How Passivhaus and heat network design principles can be employed in schools to achieve 65 kWh/m2/year.

Adrian Rogers - Product Manager - Central Plant SAV Systems

Sponsored by

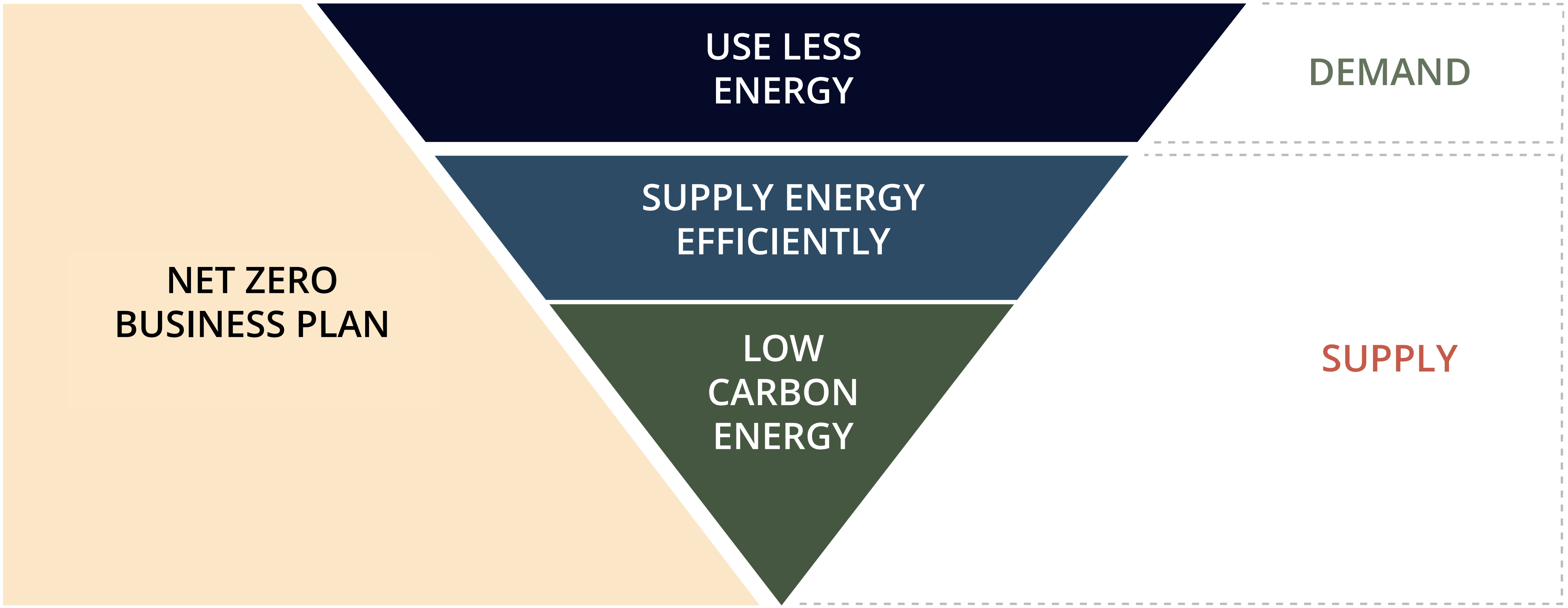
Weathering Net Zero

Lean System Design (LSD) for Schools

Achieving Net Zero is Like Running a Farm

Achieving Net Zero is a Business Challenge

Net Zero Business Plan



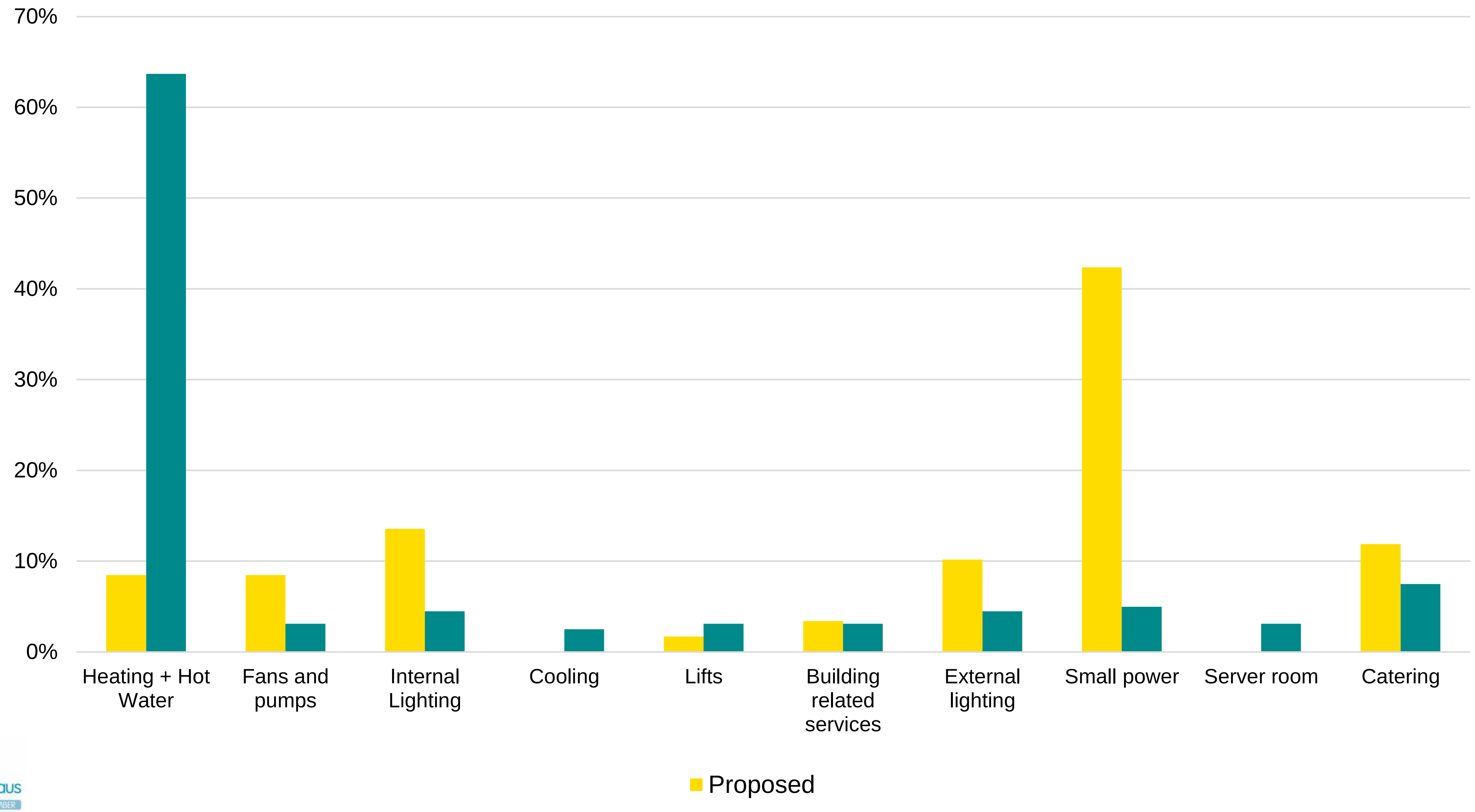
Step One:
Use Less Energy

DfE Targets

Department for Education (DfE)

