Designing with large delta T heat pumps

SAV

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Heat Networks start with energy efficient buildings

Reducing return temperature results in:

- Lower network pumping costs
- Lower distribution heat losses
- Higher energy centre heat generation outputs
- Maximise stored energy capacity

Climate Change Committee – 20% of population connected to a HN by 2050

Anchor loads – large commercial buildings are vital

Make buildings “Heat Network Ready”

DHW Strategy
Stored or Instantaneous?

- Stored DHW: Large water volume
  Legionella risk
  Recirculation losses
  High temperatures, low SCOP
  Avoid coil calorifiers

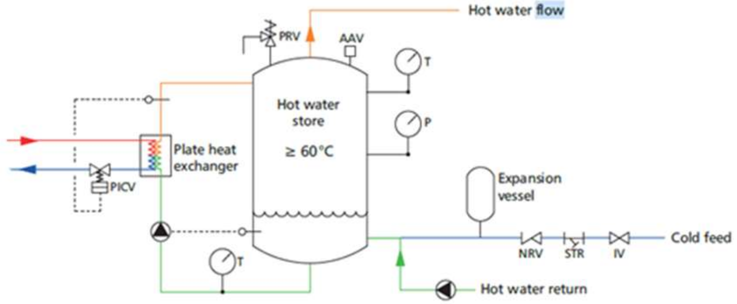

Figure 26 Plate heat calorifier

CIBSE Design Guide

- Instantaneous: Point of use PHE / HIU
  On-demand DHW, no recirc.
  Low return temperature
  Lower ASHP flow temperature
  Higher SCOP

Maximise
Thermal
Storage

160 m³ Thermal Store @ Woking

8 m³ Thermal Store @ 60/30
Capacity = 280 kWh

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Capacity 5,568 kWh

70 30

Capacity 7,424 kWh

33% Increase

Calculate
Thermal Storage

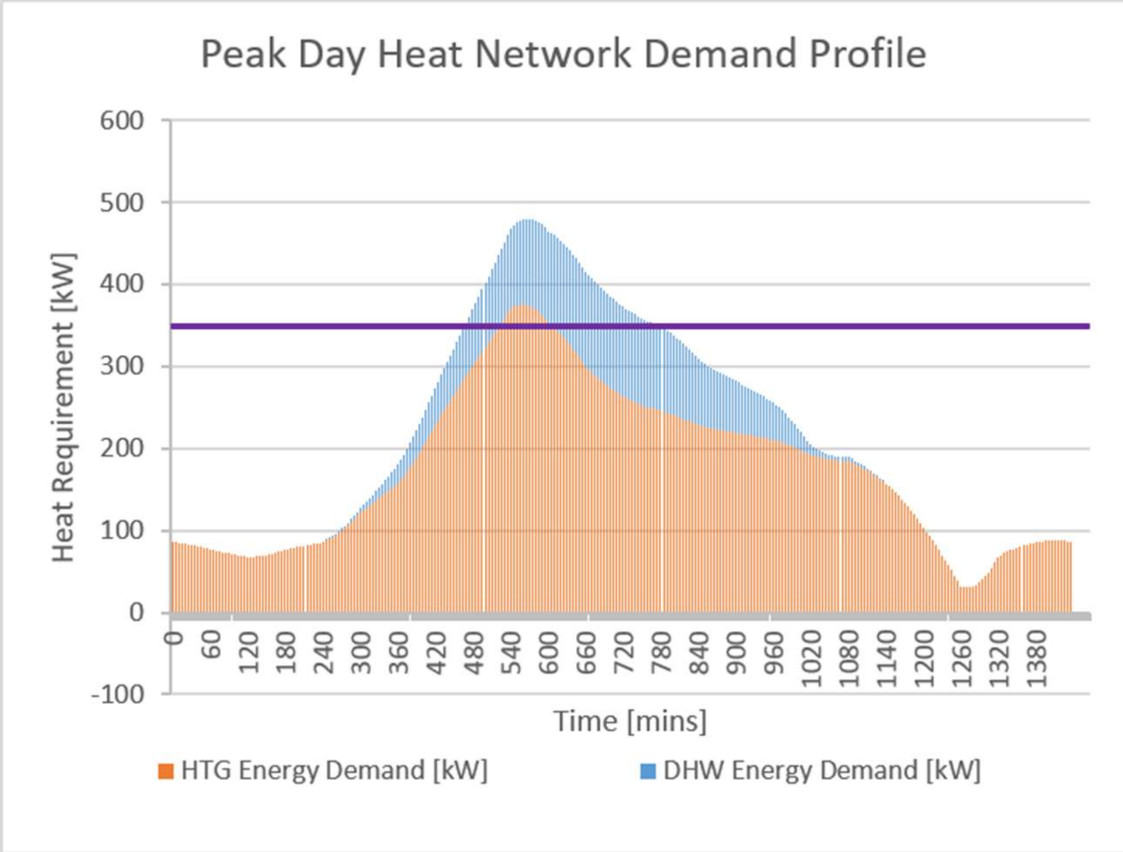
Go beyond HP manufacturers “minimum”

Use thermal store to “shave” peak

Peak = Installed plant PLUS store discharge

Store recharges when network load is low

28% less plant, space, CAPEX, Noise, FLC..



