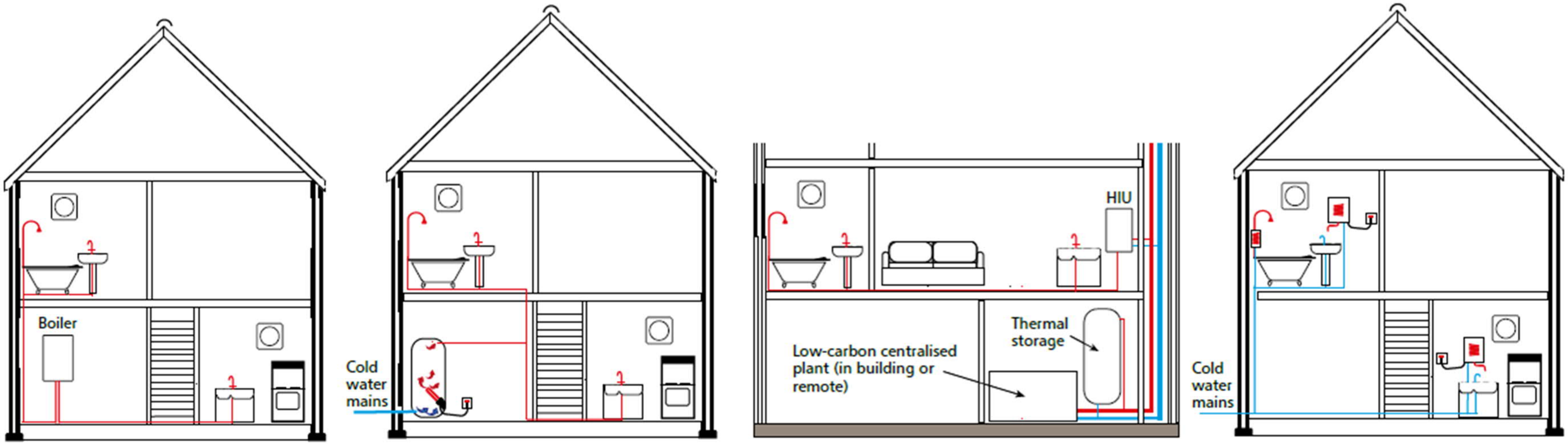
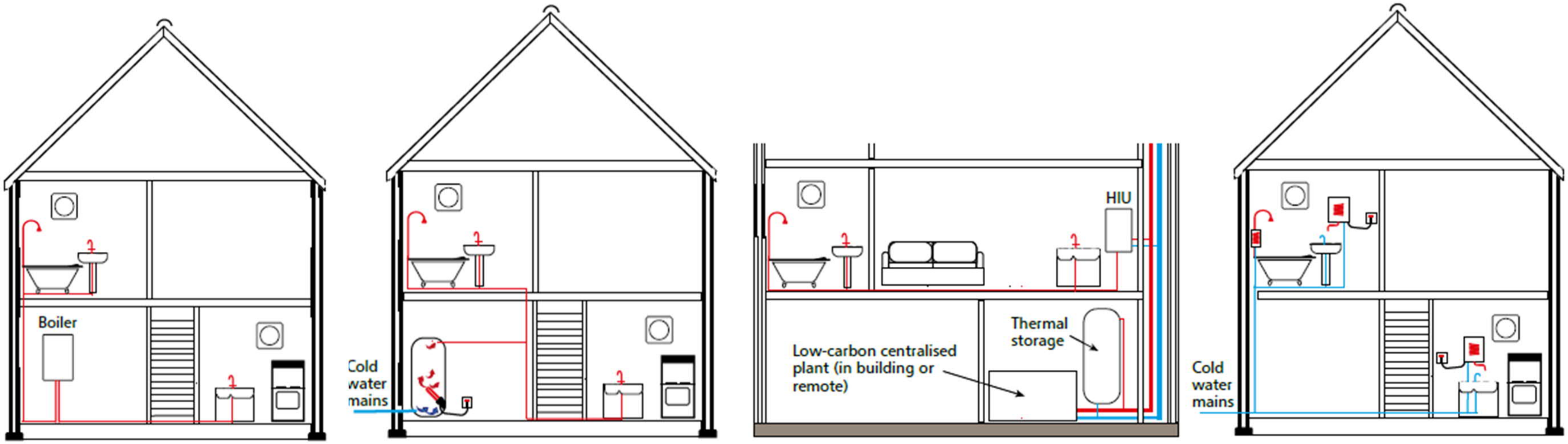


What to do about Hot Water ?

Homes for the Future Group Debate



Welcome and Safety Moment

Safety Moment

‘Last month, as part of an office move, circa 100 bags of waste paper were collected for shredding

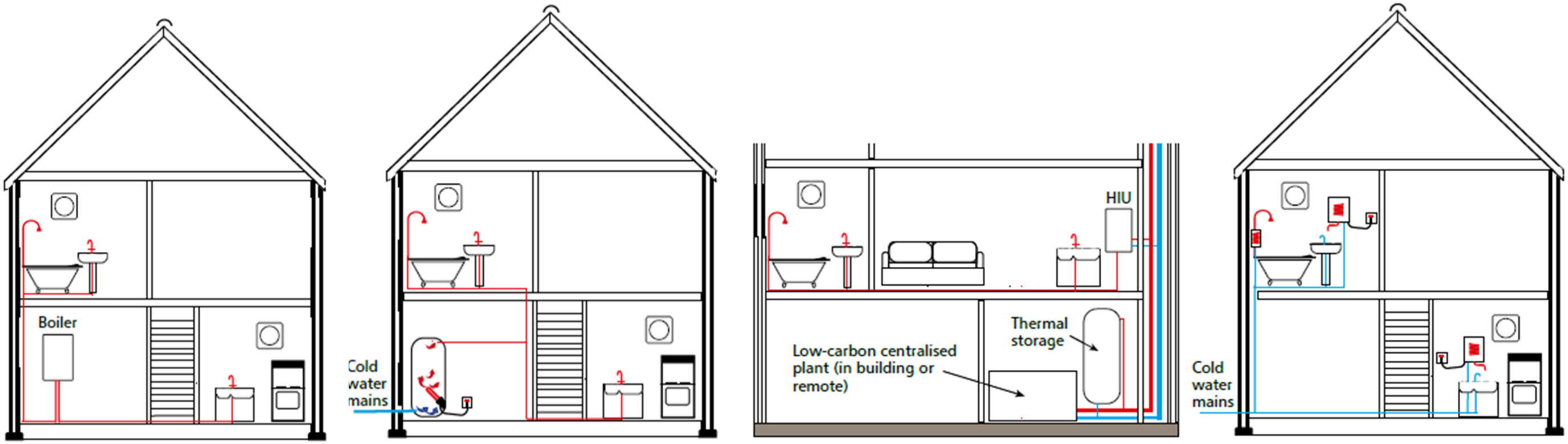
Unbeknown to AECOM and Shred It staff, someone had put an aerosol in with the waste paper.

When the shredder in the Shred It truck started the aerosol exploded and caught fire, setting fire to everything in the back of the truck.

Fortunately the driver is okay, the fire service and police attended but this could easily have become a much more serious incident.

It goes with out saying how important it is that bins are appropriately signed and staff take responsibility for appropriately segregating recyclable materials’

AECOM



Introduction

Tom Lelyveld, AECOM, Chair - Homes for the Future Group

Agenda

17.30	Arrival, refreshments and networking
18:00	**Welcome**
18:05	**Introduction, HFG Remit and Debate Context** Tom Lelyveld, AECOM, Chair of the CIBSE Homes for the Future Group
18:05	**State of the Market, Where We Are Now and Where We Could Be in 2030** Becci Taylor, Associate Director at ARUP
18: 15	**Reducing energy use in the delivery of Domestic Hot Water** Gareth Jones, Managing Director, FairHeat
18:30	**Heat Batteries – the Phase Change energy storage of heat** Bill Edrich, Global head of Commercial & Industrial, Sunamp Ltd.
18:40	Discussion and debate
19:15	Summary and Networking
20:00	Event close

AECOM

ARUP

Domestic Hot Water:
State of the Market, Where We Are Now and Where We Could Be in 2030

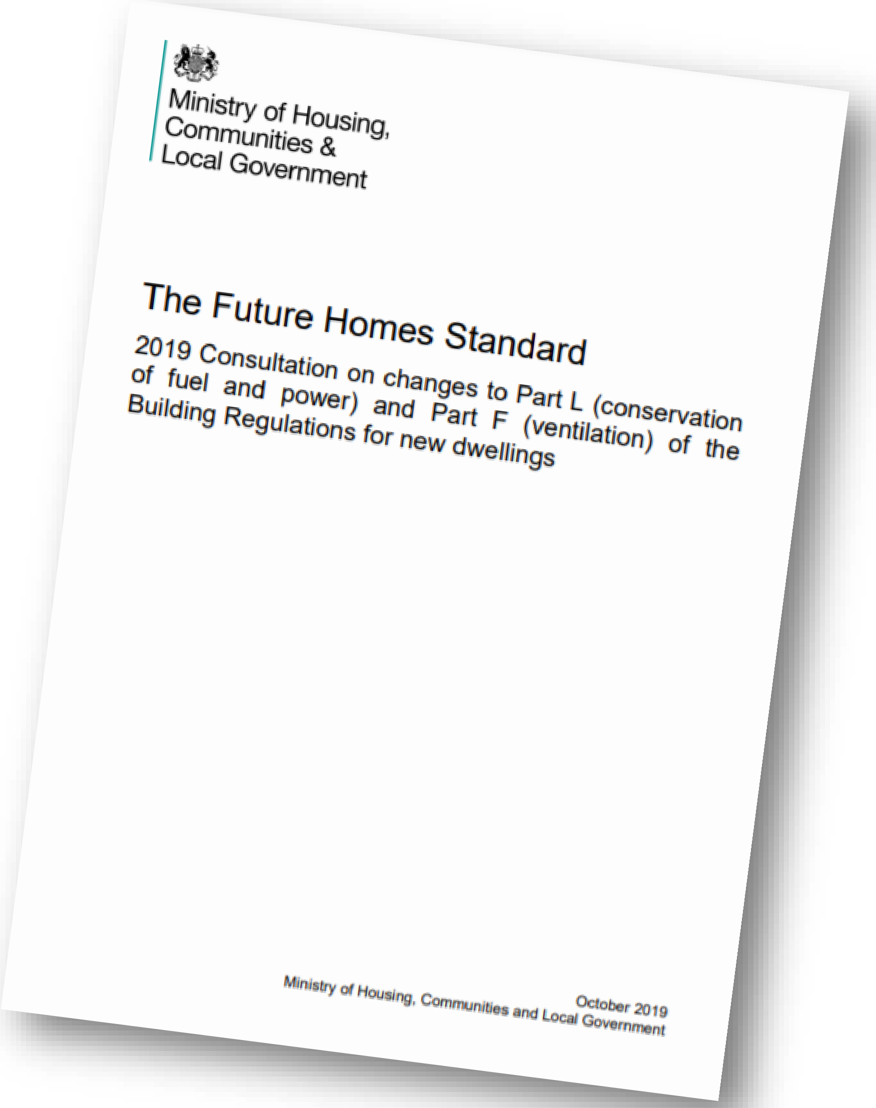
BECCI TAYLOR

Future Homes Standard Consultation

DHW limited to:

- Storage cylinder insulation/controls
- WWHR
- DHW Heat pump COP >2

DHW NEEDS MORE CONSIDERATION IN CONSERVATION OF FUEL AND POWER?