UK Schools Annual Energy Intensity Target (Technical Annex 2H)	
Primary	52 kWh/m^2
Secondary	67 kWh/m^2

School Energy Consumption

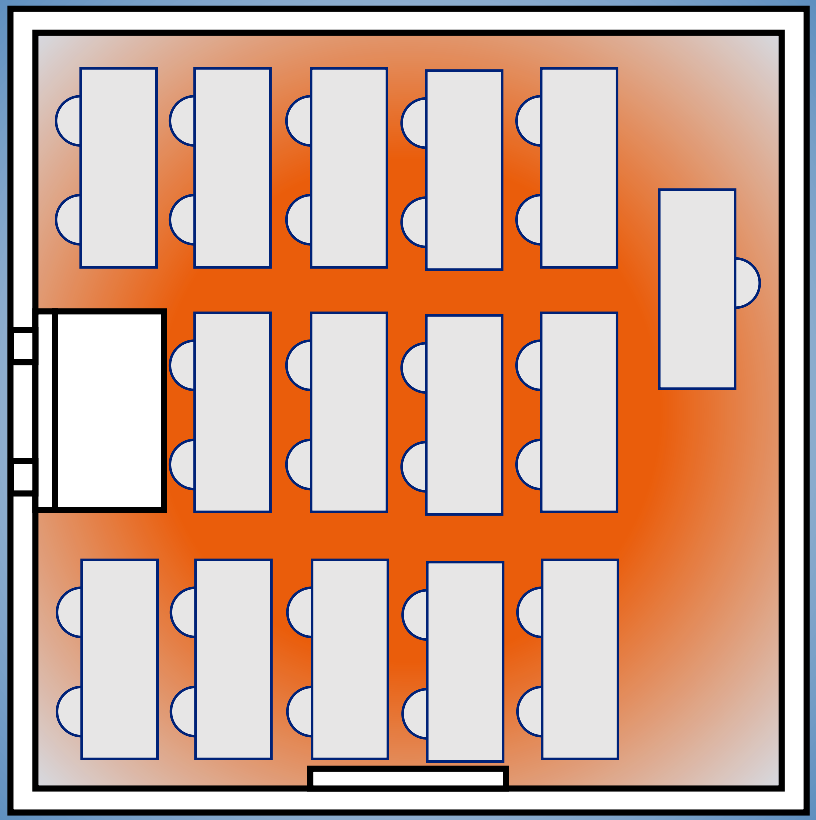


Source for Existing: Building Energy Efficiency Survey: Education sector, 2014–15

Source for Proposed: Department for Education, School Output Specification Technical annex 2H: Energy