In the example above, peak is shaved by 28%

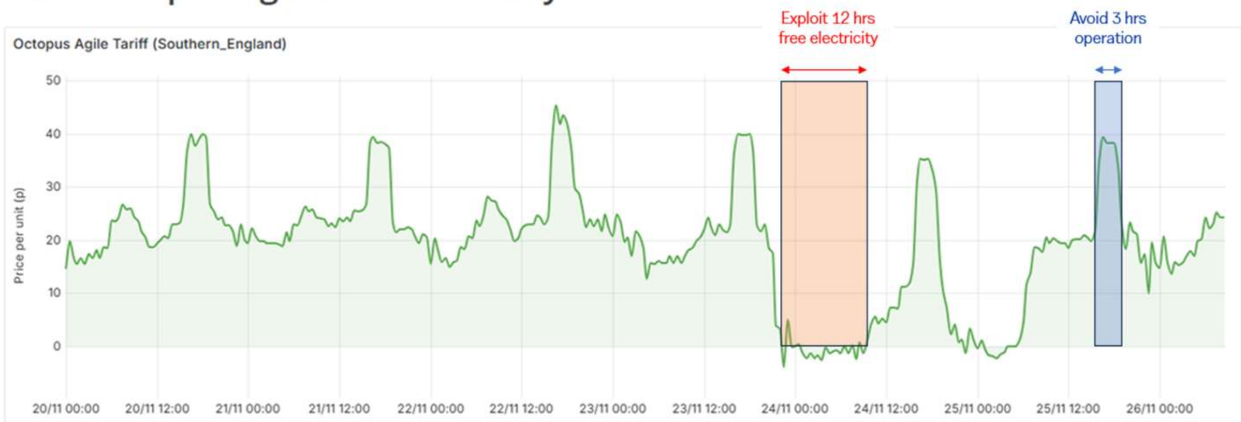
- 490kW network peak
- 349kW ASHP
- 8000L thermal storage

Variable Tariffs

- High carbon electricity is expensive
- Shift loads to avoid peaks
- On-site PV is free
- Convert surplus electricity into heat
- Store molecules, not electrons!

Average unit price for each 30 minute slot for the last 365 days

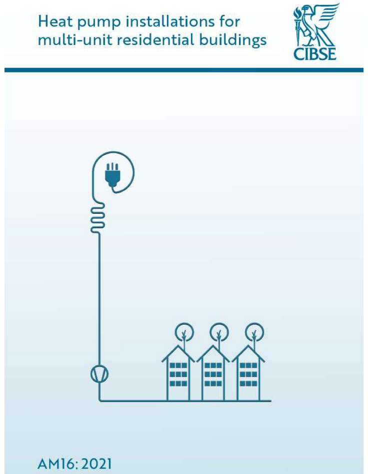
Half hour pricing for the last 7 days



Hybrid/Bivalent systems

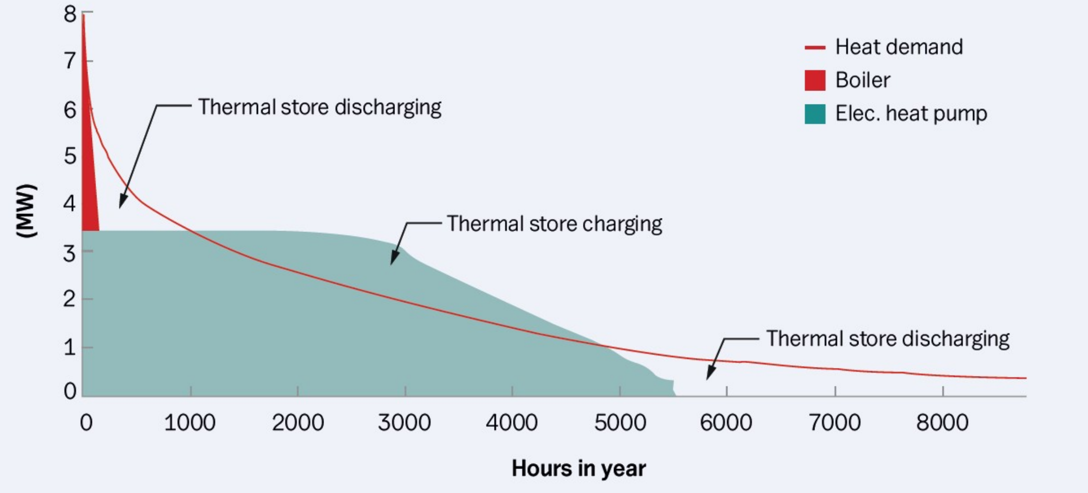
Hybrid plantrooms allows for the most efficient heat pump utilisation without oversizing

Multi-stage modulating boilers for top-up, system resilience and grid balancing



Hybrid Energy

A hybrid solution optimises heat pump operation and reduces the capital cost of the energy centre equipment. It minimises the space requirement for heat pumps and provides higher security and resilience of the design.