Ministry of Housing, Communities & Local Government

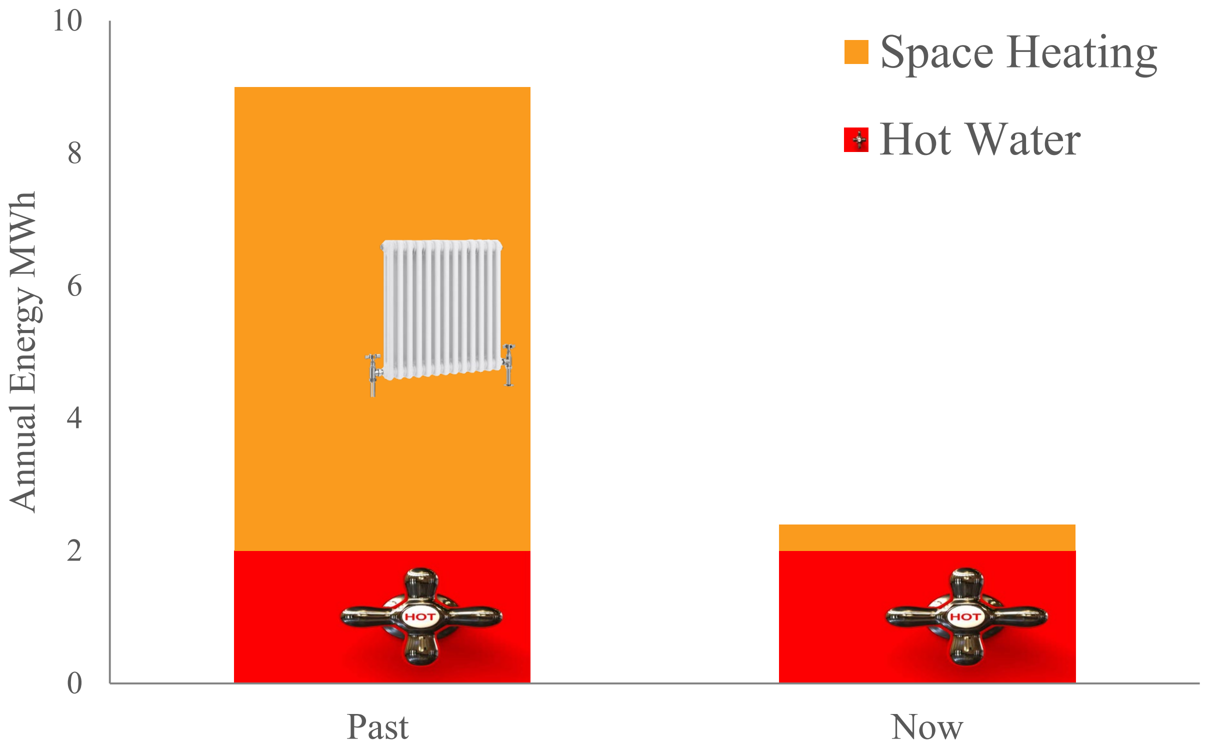
The Future Homes Standard

2019 Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for new dwellings

October 2019

Ministry of Housing, Communities and Local Government

The Elephant in the Home



DRIVING CHANGE

Working Group

Collaboration:

- CIBSE Homes for the Future Group
- Heat Networks
- SoPHE
- Domestic Building Services Panel

- Public health still primary driver
- Risk based assessment temperatures

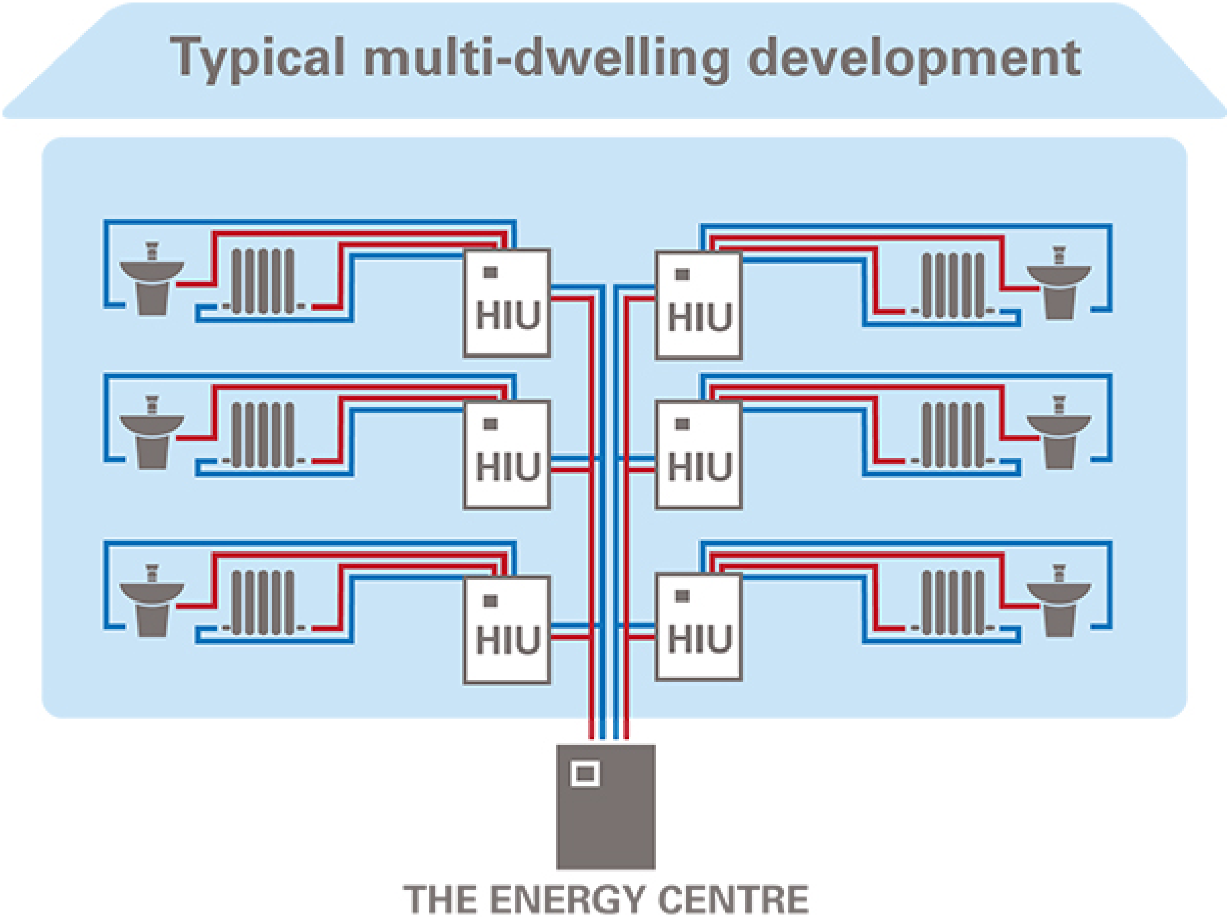
- Reducing instantaneous hot water temperatures: easiest win to reduce carbon emissions