Passivhaus Principles

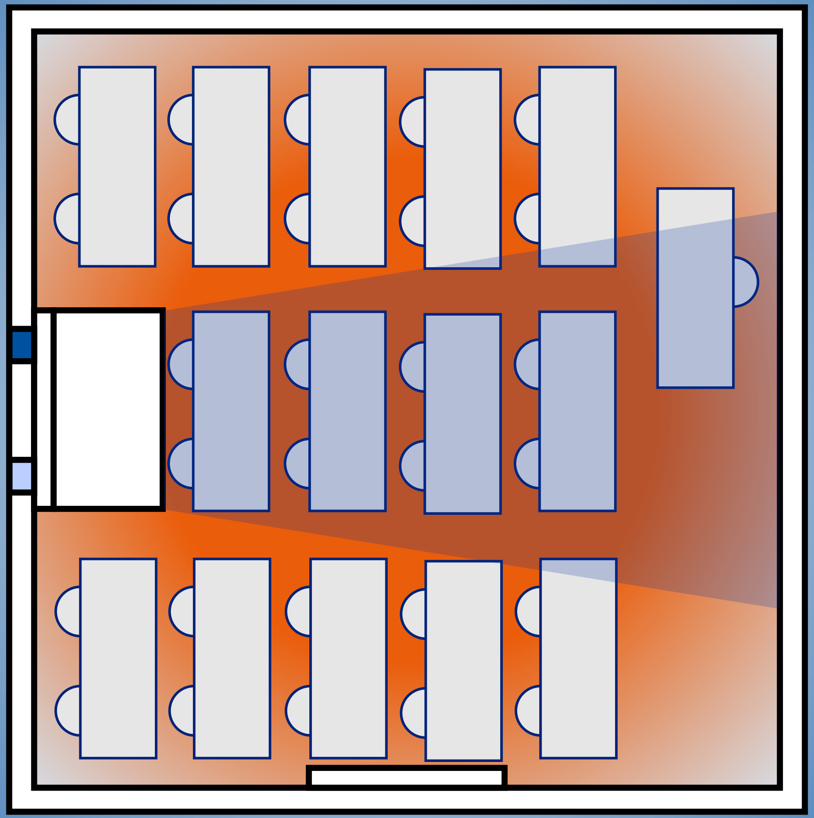
isolate indoors



from outdoors

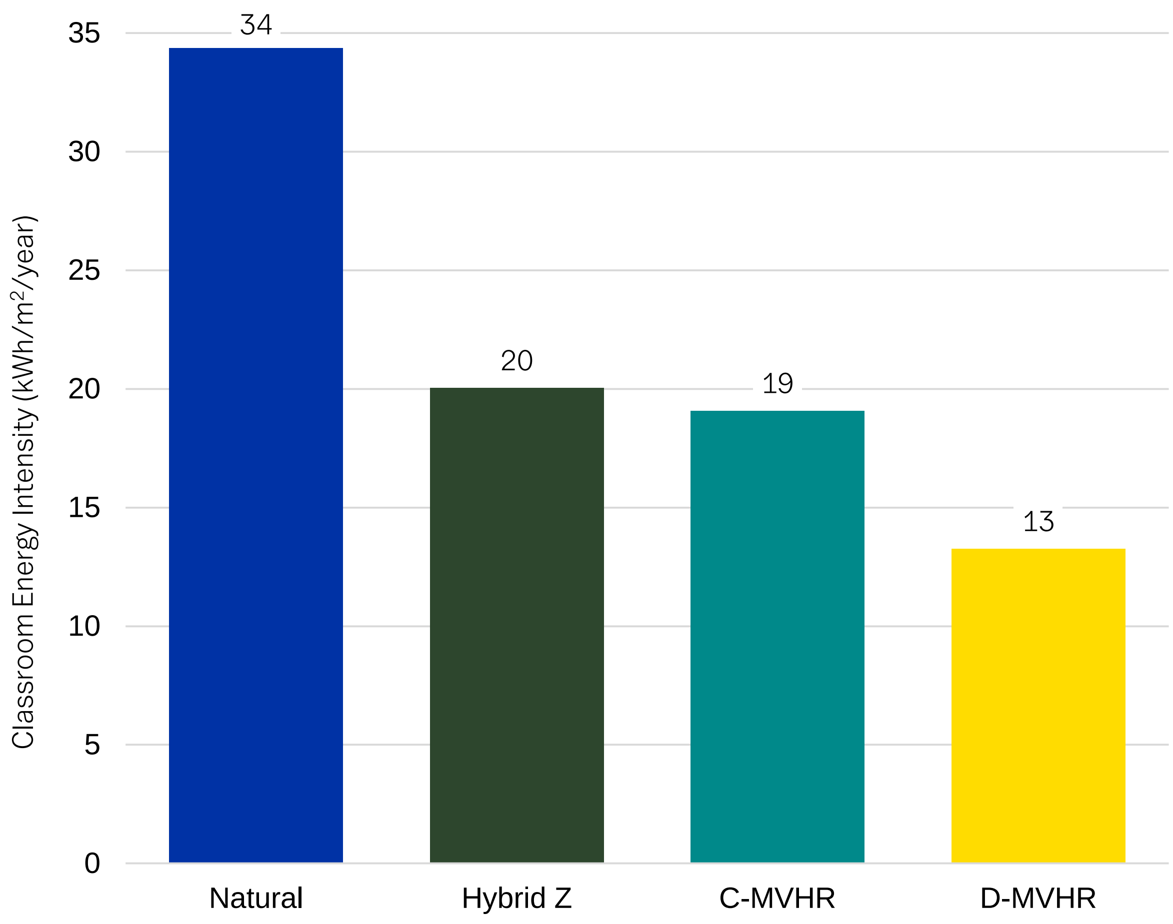
Passivhaus School Ventilation

5 air changes per hour



without heat loss

Cut Heat Loss – Heating and Ventilation



	SFP (W/l/s)	Heat Recovery Efficiency (%)
Natural	n/a	n/a
Hybrid Z	0.2	40
C-MVHR	2.0	84
D-MVHR	0.9	84

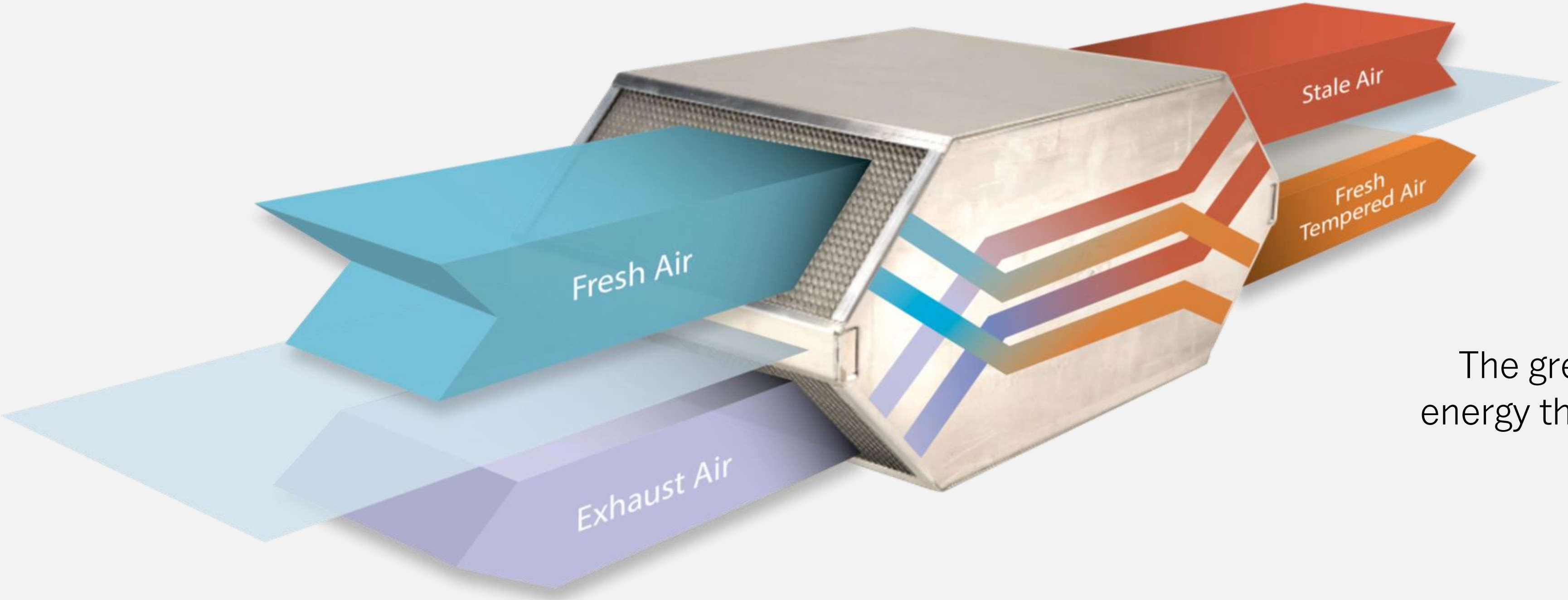
Hybrid Z | **30%** of 67 kWh/m^2/year

D-MVHR | **19%** of 67 kWh/m^2/year

CERTIFIED COMPONENT
Passive House Institute

Passivhaus Trust MEMBER
The UK Passive House Organisation

Proper Mechanical Ventilation with Heat Recovery



The greenest energy is the energy that you don't consume

Cutting Energy Demand

	HR (%)	kWh/m²	Floor Area (m²)	Energy Consumption (kWh)	Change
Hybrid Z	40	20	12,000	240,000	-43%
D-MVHR	90	13	12,000	136,000	

43% reduction in energy demand

New Scottish Schools – Passivhaus Standard

SAV

Passive House Institute

Rheinstr. 44/46, 64283 Darmstadt, Germany, www.passivehouse.com

Criteria
for the Passive House,
EnerPHit and
PHI Low Energy Building Standard

2030

Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standard, version 9f, revised 15.08.2016 1/27

