Heat emitters for Heat Pump systems

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The Institute

- Founded in 1964
- Systems incorporating circulating pumps needed for small-bore pipework
- Need careful design
- Entry into membership via one-year design course
- Higher grades of membership for consulting engineer members

The Institute

- Membership by qualification
- Membership by experience
- Members chair various industry groups
  - Heating Strategy Group of the Energy Efficiency Partnership for Homes
  - CIBSE Domestic Building Services Panel
  - HHIC Training Group
- Members serve on various committees
  - Most industry related BSI groups include, and some chaired by, IDHEE members

The Institute

- Major contributor to the CIBSE Domestic Guides
  - Domestic Heating Design Guide
  - Underfloor Heating Design & Installation Guide
  - Solar Heating Design & Installation Guide
- Originator of Energy Efficiency for Domestic Heating course and assessment
- Provider of courses
  - Domestic heating design
  - Solar heating design
  - Ground Source Heatpumps system design (work in progress)

Radiators with GSHPs

- Radiator outputs influenced by temperature of circulating heating medium (water)…
- …and the design air temperature of the space being heated
- The greater the temperature difference between the water and the air, the greater the output per m^2 of radiator surface
- Radiators with lower circulating temperatures require greater surface area, i.e. bigger

Radiators with GSHPs

- Radiators installed with older non-condensing boilers were probably oversized in the first place and may well provide the required output with a condensing boiler (not guaranteed)
  - 82°C / 70°C flow / return (non-condensing)
  - 70°C / 50°C flow / return (condensing)
- Radiators installed with GSHPs will need larger radiators (more surface area)
  - 50°C / 42°C flow / return (typical)

Radiators with GSHPs

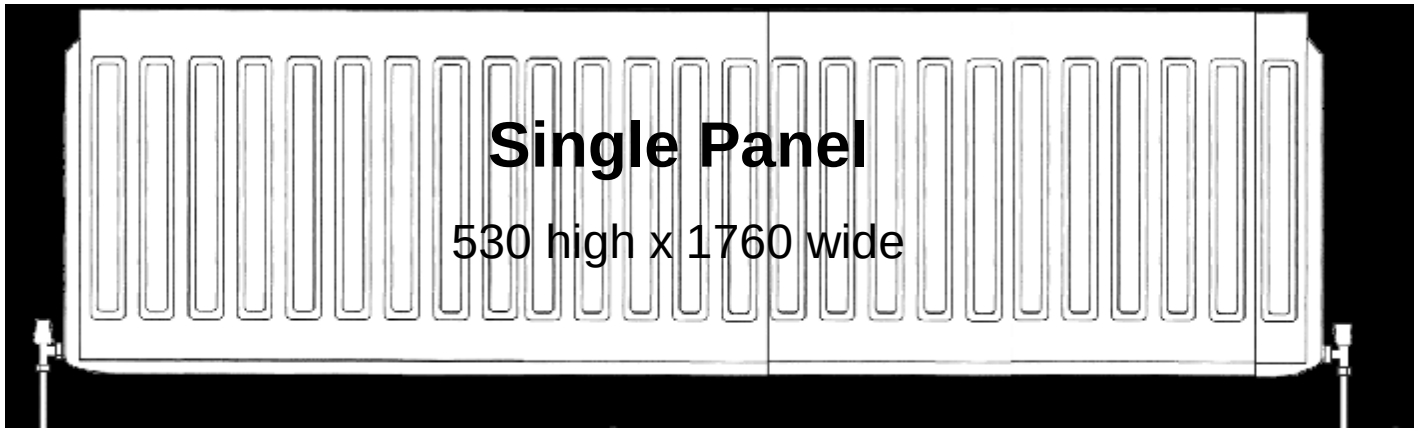
- So, how much larger?
- To demonstrate the difference we will use a design room temperature of 21°C
- The mean water to air temperature differences for the three system types under discussion are
  - 55 degC for older non-condensing boiler systems
  - 39 degC for modern condensing boiler systems
  - 25 degC for ground source heatpump systems

Radiators with GSHPs

- So, how much larger?
- Radiator outputs are quoted at a mean water to air difference of 50 degC
- If the difference is 55 then the radiator will emit 12.6% more heat than the catalogue states
- If the difference is 39 then the radiator will emit 26.5% LESS heat than the catalogue states
- If the difference is 25 then the radiator will emit 57.7% LESS heat than the catalogue states