Example of an annual load duration curve for a heat pump plant

First Generation
Heat Pumps

- Designed around chiller circuit
- Small delta T (typ. 5° K)
- Constant flow rate
- Primary pump “by others”
- Synthetic refrigerants
- Flow temperature limitation
- Single stage of heat exchange
- Poor COP in heating systems

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55 50

Second Generation Heat Pumps

- Designed as **heat pump**
- **High** delta T (30°K like heat network)
- **Variable** flow rate
- Primary pump **internal**
- **Natural** refrigerants
- Flow temperature up to 70°C
- **Multiple** stages of heat exchange
- **High** COP for heating system

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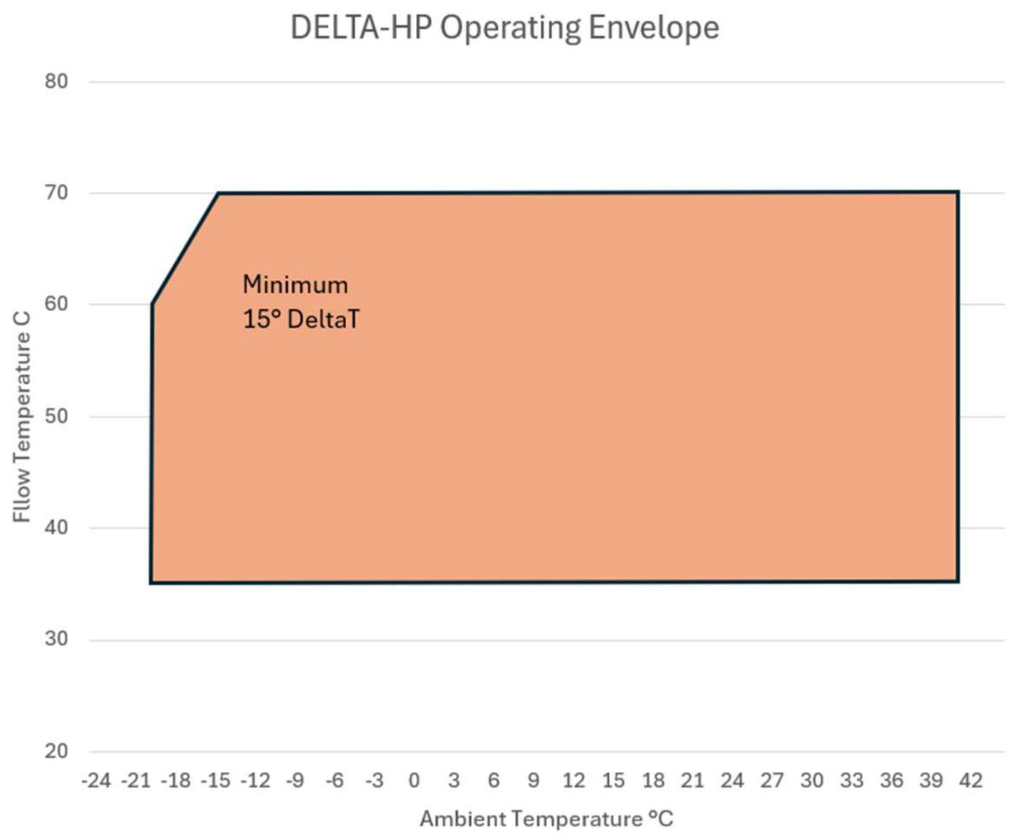
Natural refrigerant R290 (propane)

Outstanding performance with ultra-low environmental impact (GWP 0.02).