Combined supplies

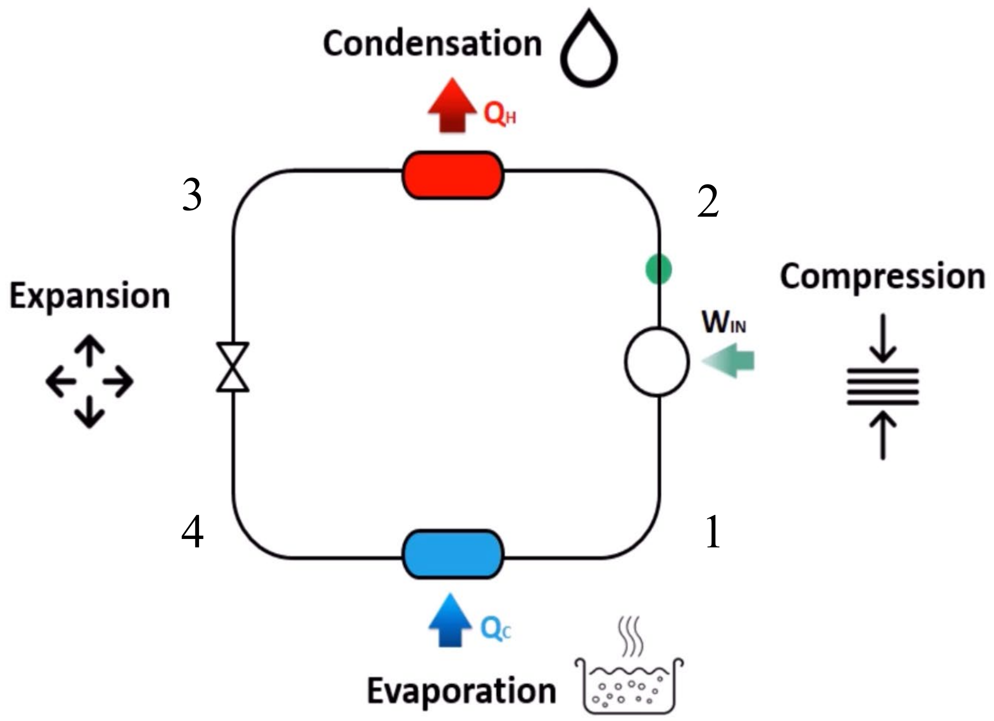
- DHW highest temperature

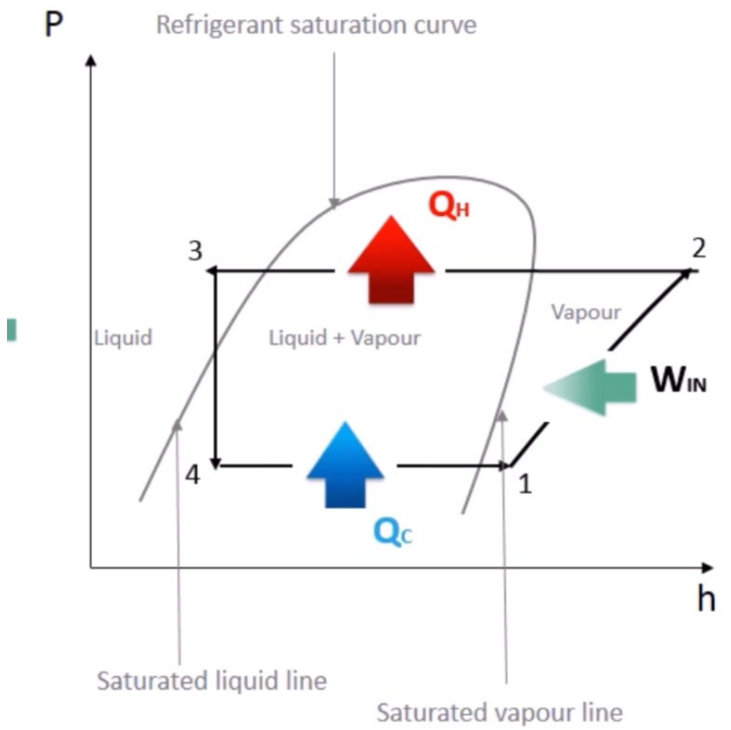
  → DHW drives COP of whole system

- DHW forms majority of load



Refrigeration Cycle



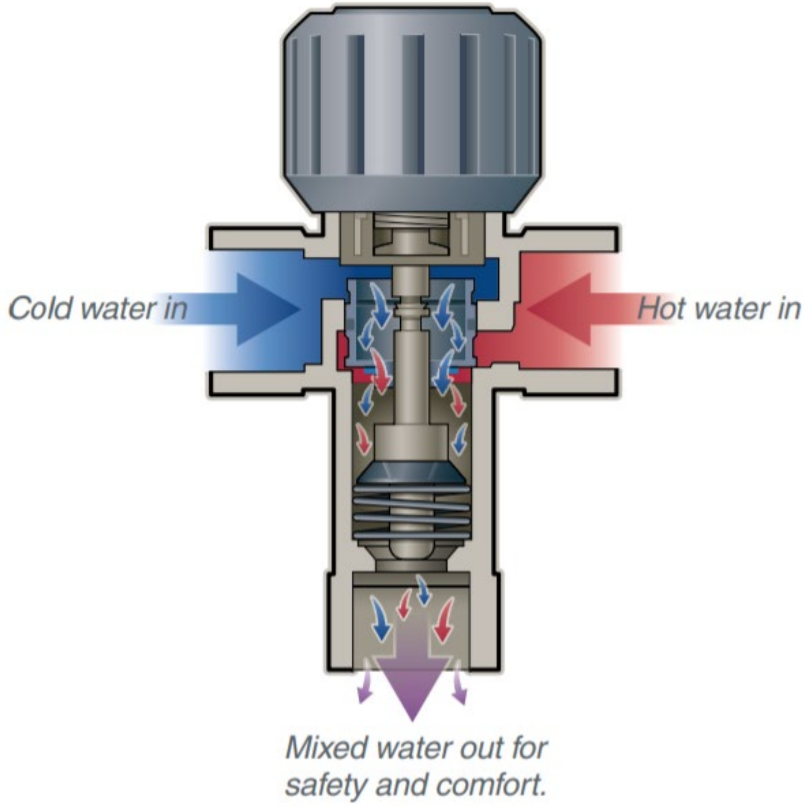


- Higher efficiency when condenser temperature closer to evaporator
  - Lower hot water temperature = higher COP
- Heat pump COP increases by ~10% for every 5° C reduction in condenser water*

*For an air source heat pump operating in the range of 45-60 degC condenser water temperature

Entropy

- It takes energy to increase order
- Mixing is irreversible, entropy goes up = waste
- Should aim to avoid where we can!



Climate Emergency

- Current instantaneous health based temperature guidance is unclear
- Combine clarity with thermodynamic opportunities to reduce carbon
- When is it ok to heat water up and then cool it down?
- Other advantages: limescale, scalding risk

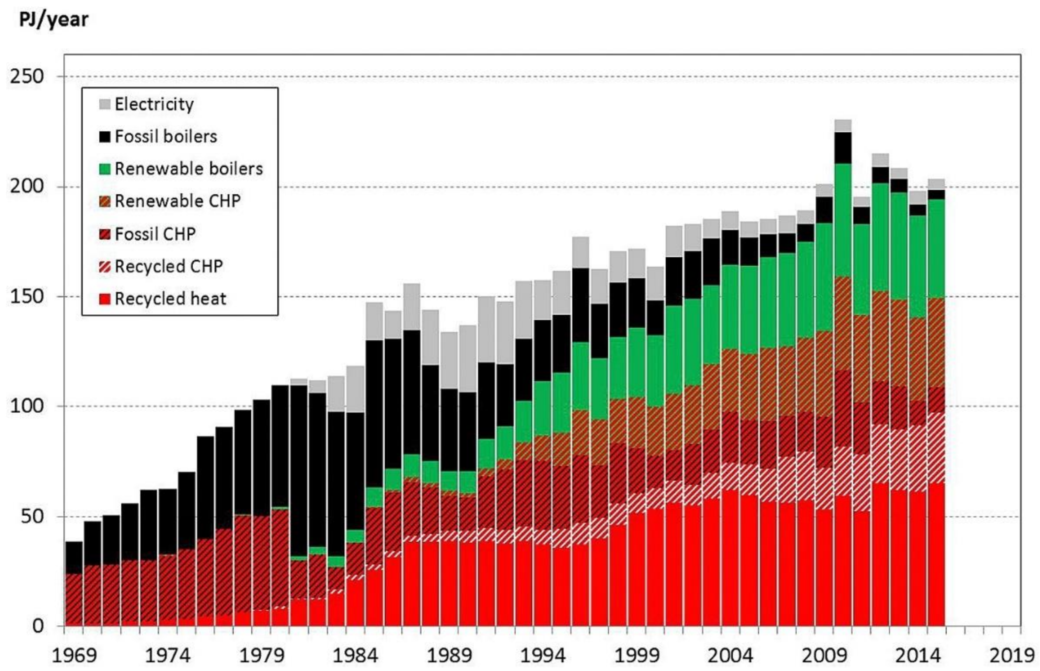
BSRIA HIU guide:
The tendency to scaling of the heat exchanger will increase with higher hot water temperatures, so end users should be encouraged to set the hot water controls to give the lowest acceptable delivery temperature, subject to health and safety considerations. For hot water systems without storage this is 50° C.

