The Electrification of Heat & Load Management

CIBSE HVAC Group

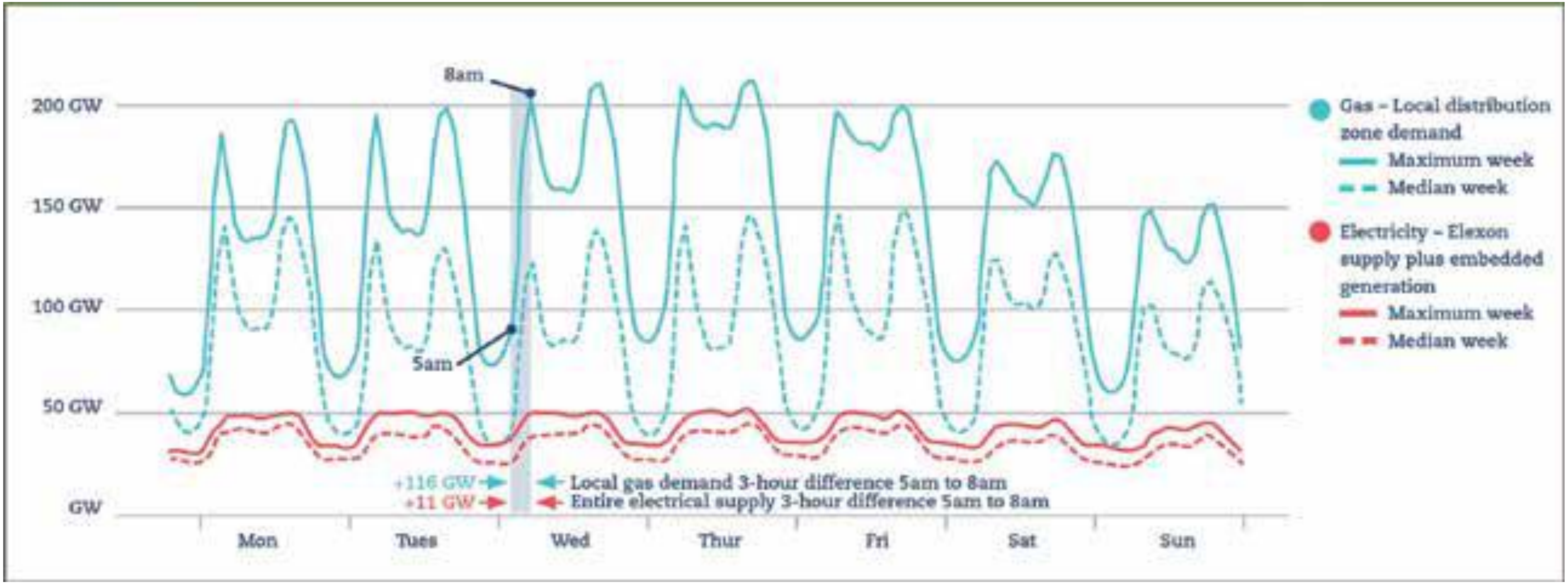
Application of Phase Change Materials

Contents

TM 67 - the importance of thermal storage

- The UK peak heat demand (on the gas grid) is between three and four times the peak winter electricity demand
- Even with high heat pump coefficients of performance (CoPs) this still represents a very significant shift in order to meet future thermal demand requirements through electrification.
- Demand reduction and energy efficiency will have a crucial part to play for the decarbonisation of electricity, heat and transport, in order to reduce the scale of investment required in electricity networks and generation capacity.
- The costs of electrical network upgrades will ultimately be born both directly and indirectly by end users, and buildings (and EVs) will need to play a much more active role in balancing the electrical grid.

Cont…..



8am
5am
200 GW
150 GW
100 GW
50 GW
GW
Gas – Local distribution zone demand
Maximum week
Median week
Electricity – Elexon supply plus embedded generation
Maximum week
Median week
+116 GW
+11 GW
Local gas demand 3-hour difference 5am to 8am
Entire electrical supply 3-hour difference 5am to 8am
Mon
Tues
Wed
Thur
Fri
Sat
Sun

Using thermal storage to facilitate transition

- Reduced export of renewable energy generation
  - Reduces demand on the grid
  - Reduces CO_2 emissions
  - Reduces running costs

- Decouple the electrical demand from the heating/cooling and hot water demand
  - Enables load shifting and the reduction in peak demands –
    - reduces demand on the grid
    - Reduces central plant size
  - Avoids peak tariffs and reduces running costs