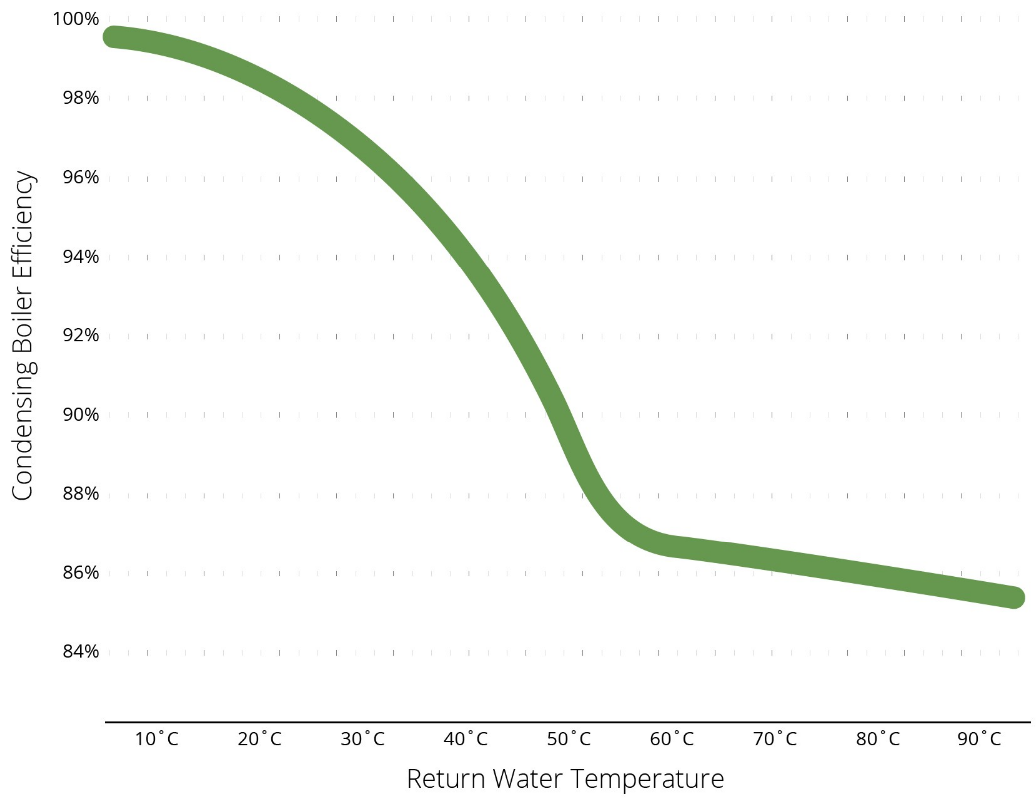
DELTA heat pumps

- Operating envelope = Capability

- 70°C flow at -15°C ambient
- 60°C flow at -20°C ambient
- Aim for largest possible DeltaT



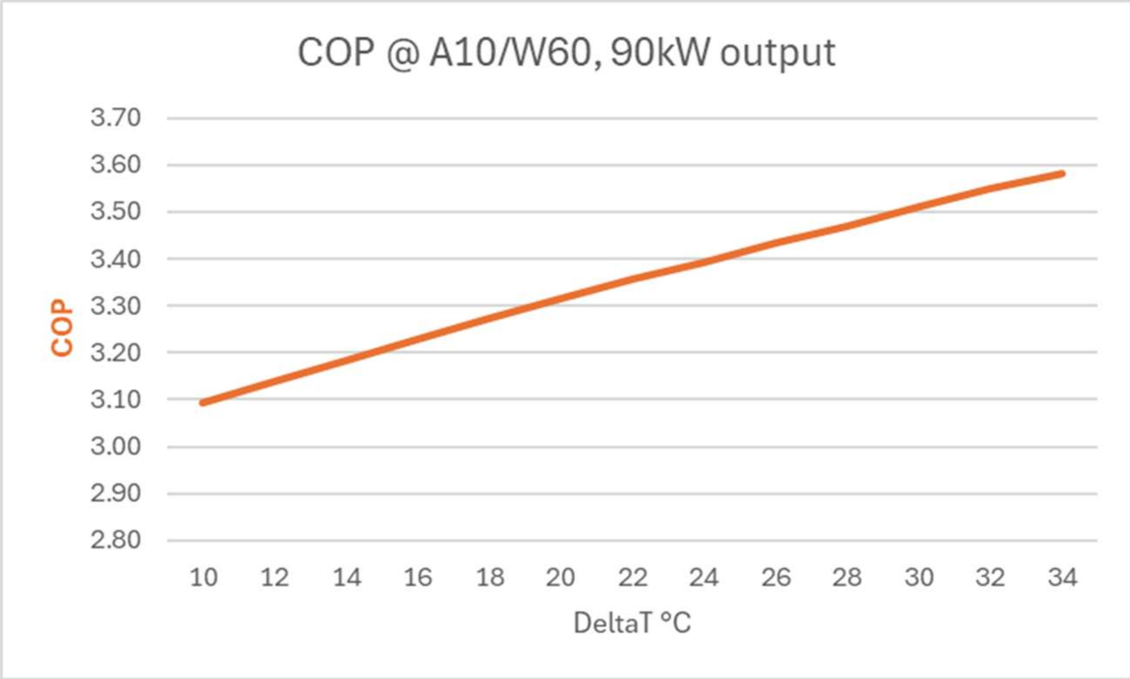
How do we increase the efficiency of a condensing boiler?