DHW Temperatures: Heat Networks

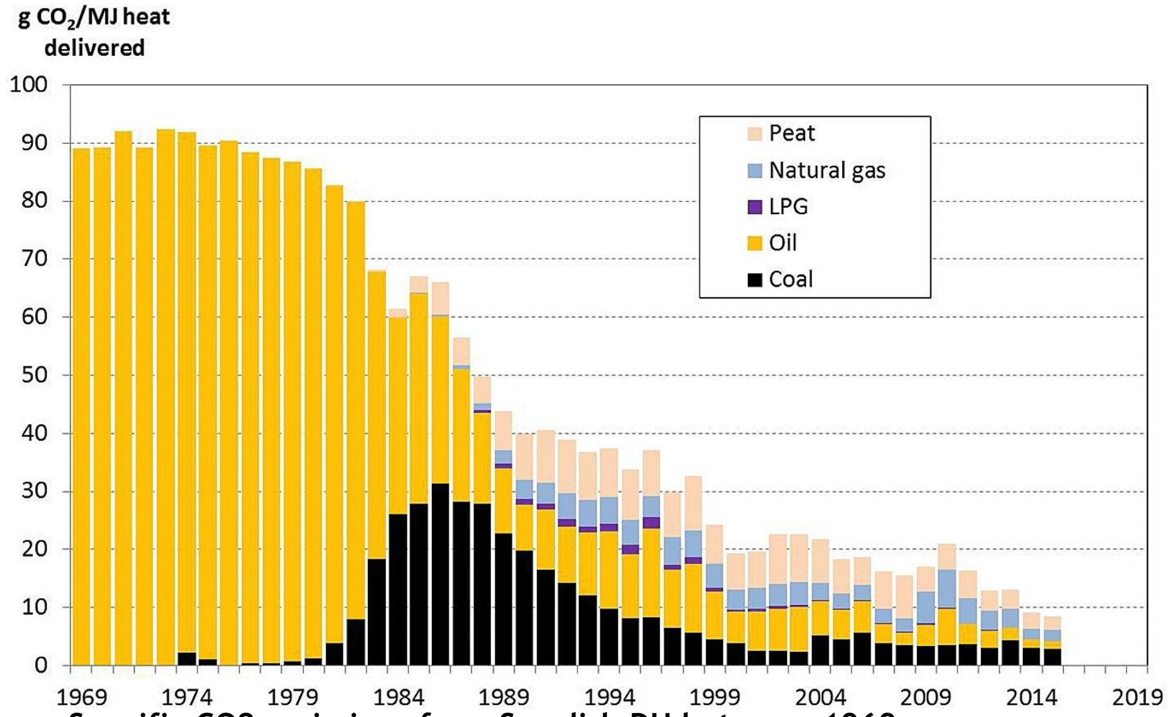
CIBSE Homes for the Future

03 December 2019

Demonstrated model for reducing carbon from heat



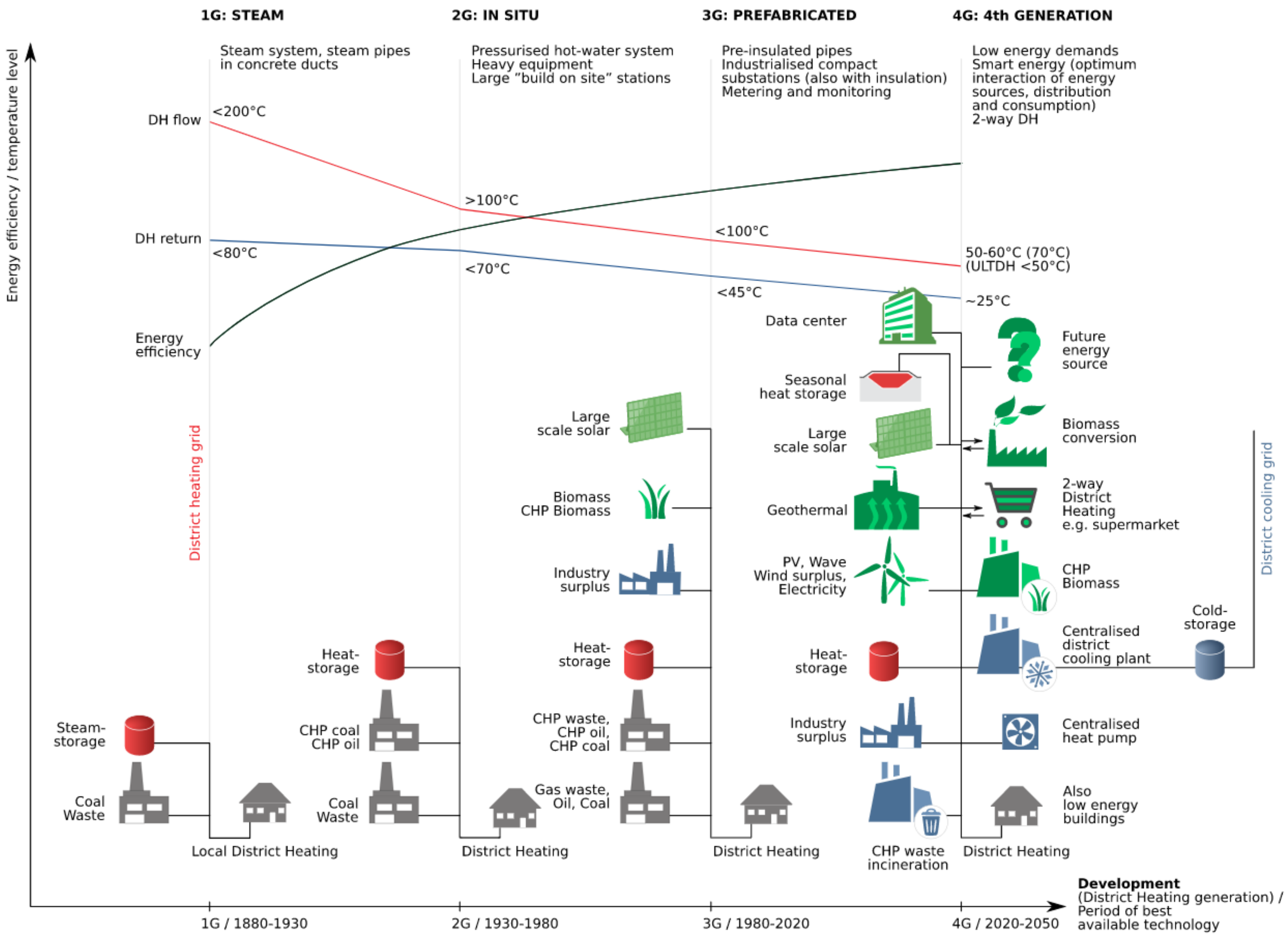
Heat supply to Swedish DH systems between 1969 and 2015 by heat source.



Specific CO2 emissions from Swedish DH between 1969 and 2015 by input fuel.

Source: Werner, 2017

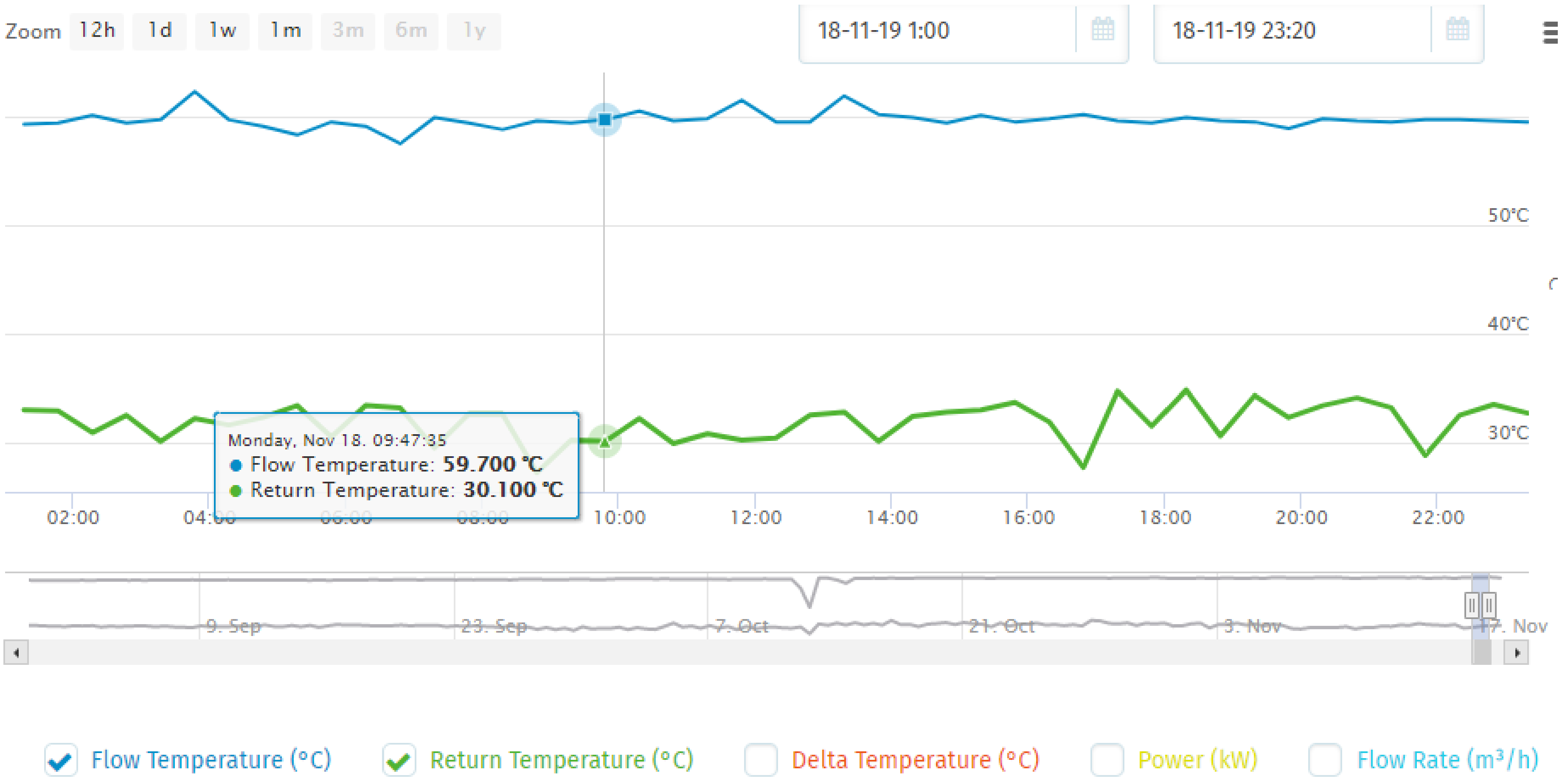
Global trend toward integrated low temperature heat networks (4DH)



Source: Lund et al., 2014

…which we are starting to see in the UK

Example Network Flow & Return Temperatures: 18 November 2019



Low operating temperatures require low DHW temperatures

Low Flow Temperature – 55°C

HIU forward approach temperature of 5°C

- Implies a **max DHW temperature of 50 °C**

Two issues to review in relation to DHW temperature

1. Health & Safety risk
2. Dish washing

Two key H&S issues for a domestic DHW system

1. Legionella
2. Scalding

Certain conditions increase risk from Legionella

a) the water temperature in all or some parts of the system may be between 20–45 °C

b) it is possible for water droplets to be produced and if so, they can be dispersed;

c) water is stored and/or re-circulated;

d) there are deposits that can support bacterial growth

Showers are an issue

a) the water temperature in all or some parts of the system may be between 20–45 °C

b) it is possible for water droplets to be produced and if so, they can be dispersed;

c) water is stored and/or re-circulated;

d) there are deposits that can support bacterial growth

Most discussion based on traditional systems with DHW storage

a) the water temperature in all or some parts of the system may be between 20–45 °C

b) it is possible for water droplets to be produced and if so, they can be dispersed;

c) water is stored and/or re-circulated;

d) there are deposits that can support bacterial growth

…with guidance to control risk through temperature

- Set control parameters to ensure water is stored at 60°C
- Ensure DHW delivered to outlet at a minimum of 50°C within one minute
- Ensure return temperatures at least 50°C on systems with recirculation

Guidance for low storage systems (e.g. HIUs) is different

“2.68 Low storage volume heaters (ie no greater than 15 litres) such as instantaneous units and POU heaters, may be generally regarded as lower risk”

