	389	16%
Efficient heat pump, time of use tariff	350%	438%	£0.21	£0.06	£670	389	16%

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Radiators

Key message:

increasing the size of your radiators will increase the efficiency of your heat pump, lower running costs, and reduce CO2 emissions even further

Heat loss survey

- Required before a heat pump is installed to determine radiators sizes and heat pump size (capacity)
- An installer will typically charge you for this up front (£250 to £400) before being able to provide an accurate quote. Can be difficult if you are trying to get multiple quotes
- Involves visiting your home, taking 200+ measurements – walls, windows, floor, loft, radiator sizes – minimum of 2 hours on site
- Primary objective is to ‘accurately’ size the radiator(s) in each room
- Transition Bath provides this, so you can go out to multiple installers to get an ‘accurate’ quote

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Hot water

- Heat pumps typically require a hot water cylinder; they can’t be used to directly provide hot water for a shower or bath like a combi gas boiler
- Generally a new cylinder is required as a larger coil is required in the cylinder to work with the lower flow temperatures
- If you take lots of Bath your cylinder may need to be larger than that of a gas boiler because of the lower temperature of the water (45C versus 70C)
- Discuss your hot water usage with your installer
- If you don’t have a Bath, then inline hot water heaters, or a Sunamp cylinder might be a better solution

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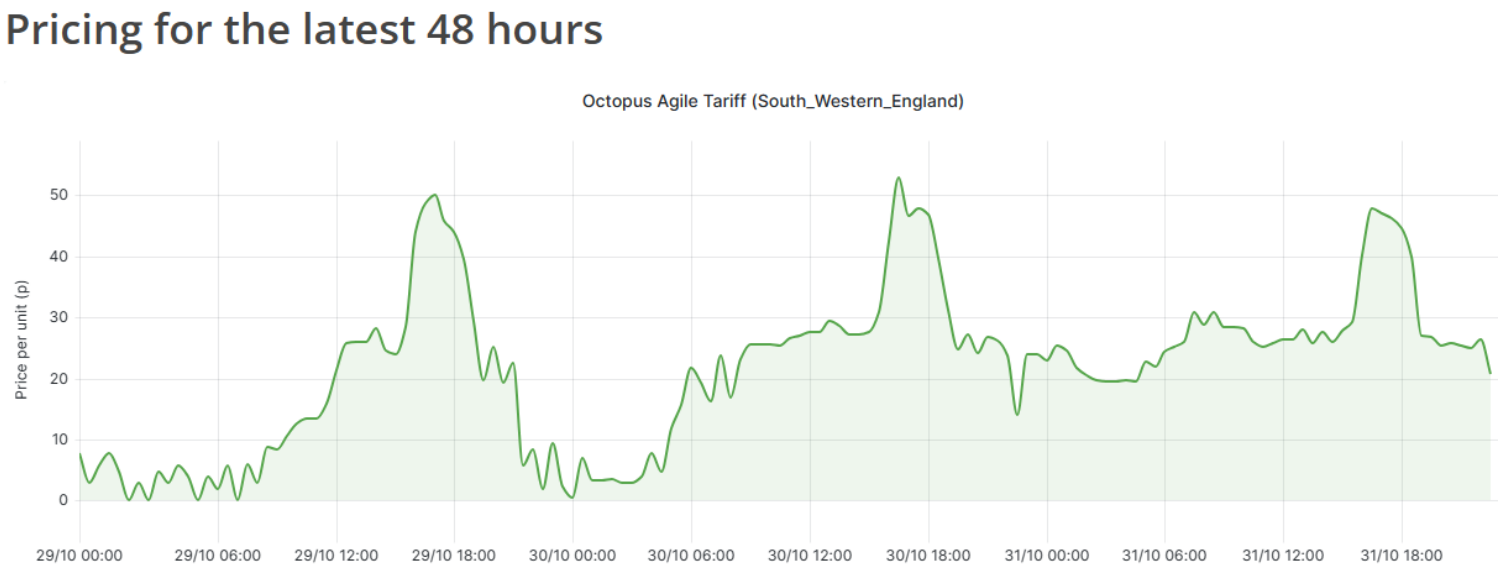
Other components/considerations

- Some homes will need ‘buffer tanks’ – for defrosting – has implications for drainage below the outdoor unit
- Some installers will specify anti-freeze valves rather than using anti-freeze (gycol) in heating circuit
- Zoning – generally not advised unless large > 200m2 home
- Tuning your weather compensation survey post install during winter
- Heat pumps are generally more efficient when gently heating the whole of your home all day, rather than the more intermittent use set by timers for gas boilers
- You should aim disconnect your gas meter if getting rid of gas altogether (generally a good idea, to save £100/year on standing charges)