DELTA R290
Large DeltaT

Exploit the DeltaT

Larger DeltaT = higher efficiency



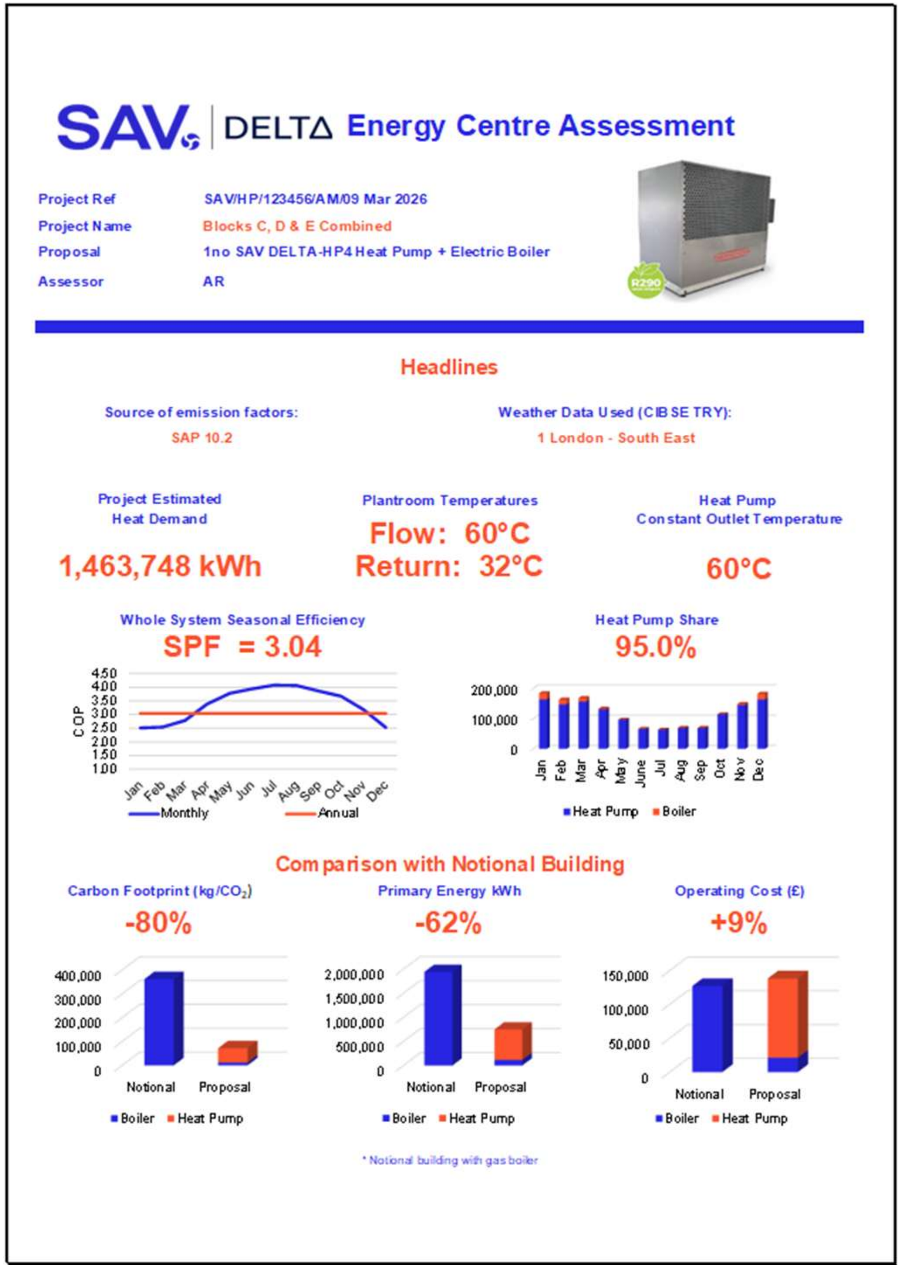
Hybrid Plant Assessment

Bivalent - Heat pump + E-Boiler

- 62% lower CAPEX
- 66% less space

- SPF 3.04 including boiler

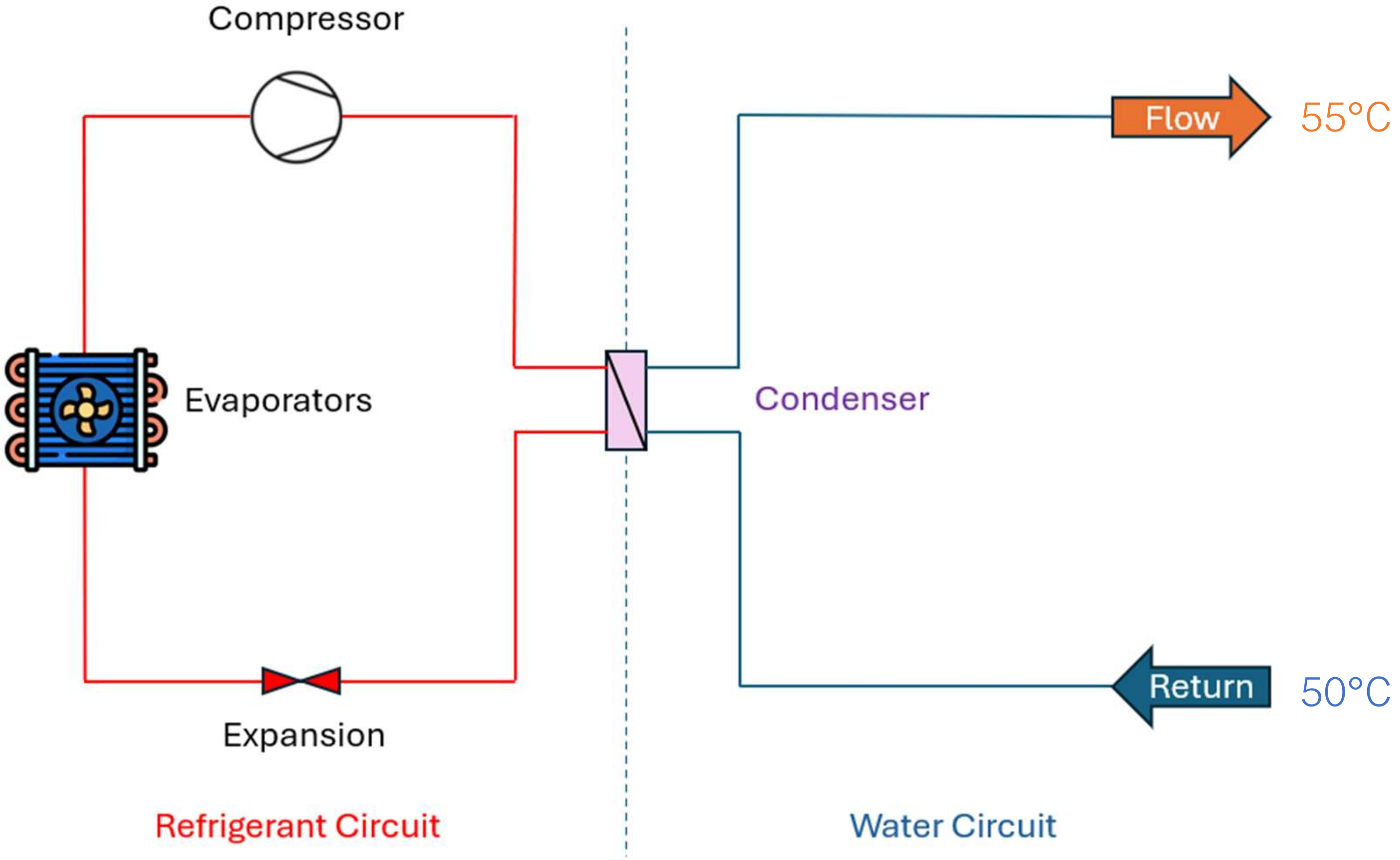
(Typical 5° DeltaT synthetic would be 2.4)