Guidance for low storage systems (e.g. HIUs) is different

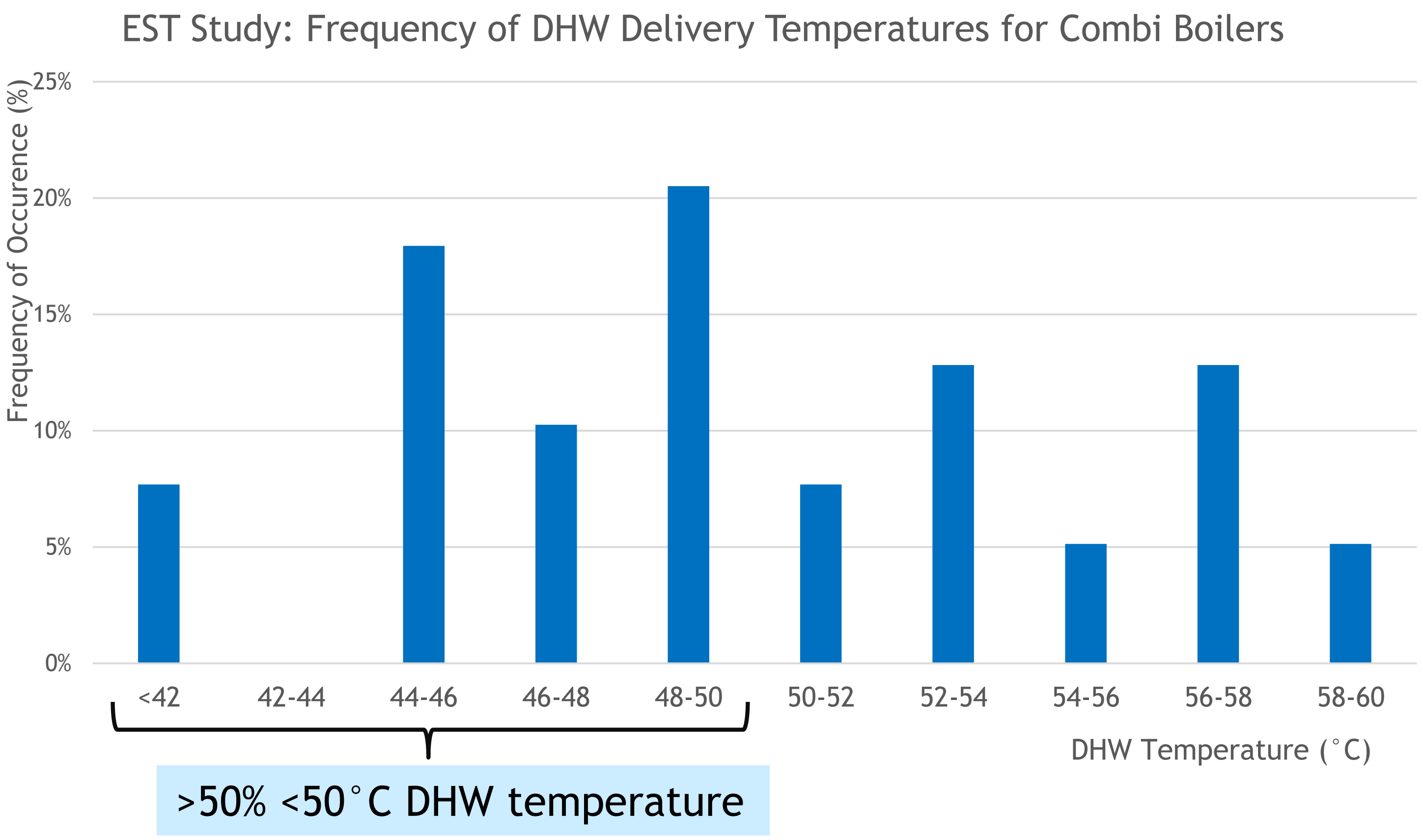
"2.68 Low storage volume heaters (ie no greater than 15 litres) such as instantaneous units and POU heaters, may be generally regarded as lower risk"

HSG 274 Part 2 Guidance for Low storage systems:

- Should be able to achieve a peak temperature of 50 °C - 60 °C
- Recommend using temperatures <50 °C only where there is high turnover (or alternative control)

Significant tangential evidence that low temps not an issue

- European Examples – e.g. Denmark
- Combi boilers



Source: Energy Savings Trust, Measurement of DHW Consumption in Dwellings, 2008

Two key H&S issues for a domestic DHW system

1. Legionella
2. Scalding

Two key H&S issues for a domestic DHW system

1. Legionella
2. Scalding

HSG 274 Part 2:

- *"At 50 ℃, the risk of scalding is small for most people but the risk increases rapidly with higher temperatures and for longer exposure times."*

>10-fold increase in risk of scalding from 50˚C to 55˚C

Type of burn by time of exposure by DHW temperature*

Type of Burn	Time of exposure in minutes and seconds							
Temp	45°C	50°C	55°C	60°C	65°C	70°C	75°C	80°C
Adult 3rd	>60 m (e)	300 s	28 s	5.4 s	2.0 s	1.0 s	0.7 s	0.6 s (e)
Adult 2nd	>60 m (e)	165 s	15 s	2.8 s	1.0 s	0.5 s	0.36 s	0.3 s (e)
Child 3rd	50 m (e)	105 s	8 s	1.5 s	0.52 s	0.27 s	0.18 s	0.1 s (e)
Child 2nd	30 m (e)	45 s	3.2 s	0.7 s	0.27 s	0.14 s	<0.1 s	<0.1 s (e)

(e) = estimated

c. 2,500 cases of scalding per annum (400 hospital admissions from hot water scalding for children)
c. 400 cases of Legionnaires' disease per annum (includes cooling towers, travel)

*Source: Children's Burns Trust campaign's HotWaterBurns website

On balance, good case for limiting HIU DHW temp to 50°C

- HSG 274 Part 2: low volume instantaneous DHW systems "low risk", with guidance for 50°C at outlet
- Conversely >10-fold increase in risk of scalding from 50°C to 55°C

Two issues to review in relation to DHW temperature

1. Health & Safety risk
2. Dish washing

Four sources of comfort on 50°C for manual dish washing

1. Testing of dishwashing detergents
2. Confirmation from manufacturer
3. Empirical feedback from residents
4. Testing of hot water decay

All dishwashing detergents in EU tested at 45°C

1. All dishwashing detergents in Europe tested for effectiveness
2. Tests conducted at starting temperature of 45°C, able to drop to 35°C during test
3. >500 products tested
4. Conclusion: demonstratable that 50°C sufficient for cleaning dishes

Proctor & Gamble R&D

Response from Proctor & Gamble's R&D department:

"We test Fairy across a range of temperatures. However, 38-41 ℃ is in the normal temperature range that a consumer would use for this product."

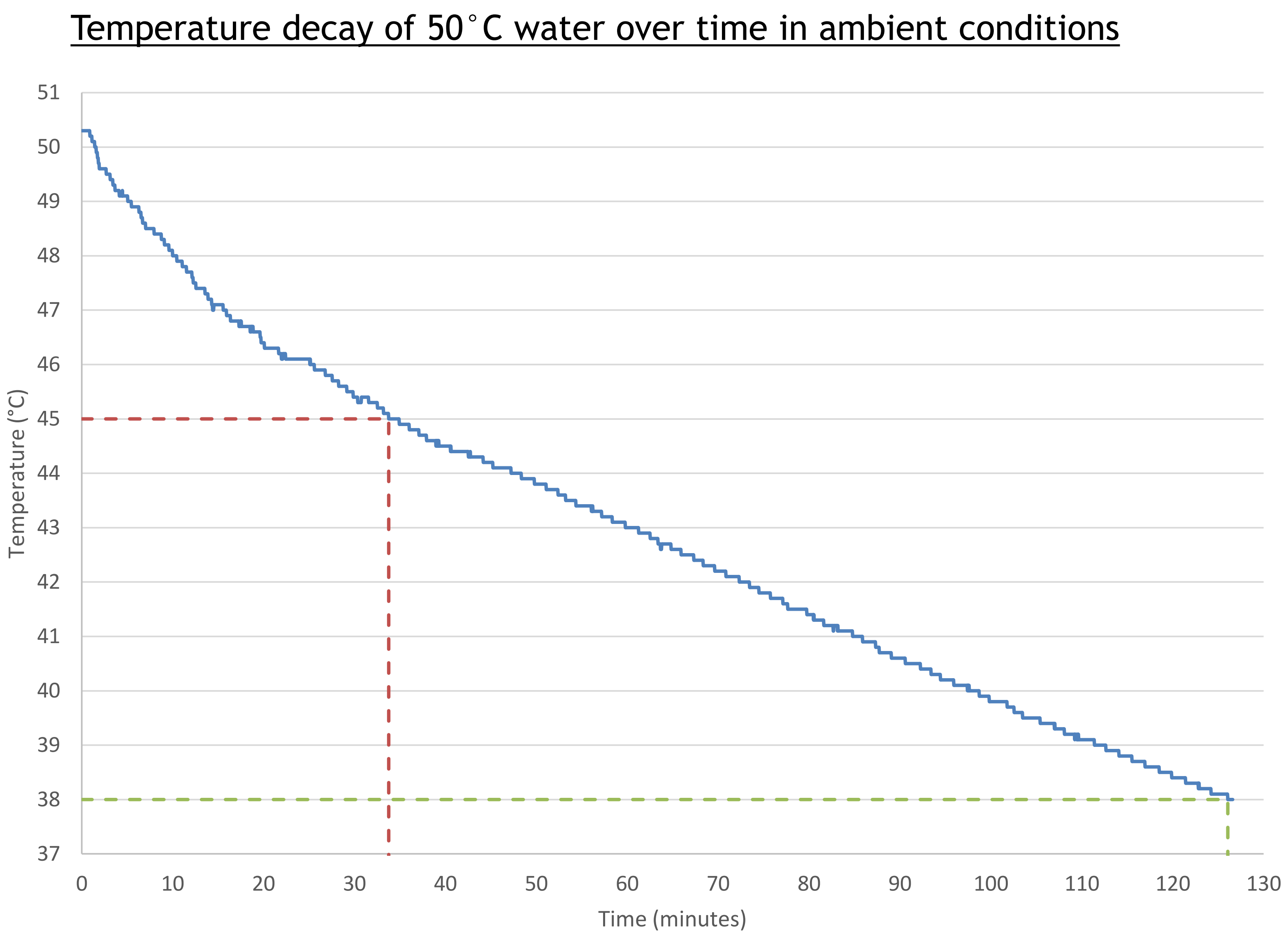
Empirical evidence from developments

- FairHeat working extensively with sites delivering DHW at 50°C, both new build and legacy
- Role includes resident engagement on in home systems
- Complaints tend to be:
    - Time to deliver hot water
    - Delivery temperature in bath, where lower temperature policy
- Lack of complaints about output temperature at kitchen sink