Passivhaus Trust MEMBER
The UK Passive House Organisation

Step Two:
Supply Energy Efficiently

Heat Network Temperature Set

SAV

60 30

55/50°C $m = \frac{3kW}{4.2 \cdot 5} = 0.14\ kg/s$

60/30°C $m = \frac{3kW}{4.2 \cdot 30} = 0.024\ kg/s$

Lower flow rates	Smaller pumps
Smaller pipe sizes	Optimises use of thermal storage

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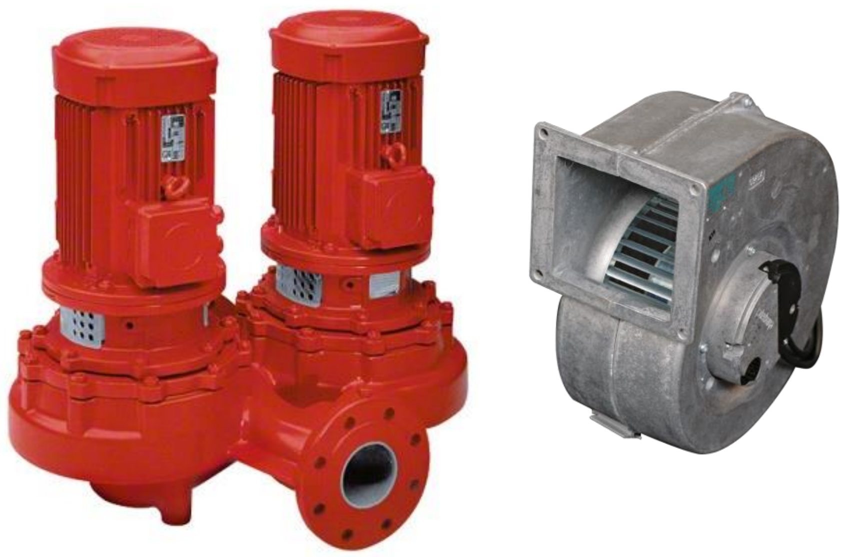
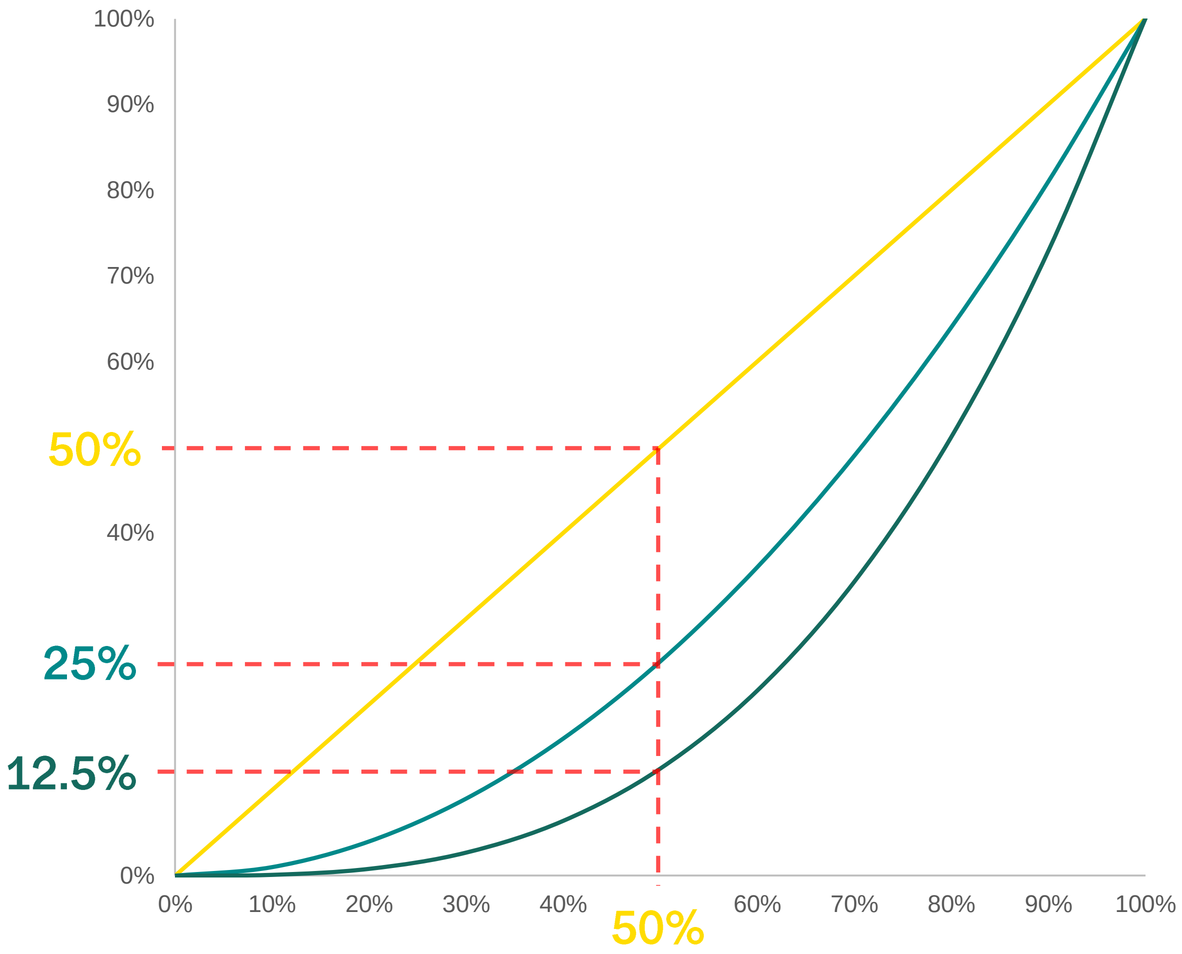
Reduced Pump Energy



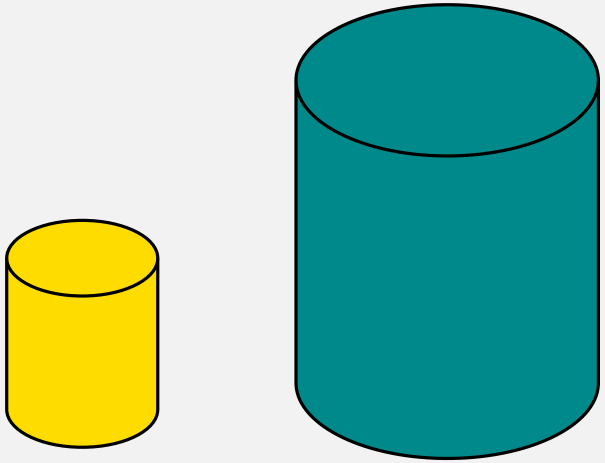


½ Speed

¼ Pressure (i.e. 0.5^2)