1st Generation Heat Pump – Small DeltaT

- 5°C DeltaT
- Very high flowrate
- Constant Flow
- 1 heat exchanger
- Legacy design

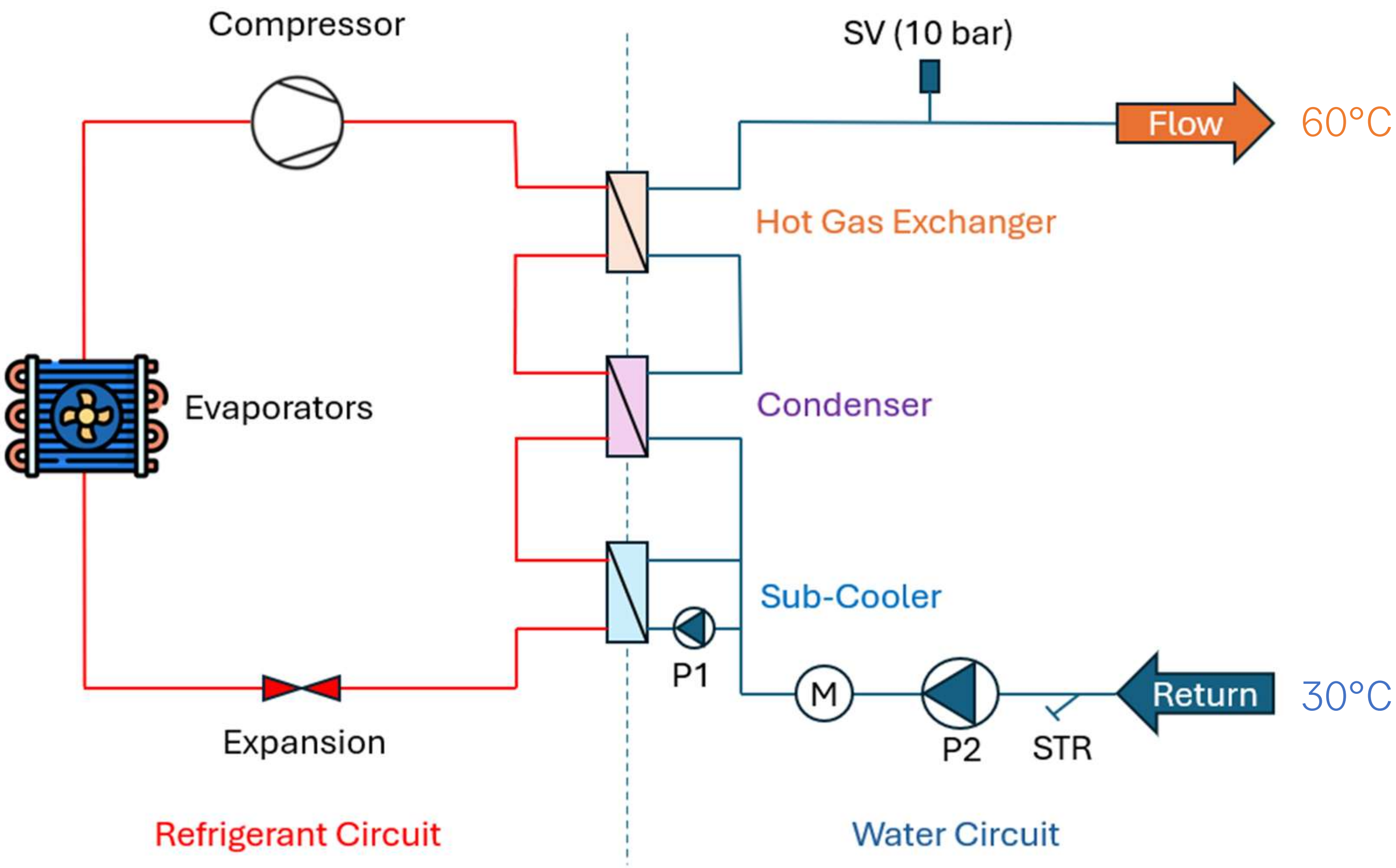
- COP 2.7 @ W55/A10



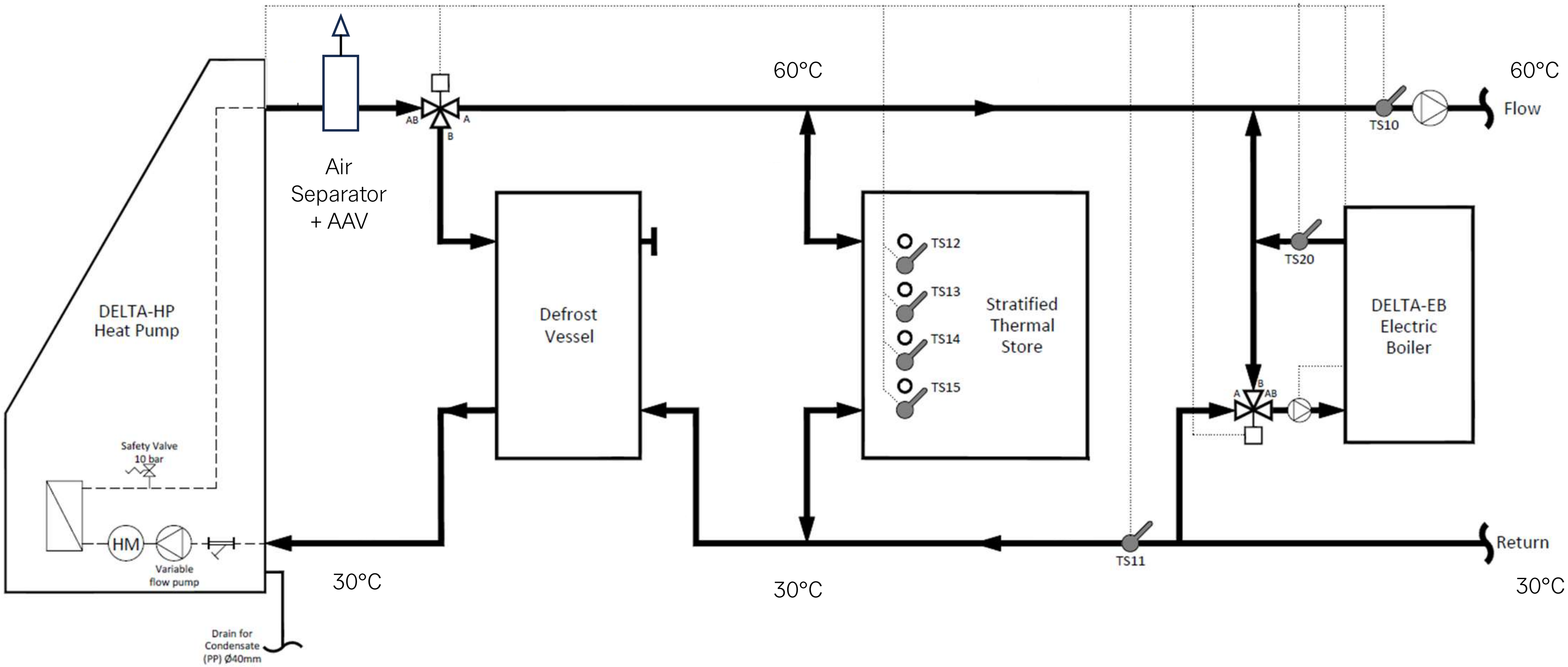
2nd Generation Heat Pump – DELTA-HP1

- 30°C DeltaT
- Variable (low) flowrate