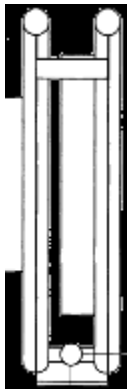
Radiators with GSHPs

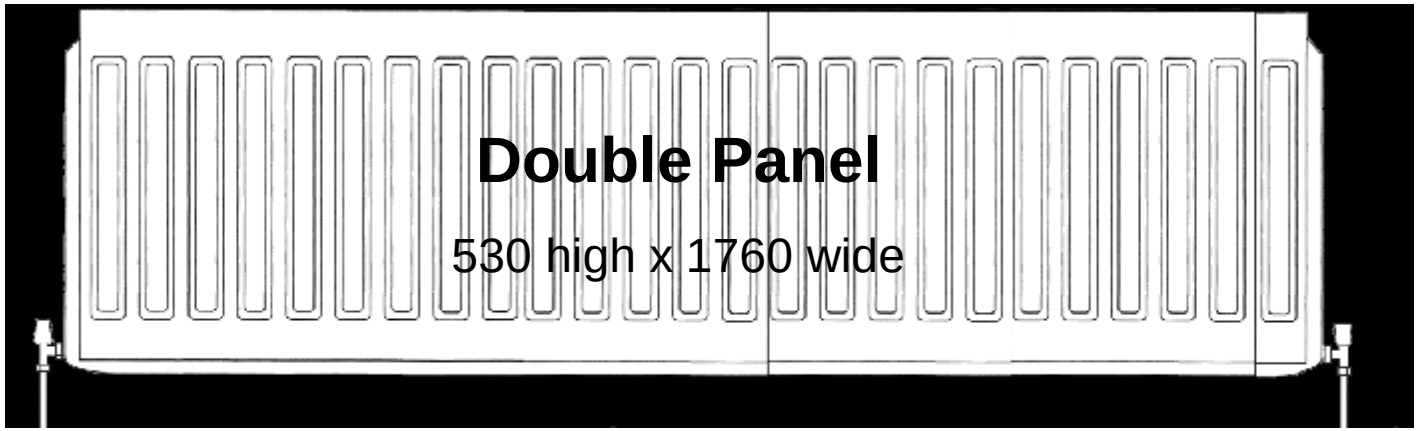
- So, how much larger?
- For a design heat load of 1500 Watts
- With a non-condensing boiler select a radiator from catalogue for 1332 Watts



Radiators with GSHPs

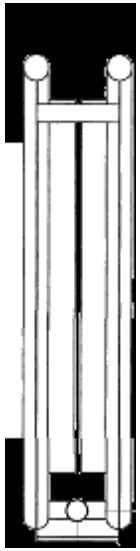
- So, how much larger?
- For a design heat load of 1500 Watts
- With a condensing boiler select a radiator from catalogue for 2041 Watts

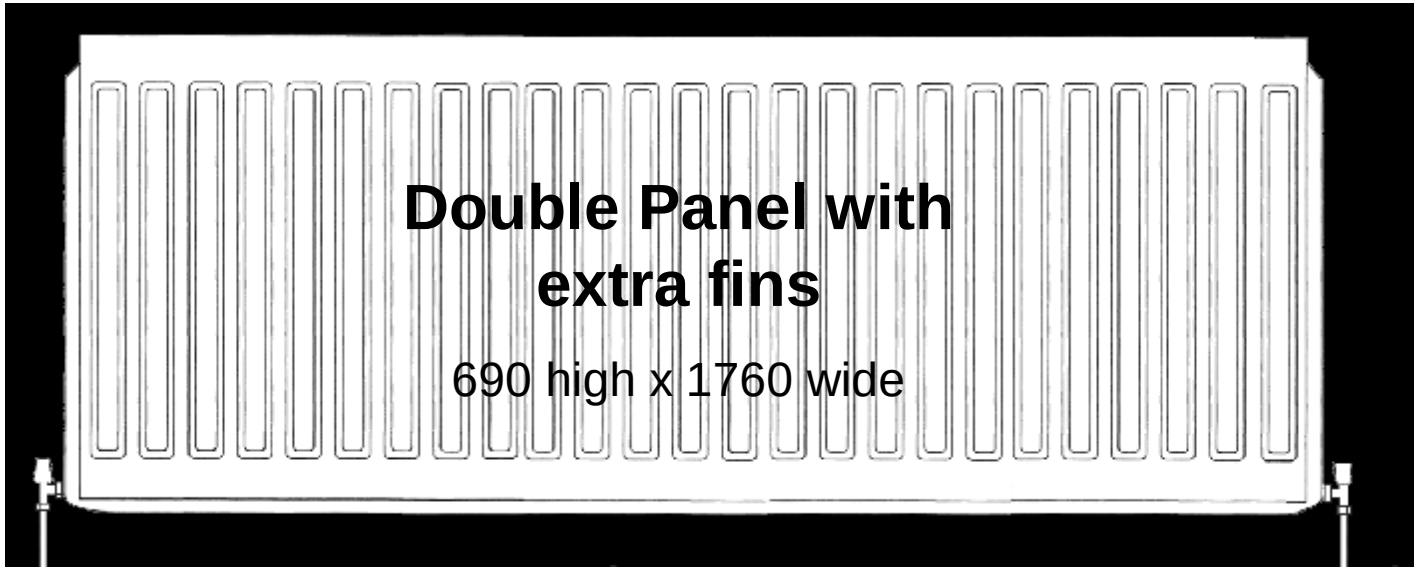




Radiators with GSHPs

- So, how much larger?
- For a design heat load of 1500 Watts
- With a heatpump select a radiator from catalogue for 3546 Watts