⅛ Energy Consumption (i.e. 0.5^3)

The Effect of ΔT on Thermal Storage

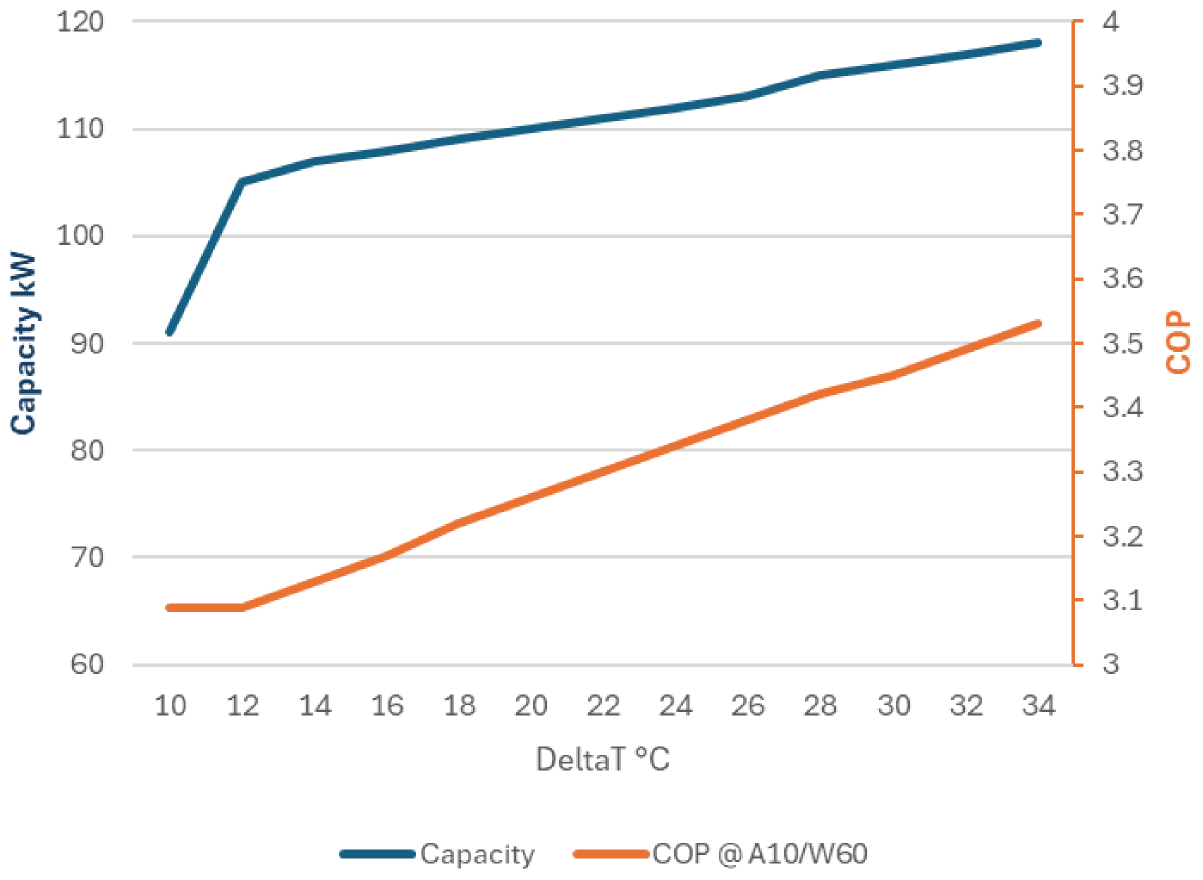


To achieve the same capacity, the vessel with a ΔT of 40 K is **8 times smaller!**

ΔT / Storage Capacity	5 K	40 K
1,500 L	6 kWh	48 kWh
5,000 L	30 kWh	240 kWh
10,000 L	60 kWh	480 kWh
15,000 L	90 kW	720 kWh

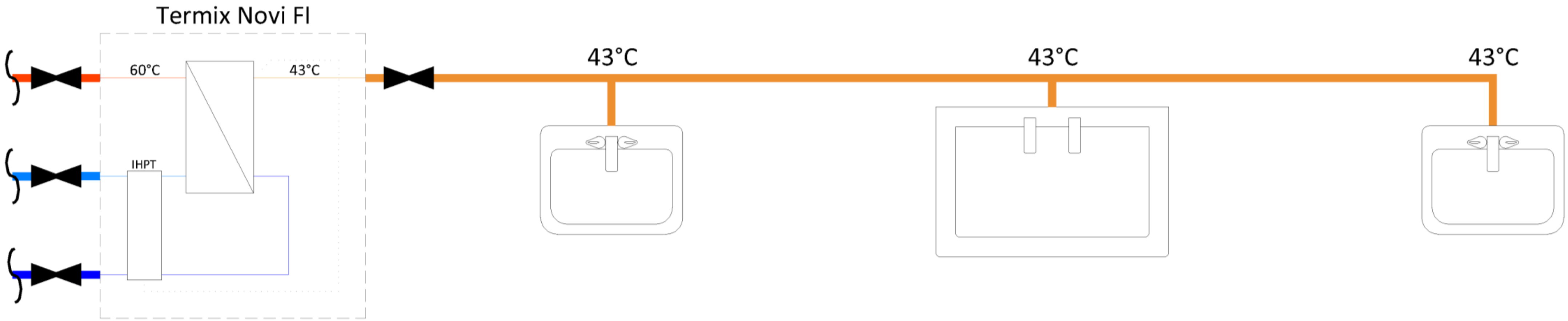
N.B. 40 K as heat pump flows at 70°C with no impact on COP.