SUNAMP

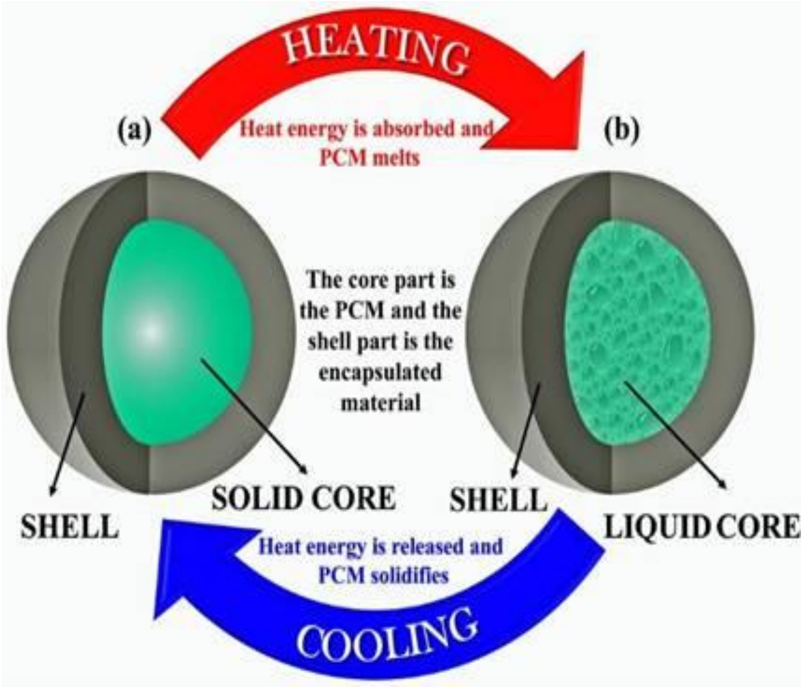
Phase Change Materials

SUSTAINED WITH PLENTIGRADE
A SUNAMP THERMAL TECHNOLOGY

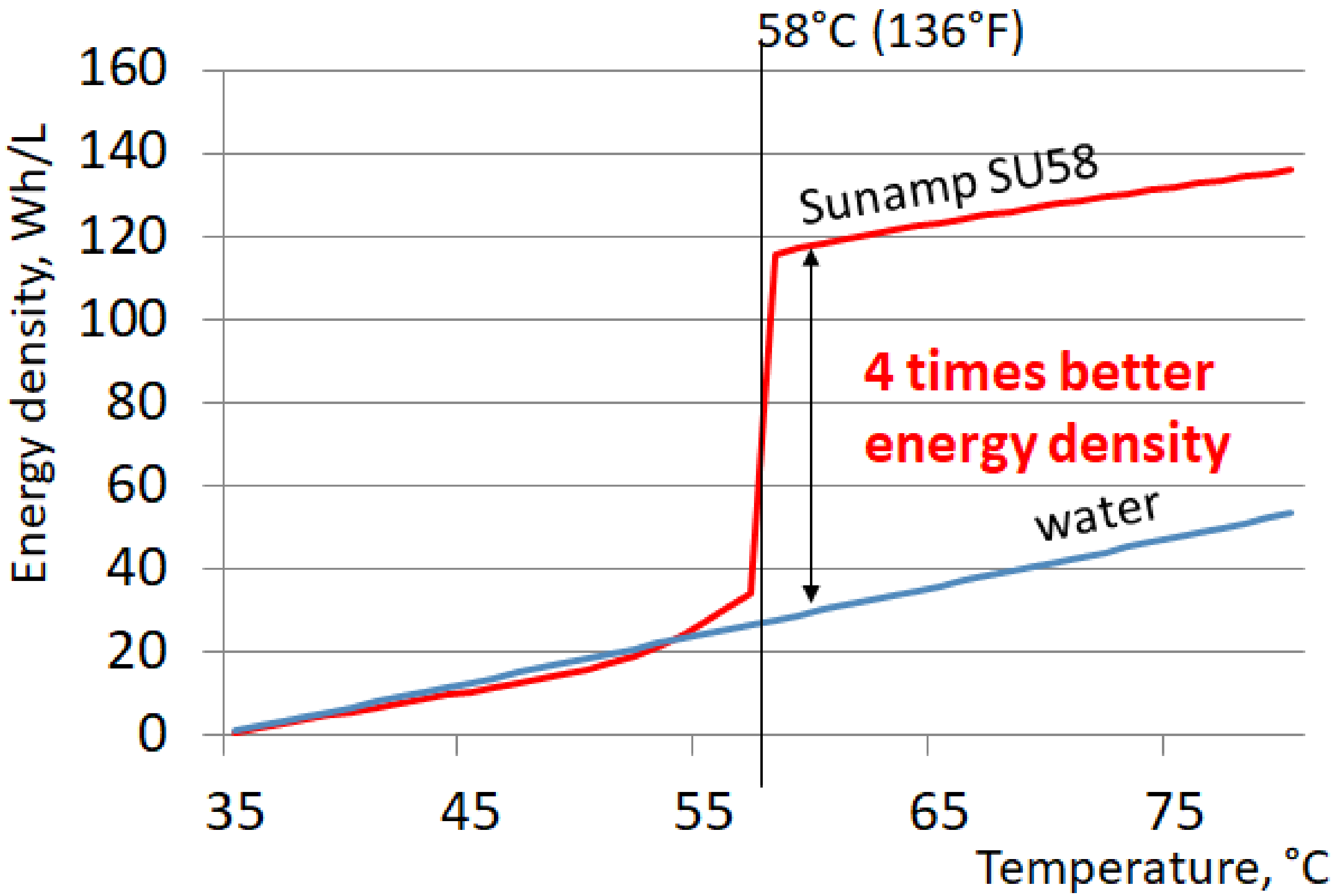
Using Phase Change Materials for thermal storage

- The successful application of PCMs comes down to a very simple goal: controlling how a material melts and re-solidifies, so you can use this material as heat storage.

- Utilizing latent heat storage (PCM’s) over sensible heat storage (hot water) enables circa 4 times more energy absorption, which significantly reduces the space requirements.



Using Phase Change Materials for thermal storage



Challenges of existing PCMs:

Poor cycle stability

Failure to release heat when wanted

Slow heat release

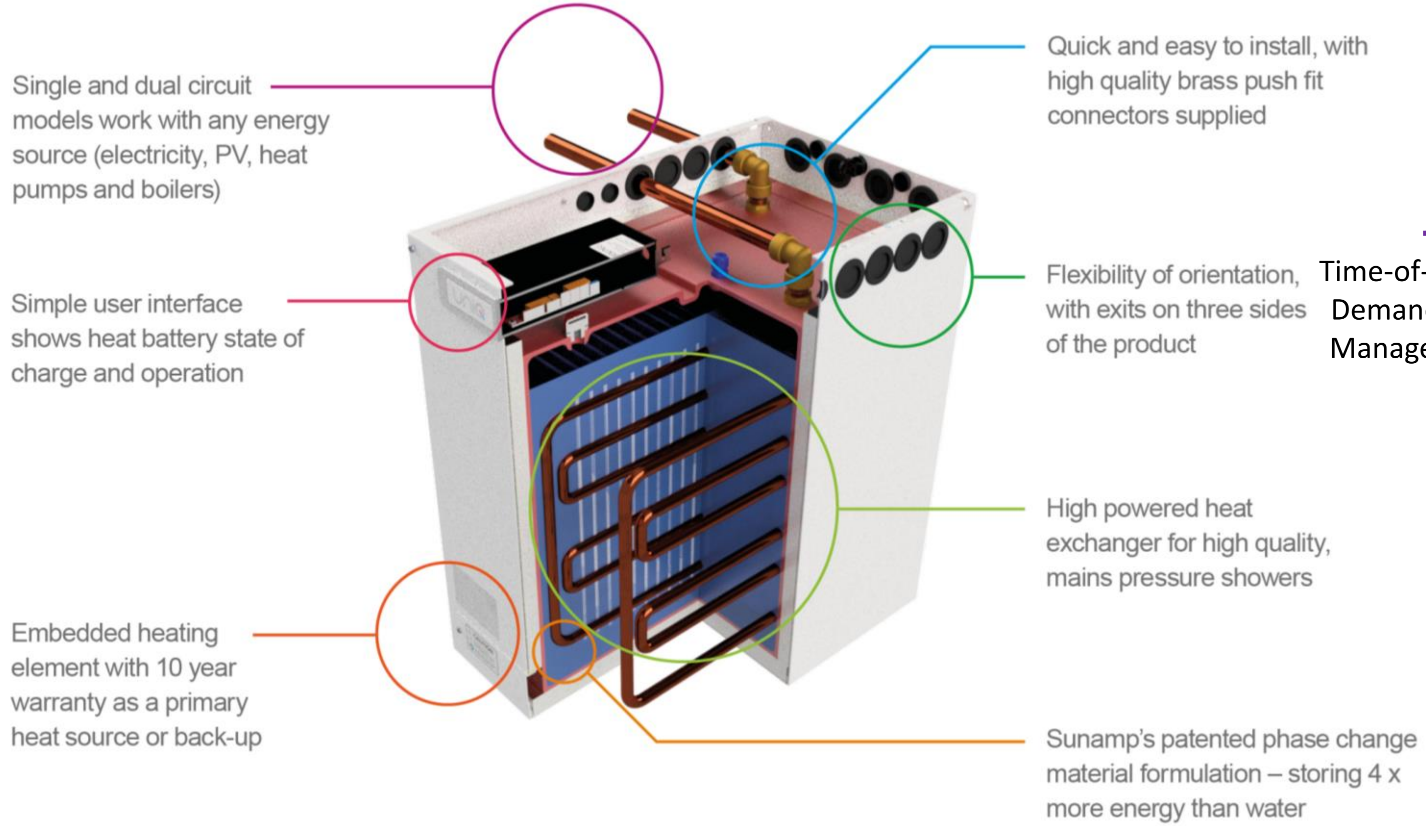
Flammability

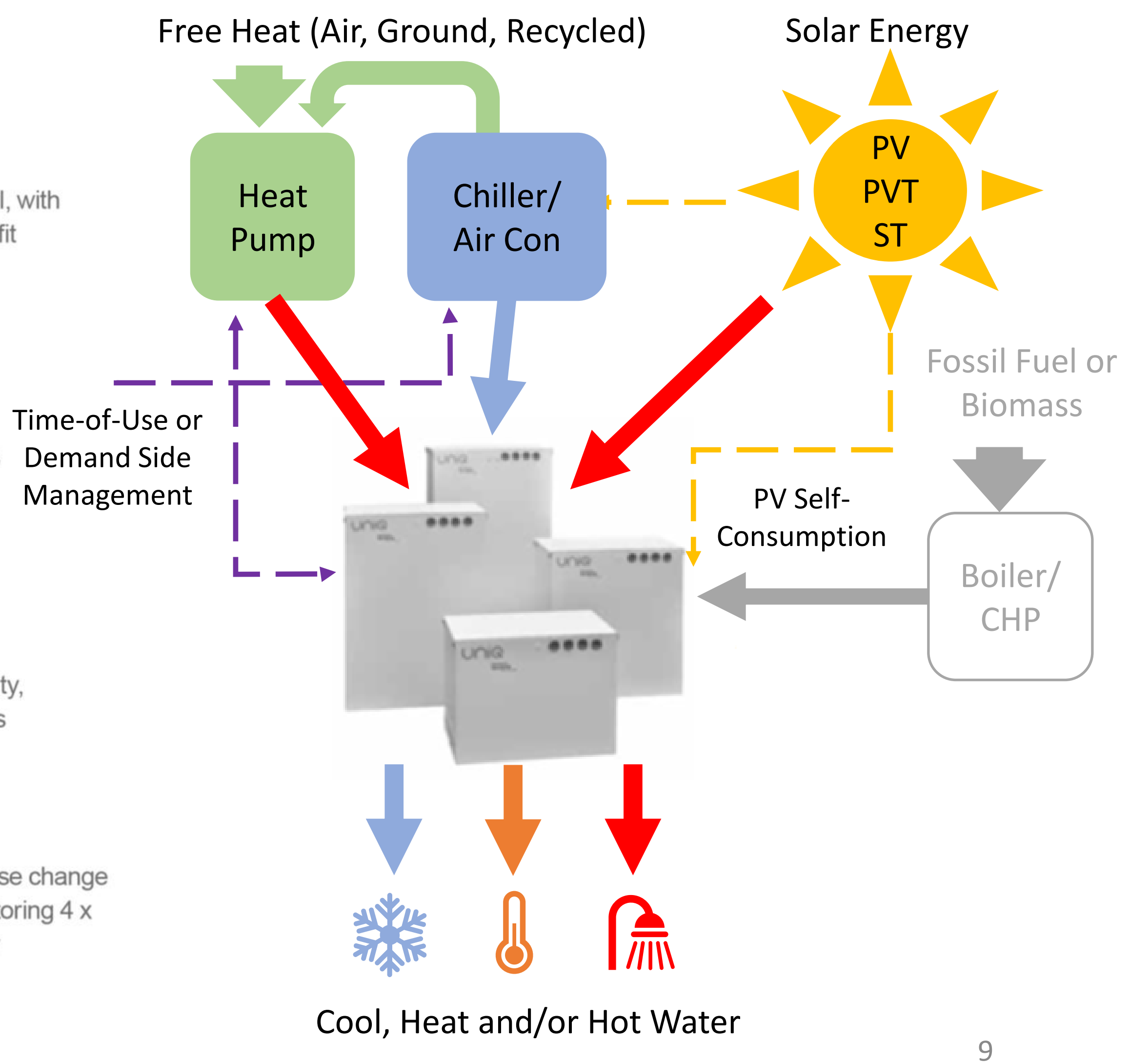
Toxicity

Unsustainable sources like palm oil

High cost

Compatible with almost any heating apparatus, HVAC system & renewable





Compact Storage Options

Cost-Effective
Comparable price to hot water tanks
Lower total cost of ownership

Modular
Cuboid for optimum space occupation when multiple units are used in the same system, unlike cylinders.