- 3 heat exchangers
- 83% less flowrate
- 18% less electricity

- COP 3.3 @ W60/A10



DELTA schematic

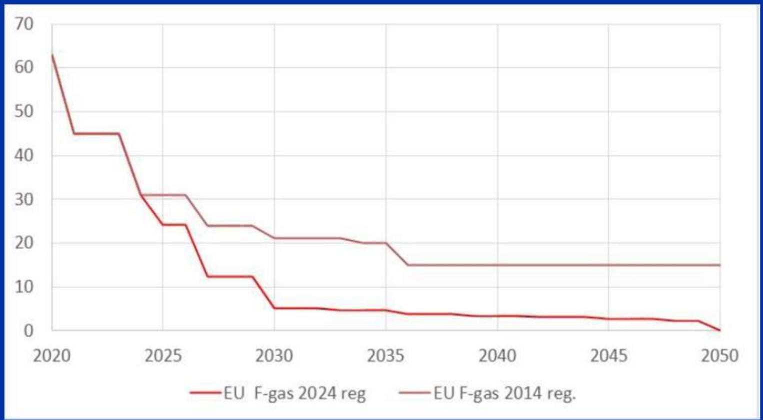


Modular approach – easy to install

10no = 330 kW, 440A

1no = 351 kW, 232A

F Gas Regulations Phasedown



ATMO sphere

Impact of Refrigerants Fact Sheet #2 (V.1.)