- Side note: combi boiler temperatures in UK

Tested hot water decay in typical sink

DHW temperature decay much longer than typical wash



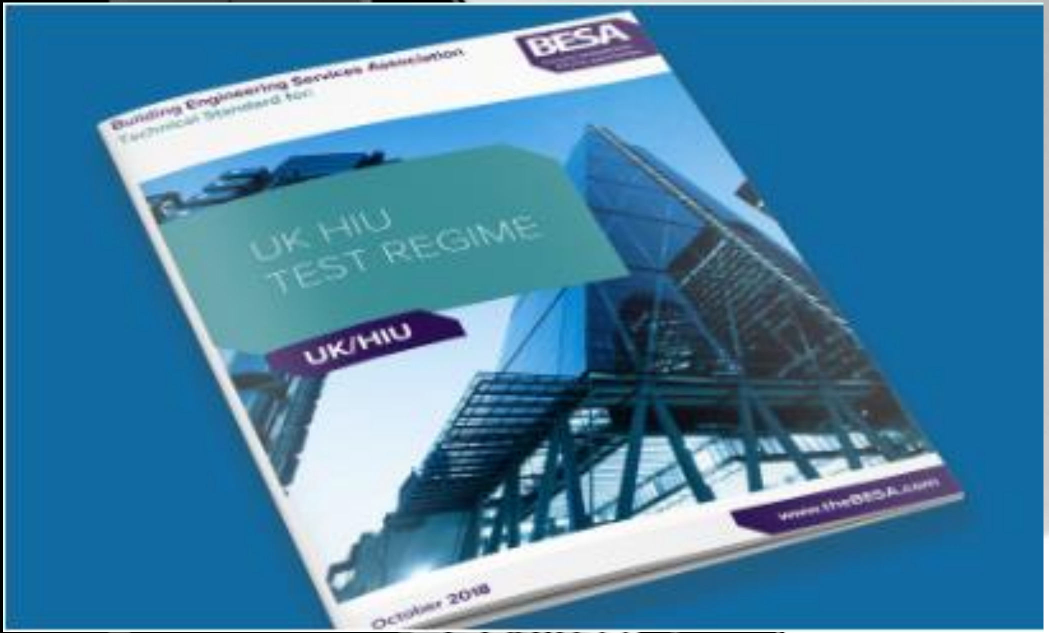
Summary: 50°C sufficient for manual dish washing

1. Dishwashing detergents proven to be effective at temperatures of 45°C and below
2. Confirmation from manufacturer that product expected to be used at 38°C – 41 °C
3. Testing of hot water decay shows that temperatures above recommended operating temperatures maintained for a long period (1.5 – 2 hours)
4. No complaints from residents at sites where 50°C being delivered to the kitchen sink

In summary, strong support for reducing DHW temps with HIUs

1. Health & Safety:
   - Low storage systems (HIUs) = low risk systems
   - No evidence supporting >50°C
   - Potential for 45°C - 50°C? (Further studies required)
2. Dish washing:
   - 45°C sufficient

UK HIU Test Standard



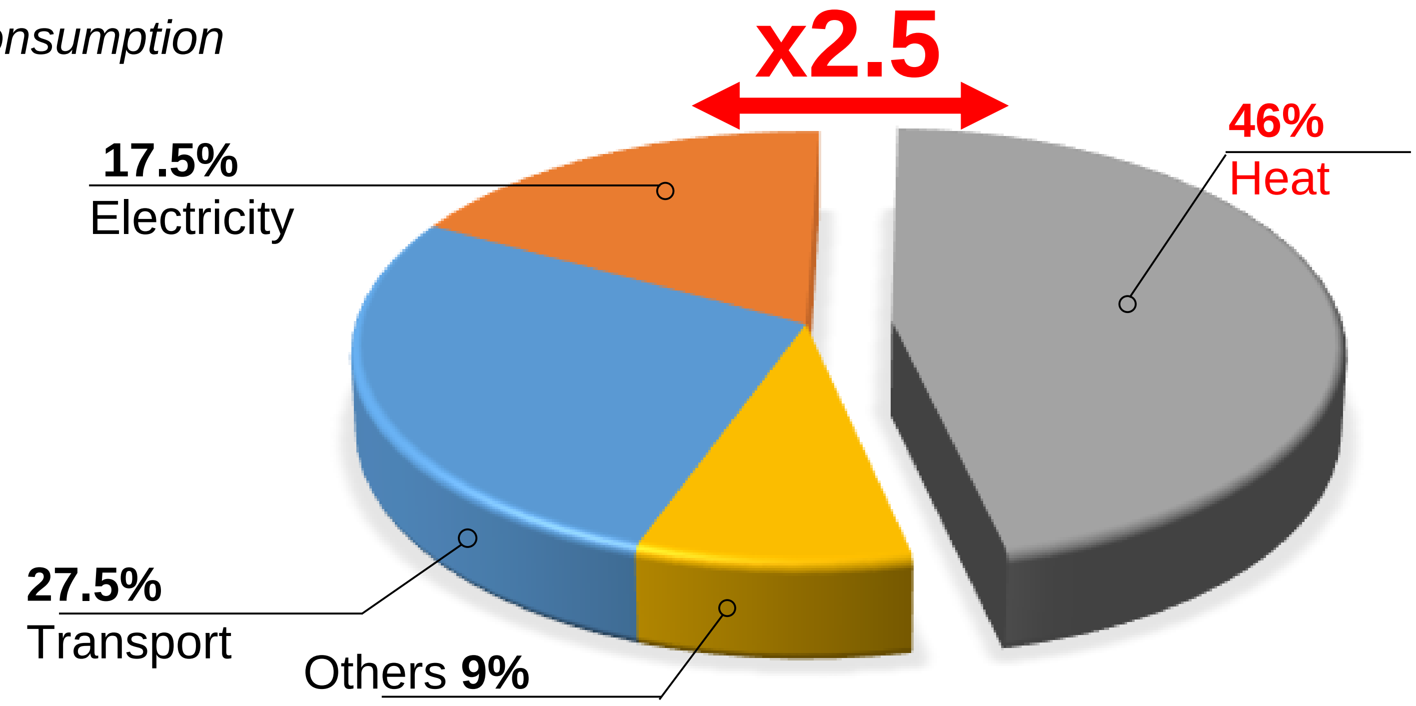
Sunamp

Introduction to company and technology

The Heat Opportunity

Sunamp

World energy consumption



- Space Heat
- Hot Water
- Process Heat
- Cooling

Heating without global warming, IEA, 2014.

Electrical storage:		Heat storage:	
✗	Over invested	✓	Has not changed in centuries
✗	Overcrowded	✓	Ripe for improvement
✗	High entry barriers	✓	More heat storage needed
✗	Materials questions	✓	Low cost, sustainable materials

Highlights

- Advanced thermal energy storage
- Founded in 2005 in Edinburgh
- Key R&D partnership with University of Edinburgh
- UK R&D and manufacturing
- Products now launched and in serial production

>60 people directly employed (100% increase 2019)

>2,500 homes impacted including:

>800 homes in social housing

>700 sold via OEMs

Hundreds of direct customers & other resellers

Factory scaling up to 20,000 per year capacity

Two OEMs signed for Global Markets

Business Units

Sunamp

Residential

- UK focussed
- Social housing –retrofit and new build, electrification of heat and heat networks
- Housebuilders inc. modular
- Owner occupied
- Distributors & resellers

Automotive

- Global Tier 1 automotive OEM
- Commercial vehicles e.g. rapid warm up, cold storage
- Last mile delivery vans range extension & cold storage
- Electric range extension

OEM

- Global OEM
- Global expansion
- Global and country distributors
- Global Integrated heat and cooling products

C&I

- Global Industrial process applications
- Global Commercial applications
- Global X as a service including Demand Side Response and flexibility
- Global cooling
- Global Agriculture
- Global heat & cool networks

Thermal storage battery

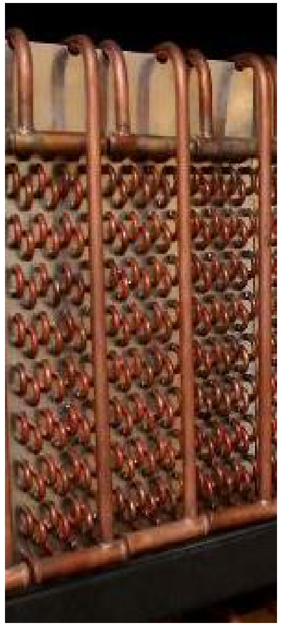
High Energy Density

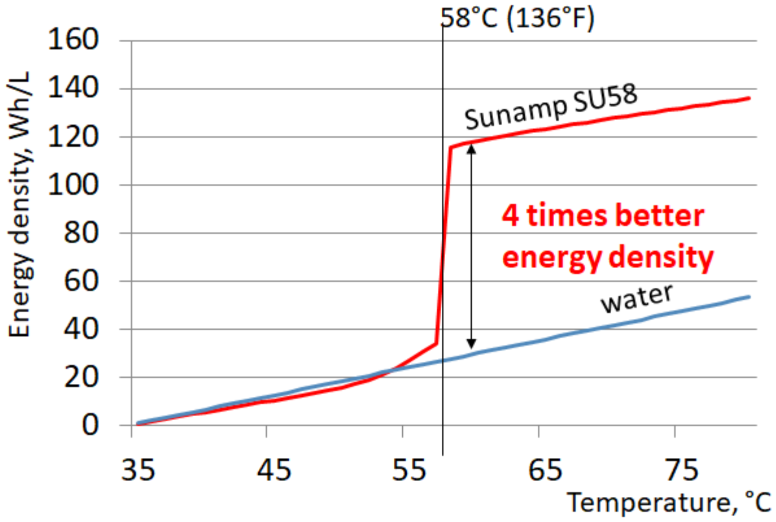
Melting and freezing a PCM (Phase Change Material) stores 3-4 times as much energy in latent heat as the sensible heat of water in a hot water cylinder. Required a material breakthrough to stabilize a well-known, non-toxic, low-cost but unstable PCM. Achieved (40,000 cycles proven)

RAL Güte-Gemeinschaft PCM e. V.