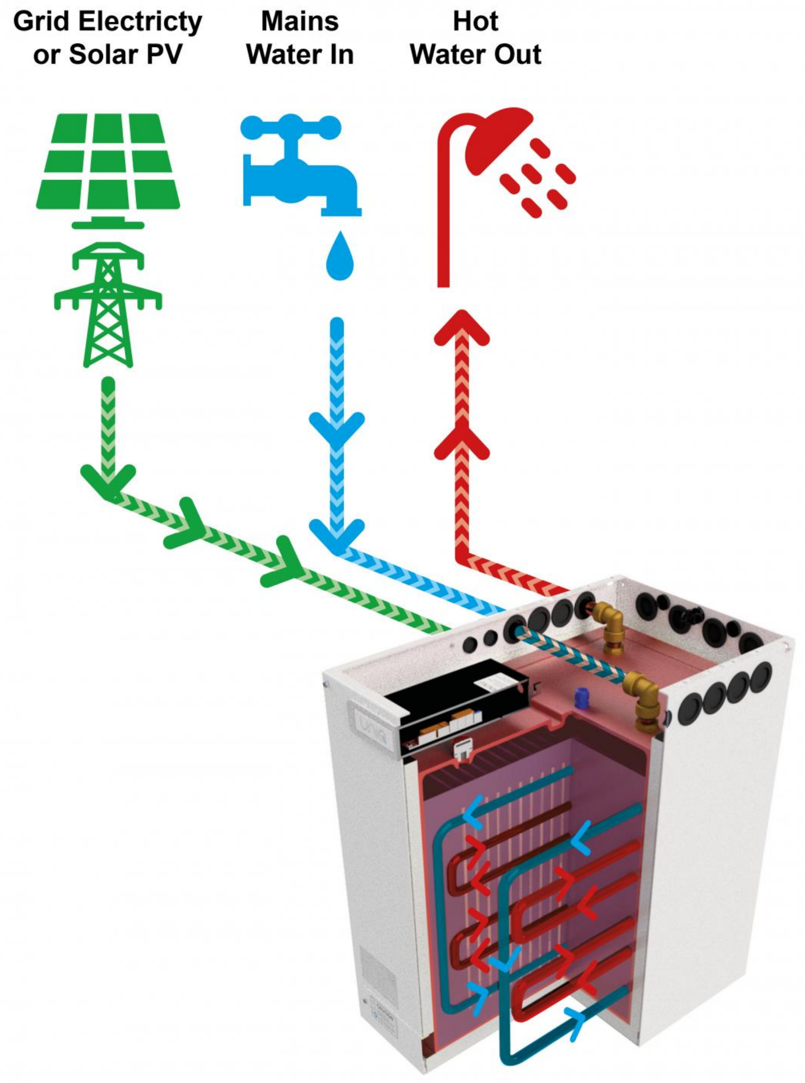
Applications

Direct Electric

Charge using grid electricity and/or Solar PV with an optional programmable timer to maximise off peak/variable tariffs.

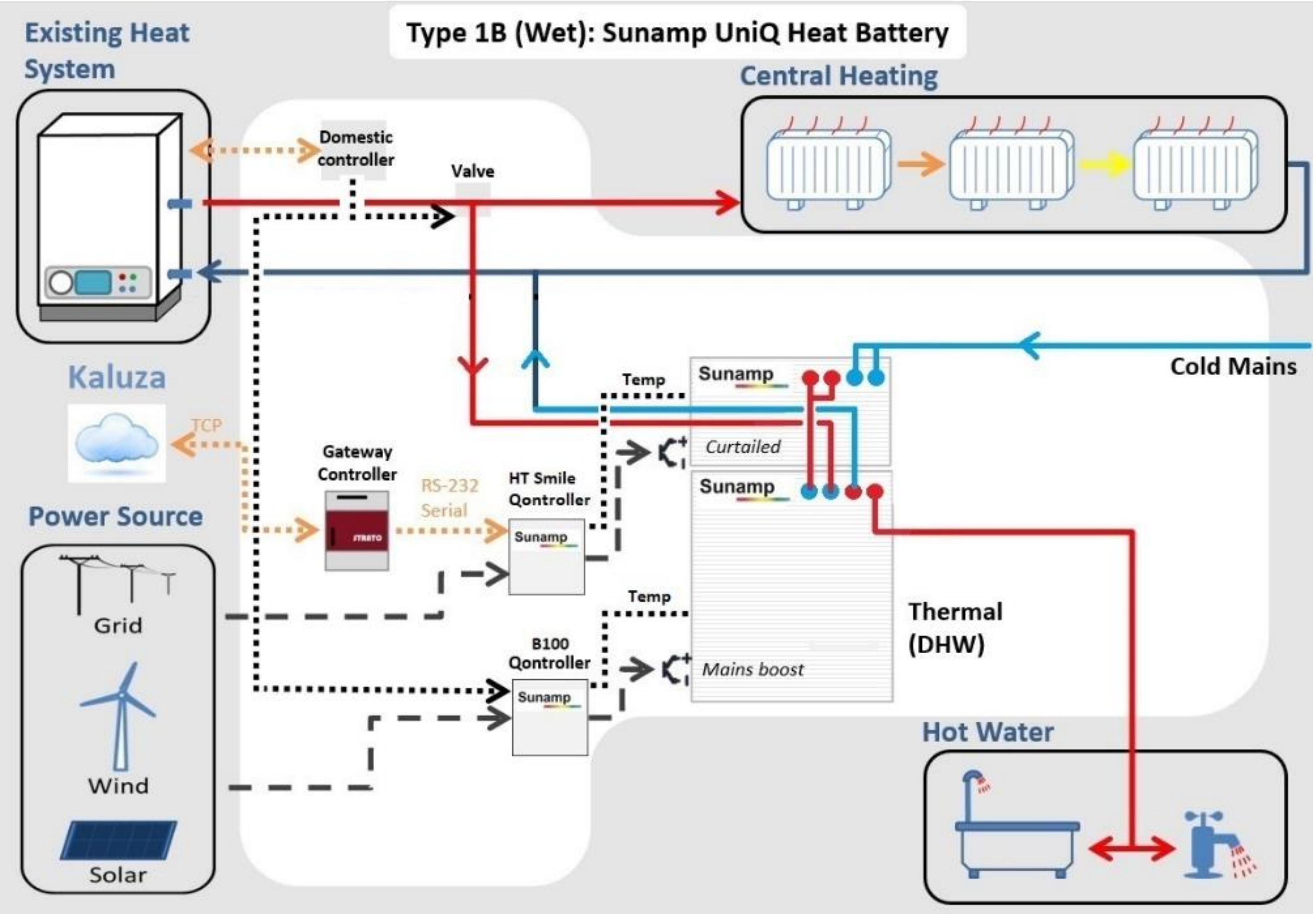
Key benefits:

- Load shifting
- Off peak tariffs
- Increased use of renewable energy generation
- Reduced running costs



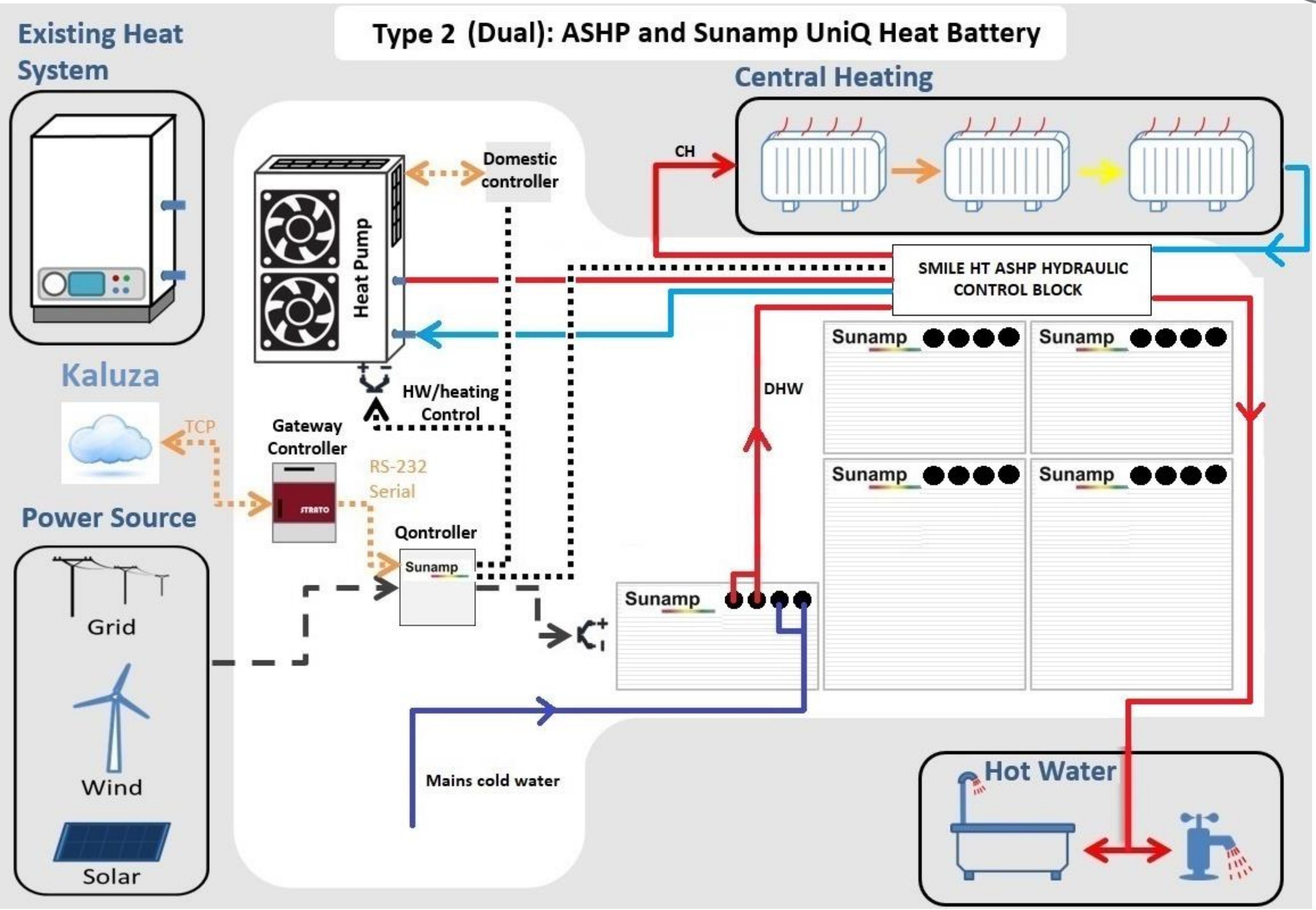
Type 1

Two or three Sunamp PCM Heat Batteries either operating independently or in conjunction with a previously existing boiler or heat pump.