The Effect of Return Temperatures on Heat Pumps



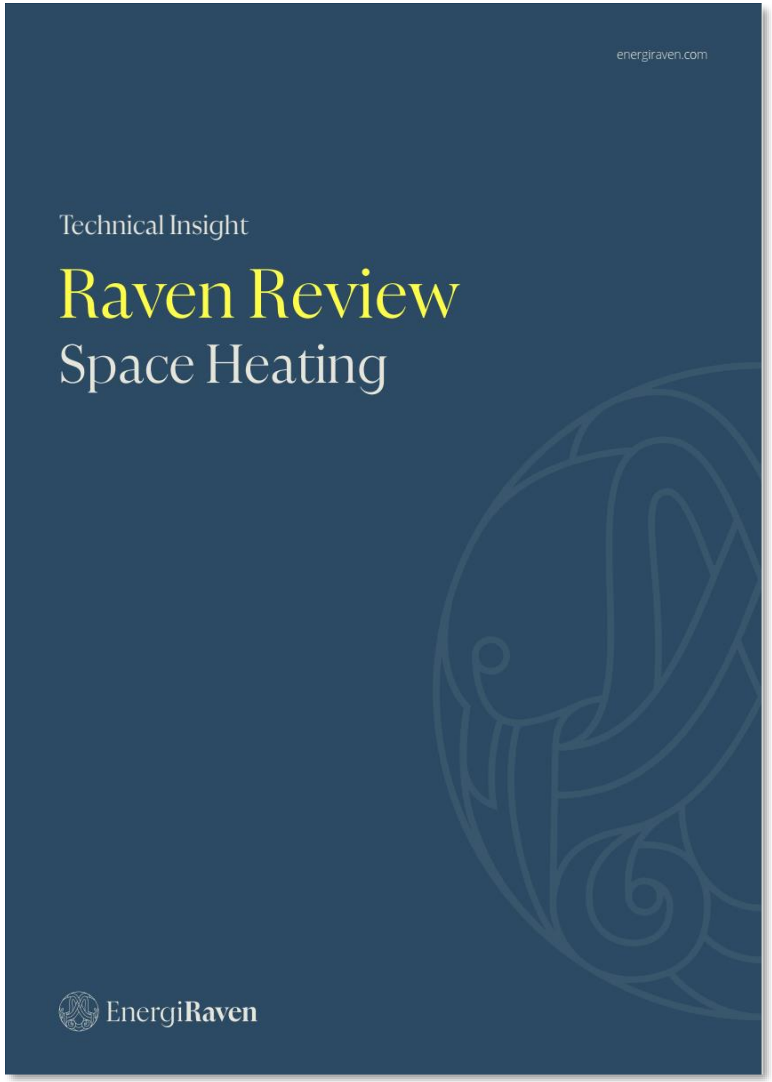
DHW - Eliminating Stored Hot Water

Fed from CT circuit



Localised heat generation using an HIU. Recirculation not required. Lower returns expected. **Requirement: DHW setpoint 43˚C. (School Output Specification) 6-10˚C required across TMV.**