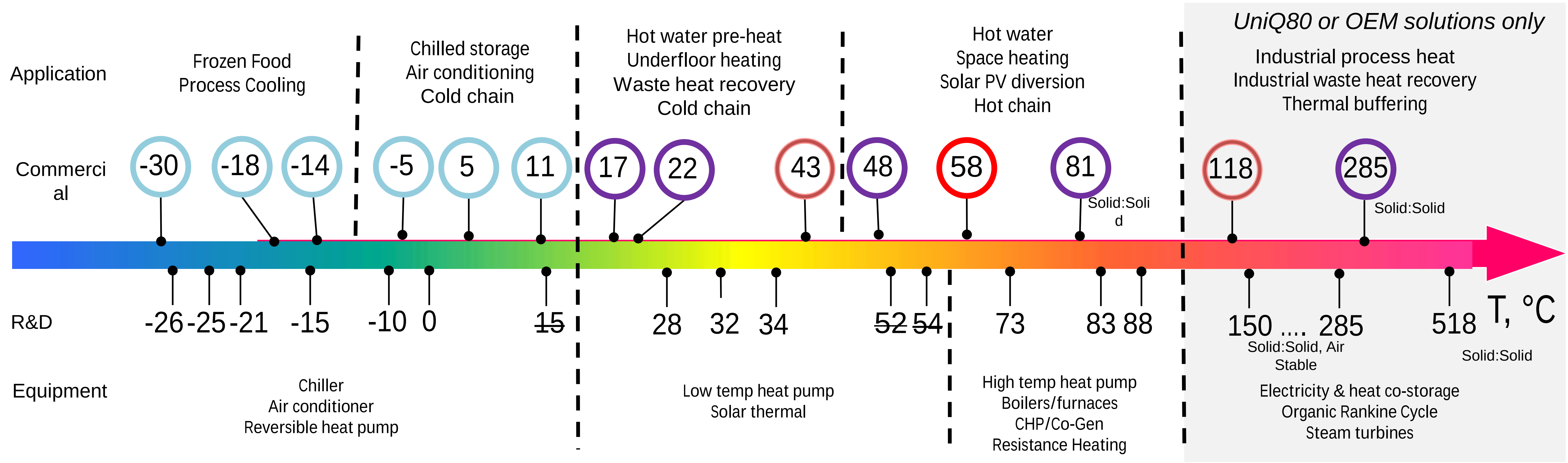
High thermal power

High power charge and discharge for rapid recovery and high flow rate hot water is key user requirement. But the PCM has very low thermal conductivity. **Required** a mechanical design with high-power, low-cost heat exchanger inside, so heat can be rapidly charged into the PCM in the heat battery and equally quickly extracted. **Achieved**





Temperature Range



Materials			**R&D Status**	
Cooling		Heating		
○	Available by special order to early adoption customers	○	R&D stopped	~~52~~
○	Current full commercial volume products	○	R&D active, material may enter market	32
			Accelerated commercialisation	○

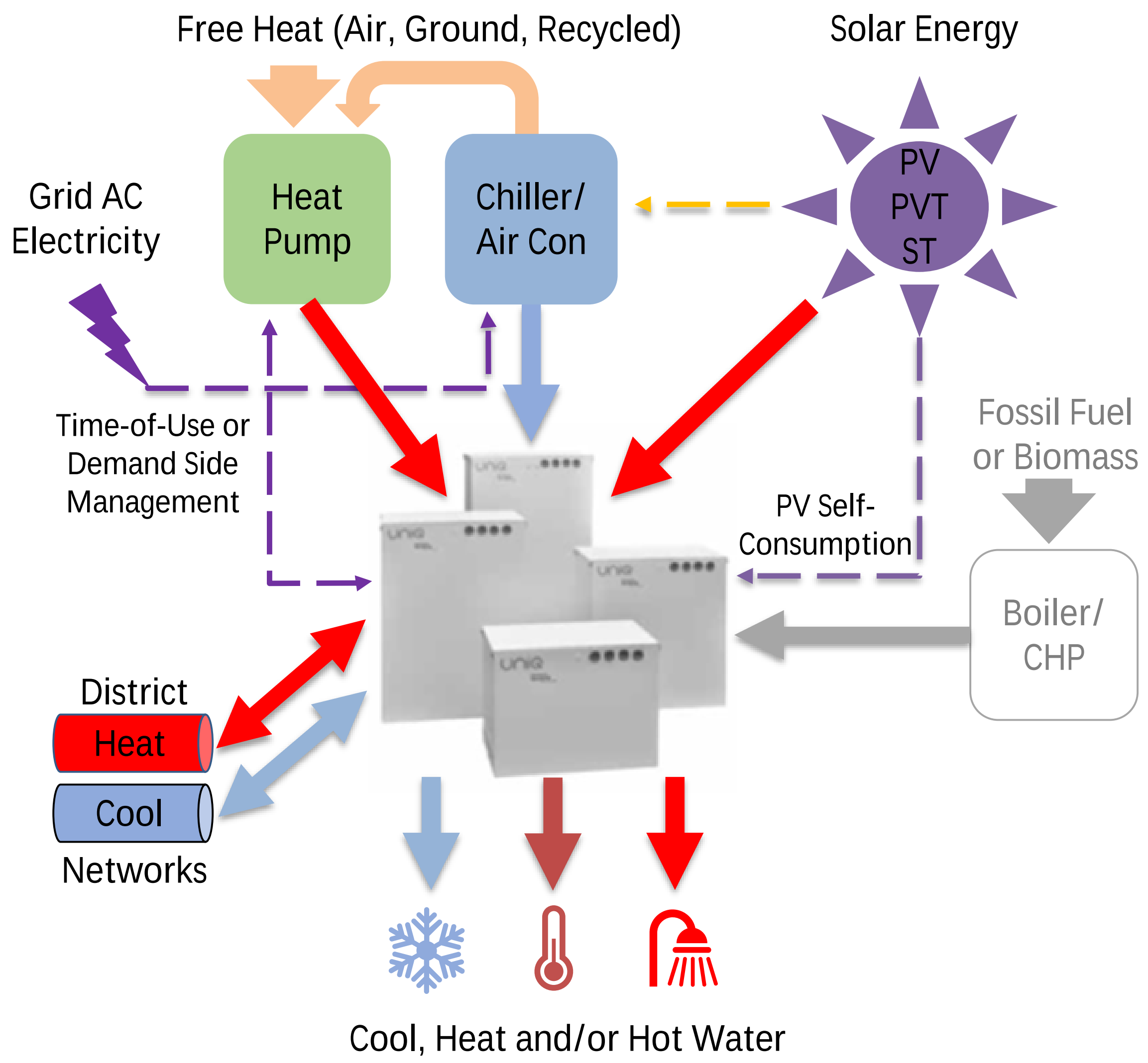
Sunamp Cool Batteries and Heat Batteries can be filled with different PCMs to optimise each application

Sunamp's Phase Change Materials (PCMs) are internally developed, and generally inorganic, non-flammable materials. Values indicate phase change temperature.

Note: PCMs at different level of development and not all commercially available today.

Flexible Applications

Sunamp



Product Usage – Hot Water

Sunamp

Better than unvented hot water cylinder.

Benefits:

- Mains pressure hot water
- Rapid reheat
- High discharge flow rate
- Compact Size
- Low heat losses, ERP A+
- No Pressure & Temperature safety valve
- No risk of explosion
- No discharge pipework
- Flexible Siting, lower cost and easy install
- No need to comply with G3 regs*
- No official maintenance requirements

*UK regulation for unvented cylinders requiring mandatory yearly inspection

ErP A+

Compact - Low heat loss

Sunamp

-71% in volume

Equal energy stored

Albin Trotter ATI E-305L

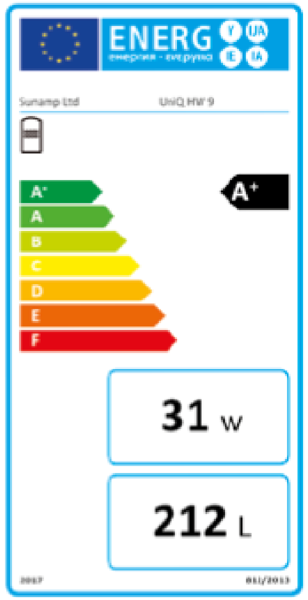
→ ½ →

½ in both height and depth

→ ½ →

UniQ eHW 12

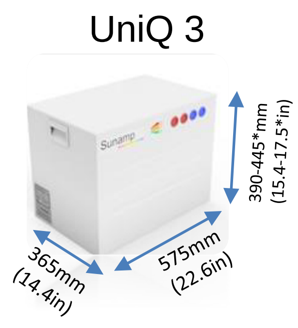
Equiv Cylinder	Daily heat loss	Annual
Installed base (10 years old)	2.5 to 3.5 kWh	1,095 kWh
Brand new, top quality	1.3 kWh	475 kWh
Sunamp UniQ HW 9	0.74 kWh	270 kWh

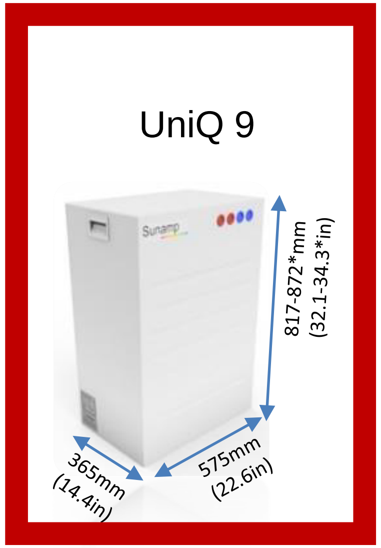


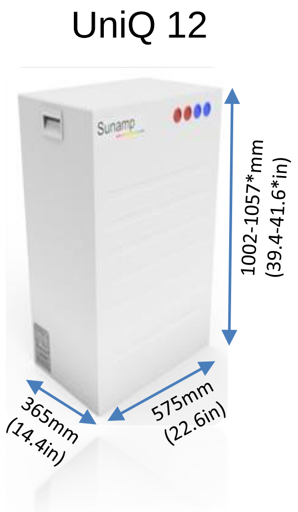
UniQ® Product Line

Sunamp

Most commonly sold size.
Replaces 210L water tank







Key benefit:

- Highest efficiency on the market, nearest competitor offers water tank with B rating
- Space saving (70%)
- Price similar to water storage

ErP A+

*height for models including stand-by electric heaters

Model Example	Measured kWh	Equivalent cylinder (L)	Heat Loss (kWh/24h)	Comments	ErP Rating
UniQ HW 3	3.5	70	0.449		A+
UniQ Heat 6	7	140	0.649	Stackable two high for larger storage	A+
UniQ HW 9	10.5	210	0.738		A+
UniQ Dual 12	14	280	0.809		A+
UniQ Heat 80	90	1800	2.2 (provisional)	Palletised, 1.5 Tonnes	No / Non ErP

Published Worldwide PCT Applications:
WO 2009/138771, WO 2011/058383, WO 2014/202974,
WO 2014/195691, WO 2014/191778, WO 2015/025175, WO 2017/221025

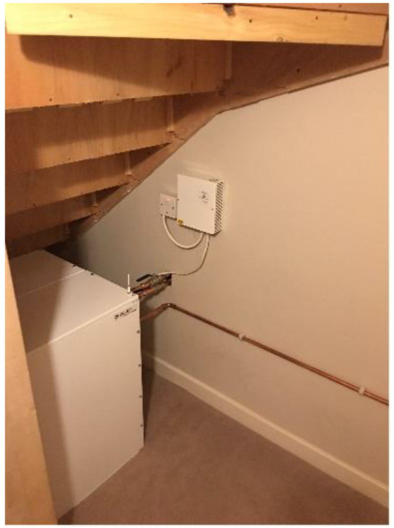
Thousands of Installations of Products Completed