Type 2

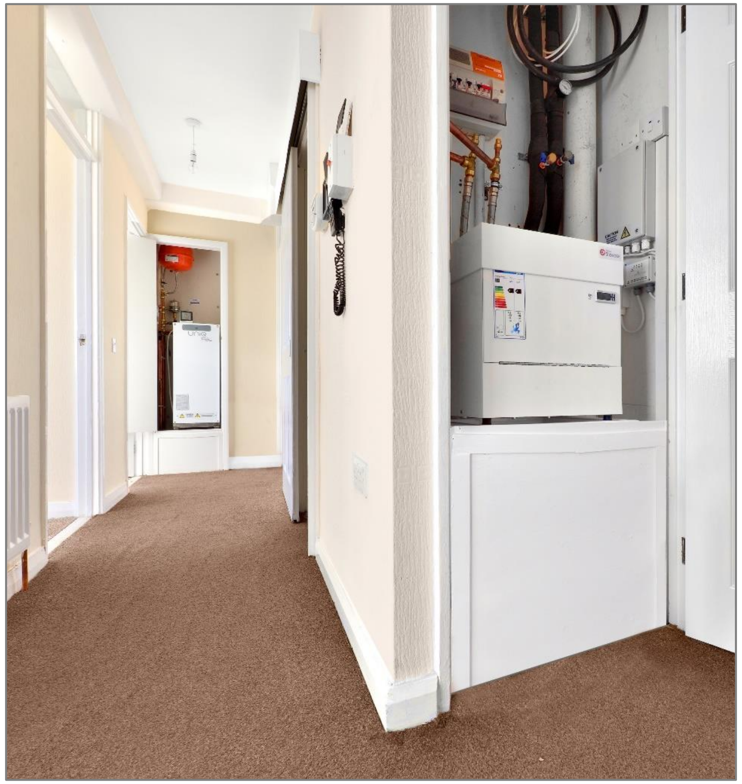
Five Sunamp PCM Heat Batteries along with an air to water heat pump. This provided storage for the hot water and central heating



Project Re-Heat

- Large-scale technical trial of PCM storage in conjunction with smart control and heat pumps investigating the capability to:
  - Reduce peak demand on LV networks and therefore defer or avoid conventional reinforcement
  - Time-shift heat demand to better match available wind generation and therefore reduce constraint payments
- 150 ASHPs in domestic homes across three local authority areas. These will be connected to thermal storage units developed by Sunamp, enabling customers to be flexible around their energy demand for heating.
- Planning and analysis tools 'DSO Toolkit' to assess the impact of installation and operation of electric heating technologies on the electricity networks, and enable design solutions using thermal storage with smart control to be evaluated.

GSHP - Core 364 Sunderland



No decanting

Fire-risk greatly reduced

Gas combis eliminated

Landlord savings -£1.65m

Tenant savings -£230/yr/apt

CO_2 emissions -70%

Trending to zero carbon as grid decarbonises

A revolutionary solution – already going into thousands of homes

Sunderland, Leeds, Newcastle, Birmingham, London, …

Overview of District Heating Networks Generations

District Heating - Generation	DHN Heat Transport media	DHN Flow temperature	DHN Return temperatures	Building heating system design temperatures
1st Generation (1GDH)	Steam	250 – 300 °C	50 – 60 °C	Very old – Very few systems in use
2nd Generation (2GDH)	High pressure and high temperature water	> 100 °C Sweden, Norway: 120°C Germany: 130°C Eastern Europe: 120 - 150°C	50 – 60 °C	Heating (old): 80 – 60 °C Heating (Current): 60 – 40 °C HW: 55 - 65°C
3rd Generation (3GDH)	Pressurised hot water	< 100 °C Typical range: 75 – 85°C	40 – 50 °C	Heating: 60 – 40°C Hot water: 50 - 65°C
4th Generation (4GDH) • *Top up heat input at point of use is out of scope*	Pressurised hot water	< 60 °C a) 50 – 55 °C b) 60 – 65 °C	a) 25 – 30 °C b) 40 °C	a) Heating: 45 – 30 °C b) Heating: 55 – 35 °C Hot water: 40 – 50°C
5th Generation (5GDH) • *The DHN operates close to the ground temperatures and therefore lower distribution losses* • *Local heat pumps and chillers in each building modulate to provide required levels of heating and cooling* • *Easier to expand network or change use of buildings due to decentralised heat production* • *Enables sharing of excess thermal energy between buildings therefore bidirectional flow in network can provide simultaneous heating and cooling.*	Pressurised water	a) Warm: 16 – 40°C *b) Cold: 6 – 30 °C*	a) Warm: 16 – 40°C *b) Cold: 6 – 30 °C*	Heating: 30 – 40 °C Cooling: 6 – 15 °C Hot water: 40 – 50 °C

Notes and references

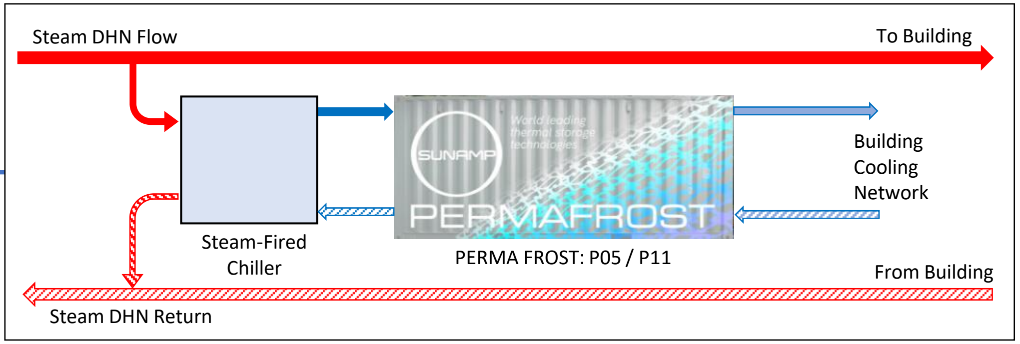
1) Guidelines for Low-Temperature District Heating: "EUDP 2010-11: Full scale Demonstration of Low-Temperature District Heating in Existing Buildings

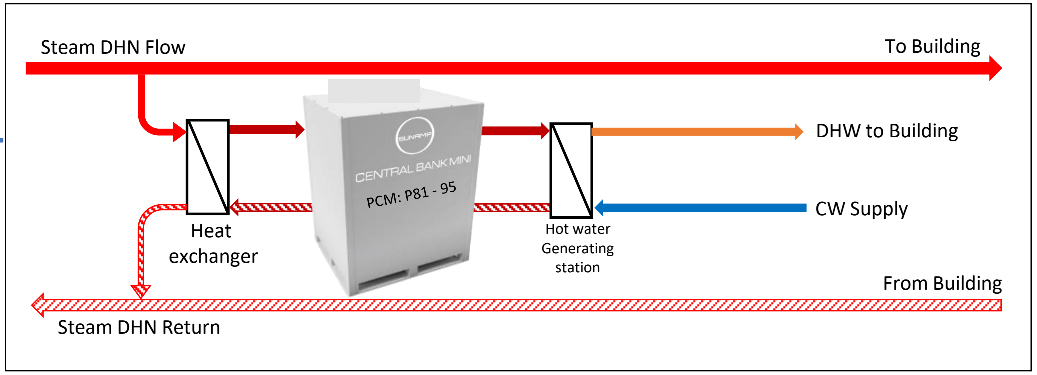
2) A novel Method for Designing Fifth-Generation District Heating and Cooling Systems, Marwan Abugabbara, James Lindhe, Lund University, Sweden 9Cold Climate HVAC & Energy 2021