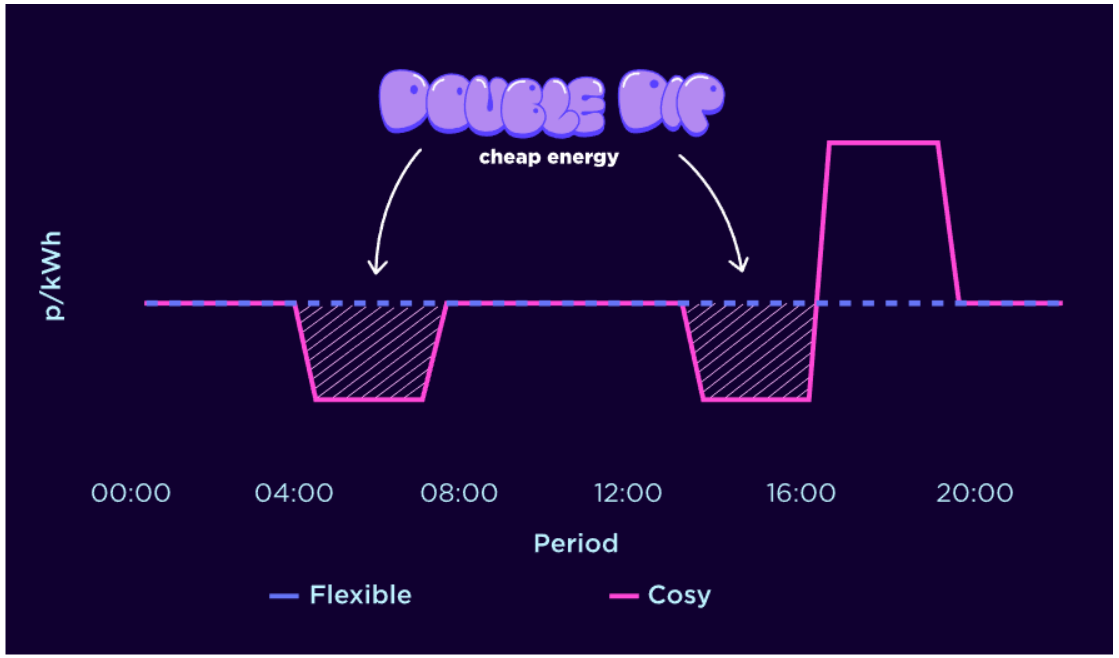
Time of Use Tariffs: potential 30% running cost saving

- Electricity tariffs that vary during the day, you need a smart meter, Economy 7 used to be an example of this
- Octopus 7 different tariffs, some heat pump or EV specific https://energy-stats.uk/octopus-agile-south-western-england/
- E.g. Agile:



Time of Use Tariffs

- Octopus Cozy (heat pump specific):



‘Green levies’ may move from electricity to gas reducing standard charges next year. Consider removing gas meter. But Octopus Time of use tariffs might not persist forever. You need a Smart Meter.

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Control of heat pumps

- Manufacturer controls often difficult to understand; often most unsatisfactory aspect of an installation
- Third party controls can ‘short cycle’ – turn heat pump on and off too often
- Internet based controls can be easier to understand
- Heat pump typically most efficient when heating whole home (operating at > 30% max capacity)
  - which implies leaving radiators on in under used rooms
  - Setting thermostatic radiator valves so that radiators are on most of the tome, relying on heat pump weather compensation to control temperatures
- Some controls e.g. Homely will optimise the heating of your home for time of use tariffs, but don’t work on all heat pumps
- More efficiency when running for longer periods than a gas boiler

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Alternatives to heat pumps

- Hydrogen boiler: most independent studies suggest unlikely to happen for technical reasons, solution propagated by liquid and gaseous fuel suppliers. 6 times higher CO2, renewable energy requirement
- Electric boiler: 3.5 times higher CO2 and costs
- Storage heaters: 3.5 times higher CO2 and 2 times costs
- Infrared: up to 3 times higher CO2 and costs

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What homes are suitable?

- Government analysis suggests almost all home are suitable, including historic homes, examples of historic homes with heat pumps appeared in this year's Green Open Homes B&NES.
- However
  - apartments and flats are more difficult because of difficulty locating the 'outside units'
  - detached historic homes because already large radiators will need to get even bigger
  - Homes with 'microbore' pipework may need their pipework replacing

- "All housing types are suitable for heat pumps" - according to a study of ~750 heat pump installations: https://es.catapult.org.uk/news/electrification-of-heat-trial-finds-heat-pumps-suitable-for-all-housing-types/
- Probably – according to a recent BEIS consultation:
  - https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid
  - **80% of off-gas grid homes** are suitable for heat pumps based on their current energy efficiency and electrical limits

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Do I need to insulate my home first?