Radiators with GSHPs

- Is there a solution?
- Underfloor heating to the rescue!
- If the underfloor heating is designed to provide comfort at design conditions with a flow temperature to the coils of 35°C, the resulting MWT of 31°C will produce between approximately 27 W/m² (deep pile carpet or floorboards) to 49 W/m² (ceramic tiles) from pipes at 200mm centres in a 75mm screed
- A table of typical outputs per m² of heated floor follows

Radiators with GSHPs

- Is there a solution? - Underfloor heating to the rescue!

MWT = 31°C :: (Flow = 35°C) :: Room temp. = 20°C							
Ceramic tiles		Parquet blocks		Carpet		Deep pile carpet	
Underfloor pipe centres :: W/m² output							
100	200	100	200	100	200	100	200
66	**49**	**49**	**38**	**38**	**31**	**32**	**27**

Radiators with GSHPs

- Is there a solution? - Underfloor heating to the rescue!

MWT = 46°C :: (Flow = 50°C) :: Room temp. = 20°C							
Ceramic tiles		Parquet blocks		Carpet		Deep pile carpet	
Underfloor pipe centres :: W/m² output							
100	200	100	200	100	200	100	200
160	**119**	**119**	**93**	**94**	**76**	**79**	**66**

Source: Underfloor Heating Design & Installation Guide

Radiators with GSHPs

- What does all mean for systems that mix radiators with underfloor heating?
- The heatpump must operate to deliver water to the system at not less than 50°C
  (to satify the radiators' requirements)
- This means a typical CoP will be 2.8

- What does this mean for systems with only underfloor heating, on each floor?
- The heatpump can operate to deliver water to the system at 35°C
- This means a typical CoP will be 4.0

Radiators with GSHPs

- Are heatpumps with radiators viable?
- Take a heating system with a design load of 11 kW
- The cost of gas is around 3p per kWh (average)
  - Typical heating season fuel cost £385.00
- The cost of electricity is around 10.8p per kWh (average)
  - Typical heating season fuel cost £445.00 (H/P CoP 2.8)

Underfloor Htg with GSHPs

- Are heatpumps with underfloor heating throughout viable?
- Take a heating system with a design load of 11 kW
- The cost of gas is around 3p per kWh (average)
  - Typical heating season fuel cost £385.00
- The cost of electricity is around 10.8p per kWh (average)
  - Typical heating season fuel cost £312.00 (H/P CoP 4.0)

In conclusion….

- Beneficial to design GSHPs into new build
  - all space heating requirements can be satisfied using underfloor heating
  - CoP of heatpump means cost per kWh of delivered heat is less than natural gas at current prices
  - but consider payback period to cover the difference in cost of gas boiler installation or GSHP installation
- If any radiators used for heat emission
  - lower CoP raises cost per kWh of delivered heat above that of natural gas
  - Cannot raise stored domestic hot water to a safe temperature

In conclusion….

- If any radiators used for heat emission
  - lower CoP raises cost per kWh of delivered heat above that of natural gas
  - but if not on mains gas, GSHPs show significant running cost savings over both oil-fired or LPG-fired boiler/radiator systems
  - still cannot raise stored domestic hot water to a safe temperature

In conclusion….

- Adding GSHPs into existing heating systems
  - not before improving insulation levels in every way possible
  - even with improved insulation (if possible) radiators may not be large enough for lower water temperatures
- If any radiators used for heat emission
  - lower CoP raises cost per kWh of delivered heat above that of natural gas
    - but still lower cost than oil or LPG
  - Cannot raise stored domestic hot water to a safe temperature

….and finally, based on running costs

	GSHP 35°C	GSHP 50°C	Nat. Gas Boiler	Oil Boiler	LPG Boiler
Underfloor Heating throughout	ü	û	û	û	û
Part Underfloor Heating, part Radiators	û	?	ü	û	û
Radiators throughout	û	?	ü	ü	ü
DHW (No supplementary)	û	û	ü	ü	ü

? Depends on available radiator surface area

Thank you for your attention

CIBSE Domestic Design Guides are available from the IDHEE online shop

Domestic Heating

Underfloor Heating

Solar Heating

www.idhee.org.uk

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