3) District Energy 101, Vladimir Mikler, Integral Group

Overview of District Heating Networks type 1GDH: Sunamp Technology Applications

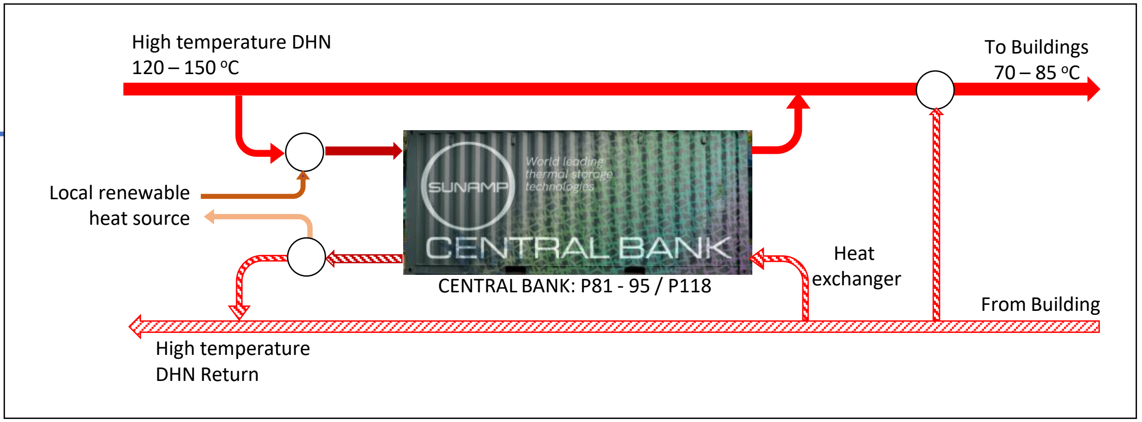
Generation (1GDH): Steam DHN 250 – 300 ºC	
DHN Sector	**Sunamp Technology Application**
DHN Main Plant	None – Outdated and no new systems planned
DHN – Building & Subnetwork node level	• High temperature heat buffering for heating from steam with heat exchanger interface
	• Chilled water buffering for cooling by means of a steam powered chiller
	• Building centralised hot water production
Apartment / Office level in the building	• Very unlikely because of building heating network design

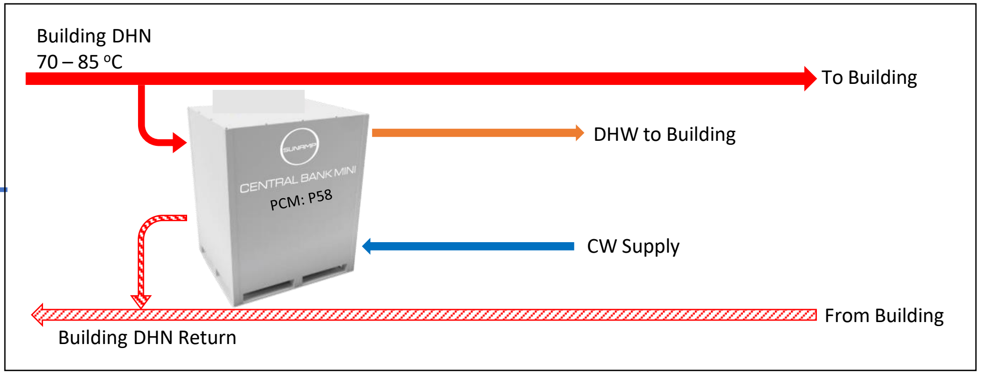


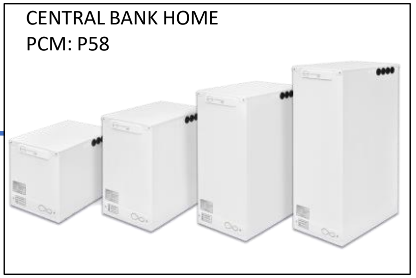


Overview of District Heating Networks type 2GDH

2nd Generation (2GDH): High pressure & temperature hot water DHN 120 – 150 °C	
DHN Sector	Sunamp Technology Application
DHN Main Plant	None – Outdated (Replaced by 3GDH)
DHN – Main Substations	• Buffering heat for load balancing • Buffering heat from local renewable heat sources (e.g. solar)
Building Level	• Central hot water generation for the building • Buffering heat from local renewable heat sources (e.g. solar)
Apartment / Office level in the building	• Replacement for traditional based HIU