Small district heating with Heat Battery

150 electric hot water tanks replaced by Heat Battery

Village Hall with PV, 2x heat pumps and PV

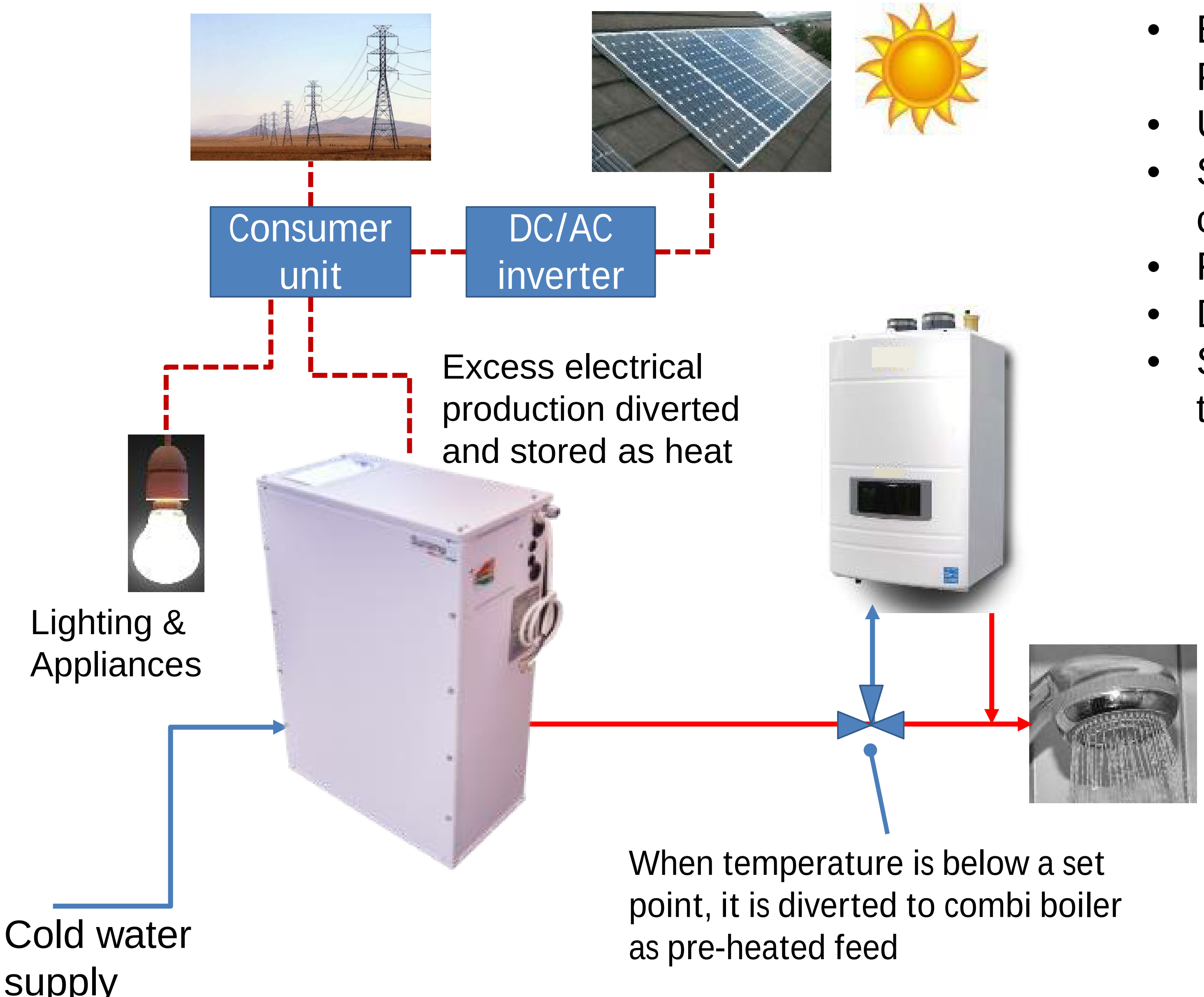
In a prestige Passivhaus project as seen on [Grand Designs]



Our customers innovating new siting locations

Hot Water with solar PV and Combis (>400 home trial)

Sunamp



- Enhanced behind-the-meter utilisation of on-site PV.
- Unique link between PV and combi boiler
- Side-steps feed-in tariff or net-metering complexities.
- Flexible: Can also be a primary hot water supply
- Displaces fossil-fuels (gas, oil, propane, LPG)
- Subsequently tested in >400 homes in EastHeat trial

Early adopter testing at Colin Pulham's house!

Installation solar PV and Combis

Sunamp

Solar PV, combi boilers and Sunamp Storage

- Electricity consumption reduced due to PV on roof   £101 SAVED
- Gas consumption reduced as a result of SunampPV   £74 SAVED

Customers – Happy experience

The Lynne Family

“Our hot water is plentiful, comes out of the taps quickly and is an excellent temperature”

Alec & Joan

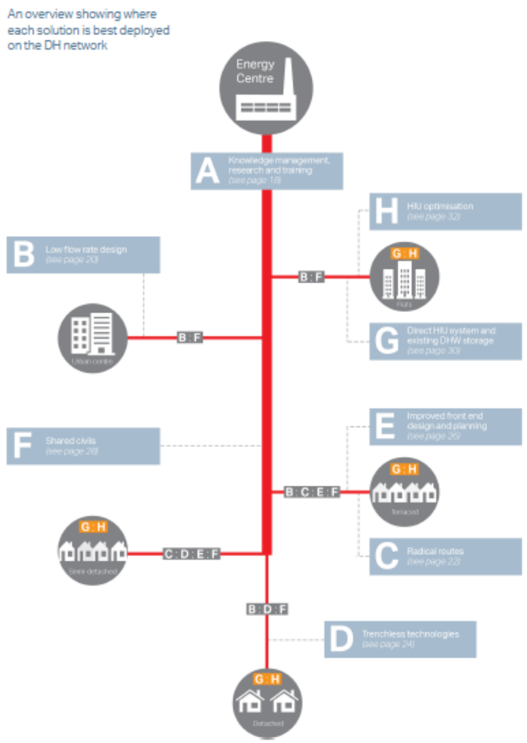
“In comparison to the old system, the new system performs to a much higher standard, providing a larger quantity of hot water for a much cheaper price.”

John and Jayne

“ It gets a bit to getting used to, switching on the hot tap normally you would hear the sound of the gas boiler that doesn’t happen any more”

District heating - Hot water peak load shaving

Sunamp



Reducing the capital cost of district heating network infrastructure, AECOM & ETI 2017

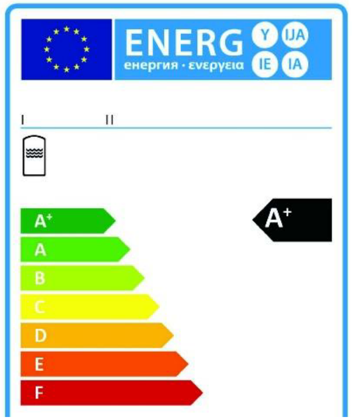
Network benefits

- Distributed storage to reduce peak loads
- Distributed storage to reduce pumping
- Improved operational running of the heat generator whether gas CHP or heat pump
- Reduced capital expenditure because you have reduced your peak load i.e. the pipes are smaller
- Reduce on-going O&M costs less wear and tear on pumps
- Elimination of a separate Heat Interface Unit our batteries operate as the interface unit
- Elimination of legionaries as the batteries are heated to over 60ºC and have no volume hot water storage
- Mains pressure for showers without complex pressure release configurations and pipework
- Small to fit into modern apartments
- Quick to install and easy to handle
- Can be wired to electricity to provide Demand Side Response heat as a service solution

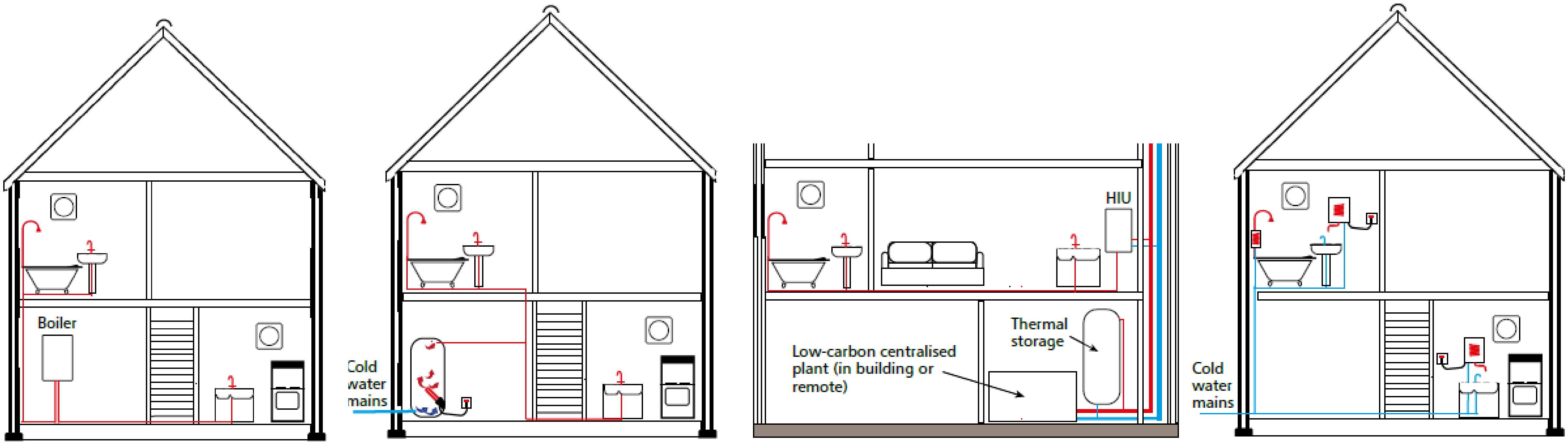
Summary Highlights

Sunamp

▪Sunamp **Thermal Batteries** are the world's most energy efficient Thermal Stores



- Disruptive to hot water tanks (~43m of 107m water heaters sold/year globally, ~$50Bn market)
- Performance superiority (compactness, energy density, efficiency, flow rate, power, reliability, safety, weight)
- Cost parity today versus hot water; significant cost advantage by end 2019
- Complementary to HVAC equipment, electric batteries, renewable energy & intermittent grids
- Unique applications in high temperature, cooling and automotive



Questions and Debate