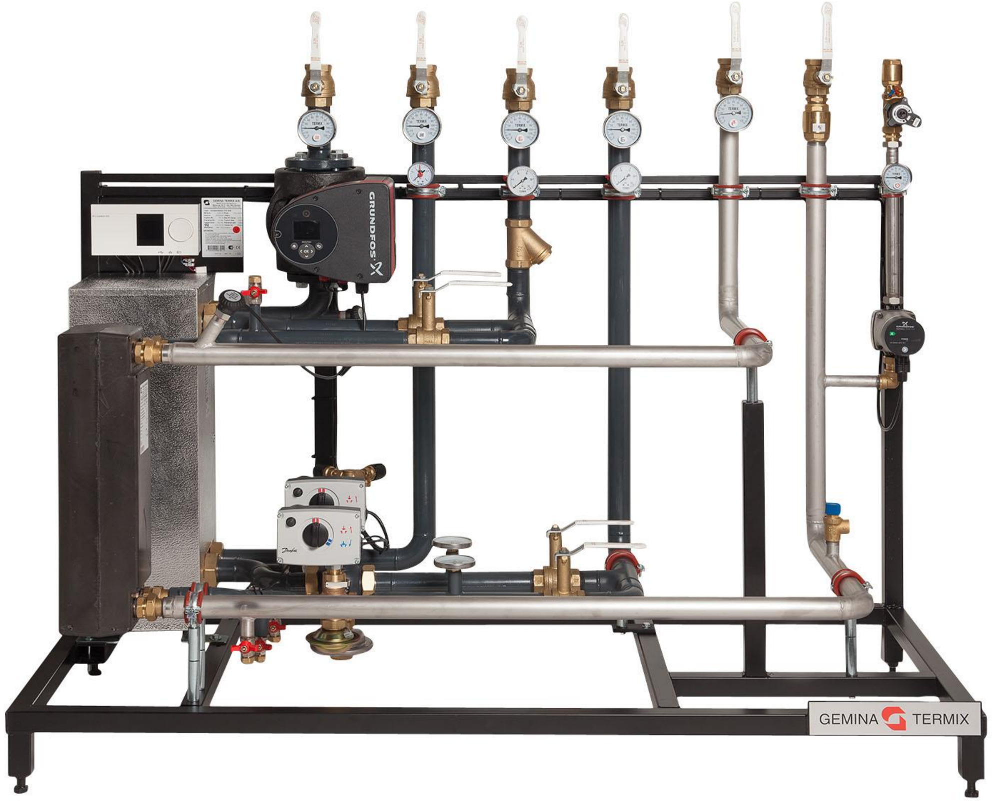
HTG– Control and Ongoing Commissioning



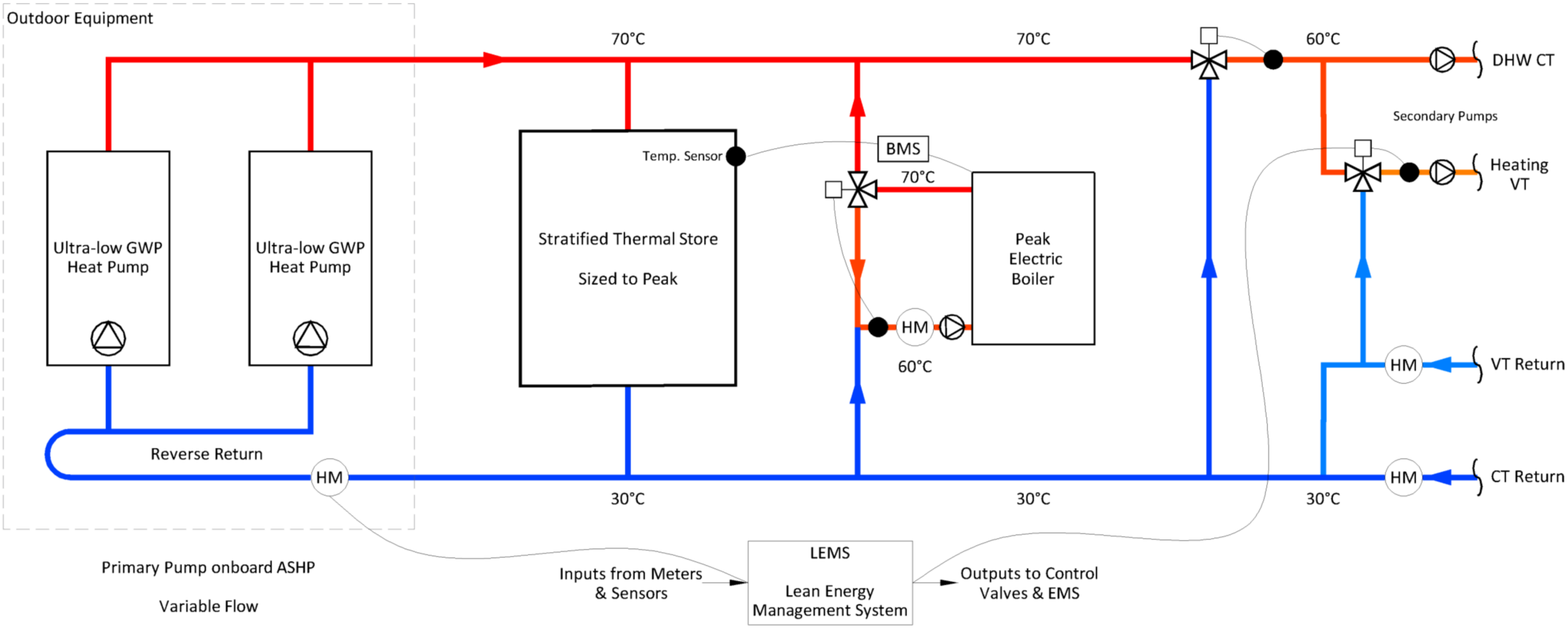
Step Three:
Low Carbon Energy

Heat Network Connected

60 30

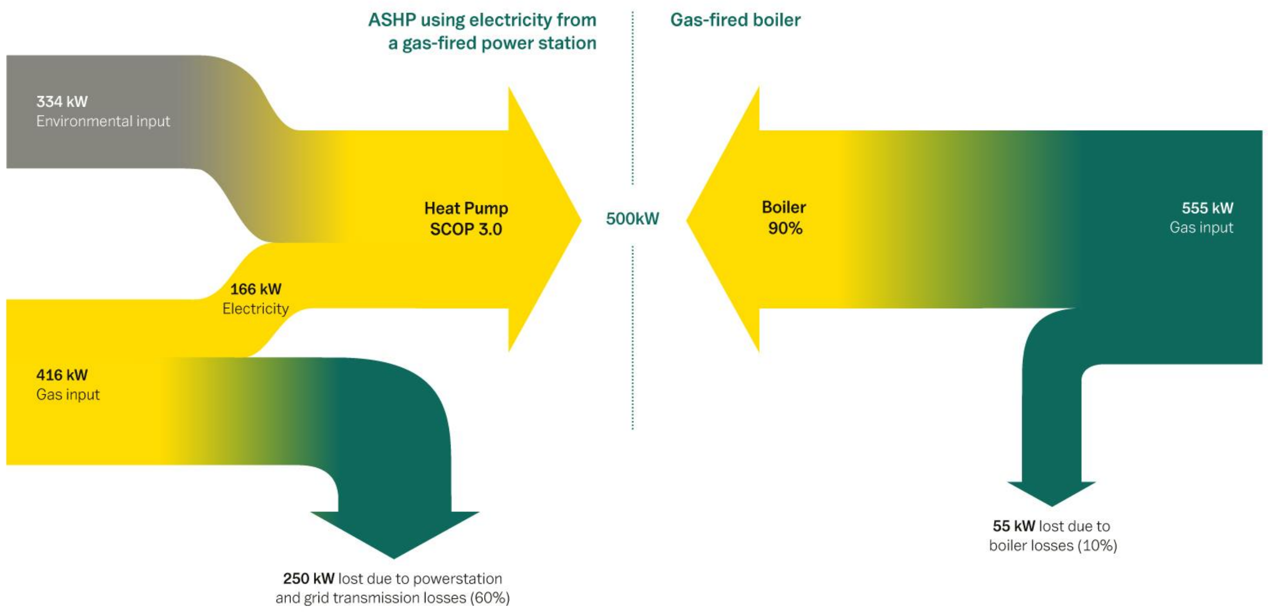


LSD Scope 2



Outdoor Equipment
70°C
70°C
60°C
DHW CT
Secondary Pumps
Temp. Sensor
BMS
70°C
Heating VT
Ultra-low GWP Heat Pump
Ultra-low GWP Heat Pump
Stratified Thermal Store
Sized to Peak
Peak Electric Boiler
HM
60°C
HM
VT Return
Reverse Return
HM
HM
CT Return
30°C
30°C
30°C
LEMS
Lean Energy Management System
Inputs from Meters & Sensors
Outputs to Control Valves & EMS
Primary Pump onboard ASHP
Variable Flow