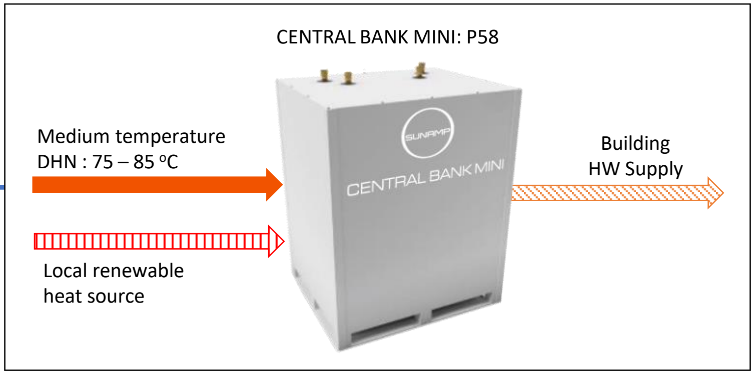


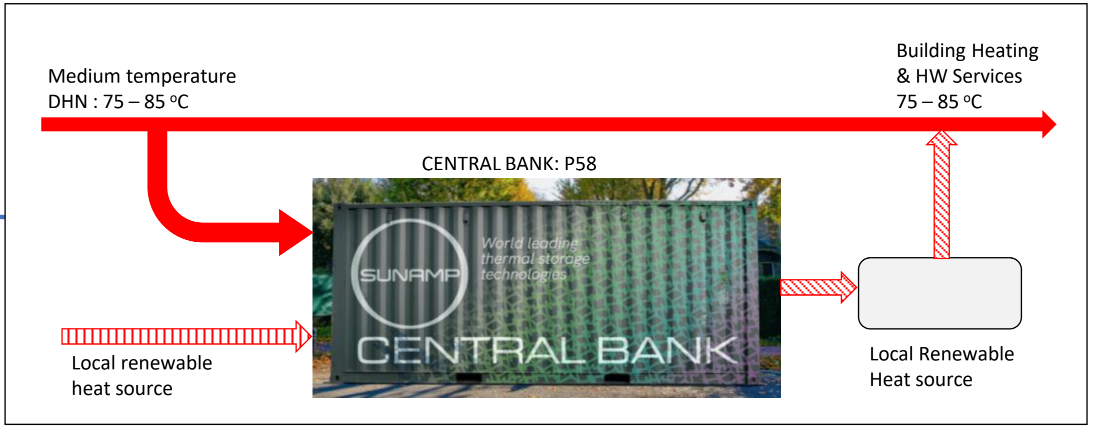




Overview of District Heating Networks type 3GDH: Sunamp Technology Applications

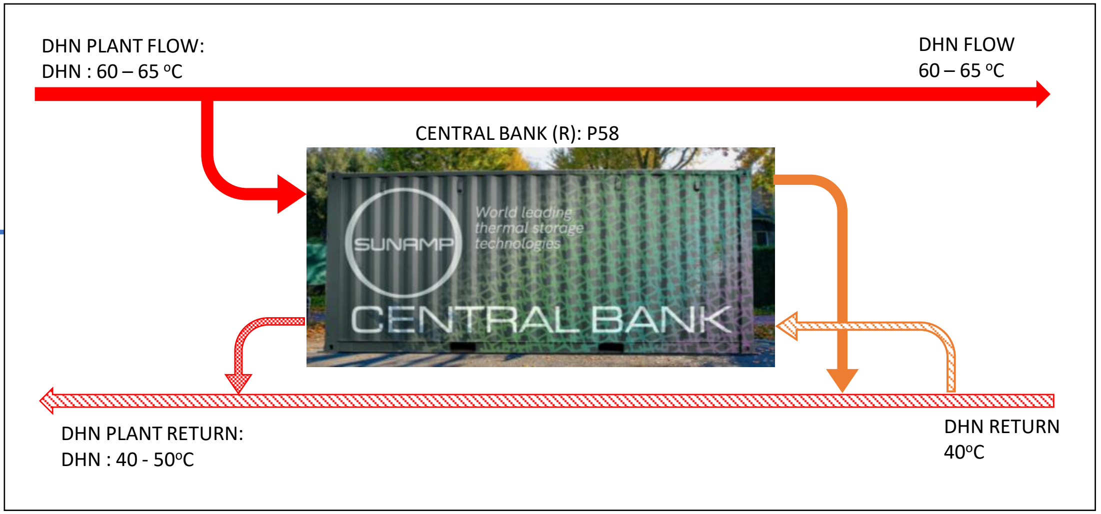
3rd Generation (3GDH):	Pressurised hot water DHN 75 – 85 ºC
DHN Sector	Sunamp Technology Application
DHN Main Plant	Current most common design
Building Level	• Central hot water generation for the building • Buffering heat from local renewable heat sources (e.g. solar)
Apartment / Office level in the building	• Replacement for traditional based HIU for Heating & HW • Local HIU for HW heating only

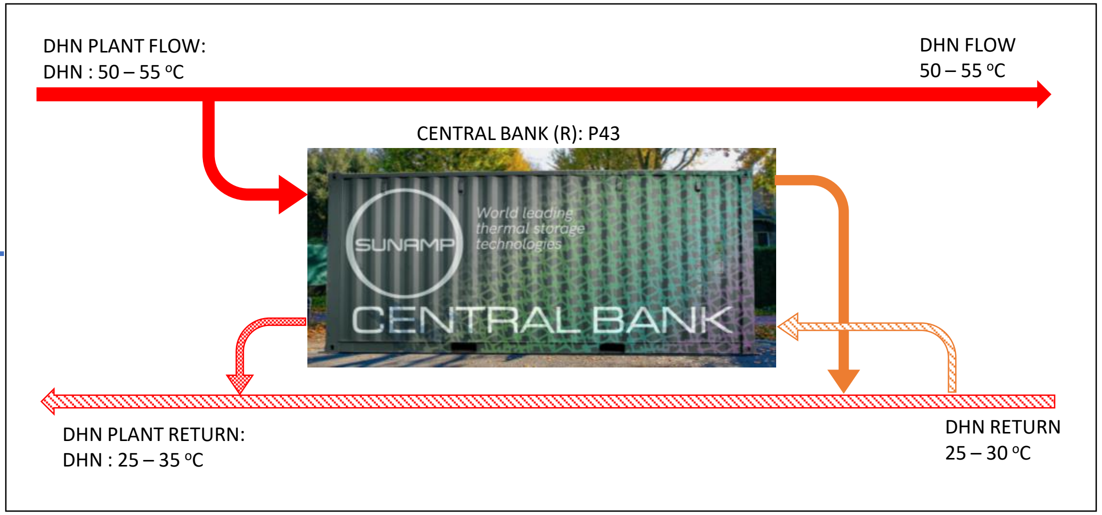




Overview of District Heating Networks type 4GDH: Sunamp Technology Applications

4th Generation (4GDH):	Pressurised hot water DHN 50 – 55 ºC / 60 – 65 ºC
DHN Sector	**Sunamp Technology Application**
DHN Main Plant	Current most common design for mew plants
Building Level	• Unlikely due to temperature gradient
Apartment / Office level in the building	• Replacement for traditional based HIU for Heating & HW • Local HIU for HW heating only





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Thank you for listening

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