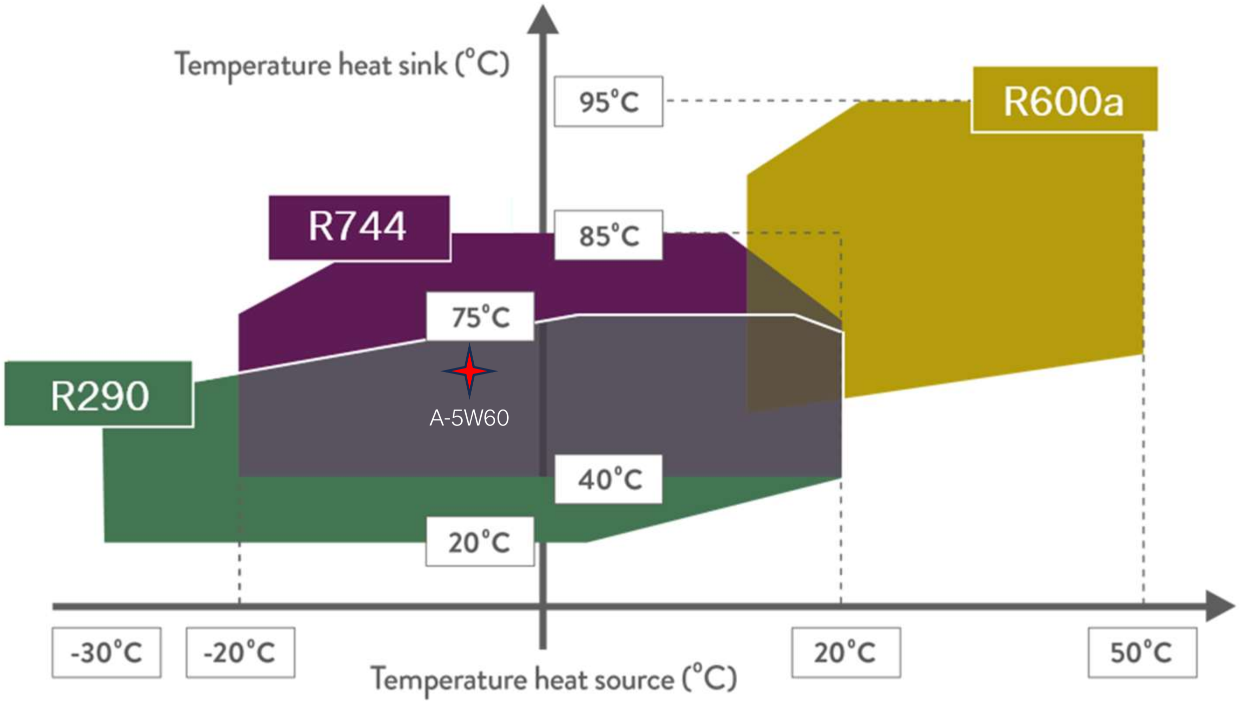
Refrigerants: Real GWP and PFAS

			IPCC AR4 (2007)		IPCC AR6 (2021)		PFAS
Refrigerants / Brand Name	Type	Composition	GWP 100 years	Real GWP 20 years	GWP 100 years	Real GWP 20 years	Yes/No
R32	HFC	100% R32	650	2330	771	2690	No
R452B Opteon XL55	HFC/ HFO	67% R32 / 7% R125 / 26% R1234yf	681	2006	779	2275	Yes
R454B Opteon XL41	HFC/ HFO	68.9% R32 / 31.1% R1234yf	448	1606	531	1854	Yes
R513A Opteon XP10	HFC/ HFO	44% R134a / 56% R1234yf	629	1686	673	1823	Yes
R744	Natural	CO_2	1	1	1	1	No
R290	Natural	Propane	<1	<1	<1	<1	No

IPCC AR6 GWP over 20 years are the greatest immediate concern for global warming – all synthetic refrigerants score really badly on this timeframe

- ASHP Refrigerant GWP <150 by 2030
- F-Gas phase out by 2050

Natural Refrigerant Choices



R744 - CO2

- High flow temperature for potable DHW
- Very sensitive to return temperature
- High pressures = cost & complexity

R600a - Isobutane

- High flow temp & high source temp.
- Second stage of cascade – W2W
- Domestic refrigeration
- Flammability class A3

R290 - Propane

- ASHP heating in colder climates
- Compatible with flow/return temps.
- Flammability class A3

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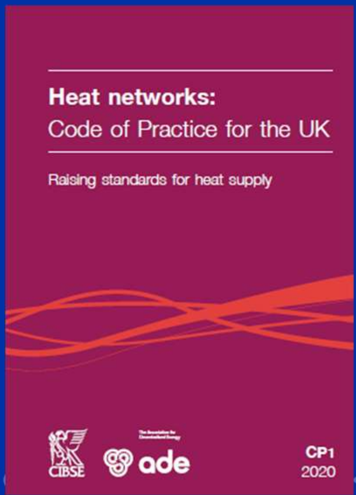
Designing with Large Delta T heat pumps



60 30

Thank you