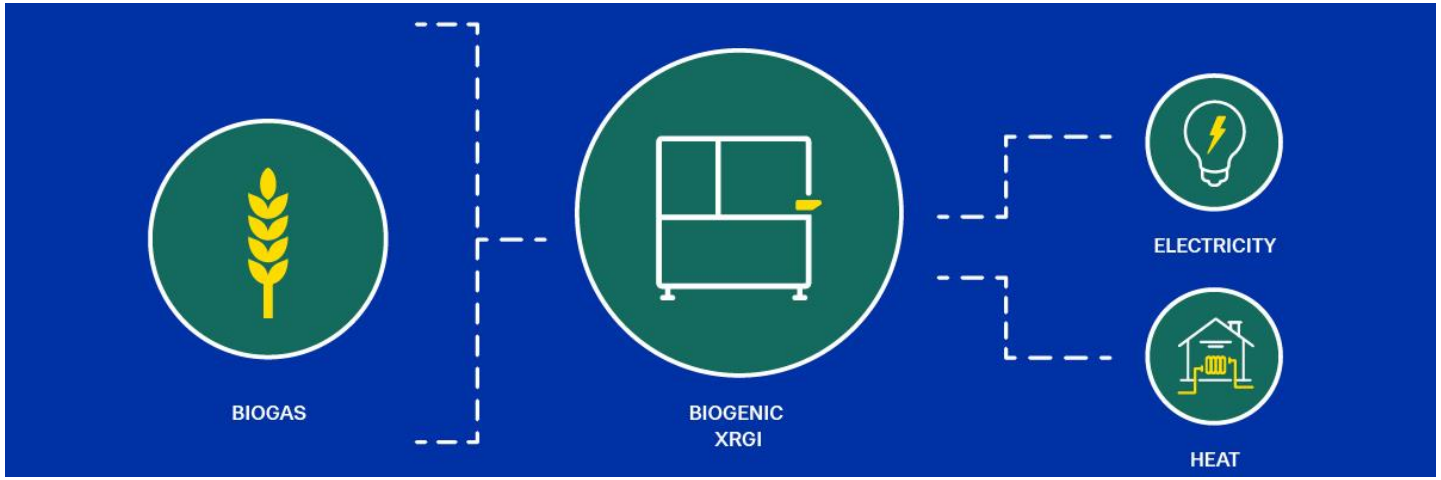
Grid Carbon Reality

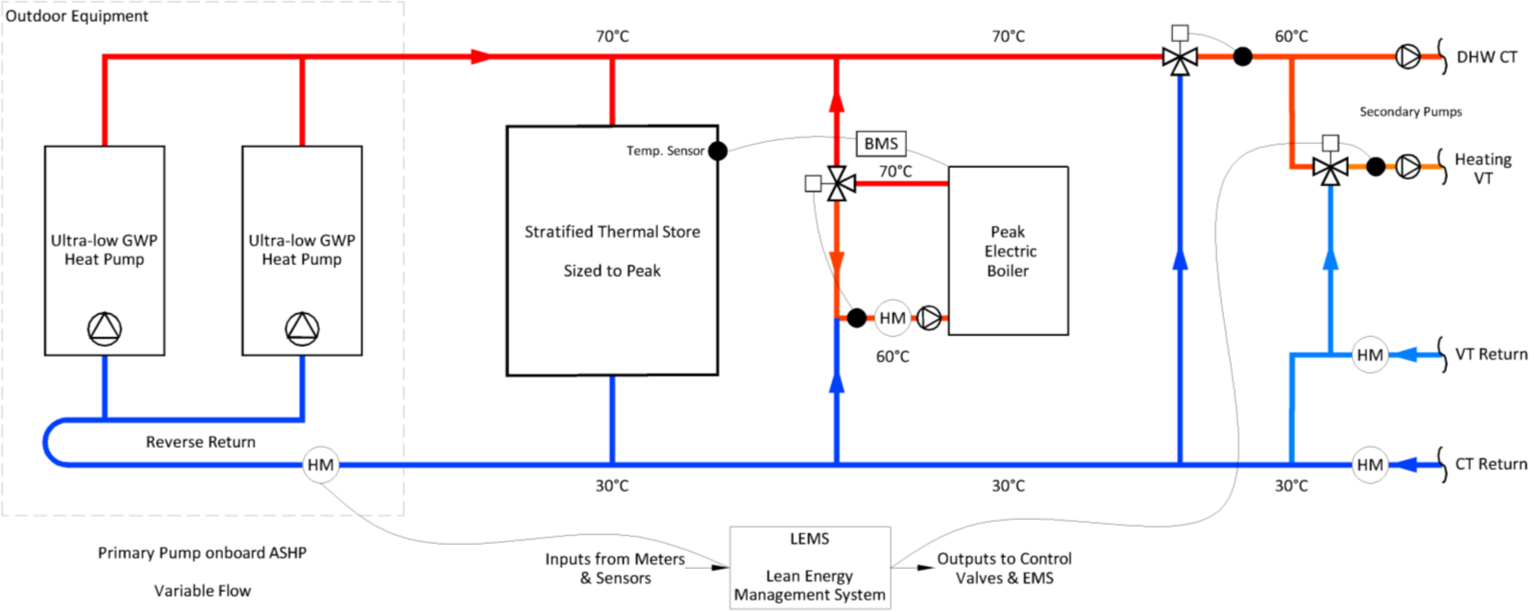


EFFICIENCY

120%	90%

LSD – Scopes 1 & 2



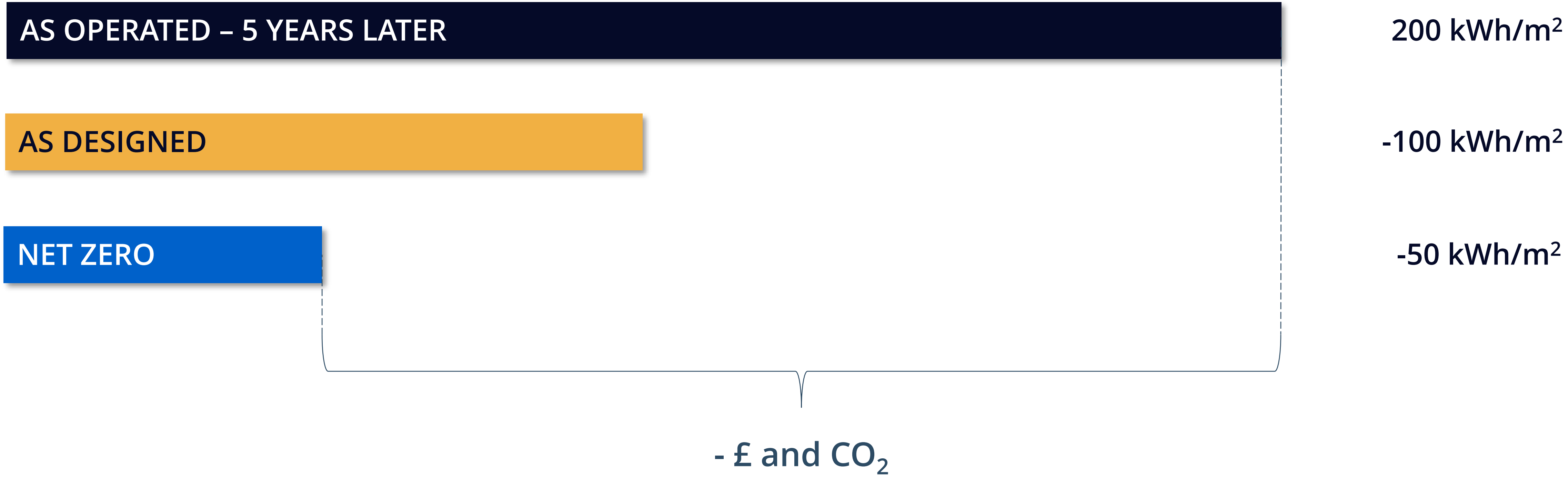


Energy Management System (EMS)

EMS


+ £ and CO_2
AS DESIGNED
100 kWh/m²
AS PURCHASED AND INSTALLED
110 kWh/m²
AS COMMISSIONED
120 kWh/m²
AS OPERATED
150 kWh/m²
AS OPERATED – 5 YEARS LATER
200 kWh/m²

EMS


AS OPERATED – 5 YEARS LATER
200 kWh/m²
AS DESIGNED
-100 kWh/m²
NET ZERO
-50 kWh/m²
- £ and CO₂

Weathering Net Zero

Passivhaus School Ventilation

60 / 30 System Design

Hybrid Energy Centres

Energy Management Systems

SAV

Thank you
for your attention