- You need an EPC with no unimplemented recommendations for cavity wall insulation or loft insulation
- Its probably worth doing sensible low cost measures e.g. topping up loft insulation
- If additional insulation has been added since a gas boiler/radiators were installed then it might reduce the need to upgrade radiators
- However in general ‘no’

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Do I need to insulate?

- Need to weigh up cost benefit – how much capital do you have to invest?
- E.g. investing in 20% larger radiators might lead to 20% better efficiency, 20% lower running costs, 20% lower carbon emissions; might be cheaper than insulation to reduce the heat losses in your home
- For post 1930s homes, just ensure cavity wall insulation, topped up loft insulation, perhaps floor insulation – which most homes will already have
- Additional insulation can lead to smaller radiators or greater heat pump efficiency if it leads to lower flow temperatures
- Transition Bath will provide bespoke advice on this, and if you have an historic home may refer to BWCE's Historic Home Retrofit service

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Is insulation cost effective?

Measure	Cost	Annual saving	Percent CO2/cost/energy reduction	Cost per % reduction	Payback/years
Top up loft insulation from 100mm to 270mm (DIY)	£250	£42	6%	£40	6
Top up loft insulation from 100mm to 400mm (DIY)	£333	£56	8%	£40	6
Install air source heat pump	£5,500		80% (CO2/energy) 10%(cost)	£70	10
DIY add secondary glazing to sash windows	£2,000	£85	12%	£160	24
Install underfloor insulation	£4,000	£43	6%	£660	94
Vacuum glaze sash windows	£20,000	£125	18%	£1,120	160
Replace existing double glazing	£8,000	£37	5%	£1,500	215

Few measures are ‘cost effective’, you need to choose carefully whether motivated by cost or CO2? There is an ‘opportunity cost’ for your investment. We will be able to guide you through some of this as part of the advice service

Planning, noise, grant requirements

- In most circumstances no planning required (permitted development)
- 1m from property boundary, 1m from external edge of flat roof
- Listed building, road side of conservation area or World Heritage Site, closer to building than to highway
- May need planning application if don't conform to the above
- Noise assessment – carried out by Transition Bath or Installer – most large modern heat pumps are very quiet designed to avoid impact on neighbours; we have not seen a heat pump refused because of noise
- You are welcome to come and visit or can recommend other homes if you are concerned
- Need no unimplemented loft or cavity wall insulation EPC recommendations for government £7,500 grant

Costs (net of £7,500 government grant)

- Free from Octopus – but inefficient, costs twice as much to run as pump with larger radiators, but half price tariff
- Good Energy, recommended installers: £6,500 to £9,000 – Good Energy have a good cost estimator on their website

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Conclusions

- You need to decide on your budget – heat pump versus other measures
- Need to decide whether you plan on further insulating your home
- You need to decide on how much you want to invest in reducing your flow temperature and increasing your radiator sizes
- You need to decide where the ‘outdoor unit’ might go
- Indoors:
  - If you already have a cylinder it will need replacing but is it more efficient to run the outdoor unit pipework to the old boiler location or direct to the new cylinder
  - If you don’t have a cylinder, where do you have space for it, and can the pipes be run from the outdoor unit to the cylinder cupboard

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Solar PV and batteries

- We can provide advice on these
- If you have batteries installed at the same time as solar you save 20% VAT
- Solar doesn’t provide enough electricity in the winter to power a heat pump
- Batteries can be used to time shift consumption from cheap times (9p/kWh) to expensive times (30p/kWh) – reducing electricity costs by up to 70% but payback is long
- Need to make sure you have the right type of battery installed: LFP, and DC coupled versus AC coupled versus Hybrid inverter
- Batteries don’t save much CO2 because of round-trip losses (15%) and embodied CO2 in their manufacture

Next steps

- I will send you a copy of this presentation tomorrow
- With a link to a survey where you provide more detail about your home
- This will be used to assess the heat pumps feasibility and to provide a quote for a heat loss survey and report

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Next steps

- Heat loss survey:
  - Approx 2 hours onsite taking lots of measurements to determine radiator sizes and heat pump capacity
  - Can be used to provide quotes from installers

Home type	Full Cost	Subsidised cost with Retrofit West Voucher
1-2 bed modern	£250	£83
2-4 bed modern	£350	£117
1-2 bed historic	£350	£117
2-4 bed historic	£450	£200

- Contact heatpumps@transitionbath.org

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Background information

- https://www.greenheatcoop.co.uk/resources
- https://www.cse.org.uk/advice/heat-pumps/
- https://greenopenhomesbanes.org/

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Q & A